The Government of the Republic of Indonesia

STATE OF CONSERVATION STATUS OF THE WORLD HERITAGE IN INDONESIA

World Heritage Property

Komodo National Park (N 609)

January 2022

STATE PARTY REPORT 2021: STATE OF CONSERVATION OF WORLD HERITAGE PROPERTY (INDONESIA)
KOMODO NATIONAL PARK (N 605)

In accordance with the recommendation of the 44th Session of the World Heritage Committee in Fuzhou – China, 16 – 31 July 2021 No. **44 COM 7B.93:** Paragraph 9, the State Party wishes to report on the State of Conservation of the Komodo National Park.

Executive Summary

In response to the recommendation of the 44th Session of the World Heritage Committee in Fuzhou – China, 16 – 31 July 2021, particularly the recommendation related to the World Heritage Properties in Indonesia on Agenda item 7B.93: Komodo National Park, the Government of Indonesia, together with relevant stakeholders, has taken measures on the protection and preservation of Komodo National Park.

The Government of Indonesia is committed to preserving the Outstanding Universal Values of Komodo National Park through various programmes and policies as laid out in the management plan of the park as a national conservation area and a UNESCO World Natural Heritage Site. This management plan operates under the following five conservation principles: (1) regulation-based; (2) science-based; (3) evidence-based; (4) experience-based; and (5) precautionary principle-based.

Our commitment to follow up the recommendation of the World Heritage Committee on Komodo National Park is reflected in the following measures:

1. Finalizing the revision of the Environmental Impact Assessment (EIA) document for the tourism infrastructure projects on Rinca Island in line with the IUCN World Heritage Advice Note on Environmental Assessment;
2. Developing the Integrated Tourism Master Plan for Komodo National Park and Labuan Bajo in Flores Island as a guideline to develop a sustainable future of tourism in Labuan Bajo Flores area;
3. Ensuring the state of conservation of Komodo dragons and other associated wildlife as evidenced in the dynamic trend of Komodo dragon's population in the past 6 years.

The Government of Indonesia appreciates the committee's decision on Komodo as a part of World's Natural Heritage. However, due to security and technical reasons, more time allocation and further assistances are still required for the government to implement all programs in Komodo National Park.

Response to the Decision: 44 COM 7B.93

In response to the recommendation of the 44th Session of the World Heritage Committee in Fuzhou – China, 16 – 31 July 2021, particularly the recommendation related to the World Heritage Properties in Indonesia on Agenda item 7B.93: Komodo National Park, the State Party would like to inform the World Heritage Committee that the Government of Indonesia, together with relevant stakeholders, have taken constructive measures to protect and preserve Komodo National Park.

Decision: 44 COM 7B.93

The World Heritage Committee,

1. **Having examined** Document WHC/19/44.COM/7B,

2. **Recalling Decision** CONF 202 21B.11, adopted at its 26th session (Budapest, 2002)

3. **Takes note** that an Integrated Master Plan is being developed and **requests** the State Party to provide detailed information on how the Outstanding Universal Value (OUV) of the property will be safeguarded in the design of the Plan, and how plans to significantly increase tourism at the property reflect the stated intention to move away from mass tourism and can thus ensure the protection of the OUV;

   Response:

   The Integrated Tourism Master Plan (ITMP) for Komodo National Park and Labuan Bajo in Flores Island is currently being developed and the draft is expected to be finalized by July 2022. The document provides detailed guidelines for the development of tourism and property in Labuan Bajo Flores areas, covering 8 regencies. the ITMP is aiming to attain the target set out by the President of Indonesia to boost socio-economic development for the people in Flores Island by bringing in 500,000 foreign tourists and 1,500,000 domestic tourists to the island within the period of 4 years (2016 – 2019). The document also ensures that neither tourism nor development in Taman Nasional Komodo will have a negative impact on the OUV and all projects will be implemented sustainably.

   The ITMP for Komodo National Park and Labuan Bajo in Flores Island covers a robust tourism management plan. One the most highlighted is the tourism carrying capacity implementation. The ITMP ensures that the distribution of

tourists will not be concentrated in Labuan Bajo and Komodo National Park but will be distributed to more than 100 tourism sites in Flores's mainland, Lembata, Alor, and Bima. The tourism carrying capacity will be consistently applied and managed to protect the OUV of the property supported by integrated information technology. The idea is to shift from mass tourism and focus more on sustainable high-end tourism and improved infrastructures that boost the local economy and stimulate community development, which ultimately will support the long-term protection of the property. The Government of Indonesia will collaborate with IUCN experts to ensure that none of the actions proposed in the document will have a negative impact on the OUV of the property

As stipulated in the ITMP, the Indonesian Government has no intention to relocate the people of Komodo Village who live in the Komodo National Park. A Community Based Ecotourism program is currently being developed highlighting local community involvement and based on the traditions and culture of Komodo Island. The program empowers village communities inside the National Park to actively participate in conservation and tourism. Villages in the park will be empowered as part of social culture attractions and to be included in the park travel tour destinations, such as fisher villages, coastal culture performances, creative economy, etc. In addition, some tourism products made by locals have been introduced to attract visitors since 2021. Rearrangement of tourism experience has been delivered through improved interpretive tour and heritage museum to optimize education contents of the World Heritage Site.

Upon the finalization of ITMP, the Government of Indonesia is setting out a plan to conduct a strategic environmental assessment (SEA) to ensure that any development proposed within the ITMP will not have any negative impact on the OUV of the property.

The Komodo National Park has been closely and constructively involved throughout the process of developing the ITMP Labuan Bajo, particularly in formulating the development plan of tourism sites outside Komodo National Park's territory and limiting the number of tourist visits in the area.

In this regard, The Komodo National Park is fully committed to supporting the local government and other relevant institutions in developing tourism sites beyond the park's area to minimize the risk of mass tourism as indicated in the trend of tourist visits to Komodo National Park in the past 10 years (2010 – 2019).

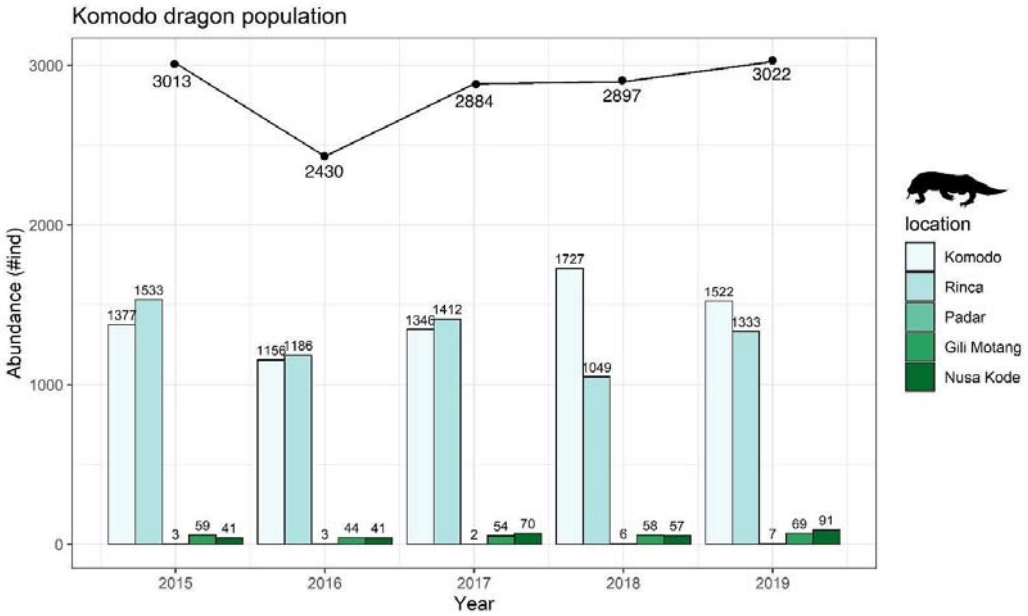
The Komodo National Park has implemented a tourism carrying capacity policy based on a scientific study conducted by the Ministry of Environment and

Forestry Republic of Indonesia in 2018. Operationally, it limits the number of visitors in at least four locations, namely: (1) Karang Makassar, (2) Batu Bolong, (3) Siaba Besar, dan (4) Mauwan. The document of Tourism Carrying Capacity of Komodo National Park (2018) is attached in **Annex 1.** The trend of tourists visits to Komodo National Park (2010 – 2019 Period) is attached in **Annex 2.** Since August 2021, an online registration platform has been developed to manage the tourism carrying capacity of 2 sites: Gili Lawa Resort and Padar Selatan Resort (https://registration.labuanbajoflores.id/)

4. **Notes with satisfaction** the research activities and long-term monitoring of the Komodo dragon, which show a stable population trend, and **urges** the State Party to continue regular population censuses and implement management measures in the context of proposed tourism increase;

Response:

The Government of Indonesia cq Komodo National Park is fully committed to ensuring the state of conservation of the Komodo dragons and other associated wildlife as evidenced by the dynamic trend of Komodo dragon population in the past 6 years. The Komodo National Park regularly monitors the population of Komodo dragons across the property since 2002 and has reinforced the monitoring activities with the support of the Komodo Survival Program (KSP) since 2007, using a mark-recapture method and camera trapping with site occupancy approaches. In addition, 1,217 Komodo dragons have been permanently tagged with Passive Integrated Transponder (PIT-tag) for population monitoring purposes, including to observe growth and survival rates. The population of the Komodo dragon has shown small fluctuations during the last five years but has remained stable with an abundance of around 3,000 individuals.



Around 0.5% of the total population of Komodo dragons in the property is interacting (passing through, resting, etc.) with the surroundings of Loh Buaya site (where the park infrastructure is being renovated and upgraded). According to the EIA result, none of the infrastructure renovation or development will negatively impact the Komodo dragon population, as it occurs in a small area (1.3 ha) that already contains buildings.

The Government of Indonesia cq Komodo National Park establishes 'Team Seven' in collaboration with the Komodo Survival Program to further ensures research activities and long-term monitoring of the Komodo dragon. In 2020 – 2021, a group of selected rangers was trained intensively on the science of dragons, population monitoring techniques, and human-wildlife conflict interventions. The trainees are expected to be a group of experts on komodo dragons to conduct improved activities scientifically and professionally.

The Komodo National Park plans to formulate a 5-yearly Research Roadmap that aims to identify the needs of multidiscipline studies to support the park's management and safeguarding plan of the OUV. Furthermore, the Komodo National Park also provides opportunities for internship and research programs in the Park for universities and other educational institutions, both national and international, who are interested to conduct research on Komodo dragons.

5. **Notes with concern** the different tourism infrastructure projects undertaken and planned in the property and, **also recalling** that it should be informed, via the World Heritage Centre, of any major restoration or new construction before making any decision that would be difficult to reverse, in accordance with Paragraph 172 of the Operational Guidelines, **also requests** the State Party to revise the Environmental Impact Assessment (EIA) for the tourism infrastructure projects on Rinca Island in line with the IUCN World Heritage Advice Note on Environmental Assessment, and to resubmit it to the World Heritage Centre for review by IUCN as a matter of urgency, in line with Paragraph 118bis of the Operational Guidelines, and to submit further information on other attributed tourism concessions in the property as well as its revised zoning plan;

Response:

The Government of Indonesia highlights that the tourism projects concerned are not new infrastructure developments in Loh Buaya (Rinca Island) of Komodo National Park, but a renovation project of the old park infrastructure in the Loh Buaya area.

The refurbishment of the old park infrastructure in Loh Buaya is considered critical, as based on the Park's assessment, the existing infrastructure would not sustainably support the growing number of visitors to Komodo National Park that has been increasing significantly based on the trend in the past 10 years (2010 – 2019). The highest number of tourists visits in 2019 was reaching 221,703. Furthermore, anecdotal evidence from the park rangers mentioned that Loh Buaya Resort in Rinca Island received almost 400-500 visitors daily, while the previous infrastructures capacity in the resort only ideally support to 150 visitors in a day.

Despite the growing number of tourists has resulted in a positive multiplier effect on the people that live within Komodo National Park and Labuan Bajo, it has also created concern about the infrastructure's durability and the surrounding environment. For this reason, the Komodo National Park has been implementing the tourism carrying capacity, which is aimed not only to cap and distribute the visitor numbers to Flores's area, but also to keep the park as a major attraction to visitors globally.

The tourism carrying capacity system is designed after obtaining constructive feedback from the tourism stakeholders, mainly from the Diving Operator Community Komodo (DOCK), the Indonesian Marine Tourism Association (GAHAWISRI) of Labuan Bajo, the Recreation Boat Network (JANGKAR), the Tourism Boat Association (ASKAWI), and the Association of the Indonesian Tours and Travel Agencies (ASITA) of West Manggarai. The Komodo National Park had initiated a trial of the tourism carrying capacity system in September 2019 on the most visited diving sites that consist of the Batu Bolong, the Karang Makassar, the Siaba Besar, and the Mauwan. The Komodo National Park had also arranged a monthly meeting with the stakeholders to evaluate the effectiveness of the system and to gain insights into whether the capacity required to be adjustable following the trend of the tourists in Labuan Bajo.

To better enhance the tourism carrying capacity, the Komodo National Park has also attempted to create an online booking system to better regulate the growing number of tourists and to further prevent the spread of COVID-19 amongst the tourists who will be visiting the park. The Park desires to enhance the carrying capacity implementation by setting daily quotas on the park's terrestrial destinations: the Loh Liang Resort, the Padar Selatan Resort, and the Gili Lawa Resort, in addition to the diving sites that were already being regulated. The online booking system is created jointly with the Labuan Bajo Flores Tourism Authority in 2020 and both stakeholders keep advancing the system following the condition and the local urgencies in Labuan Bajo.

The system creation had also gained inputs from the local stakeholders continuously. Komodo National Park believes that these efforts will align with the park's management plan and will reinforce the tourist management system currently operating in the park sustainably. Both the tourism carrying capacity and the online booking system will support the urgency of the Komodo National Park to greatly distribute the number of tourists to the nearby tourism destinations in Labuan Bajo and the greater Flores Island.

Thus, infrastructures improvement becomes pivotal to allow tourists visiting the park sustainably and to safeguard the OUV in the property. A recent study conducted by the Komodo National Park concludes that the new infrastructures would sustainably support approximately 1,000 tourists in a day. In addition, to preserve the wildlife in Loh Buaya Resort, tourists were no longer allowed to directly interact with the wildlife in the newly improved buildings/facilities.

The Government of Indonesia has finalized the revision of the EIA document for the project in a collaboration with world heritage and environmental experts, from universities and international NGOs (the Komodo Survival Program Foundation and WCS Indonesia Program), as well as governmental agencies, including the Komodo National Park, Ministry of Public Works and Public Housing.

A summary of the impacts identified by the team is shown in the table below:

Impact Criteria	No impact assessed on OUV	Negligible impact assessed on OUV	Minor impact assessed on OUV	Moderate impact assessed on OUV	Major impact assessed on OUV
Values described under criterion (vii)/OUV					
1. Mangrove Ecosystem					
2. See grass & Coral Reef					
3. White sandy beaches					
4. Deciduous Monsoon and Quasy-mountane forest ecosystem					
5. Savanna ecosystem					
Values described under criterion (x)/OUV					

Impact Criteria	No impact assessed on OUV	Negligible impact assessed on OUV	Minor impact assessed on OUV	Moderate impact assessed on OUV	Major impact assessed on OUV
1. Komodo dragons					
(a) Population					
(b) Behavior					
(c) Reproductive activities					
(d) Minimal of thermal resources					
2. Terrestrial mammals					
3. Avifauna					
4. Marine fauna & Flora : Dolphins & Sea turtles					
Non OUV					
Impact Criteria on Non OUV	No impact assessed	Negligible impact assessed	Minor impact assessed	Moderate impact assessed	Major impact assessed
5. Herpetofauna					
6. Social Impact : *Increasing Multiplier Effect on Local Economy*				POSITIVE IMPACT	

The complete document of EIA REVISION KOMODO NATIONAL PARK: Tourism Infrastructure Development in Loh Buaya – Rinca Island and its Environmental Management Plan is attached in **Annex 3a and 3b**.

6. **Also urges** the State Party to halt all tourism infrastructure projects in and around the property that have the potential to impact on its OUV until the revised EIA is submitted and reviewed by IUCN;

Response:

The Government of Indonesia is committed to fulfilling the spirit and recommendation of the World Heritage Convention. As a state party, Indonesia has introduced relevant policies, regulations and programs, and has implemented them in accordance with the convention to ensure that our heritage is conserved.

Regarding the infrastructure projects surrounding the property of Loh Buaya, efforts have been in place to ensure that those projects will not infringe or disturb any natural area within the national park, as well as to ensure they will not extend beyond the boundaries of the existing infrastructure. Additionally, the Government of Indonesia has been continuously improving and renovating the site to mitigate any negative impact on the OUV due to the increasing numbers of tourists (over 220,000 visits in 2019). These efforts have resulted in an improvement of infrastructure in Loh Buaya (including the construction of elevated decks) and will prevent any possible interaction between visitors and Komodo dragons in the future.

7. **Further requests** the State Party to invite a joint World Heritage Centre/IUCN Reactive Monitoring mission to the property to assess the impact of ongoing development on the OUV of the property and review its state of conservation;

Response:

The Government of Indonesia is welcome to invite IUCN Reactive Monitoring Mission to visit the property of Komodo National Park to examine the state of conservation of the property.

Considering the various conditions, our proposed time for the visit is in March 2022. Further, a communication channel between the Government of Indonesia and the IUCN Reactive Monitoring Mission and UNESCO Office in Jakarta has been set out to discuss the technical arrangement of the visits. The Government of Indonesia stands ready and looking forward to working closely with the WHC Secretariat.

8. **Also notes with concern** the lack of operational equipment and technical capacity to manage the property's marine area, and requests furthermore the State Party to urgently strengthen marine management and law enforcement capacities in the property, with a specific emphasis on controlling illegal fishing activities and boat anchoring, and to allocate a sufficient budget for marine research, monitoring, education, and compliance with marine regulations;

Response:

A. The Protection of the Property

The Government of Indonesia is fully committed to strengthening the protection and surveillance efforts continuously and consistently with the aid of the interprofessional collaboration amongst the law enforcement agencies, such as: the West Manggarai Policemen, the Indonesian National Marines, and the Directorate General of Law Enforcement Ministry of Environment and Forestry Republic of Indonesia in the form of joint patrols ever year. In addition, the Komodo National Park also collaborates with marine tourism forum stakeholders, including Labuan Bajo Flores Tourism Authority, diving operators, boat operators, and the tourism community to manage fasts reports and responses to protect the area.

Figure: Park's joint patrol

The rate of infringement and disturbances toward the park's ecosystems, particularly related to poaching and illegal fishing has been decreased significantly compared to previous years. This is evidenced by the increasing trend in the population of Komodo dragons' preys as the result of the increasing coverage of ranger patrols in Komodo National Park. The trend of Komodo dragons' preys' population is attached in **Annex 4**; the map of patrols coverage within Komodo National Park from January – June 2021 is attached in **Annex 5**.

The Government of Indonesia cq Komodo National Park is fully committed to provisioning a marine ecosystem restoration program by conducting coral reef transplantation in Komodo National Park areas. In 2020, three coral transplantation activities were conducted followed by three additional activities in 2021. Furthermore, The Komodo National Park also conducted a reef check monitoring program in 2020 and was actively involved in numerous public webinars or discussions to disseminate updated information about the park as part of education. These research-based and community empowerment activities will be the government's focus for the next years to raise awareness among locals and to educate visitors who visit the biosphere reserve area. For instance, Komodo National Park had participated as a guest speaker on the following webinars: "Paradise of Indonesia" Ghent University Belgium (2021), "Wildlife Campaign" IPB University (2021), "*Mitigasi Bencana Alam di Kawasan Taman Nasional Komodo*" Malang National Technology Institute (2021), etc.

In addition, to improve the operational equipment and technical capacity of the management in the marine area, the Komodo National Park has set up 18 units of mooring buoys.

According to the Coral Reef Health Monitoring Report conducted at Komodo National Park (2016), the average fish abundance in the No Take Zone is ranged from 867 $\pm$ 240 individuals/Ha and about 1,006 $\pm$ 193 individuals/Ha in the Marine Utilization Zone. Meanwhile, the average fish abundance in the outside marine areas of Komodo National Park is ranged from 1,343 $\pm$ 262 individuals/Ha. It can be concluded that the degree of coral health and abundance of fish in both areas are in very good condition. Thus, park patrols carried out jointly by the *Community Park Ranger* and relevant law enforcement partners have successfully reduced the number of illegal fishing.

To support the Komodo National Park in strengthening its marine management, UNESCO's World Heritage Marine Programme organized a Marine World Heritage Workshop in Labuan Bajo and Komodo National Park

from 25 to 29 November 2019. As a follow up to of the workshop, the Government of Indonesia has developed an outline of steps toward strengthening and improving the management of the marine component of the Komodo National Park. The document is attached in **Annex 6**.

B. Community Empowerment and Socialization Within the Property

Komodo National Park is currently implementing Resort-Based Management (RBM) as an ideal management strategy by deploying rangers to 13 resorts in many corners and borders of the park. The rangers are not only assigned to protect the park's boundary but also to collect wildlife monitoring data on a daily basis as well as to develop unique community empowerment activities together with the locals. The Komodo National Park conducted 669 disseminations concerning the park's regulation to communities within the park between January – March 2021.

9. **Finally requests** the State Party to submit to the World Heritage Centre, by **1 February 2022**, an updated report on the state of conservation of the property and the implementation of the above, for examination by the World Heritage Committee at its 45th session in 2022.

Public access to the State of Conservation Report

This report will be uploaded for public access on the World Heritage Centre's State of Conservation Information System

Jakarta, 26 January 2022.
Director General of Conservation on Natural Resources and Ecosystem
Ministry of Environment and Forestry – Republic of Indonesia

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Daya Dukung Wisata Taman Nasional Komodo 2018

PUSAT PENGENDALIAN PEMBANGUNAN EKOREGION BALI DAN NUSA TENGGARA

bekerjasama dengan

WWF INDONESIA

DAYA DUKUNG WISATA TAMAN NASIONAL KOMODO 2018

Pengarah : Drs. Rijaluzzaman (Kepala P3E Bali dan Nusa Tenggara)

Penanggung Jawab : Suwardi STP, MSi (Kepala Bidang Inventarisasi DDDT SDALH P3E Bali dan Nusa Tenggara)

Tim Penyusun :

Kajian Daya Dukung Wisata Wilayah Terestrial

1. Cokorda Istri Muter Handayani (Kepala Subbidang PEPK P3E Bali Nusra)
2. I Gede Eka Sarjana
3. Angga Putra Nugraha
4. Wayan Damar Windu (Universitas Pendidikan Ganesha)
5. I Ketut Sridana
6. Budi Hartono
7. NK Dewi Rahmaeni
8. Ni Ketut Murtini
9. Mu'tasim Billah

Kajian Daya Dukung Wisata Wilayah Perairan

1. Wempy Endarwin (Kepala Subbidang Hutan Hasil Hutan P3E Bali dan Nusa Tenggara)
2. Ranny Yuneni (WWF Indonesia)
3. Wayan Damar Windu (Universitas Pendidikan Ganesha)
4. I Made Agus Sukarji
5. Made Jasmini
6. Lutfi Amer
7. Ande Kefi (Balai TN Komodo)

foto sampul
depan : p3e bali nusra, wwf Indonesia
belakang : p3e bali nusra

PUSAT PENGENDALIAN PEMBANGUNAN EKOREGION BALI DAN NUSA TENGGARA

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WWF INDONESIA

2018

KATA PENGANTAR

Puji syukur kehadirat Tuhan Yang Maha Esa karena atas berkat rahmat dan hidayahNya kami dapat menyelesaikan dokumen Daya Dukung Wisata Taman Nasional Komodo meskipun banyak tantangan, hambatan dan keterbatasan yang dihadapi.

Dokumen ini disusun diawali dengan adanya arahan Bapak Dirjen KSDAE agar P3E dapat menghitung daya dukung kawasan Taman Nasional, kemudian ditindaklanjuti oleh Balai Taman Nasional Komodo agar P3E Bali Nusra dapat memfaslitasi perhitungan daya dukung wisata Taman Nasional Komodo. Penyusunan D3TLH juga sesuai dengan amanat PermenLHK No. 18 Tahun 2015 tentang Organisasi dan Tata Kerja kementerian LHK, dimana salah satu tugas dan fungsi P3E Bali dan Nusa Tenggara adalah melaksanakan inventarisasi daya dukung dan daya tampung sumber daya alam dan lingkungan hidup di ekoregion Bali dan Nusa Tenggara, serta PermenLHK No. 52 Tahun 2016 tentang NSPK P3E, dimana Ruang lingkup inventarisasi daya dukung dan daya tampung SDALH meliputi : D3TLH wilayah Pulau Kepulauan, D3TLH sektor dan D3TLH Subyek lainnya seperti DAS, Karst, pesisir dan laut, danau, kawasan pariwisata, dll.

Pemerintah melalui Kementerian Pariwisata telah mencanangkan program peningkatan pertumbuhan ekonomi nasional dari kegiatan pariwisata, salah satu implementasi kebijakan tersebut adalah dengan penetapan sepuluh destinasi wisata prioritas daerah kawasan konservasi dan dua diantaranya berada di wilayah kerja P3E Bali Nusra yaitu Taman Nasional Gunung Rinjani (TNGR) di Provinsi NTB dan Taman Nasional Komodo (TNK) di Provinsi NTT.

Peningkatan kunjungan wisatawan, baik nusantara maupun manca negara ke Kawasan taman nasional diharapkan akan dapat mendongkrak pertumbuhan ekonomi nasional secara signifikan. Pemerintah berharap bahwa pada tahun 2019 lebih dari 20 juta wisatawan manca negara dan 275 juta wisatawan nusantara akan datang dan berwisata ke taman nasional konservasi yang ada di Indonesia.

Peningkatan jumlah kunjungan wisatawan ke taman nasional harus dibarengi dengan kebijakan pengelolaan dan perlindungan lingkungan dan SDA, sehingga prinsip pembangunan berkelanjutan yang diamanatkan pada Undang-Undang 32 tahun 2009 akan dapat diimplementasikan pada setiap perencanaan program dan kegiatan. Penyusunan daya dukung dan

daya tampung adalah salah satu instrument pencegahan yang dilakukan oleh pemerintah untuk memastikan bahwa setiap rencana, program dan kebijakan pembangunan yang akan dilaksanakan dapat dilaksanakan tanpa mendegradasi fungsi lingkungan.

Dokumen daya dukung wisata Taman Nasional komodo ini memberikan gambaran tentang jumlah wisatawan yang dapat berkunjung atau melakukan aktivitas di satu titik lokasi dalam satu hari serta jasa ekosistem yang terpengaruh oleh aktivitas pengunjung. Penentuan daya dukung lingkungan hidup dalam kajian ini dilakukan berdasarkan tiga pendekatan yaitu Kemampuan lahan wisata, Fungsi Jasa Ekosistem, dan Jumlah maksimum wisatawan yang dapat ditampung kawasan. Hasil penentuan daya dukung lingkungan hidup ini merupakan acuan dalam pengelolaan Kawasan wisata yang berkelanjutan.

Menafaat yang diharapkan dari tersusunnya dokumen daya dukung wisata Taman Nasional Komodo ini adalah sebagai pedoman bagi pengelola khususnya dalam perencanaan pengembangan pariwisata di Kawasan Taman Nasional Komodo, sebagai media koordinasi, sinkronisasi dan sinergi program-program pengembangan sektoral khususnya sektor pariwisata untuk mewujudkan pembangunan pariwisata berkelanjutan.

Penyusunan dokumen ini banyak melibatkan berbagai kalangan, baik dari akademisi, pengelola Taman Nasional Komodo, LSM, serta pemerintah daerah, yang telah memberikan kontribusinya baik berupa data dan informasi serta pemikiran-pemikiran yang bersifat membangun dalam menghasilkan dokumen ini. Disadari bahwa dokumen ini masih jauh dari kata sempurna, karena keterbatasan kami. Untuk itu, kritik, dan saran sangat diharapkan dalam usaha perbaikan dalam penyusunan dokumen berikutnya.

Denpasar, Desember 2018
Kepala Pusat Pengendalian Pembangunan
Ekoregion Bali dan Nusa Tenggara

Drs. Rijaluzzaman

SAMBUTAN SEKRETARIS JENDERAL KEMENTERIAN LINGKUNGAN HIDUP DAN KEHUTANAN

Saat ini negara-negara di dunia tengah dihadapkan pada persaingan global di segala bidang, baik ekonomi, sosial, teknologi, informasi maupun budaya. Tidak terkecuali Indonesia sebagai anggota komunitas masyarakat dunia, juga dituntut untuk meningkatkan daya saing dan pertumbuhan pembangunan untuk dapat mensejajarkan diri dengan negara-negara lain di dunia. Seperti halnya negara-negara yang sedang berkembang, pertumbuhan sosial dan ekonomi masih menjadi fokus utama pembangunan di Indonesia, disamping pembnagunan di bidang sumber daya manusia. Hal ini dimaksudkan untuk meningkatkan kesejahteraan masyarakat di berbagai lapisan, memperkecil kesenjangan sosial dan ekonomi, serta menurunkan angka kemiskinan.

Percepatan pembangunan di bidang ekonomi yang dituangkan dalam berbagai kebijakan nasional telah memperlihatkan keseriusan pemerintah untuk menghadirkan kesetaraan dan keseimbangan di masyarakat. Pembangunan di berbagai sektor. Pencapaian pemerintah yang tinggi di bidang pembangunan dan ekonomi tidak terlepas dari peran sumber daya yang dimiliki oleh bangsa dan negara kita, baik sumber daya alam, sumber daya manusia, maupun sumber daya sosial dan budaya. Oleh karenanya pengelolaan seluruh potensi sumber daya secara baik dan professional menjadi titik fokus pemerintah saat ini.

Salah satu sektor yang diharapkan dapat menjadi lokomotif pendorong ekonomi nasional adalah bidang pariwisata. Berbagai potensi wisata yang tersebar di seluruh wilayah nusantara mendapatkan perhatian serius untuk ditingkatkan pengelolaannya, sehingga dapat dikenal di tingkat nasional maupun di manca negara. Namun demikian, pengembangan sektor pariwisata nasional harus diimbangi dengan upaya-upaya perlindungan terhadap sumber daya alam dan lingkungan, sehingga dapat terjaga keberlanjutannya.

Kawasan taman nasional merupakan salah satu potensi wisata yang sangat mungkin untuk dikembangkan dan dikelola menjadi sumber pemasukan negara dari sektor pariwisata. Taman Nasional Komodo (TNK) di Provinsi NTT adalah satu dari sekian banyak potensi wisata yang sedang dikembangkan saat ini di Indonesia. Taman nasional ini telah menjadi daya tarik yang luar biasa bagi jutaan wisatawan nusantara maupun manca negara untuk datang ke wilayah timur Indonesia ini. Laju arus wisatawan ke TNK yang kian hari terus meningkat pesat ini harus disikapi secara baik dan profesional, agar tidak menimbulkan dampak negatif terhadap lingkungan,

yang pada akhirnya akan mendegradasi kondisi obyek wisata itu sendiri. Karenanya diperlukan sebuah instrumen pengendali yang dapat menyeimbangkan kedua aspek tersebut, seperti instrument Daya Dukung dan Daya Tampung Lingkungan Hidup (DDDTLH).

Pusat Pengendalian Pembangunan Ekoregion Bali dan Nusa Tenggara (P3E) memainkan peran yang sangat vital dalam mendorong pemerintah daerah di wilayah kerja Bali, NTB dan NTT untuk tetap memperhatikan keseimbangan pembangunan sektor ekonomi dan lingkungan dalam setiap proses pengambilan keputusannya, melalui penyusunan dokumen Daya Dukung Wisata Kawasan Taman Nasional Komodo pada tahun 2018 ini. Dokumen ini memiliki peran yang sangat penting dalam proses pembangunan; salah satunya adalah untuk memastikan bahwa prinsip pembangunan berkelanjutan (Sustainable Development) yang mensinergikan elemen ekonomi, sosial dan lingkungan telah diimplementasikan dalam setiap proses perencanaan dan proses pengambilan keputusan.

Saya berharap bahwa dokumen yang telah disusun melalui kajian dan penelitian ilmiah dapat memberikan sumbangsih dan manfaat kepada pemerintah daerah maupun semua komponen yang berkaitan dalam menyusun perencanaan kegiatan maupun pengelolaan Kawasan TNK, sehingga dapat berkelanjutan di masa yang akan datang. Pada kesempatan yang baik ini saya, atas nama Kementerian Lingkungan Hidup dan Kehutanan, menyampaikan rasa terima kasih yang sebesar-besarnya atas dedikasi yang tinggi dari semua pihak yang telah terlibat aktif dalam penyusunan Dokumen Daya Dukung Wisata Kawasan Taman Nasional Komodo tahun 2018. Saya berharap dokumen ini dapat menjadi acuan dan landasan berfikir dan bertindak bagi pemerintah daerah maupun para pihak terkait dalam menyusun kebijakan dan perencanaan pembangunan yang tepat dan cermat, bagi pengelolaan Kawasan Taman Nasional Komodo di Provinsi Nusa Tenggara Timur.

Jakarta, Desember 2018
Sekretaris Jenderal,

Dr. Ir. Bambang Hendroyono, M.M.

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BAB I

PENDAHULUAN

1.1 Latar Belakang

Indonesia merupakan negara kepulauan yang sangat luas dengan potensi sumberdaya alam melimpah yang tentunya dapat memberikan manfaat yang beragam. Salah satunya adalah potensi wisata di Taman Nasional Komodo yang berada di Provinsi Nusa Tenggara Timur dan Nusa Tenggara Barat. Taman nasional Komodo ini terdiri dari 3 (tiga) pulau besar yakni Pulau Komodo, Pulau Rinca, dan Pulau Padar serta beberapa pulau kecil.

Taman Nasional Komodo (TNK) merupakan habitat asli dari binatang komodo. Selain itu, TNK juga menyimpan berbagai potensi wisata keanekaragaman hayati lainnya, seperti monyet ekor panjang, burung walet, kuda, ikan pari, lumba-lumba, dan ikan hiu (BTNK, 2015). Taman Nasional Komodo juga memiliki potensi wisata bahari, seperti pantai merah dan dasar laut yang dipenuhi terumbu karang dengan berbagai jenis ikan di dalamnya (BTNK, 2015). Potensi wisata ini mendatangkan banyak wisatawan untuk melakukan aktivitas wisata, seperti trecking, memancing, bersampan, *diving, snorkeling*, pengamatan satwa, berkemah, dan sebagainya (BTNK, 2015). Beberapa tahun terakhir jumlah wisatawan mancanegara maupun wisatawan domestik terus mengalami peningkatan bahkan selalu melampaui target pemerintah setempat. Data Statistik Balai Taman Nasional Komodo pada tahun 2014, menunjukkan bahwa jumlah wisatawan ke TNK mengalami peningkatan, dari 21.762 orang pada tahun 2008 menjadi 63.801 orang di tahun 2013 dengan persentase wisatawan lokal adalah 15% sedangkan wisatawan mancanegara adalah 85% (BTNK, 2015). Manfaat dari peningkatan jumlah wisatawan tentunya dapat dirasakan langsung oleh masyarakat setempat dari segi ekonomi maupun bagi pemerintah setempat dalam bentuk tambahan pemasukan daerah.

Selain itu selain peluang ekonnomi, tantangan utama dalam pengelolaan TNK karena TNK bukan hanya merupakan kawasan wisata melainkan juga kawasan konservasi untuk melindungi komodo dan ekosistem lainnya.

Pertentangan kegiatan yang terjadi di wilayah TNK antara kegiatan wisata dengan kegiatan konservasi memberikan tekanan kepada sumberdaya yang ada di wilayah tersebut karena memungkinkan para wisatawan untuk melakukan interaksi langsung dengan satwa di daratan maupun sumberdaya laut dan ekosistem terumbu karang yang sensitif terhadap adanya interaksi. Selain itu, juga terdapat tindakan illegal yang dilakukan oleh masyarakat, yaitu perburuan rusa dan kerbau yang menjadi makanan komodo serta penangkapan hiu dan pari manta yang menjadi daya tarik wisata. Pertambahan jumlah penduduk di sekitar wilayah TNK juga turut menyumbang permasalahan baru karena adanya perluasan area pemukiman yang mengancam area konservasi dan area wisata serta bertambahnya penggunaan kayu bakar yang diperoleh dari aktivitas penebangan pohon di wilayah TNK. Tindakan-tindakan ini akan mempengaruhi sektor pariwisata karena spot wisata di TNK akan mengalami penurunan, baik wisata darat maupun wisata bahari (BTNK, 2013). Ketersediaan sumberdaya alam/ data tampung alami di Taman Nasional Komodo tidak mengalami peningkatan atau tetap setiap tahunnya

Foto : P3E Bali Nusra

bahkan dapat mengalami penurunan apabila jumlah wisatawan nantinya melebihi dari daya tampung alamnya.

Oleh sebab itu, berdasarkan pemaparan diatas diperlukan kajian Daya Dukung dan Daya Tampung Wisata untuk menentukan jumlah maksimum wisatawan yang dapat ditampung. Kajian Daya Dukung dan Daya Tampung Lingkungan Hidup yang digunakan yakni DDTLH Jasa Ekosistem dan Daya Dukung Wisata. DDTLH Jasa ekosistem adalah manfaat yang diperoleh manusia dari suatu eksosistem. Manfaat ini termasuk jasa penyediaan (provisioning), seperti pangan dan air; jasa pengaturan (regulating) seperti pengaturan terhadap banjir, kekeringan, degradasi lahan dan penyakit; jasa pendukung (supporting), seperti pembentukan tanah dan silkus hara; serta jasa kultural (cultural), seperti rekreasi, spiritual, keagamaan dan manfaat nonmaterial lainnya.

Peranan DDTLH berbasis jasa ekosistem disini berperan untuk melihat fungsi ekosistem dan pengaruhnya terhadap Daya Tarik Wisata. Sedangkan Daya Dukung Wisata digunakan untuk mengetahui kesesuaian lahan wisata di perairan dan penentuan jumlah wisatawan maksimum yang dapat ditampung oleh suatu Daya Tarik Wisata. Penggabungan kedua metode tersebut bermanfaat untuk mengetahui jumlah wisatawan maksimum yang dapat ditampung sesui dengan fungsi ekosistem di Taman Nasional Komodo.

1.2 Tujuan

Berdasarkan latar belakang di atas, tujuan dari kajian ini adalah sebagai berikut:

1. Untuk mengetahui kondisi fungsi jasa ekosistem di suatu Kawasan perairan dan di jalur trekking darat.
2. Untuk mengetahui kesesuaian lahan wisata perairan dangkal di Kawasan Taman Nasional Komodo
3. Untuk mengetahui jumlah maksimum wisatawan yang dapat ditampung oleh suatu objek wisata / Kawasan

1.3 Manfaat

Manfaat dari kajian DDTLH Jasa Ekosistem dan Daya Dukung wisata di Taman Nasional Komodo antara lain untuk mengetahui:

1. PROFIL, menyajikan kondisi atau rona awal lingkungan khususnya terkait dengan jumlah wisatawan maksimum yang bias didukung kawasan
2. PREDIKSI, melakukan prediksi pengaruh suatu kegiatan wisata terhadap fungsi ekosistemnya.
3. PENGENDALI, upaya pengendalian pemanfaatan ruang yang dapat menimbulkan kerusakan dan kerugian lingkungan

1.4 Sasaran

Sasaran yang hendak dicapai dalam kajian Daya Dukung dan Daya Tampung Lingkungan Hidup Jasa Ekosistem dan Daya Dukung dan Daya Tampung Wisata Taman Nasional Komodo adalah:

1. Menyediakan data dan informasi fungsi jasa ekosistem pada Kawasan wisata atau pada daya tarik wisata;
2. Menyediakan data dan informasi Daya dukung Kawasan wisata (kesesuian lahan dan jasa ekosistem); serta
3. Menyediakan data dan informasi jumlah wisatawan maksimum pada masing – masing daya tarik wisata atau Kawasan.

1.5 Keluaran Yang Dihasilkan

Keluaran yang dihasilkan dari hasil kajian ini adalah sebagai berikut:

a. Informasi berupa tabel tentang kondisi dan pengaruh fungsi jasa ekosistem di masing – masing daya tarik wisata,
b. Informasi berupa peta daya dukung wisata berupa kesesuaian lahan wisata perairan
c. Informasi berupa tabel tentang jumlah wisatawan maksimum yang dapat ditampung oleh lingkungan pada masing – masing jalur trekking di Taman Nasional Komodo.

BAB II

GAMBARAN UMUM WILAYAH TAMAN NASIONAL KOMODO

2.1 Kondisi Kawasan

2.1.1 Geografis

Secara geografis Taman Nasional Komodo berada di posisi 119^0 09’ 00” - 119^0 55’ 00” BT dan antara 8° 20’ 00” - 8° 53’ 00” LS.. Berdasarkan Keputusan Direktur Jenderal Perlindungan Hutan dan Konservasi Alam No. 21/IV- Set/2012 tanggal 24 Pebruari 2012 total luas Taman Nasional Komodo 173.300 Ha. Luas total mencapai 1.817 km2, di mana hanya 33% di antaranya daratan dan 67% merupakan perairan laut.

Taman Nasional Komodo memiliki 5 (lima) pulau besar yaitu Pulau Komodo yang memiliki luas 336 km2, Pulau Rinca (211 km2), Padar (16 km2), Gili Motang (10 km2) dan Nusa Kode (7 km2). Diantara 5 pulau besar tersebut, termasuk ke dalam Taman Nasional Komodo adalah juga pulau-pulau kecil yang terletak antara Selat Sape di sebelah barat, Selat Sumba di sebelah selatan, Selat Molo di sebelah timur, dan Laut Flores di utara.

Taman nasional ini terletak di antara dua pulau yaitu Pulau Sumbawa dan Pulau Flores perbatasan wilayah Provinsi Nusa Tenggara Barat dan Provinsi Nusa Tenggara Timur. Secara administratif, Taman Nasional Komodo terletak di Kecamatan Komodo, Kabupaten Manggarai Barat, Nusa Tenggara Timur. Letak geografis kawasan berada di antara Pulau Flores (NTT) dan Pulau Sumbawa (NTB), yang berbatasan dengan Laut Sumba (selatan) dan Laut Flores (utara).

2.1.2 Topografi

Pada umumnya, di kawasan Taman Nasional Komodo banyak terdapat bukit-bukit maupun gunung-gunung. Hal ini disebabkan

karena kawasan Taman Nasional Komodo merupakan tempat bertemunya lempeng Sahul dan lempeng Sunda. Tidak ada gunung berapi aktif di Taman Nasional Komodo meskipun kepulauannya terletak pada salah satu garis gunung berapi paling aktif di dunia. Getaran sudah umum terjadi di garis gunung berapi ini. Gunung berapi aktif yang paling dekat adalah Gili Banta berjarak sekitar 10 km sebelah barat Pulau Komodo. Gili Banta adalah gunung api di bawah permukaan laut yang terakhir kali meletus pada tahun 1957. Gunung Sangeang Api terletak disebelah barat laut Pulau Komodo dan terakhir kali meletus pada tahun 1996, dan hingga sekarang masih mengeluarkan asap dari puncak sebelah utaranya.

Topografi kawasan Taman Nasional Komodo bervariasi, dengan kelerengan berkisar antara 0 - 800. Hanya terdapat sedikit dataran, dan itu umumnya terletak dekat pantai. Di Pulau Komodo, dataran ditemukan dekat pantai timur dan di sebelah utara. Daerah bagian barat dan selatan kebanyakan bergunung. Terdapat banyak tebing curam ke laut, banyak teluk kecil dan besar. Di pulau Rinca, dataran ditemukan di sebelah utara, dan beberapa di bagian timur dan barat (Loh Buaya, Loh Kima, Loh Beru, Kampung Rinca dan Kampung Kerora). Di luar itu, daerahnya berbukit-bukit. Di pulau Padar, seluruh daerahnya bergunung kecuali di dekat pantai.

Ketinggian berkisar antara permukaan laut sampai 735 m di atas permukaan laut. Puncak tertinggi ialah Gunung Satalibo (735 m dpl) di Pulau Komodo. Di Pulau Rinca gunung tertinggi ialah Doro Ora dengan 667 m dpl, sedangkan gunung tertinggi di pulau Padar ialah Piramida dengan tinggi 269 m dpl.

Pulau-pulau di kawasan Taman Nasional Komodo ditutupi oleh padang savana yang kering dengan sumber mata air tawar terbatas serta suhu udara yang panas. Taman Nasional Komodo berada dalam zonasi transisi antara flora dan fauna Asia dan Australia. Ekosistem perairannya dipengaruhi oleh dampak El- Nino dan La Nina, sehingga lapisan air laut di sekitarnya memanas dan sering terjadi arus laut yang kuat.

Secara umum, sungai dan anak sungai timbul saat musim hujan dan menghilang saat musim kering. Bagaimanapun, sumber air yang cukup besar dapat ditemukan di Gunang Ara dan Gunang Satalibo di Komodo dan Doro Ora di Rinca. Aliran air tergantung pada kerapatan tutupan hutan di daerah ini. Sumber air ini menyediakan air segar yang terbatas melalui mata air dan kolam sepanjang tahun di Komodo dan Rinca, tetapi kualitas dan ukuran mata air ini bervariasi besarnya.

Walaupun beberapa sungai dilaporkan mengalir sepanjang tahun di pertengahan 1970an, sekarang tak ada lagi yang mengalir sepanjang tahun. Ini mungkin dikarenakan meningkatnya penggunaan air atau pengalihan sumber air oleh masyarakat, memburuknya hutan dalam daerah resapan air, atau perubahan iklim.

2.1.3 Geologi dan Tanah

Pertemuan dua lempengan kontinen Sahul dan Sunda, menyebabkan gesekan antara kedua lempengan tersebut, sehingga menimbulkan letupan vulkanis besar dan tekanannya yang menyebabkan pengangkatan terumbu karang. Fenomena vulkanis itulah yang menjadikan pulau-pulau yang tersebar di kawasan Taman Nasional Komodo. Komodo Barat, oleh para ahli diperkirakan

terbentuk pada era jurasic atau sekitar 130 juta tahun lalu, sedangkan Komodo Timur, Rinca, dan Padar, diperkirakan terbentuk sekitar 49 juta tahun lalu dalam era Eosin. Pulau-pulau tersebut berubah terus menerus melalui proses erosi dan penumpukan. Berdasarkan geologis berskala 1:250.000 oleh Van Bemmelen tahun 1949, formasi batu yang tersebar di Taman Nasional Komodo adalah formasi andesit, deposit vulkanis dan formasi efusif.

Taman Nasional Komodo berada pada Kabupaten Manggarai Barat, secara geologi Komodo Barat terdiri dari konglomerat kapur, serpihan pasir, tanah liat, batu vulkanis dan batu pasir. Kapur koral predominan di Komodo Timur, Rinca dan Padar. Tanah terutama terdiri dari dysropept. Jenis ini mudah tererosi pada musim hujan, mengingat kebakaran yang sering terjadi pada vegetasi sekitar serta asal usul vulkanis daerah ini. Berdasarkan peta tanah tahun 1970 (skala 1:250.000) dari Lembaga Penelitian Tanah, Taman Nasional Komodo memiliki jenis-jenis tanah sebagai berikut:

- Tanah mediteranea merah-kuning, ditemukan di pulau Rinca dan beberapa pulau kecil di sekitarnya. Tanah mediteranea merah-kuning peka terhadap erosi. khususnya setelah turun hujan karena tanahnya terkelupas akibat kebakaran yang sering muncul di musim panas mengelupasi tanah yang sering terbakar saat musim kering.
- Tanah komplek, ditemukan di pulau Komodo dan pulau Padar, dan pulau-pulau kecil di sekitarnya; jenis tanah ini berwarna coklat keabu-abuan dan merupakan komposit dari beberapa jenis tanah, termasuk latosol dan grumosol yang peka terhadap erosi.

Berdasarkan peta geologis berskala 1:250.000 oleh Van Bemmelen tahun 1949**,** formasi batu yang tersebar di Taman Nasional Komodo sebagai berikut:

- Formasi andesit ditemukan di bagian selatan dan utara pulau Komodo, bagian selatan pulau Rinca dan di beberapa tempat di pulau Padar dan pulau Gili Motang.
- Deposit vulkanis terdapat di bagian timur pulau Komodo, di bagian tengah pulau Rinca dan di sebagain pulau Padar.
- Formasi efusif ditemukan di bagian tengah Pulau Komodo dan bagian utara pulau Rinca.

2.1.4 Iklim

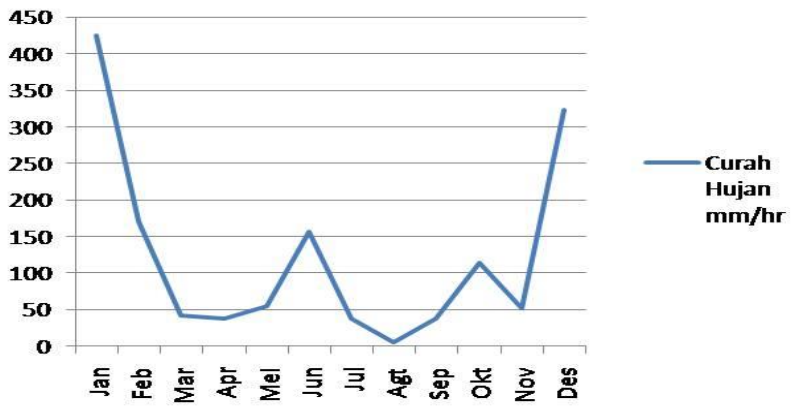
Kawasan Taman Nasional Komodo sangat dipengaruhi oleh hujan musim dengan tingkat kelembaban yang tinggi. Iklim Taman Nasional Komodo berdasarkan klasifikasi Schmidt dan Ferguson, iklimnya termasuk klasifikasi jenis F (sangat kering). Bulan kering antara april sampai oktober dan bulan basah terjadi antara bulan November sampai dengan Maret.

Iklim di daerah ini sangat dipengaruhi oleh angin muson serta sejumlah uap air yang dibawanya. Dari Bulan April hingga Oktober, angin pasat tenggara yang kering dari Australia membawa sangat sedikit uap air ke daerah ini. Dari Bulan November hingga Maret angin muson barat datang dari daratan Asia. Angin ini membawa uap air, tetapi kebanyakan uap air jatuh di bagian barat Indonesia sebelum sampai ke wilayah Taman Nasional Komodo. Angin kering yang bertiup kencang dari arah Tenggara pada bulan April sampai November menyebabkan terjadinya musim kering/kemarau di kawasan Taman Nasional Komodo, sedangkan angin yang membawa hujan bertiup dari arah barat laut pada bulan Oktober sampai Maret menyebabkan musim basah/hujan di kawasaan Taman Nasional Komodo ini (Usboko, 2009)

Tabel 2.1 Data Hujan Bulanan TN Komodo Tahun 2016

	Jan	Feb	Mar	Apr	Mei	Jun	Jul	Agt	Sep	Okt	Nov	Des
Curah Hujan	425,1	171	43	38	55	157	37	6	38	115	53	324
Curah Hujan Maksimum	98,6	36	9	11	15	53	34	4	28	62	17	56
Hari Hujan	15	20	12	11	10	8	7	3	7	15	13	28

Sumber: Stasiun Meteorologi Komodo, BMKG



Gambar 2.1 Grafik curah Hujan TN Komodo Tahun 2016
Sumber: hasil analisis P3E Bali Nusra

Pada tahun 2016 menurut Data Stasiun Meteorologi Komodo, BMKG, curah hujan di Taman Nasional Komodo adalah 1459.7 mm dengan curah hujan tertinggi terjadi pada bulan Januari yaitu sebesar 425,1 mm. Rata - rata curah hujan bulanan pada tahun 2016 adalah sebesar 121,64 mm/bulan. Sedangkan hari hujan terbanyak terjadi pada bulan Desember, terdapat 28 hari hujan pada bulan ini. Jauh lebih banyak dari bulan Januari yang hanya terjadi 15 hari hujan pada posisi kedua. Untuk bulan terendah terjadi pada bulan Agustus. Sepanjang bulan ini, menurut data hanya terjadi 3 hari hujan.

Suhu tahunan tertinggi di Taman Nasional Komodo adalah 43 derajat Celcius, sedangkan suhu minimum adalah 17 derajat Celcius.

Bulan November adalah bulan terpanas dalam setahun. Suhu terpanas setiap harinya adalah pada awal siang hari. Pada kondisi seperti ini, komodo akan mencari tempat berteduh dan beristirahat pada saat suhu sangat panas. Tingkat kelembaban rata-rata adalah 36%. Kelembaban udara tertinggi dicapai pada Bulan Februari yakni sekitar 86%. Tingkat kelembaban tinggi sepanjang tahun hanya ditemukan di hutan tampak-berawan yang terletak di puncak gunung dan pegunungan.

2.2 Sejarah

Dalam dunia ilmu pengetahuan komodo pertama kali diperkenalkan pada tahun 1912 oleh Peter A. Ouwens, Direktur musium Zoologi Bogor, yang menerima laporan mengenai penemuan satwa oleh Jacques Karel Henri van Steyn van Hensbroek, seorang Perwira Hindia Belanda yang bertugas sebagai administator sipil di Reo, Pulau Flores. Van Steyn menerima laporan dari penduduk lokal tentang adanya kadal raksasa yang sering ditemukan di barat pulau Flores. Pada tahun 1911 ahirnya beliau berhasil menangkap satu satwa ini dengan panjang 2,2meter, yang kemudian dikirimkan ke museum zoologi untuk penelitian. Semenjak saat itu komodo diberi nama *Varanus komodoensis* oleh Ouwens. Berdasarkan peristiwa ini, mulai muncul kesadaran berbagai pihak untuk menjaga kelestarian satwa langka ini.TN Komodo merupakan salah satu dari 5 (lima) kawasan Taman Nasional yang pertama kali ditetapkan oleh pemerintah melalui Pengumuman Menteri Pertanian tanggal 6 Maret 1980 tentang pembentukan 5 (lima) TN pertama di Indonesia. Taman ini awalnya didirikan untuk melestarikan keunikan komodo, namun tujuan tersebut semakin diperluas untuk melindungi keanekaragaman hayati, laut dan darat. Taman Nasional Komodo sebagai kawasan konservasi yang harus mempertahankan fungsinya sebagai; (1) perlindungan sistem penyangga kehidupan, (2) pengawetan keanekaragaman jenis tumbuhan dan satwa, serta (3) pemanfaatan secara lestari sumber daya alam hayati dan ekosistem yang terkandung di dalamnya.

Setelah itu penetapan dan pengelolaan terkait Taman Nasional Komodo melalui beberapa rangkaian diantaranya adalah:

1. *Zelfbestuur van Manggarai*, verordening No.32/24 September 1938 tentang Pembentukan Suaka Margasatwa Pulau Padar, Bagian Barat dan Selatan Pulau Rinca.
2. *Residen van Timor en onder horigheden* No.19/27 Januari 1939 (Pengesahan Peraturan Daerah pada butir 1)
3. Surat Keputusan Menteri Kehutanan No.66/Dep.Keh/1965 tanggal 21 Oktober 1965 tentang Penunjukkan Pulau Komodo sebagai Suaka Margasatwa seluas 31.000 Ha.
4. Surat Keputusan Gubernur KDH Tk. I Nusa Tenggara Timur No.32 Tahun 1969 tanggal 24 Juni 1969 tentang penunjukkan Pulau Padar, Pulau Rinca dan Daratan Wae Wuul/Mburak sebagai Hutan Wisata/ Suaka Alam seluas 20.500 Ha.
5. Surat Keputusan Dirjen Kehutanan No.97/Tap/Dit. Bina/1970, tentang Pembentukan Seksi PPA di Labuan Bajo.
6. Pengumuman Menteri Pertanian tanggal 6 Maret 1980 tentang Pembentukan Taman Nasional Komodo.
7. Keputusan Dirjen PHPA No.46/Kpts/VI-Sek/84 tanggal 11 Desember 1984 tentang Penunjukkan Wilayah Kerja Taman Nasional Komodo.

8. Keputusan Menteri Kehutanan No.306/Kpts-II/92 tanggal 29 Pebruari 1992 tentang Perubahan Fungsi Suaka Margasatwa Pulau Komodo, Pulau Rinca, Pulau Padar seluas 40.728 Ha serta Penunjukkan Perairan Laut di sekitarnya seluas 132.572 Ha yang terletak di Kabupaten Dati II Manggarai Propinsi Dati I Nusa Tenggara Timur menjadi Taman Nasional dengan nama Taman Nasional Komodo.
9. Tahun 1992, Perubahan fungsi Suaka Margasatwa P.Komodo, P. Rinca dan P. Padar seluas 40.728 Ha dan Penunjukan Perairan Laut seluas 132.572 Ha menjadi Taman Nasional Komodo.
10. Keputusan Menteri Kehutanan dan Perkebunan No.172/Kpts-II/2000 tanggal 29 Juni 2000 tentang Penetapan Kawasan Pelestarian Alam Perairan Taman Nasional komodo seluas 132.572 Ha yang terletak di Kabupaten Daerah Tingkat II Manggarai Provinsi Nusa Tenggara Timur.
11. Keputusan Direktur Jenderal Perlindungan Hutan dan Konservasi Alam No.SK.21/IV-Set/2012 tanggal 24 Pebruari 2012, zonasi kawasan TN Komodo seluas 173.300 Ha.

Selain penetapan dan pengelolaan, beberapa pengakuan mengenai kawasan Taman Nasional Komodo juga telah diterima, baik dari tingkat nasional maupun dari dunia internasional, antara lain:

1. Cagar Biosfer (*A Man and Biosfer Reserve*) Komodo ditunjuk pada tahun 1977 dengan area inti Taman Nasional Komodo seluas 173.300 ha yang ditetapkan pada tahun 1990. Pada tahun 1977, areal ini diresmikan sebagai Suaka Biosfer di dalam Program *Man and the Biosphere* (MAB) UNESCO. Suaka Biosfer dirancang sebagai “lokasi-lokasi eksperimen untuk pembangunan berkelanjutan, penelitian dan pemantauan ekosistem dan konservasi biodiversitas. Biosfer juga dimaksudkan untuk “meningkatkan kesejahteraan masyarakat setempat yang tinggal di dalam dan di sekitar suaka” UNESCO (1995). Dengan demikian peran masyarakat setempat perlu ditingkatkan terutama dalam

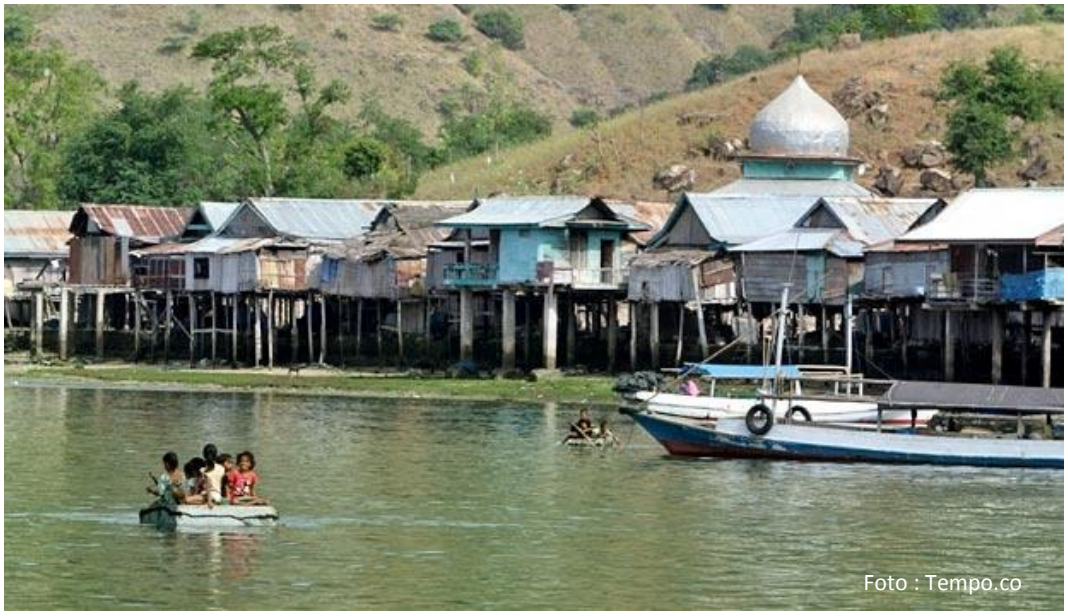
kesadaran dan pengetahuan, dan ini dapat diperbaiki dengan hubungan yang lebih aktif antara program MAB dan para perencana Taman Nasional Komodo dan zona penyangga.

2. Pada tahun 1991 Kawasan Taman Nasional Komodo juga dideklarasikan sebagai Situs Warisan Dunia (*World Heritage Site*) oleh UNESCO. Kondisi alam Taman Nasional Komodo unik, terdapat ekosistem pantai, ekosistem hutan bakau, ekosistem padang rumput, ekosistem hutan hujan tropis, ekosistem air laut, dan ekosistem savanna. Terdapat pula komunitas hutan mangrove/bakau yang berguna sebagai penghalang atau benteng fisik alami terhadap erosi dan akarnya menjadi tempat pembiakan dan daerah perlindungan bagi kepiting, udang dan moluska. Di kawasan ini kita dapat menjumpai 253 spesies terumbu karang yang merupakan salah satu pesona biota terindah di dunia, dan ditambah lagi 1.000 spesies ikan yang menambah semarak panorama laut. Pada saat ini untuk mencapai status sebagai lokasi warisan dunia diperlukan usaha-usaha yang menghubungkan sejarah alam dan budaya kawasan ini.
3. Komodo ditetapkan oleh Presiden RI sebagai Satwa Nasional melaui Keppres No. 4 tahun 1993 tanggal 9 Januari 1993
4. Tahun 2006; Komodo termasuk 21 Taman Nasional Model di Indonesia sesuai dengan SK Direktur Jenderal PHKA Nomor: SK.128/IV-Sek/2006 tentang Perubahan Keputusan Direktur Jenderal PHKA Nomor: SK.69/IV- Set/HO/2006 tentang penunjukkan 20 (Dua puluh) Taman Nasional sebagai Taman Nasional Model.
5. *The Real Wonder of The World* (The Real WOW!) oleh Pemerintah RI melalui Yayasan Real Wonder of The World pada tahun 2011.
6. Taman Nasional Komodo sebagai *New 7 Wonders of Nature* oleh *New 7 Wonders Foundation* tahun 2011. Pada tanggal 11 November 2011, Taman Nasional Komodo terpilih menjadi salah satu pemenang sementara *New 7 Wonders* (Tujuh Keajaiban

Dunia Baru) berdampingan dengan Hutan Amazon, Teluk Halong, Air Terjun Iguazu, Pulau Jeju, Sungai Bawah Tanah Puerto Princesa, dan Table Mountain. Dari keseluruhan pemenang sementara tersebut, Taman Nasional Komodo mendapatkan suara terbanyak. Oleh karena itu Taman Nasional Komodo akhirnya ditetapkan sebagai salah satu dari 7 Keajaiban Dunia Terbaru pada tanggal 13 September 2013. Merupakan satu-satunya wilayah konservasi di mana di dalamnya terdapat habitat asli satwa purbakala endemik Komodo. Keberhasilan Taman Nasional Komodo menjadi contoh inspiratif bagaimana sebuah masyarakat secara bersama-sama berusaha melindungi sebuah spesies yang hampir punah dan melindungi kawasan perairan yang kaya akan sumber daya alam hayati perairan.

2.3 Kondisi Sosial Masyarakat

Masyarakat yang berada di dalam kawasan Taman Nasional Komodo tinggal di zona pemukiman masyarakat tradisional. Kawasan TNK terdiri dari tiga desa, yaitu Desa Komodo di Pulau Komodo, Desa Papagaran di Pulau Papagaran, dan Desa Pasir Panjang di Pulau Rinca (BTNK, 2015). Jumlah penduduk yang tinggal dalam kawasan TNK hingga tahun 2016 adalah 4994 orang dengan luas areal tempat pemukiman adalah 298 ha. Masyarakat di dalam kawasan TNK adalah masyarakat dengan budaya kelautan sehingga laut merupakan sumberdaya alam utama untuk masyarakat menggantungkan hidup.



Mata pencaharian utama masyarakat di dalam kawasan TNK adalah nelayan sehingga interaksi masyarakat dengan wilayah perairan TNK sangat tinggi. Masyarakat memiliki interaksi positif terhadap pemanfaatan sumberdaya alam TNK dengan memanen buah asam dan buah srikaya untuk dikonsumsi, tetapi masyarakat juga melakukan interaksi negatif, yaitu dengan melakukan penebangan pohon untuk keperluan kayu bakar dan perburuan satwa seperti rusa, kerbau, hiu, dan pari manta (BTNK, 2015). Akan tetapi, pada tahun 2013 telah dimulai sistem binaan kelompok masyarakat oleh pihak Balai Taman Nasional Komodo terkait kegiatan usaha ekonomi dan penyediaan jasa wisata. Hal ini bertujuan untuk meningkatkan pendapatan dan kemandirian kelompok masyarakat karena terciptanya lapangan kerja baru sebagai pelaku usaha wisata (BTNK, 2015).

2.4 Pembagian Zonasi Taman Nasional Komodo

Taman Nasional Komodo ialah kawasan konservasi dengan kategori Kawasan Pelestarian Alam (KPA) (PP No. 68 Tahun 1998). Pengelolaan dan konservasi di dalam kawasan menggunakan sistem zonasi. Berdasarkan ketentuan ini, Taman Nasional Komodo tidak bisa menggunakan pola tata ruang lain, selain zonasi yang sudah ditetapkan. Acuan normatif dalam penentuan kriteria zonasi adalah UU No. 5 tahun

1990 tentang Konservasi Sumberdaya Alam Hayati dan Ekosistemnya dan Peraturan Menteri Kehutanan No. P.56/Menhut-II/2006 tentang Pedoman Zonasi Taman Nasional. Kedua regulasi tersebut telah mengatur zonasi kawasan taman nasional yang terdiri dari Zona inti, Zona rimba; Zona perlindungan bahari untuk wilayah perairan, Zona pemanfaatan, dan Zona lain (Zona tradisional, Zona rehabilitasi, Zona religi, budaya dan sejarah, dan Zona khusus).

Zonasi kawasan Taman Nasional Komodo dilaksanakan berdasarkan Peraturan Pemerintah Nomor 28 Tahun 2001 tentang Pengelolaan Kawasan Suaka Alam dan Kawasan Pelestarian Alam. Pada pasal 16 ayat 1 dan ayat 2 disebutkan bahwa penataan kawasan dilakukan dengan penyusunan zonasi dan penataan wilayah kerja, sedangkan pada pasal 18 ayat 1 dan 2 menyebutkan bahwa zonasi pengelolaan pada Taman Nasional meliputi Zona Inti, Zona Rimba, Zona Panfaatan, dan/atau zona lain sesuai dengan keperluan yang ditetapkan oleh Menteri atau pejabat yang ditunjukan berdasarkan kriteria. Surat Keputusan Direktorat Jenderal PHKA Nomor: SK.21/IV-SET/2012 tentang zonasi Taman Nasional Komodo tersebut juga mengatur secara rinci ketentuan peraturan yang terkait dengan masing-masing jenis/kategori zonasi.

Berdasarkan pasal 32 Undang-undang No. 5 tahun 1990 mengenai Konservasi Sumberdaya Alam Hayati dan Ekosistemnya, taman nasional dikelola dengan sistem zonasi, termasuk Taman Nasional Komodo. Pembagian zonasi bertujuan untuk membatasi kegiatan yang dilakukan di dalam kawasan karena kawasan Taman Nasional merupakan kawasan konservasi sehingga ada beberapa wilayah yang tidak dapat dijangkau wisatawan. Berikut merupakan tabel pembagian zonasi Taman Nasional Komodo beserta kegiatan yang diijinkan untuk dilakukan di zona-zona tersebut.

Berdasarkan Keputusan Direktur Jenderal Perlindungan Hutan dan Konservasi Alam No.SK.21/IV-Set/2012 tanggal 24 Pebruari 2012, zonasi kawasan TN Komodo terdiri atas 9 Zonasi yaitu Zona Inti (34.311 ha), Zona Rimba (22.187 ha), Zona Perlindungan Bahari (36.308 ha), Zona Khusus

Pelagis (59.601 ha), Zona Khusus Permukiman (298 ha), Zona Pemanfaatan Tradisional Daratan (879 ha), Zona Pemanfaatan Tradisional Bahari (17.308 ha), Zona Pemanfatan Wisata Daratan (824 ha), dan Zona Pemanfatan Wisata Bahari (1584 ha), total luas TN Komodo 173.300 ha.

Tabel 2.2 Pembagian Zonasi Taman Nasional Komodo

No	Nama Zona	Luas (Ha)	Kegiatan yang Diijinkan
1	Zona Inti	± 34.311	-Pemantauan oleh petugas TNK
			- Penelitian (dengan ijin)
			- Restorasi Lingkungan
2	Zona Rimba	± 66.921, 08	- Penelitian
			- Pemantauan
			- Kunjungan wisata alam terbatas
			- Pendidikan
3	Zona Perlindungan Bahari	± 35.308	- Penelitian
			- Pemantauan
			- Pendidikan
			- Kunjungan wisata alam terbatas
4	Zona Pemanfaatan Wisata Daratan	± 824	- Kegiatan wisata
			- Pendidikan konservasi
5	Zona Pemanfaatan Wisata Bahari	± 1.584	- Kegiatan wisata
			- Pendidikan
			- Penelitian
			- Pengembangan ilmu pengetahuan
6	Zona Pemanfaatan Tradisional Daratan	± 879	- Kegiatan wisata
			- Pemanenan asam
7	Zona Pemanfaatan Tradisional Bahari	± 17.308	- Kegiatan wisata
			- Pemanfaatan ikan komersial
8	Zona Khusus Pemukiman	± 298	- Pemukiman

9	Zona Khusus Pelagis	± 59.601	- Pemanfaatan biota laut
			- Kegiatan wisata alam

Sumber: Zonasi Taman Nasional Komodo (2012)

1. Zona Inti

Zona inti merupakan zona yang mutlak dilindungi, di dalamnya tidak diperbolehkan adanya perubahan apapun oleh aktivitas manusia. Kegiatan yang diperbolehkan hanya yang berhubungan dengan ilmu pengetahuan, pendidikan dan penelitian dengan ijin dari otoritas pengelola Taman Nasional. Luas zona inti adalah 34.311 Ha, meliputi bagian utara Pulau Komodo dan pulau-pulau Gili Lawa Laut, Gili Lawa Darat, Pulau Kelor, Pulau Bugis, Pulau Merah, Pulau Punya, Pulau Sebita, Pulau Makasar, Pulau Tala, Pulau Indihang, Pulau Soro Masangga, di bagian selatan Pulau Komodo, dan pulau-pulau Nusa Kode, Pulau Serai, Pulau Gili Motang, di bagian barat laut dan selatan Pulau Rinca. Perubahan untuk Zona Inti yang paling besar adalah pertimbangan aspek Hidrologis (pengatur tata air/pengamanan sumber mata air dan bahaya erosi di wilayah daratan).

2. Zona Rimba

Zona rimba merupakan zona daratan yang di dalamnya hanya dapat dilakukan kegiatan sebagaimana kegiatan pada Zona Inti dan kegiatan wisata alam terbatas. Luas zona rimba adalah 22.187 ha. Zona Rimba terdapat di Pulau Komodo (sekitar Loh Liang, Loh Kubu, Bukit Todoklea, sekitar Pantai Merah sampai Tanjung Kuning, Bukit Rudolf sampai sekitar Loh Sebita, sebagian Loh Lawi, Loh Srikaya, Sok Keka sampai Loh Wenci, dan sebagian Loh Wau serta beberapa pulau kecil di sekitar Pulau komodo); Pulau Rinca (sekitar Loh Buaya sampai sekitar Kampung Rinca dan Kampung Kerora kecuali Doro Pangkarmea, Tambora sampai sebagian Loh Baru, sebagian Loh Ginggo, sebagian Loh Kima, dan sebagian kecil Loh Dasami, serta beberapa pulau kecil di sekitar Pulau Rinca); Pulau Padar (seluruh

pulau kecuali bagian utara pulau sebelah timur dan barat); dan pulau-pulau kecil diantaranya sebagian Pulau Tatawa, Pulau Siaba Besar, Pulau Mangiatan, Pulau Mauwan, Pulau Pengah, Pulau Papagaran Kecil, Pulau Pempe, Pulau Kalong, Pulau Kelapa, Pulau Gado, dan Pulau Muang.

3. Zona Bahari

Zona Bahari merupakan zona perairan laut yang didalamnya hanya dapat dilakukan kegiatan sebagaimana kegiatan pada zona inti dan kegiatan wisata bahari terbatas. Zona Bahari juga disebut Zona Rimba Perairan. Luas Zona Bahari mencapai 36.308 Ha, meliputi bagian perairan yang membentang 500 meter ke arah laut lepas dari garis isodepth 20 meter, keliling pulau, terumbu karang, batu dan gunung laut di semua kawasan perairan, kecuali Zona Pemanfaatan Tradisional dan Zona Pelagis. Pada zona ini tidak boleh dilakukan kegiatan pengambilan hasil laut, seperti halnya pada zona inti kecuali kegiatan wisata alam terbatas. Pada zona ini tidak boleh dilakukan kegiatan pengambilan hasil laut, seperti halnya pada zona inti kecuali kegiatan wisata alam terbatas.

Foto : WWF Indonesia

4. Zona Pemanfaatan Wisata Daratan

Zona ini merupakan zona daratan yang didalamnya dapat dilakukan kegiatan sebagaimana pada Zona Inti dan Zona Rimba dan diperuntukan bagi pusat pembangunan sarana/prasarana dalam rangka pengembangan kepariwisataan alam dan rekreasi terestrial. Luas zona ini mencapai 824 Ha, meliputi bagian daratan Pulau Lasa,

Loh Buaya di Pulau Rinca, Loh Liang dan Tanjung Liang di Pulau Komodo, ditambah Pulau Lasa, dan Pulau Padar.

5. Zona Pemanfaatan Wisata Bahari

Zona ini merupakan zona perairan laut yang di dalamnya dapat dilakukan kegiatan sebagaimana pada Zona Inti dan Zona Rimba dan diperuntukan bagi pusat pembangunan sarana/prasarana dalam rangka pengembangan kepariwisataan alam dan rekreasi bahari. Luas zona ini mencapai 1.584 Ha, meliputi bagian perairan Teluk Loh Liang, antara Pulau Lasa dan Tanjung Liang di Pulau Komodo, perairan teluk Loh Buaya di Pulau Rinca.

6. Zona Pemanfaatan Tradisional Daratan

Zona ini merupakan zona daratan yang didalamnya dapat dilakukan untuk mengakomodasi pemanfaatan bagi kebutuhan dasar bagi penduduk asli di dalam kawasan, dan untuk melindungi Zona Inti, Zona Rimba dan Zona Bahari, serta mempertahankan hubungan tradisional antara kepentingan masyarakat asli dengan hutan, yang pelaksanaannya diatur lebih lanjut oleh Pengelola Taman Nasional. Luas zona ini adalah 879 Ha, meliputi bagian daratan pantai utara Loh Lawi, pantai selatan Loh Gong, pantai barat Loh Sabita di Pulau Komodo, sekitar kampung Kerora, sekitar kampung Rinca, sebelah barat daya pantai Loh Baru, sebelah barat daya kampung Kerora di Pulau Rinca.

7. Zona Pemanfaatan Tradisional Bahari

Zona ini merupakan zona perairan laut yang didalamnya dapat dilakukan kegiatan untuk mengakomodasi pemanfaatan bagi kebutuhan dasar bagi penduduk asli di dalam kawasan, dan untuk melindungi Zona Inti, Zona Rimba dan Zona Bahari, serta mempertahankan hubungan tradisional antara kepentingan masyarakat asli dengan kegiatan penangkapan ikan secara tradisional di perairan laut, yang pelaksanaannya diatur lebih lanjut oleh Pengelola Taman Nasional. Luas zona ini mencapai 17.308 Ha, meliputi bagian perairan Loh Gong dan periran Loh Sebita di Pulau Komodo, perairan sebelah timur Pulau Rinca, antara selat Molo sampai Loh Baru, perairan sebelah utara Pulau Rinca antara Selat Molo sampai Siaba Besar, perairan di depan pantai barat daya Pulau Komodo (Loh Wia) dan Barat Laut Pulau Komodo (Loh Wenci).

8. Zona Pemukiman Masyarakat Tradisional

Zona ini merupakan zona yang didalamnya dapat digunakan masyarakat asli setempat untuk tempat bermukim, berdasarkan jumlah kepala keluarga dan pendudukan yang diijinkan dalam sistem kerjasama perlindungan, pelestarian, pemanfaatan dan pembangunan infrastruktur pengembangan desa yang diijinkan oleh

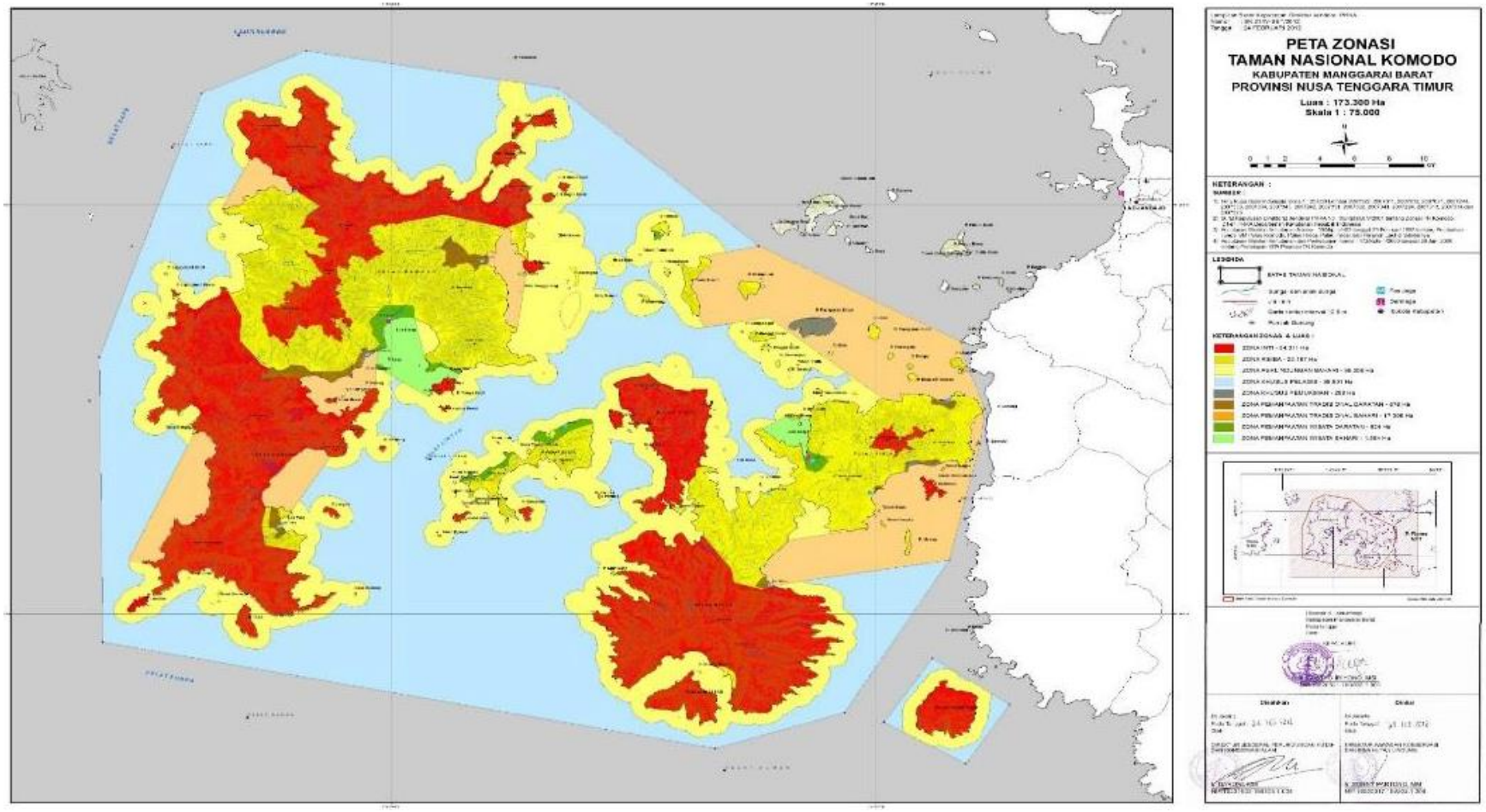
pengelola Taman Nasional. Zona ini memiliki luas 298 Ha, meliputi Desa Papagarang, Kampung Rinca, Kampung Kerora dan Kampung Komodo.

9. Zona Pemanfaatan Khusus Pelagis

Zona ini merupakan zona perairan yang di dalamnya dapat diijinkan untuk penangkapan ikan dari jenis-jenis pelagis yang tidak dilindungi dengan cara tradisional dan untuk perikanan olahraga/rekreasi, yang pelaksanaannya diatur lebih lanjut oleh Pengelola Taman Nasional. Total luas zona Pelagis 59.601 Ha, meliputi kawasan perairan Taman Nasional Komodo di luar Zona Bahari, Zona Pemanfaatan Wisata Bahari, dan Zona Pemanfaatan Tradisional Bahari.

Berdasarkan pembagian zona tersebut, dapat dilihat bahwa hampir seluruh zona diperbolehkan untuk melakukan kegiatan wisata dengan ijin dari otoritas pengelola TNK sehingga kegiatan wisata menjadi salah satu sektor andalan untuk memperoleh Pendapatan Asli Daerah (PAD). Berikut adalah Peta zonasi Taman Nasional Komodo.

Foto: P3E Bali Nusra



Gambar 2.2 Peta Zonasi taman nasional Komodo

2.5 Keanekaragaman Hayati

2.5.1 Ekosistem dan Vegetasi

Beragam ekosistem yang tersedia menjadikan kawasan ini sangat kaya yaitu: (1) padang rumput dan hutan savana mencapai ± 70% dari luas terristrial Taman Nasional Komodo, (2) hutan tropis musim sekitar 25% dari luas kawasan, (3) vegetasi di puncak-puncak bukit, (4) hutan bakau yang berada di teluk yang terlindungi dari hempasan gelombang, dan (5) ekosistem terumbu karang. Terumbu karang merupakan komunitas yang terdiri dari sejumlah tumbuhan dan biota laut, baik yang hidup maupun yang telah mati. Terumbu karang merupakan habitat penting bagi sekitar 1000 jenis ikan di Taman Nasional Komodo. Selain itu lebih dari 250 jenis koral pembentuk karang, sedikitnya 105 jenis crustaceae, dan 70 jenis bunga karang.

Ekosistem Taman Nasional Komodo dipengaruhi oleh iklim yang dihasilkan dari musim kemarau panjang, suhu udara tinggi dan curah hujan rendah. Disamping itu Taman Nasional Komodo terletak dalam zonasi transisi antara flora dan fauna Asia dan Australia. Ekosistem perairannya dipengaruhi oleh dampak El-Nino/La Nina, yang berakibat memanasnya lapisan air laut di sekitarnya dan sering terjadi arus laut yang kuat Sebaran Vegetasi di Taman Nasional Komodo pada setiap pulau. Berikut adalah tipe-tipe vegetasi yang terdapat di Taman Nasional Komodo;

a. Padang Rumput dan Hutan Savana

Terdapat padang rumput dan hutan savana yang luasnya mencapai kurang lebih 70% dari luas Taman Nasional Komodo. Tumbuh berbagai jenis rumput diantaranya; *Setaria adhaerens*, *Chloris barbata*, *Heteropogon contortus*, *Themeda gigantea* dan *Themeda gradiosa* yang diselingi oleh pohon lontar (*Borassus flobellifer*) yang merupakan tumbuhan khas.

b. Hutan Tropis Musim (dibawah 500 m dpl)

Sekitar 25% dari luas kawasan Komodo merupakan vegetasi hutan tropis musim dengan jenis tumbuhan, antara lain: kesambi (Schleichera oleosa), asem (Tamarindus indica), kepuh (Sterculia foetida), dan beberapa jenis tumbuhan lainnya. Hutan tropis musim ditemukan biasanya mengeliling bagian bawah perbukitan, atau sebagai serambi hutan sepanjang hamparan anak sungai.

c. Hutan di atas 500 m dpl

Pada ketinggian di atas 500 m dpl. di puncak-puncak bukit, vegetasinya antara lain; Collophyllum spectobile, Colona kostermansiana, Glycosmis pentaphylla, Ficus urupaceae, Mischarpus sundaicus, Podocarpus netrifolia, Teminalia zollingeri, Uvaria ruva, rotan (Callamus sp.), bambu (Bambusa sp.), dan pada tempat yang cukup teduh biasanya ditemukan lumut yang hidup menempel di bebatuan.

d. Hutan Mangrove

Terdapat di teluk yang terlindungi dari hempasan gelombang. Jenis vegetasinya, antara lain; *Rhizophora sp*., *Rhizophora mucronata*, dan *Lumnitzera racemosa* merupakan jenis vegetasi yang dominan. Namun secara umum terdapat pula api-api (*Avicennia marina*), *Bruguiera sp*., *Capparis seplaria*, *Ceriops tagal*, dan *Sonneratia alba*. Komunitas mangrove di Taman Nasional Komodo merupakan penghalang/benteng fisik alami terhadap erosi tanah dan akarnya menjadi tempat pembiakan, berpijah, dan daerah perlindungan bagi ikan, kepiting, udang, dan moluska.

Tabel 2.3 Sebaran Vegetasi Berdasarkan Tipe Ekosistem di Taman Nasional Komodo

Tipe Ekosistem	Luas Sebaran Vegetasi (Ha)				
	P. Komodo	P. Rinca	P. Padar	P. Gili Motang	P. Nusa Kode
Hutan Mangrove	3,01	6,50	0,4	0,00	0,04
Hutan Gugur Terbuka	79,29	64,88	0,92	7,58	6,18
Hutan Lebat Tertutup	38,63	27,24	0,00	0,53	0,00
Hutan Kuarsi Berawan	8,63	0,00	0,00	0,00	0,00
Savana Hutan dan Savana Rumput	185,05	112,66	13,17	1,37	1,15

Sumber: Balai Taman Nasional Komodo

2.5.2 Fauna

Hewan yang banyak ditemukan di Taman Nasional Komodo adalah bagian penting dari ekologi binatang komodo. Komodo adalah pemangsa tingkat atas dalam lingkungannya, dan semua binatang yang terdapat di Taman Nasional Komodo dapat menjadi mangsa bagi komodo. 277 spesies hewan yang ditemukan di Taman Nasional Komodo terdiri dari perpaduan hewan yang berasal dari Asia atau Australia. Termasuk di dalamnya adalah 32 spesies mamalia, 128 spesies burung, dan 37 spesies reptilia. Bersama dengan Komodo, setidaknya 25 spesies hewan darat atau burung di dalam Taman Nasional Komodo dilindungi karena jumlahnya yang terbatas atau terbatasnya penyebaran mereka.

Di dalam kawasan Taman Nasional Komodo, komodo dapat ditemukan di Pulau komodo, Rinca, Gilimotang dan Nusa Kode. Saat ini, diperkirakan terdapat 5.410 ekor komodo di dalam kawasan Taman Nasional Komodo, diantaranya 2.841 ekor terdapat di Pulau Komodo, 2.406 ekor di Pulau Rinca, 63 ekor di Pulau Gili Motang dan 99 ekor di Pulau Nusa Kode. Komodo dapat ditemukan hampir di semua tempat di Komodo, Rinca, Gili Motang dan Nusa Kode. Mereka dapat ditemukan di hutan hujan, dalam savanna dan di pantai.

Selain Komodo, terdapat pula fauna endemik lain jenis mamalia, seperti: rusa (*Rusa timorensis*), anjing hutan (*Cuon alpinus*), babi hutan (*Sus scrofa*), kera ekor panjang (*Macaca fascicularis*), kuda liar (*Equus caballus*), kerbau liar (*Bubalus bubalus*), musang (*Paradoxurus hermaphroditus*), tikus besar Rinca (*Ratus ritjanus*), dan kalong buah (*Cynopterus brachyotis* dan *Pteropsis* sp.) Fauna lainnya adalah jenis aves, khususnya burung yang tercatat 111 jenis, antara lain: burung gosong (*Megapodius reinwardti*), kakatua jambul kuning (*Cacatua sulphurea*), perkutut (*Geopelia striata*), tekukur (*Streptopelia chinensis*), pergam hijau (*Ducula aenea*), *Philemon buceroides*, burung raja udang (*Halcyon capensis*), dan burung kacamata laut (*Zosterops chloris*). Sedangkan bangsa reptile terdapat sekitar 34

jenis seperti; ular kobra (*Naja naja*), ular russel (*Viperia russeli*), ular pohon hijau (*Trimeresurus albolabris*), ular sanca (*Python* sp.), ular laut (*Laticauda colubrina*), kadal (*Scinidae, Dibamidae*, dan *Varanidae*), tokek (*Gekko* sp.), penyu sisik (*Eretmochelys imbricata*), dan penyu hijau (*Chelonia mydas*).

2.5.3 Biota Laut

Binatang komodo sepertinya sudah menjadi lambang utama dari nama besar Taman Nasional Komodo. Namun penjelasan pada status World Heritage Site dan Biosphere Reserve juga menerangkan keunikan penghuni laut dari Taman Nasional. Terumbu karang di perairan Taman Nasional Komodo termasuk yang terindah di dunia. Berbagai bentuk dan warna karang keras dan karang lunak sangat menarik untuk dilihat. Terdapat lebih dari 1000 jenis ikan termasuk Manta dan Hiu. Taman Nasional juga tercatat merupakan lintasan dari jenis lumba-lumba (10 spesies), paus (8

spesies), maupun duyung (dugong). Dua jenis populasi penyu juga dipastikan melakukan peneluran di dalam kawasan. Spesies tersebut ialah Penyu Hijau(*Chelonia mydas)* dan Penyu Sisik (*Eretmochelys imbricata).* Terdapat pula 260 jenis karang dan 70 jenis bunga karang (sponge) dan banyak invertebrata lain yang dapat dijumpai di banyak tempat di Taman Nasional Komodo. *Acropora spp, Favites sp, Leptoria sp, Fungia sp, Sarcophyton sp* dan *Xenia sp* adalah jenis karang yang umum dijumpai.

Foto: WWF Indonesia

Selain itu dapat dijumpai juga berbagai jenis spesies gorgonians, sea fan, sea pens, anemones dengan clown fish, star fishes, *christmas tree worms*, kima (*Tridacna sp*), lobster, *nudibranchs*, dll. Berbagai ikan karang hidup di sini, diantaranya *Chaetodon spp*, *Amychiprion* spp, 8 jenis kereapu dan Napoleon (*Chelinus undulatus*).

Kondisi penutupan karang di Taman Nasional Komodo yang tergolong kategori “baik” terdapat di lokasi Batu Bolong, di lokasi *Shoott Gun*, Tatawa kecil, *Crystal Rock*, Loh Namo, dan Karang Makasar tergolong kategori “sedang”, sementara itu di lokasi lainnya tergolong buruk. Densitas dan biomass ikan karang pada umumnya masih tergolong baik. Indeks kerusakan karang yang tinggi di dalam kawasan Taman Nasional Komodo teridentifikasi diakibatkan oleh kegiatan manusia diantaranya adalah kegiatan labuh jangkar

kapal/perahu di daerah karang, penangkapan ikan oleh nelayan menggunakan dinamit, dan sampah.

2.6 Potensi Wisata Taman Nasional Komodo

Pariwisata mempunyai potensi untuk menjadi instrumen dalam meningkatkan kualitas hidup masyarakat, khususnya penduduk sekitar destinasi pariwisata. Pengembangan sektor pariwisata dapat meningkatkan kesejahteraan masyarakat, bukan saja kesejahteraan material dan spiritual, tetapi juga sekaligus meningkatkan kesejahteraan kultural dan intelektual. Ditilik dari perspektif bangsa yang lebih luas, pariwisata mempunyai potensi yang jauh lebih besar dan juga lebih mulia, yaitu dapat meningkatkan kualitas hubungan antarmanusia dan antarbangsa sehingga terjalin saling pengertian yang lebih baik, sikap saling menghargai, persahabatan, solidaritas, bahkan perdamaian.

Sektor pariwisata yang telah berperan sebagai penyumbang devisa terbesar kedua setelah migas, menjadi industri atau sektor penting yang dapat diandalkan Pemerintah ke depan untuk menjadi pilar utama pembangunan ekonomi nasional. Dalam konteks tersebut, maka pengembangan sektor pariwisata harus digarap secara serius, terarah, dan profesional agar pengembangan dan pemanfaatan aset-aset pariwisata dapat memberi kontribusi signifikan dalam mewujudkan peran sektor pariwisata sebagai sektor andalan dalam pembangunan di masa depan.

Berdasarkan Rencana Induk Pembangunan Kepariwisataan Nasional 2010-2025 (PP No. 50 Tahun 2011), pewilayahan pembangunan kepariwisataan Indonesia dibagi dalam 222 Kawasan Pengembangan Pariwisata Nasional (KPPN), dan 50 Destinasi Pariwisata Nasional (DPN) (Lampiran II PP No. 50 Tahun 2011). Dari jumlah tersebut, 88 kawasan dianggap strategis secara nasional (Lampiran III PP No. 50 Tahun 2011), dan disebut sebagai Kawasan Strategis Pariwisata Nasional (KSPN). Taman Nasional Komodo yang memiliki potensi wisata yang sangat besar baik daratan maupun perairan, merujuk dalam lampiran PP No. 50 Tahun 2011 dimasukkan kedalam kawasan KPPN, DPN, dan KSPN.

Kawasan Taman Nasional Komodo merupakan kawasan kepulauan dengan beberapa pulau kecil dan perairan laut yang telah menjadi salah satu destinasi wisata alam di Indonesia, khususnya wilayah Bali dan Nusa Tenggara. Wisata yang dikembangkan di pulau-pulau kecil pada umumnya telah banyak menarik jutaan wisatawaan dengan daya tarik wisata berupa pantai yang indah, iklim yang *moderate*, hutan pantai, *coral reefs* dan spesies ikan yang penuh warna. Berbeda dengan wisata pulau-pulau kecil umumnya tersebut, Taman Nasional Komodo memiliki daya tarik lain yang sangat unik dan langka, yaitu komodo (*Varanus komodoensis*) dan keindahan pantai yang memiliki hamparan pasir berwarna merah muda (*pink*) di beberapa pesisir pantai pulau-pulaunya.

Daya tarik utama Taman Nasional Komodo adalah komodo, tetapi keaslian dan keindahan alam khususnya savana dan bawah laut menjadi daya tarik pendukung yang sangat potensial. Wisata bahari seperti memancing, snorkeling, diving, sampan dan wisata darat seperti pengamatan satwa, berkemah, maupun menikmati pemandangan alam menjadi kegiatan wisata yang sering dilakukan di kawasan ini. Beberapa lokasi yang menjadi daya tarik wisata di kawasan TNK adalah:

1. Loh Liang dengan aktivitas yang dapat dilakukan di lokasi ini adalah pengamatan satwa seperti komodo, rusa, babi hutan, burung dan bermain sampan.
2. Pantai Merah merupakan pantai dangkal yang indah dan dipenuhi dengan terumbu karang. Aktivitas yang dapat dilakukan di lokasi ini adalah snorkeling, diving, maupun berjemur.
3. Loh Sebita merupakan daerah mangrove. Aktivitas yang dapat dilakukan di lokasi ini adalah pengamatan burung, tracking, maupun menikmati pohon mangrove.
4. Loh Buaya dengan aktivitas yang dapat dilakukan di lokasi ini adalah pengamatan satwa.

5. Pulau Kalong merupakan lokasi yang dipenuhi dengan kelelawar yang berjumlah cukup besar. Aktivitas yang dapat dilakukan di lokasi ini adalah pengamatan kelelawar waktu yang tepat adalah di sore hingga malam hari diman waktu tersebut merupakan momen ketika kelelawar mulai beraktivitas.

6. Golo Kode merupakan sebuah bukit dimana wisatawan dapat menikmati panorama dan bentang alam berbagai tipe ekosistem.
7. Selat Molo merupakan selat yang memiliki arus deras seperti sungai mengalir sehingga wisatawan dapat menikmati keindahan selat tersebut.

Selain beberapa lokasi yang menjadi daya tarik wisata, TNK juga memiliki 36 dive sites yang sering dikunjungi oleh wisatawan untuk menyelam dan snorkeling di antaranya Pulau Tatawa, Manta Point, Pulau Siaba, Gililawa, Loh Dasami, Pillar Steen, Batu Bolong, dan Karang Makassar. Selain itu, keberagaman jenis flora dan fauna yang ada di dalam kawasan TNK juga menjadi daya tarik utama.

Flora yang ada di dalam kawasan TNK terbagi ke dalam 68 spesies. Dari 68 spesies tersebut, flora yang menjadi daya tarik utama dalam kawasan TNK adalah Palm, Bidara, Zizhypus jujuba, dan Borassus flabellifer. Keempat flora ini jarang ditemukan di tempat lain dan menjadi salah satu keunikan di dalam Taman

Nasional Komodo karena keempat flora ini berpadu dengan kondisi TNK yang dipenuhi dengan padang savana.

Sedangkan, fauna yang ada di dalam kawasan TNK terbagi ke dalam 5 class dan 169 spesies (lihat dalam Lampiran 5). Jenis fauna yang menjadi daya tarik utama dalam kawasan TNK adalah Komodo, Pari Manta, Hiu, dan Kakatua Jambul Kuning. Keempat jenis fauna ini menjadi daya tarik utama untuk menarik wisatawan datang ke kawasan Taman Nasional Komodo, karena keempat satwa tersebut jarang ditemukan di kawasan lain atau bahkan tidak dapat ditemukan di kawasan lain dan merupakan jenis satwa yang dilindungi. Selain itu, keberadaan komodo telah menjadi daya tarik masyarakat internasional sehingga banyak mendatangkan wisatawan mancanegara. Pari manta dan hiu juga menjadi daya tarik utama bagi wisatawan mancanegara karena wisatawan ingin merasakan menyelam bersama kedua hewan tersebut. Selain keberagaman jenis flora dan fauna, kawasan TNK juga memiliki keindahan terumbu karang yang menjadi salah satu daya tarik utama untuk dilakukannya kegiatan snorkeling dan diving. Berikut adalah beberapa jenis terumbu karang yang dapat ditemukan di dalam kawasan TNK.

Tabel 2.4 Jenis Terumbu Karang di Taman Nasional Komodo

Coral	
Acropora symmetrica	Millepora sp.
Acropora sp.	Montipora sp.
Caulastrea sp.	Mycedium sp.
Echinophyllia sp.	Pachyseris sp.
Echinopora sp.	Porites sp.
Fungia sp.	Seriatopora caliendrum
Heterocyathus sp.	Seriatopora sp.
Heteropsammia sp.	Stylophora pistillata
Hydnophora sp.	Stylophora pistillata
Merulina sp.	

2.7 Karakteristik Wisatawan Taman Nasional Komodo

Karakteristik wisatawan yang digunakan dalam penelitian ini merupakan pengelompokkan wisatawan berdasarkan usia, lama tinggal, dan jarak dari tempat asal wisatawan ke lokasi wisata. Karakteristik ini akan digunakan sebagai dasar untuk melakukan analisa cluster dalam pengelompokkan persepsi wisatawan serta untuk melihat pengaruh antara variabel pembentuk klasifikasi wisatawan dengan besaran biaya yang dikeluarkan oleh wisatawan. Selain itu, untuk melihat tingkat keunggulan kompetitif yang dimiliki kawasan wisata Taman Nasional Komodo dapat dilihat dari jumlah perkembangan wisatawan (Miladiyah, 2014).

Berdasarkan catatan Balai Taman Nasional Komodo, wisatawan yang melakukan kunjungan ke Taman Nasional Komodo terus mengalami peningkatan setiap tahunnya. Berikut adalah data jumlah wisatawan dari tahun 2008 hingga tahun 2016.

Tabel 2.5 Jumlah Wisatawan Taman Nasional Komodo

Tahun	Jumlah Wisatawan
2008	21.762
2009	36.534
2010	44.672
2011	48.010
2012	49.982
2013	63.801
2014	80.626
2015	95.410
2016	107.711

Berdasarkan tabel 2.5 dapat dilihat bahwa pada tahun 2013, jumlah wisatawan mengalami peningkatan yang cukup signifikan, yaitu sekitar 27,65% dari tahun sebelumnya. Peningkatan jumlah wisatawan tersebut terus berkelanjutan hingga mencapai angka 107.711 pada tahun 2016. Peningkatan jumlah wisatawan ini mendorong adanya peningkatan pelayanan dan fasilitas yang diperlukan wisatawan agar kawasan wisata di Taman Nasional Komodo dapat bersaing dengan kawasan wisata di tempat lainnya.

BAB III

METODOLOGI KAJIAN

3.1 Konsep Daya Dukung Lingkungan Hidup

Undang-undang Nomor 32 Tahun 2009 tentang Perlindungan dan Pengelolaan Lingkungan Hidup Pasal 1 angka 7 menyebutkan bahwa daya dukung lingkungan hidup adalah kemampuan lingkungan hidup untuk mendukung perikehidupan manusia, makhluk hidup lain, dan keseimbangan antar keduanya. Daya tampung lingkungan hidup adalah kemampuan lingkungan hidup untuk menyerap zat, energi, dan/atau komponen lain yang masuk atau dimasukkan ke dalamnya. Peraturan Menteri Negara Lingkungan Hidup Nomor 17 Tahun 2009 Tentang Pedoman Penentuan Daya Dukung Lingkungan Hidup dalam Penataan Ruang Wilayah menyebutkan bahwa penentuan daya dukung lingkungan hidup dilakukan dengan cara mengetahui kapasitas lingkungan alam dan sumber daya untuk mendukung kegiatan manusia/penduduk yang menggunakan ruang bagi kelangsungan hidup. Besarnya kapasitas tersebut di suatu tempat dipengaruhi oleh keadaan dan karakteristik sumber daya yang ada di hamparan ruang yang bersangkutan. Kapasitas lingkungan hidup dan sumber daya akan menjadi faktor pembatas dalam penentuan pemanfaatan ruang yang sesuai.

3.1.1 Konsep Jasa Ekosistem

Jasa Ekosistem adalah manfaat yang diperoleh oleh manusia dari berbagai sumberdaya dan proses alam yang secara bersama-sama diberikan oleh suatu ekosistem (MA, 2005). Jasa ekosistem dikategorikan menjadi empat, yaitu meliputi jasa penyediaan (*provisioning*), jasa pengaturan (*regulating*), jasa budaya (*cultural*), dan jasa pendukung (*supporting*) (MA, 2005). Berdasarkan empat kategori ini dikelaskan ada 23 kelas klasifikasi jasa ekosistem, yaitu (De Groots, 2002):

A. Jasa penyediaan : (1) bahan makanan, (2) air bersih, (3) serat, bahan bakar dan bahan dasar lainnya (4) materi genetik, (5) bahan obat dan biokimia, (6) spesies hias.
B. Jasa Pengaturan : (7) Pengaturan kualitas udara, (8) Pengaturan iklim, (9) Pencegahan gangguan, (10) Pengaturan air, (11) Pengolahan limbah, (12) Perlindungan tanah, (13) Penyerbukan, (14) Pengaturan biologis, (15) Pembentukan tanah.
C. Budaya : (16) Estetika, (17) Rekreasi, (18) Warisan dan indentitas budaya, (20) Spiritual dan keagamaan, (21) Pendidikan.
D. Pendukung : (22) Habitat berkembang biak, (23) Perlindungan plasma nutfah

Berdasarkan pengertian dan klasifikasi di atas, terdapat kesamaan substansi pengertian jasa ekosistem dengan daya dukung dan daya tampung lingkungan hidup, dimana pengertian jasa penyediaan, budaya lebih mencerminkan konsep daya dukung lingkungan dan jasa pengaturan memiliki kesamaan susbtansi dengan daya tampung lingkungan. Sedangkan jasa pendukung bisa bermakna dua yaitu daya dukung maupun daya tampung lingkungan

Secara operasional, kajian ini menetapkan daya dukung dan daya tampung lingkungan hidup dengan pendekatan konsep jasa ekosistem, dengan pengembangan asumsi dasar sebagai berikut :

- Semakin tinggi jasa ekosistem suatu wilayah, maka semakin tinggi kemampuan lingkungan hidup untuk mendukung perikehidupan manusia, makhluk hidup lain, dan keseimbangan antar keduanya (lihat jasa penyediaan, Jasa budaya, dan pendukung)
- Semakin tinggi jasa ekosistem suatu wilayah, maka semakin tinggi kemampuan lingkungan hidup untuk menyerap zat, energi, dan/atau komponen lain yang masuk atau dimasukkan ke dalamnya (lihat jasa pengaturan)

Konsep daya dukung dan daya tampung lingkungan hidup berbasis jasa ekosistem tersebut di atas, secara operasional dilakukan dengan menggunakan pendekatan keruangan yaitu

menghitung tingkat daya dukung dan daya tampung lingkungan hidup jasa ekosistem sebanyak 6 jenis jasa ekosistem yang bersesuaian dengan isu – isu wilayah TN Komodo sesuai dengan sektor wisata pada jalur trekking, dan 7 jasa ekosistem pada wisata perairan. Berdasarkan isu kewilayahan yang ada maka terdapat enam jasa ekosistem yang terkait dengan bentanglahan wisata trekking yaitu jasa penyedia pangan, air bersih, jasa pengaturan iklim, kebencanaan, jasa estetika, dan jasa pendukung biodiversitas. Sementara itu, 7 jasa wisata perairan adalah jasa pangan, serat, iklim, kebencanaan (erosi/abrasi), Rekreasi, biodiversitas, dan siklus nutrient.

Secara khusus, konsep DDDTLH dengan pendekatan jasa ekosistem ini dipilih dalam kajian di Taman Nasional Komodo karena secara operasional dilakukan pada dua parameter yang mempengaruhi kondisi permukaan bumi yaitu eksogen dan endogen. Proses endogen diwakili oleh kondisi ecoregionnya (bentuk lahan), proses eksogen dicerminkan dalam kondisi tutupan lahan diatasnya, sementara itu kondisi keduanya dilihat secara spesifik kedalam beberapa parameter yang menentukan aktifitas wisata, yaitu keragaman vegetasi, kondisi lansekap, keanekaragaman satwa, kelerengan, dan curah hujan. Secara khusus DDDTLH jasa ekosistem ini menggambarkan indikasi kondisi daya dukung dan daya tampung di suatu wilayah, sehingga penerapan pendekatan ini dapat dilakukan dengan efisien, tanpa mengurangi substansi yang dibutuhkan.

3.1.2 Konsep Daya Dukung Wisata

Pengelolaan pengunjung merupakan salah satu isu penting di dalam pengembangan pariwisata. Pengelola suatu kawasan wisata seringkali dihadapkan kepada sebuah pertanyaan berapa banyak wisatawan yang dapat diperkenankan untuk memasuki sebuah kawasan wisata?. Nijs (2013) menyebutkan bahwa tingkat kunjungan yang terlalu sedikit ataupun terlalu banyak pada suatu destinasi sama-sama dapat membawa dampak negatif akibat pengelolaan yang tidak

berkelanjutan. Untuk mengidentifikasi dan menetapkan batas kunjungan, maka diperlukan sebuah kajian daya dukung wisata yang dapat menjadi acuan dalam penyusunan perencanaan pariwisata yang berkelanjutan.

Istilah daya dukung wisata (tourism carrying capacity) bukanlah suatu konsep baru, istilah ini telah muncul sejak tahun 1960an dengan penekanan kepada batas ekologi dan secara perlahan berkembang dengan lebih memperhatikan aspek sosial budaya dan ekonomi (google, 2018). Konsep daya dukung ini pada awalnya berkembang dari ilmu ekologi yang berkaitan dengan daya dukung suatu habitat terhadap populasi satwa/binatang. Konsep ini kemudian diadopsi dan diaplikasikan untuk menghitung kapasitas suatu dsetinasi wisata. Stanley et al (1984) mereformulasikan daya dukung wisata sebagai batas perubahan yang dapat ditoleransi (*the limit of acceptable change*) dengan lebih menekankan kepada kondisi lingkungan yang diharapkan dibandingkan dengan batas sumber daya yang dapat dimanfaatkan. Dengan kata lain bahwa sumber daya dapat dimanfaatkan selama kondisi lingkungan yang muncul akibat dari penggunakan sumber daya tersebut masih sesuai dengan yang diinginkan.

Perkembangan ilmu pengetahuan dan munculnya pemikiran-pemikiran baru melahirkan beberapa pendekatan alternatif dalam rangka penghitungan daya dukung wisata. Model perhitungan daya dukung wisata yang lebih konvensional menekankan secara eksplisit terhadap batasan jumlah wisatawan atau jenis aktivitas yang

diperkenankan. Namun demikian dengan perkembangan *supply* dan *demand* untuk pariwisata mendorong proses diversifikasi produk wisata yang semakin beragam sehingga perlu pendekatan baru untuk menentukan kebijakan pengelolaan kawasan wisata. Daya dukung wisata saat ini lebih dilihat sebagai instrument pengelolaan yang tidak secara kaku digunakan untuk membatasi jumlah wisatawan tetapi dimanfaatkan untuk strategi untuk meningkatkan kemampuan pengelola. O'Rilley (1986) menjelaskan tiga aspek yang harus dipertimbangkan di dalam Penghitungan daya dukung wisata juga tidak hanya mempertimbangkan pengaruh wisata secara fisik terhadap lingkungan tetapi juga mengukur pengaruhnya terhadap kondisi ekonomi dan sosial budaya masyarakat. kenyataannya pada beberapa destinasi wisata kondisi masyarakatnya sangat rentan terhadap perubahan ekonomi dan sosial budaya akibat masuknya arus wisatawan dari luar. Pada kondisi tertentu jika melebihi daya dukungnya aktivitas wisata ini akan menimbulkan konsekuensi tidak hanya terhadap kondisi lingkungan secara fisik tetapi juga dapat merubah tatanan sosial budaya dan ekonomi masyarakat sekitar.

Kajian daya dukung adalah suatu mekanisme yang digunakan dalam pengelolaaan wisata untuk menentukan batas atas dalam hal pengembangan dan pengaturan pengunjung serta pemanfaatan potensi sumberdaya pariwisata yang optimal (Hasan et al, 2014). Beberapa metode dan pendekatan telah dikembangkan dalam rangka menghitung daya dukung suatu destinasi pariwisata. Hampir semua metode melihat kajian daya dukung wisata sebagai sebuah perangkat/instrumen pengelolaan (*management tool*) bagi pengelola untuk menyusun sebuah kebijakan yang terkait dengan pengelolaan pengunjung dalam rangka menciptakan sebuah destinasi pariwisata yang berkelanjutan.

Salah satu pendekatan yang banyak digunakan adalah metode kajian daya dukung wisata pada kawasan konservasi (protected areas) yang dikembangkan oleh Cifuentes (1992). Metode ini

menitikberatkan kemampuan daya dukung suatu destinasi wisata dari aspek ketersediaan ruang bagi wisatawan, faktor-faktor lingkungan yang mempengaruhi aktivitas wisatawan serta kemampuan manajemen dalam mengelola suatu destinasi. Cifuentes (1992) membagi pernghitungan daya dukung wisata menjadi 3 tahapan yaitu daya dukung fisik (Physical Carrying Capacity), daya dukung riil (Real Carrying Capacity) dan daya dukung efektif (Effective Carrying Capacity).

Secara operasional metode penghitungan daya dukung wisata yang dikembangkan oleh Cifuentes (1992) memiliki beberapa asumsi dalam penghitungannya antara lain :

1. Semakin besar areal yang tersedia bagi wisatawan untuk melakukan aktivitas wisata/rekreasi maka nilai daya dukung akan semakin besar.
2. Nilai daya dukung fisik lebih besar dari nilai daya dukung sebenarnya dan nilai daya dukung sebenarnya lebih besar dari nilai daya dukung efektif.
3. Besaran nilai dan jenis faktor koreksi (biofisik, lingkungan dan sosial) akan berbeda untuk setiap destinasi dan jenis aktivitas wisata.

3.2 Metode Daya Dukung Wisata Wilayah Terestrial

3.2.1 Daya Dukung Berbasis Jasa Ekosistem

Jasa Ekosistem adalah manfaat yang diperoleh oleh manusia dari berbagai sumberdaya dan proses alam yang secara bersama-sama diberikan oleh suatu ekosistem (MA, 2005). Dalam hal ini jasa ekosistem wisata berarti bahwa segala kemampuan lingkungan hidup yang ada dinilai dalam hal untuk mendukung perikehidupan manusia, makhluk hidup lain, dan keseimbangan antar keduanya yang terkait dengan wisata. Beberapa jasa ekosistem yang sesuai dan dapat digunakan sebagai pendukung dalam mengetahui daya dukung wisata antara lain jasa ekosistem pengaturan iklim, jasa ekosistem

pengaturan kebencanaan, jasa ekosistem estetika, dan jasa ekosistem pendukung biodiversitas.

1. Jasa Ekosistem Pengaturan Iklim

Ekosistem di Taman Nasional Komodo memiliki peran yang cukup besar dalam menjaga agar iklim tetap dapat terjaga dengan baik, sehingga kehidupan yang ada di wilayahnya, tetap dapat berlangsung sebagaimana mestinya. Selain itu peran jasa ekosistem pengaturan iklim ini juga terkait dengan kemampuan ekosistem dalam mengatur kondisi iklim lokal baik suhu, kelembaban & hujan, maupun gas rumah kaca / karbon.

2. Jasa Ekosistem Pengaturan Kebencanaan

Fungsi ekosistem di Taman nasional Komodo ini dalam kapasitasnya berfungsi sebagai infrastruktur alam untuk pencegahan dan perlindungan dari bencana alam seperti ; kebakaran hutan dan lahan, erosi, abrasi, longsor, tsunami, dll. Dalam kajian ini, pengaturan kebencanaan lebih difokuskan pada pencegahan kebakaran hutan dan lahan, serta longsor.

3. Jasa Ekosistem Estetika

Fungsi ekosistem di Taman Nasional Komodo berperan dalam menyediakan keindahan alam yang memiliki nilai jual. Semakin tinggi angka penyediaan jasa ekosistem estetika di Taman Nasional Komodo berarti bahwa keindahan alam yang ada memiliki nilai jual yang semakin tinggi juga.

4. Jasa Ekosistem Pendukung Biodiversitas

Fungsi ekosistem di Taman Nasional Komodo ini berperan dalam mendukung keanekaragaman hayati. Semakin tinggi angka jasa ekosistem pendukung biodiversitanya maka semakin tinggi pula keanegaragaman hayati yang ada.

5. Penilaian Jasa Ekosistem

Jasa ekosistem dinilai berdasarkan indeks jasa pada suatu unit analisis. Indek Jasa Ekosistem adalah nilai indek yang menunjukkan besar kecilnya nilai jenis-jenis jasa ekosistem. Nilai indeks jasa ekosistem berkisar antara 0 (kecil) – 5 (besar), yang ditampilkan

menurut administrasi atau unit wilayah perencanaan. Nilai Indek Jasa Ekosistem (IJE) pada hakekatnya adalah variasi nilai skor/koefisien Jasa Ekosistem yang dibobot dengan luas poligon (area). Secara singkat dirumuskan sebagai berikut:

$$IJE_{ix} = \frac{(KJE_{i,a} x\, LP_a) + (KJE_{i,b} x\, LP_b) + (KJE_{i,c} x\, LP_c) + ...(KJE_{i,n} x\, LP_n)}{LA_{tot}}$$

Keterangan:

IJE $_{i,x}$ = Nilai Indek Jasa Ekosistem Jenis i (misalnya pangan) di wilayah x (misalnya kecamatan atau wp tertentu)

KJE $_{i,x}$ = Koefisien/skor Jasa Ekosistem Jenis i (misalnya pangan) di poligon a

LP_a = Luas Poligon a dengan nilai KJE a

LA_{tot} = Luas Poligon Total

Indek Jasa Ekosistem (IJE) ditampilkan menurut unit analisis wilayah adminsitrasi atau daya tarik wisata (DTW), untuk membandingkan secara relatif nilai jasa ekosistem antar wilayah administrasi atau DTW Indek Komposit Jasa Ekosistem adalah nilai gabungan dari indek jenis-jenis jasa ekosistem yang diperoleh dengan cara melakukan perhitungan rata-rata *(mean).* Indek Komposit Jasa Ekosistem ini merupakan dasar dari penentuan arahan pengelolaan suatu wilayah (unit administrasi atau DTW) agar sesuai dengan kondisi layanan ekosistemnya. Adapun formulasi IKJE adalah sebagai berikut:

$$IKJE_{i,x} = \frac{IJE_{i,x} + IJE_{j,x} + IJE_{k,x} + IJE_{l,x} + IJE_{m,x}}{\sum IJE}$$

Keterangan

IKJE $_{i,x}$ = Indek komposit jasa ekosistem untuk sektor wisata (6 atau 7 jasa ekosistem)

IJE $_{i,x}$ = Indek jasa ekosistem i (misalnya pangan, air bersih, serat, bahan bakar sumberdaya genetik), diwilayah x

∑IJE = Jumlah jasa ekosistem (dalam hal ini 6 atau 7 jasa ekosistem)

Indeks komposit ini juga dijadikan sebagai dasar dalam penentuan pengaruh suatu rencana di unit wilayah tertentu terhadap fungsi jasa ekosistemnya, melalui perbandingan antara indeks jenis jasa ekosistem dengan Indeks komposit jasa ekosistem. Jika IJE > dari IKJE, maka suatu unit wilayah memiliki pengaruh positif terhadap fungsi jasa ekosistemnya, dan sebaliknya.

6. Klasifikasi Daya Dukung Jasa Ekosistem Wisata

Daya Dukung dan Daya Tampung berbasis Jasa Ekosistem Sektor Wisata dibuat berdasarkan tumpangsusun unit analisis daya tarik wisata, jasa ekosistem, serta peta pendukung lainnya. Desain Daya Dukung dan Daya Tampung berbasis Jasa Ekosistem Sektor Wisata adalah sebagai berikut;

Tabel 3.1. Klasifikasi Daya Dukung dan Daya Tampung berbasis Jasa Ekosistem Sektor Wisata

DDDTLH	Ketentuan
Tinggi	IKJE > rerata IKJE wilayah
Rendah	IKJE < rerata IKJE wilayah

Sumber: KLHK

3.2.2 Daya Dukung Wisata Jalur Pengamatan (*Tracking*)

Penghitungan daya dukung wisata pada wilayah terrestrial atau daratan dilakukan untuk jenis aktivitas wisata yang umum dilakukan di Kawasan TN Komodo yaitu kegiatan mendaki. Pendekatan yang digunakan untuk menghitung nilai daya dukung wisata di darat sama dengan yang digunakan untuk menghitung nilai daya dukung wisata perairan yaitu daya dukung yang berbasis kepada ketersediaan ruang (*physical carrying capacity*) yang dikembankan oleh Cifuentes (1992). Namun demikian parameter yang digunakan berbeda dengan parameter yang digunakan untuk menghitung daya dukung wisata di perairan. Daya dukung merupakan kemampuan dari suatu sistem untuk mendukung (support) suatu aktivitas sampai pada level tertentu. Dalam perspektif biofisik wilayah, daya dukung dapat didefinisikan sebagai jumlah maksimum populasi yang dapat didukung oleh suatu wilayah,

sesuai dengan kemampuan teknologi yang ada (Binder and Lopez, 2000). Persamaan yang digunakan untuk menghitung nilai daya dukung wisata di darat adalah sebagai berikut:

$$K(RCC) = PCC\, x\, Cf_1\, x\, Cf_2 ... x\, Cf_n$$

Keterangan:

RCC = *Real Carrying Capacity*

PCC = *Physical Carrying Capacity*

Cf = *Correction factor*

$$PCC = A\, x \frac{1}{B}\, x\, Rf$$

Keterangan

A = Luas Area yang digunakan untuk wisata (jalur trekking)

B = Luas area yg dibutuhkan oleh seorang wisatawan dengan tetap memperoleh kepuasan, sebesar 1 m (Querioz et al, 2014)

Rf = Faktor Rotasi

1. Faktor Koreksi

Variabel yang digunakan untuk melakukan koreksi Daya Dukung Wisata yakni sebagai berikut:

Tabel 3.2. Variabel koreksi untuk Daya Dukung Wisata

Variabel	Mn	Mt	Pustaka Terkait
Diversitas Vegetasi	Data Primer	1	Odum (1993)
Diversitas Satwa	Data Primer	1	Odum (1993)
Potensi Landsekap	Data Primer	33	Sustri (2003)
Gangguan Musim Kawin Komodo	Data Primer	1	Modifikasi, Khair (2006)
Kelerengan	ASTER GDEM	65	Muta'ali (2012)
Kepekaan Erosi	Data Sekunder	0.64	Muta'ali (2012)
Curah Hujan	Data Sekunder	7	BPS / BROL

2. Variabel Biotik (Diversitas Vegetasi dan Diversitas Satwa)

Variabel biotik ini digunakan sebagai bagian dari penentuan nilai ECC meliputi diversitas vegetasi dan diversitas satwa. Mendata faktor koreksi ECC dalam bentuk diversitas spesies untuk

pepohonan/vegetasi dan satwa (indeks diversitas Simpson) (Odum, 1993). Sampel pada sepanjang jalan trek wisata dan areal wisata didata jenis dan jumlah individu. Masing-masing diterapkan secara terpisah yaitu untuk faktor koreksi untuk diversitas pepohonan dan faktor koreksi untuk diversitas burung. Data-data yang diperoleh kemudian dihitung untuk memperoleh indeks dominansi (λ) untuk menghitung indeks diversitas simpson (ID) masing-masing untuk pepohonan dan burung.

$$ID = 1 - \lambda$$

$$\lambda = \frac{\sum_{i=1}^{s} ni(ni-1)}{n(n-1)}$$

Keterangan:

s = jumlah spesies;

ni = jumlah individu spesies ke-i;

n = jumlah individu semua spesies.

3. Variabel Abiotik/ Potensi Lansekap

Variabel abiotik ini digunakan sebagai bagian dari penentuan nilai ECC. Mendata faktor koreksi dalam ECC bentuk Potensi lansekap (indeks Bureau of Land Management) (Sustri, 2003) Dinilai berdasarkan poin kriteria pada masing-masing unsur lansekap yaitu bentuk (landform), vegetasi (vegetation), warna (colour), pemandangan (scenery), kelangkaan (scarcity) dan modifikasi struktural sebagaimana tabel berikut:

Tabel 3.3. Penilaian terhadap Indeks Potensi Lansekap Areal Wisata

No	Kriteria	Skor
1	Bukit rendah dan berombak; bukit di kaki gunung atau dasar lembah bukan ciri-ciri lansekap yang menarik.	1

	Ngarai/ lereng yang curam, kerucut gunung api atau pola-pola erosi yang menarik atau variasi ukuran dan bentuk lahan atau ciri-ciri detil yang dominan.	3
	Relief vertikal yang tinggi yang ditujukan adanya puncak mencolok; puncak seperti menara; singkapan batuan raksasa atau variasi permukaan yang menakjubkan; formasi-formasi yang mudah tererosi atau ciri dominan yang sangat mencolok.	5
2	Sedikit atau tidak ada perbedaan vegetasi.	1
	Beberapa jenis vegetasi tetapi hanya 1-2 jenis yang dominan.	3
	Sebuah variasi dari tipe vegetasi yang ditunjukkan dengan pola, tekstur dan bentuk yang menarik.	5
3	Variasi warna yang halus dan kontras, umumnya bersifat mati.	1
	Terdapat jenis-jenis warna, ada pertentangan dari tanah, batu dan vegetasi tetapi bukan pemandangan yang dominan.	3
	Kombinasi warna yang beragam jenis atau pertentangan yang indah dan warna tanah, batu, vegetasi air dan lain-lain.	5
4	Pemandangan di dekatnya sedikit/ tidak berpengaruh terhadap kualitas pemandangan.	0
	Pemandangan di dekatnya cukup berpengaruh terhadap kualitas pemandangan.	3
	Pemandangan di dekatnya sangat berpengaruh terhadap kualitas pemandangan.	5
5	Mempunyai latar belakang yang menarik tetapi hampir sama dengan keadaan umum dalam suatu daerah.	1
	Khas meskipun hampir sama dengan daerah tertentu.	3

	Suatu area yang khas/ berbeda dengan obyek lainnya sehingga menimbulkan kesan.	5
6	Modifikasi menambahkan variasi tetapi sangat bertentangan dengan alam dan menimbulkan ketidakharmonisan.	-4
	Modifikasi menambah sedikit atau sama sekali keragaman pemandangan.	0
	Pembangunan sarana-sarana seperti instalasi/ listrik, saluran air, rumah memberikan modifikasi yang mampu menambah keragaman visual; tidak ada modifikasi.	2
Jumlah Indeks potensi lansekap		27

Sumber: Bureau of Land Management dalam Fandeli dan Muhammad (2009)

4. Variabel Gangguan Musim Kawin Komodo

Mendata faktor koreksi ECC dalam bentuk gangguan terhadap musim kawin kawin komodo (Khair, 2006)

$$Cf_n = \frac{G_n}{G_t} x100\%$$

Keterangan:

G_n= jumlah bulan terjadinya musim kawin;

G_t = jumlah bulan dalam setahun.

5. Variabel Kelerengan

Mendata faktor koreksi ECC dalam bentuk indeks kelerengan (Muta'ali, 2012). Dinilai berdasarkan tingkat kelerengan sebagaimana pada tabel berikut:

Tabel 3.4. Sistem skoring pada kriteria lereng

Kelas Lereng	Klasifikasi Kelas Lereng (%)	Klasifikasi Kelas Lereng (%) (modifikasi)	Keterangan	Nilai
1	0 – 8	0 - < 8	Datar	20
2	8 – 15	8 - < 15	Landai	40
3	15 - 25	15 - < 25	Agak Curam	60
4	25 - 40	25 - < 40	Curam	80
5	> 40	≥40	Sangat Curam	100

Sumber: SK. Menteri Pertanian No.837/KPTS/UM/11/1980 dalam Muta'ali (2012)

6. Variabel Kepekaan Erosi

Mendata faktor koreksi ECC dalam bentuk kepekaan erosi tanah (indeks tingkat erosi) (Muta'ali, 2012) Kepekaan tanah dinilai berdasarkan jenis tanah sebagaimana tabel berikut:

Tabel 3.5 Indeks kepekaan tanah terhadap erosi

Kelas Tanah	Klasifikasi Jenis Tanah	Klasifikasi Jenis Tanah	Nilai
1	Alluvial, tanah glei, pansol, hidromorf kelabu, lateria air tanah	Tidak peka	15
2	Latosol	Agak peka	30
3	Brown forest soil, non calcic	Kurang peka	45
4	Andosol, lateritik, gromosol podsolik	Peka	60
5	Regosol, litosol, organosol, rensina	Sangat peka	75

Sumber: SK. Menteri Pertanian No.837/KPTS/UM/11/1980 dalam Muta'ali (2012).

7. Variabel Curah Hujan

Mendata faktor koreksi ECC dalam bentuk rasio/ indeks nilai Q [bulan kering/basah]) selama 10 tahun terakhir (Lakitan, 1997).

$$Q = \frac{\sum rata - rata\, bulan\, \ker ing}{\sum rata - rata\, bulan\, basah}$$

Keterangan:

- Bulan kering adalah bulan dengan curah hujan <60 mm.
- Bulan lembab adalah bulan dengan curah hujan 60-100 mm.
- Bulan basah adalah bulan dengan curah hujan > 100 mm

3.3 Metode Daya Dukung Wisata Wilayah Perairan

3.3.1 Analisis Kesesuaian Perairan untuk Pariwisata

Kesesuaian lahan untuk wisata perairan dilakukan untuk mendapatkan wilayah mana saja dalam suatu area model zonasi yang sesuai untuk wisata menyelam dengan obyek daya Tarik wisata yaitu terumbu karang. Menurut Ketjulan (2010), analisis kesesuaian didasarkan pada potensi sumber daya yang ada dan parameter

kesesuaian untuk setiap kegiatan wisata. Kesesuaian wisata bahari, sebagai ketetapan atau kecocokan penggunaan sumberdaya kelautan terhadap suatu kegiatan dikarenakan setiap kegiatan wisata bahari mempunyai persyaratan sumberdaya lingkungan yang sesuai dengan objek wisata yang akan dikembangkan (Ketjulan, 2010). Yulianda (2007), merumuskan beberapa parameter yang dapat mempengaruhi kelayakan suatu perairan untuk dijadikan lokasi wisata selam atau snokeling. Parameter tersebut temasuk kondisi ekosistem terumbu karang dan juga kondisi oseanografi perairan. Ada 4 parameter pokok dalam penentuan kesesuaian terumbu untuk wisata yaitu 1). Sebaran Tutupan Terumbu Karang, 2). Kecerahan Perairan, 3). Kedalaman Terumbu Karang / kedalaman periaran, serta 4). Kecepatan Arus (Yulianda, 2007).

1. Sebaran Tutupan Terumbu Karang

Identifikasi sebaran terumbu dan kecerahan perairan dilakukan melalui beberapa tahapan pengolahan citra satelit. Berikut merupakan tahapan pengolahan data citra satelit SPOT 6/7 untuk menghasilkan sebaran terumbu dan kecerahan perairan;

Pra Pemrosesan *Data*

- Koreksi Geometri
- Koreksi Sunglint

Koreksi sunglint dilakukan untuk menghilangkan efek pantulan cahaya pada perairan dangkal yang menyebabkan informasi habitat bentik perairan dangkal tidak terlihat. Sunglint dapat dihilangkan menggunakan saluran inframerah. Persamaan yang digunakan untuk menghilangkan sunglint yaitu:

$$Ri' = Ri - bi\,x\,(R_{NIR} - M_{NIR})$$

Keterangan:

R_i' = nilai reflektan dari saluran *visible*

b_i = nilai Regression *slope* yang diperoleh dari analisis regresi

R_{NIR} = nilai reflektan saluran inframerah dekat

M_{NIR} = nilai minimum reflektan pada saluran inframerah dekat

- Pan-sharpening

Pansharpening dilakukan untuk menajamkan citra satelit secara spasial dengan cara menggabungkan dua citra yang memiliki spesifikasi berbeda. SPOT 6/7 memiliki resolusi spasial 6 m untuk saluran multispectral dan 1,5 m untuk saluran pankromatik. Citra multispectral pada SPOT 6/7 dilakukan fusi dengan citra pada saluran pankromatik sehingga akan menghasilkan citra multispectral dengan resolusi yang lebih tinggi. Dengan begitu akan lebih mudah dalam mengidentifikasi objek karena secara visual lebih tajam

- Interpretasi visual

Interpretasi dilakukan secara visual menggunakan citra hasil pan-sharpening. Objek terumbu karang dibedakan ke dalam 2 kelas yaitu terumbu karang hidup dan terumbu karang mati (*dead coral)*.

- Reinterpretasi

Reinterpretasi dilakukan untuk memvalidasi hasil interpretasi dengan data lapangan.

2. Kecerahan Permukaan Perairan

Pra Pemrosesan Data

- Koreksi Geometri
- Koreksi Radiometri

Koreksi radiometrik pada citra SPOT-6 dilakukan hingga mendapatkan nilai *at surface reflectanc*e. Koreksi ini terdiri dari 3 tahap yaitu kalibrasi sensor untuk mengkonversi DN ke nilai *TOA Radiance*, koreksi *sunlight* untuk mendapatkan nilai *at sensor reflectance,* dan yang terakhir koreksi atmosfer untuk meminimalisir gangguan atmosfer dan untuk mendapatkan nilai *at surface reflectance*.

Konversi DN ke nilai *TOA Radiance* (Astrium, 2013)

$$Lb = \frac{DNi}{Gi} + BIAS$$

Keterangan:

Lb = Nilai spektral radian

Gi = *Gain* setiap saluran

DNi = *digital number* tiap saluran

BIAS = nilai BIAS = 0

Konversi nilai *TOA Radiance* ke *TOA Reflectance* (Astrium, 2013)

$$\rho_b = \frac{\Pi \, x \, Lb \, x \, d2}{ESUNi \, x \cos\theta}$$

Keterangan:

ρ_b = Nilai reflektan

Lb = Nilai spektral radian

d^2 = Jarak bumi dan matahari dalam astronomi

ESUNi = *Solar Irradiance* tiap saluran

DNi = *digital number* tiap saluran

Koreksi TOA menghasilkan citra yang tajam dan jelas secara karena koreksi ini menghilangkan efek kekaburan (LAPAN, 2014).

- Koreksi Atmosferik

Koreksi atmosferik DOS menggunakan piksel objek tergelap sebagai kalibrasi. Objek tergelap dapat berupa air jernih (laut dalam) maupun bayangan awan. Formula koreksi DOS:

$$\rho_s = \rho_i - \rho_{si}$$

Keterangan:

ρ_s = Surface *Reflectance*

ρ_i = TOA reflectance pada saluran i

ρ_{si} = Path *Radiance* dalam saluran i

ρ_{si} = *Mean* ρ *dark object* dalam saluran i – (standar deviasi ρ *dark object* dalam saluran i)

- Koreksi Sunglint

Koreksi sunglint dilakukan untuk menghilangkan efek pantulan cahaya pada perairan dangkal yang menyebabkan informasi habitat bentik perairan dangkal tidak terlihat. Sunglint dapat dihilangkan menggunakan saluran inframerah. Persamaan yang digunakan untuk menghilangkan sunglint yaitu:

$$Ri' = Ri - bi \, x \, (R_{NIR} - M_{NIR})$$

Keterangan:

R_i' = nilai reflektan dari saluran *visible*

b_i = nilai *Regression slope* yang diperoleh dari analisis regresi

R_{NIR} = nilai reflektan saluran inframerah dekat

M_{NIR} = nilai minimum reflektan pada saluran inframerah dekat

- Masking Citra

Masking citra dilakukan untuk memisahkan antara daratan dan lautan. Pemrosesan ini dilakukan untuk menghindari pengaruh nilai piksel yang ada di daratan terhadap nilai piksel yang ada di area kajian yaitu perairan. Masking area dilakukan dengan menggunakan data vektor daratan dan lautan yang didigitasi berdasarkan garis pantai.

- Transformasi Spektral Kejernihan Air Permukaan

Transformasi spektral diterapkan untuk mengestimasi nilai kejernihan air permukaan. Pendugaan nilai kejernihan air permukaan menggunakan beberapa saluran yaitu saluran biru dan saluran merah yang diadopsi dari penelitian yang dilakukan oleh:

1) Olmason, dkk (2001) dan Kloiber, dkk (2002) menggunakan citra Landsat 5 TM merumuskan:

   Ln (SDT) = a(band1/band3) + b(band1) + c

   Dengan nilai R^2 = 0,63 – 0,75, sehingga dapat dirumuskan pada citra SPOT 6/7:

   Ln (SDT) = B_{biru}/B_{merah} dan B_{biru} menggunakan regresi linear berganda

2) Chipmann, dkk (2004) merumuskan:

   Ln (SDT) = B_{biru}/B_{merah}

3. Kriteria Kesesuaian Perairan untuk Pariwisata

Penentuan kesesuaian wilayah perairan untuk kegiatan pariwisata dilakukan dengan melakukan pembobotan terhadap masing-masing parameter (sebaran terumbu karang, kecerahan perairan, kedalaman perairan dan kecepatan arus) dengan kriteria seperti pada table x dibawah. Selanjutnya dilakukan klasifikasi kesesuaian perairan untuk

pariwisata yang dikelompokkan menjadi beberapa kelas kesesuaian sebagai berikut:

- Kelas S1: Sangat sesuai (*highly suitable*) atau tidak mempunyai pembatas yang serius untuk suatu penggunaan secara lestari atau hanya mempunyai pembatas yang tidak berarti, dan dipengaruhi secara nyata terhadap produksinya, serta tidak menaikkan masukan yang lebih besar dari yang telah diberikan.
- Kelas S2: Sesuai bersyarat (*marginaly suitable*) atau mempunyai pembatas- pembatas yang serius untuk mempertahankan tingkat pengelolaan yang harus diterapkan. Pembatas akan mengurangi produksi dan keuntungan atau lebih meningkatkan masukan yang diperlukan.
- Kelas N: Tidak sesuai (*currently not suitable*) atau lahan yang mempunyai pembatas yang lebih serius yang masih memungkinkan untuk diatasi, akan tetapi upaya perbaikan ini tidak dapat dilakukan dengan tingkat pengelolaan menggunakan modal normal. Keadaan pembatasnya sedemikian sehingga mencegah penggunannya secara berkelanjutan.

Dalam penentuan kesesuaian wisata selam dan snorkeling, telah ditentukan beberapa parameter dengan kriteria oleh seperti pada tabel berikut.

Table 3.6 Besaran nilai bobot dan skor dalam penentuan kelas kesesuaian perairan untuk pariwisata di TN Komodo

No.	Parameter	Bobot	Kelas	Skor
1	Kecerahan Perairan (%)		80	4
			≥50 - <80	3
			≥20 - <50	2
		5	<20	1
2	Tutupan komunitas karang (%)		>75	4
			>50 - ≤75	3
			>25 - ≤50	2
		5	≤25	1
3	Kecepatan arus (cm/s)		<15	4
			>15 - ≤30	3
			>30 - ≤50	2
		1	>50	1
			6 - 15	4

4	Kedalaman terumbu karang (meter)		>15 - 20	3
			>20 - 30	2
			>30 dan <1	1

Matriks tersebut digunakan sebagai acuan untuk menggunakan indeks kesesuaian wisata dalam penentuan kesesuaian suatu lokasi dalam penentuan kawasan wisata.

$$IKW = \sum \left(\frac{Bobot\ x\ Skor}{N\ Maks} \right) x100$$

Setelah ditemukan indeks kesesuaian wisata, maka dapat ditentukan kesesuaian suatu wilayah dengan kategori pada Tabel berikut,

Table 3.7. Kategori kelas kesesuaian perairan untuk pariwisata di TN Komodo

No.	Kategori	Kelas Kesesuaian (%)
1	S1(Sesuai)	≥83 – 100
2	S2(Sesuai	≥50 – <83
3	N (Tidak Sesuai)	<50

Sumber: Yulianda, 2007

3.3.2 Daya Dukung Wisata Menyelam (*Diving)*

Berdasarkan Rios Jaro (2013) yang melakukan penelitian daya dukung wisata di Meksiko dan di Colombia (Fransisco et all, 2014) dalam Yuneni et all (2017)), maka dengan metodelogi yang hampir serupa dengan beberapa modifikasi, daya dukung wisata selam dengan

Foto: WWF Indonesia

memperhatikan beberapa faktor di 14 lokasi penyelaman favorit di Taman nasional Komodo yang terbagi di bagian utara (Castle Rock, Crystal Rock, Golden Passage, The Cauldron), bagian tengah (Batu Bolong, Karang Makassar, Mawan, Pengah Kecil, Tatawa Besar, Tatawa Kecil, Siaba Besar, Siaba Kecil), dan bagian selatan (Manta Alley). Pada dasarnya tidak ada batas untuk bagian utara, tengah maupun selatan, namun para pelaku wisata sering menyebut 3 bagian tersebut demi memudahkan dalam perencanaan penyelaman.

Dalam perhitungan daya dukung wisata ini area yang digunakan adalah luasan area dimana pengambilan langsung (GPS Tracking) dan mengestimasi panjang dan lebar yang digunakan untuk penyelaman efektif bagi para wisatawan. Tourism Carrying Capacity (TCC) atau Daya Dukung Wisata pada dasarnya adalah menghitung jumlah penyelam di dive site tertentu dalam satu hari yang bisa diterima dengan menggunakan faktor koreksi yang sesuai dengan masing-masing kawasan konservasi. Tentunya Taman Nasional Komodo akan berbeda dengan kawasan lain seperti Taman Nasional Wakatobi atau Kawasan Konservasi Perairan Daerah Flores Timur misalnya. Daya dukung wisata ditetapkan oleh level dampak yang dapat diterima (Davis and Tisdell, 1996). Selain faktor koreksi, hal lain yang dinilai adalah kapasitas pengelola yang dinilai oleh wisatawan yang berkunjung ke Taman Nasional Komodo.

Perhitungan daya dukung wisata dengan menggunakan metode oleh Cifuentes (1999) dengan beberapa koreksi faktor yang telah diadopsi oleh Rios Jara (2013) yang disesuaikan dengan kondisi bawah laut dengan memperhatikan resiko dan keretanan ekosistem, dengan 3 tahap yaitu:

- Perhitungan Phisical Carrying Capacity (PCC)
- Perhitungan Real Carrying Capacity (RCC); dan
- Perhitungan Tourism Carrying Capacity (TCC)

1. Physical Carrying Capacity (PCC)

PCC adalah perhitungan yang dilakukan untuk mengestimasi maksimal jumlah kunjungan secara fisik bisa diterima di area tertentu dengan periode waktu tertentu pula, dengan rumus sebagai berikut:

$$PCC = \left(\frac{S}{SP}\right) x\, NV$$

Keterangan:

PCC : Physic Carrying Capacity

S : Available Surface Linear/Panjang Rute Penyelaman (meter)

SP : Used Surface/Area yang digunakan dari penyelam (meter)

NV : Jumlah kunjungan (visits) yang bisa diulang saat penyelaman (Visits/day/dive site)

Dimana nilai NV didapatkan dari:

$$NV = \frac{Vt}{Tv}$$

Keterangan:

NV : Jumlah kunjungan (visits) yang bisa diulang saat penyelaman (Visits/day/dive site)

Vt : Total potensial waktu dalam 1 hari

Tv : Waktu yang digunakan dalams setiap kunjungan

2. Real Carrying Capacity (RCC)

Dalam mendapatkan nilai RCC, faktor koreksi sangat diperlukan yang pastinya berbeda didalam dive site tertentu. Menurut Gallo, et all (2003) perhitungan dasar dalam mengukur faktor berdasarkan formula dasar yaitu:

$$CFx = 1 - \frac{Lmx}{Tmx}$$

Keterangan:

CFx : Koreksi faktor variable x

Lmx : Besaran maksimal variable x

Tmx : nilai besaran total dari variable x

Faktor koreksi yang didapatkan bisa dimengerti dalam hal statistik probablitas dimana koreksi tersebut sama dengan kemungkinan hal-hal yang terjadi dalam variable x yang berhubungan dengan frekuensi relatif

dari x yang diestimasi berdasarkan pengamatan langsung ketika di lapangan atau menggunakan informasi yang sudah ada untuk mengetahui kondisi fisik dan biologi dalam dive site. Dengan demikian, faktor koreksi ini juga secara kuantitatif mengestimasi kemungkinan hal-hal yang tidak terjadi pula dalam variable x. Dalam hal ini koreksi faktor menggunakan pendekatan kuantitif, dimana kemungkinan x bisa tidak terjadi, CFx = 1 p(x).

Dalam penelitian ini, RCC dapat dilihat dengan faktor koreksi sebagai berikut:

$$RCC = PCC\, x\, Cfsos\, x\, CFfg\, x\, CFda\, x\, Cfwind$$

Dimana nilai tersebut adalah:

RCC: Real Carrying Capacity (RCC)

PCC: Physical Carrying Capacity (PCC)

Dengan nilai koreksi:

- Cfsos: Faktor Koreksi Sosial (Social Correction Factor), faktor ini menggunakan aspek yang berbeda dalam kualitas kunjungan untuk mendapatkan kepuasan yang menyenangkan selama pesiar. Hal ini berdasarkan jumlah grup, durasi penyelaman, dan jarak antar grup untuk mengurangi ‘kemacetan’ di bawah laut dan meningkatkan pengawasan dan kontrol terhadap penyelam.
- CFfg: Perhitungan faktor koreksi kerapuhan (Fragility Factor) yaitu dengan mengestimasi tutupan karang keras yang sangat rentan karena penyelam sering berinteraksi dengan terumbu karang dan jangkar kapal (Hawkins and Roberts, 1992).
- Cfda: Faktor Koreksi ini berdasarkan dari frekuensi kontak dengan dasar perairan (terumbu karang maupun biota laut lainnya seperti hiu dan pari manta) dan kemungkinan ini dapat menyebabkan dampak. Koreksi ini disebut Faktor kerusakan akibat kontak penyelam (Damage due to contact Factor).
- Cfwind: Faktor Koreksi Angin (Wind Correction) ini dapat mempengaruhi secara langsung terkait dengan gelombang perairan

dan dapat menyebabkan kesulitan dalam mengakses dive site untuk beberapa saat

3. Tourism Carrying Capacity (TCC) / Effective Carrying Capacity

Dalam estimasi Daya dukung wisata sangat berhubungan dengan Kapasitas Pengelola atau Management Capacity (MC). Dalam penelitian Fransisco (2014) di Colombia estimasi ini juga sering disebut juga Daya Dukung Efektif atau Effective Carrying Capacity (CEE) yang didefinisikan sebagai kondisi terbaik yang pengelola seharusnya upayakan dan dapat disesuaikan dengan kepuasan pelanggan. Nilai TCC bisa didapat dengan:

$$TCC = RCC \, x \, MC$$

TCC : Tourism Carrying Capacity

RCC : Real Carrying Capacity/Daya Dukung

MC : Management Capacity

Dalam mendapatkan nilai MC yaitu dengan mengestimasikan dari perhitungan beberapa variable seperti infrastruktur, peralatan-peralatan, kapasitas personel yang ada di dalam Taman Nasional Komodo, dan penyedia layanan wisata. Nilai MC dapat optimal jika pengelola dapat mengembangkan aktivitasnya dan mencapai tujuan/sasarannya. (Cifuentes and others, 1999), sedangkan dalam hal ini Taman Nasional Komodo upayanya dalam mencapai visi dan misi. Metode yang digunakan adalah interview kepada pengunjung Taman Nasional yang menilai bagaimana variable tersebut berjalan saat melakukan wisata di dalam kawasan.

BAB IV

HASIL KAJIAN

4.1 Daya Dukung Wisata Wilayah Terestrial TN Komodo

4.1.1 Daya Dukung Berbasis Jasa Ekosistem Taman Nasional Komodo

Hasil penilaian Jasa Ekosistem dan Daya Dukung Wisata di Pulau Komodo menunjukkan tingkatan yang berbeda-beda pada masing-masing jenis jasanya yang dipengaruhi oleh beberapa variabel antara lain keragaman vegetasi, keragaman satwa, kondisi kelerengan dan kondisi lansekap. Keragaman vegetasi meliputi jumlah jenis vegetasi pohon yang dijumpai di sepanjang jalur serta jumlah vegetasi berkayu pada masing – masing tangka (Tingkat Semai, Pancang, Tiang dan Pohon). Keragaman satwa dilihat dari perbandingan komposisi keragaman dan jumlah jenis satwa. Kondisi kelerengan meliputi kelas lereng datar, landai, agak curam, curam dan sangat curam. Kemudian yang terakhir adalah kondisi lansekap yang dilihat dari kondisi keindahan lansekap berdasarkan kriteria keindahan.

Tabel 4.1. Daya Dukung Jasa Ekosistem di Pulau Komodo

Nama Jalur	Panjang Track (m)	JE Wisata Tracking	Pangan	AirBersih	Iklim	Kebencanaan	Estetika	Biodiversitas	PCC	RCC	ECC	JUMLAH WISATAWAN
Dekat Sulphurea	486.66	3.79	Tinggi	Tinggi	Rendah	Rendah	Rendah	Tinggi	6813	49	36	36-49
Hutan asam banu nggulung	1014.16	3.79	Tinggi	Tinggi	Rendah	Rendah	Rendah	Tinggi	14198	102	74	74-102
Hutan asam dikit	545.16	3.91	Tinggi	Tinggi	Rendah	Rendah	Tinggi	Rendah	7632	55	40	40-55
Loh Liang Ara	5005.58	3.90	Tinggi	Tinggi	Rendah	Rendah	Tinggi	Rendah	14016	85	62	62-85
Loh Liang Sebita	8365.13	3.98	Tinggi	Tinggi	Rendah	Rendah	Tinggi	Rendah	14639	89	65	65-89
Short trek	2098.96	3.91	Tinggi	Tinggi	Rendah	Rendah	Tinggi	Rendah	14693	95	69	69-95
Sulphurea Banunggulung	914.18	3.79	Tinggi	Tinggi	Rendah	Rendah	Rendah	Tinggi	12799	92	67	67-92
Sulphurea trail	488.82	3.79	Tinggi	Tinggi	Rendah	Rendah	Rendah	Tinggi	6844	49	36	36-49
Komodo Unnamed Track	875.76	3.91	Tinggi	Tinggi	Rendah	Rendah	Tinggi	Rendah	12261	88	64	64-88

Sumber: Hasil Analisis P3E Bali Nusra

1. Jasa Ekosistem Pangan

Berdasarkan hasil analisa jasa ekosistem dan daya dukung wisata di Pulau Komodo pada jasa ekosistem pangan (dapat dilihat pada tabel

4.1) menunjukkan hasil yang baik (berada pada kelas tinggi) di seluruh jalur trekking. Tingginya kelas jasa ekosistem pangan ini menunjukkan bahwa indeks pangan di Pulau Komodo memiliki angka yang lebih tinggi dibandingkan dengan indeks wisata. Variabel yang paling berpengaruh terhadap tingginya jasa ekosistem pangan di Pulau Komodo yakni variabel keragaman vegetasi cukup besar. Peran vegetasi dalam mendukung penyediaan pangan karena vegetasi tingkat pohon dan tiang mampu menghasilkan buah yang dapat dimanfaatkan sebagai bahan pangan.

Kondisi jasa ekosistem penyediaan pangan di Pulau Padar juga berada pada kondisi baik yang ditunjukkan pada Tabel 4.2 tergolong dalam kelas tinggi yang artinya kemampuan ekosistem dalam menyediakan pangan masih dalam kondisi yang baik. Sementara itu kondisi jasa ekosistem pangan di Pulau Rinca sedikit mengalami perbedaan (dapat dilihat pada tabel 4.3) yakni pada jalur trekking dekat ke loh kima bak air dan jalur trekking oh buaya loh kima berada pada kelas jasa ekosistem pangan rendah. Kondisi jasa ekosistem pangan rendah yang artinya bahwa indeks pangan yang dihasilkan memiliki angka yang lebih rendah dibandingkan indeks jasa ekosistem wisata. Selain itu jasa ekosistem pangan rendah artinya bahwa ekosistem yang ada pada jalur trekking tersebut kurang mampu dalam penyediaan pangan.

Tabel 4.2 Jasa Ekosistem di Pulau Padar

Nama Jalur	Panjang Track (m)	JE Wisata Tracking	Pangan	AirBersih	Iklim	ebencanaa	Estetika	iodiversita	PCC	RCC	ECC	JUMLAH WISATA WAN
Padar Treking	4820.81	2.17	Tinggi	Tinggi	Rendah	Rendah	Tinggi	Rendah	19283	68	49	49-68

2. Jasa Ekosistem Air Bersih

Jasa ekosistem penyediaan air bersih di Pulau Komodo menunjukkan hasil yang baik (berada pada kelas tinggi) di seluruh jalur trekkingnya. Apabila dilihat dari indeks jasa ekosistem yang dihasilkan menunjukkan bahwa indeks jasa ekosistem air bersih lebih tinggi dibandingkan indeks wisata yang dihasilkan pada setiap jalur

trekkingnya sehingga jasa ekosistem air bersih berada pada kelas tinggi. Variabel yang paling berpengaruh terhadap jasa ekosistem penyediaan air bersih yakni keragaman vegetasi dan faktor kelerengan. Tingginya penyediaan air bersih ini berarti bahwa jumlah keragaman vegetasinya tinggi dengan kondisi lereng yang cenderung datar sehingga mampu menyimpan cadangan air bersih lebih banyak. Berdasarkan Tabel 4.2 menjukkan bahwa jasa ekosistem air bersih di Pulau Padar juga berada berada pada kondisi yang baik yakni berada pada kelas tinggi. Sementara itu untuk di Pulau Rinca memiliki perbedaan yang cukup jauh dimana dominan jalur trekkingnya berada pada jasa ekosistem air bersih kelas rendah yang artinya ekosistem diwilayah tersebut kurang mampu dalam menyediakan air bersih. Variabel yang sangat berpengaruh terhadap air bersih adalah variabel keragaman vegetasi dan kondisi lereng. Semakin jarang vegetasi berupa pohon dan lerengnya semakin curam maka akan semakin sedikit kemampuannya untuk menyimpan air.

Tabel 4.3 Jasa Ekosistem di Pulau Rinca

Jalur	Panjang Jalur (m)	JE Wisata	Pangan	Air Bersih	Iklim	Kebencanaan	estetika	biodiversi	PCC	RCC	ECC	JUMLAH WISATAWAN
Dekat ke loh kima bak air	864.87	4.00	Rendah	Rendah	Tinggi	Rendah	Rendah	Tinggi	15568	40	29	29-40
Loh Buaya Loh Kima	3610.88	4.19	Rendah	Tinggi	Tinggi	Rendah	Rendah	Tinggi	21665	50	37	37-50
Rinca Unnamed Track	2477.60	3.61	Tinggi	Rendah	Tinggi	Rendah	Rendah	Tinggi	14866	35	25	25-35
Wae waso	2965.49	3.48	Tinggi	Rendah	Tinggi	Rendah	Rendah	Tinggi	17793	41	30	30-41

3. Jasa Ekosistem Iklim

Iklim menjadi salah satu aspek penting dalam suatu ekosistem yang bermanfaat guna mendukung keberlanjutan daya dukung suatu wilayah. Peran iklim dalam kaitannya dengan daya dukung jasa ekosistem dan daya dukung wisata adalah kemampuan ekosistem dalam mengatur suhu lokal. Sehingga jika mencermati dari konsep ini, wilayah dengan fungsi Jasa Ekosistem iklim tinggi akan berada di area dengan tutupan vegetasi yang tinggi dan kondisi lansekap yang indah. Berdasarkan hasil pengolahan daya dukung jasa ekosistem iklim di Pulau Komodo menunjukkan kondisi yang kurang baik (berada pada

kelas rendah pada keseluruhan jalur trekking. Kondisi tersebut dapat disebabkan oleh rendahnya jumlah pohon dibandingkan vegetasi tingkat semai sehingga tidak mampu mengatur suhu local secara maksimal. Selain itu kondisi lansekap yang kurang indah dan beragam juga berpengaruh terhadap rendahnya jasa ekosistem iklim. Apabila dilihat pada tabel menunjukkan bahwa indeks jasa ekosistem iklim memiliki angka yang lebih kecil dibandingkan jasa ekosistem wisata. Sementara itu Pulau Padar juga memiliki kondisi yang sama dengan Pulau Komodo yakni berada pada kelas jasa ekosistem iklim rendah. Sedangkan untuk Pulau Rinca memiliki kondisi yang berbeda dengan pulau lainnya yakni berada pada kondisi yang baik yang tunjukkan dengan keseluruhan jalur trekkingnya berada pada kelas jasa ekosistem tinggi. Dapat dilihat pada Tabel 4.3. kondisi tersebut menunjukkan bahwa ekosistem di wilayah tersebut memiliki kemampuan mengatur suhu lokal dengan baik.

4. Jasa Ekosistem Kebencanaan

Berdasarkan penilaian kondisi tutupan lahan, keragaman vegetasi, satwa, lansekap, dan kelerengan, diperoleh gambaran bahwa semua jalur trekking di P. Komodo memiliki pengaturan kebencanaan yang rendah. Penyebab utamanya adalah jumlah vegetasi tingkat Pohon yang relative sedikit jika dibandingkan dengan sebaran vegetasi semai yang ada di jalur trekking pulau Komodo ini. Padahal vegetasi tingkat pohon memiliki peran yang besar dalam mencegah terjadinya bencana longsor. Kondisi tersebut menunjukkan bahwa ekosistem yang ada di wilayah tersebut kurang mampu dalam melakukan pencegahan terhadap resiko bencana yang terjadi. Sementara itu di Pulau Padar dan Pulau Rinca juga berada pada kondisi yang sama yakni berada pada kelas jasa ekosistem kebencanaan rendah. Apabila dilihat secara keseluruhan di Taman Nasional Komodo ini berarti ekosistem yang ada di dalamnya kurang mampu dalam melakukan pencegahan terhadap bencana.

5. Jasa Ekosistem Estetika

Beberapa jalur trekking di Pulau Komodo memiliki jasa estetika yang rendah. Tinggi rendahnya jasa ekosistem estetika ditentukan berdasarkan empat variabel yakni keregaman vegetasi, keragaman satwa, kondisi lereng, dan kondisi lansekap. Beberapa jalur seperti jalur trekking Suphurea Banunggulung, dll berada pada kelas rendah yang disebabkan oleh rona dan variasi warna vegetasi yang cenderung mati (seragam). Beberapa jalur yang berada pada kelas jasa ekosistem estetika tinggi menunjukkan bahwa keberagaman vegetasinya tinggi, memiliki keragaman satwa, kondisi lereng yang beragam sehingga memiliki kondisi lansekap yang indah sehingga memiliki nilai estetika yang tinggi. Sementara itu jasa ekosistem estetika di Pulau Padar berada pada kelas jasa ekosistem yang baik, yang artinya bahwa ekosistem yang ada pada jalur trekking di Pulau Padar mempu mendukung estetika di wilayah tersebut. Kemudian di Pulau Rinca memiliki kondisi jasa ekosistem estetika yang paling buruk dibandingkan kedua pulau lainnya di yakni berada pada kelas rendah di seluruh jalur trekkingnya. Kondisi tersebut disebabkan oleh rona dan variasi warna vegetasi yang cenderung mati (seragam) sehinga kurang memberikan nilai estetika bagi wilayah tersebut.

6. Jasa Ekosistem Biodiversitas

Kondisi jasa ekosistem biodiversitas di Pulau Komodo berada pada kelas yang berbeda-beda untuk masing-masing jalur trekkingnya. Kondisi biodiversitas dipengaruhi oleh 3 (tiga) variabel yakni keragaman vegetasi, keragaman satwa, dan kondisi lansekap. Semakin beragam vegetasi, satwa, dan kondisi lansekap yang ada didalamnya maka semakin tinggi pula fungsi jasa ekosistem biodiversitasnya. Berdasarkan hasil pengolahan untuk Pulau Komodo dijumpai beberapa jalur trekking yang berada pada kelas jasa ekosistem biodiversitas rendah yakni Hutan asam dikit, Loh Liang Ara, Loh Liang Sebita, Short trek, dan Komodo Unnamed Track. Kondisi

tersebut berarti bahwa pada kelima jalur trekking tersebut memiliki keragaman vegetasi, keragaman satwa, dan kondisi lansekap yang rendah.

Sementara itu Pulau Padar hanya memiliki satu jalur trekking saja, sehingga berdasarkan penilaian kondisi tutupan lahan, keragaman vegetasi, satwa, lansekap, dan kelerengan, diperoleh gambaran bahwa jalur trekking di pulau ini memiliki jasa ekosistem pendukung (biodiversitas) rendah. Meskipun jika dilihat dari sisi lansekap wilayah ini memiliki potensi yang besar untuk mendatangkan wisatawan. Kemudian kondisi jasa ekosistem biodiversitas di Pulau Rinca berada pada kondisi yang baik yakni seluruh jalur trekking yang ada disana tergolong kedalam kelas tinggi, yang artinya ekosistem yang ada meliputi keragaman vegetasi, keragaman satwa, dan kondisi lansekapnya memiliki keragaman yang tinggi.

4.1.2 Daya dukung wisata Jalur Pengamatan/*Trekking* Kawasan TN Komodo

Daya dukung wisata, yang artinya adalah jumlah maksimum orang yang boleh mengunjungi satu tempat wisata pada saat bersamaan tanpa menyebabkan kerusakan lingkungan fisik, ekonomi dan sosial budaya dan penurunan kualitas yang merugikan bagi kepuasan wisatawan (Livina, 2009).

1. Faktor-faktor Koreksi Daya Dukung Efektif Wisata Alam

Faktor-faktor koreksi yang digunakan dalam menghitung daya dukung wisata terdiri dari unsur biotik yaitu indeks keragaman vegetasi, indeks keragaman satwa dan unsur abiotik yaitu kondisi lansekap, kelerengan, tanah dan curah hujan. Berikut ini adalah hasil pengamatan di Taman Nasional Komodo.

2. Indeks Keragaman Vegetasi

Tingkat vegetasi yang diamati antara lain vegetasi pada tingkat semai, vegetasi tingkat pancang, vegetasi tingkat tiang, dan vegetasi tingkat pohon. Vegetasi tingkat semai adalah vegetasi yang masih berupa anakan pohon yang memiliki tinggi kurang dari 150 cm. Vegetasi

tingkat pancang berupa anakan pohon dengan tinggi lebih dari 150 cm, tetapi memiliki diameter batang kurang dari 10 cm. Kemudian vegetasi tingkat tiang adalah pohon dengan ukuran diameter antara 10 cm dan 20 cm. Sedangkan vegetasi tingkat pohon adalah tumbuhan berkayu yang memiliki diameter lebih dari 20 cm. Data hasil inventarisasi selanjutnya diperhitungkan indeks diversitas simpson (I-DS) dengan menggunakan persamaan sebagai berikut:

$$ID = 1 - \lambda$$

$$\lambda = \frac{\sum_{i=1}^{s} ni(ni-1)}{n(n-1)}$$

Keterangan:

s = jumlah spesies;

ni = jumlah individu spesies ke-i;

n = jumlah individu semua spesies.

Berdasarkan perhitungan dari persamaan diatas dihasilkan indeks diversitas simpson di Pulau Komodo sebesar 0.5167181; sedangkan di Pulau Padar sebesar 0.651912075; kemudian untuk Pulau Rinca sebesar 0.704583641. Berikut ini adalah tabel hasil inventarisasi dari keragaman vegetasi di Pulau Komodo, Pulau Padar, dan Pulau Rinca

Tabel 4.4. Tabel Hasil Inventarisasi Dari Keragaman Vegetasi di Pulau Komodo

Tingkat Vegetasi	Jumlah	ni(ni-1)	n	n(n-1)	lmda	IDS
A.Vegetasi Tingkat Semai	18785	352857440				
B.Vegetasi Tingkat Pancang	4671	21813570				
C.Vegetasi Tingkat Tiang	3633	13195056				
D.Vegetasi Tingkat Pohon	1303	1696506				
Jumlah	**28392**	**389562572**		**806077272**	**0.48328192**	**0.51671808**
Faktor koreksi						**0.48328192**

Tabel 4.5. Tabel Hasil Inventarisasi Dari Keragaman Vegetasi di Pulau Padar

Tingkat Vegetasi	Jumlah	ni(ni-1)	n	n(n-1)	lmda	IDS
A.Vegetasi Tingkat Semai	40	1560				
B.Vegetasi Tingkat Pancang	5	20				
C.Vegetasi Tingkat Tiang	25	600				
D.Vegetasi Tngkat Pohon	12	132				
Jumlah	**82**	**2312**		**6642**	**0.34808793**	**0.65191207**
Faktor koreksi						**0.34808793**

Tabel 4.6. Tabel Hasil Inventarisasi Dari Keragaman Vegetasi di Pulau Rinca

Tingkat Vegetasi	Jumlah	ni(ni-1)	n	n(n-1)	lmda	IDS
A.Vegetasi Tingkat Semai	9275	86016350				
B.Vegetasi Tingkat Pancang	6235	38868990				
C.Vegetasi Tingkat Tiang	3422	11706662				
D.Vegetasi Tingkat Pohon	3531	12464430				
Jumlah	**22463**	**149056432**		**504563906**	**0.29541636**	**0.70458364**
Faktor koreksi						**0.29541636**

3. Indeks Keragaman Satwa

Berdasarkan hasil inventarisasi keragaman satwa di sepanjang areal wisata Pulau Komodo, diperoleh 16 jenis satwa. Pulau Padar diperoleh 3 jenis satwa dan Pulau Rinca diperoleh 16 jenis satwa. Berdasarkan hasil perhitungan diperoleh hasil indeks diversitas simpson untuk Pulau Komodo (ID) sebesar 0.780441; kemudian untuk Pulau Padar sebesar 0.476190476; sedangkan untuk Pulau Rinca diperoleh indeks diversitas simpson sebesar 0.879784367. Perhitungan nilai IDS pada masing-masing pulau di Taman Nasional Komodo disajikan pada tabel berikut.

Tabel 4.7. Tabel Hasil Sampling Dari Keragaman Satwa di Pulau Komodo

No.	Jenis	Jumlah	ni(ni-1)	n	n(n-1)	Imda	IDS
1.	Ayam Hutan	4	12				
2.	Komodo	2	2				
3.	Rusa	4	12				
4.	Kakatua Jambul Kuning	2	2				
5.	Burung Elang Bondol	1	0				
6.	Babi Hutan	1	0				
7.	Burung Gosong	2	2				
8.	Burung Perkutut	3	6				
9.	Burung Gagak	33	1056				
10.	Burung Kacamata	6	30				
11.	Burung Srigunting	2	2				
12.	Burung Kepodang	2	2				
13.	Burung Kancilan Mas	3	6				
14.	Burung Sikatan Kepala Abu-Abu	1	0				
15.	Burung Tekukur	2	2				
16.	Burung Terukcuk	5	20				
	Jumlah	73	1154	73	5256	0.2195586	0.7804414

Tabel 4.8. Tabel Hasil Sampling Dari Keragaman Satwa di Pulau Padar

No	**Jenis**	**Jumlah**	**ni(ni-1)**	**n**	**n(n-1)**	**lmda**	**IDS**
1	Jenis	Jumlah	ni(ni-1)	n	n(n-1)	lmda	
2	Elang Bond	2	2				
3	Burung Kep	5	20				
	Jumlah	**7**	**22**	**7**	**42**	**0.5238095**	**0.4761905**
	Faktor koreksi	**0.31818**					**0.5238095**

Tabel 4.9. Tabel Hasil Sampling Dari Keragaman Satwa di Pulau Rinca

No	Jenis	Jumlah	ni(ni-1)	n	n(n-1)	lmda	IDS
1	Monyet	27	702				
2	Rusa	8	56				
3	Komodo	13	156				
4	Ayam Hutan	2	2				
5	Anjing	1	0				
6	Kerbau	1	0				
7	Burung Elang Bondol	2	2				
8	Burung Pipit	13	156				
9	Burung tekukur	9	72				
10	Burung cucut	3	6				
11	Burung Srigunting	2	2				
12	Burung Gosong	10	90				
13	Burung Perkutut	10	90				
14	Burung Pelatuk	2	2				
15	Burung Kepodang	2	2				
16	Burung Gagak	1	0				
	Jumlah	106	1338	106	11130	0.1202156	0.8797844
	Faktor koreksi	0.07922					0.1202156

4. Kondisi Lansekap

Berikut ini adalah hasil penilaian lapangan terhadap kondisi lansekap.

Tabel 4.10 Penilaian Terhadap Indeks Potensi Lansekap Areal Wisata

No.	Kriteria	Skor	Nilai
1.	Bukit rendah dan berombak; bukit di kaki gunung atau dasar lembah bukan ciri-ciri lansekap yang menarik.	1	3
	Ngarai/ lereng yang curam, kerucut gunung api atau pola-pola erosi yang menarik atau variasi ukuran dan bentuk lahan atau ciri-ciri detil yang dominan.	3	
	Relief vertikal yang tinggi yang ditujukan adanya puncak mencolok; puncak seperti menara; singkapan batuan raksasa atau variasi permukaan yang menakjubkan; formasi-formasi yang mudah tererosi atau ciri dominan yang sangat mencolok.	5	
2.	Sedikit atau tidak ada perbedaan vegetasi.	1	3
	Beberapa jenis vegetasi tetapi hanya 1-2 jenis yang dominan.	3	
	Sebuah variasi dari tipe vegetasi yang ditunjukkan dengan pola, tekstur dan bentuk yang menarik.	5	
3.	Variasi warna yang halus dan kontras, umumnya bersifat mati.	1	3
	Terdapat jenis-jenis warna, ada pertentangan dari tanah, batu dan vegetasi tetapi bukan pemandangan yang dominan.	3	
	Kombinasi warna yang beragam jenis atau pertentangan yang indah dan warna tanah, batu, vegetasi air dan lain-lain.	5	
4.	Pemandangan di dekatnya sedikit/ tidak berpengaruh terhadap kualitas pemandangan.	0	3
	Pemandangan di dekatnya cukup berpengaruh terhadap kualitas pemandangan.	3	
	Pemandangan di dekatnya sangat berpengaruh terhadap kualitas pemandangan.	5	
5.	Mempunyai latar belakang yang menarik tetapi hampir sama dengan keadaan umum dalam suatu daerah.	1	5
	Khas meskipun hampir sama dengan daerah tertentu.	3	
	Suatu area yang khas/ berbeda dengan obyek lainnya sehingga menimbulkan kesan.	5	
6.	Modifikasi menambahkan variasi tetapi sangat bertentangan dengan alam dan menimbulkan ketidakharmonisan.	-4	0
	Modifikasi menambah sedikit atau sama sekali keragaman pemandangan.	0	
	Pembangunan sarana-sarana seperti instalasi/ listrik, saluran air, rumah memberikan modifikasi yang mampu menambah keragaman visual; tidak ada modifikasi.	2	
	Jumlah	27	17
	Indeks potensi lansekap		0,63

5. Kelerengan

Kondisi lereng yang dijumpai di Taman Nasional Komodo sebagian besar berupa landai dan sedikit curam. Data kelerengan ini diperoleh dengan menggunakan data penginderaan jauh berupa Citra Satelit SRTM. Kaitannya kelerengan dengan daya dukung wisata adalah jalur trek wisata yang agak curam dianggap agak memberatkan langkah wisatawan.

6. Tanah

Mengetahui kondisi tanah berfungsi untuk mengetahui karakteristik tanah untuk kaitannya dengan kepekaan terhadap erosi. Berikut ini adalah tabel klasifikasi jenis tanah yang digunakan.

Tabel 4.11. Klasifikasi Jenis Tanah

Kelas tanah	Klasifikasi Jenis Tanah	Klasifikasi Jenis Tanah	Nilai
1	Alluvial, tanah glei, panasol, hidromorf kelabu, lateria air tanah	Tidak peka	15
2	Latosol	Agak peka	30
3	Brown forest soil, non calcic	Kurang peka	45
4	Andosol, lateritik, gromosol, podsolik	Peka	60
5	Regosol, litosol, organosol, renzina	Sangat peka	75

Sumber: SK.Menteri Pertanian No.837/KPTS/UM/11/1980 dalam Muta'ali (2012).

Jenis tanah yang dijumpai di Taman Nasional Komodo didominasi oleh jenis tanah gromosol dimana tanah gromosol memiliki kepekaan terhadap erosi yang peka.

4.1.3 Penentuan Nilai Daya Dukung Wisata

Berdasarkan penilaian terhadap indeks dari masing-masing faktor koreksi, maka dapat diperhitungkan nilai daya dukung wisata di Taman Nasional Komodo yang disajikan pada tabel berikut:

Tabel 4.12. Nilai Faktor Pengkoreksi pada Penentuan Nilai Daya Dukung Wisata

Parameter	Nilai Faktor Pengkoreksi
Curah Hujan (Indeks Nilai Q [Bulan kering/Basah])	0.50
Keragaman Vegetasi	0.48
Keragaman Satwa (Densitas Jenis, Indeks Diversitas Simpson)	0.22
Kondisi Lansekap (Indeks Bureau Of Land Management)	0.62
Kondisi Lereng (Indeks Kelerangan)	0.51
Jenis tanah terhadap kepekaan erosi	0.40

Tabel 4.13. Hasil Perhitungan Potensi Ekologis Wisata dan Daya Dukung Efektif di Pulau Komodo

Name	PCC	Curah Hujan	Vegetasi	Keragaman Satwa	Kondisi Lansekap	Kondisi Lereng	Erosi	Ckomodo	RCC	ECC	Wisatawan
Loh Liang Ara	14015.63	0.50	0.48	0.22	0.62	0.51	0.40	0.92	85.14	62.15	62-85
Short trek	14692.70	0.50	0.48	0.22	0.62	0.54	0.40	0.92	94.66	69.10	69-95
Loh Liang Sebita	14638.98	0.50	0.48	0.22	0.62	0.51	0.40	0.92	88.93	64.92	65-89
Sulphurea trail	6843.52	0.50	0.48	0.22	0.62	0.60	0.40	0.92	49.13	35.87	36-49
Dekat Sulphurea	6813.28	0.50	0.48	0.22	0.62	0.60	0.40	0.92	48.91	35.71	36-49
Sulphurea Banunggulung	12798.52	0.50	0.48	0.22	0.62	0.60	0.40	0.92	91.88	67.07	67-92
Hutan asam banu nggulung	14198.23	0.50	0.48	0.22	0.62	0.60	0.40	0.92	101.93	74.41	74-102
Hutan asam dikit	7632.25	0.50	0.48	0.22	0.62	0.60	0.40	0.92	54.79	40.00	40-55
Komodo Unnamed	12260.58	0.50	0.48	0.22	0.62	0.60	0.40	0.92	88.02	64.25	64-88

Berdasarkan penilaian kondisi tutupan lahan, keragaman vegetasi, satwa, lansekap, dan kelerengan, diperoleh gambaran bahwa semua jalur trekking di Pulau Komodo memiliki pengaturan kebencanaan yang rendah. Penyebab utamanya adalah jumlah

vegetasi tingkat Pohon yang relative sedikit jika dibandingkan dengan sebaran vegetasi semai yang ada di jalur trekking pulau Komodo ini. Selain itu beberapa jalur trekking juga memiliki jasa estetika yang rendah seperti jalur trekking Suphurea Banunggulung, dll, yang disebabkan oleh rona dan variasi warna vegetasi yang cenderung mati (seragam). Pada jalur yang memiliki lintasan yang cukup Panjang (misalnya Loh Liang Ara), manajemen wisata perlu memperhatikan kondisi biodiversitasnya karena jasa ekosistem di jalur ini rendah.

Tabel 4.14. Hasil Perhitungan Potensi Ekologis Wisata dan Daya Dukung Efektif di Pulau Padar

Name	PCC	Curah Hujan	Vegetasi	Keragaman Satwa	Kondisi Lansekap	Kondisi Lereng	Erosi	Ckomodo	RCC	ECC	Wisatawan
Padar Unnamed	19283.22831	0.5	0.348	0.52	0.222	0.4769	0.4	0.916667	67.73	49.4	49-68

Di sisi lain, Pulau padar hanya memiliki satu jalur trekking saja, sehingga berdasarkan penilaian kondisi tutupan lahan, keragaman vegetasi, satwa, lansekap, dan kelerengan, diperoleh gambaran bahwa jalur trekking di pulau ini memiliki jasa ekosistem dari kelompok pengaturan (iklim dan bencana) dan pendukung (biodiversitas) sangat rendah. Meskipun jika dilihat dari sisi lansekap wilayah ini memiliki potensi yang besar untuk mendatangkan wisatawan, namun hal ini yang justru perlu dipertahankan keberlanjutannyga, sehingga nilai faktor koreksi lansekap cenderung kecil pada pulau ini. Sementara itu, Vegetasi di wilayah ini sangat seragam dari kelompok vegetasi tidak berkayu, sehingga kekhawatiran terbesar dari rendahnya jasa kebencanaan ini adalah potensi kebakaran lahan.

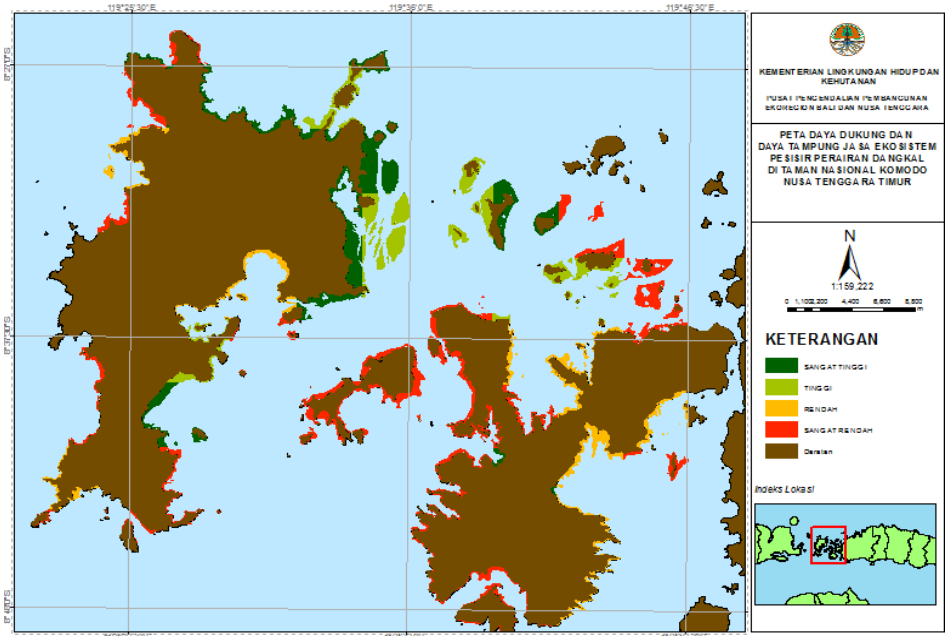
Tabel 4.15. Hasil Perhitungan Potensi Ekologis Wisata dan Daya Dukung Efektif di Pulau Rinca

Name	PCC	Curah Hujan	Vegetasi	Keragaman Satwa	Kondisi Lansekap	Kondisi Lereng	Erosi	Ckomodo	RCC	ECC	Wisatawan
Rinca Loh Buaya Loh Kima	21665.2719	0.5	0.295	0.12	0.666	0.538461538	0.4	0.916666667	50.42405381	36.80955928	37-50
Rinca Dekat ke loh kima bak air	15567.58456	0.5	0.295	0.12	0.666	0.6	0.4	0.916666667	40.37303606	29.47231633	29-40
Rinca Wae waso	17792.94963	0.5	0.295	0.12	0.666	0.538461538	0.4	0.916666667	41.41155734	30.23043685	30-41
Rinca Unnamed	14865.58225	0.5	0.295	0.12	0.666	0.538461538	0.4	0.916666667	34.59836196	25.25680423	25-35

Jika dilihat berdasarkan daya dukung wisata di Pulau Komodo, maka jalur trekking yang memiliki kapasitas menampung wisatawan terbanyak adalah jalur Hutan asam banu nggulung dengan jumlah wisatawan pada perhitungan RCC (Real Carrying Capacity) 102 orang / hari dan pada ECC (Efektivity Carrying Capacity) sejumlah 74 orang / hari. Secara keseluruhan nilai daya dukung wisata untuk jalur trekking yang ada di pulau Komodo adalah 513 orang / hari atau setara dengan 187.245 orang / tahun. Pulau Padar memiliki kapasitas menampung wisatawan dengan jumlah wisatawan pada perhitungan RCC (Real Carrying Capacity) 68 orang/hari dan pada ECC (Efektivity Carrying Capacity) sejumlah 49 orang/hari atau setara dengan 17.885 orang / tahun. Pulau RInca memiliki kapasitas menampung wisatawan dengan jumlah wisatawan terbanyak pada jalur trekking rinca loh buaya loh kima dengan jumlah wisatawan pada perhitungan RCC (Real Carrying Capacity) 50 orang/hari dan pada ECC (*Effective Carrying Capacity*) sejumlah 37 orang/hari. Secara keseluruhan nilai daya dukung wisata pada jalur trekking yang ada di pulau Rinca adalah 121 orang / hari atau setara dengan 44.165 orang / tahun.

4.2 Daya Dukung Wisata Wilayah Perairan TN Komodo

4.2.1 Hasil Penilaian Daya Dukung berbasis Jasa Ekosistem



Gambar 4.1. Kondisi daya dukung berbasis jasa ekosistem wilayah perairan dangkal Taman Nasional Komodo

Jasa ekosistem diperoleh melalui 3 faktor input yaitu tutupan lahan, ecoregion, dan ekosistem vegetasi. Secara umum, karena ecoregion dan kondisi ekosistem vegetasi di seluruh wilayah perairan di Kawasan Taman Nasional Komodo relative seragam, maka praktis hanya tutupan lahan saja yang berfungsi secara optimal dalam menghasilkan kondisi fungsi ekosistem di wilayah perairan. Ada total 7 jasa ekosistem yang digunakan dalam penghitungan jasa ekosistem sektor wisata perairan dangkal yaitu jasa pangan, serat, iklim, kebencanaan (erosi/abrasi), Rekreasi, biodiversitas, dan siklus nutrient. Semua jasa ekosistem ini menggambarkan fungsi ekosistem dalam menyediakan, mengatur, dan mendukung segala kegiatan diatasnya, tidak terbatas pada aktifitas manusia, tapi juga dilihat dalam konteks biota – biota yang ada / hidup diatasnya. Fungsi ekosistem dalam konteks pariwisata berkelanjutan di Kawasan Taman Nasional Komodo lebih berfungsi sebagai indikator dalam penentuan profil wilayah, prediksi dampak kegiatan, serta evaluasi kegiatan.

Pemilihan ketujuh jasa ekosistem dilakukan berdasarkan isu – isu strategis yang ada di wilayah Kawasan Taman Nasional Komodo. Jasa ekosistem pangan misalnya, dipilih karena jasa ini memberikan gambaran mengenai kemampuan ekosistem dalam menyediakan kebutuhan pangan untuk semua makhluk hidup diatasnya. Sehingga, dalam konteks ini jasa ekosistem pangan memiliki keterkaitan yang signifikan dengan keragaman biota perairan serta kesesuaian lahan wisata. Berdasarkan tabel matriks jasa ekosistem perairan dangkal di taman nasional Komodo, wilayah yang memiliki fungsi penyedia pangan yang baik (positif) sebagian besar ada dibagian Utara – timur Pulau Komodo (KMD 11, KMD 28, KMD 5, 6) dan di utara pulau Tatawa. Hal ini berarti wilayah – wilayah ini menyimpan potensi biota laut yang beragam, mengingat ekosistem berfungsi sangat baik sebagai penyedia pangan.

Table 4.16. Kondisi daya dukung berbasis jasa ekosistem wilayah perairan TN Komodo

ZONA	PULAU BESAR	JASA EKOSISTEM PESISIR PERAIRAN DANGKAL								TINGKAT DDDTLH JEPPD
		Index Ekosistem Pesisir	Pangan	Serat	Iklim	Perlindungan Pesisir	Rekreasi	Bio diversi	Nutrient	
KMD 10	KOMODO	0.80	-	+	+	-	-	-	-	TINGGI
KMD 11	KOMODO	0.44	+	+	+	-	+	-	-	RENDAH
KMD 12	KOMODO	0.59	-	+	-	+	+	-	-	RENDAH
KMD 13	KOMODO	0.69	-	-	-	+	+	-	-	TINGGI
KMD 14	KOMODO	0.60	-	-	-	+	+	-	-	SANGAT RENDAH
KMD 15	KOMODO	0.85	-	-	-	+	+	+	-	SANGAT TINGGI
KMD 16	KOMODO	0.58	-	-	-	+	+	-	-	SANGAT RENDAH
KMD 17	KOMODO	0.55	-	-	-	+	+	-	-	SANGAT RENDAH
KMD 18	KOMODO	0.57	-	-	-	+	+	-	-	SANGAT RENDAH
KMD 19	KOMODO	0.55	-	-	-	+	+	-	-	SANGAT RENDAH
KMD 2	KOMODO	0.89	-	+	-	+	+	+	-	SANGAT TINGGI
KMD 20	KOMODO	0.50	-	+	-	+	+	-	-	RENDAH
KMD 21	KOMODO	0.51	-	-	-	+	+	-	-	SANGAT RENDAH
KMD 22	KOMODO	0.54	-	-	-	+	+	-	-	SANGAT RENDAH

ZONA	PULAU BESAR	JASA EKOSISTEM PESISIR PERAIRAN DANGKAL								TINGKAT DDDTLH JEPPD
		Index Ekosistem Pesisir	Pangan	Serat	Iklim	Perlindungan Pesisir	Rekreasi	Bio diversi	Nutrient	
KMD 23	KOMODO	0.57	-	-	-	+	+	-	-	SANGAT RENDAH
KMD 24	KOMODO	0.57	-	-	-	+	+	+	-	RENDAH
KMD 25	KOMODO	0.79	-	+	-	+	+	-	-	SANGAT TINGGI
KMD 26	KOMODO	0.62	-	-	-	+	+	-	-	SANGAT RENDAH
KMD 27	KOMODO	0.66	-	-	-	+	+	-	-	SANGAT RENDAH
KMD 28	KOMODO	1.07	+	-	+	+	+	+	-	SANGAT TINGGI
KMD 3	KOMODO	0.74	-	-	-	+	+	-	-	TINGGI
KMD 4	KOMODO	0.68	-	+	-	+	+	-	-	SANGAT TINGGI
KMD 5	KOMODO	1.08	+	-	+	+	+	+	-	SANGAT TINGGI
KMD 6	KOMODO	0.87	+	+	+	-	-	-	-	SANGAT TINGGI
KMD 7	KOMODO	0.77	-	-	-	+	+	+	-	SANGAT TINGGI
KMD 8	KOMODO	0.86	-	+	+	-	-	-	-	TINGGI
KMD 9	KOMODO	0.84	-	-	-	+	+	+	-	SANGAT TINGGI
KMD1	KOMODO	0.72	-	+	+	+	+	-	-	SANGAT TINGGI
PDR 1	PADAR	0.60	-	-	-	+	+	-	-	SANGAT RENDAH

ZONA	PULAU BESAR	JASA EKOSISTEM PESISIR PERAIRAN DANGKAL								TINGKAT DDDTLH JEPPD
		Index Ekosistem Pesisir	Pangan	Serat	Iklim	Perlindungan Pesisir	Rekreasi	Bio diversi	Nutrient	
PDR 2	PADAR	0.59	-	-	-	+	+	-	-	SANGAT RENDAH
PDR 3	PADAR	0.55	-	-	-	+	+	-	-	SANGAT RENDAH
RCA 1	RINCA	0.64	-	-	-	+	+	-	-	SANGAT RENDAH
RCA 10	RINCA	0.56	-	-	-	+	+	-	-	SANGAT RENDAH
RCA 11	RINCA	0.53	-	+	-	+	+	-	-	RENDAH
RCA 12	RINCA	0.51	-	+	-	+	+	-	-	RENDAH
RCA 13	RINCA	0.60	-	-	-	+	+	-	-	SANGAT RENDAH
RCA 14	RINCA	0.63	-	-	-	+	+	-	-	SANGAT RENDAH
RCA 15	RINCA	0.61	-	-	-	+	+	-	-	SANGAT RENDAH
RCA 16	RINCA	0.61	-	-	-	+	+	-	-	SANGAT RENDAH
RCA 17	RINCA	0.58	-	-	-	+	+	-	-	SANGAT RENDAH
RCA 18	RINCA	0.53	-	-	-	+	+	-	-	SANGAT RENDAH
RCA 19	RINCA	0.59	-	-	-	+	+	-	-	SANGAT RENDAH
RCA 20	RINCA	0.57	-	-	-	+	+	+	-	RENDAH
RCA 21	RINCA	0.59	-	-	-	+	+	-	-	SANGAT RENDAH

ZONA	PULAU BESAR	JASA EKOSISTEM PESISIR PERAIRAN DANGKAL								TINGKAT DDDTLH JEPPD
		Index Ekosistem Pesisir	Pangan	Serat	Iklim	Perlindungan Pesisir	Rekreasi	Bio diversi	Nutrient	
RCA 22	RINCA	0.68	-	+	-	+	+	-	-	SANGAT TINGGI
RCA 3	RINCA	0.73	-	-	-	+	+	-	-	TINGGI
RCA 4	RINCA	0.59	-	-	-	+	+	-	-	SANGAT RENDAH
RCA 5	RINCA	0.59	-	+	-	+	+	-	-	RENDAH
RCA 6	RINCA	0.55	-	-	-	+	+	-	-	SANGAT RENDAH
RCA 7	RINCA	0.53	-	+	+	-	+	-	-	RENDAH
RCA 8	RINCA	0.63	-	+	-	+	+	-	-	RENDAH
RCA 9	RINCA	0.57	-	+	-	+	+	-	-	RENDAH
RCA2	RINCA	0.90	-	+	+	-	-	-	-	TINGGI
TTW 1	TATAWA	0.68	-	-	-	+	+	-	-	TINGGI
TTW 2	TATAWA	1.32	+	+	+	-	-	+	-	SANGAT TINGGI
TTW 3	TATAWA	0.88	-	+	+	-	-	-	-	TINGGI
TTW 4	TATAWA	0.99	-	+	+	-	-	+	-	SANGAT TINGGI
TTW 5	TATAWA	0.57	-	-	-	+	+	-	-	SANGAT RENDAH

Sementara itu, jasa ekosistem serat dipilih atas dasar serat yang disediakan ekosistem dapat memiliki nilai ekonomis yang relative tinggi bagi manusia. Dalam hal ini, keberadaan padang lamun memberikan implikasi pada tingginya jasa penyedia serat di Kawasan Taman Nasional Komodo. Hal ini bisa dicermati pada tabel diatas bahwa jasa penyedia serat dengan nilai positif banyak tersebar di sekitar pulau Tatawa dan bagian Utara – Barat Pulau Rinca yang bersesuaian dengan sebaran padang lamun di wilayah ini.

Jasa ekosistem pengaturan iklim / daya serap karbon dipilih karena jasa ini terkait dengan kemampuan ekosistem dalam mengatur suhu lokal, kelembapan, dan kemampuan serap karbon dari tutupan terumbu karang. Sehingga, jika mencermati dari konsep ini, wilayah dengan fungsi jasa ekosistem iklim yang tinggi akan berada di wilayah dengan tutupan terumbu yang tinggi. Hal ini terlihat dari hasil kajian bahwa jasa ekosistem pengaturan iklim pada kelas tinggi banyak tersebar pada bagian dalam perairan dengan kondisi antar pulau saling berhadapan. Hal ini berkaitan dengan tutupan terumbu hidup di area – area ini yang sangat tinggi. Disisi lain, jasa ekosistem kebencanaan dipilih karena menggambarkan kemampuan ekosistem dalam mencegah bencana kepesisiran seperti abrasi, banjir rob atau tsunami, dan sebagainya.

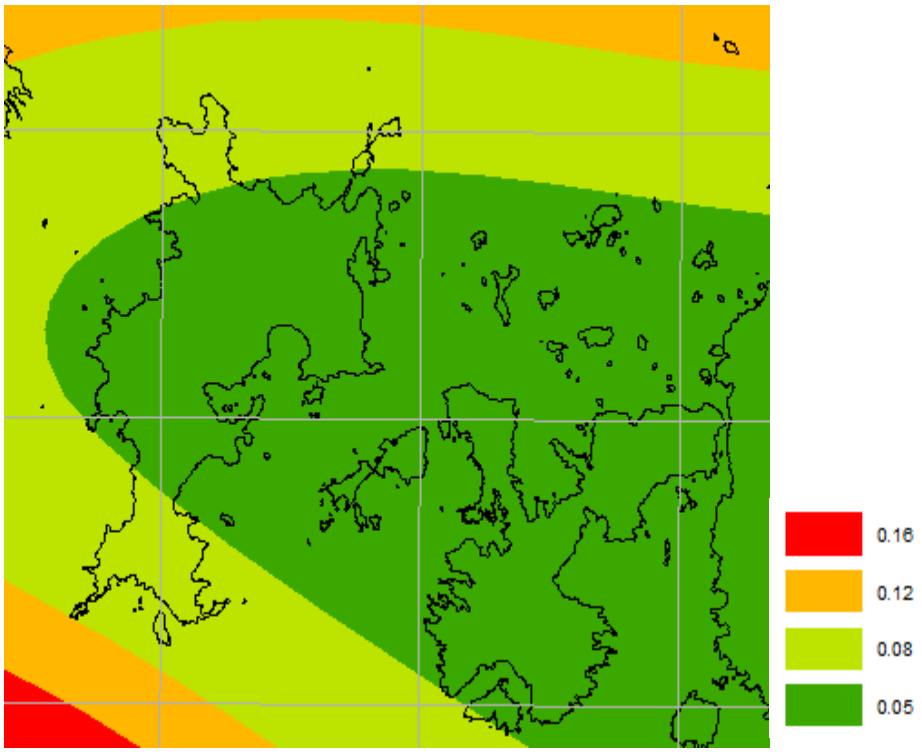
Hal yang berpengaruh sangat besar terhadap jasa ekosistem kebencanaan ini adalah kondisi bathymetri dan tutupan habitat bentik perairan dangkal. Semakin landai suatu pesisir, semakin rendah potensi bencannya atau dengan kata lain ekosistem secara alami mampu mencegah terjadinya bencana abrasi. Selain bencana, faktor biodiversitas dan siklus nutrient juga dipertimbangkan dalam penentuan daya dukung dan daya tampung berbasis jasa ekosistem ini. Biodiversitas suatu Kawasan akan sangat menentukan persepsi keunikan lansekap bagi wisatawan. Hal ini menjadi dasar mengapa fungsi ekosistem dalam mendukung keanekaragaman hayati penting untuk dimasukkan dalam analisis ini. Selain itu, pendukung siklus

nutrient juga menentukan biota – biota laut unik yang tersebar di sekitar daya tarik wisata. Secara umum, hasil analisis daya dukung & daya tampung berbasis jasa ekosistem sektor wisata perairan dangkal di Kawasan taman nasional Komodo ini menunjukkan gambaran bahwa sebagian besar wilayah yang memiliki fungsi ekosistem yang sangat baik dalam mendukung dan menampung kegiatan wisata diatasnya sebagian besar tersebar di perairan pesisir timur dan utara pulau Komodo, serta sedikit di pulau Tatawa dan Rinca.

4.2.2 Kesesuaian Perairan Taman Nasional Komodo Untuk Pariwisata

Analisis kesesuaian wisata wilayah perairan dangkal kawasan taman nasional Komodo dilakukan dengan beberapa parameter antara lain kecepatan arus, kedalaman perairan, kecerahan perairan dan sebaran habitat bentik.

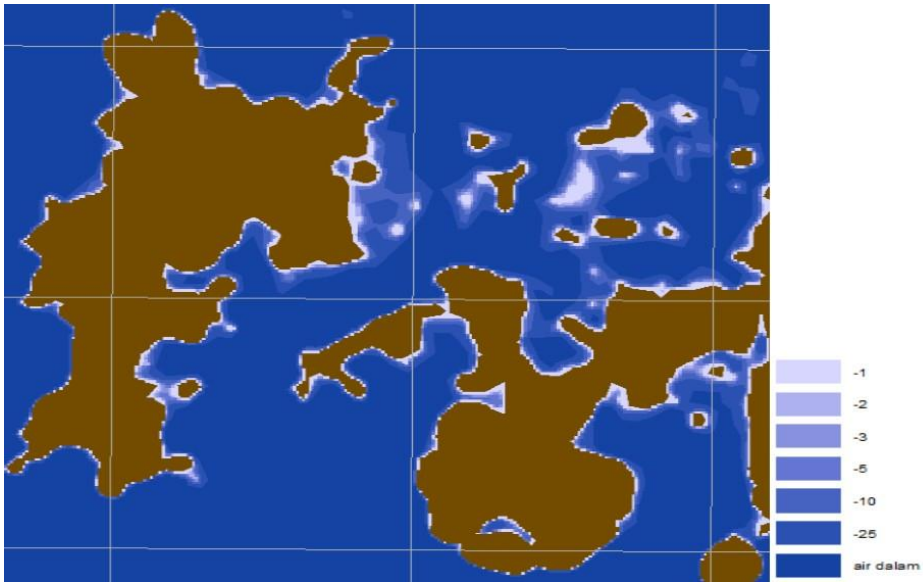
1. Kondisi Arus Perairan TN Komodo



Gambar 4.2. Kondisi arus perairan disekitar wilayah taman nasional Komodo

Berdasarkan hasil pemrosesan data sekunder yang diperoleh dari Balai Riset dan Observasi Laut, sebagian besar wilayah perairan di dalam Kawasan TN Komodo didominasi arus yang sangat lemah (ditunjukkan dengan warna hijau) dengan kecepatan maksimum sebesar 0.05 m / dt. Dari hasil ini menunjukkan bahwa di Kawasan TN Komodo bagian dalam (Pulau Padar dan sebagian besar pulau Rinca), jika dilihat dari sudut pandang aspek fisik lahan, maka obyek yang menjadi salah satu daya tarik wisata di perairan tersebut (terumbu karang) dapat tumbuh dan berkembang dengan baik serta memiliki potensi berkembangnya berbagai jenis terumbu sehingga menambah nilai keindahan di bawah perairan. Dari kondisi arus ini juga dapat diartikan bahwa penyelam pemula dan/atau wisatawan dengan kegiatan snorkeling dapat melakukan aktifitasnya di titik wisata / daya tarik wisata di bagian dalam atau di bagian tengah wilayah perairan TN Komodo. Penyelam yang tidak memiliki keahlian khusus dan/atau tanpa pemandu yang memiliki sertifikat keahlian tertentu tidak disarankan untuk melalukan aktifitas wisata diluar Kawasan yang berwarna hijau tersebut.

2. Kondisi Kedalaman Perairan (Bathymetri) TN Komodo

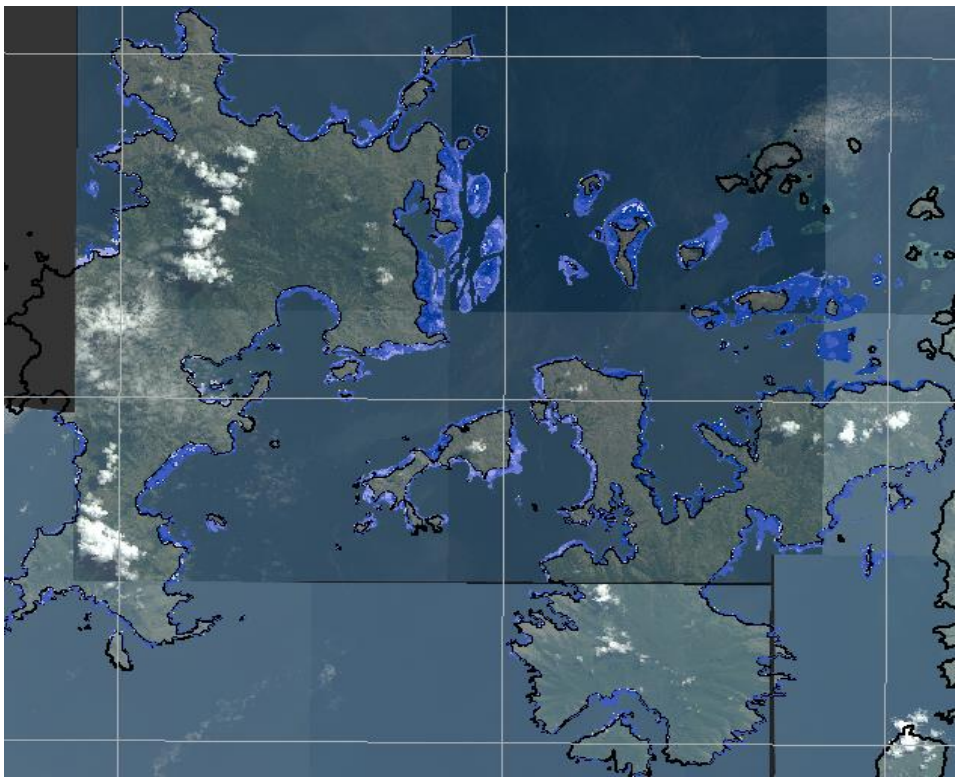


Gambar 4.3. Kondisi Kedalaman Perairan disekitar wilayah TN Komodo

Semua makhluk hidup pada dasarnya membutuhkan cahaya matahari untuk kehidupannya, terutama vegetasi dan satwa yang berada pada rantai makanan tingkat konsumen I. Oleh sebab itu, kondisi kedalaman perairan sangat penting untuk dikaji agar diperoleh gambaran secara umum potensi biodiversitas satwa perairan serta potensi perkembangan dari suatu jenis terumbu karang. Pada dasarnya terumbu karang membutuhkan kedalaman tumbuh kembang yang ideal, agar memperoleh penyinaran yang cukup namun jauh dari gangguan permukaan (ex, lalu lintas kapal, material tersuspensi dan lainnya).

Secara teori, terumbu karang mampu hidup dan berkembang pada kedalaman maksimum 30 meter dibawah permukaan laut, sehingga data bathymetri dikelaskan dalam rentang – 1 sampai dengan - 30 meter dan perairan dalam (kurang dari 30 m). Gambar diatas menunjukkan kondisi bathymetri perairan di TN Komodo yang divisualisasikan dalam warna biru dari rentang putih (kedalaman – 1 meter) sampai biru tua (- 30 meter dan perairan dalam). Semakin dalam posisi suatu terumbu karang (sampai batas – 30 m) maka semakin bagus potensi tumbuh dan kembang terumbu karang tersebut, beserta biota – biota laut yang dilingkupinya (ex, ikan, pari manta, dll). Namun hal ini berbanding terbalik dengan tingkat kesulitan menyelam untuk menikmati pemandangan dibawah permukaan laut. Sehingga, dalam kaitannya dengan ini, data kondisi bathymetri digunakan sebagai salah satu parameter dalam menentukan potensi hidup dan berkembang terumbu karang, di sisi lain, data ini juga digunakan dalam menentukan potensi wisatawan pada semua tingkat keahlian menyelam untuk menikmati wisata bawah air. Atau dengan kata lain, data bathymetri ini digunakan sebagai salah satu parameter dalam menghitung kesesuaian lahan untuk wisata bawah air di perairan dangkal.

3. Kondisi Kecerahan Perairan TN Komodo



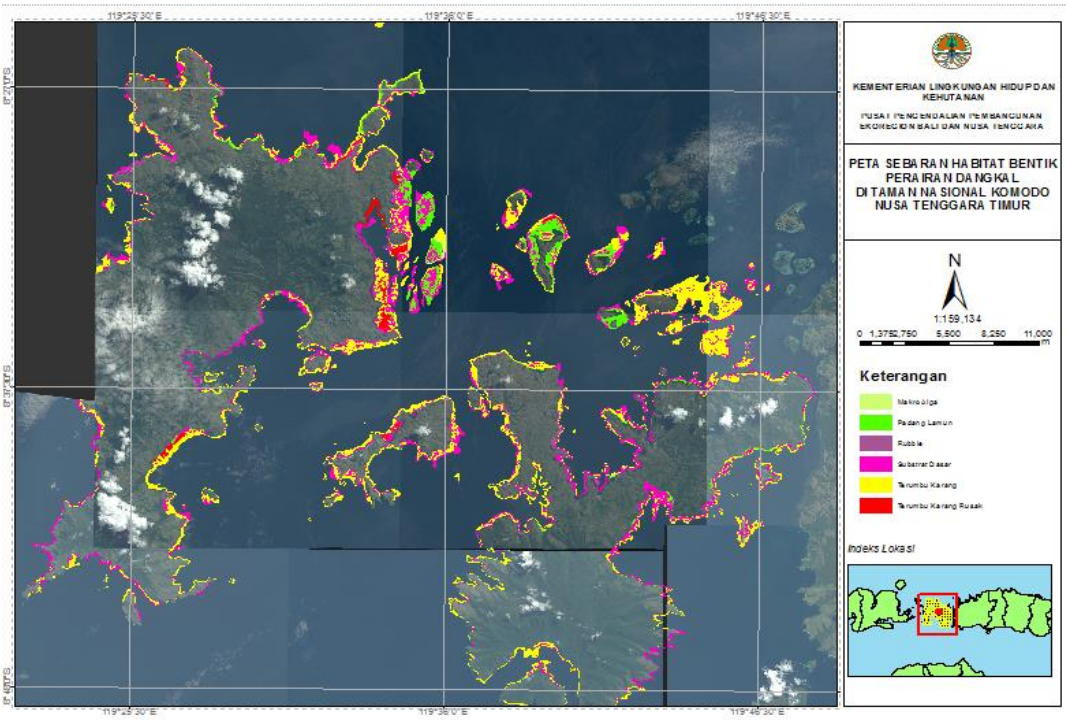
Gambar 4.4. Kondisi kecerahan perairan disekitar wilayah taman nasional Komodo

Luas wilayah TN Komodo yang relative luas jika dilihat dalam konteks Kawasan taman nasional, menyebabkan penentuan tingkat kecerahan perairan tidak mungkin dilakukan dengan pengukuran lapangan dalam waktu yang singkat. Sehingga alternative penghitungannya menggunakan pendekatan data penginderaan jauh melalui index Chipman. Meskipun index Chipman tidak mewakili secara langsung tingkat kecerahan berdasarkan kedalaman perairannya, namun index ini sudah dapat mewakili tingkat kecerahan relative perairan berdasarkan pantulan gelombang yang diterima oleh sensor yang membandingkan antara pantulan perairan (dengan menghilangkan efek gangguan atmosferik dan radiometric) dengan pantulan keberadaan suspense tanah yang terkandung diperairan.

Data tingkat kecerahan perairan di TN Komodo ini pada dasarnya menunjukkan jarak pandang penyelam dalam menikmati pemandangan bawah air. Karena pendekatan yang digunakan adalah index Chipman, maka logika analisis yang digunakan adalah semakin

tinggi tingkat kecerahan suatu area perairan, maka semakin tinggi potensi life cover terumbu karang dan juga semakin tinggi potensi visibilatas yang diperoleh penyelam dalam menikmati pemandangan bawah perairan. Tingkat kecerahan ini juga menjadi salah satu parameter penentu kesesuaian lahan wisata perairan dangkal di TN Komodo. Dalam hal ini, semakin tinggi tingkat kecerahannya, semakin sesuai suatu area untuk digunakan sebagai Kawasan wisata menyelam atau snorkeling. Jika dilihat berdasarkan peta kecerahan, maka tingkat kecerahan perairan yang tinggi sebagian besar berada di wilayah tengah – utara Kawasan TN Komodo. Artinya, wilayah ini memiliki potensi wisata selam / snorkeling yang relative tinggi untuk wisatawan dengan pengalaman dan keahlian menyelam / snorkeling yang dibawah rata – rata.

4. Kondisi Habitat Bentik Perairan Dangkal TN Komodo



Gambar 4.5. Sebaran habitat bentik disekitar wilayah taman nasional Komodo berdasarkan analisis citra satelit

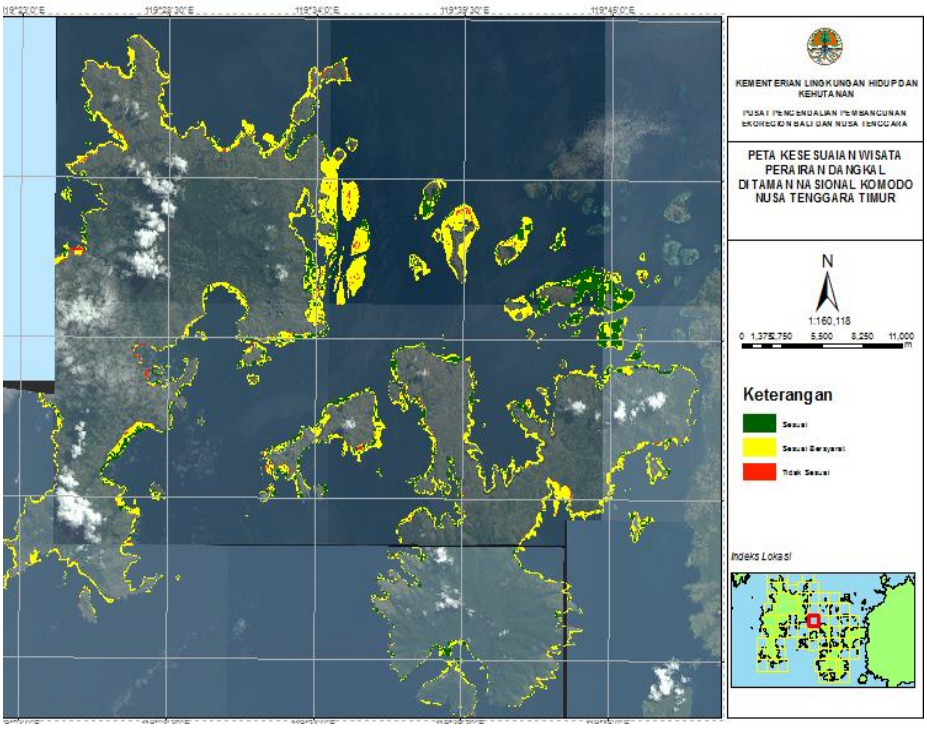
Dalam Penentuan kesesuaian lahan wisata perairan dangkal di Kawasan Taman Nasional Komodo, faktor yang tidak bisa tergantikan peranannya dengan data lain dari ke-4 penentu kesesuaian lahan adalah informasi sebaran Habitat bentik perairan dangkal. Hal ini karena sebaran habitat bentik memuat informasi life cover terumbu karang. Dengan kata lain, habitat bentik dijadikan sebagai salah satu dasar dalam membentuk informasi life cover terumbu karang dalam suatu Kawasan yang dipetakan secara detil pada skala 1 : 10.000 atau dengan luas unit pemetaan seluas 100Ha. Habitat bentik perairan dangkal diperoleh melalui interpretasi citra satelit SPOT 6/7 dengan resolusi spasial sebesar 2,5 meter. Hasil interpretasi ini tentunya tidak dapat digunakan begitu saja karena harus diukur tingkat akurasinya terhadap kebenarannya di lapangan.

Pengambilan sampel di lapangan dilakukan dalam rangka uji interpretasi yang dilakukan Bersama dengan WWF di 12 titik wisata

penyelaman sebagai unit sampel. Sampel terumbu karang yang diambil tersebar di bagian tengah Kawasan sampai dengan bagian selatan Kawasan Taman Nasional Komodo. Berdasarkan hasil pengamatan di lapangan, diperoleh informasi bahwa hasil interpretasi HBPD di bagian selatan memiliki akurasi yang relative rendah yaitu dengan kisaran nilai akurasi sebesar 71%. Di wilayah ini, beberapa objek terumbu karang hasil interpretasi ternyata merupakan rubble / substrat dasar yang relative disukai oleh fauna bawah perairan (misalnya, ikan, pari manta, dll). Sementara itu pada wilayah bagian tengah Kawasan, beberapa perbedaan ditemui pada kelas terumbu karang dan terumbu karang rusak, sehingga akurasi pada wilayah tengah relative tinggi. Misalnya saja di peta tercatat hasil interpretasi sebagai terumbu karang sehat, namun ternyata di lapangan sebagai terumbu karang rusak. Akurasi pada wilayah tengah Kawasan TN Komodo ini berkisar antara 82% - 85%. Tingginya akurasi pada wilayah tengah ini lebih dipengaruhi oleh faktor kondisi citra, dimana kenampakan citra pada wilayah ini cenderung bersih dari efek gangguan atmosferik, seperti sunglin, kabut dan awan. Jika digabungkan seluruh Kawasan, maka akurasi hasil interpretasi diperoleh nilai sebesar 79%.

Hasil pemetaan habitat bentik perairan dangak menunjukkan, cover terumbu karang sebagian besar tersebar di bagian tengah Kawasan taman Nasional Komodo. Sementara itu, di wilayah terluar pada garis pantai 2 pulau besar yaitu Pulau Komodo (bagian Barat dan Selatan) dan Pulau Rinca (bagian Selatan) relative banyak ditemui kenampakan rubble dan substrat dasar. Kondisi ini menandakan bahwa wilayah tersebut memiliki potensi yang besar untuk dilalui / sebagai tempat hidup fauna endemic perairan beberapa spesies, seperti contohnya Pari Manta. Sebaran lamun lebih banyak ditemui pada garis pantai Pulau Komodo bagian dalam, dan merupakan satu kesatuan ekosistem dengan ekosistem terumbu.

5. Kondisi Kesesuaian Wisata Perairan Dangkal Kawasan TN Komodo



Gambar 4.6. Hasil analisis kesesuaian perairan untuk pariwisata di taman nasional Komodo yang terbagi menjadi 3 kesesuaian yaitu sesuai, sesuai bersyarat dan tidak sesuai

Secara garis besar, 4 parameter yang telah disebutkan sebelumnya dilakukan analisis tumpangsusun untuk memperoleh gambaran kesesuaian lahan wisata perairan dangkal yang selanjutnya disebut sebagai daya dukung lahan Kawasan wisata di Kawasan Taman Nasional Komodo. Ke empat parameter ini diberikan bobot yang sama karena secara konseptual memiliki peranan yang sebanding untuk penentuan kesesuaian lahan kawasan wisata. Kesesuaian lahan wisata perairan dangkal ini pada dasarnya menggambarkan kemampuan lahan secara fisik (ekologis) dalam mendukung kegiatan pariwisata. Kemampuan tersebut meliputi empat aspek, yaitu, kemampuan alam dalam memunculkan potensinya secara ekologis sebagai salah satu daya tarik wisata (life cover terumbu, arus, dan kedalaman perairan), kemampuan alam dalam menyediakan

visibilitas yang sesuai untuk manusia dalam menikmati keindahan, serta kemampuan alam dalam memberikan kondisi yang aman untuk penyelam / wisatawan (arus).

Hasil penentuan kesesuaian lahan wisata perairan dangkal menunjukkan bahwa sabagian besar wilayah di Kawasan Taman Nasional Komodo memiliki kelas “Sesuai Bersyarat” untuk kegiatan wisata. Untuk kelas sesuai, lebih banyak dijumpai pada bagian tengah Kawasan yang berdekatan dengan pulau utama di Kabupaten Manggarai Barat. Beberapa kelas “Tidak Sesuai” dijumpai pada perairan yang wilayah daratnya memiliki aktifitas pariwisata atau permukiman yang relative tinggi. Dominasi kelas “Sesuai Bersyarat” ini menunjukkan bahwa pada dasarnya Kawasan Taman Nasional Komodo sesuai digunakan untuk kepentingan wisata perairan namun perlu diperhatikan unsur manajemen atau pengelolaannya. Pengelolaan yang dimaksud dapat berupa pembatasan jumlah wisatawan yang masuk dalam satu area tertentu dalam kurun waktu tertentu atau dapat dilakukan melalui pengelolaan distribusi kunjungan wisatawan di semua spot menyelam / snorkeling yang ada di Kawasan Taman Nasional Komodo agar tidak terjadi ledakan kunjungan wisatawan pada satu titik saja.

4.2.3 Daya Dukung Wisata Menyelam

1) Daya Dukung Fisik

Dalam kajian ini melakukan perhitungan dengan total 6 kali kunjungan dimana kapal harian (daily boat) biasa beroperasi pukul 09.00 – 15.00 di lokasi. Sedangkan waktu berangkat diperkirakan antara 07.00 – 09.00 dan waktu kepulangan adalah 15.00-17.00 untuk kembali ke Labuan Bajo. Nilai PCC (Physic Carrying Capacity) menghitung berapa total penyelam dengan membagi antara luasan area dengan permukaan yang dipakai untuk penyelam. Dalam penelitian ini, tinggi penyelam diperhitungkan dimana 1,7 meter adalah rata-rata tinggi yang digunakan (laki-laki maupun wanita) dan jarak dengan biota maupun penyelam lain di anjurkan sekitar 3 meter

untuk batas aman. Contohnya di lokasi Tatawa Besar, nilai PCC adalah 404 orang per hari. Tentu nilai ini terlalu besar dan membuat lokasi penyelaman akan menjadi terlalu padat dengan 6 kali kunjungan (67 penyelam dalam waktu yang bersamaan). Hal ini disebabkan karena belum melakukan perhitungan faktor koreksi untuk mendapatkan nilai RCC (Real Carrying Capacity) .

Tabel 4.17 Komponen dalam perhitungan Daya Dukung Fisik (PCC)

Komponen	Informasi
Used Surface (m)	4.7
Jumlah kunjungan (visits) yang bisa diulang saat penyelaman (NV) - Visits/day/trail	6
Total Potensial Time - Menit (Vt)	360
Waktu Penyelaman 1 hari (daily boat)	09:00 - 15:00
Total Potensial Time - Jam (Vt)	6
Waktu efektif penyelaman - menit (Tv)	60

2) Daya Dukung Sebenarnya

Dalam Yuneni, R et al (2017) Sesuai dengan metodelogi yang telah dijelaskan di atas (Rios Jara, 2013), terdapat 4 faktor yang digunakan dalam kajian ini yang sesuai dengan karakteristik Taman Nasional Komodo, dapat diuraikan sebagai berikut:

- Faktor Koreksi Sosial (Cfsos)

Dalam estimasi faktor ini, interview dilakukan untuk mengetahui jarak nyaman yang digunakan bagi penyelam antar grup. Dalam 1 grup menurut peraturan yang berlaku pada Professional Association of Diving Instructor (PADI) yang berlaku di Taman Nasional Komodo adalah 5 orang sudah termasuk guide. Hal tersebut diterapkan pada semua dive site (11 titik), namun jumlah grup di dalam lokasi penyelaman, cukup beragam yaitu sekitar 4-24 grup dalam satu trail penyelaman. Lokasi seperti Batu Bolong dan Pengah Kecil menjadi

lokasi dengan jumlah grup terkecil (4 grup) yang dianggap nyaman dan Karang Makassar yang memiliki area yang luas sehingga jumlah grup yang terbanyak (24 grup) masih dianggap nyaman oleh wisatawan maupun guide. Nilai Cfsos ini didapatkan dari:

$$CFsoc = 1 - \left(\frac{Lm}{L} \right)$$

dimana :

CFsos : Faktor Koreksi Sosial

Lm : Besarnya batasan yang didapatkan dari pengurangan antara jarak antar grup dengan total penyelam dalam satu grup dan total grup dalam satu trail

L : Jarak antar grup penyelaman

- Faktor Kerapuhan (CFfg)

Pengambilan data tutupan karang ini mengacu pada laporan Taman Nasional dalam monitoring kesehatan terumbu karang (reef health monitoring) padaa tahun 2013 (Herwata et al) dan 2016 (Kefi at al). Selain itu untuk terdapat beberapa site juga didapatkan dari perhitungan data bentik (karang keras) dari monitoring hiu dan pari manta oleh BTN. Komodo dan WWF Indonesia. Dilanjutkan pada tahun 2018, survei lanjutan dilakukan juga dengan P3E Bali Nusra.

Nilai yang didapat yaitu:

$$CFfg = 1 - \left(\frac{C(\%\ fragile\,\mathrm{cov}\,erage)}{100\%} \right)$$

dimana:

CFfg : Koreksi Kerapuhan

% fragile coverage : Presentase tutupan karang (karang yang rapuh)

- Faktor Koreksi Dampak Akibat Kontak (Cfda)

Dalam perhitungan ini menggunakan penelitian Dicker (2015) tentang Sustainable Scuba Diving : Exploring Conscious Underwater Impacts as Influenced by Perception in Puerto Galera, Philippines and Tulamben, Bali,Indonesia dalam Yuneni, R. et Al (2017) Walaupun

area yang digunakan berbeda, namun lokasi di Tulamben, Bali menjadi refrensi bagi tingkah laku wisatawan yang datang di Indonesia. Hal ini akan menjadi salah satu faktor koreksi dengan pengamatan bagi penyelam seberapa besar frekuensinya terhadap kontak pada biota, hal ini bisa diasumsikan sentuhan terhadap terumbu karang maupun hewan seperti hiu dan pari manta.

nilai didapat dari:

$$CFda = 1 - \left(\frac{Frequency\, of\ touches / diver / \min}{Dive\, time\, (\min)} \right)$$

dimana :

Cfda = Faktor Faktor Koreksi Dampak Akibat Kontak

Frequecy of touch = Frekuensi penyelam kontak dengan biota

Dive Time = Total pengamatan dalam penyelaman

- Faktor Koreksi Angin

Perhitungan yang dilakukan adalah mengetahui jumlah waktu yang bisa digunakan untuk lokasi penyelaman. Bagi lokasi penyelaman di bagian tengah (Tabel 1) tidak ada batasan waktu karena bisa dilakukan penyelaman dalam 1 tahun penuh (365 hari), berbeda dengan lokasi penyelaman di utara dan selatan yang tidak bisa diselami karena kapal tidak bisa menuju lokasi karena angin mempengaruhi tinggi rendahnya gelombang. Dengan nilai yaitu:

$$CFwind = 1 - \left(\frac{hl}{ht} \right)$$

dimana :

Cfwind : Nilai Faktor Koreksi Angin

Hl : jumlah waktu (hour) yang membatasi angin pertahun

Ht : jumlah waktu (hour) yang tersedia dalam setahun

- Kapasitas Pengelola

Dalam mendapatkan nilai MC, penelitian Rachel (2017) dalam Yuneni, R et al (2017) dapat mengakomodir dalam perhitungan kapasitas pengelola di Taman Nasional Komodo dengan metode interview pada sekitar lebih dari 400 wisatawan yang dapat mencangkup 3 aspek

yaitu Infrastuktur, Peralatan dan Personel yang tersedia di dalam kawasan.

Wisatawan memberikan penilaian tertinggi kepada kriteria pelayanan naturalist guide dan aktivitas diving/snorkeling dengan persentase nilai di atas 80%, sedangkan penilaian terendah diberikan kepada toko cenderamata, toilet, tambatan kapal, dan tempat sampah dengan rata-rata penilaian di antara 61-64%. Aktivitas wisata yang paling disukai oleh wisatawan adalah diving/snorkeling dengan besaran persentase 51% atau setara dengan 203 responden. Sehingga rata-rata nilai yang didapat dan kemudian dijadikan nilai Management Capacity (MC) yaitu sebesar 0.73

3) Nilai Daya Dukung Wisata Menyelam TN Komodo

Dalam Yuneni R. et al (2017) pemilihan lokasi dive site berdasarkan dari tingkat kunjungan oleh wisatawan yang berdasarkan informasi dive operator maupun dari rekomendasi berbagai media online maupun cetak yang tersebar. Selain itu adanya daya tarik wisata utama berupa pari manta, hiu, terumbu karang, dan lain-lain. Menurut Rachel (2017), Berdasarkan penelitian, dari 203 responden terdapat 122 responden yang menyatakan tidak bersedia untuk mengunjungi kawasan Taman Nasional Komodo apabila hiu dan manta sudah tidak lagi ditemukan di kawasan ini. Dalam perhitungan daya dukung wisata ini, diperuntukan untuk penyelam yang akan masuk ke dalam dive site dalam daftar yaitu 11 titik dari lebih dari 30 titik dalam Taman Nasional Komodo. Penelitian ini telah berjalan sejak 2015 dengan pengambilan luas area penyelaman efektif. Berdasarkan informasi dari dive guide yang telah memiliki pengalaman lebih dari 5 tahun dengan menggunakan persepsi luasan dan di ground check di lokasi masing-masing.

Dalam laporan ini terdapat 2 tabel hasil perhitungan daya dukung wisata, dimana terdapat 2 kali pengambilan data yaitu pada tahun 2015-2016 dan 2018, tentunya perhitungan dengan menggunakan metode yang sama dan disesuaikan dengan kondisi

alam di Taman Nasional Komodo. Dengan menggunakan 4 koreksi yaitu koreksi sosial, kerapuhan, dampak sentuhan, dan angin yang diharapkan menjadi pembatas jumlah wisatawan yang berasas keberlanjutan dan bertanggung jawab. Dalam penelitian tahun 2017 sebelumnya range untuk 11 lokasi wisata yang berdasarkan dengan adanya kemunculan hiu dan manta ini antara 13-143 kunjungan perhari. Tentunya dalam kondisi ini yang diperhatikan adalah jarak antara wisatawan dengan biota laut terutama hiu dan manta yaitu 3 meter dan berupaya tidak melakukan sentuhan pada terumbu karang. Selain itu adanya jarak nyaman antar wisatawan. Nilai tersebut bisa dilihat pada tabel 4.18 – 4.20.

Tabel 4.18. Estimasi nilai daya dukung wisata laut di 11 (sebelas) lokasi penyelaman (Yuneni, R 2017)

Site	Panjang Dive site (m)	PCC	Faktor Koreksi				RCC	Nilai MC	TCC per day	TCC per Tahun
			Cfsos	CFgt	Cfda	Cfwind				
1. Castle Rock	198.83	253.83	0.4	0.705	0.683	0.822	40	0.73	20-38	11,182
2. Crystal Rock	300.24	383.28	0.4	0.7375	0.683	0.822	63	0.73	37-55	14,518
3. The Cauldroun	325.45	415.46	0.4	0.725	0.683	0.822	68	0.73	30-58	15,470
4. Golden Passage	915.84	1169.15	0.2	0.65	0.683	0.822	85	0.73	53-71	19,516
5. Batu Bolong	160.47	204.86	0.8	0.275	0.683	1	31	0.73	13-31	5,787
6. Tatawa Besar	316.68	404.27	0.4	0.5233	0.683	1	58	0.73	33-51	13,220
7. Mawan	443.13	565.7	0.4	0.6742	0.683	0.822	86	0.73	53-71	19,588
8. Pengah Kecil	201.28	256.95	0.8	0.3796	0.683	1	53	0.73	30-48	12,190
9. Karang Makassar	1,113.17	1421.07	0.3	0.63	0.683	1	183	0.73	125-143	41,958
10. Siaba Besar	305.81	390.4	0.6	0.6688	0.683	0.822	88	0.73	55-73	24,473
11. Manta Alley	378.82	483.6	0.25	0.875	0.683	0.822	59	0.73	34-52	13,583

Tabel 4.19. Estimasi daya dukung wisata di lokasi penyelaman (lanjutan) di Tahun 2018

Site	Panjang Dive site (m)	PCC	Faktor Koreksi				RCC	Nilai MC	TCC per day	TCC per Tahun
			Cfsos	CFgt	Cfda	Cfwind				
12. Siaba Kecil	250	319.1489	0.8	0.66	0.71	1.00	120	0.73	78-96	26,175
13. Tatawa Kecil	150	191.4894	0.4	0.66	0.71	1.00	36	0.73	17-35	7,853
14. Light House	407.82	520.6213	0.3	0.64	0.71	0.82	58	0.73	33-51	12,785
15. Pantai Merah	280.08	357.5489	0.4	0.73	0.71	1.00	74	0.73	44-62	16,198
16. Pilarsteen	164.78	210.3574	0.4	0.75	0.71	0.82	37	0.73	18-36	8,103
17. Three Sister	205.305	262.0915	0.3	0.64	0.71	0.82	29	0.73	12-30	6,436
18. Secret Garden	106.7	136.2128	0.6	0.68	0.71	0.82	32	0.73	14-32	7,083
19. Canibal Rock	121.155	154.666	0.6	0.64	0.71	0.75	32	0.73	14-32	6,963
20. Yellow Wall	151.46	193.3532	0.8	0.81	0.71	0.75	67	0.73	39-57	14,679
21. The Boulders	183.415	234.1468	0.6	0.84	0.71	0.75	63	0.73	37-55	13,848
22. Crynoid Canyon	112.19	143.2213	0.8	0.68	0.71	0.75	42	0.73	21-39	9,103
23. Sebayur Kecil	300	382.9787	0.6	0.83	0.71	1.00	136	0.73	90-108	29,728

Tabel 4.20. Ringkasan nilai daya dukung wisata laut di TN. Komodo

No	Site	Total Kunjungan Perhari	Jumlah kapal per hari	Total Kunjungan Pertahun	Total Penyelam Pertahun
1	Castle Rock	37	5	11,182	3,727
2	Crystal Rock	48	6	14,518	4,839
3	The Cauldroun	52	6	15,470	5,157
4	Golden Passage	65	8	19,516	6,505
5	Batu Bolong	19	2	5,787	1,929
6	Tatawa Besar	44	6	13,220	4,407
7	Mawan	65	8	19,588	6,529
8	Pengah Kecil	41	5	12,190	4,063
9	Karang Makassar	140	17	41,958	13,986
10	Siaba Besar	82	10	24,473	8,158
11	Manta Alley	45	6	13,583	4,528
12	Siaba Kecil	87	11	26,175	8,725
13	Tatawa Kecil	26	3	7,853	2,618
14	Lighthouse	43	5	12,785	4,262
15	Pink Beach	54	7	16,198	5,399
16	Pilarsteen	27	3	8,103	2,701
17	Three Sister	21	3	6,436	2,145
18	Secret Garden	24	3	7,083	2,361
19	Canibal Rock	23	3	6,963	2,321
20	Yellow Wall	49	6	14,679	4,893
21	The Boulders	46	6	13,848	4,616
22	Crynoid Canyon	30	4	9,103	3,034
23	Sebayur Kecil	99	12	29,728	9,909
Total Kunjungan Pertahun			350,439		
Total Pengunjung Pertahun			116,813		

Dalam table 4.19 dapat menunjukan 12 titik penyelaman yang merupakan penelitian lanjutan dari 11 titik yang telah diambil sebelumnya, sehingga terdapat sekitar 23 lokasi penyelaman yang dimasukan ke dalam perhitungan daya dukung wisata laut ini. Total kunjungan pertahun yaitu 350,429 orang dengan asumsi jika penyelam hanya melakukan satu kali penyelaman dalam satu kunjungan ke Kawasan Taman Nasional Komodo. Jika penyelam melakukan menyelam rata-rata 3 kali dalam sehari karena sesuai dengan paket yang ditawarkan oleh dive operator dan juga waktu yang dimiliki oleh penyelam dengan memperhatikan aspek keselamatan, maka total pengunjung yang dapat diterima oleh lokasi penyelaman di Taman Nasional Komodo adalah sebesar 116,813 pengunjung per tahun dengan melakukan aktivitas selam yang tersebar di 23 titik lokasi yang juga merupakan favorit bagi penyelam di seluruh penjuru dunia.

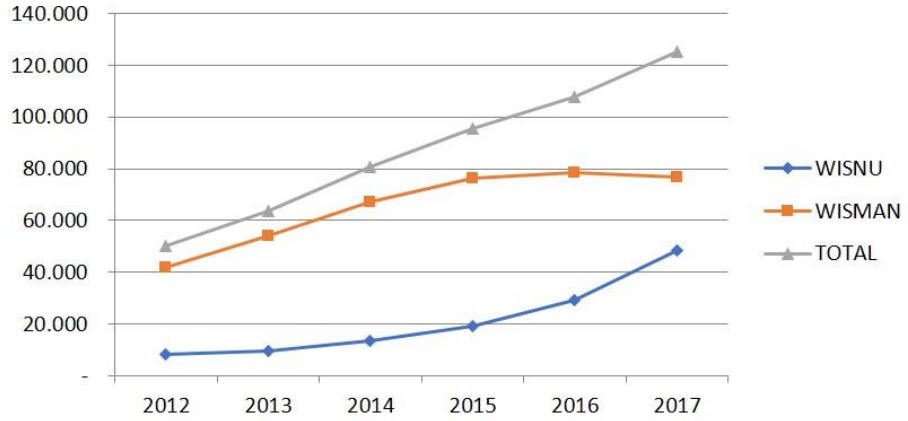
Berdasarkan informasi yang diperoleh dari tour operator yang beroperasi di kawasan TN Komodo, setiap satu unit kapal wisata membawa sekitar 8 orang wisatawan yang akan melakukan aktivitas menyelam. Masing-masing penyelam dalam satu hari rata-rata melakukan 3 kali penyelaman, sehingga jumlah pada tabel 4.20 telah disesuaikan dengan kondisi tersebut tersebut. Lokasi-lokasi ini sudah menjadi representatif di TN. Komodo yang terbagi dari utara, tengah dan selatan.

4) Daya Dukung vs Tingkat Kunjungan Wisata

Seperti dijelaskan Hasan et al (2014) bahwa daya dukung wisata adalah suatu mekanisme yang digunakan dalam pengelolaaan wisata untuk menentukan batas atas dalam hal pengembangan dan pengaturan pengunjung serta pemanfaatan potensi sumberdaya pariwisata yang optimal. Di dalam implementasi pengelolaan pariwisata taman nasional Komodo, kajian daya dukung wisata ini diharapkan menjadi salah satu pertimbangan di dalam melakukan

pengaturan pengunjung terutama dalam menentukan batasan dan sebaran pengunjung pada masing-masing atraksi wisata yang ada.

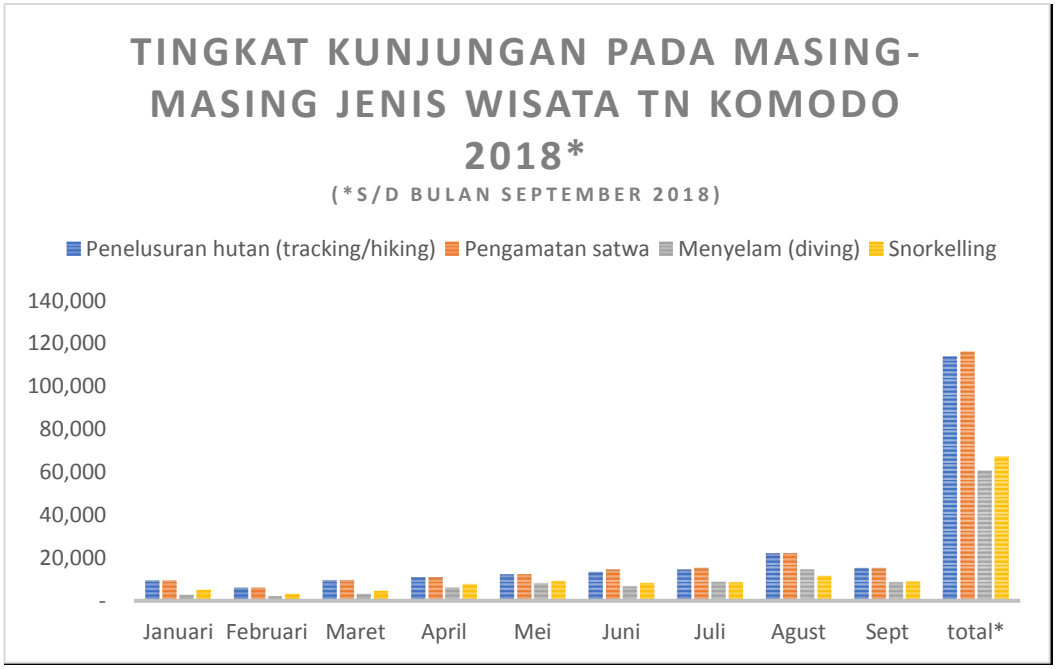
Selain informasi mengenai kondisi daya dukung wisata, data jumlah dan sebaran pengunjung juga sangat penting dalam menyusun perencanaan pengelolaan pengunjung di suatu destinasi wisata. Dengan kondisi seperti di taman nasional Komodo yang memiliki banyak alternative atraksi atau objek dan daya Tarik wisata (ODTW), informasi terkait pengunjung akan memberi gambaran tentang tingkat popularitas dan kondisi tekanan pengunjung padda masing-masing ODTW.



Gambar 4.7. Tingkat kunjungan wisata ke TN Komodo untuk periode 2012-2017

Secara umum kunjungan wisata ke taman nasional Komodo dalam 5 tahun terakhir mengalami peningkatan yang sangat signifikan. Berdasarkan data pada Balai TN Komodo seperti terlihat pada gambar 4.7 menunjukan dalam periode 5 tahun terakhir peningkatan jumlah kunjungan mencapai lebih dari 100% dari angka 50.000 orang pada tahun 2012 menjadi sekitar 125.000 pada tahun 2017. Berdasarkan profil wisatawan yang berkunjung ke taman nasional Komodo sampai saat ini masih didominasi oleh wisatawan manca negara dengan proporsi sekitar 60% dari total pengunjung (tahun 2017). Namun demikian persentase jumlah wisatawan nusantara pada saat ini terus menunjukan peningkatan dibandingkan dengan tahun sebelumnya.

Kondisi kunjungan wisatawan di taman nasional Komodo menunjukan adanya perkembangan pariwisata yang positif di kawasan tersebut dan Labuan Bajo pada umumnya, namun demikian kondisi ini juga mengindikasikan tekanan pengunjung yang semakin tinggi terhadap ekosistem yang ada di kawasan taman nasional Komodo, terutama disekitar lokasi yang menjadi atraksi wisata seperti jalur pendakian/trekking dan lokasi menyelam. Gambar 4.8 menunjukan ada 4 jenis aktivitas wisata yang dominan dilakukan di taman nasional Komodo, yaitu kegiatan penelusuran hutan (trekking/hiking), pengamatan satwa, menyelam (diving) dan snorkeling. Sepanjang tahun 2018 (s/d bulan September) tingkat kunjungan wisata untuk 4 jenis kegiatan wisata yang disebutan di atas mencapai 357.812 orang dengan rincian jumlah wisatawan untuk kegiatan penelusuran 113.975 orang, pengamatan satwa 115.992 orang, menyelam 60.603 orang dan snorkeling 67.242 orang.



Gambar 4.8. Tingkat kunjungan wisata di kawasan tn komodo berdasarkan 4 jenis aktivitas wisata yang dominan di tn komodo (penelusuran/trekking, pengamatan satwa, menyelam dan snorkeling)

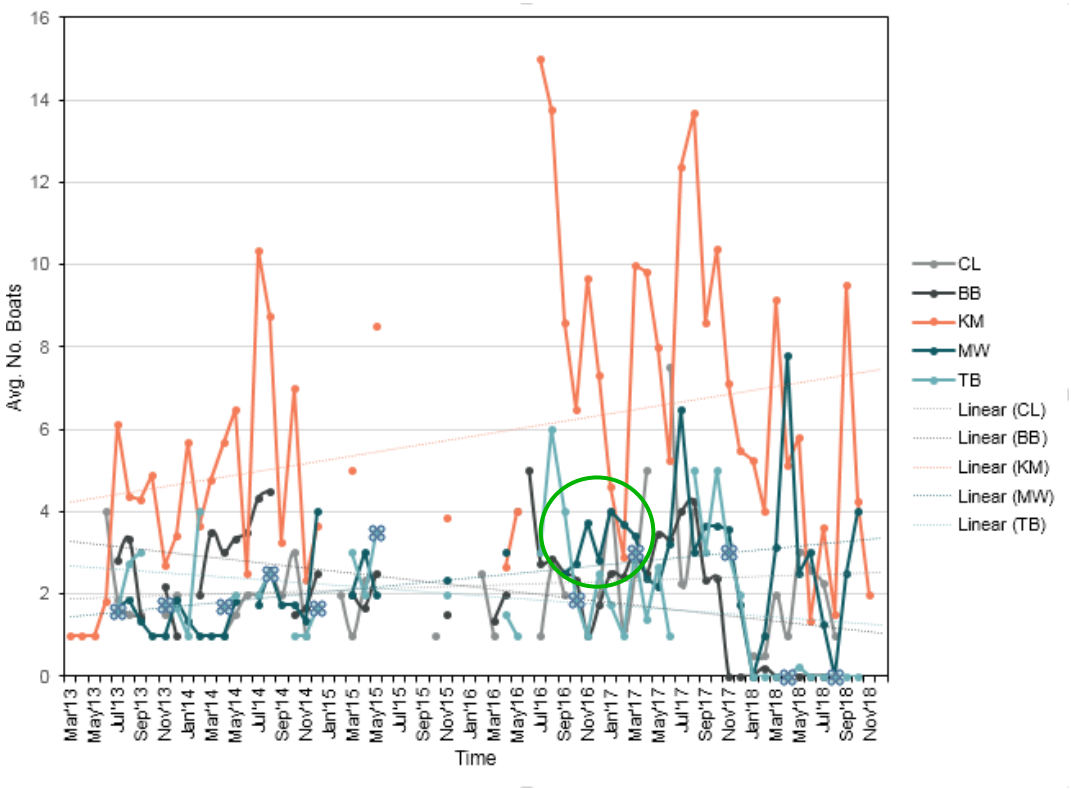
Dengan membandingkan antara besaran daya dukung wisata dengan tingkat kunjungan pada saat ini, dapat dilihat bahwa untuk

wisata di wilayah terrestrial khususnya kegiatan penelusuran/trekking dan pengamatan satwa jumlah kunjungan wisata pada saat ini 229,967 orang (pada tahun 2018 s/d bulan September2018) masih berada di bawah nilai daya dukung wisata secara keseluruhan pada 15 jalur trekking yang ada di tiga pulau (P. Komodo, P. Rinca dan P. Padar) namun sudah mendekati batas nilai daya dukungnya yaitu sebesar 249.295 orang / tahun. Untuk kegiatan menyelam, jumlah wisatawan saat ini sebesar 60.603 orang (pada tahun 2018 s/d bulan September 2018) masih berada dibawah nilai daya dukung wisata pada 23 lokasi menyelam yang sudah dikaji yaitu sebesar 116.813 orang / tahun.

Secara umum angka kungjungan wisatawan saat ini masih berada di bawah nilai daya dukung wisata baik untuk wisata terrestrial maupun wisata di perairan namun sebenarnya perlu lebih jauh diidentifikasi mengenai sebaran data pengunjung tersebut pada masing-masing lokasi baik untuk jalur wisata di darat maupun untuk wisata menyelam. Seperti diketahui bahwa saat ini terdapat 15 lokasi jalur wisata pendakian/trekking dan 42 lokasi untuk kegiatan menyelam dan snorkeling di kawasan TN Komodo. Namun keterbatasan data terkait jumlah wisatawan pada masing-masing aktivitas wisata yang didasarkan pada jumlah penjualan tiket ini tidak dapat menunjukan secara spesifik lokasi jalur wisata ataupun lokasi menyelam yang dikunjungi oleh wisatawan, sehingga tidak dapat dilakukan identifikasi mengenai sebaran dan tingkat kunjungan pengunjung pada masing-masing jalur trekking ataupun lokasi menyelam.

Walaupun secara kuantitatif tidak dapat digambarkan tentang tingkat kunjungan wisatawan pada masing-masing lokasi wisata namun secara umum terdapat beberapa lokasi baik untuk wisata terrestrial dan juga wisata perairan yang menjadi tujuan utama atau lokasi favorit dari wisatawan yang berkunjung ke TN Komodo. Berdasarkan keterangan dari pihak *tour operator* beberapa lokasi

yang relative sering dikunjungi addalah Loh Liang, Loh Buaya dan P. Padar untuk wisata terrestrial, sedangkan untuk wisata perairan khususnya menyelam lokasi yang banyak dikunjungi antara lain Batu Bolong, karang Makassar, Castle Rock, Manta Alley dan Crystal Rock. Apabila sebaran pengunjung hanya terfokus pada beberapa lokasi saja dan tidak menyebar di semua lokasi wisata yang ada baik untuk wilayah terrestrial maupun di wilayah perairan maka dikhawatirkan terjadi kunjungan yang melebihi kapasitas daya dukung pada lokasi-lokasi tersebut.



Gambar 4.9. Rata-rata jumlah kapal wisata yang berkunjung pada lokasi penyelaman di TN Komodo (CL-Couldron; BB-Batu Bolong; KM-Karang Makassar; MW-Mawan dan TB- Tatawa Besar) untuk periode 2013-2018)

Seperti terlihat pada Gambar 4.9 berdasarkan data yang diperoleh dari *DOCK/Marine Mega Fauna* terkait jumlah kapal wisata yang berkunjung ke kawasan TN Komodo, data menunjukan pada bulan Juli 2016 jumlah rata-rata kapal wisata yang berkunjung ke lokasi Batu Bolong (BB) adalah 6 kapal/hari. Dengan asumsi bahwa

setiap kapal wisata membawa 8 orang wisatawan yang melakukan aktivitas menyelam, maka rata-rata jumlah wisatawan yang datang ke lokasi Batu Bolong adalah 48 orang / hari. Jumlah tersebut melebihi nilai daya dukung wisata di lokasi Batu Bolong sebanyak 19 orang / hari atau 2 unit kapal wisata / hari. Data ini menunjukan bahwa walapun secara umum jumlah kunjungan belum melebihi nilai daya dukung wisata namun sebaran pengunjung yang ada pada saat ini tidak merata diseluruh lokasi / daya Tarik wisata (DTW) yang ada di kawasan TN Komodo sehingga ada indikasi lokasi DTW tertentu yang tingkat kunjungannya telah melebihi kapasitas daya dukungnya.

BAB V

REKOMENDASI RENCANA PENGELOLAAN

Pada bagian akhir kami menyampaikan beberapa hal yang sekiranya perlu menjadi perhatian dalam rangka pengembangan pariwisata di kawasan TN Komodo. Saran dan rekomendasi yang disampaikan pada bagian ini didasarkan pada kondisi dan temuan yang dihasilkan dalam kajian daya dukung ini.

Taman nasional Komodo memiliki keunikan ekosistem dan spesies baik di wilayah terrestrial maupun di wilayah perairan yang menawarkan pengalaman tersendiri bagi wisatawan yang berkunjung. Satwa komodo, pari manta, hiu dan keindahan panorama alam adalah daya tarik utama yang menjadi alasan wisatawan untuk berkunjung ke taman nasional Komodo. Oleh karena itu sangat penting untuk melindungi dan melestarikan sumber daya alam yang ada di sekitar taman nasional Komodo agar kegiatan pariwisata di kawasan ini dapat terus dikembangkan secara berkelanjutan.

5.1 Pengaturan pengunjung melalui penetapan kuota wisatawan

Kajian daya dukung ini diharapkan menjadi salah satu acuan untuk melakukan pengaturan pengunjung antara lain dengan menetapkan kuota kunjungan wisata pada masing-masing lokasi / DTW sesuai dengan kapasitas daya dukungnya. Selain menetapkan kuota pihak pengelola juga diharapkan dapat membangun mekanisme dalam mengatur pemberian kuota kunjungan yang telah ditetapkan baik kepada wisatawan secara langsung ataupun kepada pemegang izin usaha pariwisata (tour operator).

Selain mengatur jumlah wisatawan, pengelola juga perlu memperhatikan sebaran wisatawan pada setiap DTW serta arus pergerakan wisatawan yang ada di dalam kawasan TN Komodo. Wisatawan yang berkunjung ke taman nasional Komodo umumnya menggunakan paket kunjungan wisata dengan durasi antara 1-5 hari, namun dengan durasi yang cukup Panjang tersebut potensi DTW yang ada

belum dimanfaatkan secara optimal. Pada saat ini wisatawan cenderung terkonsentrasi pada objek wisata tertentu seperti Loh Liang dan Loh Buaya untuk wisata yang ada di pulau (terrestrial) atau Batu Bolong, dan Karang Makassar untuk wisata perairan. Penerapan kuota juga diharapkan dapat mendorong wisatawan untuk mencari alternatif kunjungan pada lokasi DTW yang selama ini belum banyak dikunjungi.

Hal lain yang perlu dilakukan adalah mendorong pihak pelaku wisata/tour operator untuk membawa wisatawan mengunjungi desa-desa wisata yang ada di dalam kawasan TN Komodo. Hal ini bertujuan untuk meningkatkan keterlibatan masyarakat lokal di dalam industri pariwisata.

5.2 Pengembangan system informasi

Aspek pelayanan merupakan elemen penting dalam pengembangan sebuah destinasi pariwisata. Ketersediaan dan kemudahan akses informasi bagi wisatawan dan pelaku usaha menjadi salah satu indikator dalam peningkatan mutu pelayanan. Pengembangan system informasi antara lain dengan menyediakan sistem pemesanan tiket secara daring dan serta membangun pusat informasi berbasis web yang dapat menyediakan segala informasi yang dibutuhkan oleh wisatawan atau calon wisatawan yang akan berkunjung ke taman nasional Komodo.

5.3 Pengawasan

Untuk menjamin program pengembangan pariwisata di taman nasional Komodo berjalan dengan baik maka perlu ditingkatkan pengawasan terhadap aktivitas yang ada di dalam kawasan TN Komodo. Seperti diketahui bahwa kawasan TN Komodo adalah wilayah dengan akses terbuka (open access) khususnya untuk wilayah perairan yang menyebabkan banyaknya wisatawan ataupun nelayan yang memasuki kawasan TN Komodo secara tidak resmi. Pengawasan diperlukan untuk meminimalisir pelanggaran yang terjadi dalam kawasan TN Komodo.

5.4 Peningkatan keselamatan dan penerapan kode etik berwisata

Aspek keselamatan juga tidak kalah penting di dalam mengembangkan pariwisata. Kegiatan wisata di kawasan taman nasional Komodo umumnya merupakan wisata alam bebas / outdoor recreation yang memiliki resiko tinggi, oleh karena itu faktor keselamatan menjadi aspek yang perlu diperhatikan di dalam rencana pengembangan pariwisata di kawasan TN Komodo. Peningkatan aspek keselamatan tidak hanya bagi wisatawan yang berkunjung tetapi juga bagi petugas yang ada di lapangan, pelaku usaha dan masyarakat sekitar kawasan. Upaya untuk meningkatkan keselamatan dalam berwisata antara lain melalui penerapan SOP dan pemberlakuan persyaratan/requirements bagi wisatawan yang akan melakukan kegiatan wisata tertentu. Misalnya untuk dapat melakukan kegiatan menyelam di taman nasional Komodo maka wisatawan diwajibkan memiliki keterampilan minimum advance open water.

Selain itu untuk menciptakan kegiatan pariwisata yang bertanggungjawab (responsible tourism) maka perlu didorong penerapan kode etik (code of conduct) wisata terutama yang berkaitan dengan interaksi wisatawan dengan satwa/biota, pengurangan penggunaan sampah plastik di dalam kawasan TN Komodo dan mekanisme penggunaan mooring buoy dan berlabuh tanpa mooring buoy. Selain untuk meningkatkan keselamatan, penerapan regulasi seperti ini juga bertujuan untuk meminimalisir kerusakan ekosistem terumbu karang yang ditimbulkan oleh aktivitas wisata.

5.5 Monitoring dan Evaluasi

Kajian daya dukung didasarkan pada penilaian kondisi lingkungan pada saat dilakukan pengukuran di lapangan. Oleh karena itu perlu dilakukan kegiatan monitoring dan evaluasi secara berkala untuk memantau perubahan kondisi daya dukung yang disebabkan oleh perubahan lingkungan dan manajemen di taman nasional Komodo.

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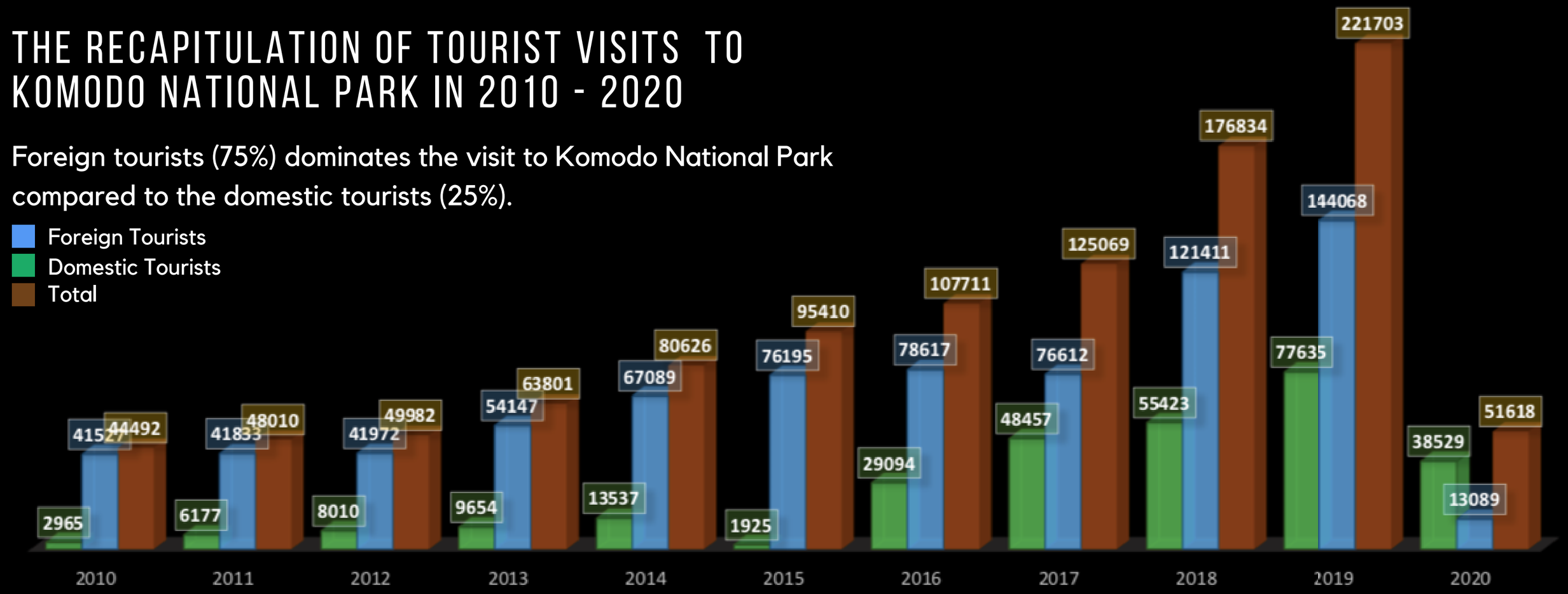
PUSAT PENGENDALIAN PEMBANGUNAN EKOREGION BALI DAN NUSA TENGGARA
WWF INDONESIA
2018

THE RECAPITULATION OF TOURIST VISITS TO KOMODO NATIONAL PARK IN 2010 - 2020

Foreign tourists (75%) dominates the visit to Komodo National Park compared to the domestic tourists (25%).



The Proportion of Tourist Difference (Domestic Tourists : Foreign Tourists)

2010		2011		2012		2013		2014		2015	
7	93	13	87	16	84	15	85	17	83	20	80
2016		**2017**		**2018**		**2019**		**2020**			
27	73	39	61	31	69	35	65	75	25		

Source: Komodo National Park Authority (2021)

EIA REVISION KOMODO NATIONAL PARK

Tourism Infrastructures Development

Loh Buaya – Rinca Island

2021

Environmental Impact Assessment of Tourism Infrastructure Renovation and Development in Loh Buaya, Rinca Island

KOMODO NATIONAL PARK

Ministry of Environment and Forestry

2021

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Acronyms & Abbreviations

CITES	:	The Convention on International Trade in Endangered Species of Wild Fauna and Flora
EIA	:	Environmental Impact Assessment
GEE		Google Earth Engine
GIS		Geographical Information System
GPS		Global Positioning System
Herpetofauna	:	Group of reptile & amphibians
IUCN	:	International Union for Conservation of Nature
KNP/ TNK (*Taman Nasional Komodo*)	:	Komodo National Park
KSP	:	Komodo Survival Program
LC	:	Least Concerned
MAB	:	Man And Biosphere
NT	:	Near Threatened
NTT	:	East Nusa Tenggara (*Nusa Tenggara Timur*)
LIPI (*Lembaga Ilmu Pengetahuan Indonesia*)	:	Indonesian Institute of Sciences
KSPN (*Kawasan Strategis Pariwisata Nasional*)	:	National Strategic Tourism Area, includes Danau Toba, Borobudur, Lombok-Mandalika, Labuan Bajo and Manado-Likupang.
OUV	:	Outstanding Universal Value
Remote Sensing	:	Process of detecting and monitoring the physical characteristics of an area by measuring its reflected and emitted radiation at a distance (typically from satellite or aircraft/UAV).
UAV	:	Unmanned Aerial Vehicle
UKL/UPL (*Upaya Pengelolaan Lingkungan/ Upaya Pemantauan Lingkungan*)	:	Environmental Management Plan/ Environmental Monitoring Plan
UNEP-WCMC	:	United Nations Environment Program World Conservation Monitoring Centre
UNESCO	:	United Nations Educational Scientific and Cultural Organization

TNC	:	The Nature Conservancy
WSS	:	Water Supply System
WCS	:	Wildlife Conservation Society
WRI	:	World Resources Institute

Executive Summary

Introduction

Komodo National Park (KNP) is located in West Manggarai Regency, East Nusa Tenggara Province, Indonesia. The area was designated as a National Park in 1980, and received the UNESCO Biosphere Reserve status in 1986 under the Man and Biosphere Programme (MAB). Furthermore, the site was inscribed as a World Heritage property in 1991 as having two out of the four natural criteria, criterion (vii) – contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance, and criterion (x) – contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation. The KNP consists of four main islands, i.e. Komodo, Padar, Rinca and Gili Motang as well as several other small islands (Figure 1).

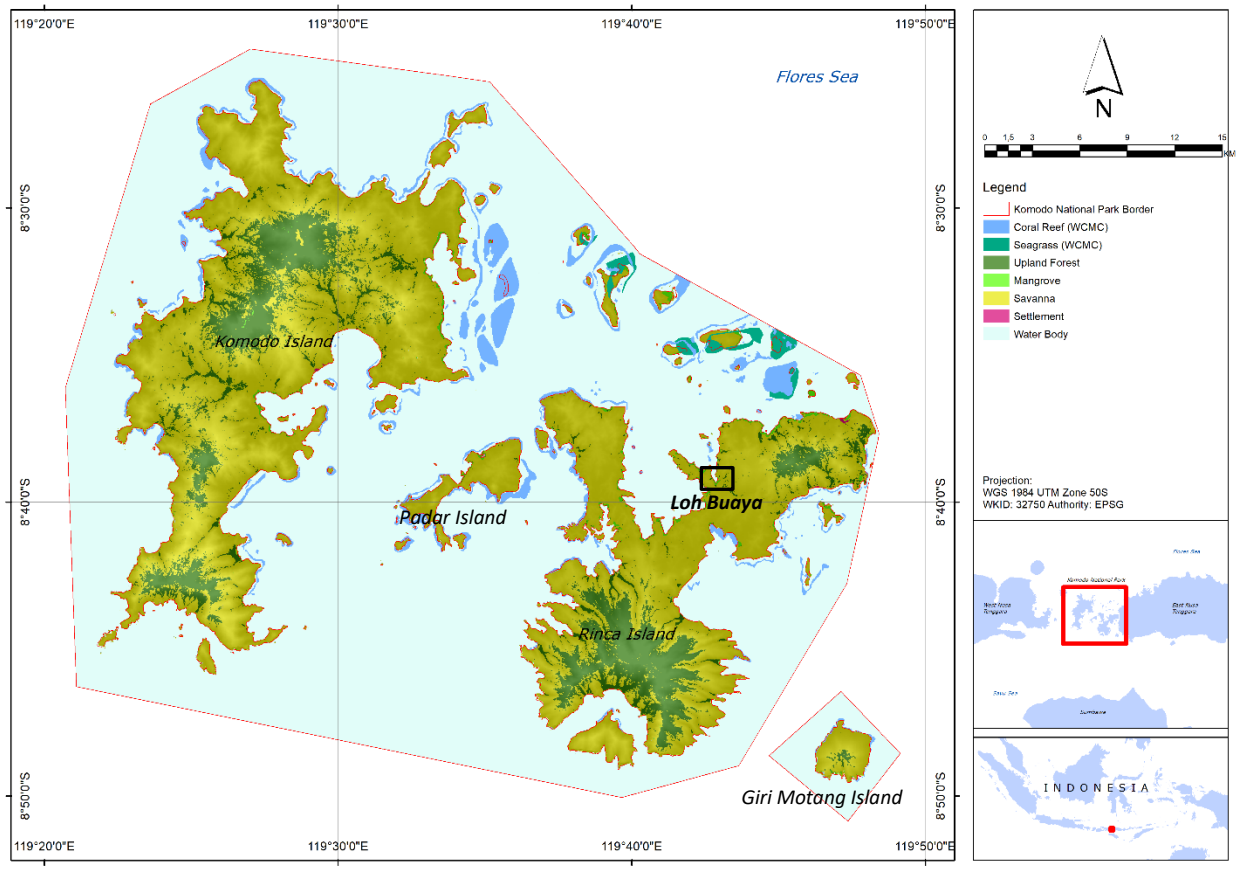

Figure 1. Komodo National Park lies between Sumbawa in West Nusa Tenggara and Flores in East Nusa Tenggara. Rinca is the second largest island of Komodo National Park after Komodo Island

There has been increasing public awareness of the importance of biodiversity conservation, contributing to the growing demand for ecotourism activities. This is reflected in the increasing number of tourists visiting KNP every year. During the last decade, the number of visitors has shown a dramatic increase, especially amongst foreigner visitors. When normal conditions return after the Covid-19 pandemic and assuming the rate of increase in visitors is the same as before the pandemic, it is estimated that by 2030 the number of visitors will

reach more than 381,000 per year. Improving the infrastructure of Komodo NP is thus critical to mitigate the negative impact of visitors on Outstanding Universal Value (OUV) of the property.

Since 2017, the Komodo National Park has become one of the national strategic areas to be developed - based on biodiversity protection - in support of the national economy (Suraji et al., 2020). Currently, the Indonesian Government is developing an Integrated Tourism Master Plan for Labuan Bajo and Flores, which also includes the Komodo National Park.

The proposed project aims to improve the quality of tourism facilities and infrastructure currently present in Loh Buaya, Rinca Island, so that it can regulate the flow of large numbers of visitors and limit the impact on the OUV of the property, the aesthetic beauty of the landscapes, as well as the ecological processes of the park. The project is in line with the Komodo National Park Medium Term Management Plan 2016-2025 which is based on the Komodo National Park Management Master Plan 2000-2025.

Proposed Renovation and Infrastructure Development Project

The proposed development on Loh Buaya, hereafter called "project" includes both in-situ renovation work as well as some additional new infrastructure that has been carefully designed as not to cause any impact on the OUV of the property.

Objectives of EIA

This study assesses in detail the impacts of the project in Loh Buaya, as well as provides a number of mitigation measures to ensure that any potential impact on the OUV of the property remains negligible. The EIA ensures that the project design complies with the strict environmental regulations and takes fully into account both ecological and visitor safety aspects.

Project Design Process

The project will take place in the Tourist Use Zone in Loh Buaya. It will replace and/or renovate the existing infrastructure (i.e. jetty, information center, cafeteria, regional section office, resort office, guest and tourist house and a number of footpaths), which was not up to standard anymore to receive the increasing number of tourists without jeopardizing their safety or having a negative impact on the property's OUV. The infrastructure that will be built includes a Camp for rangers, researchers and guides, Plaza deck, Resting post, Elevated pathway, Water Supply System/WSS (Reservoir tank and distribution pipeline), Waiting room for visitors, Jetty, Coastal protection and Information center.

The layout plan and design for the project proposed by the planner (Figure 2a) have been subjected to a series of inspections and revisions by a broad range of relevant stakeholders. The following buildings have been redesigned as the result of revisions by relevant stakeholders (Figure 2b).

a. The jetty will be extended with a floating deck.
b. The entry path will use the existing pathway, but it will be replaced by an elevated pathway.
c. The original proposed location of the reservoir tank of WSS will be changed.
d. The water supply will not be provided from a deep well, but will be delivered from Labuan Bajo
e. An additional building will be constructed to accommodate researchers

The path connecting tourist facilities for tourist management and staff will be raised to 2 meters (elevated pathway) and covered with wood. The geographical location of the Information Center was slightly shifted to avoid cutting down trees. In addition, fences were added, the pond was replaced by a wall, and holes and planting pots were added.

Total area of the project is about 1.3 ha. The proposed design is more compact, ecologically sound and ensures the safety as well as the comfort of the visitor. The improvement will maintain the Komodo National Park's Outstanding Universal Values for all future generations of mankind.

Figure 2. The layout plan of the project (a) Initial plan, (b) Final plan

Environment and Social Impact on OUV

Criteria vii statement

Landscape of the KNP is dominated by the savanna ecosystem with patches of deciduous monsoon forest and quasi-cloud forest in high elevation areas and provides a habitat for various types of protected flora and fauna. It is located in the Wallace Biogeographical Region, a special area between two continental plates of Sunda and Sahul, which is very rich with endemic and unique flora and fauna species. Meanwhile, the seascape consists of mangrove forest in the coastal line, white sandy beaches in some other areas, and a very clear blue sea so that it really pampers divers to enjoy various coral and seagrass views (Figure 1). This marine ecosystem is part of the Coral Triangle, the habitat of 600 different species of corals and the region nurtures six of the world's seven marine turtle species and more than 2000 species of reef fish.

Criteria x statement

The KNP is the home of Komodo (*Varanus komodoensis*), a world's largest lizard existing nowhere else in the world. This species is one of the megafauna species that are safe from extinction and survives on small islands as scavenging and predation (Shine & Somaweera, 2019). This species has been becoming an interesting research topic, especially in relation to evolution (Pavón-Vázquez et al., 2021; Bull et al., 2010), its ability to adapt to climate change (Jones et al., 2020), its survival in very narrow island area (Ciofi & Bruford, 1999; Purwandana et al., 2015) and ecology (Burness et al., 2001; Purwandana et al., 2016).

Other faunas are endemic rat (*Komodomys rintjanus*), the crab-eating macaque (*Macaca fascicularis*), more than 30 species of herpetofauna including the endemic and protected snake *Malayopython timorensis*, and 72 species of birds, such as the lesser sulphur-crested cockatoo (*Cacatua suplhurea*), the orange-footed scrub fowl (*Megapodius reinwardt*), and noisy friarbird (*Phiemon buceroides*).

The coral reefs fringing the coast of Komodo are diverse and luxuriant due to the clear water, intense sunlight and rapid exchange of nutrient-rich water from deeper areas of the archipelago. The marine fauna and flora are generally the same as that found throughout the Indo Pacific area, though species richness is very high, notable marine mammals include blue whale (*Balaenoptera muscullus*) and sperm whale (*Physeter catodon*) as well as 10 species of dolphin, dugong (*Dugong dugon*) and five species of sea turtles.

Project Impact on criterion (vii)

a. Negligible impact to Mangrove & Marine Ecosystem

Rinca has 272.02 ha mangrove ecosystem. Only a small fraction (0.0001%) will be disturbed, especially by the construction of an entrance pathway of 100 m long and 4 meter wide. This construction will only temporarily disturb the mangrove ecosystem due to the pruning of the tree canopy. The mangrove has the capability to form new shoots after pruning (Kathiresan et al., 2019). Likewise, for the exit pathway and the jetty, it will not interfere because it will use existing pathway and previous jetty location.

b. No impact to Seagrass & Coral Reef

The jetty will be constructed on the existing jetty in Loh Buaya. The closest distribution of coral reef and seagrass is about 1 km from the construction site (Figure 1). This is also confirmed by publication of Hadi et al., (2019) that there is neither seagrass nor coral reef at Loh Buaya.

c. No impact to white sand beaches

Distribution of white sandy beaches in Rinca Island is Western and southern part of Rinca island. Loh buaya has no white sandy beaches.

d. No impact to Deciduous Monsoon and Quasi-cloud forest ecosystem

The infrastructure development will take place in the flat and lowland savannah area of Loh Buaya, meanwhile the deciduous and quasi-cloud forest ecosystem is located in hilly and high elevation areas. It is clear that the development of infrastructure does not have a significant impact on the ecosystem.

e. Negligible impact to Savanna ecosystem

The part of the building that is built on the savanna grassland and savannah woodlands ecosystem is the information center, ranger, tour guide and researcher camp complex as well as the elevated pathway and plaza deck that connect the infrastructures (Figure 2). The elevated pathway to be built will be 695 m long. Meanwhile the plaza deck in the complex camp ranger, guide and researcher covering an area of 468.9 m m^2.

(e.1.) Impact of Camp Ranger, Tour Guide and Researcher Building complex and its Plaza Deck Development

Three buildings and a plaza that connect the buildings would be built. It can be seen clearly in Figure 2, that the building is built on barren land, grass and two clumps of shrubs. So it can be said that the development of these facilities is negligible on the ecosystem as a whole in Komodo National Park.

(e.2.) Impact of Elevated pathway development

The construction of an elevated pathway to the Information Center Building does not interfere with the ecosystem savanna because it is built at the same location of the existing pathway (Figure 2). Meanwhile, the elevated pathway towards the complex camp ranger, tour guide and researcher will not have a big impact because it is built on barren land. The construction also will not create fragmentation habitat since Komodo dragons easily move below the construction.

(e.3) Impact of Information Center Development

The infrastructure will be built on woody savannah with several trees, especially tamarin species. Even though the design has been shifted, it is estimated that there are still 5 trees that will be cut down. Compared with the total tree within the deciduous monsoon forest of the park, the impact of the construction on the OUV is negligible.

<u>Project Impact on criterion (x)</u>

We assessed the impact of the infrastructure development in Loh Buaya valley on a) Komodo dragon, b) terrestrial mammals, c) birds, d) marine fauna and flora (non-mammals), e) marine mammals, f) sea turtles.

a. Negligible impact on the population of Komodo dragon

The infrastructure development area exhibits a small footprint (0.013 km^2) compared to the total local Loh Buaya valley area (5 km^2) or that of Rinca Island's area (204.8 km^2). The project is likely to have limited non-lethal and non-permanent effects on the local Komodo dragon population. It is estimated that less than 15 individuals of Komodo dragons are interacting within the project area. This represents 23 percent of the total population in the valley (66 $\pm$ 5 individuals, in 2019), representing ~1 percent of the total Rinca island population (1,333 $\pm$ 181 individuals, in 2019). Impact and mitigation measures are summarized in Table 1.

Table 0.1. Impact of project to Komodo population and behavior, and mitigation measures to lessen the impact.

Impacts	Mitigation measures
● *Negligible impact on the habitat of Komodo Dragon*	● *Develop the new facilities only on and around the existing infrastructure in Loh Buaya valley* ● *Conducte annual population monitoring of Komodo dragon in the national park, including in Loh Buaya valley to support adaptive management approach* ● *Strengthen the daily wildlife monitoring in the Loh Buaya valley, especially in/around the infrastructure, as part of the Resort Based Management*
● *Negligible risk of displacement and unlikely changes of behavior due to disturbance*	● *Build an elevated pathway (2-m in height) to allow the natural movement of Komodo dragon and prevent interaction with tourists* ● *Strengthen the daily wildlife monitoring in the Loh Buaya valley, especially in/around the infrastructure, as part of the Resort Based Management*
● *Minimal disturbance to reproductive activities*	● *Develop the new facilities only on and around the existing infrastructure in Loh Buaya valley* ● *Continue the annual monitoring of Komodo dragon nests and female reproductive activities*
● *Minimal loss of thermal resources*	● *Develop the new facilities only on and around the existing infrastructure in Loh Buaya valley*

b. Negligible impact on the population, habitat, and behavior of terrestrial mammals

Approximately 10-20 individuals of Timor deer, 15 individuals of water buffalo, 5 individuals of wild boar, and three groups (30 to 60 individuals) of long-tailed macaques may be exposed to any impact. The numbers of individuals that may be impacted by the development are considered extremely small or negligible (Table 2). Moreover, these groups of animals present in Loh Buaya have been adapted to the presence of human activities and buildings since 1989.

Table 0.2. The impact of project on the population of mammal species.

Impacts	Mitigation measures
● *Minimal reduction to the quantity and quality of the terrestrial mammal habitat*	● *Develop the new facilities only on and around the existing infrastructure in Loh Buaya valley* ● *Continue the annual population monitoring of Timor deer, wild boar, and water buffalo (Komodo dragon key prey species)* ● *Strengthen the daily wildlife monitoring in the Loh Buaya valley, especially in/around the infrastructure, as part of the Resort Based Management* ● *Build an elevated pathway (2-m in height) to allow the natural movement of Komodo dragon and other wildlife*

c. Negligible impact on the population and habitat of birds

There are 72 bird species residing in Komodo National Park, 30 of them were observed in the project. About 87% are not-protected and 97% are not threatened (28 in Least Concern – LC and 1 in Near Threatened – NT categories). Most of the species are widely distributed and common in habitat with human presence. Therefore, the impact to the avifauna diversity is deemed negligible. A separate assessment was made for the Lesser sulphur-crested cockatoo because it is listed as Critically-Endangered and the Orange-footed scrub fowl as its nests are important to Komodo dragons. Both of them are also protected species. No impact was found based on this assessment (table 3)

Table 0.3. The impact of project on the bird population and habitat.

Impacts	Mitigation measures
● *No impact on the population of the Lesser sulphur-crested cockatoo and Orange-footed scrub fowl*	While there is no need for mitigation measures due to the absence of impacts, the following measures will nevertheless be implemented as a precautionary measure: ● *Continue the annual vantage-census of the Lesser sulphur-crested cockatoo* ● *Continue the annual monitoring of Komodo dragon nests and female reproductive activities* ● *Strengthen the daily wildlife monitoring in the Loh Buaya valley, especially in/around the infrastructure, as part of the Resort Based Management*

d. Marine fauna & Flora: Dolphins & Sea Turtles

Bottlenose dolphins are one of the most common cetaceans observed in the Komodo National Park. This dolphin sighting in the bay was also recently confirmed by the local community (Personal communication). Because the construction takes place on the land, it will not directly affect these marine mammals. Measures need to be taken later to anticipate the increasing number of tourists (Table 4).

Two species of seaturtles are found in Komodo National Park, 1) Hawksbill seaturtle (*Eretmochelys imbricata*) and 2) Green seaturtle (*Chelonia mydas*) (Personal communication with Mr. Muhammad Ikbal Putera, Komodo National Park). None of the species use the coastal area of Loh Buaya valley close to the planned construction site as nesting ground because it is all covered by mangroves (Personal communication with Loh Buaya resort park ranger, Mr. Afandi). This area is also very unlikely to be used as a feeding sites because of the absence of coral reefs (see impact d) and seagrasses (main substrate of the seafloor is rock, sand, and mud) (Lembaga Ilmu Pengetahuan Indonesia (LIPI) (Indonesian Institute of Science) 2019).

Table 0.4. The impact of project on marine mammals.

Impacts	Mitigation measures
Minimal disruption to the behavior and local abundance of coastal dolphins	● *Strengthen the daily wildlife monitoring in the Loh Buaya valley, especially in/around the infrastructure, as part of the Resort Based Management* ● *Develop and implement operating guidelines for tourist-vessels*

No impact on nesting behavior of sea turtles	● *Monitoring the possibility of presence of sea turtles in the area*

Project Impact on Integrity

The project does not cause fragmentation, patch habitat isolation, and habitat destruction. It is neither disturbing the reproduction nor predation process for Komodo dragons and other terrestrial mammals.

Project Impact on Protection & Management

The project would enhance the site's tourism carrying capacity which will allow it to have more visitors in greater numbers yet sustainably managed. The presence of tourists visiting Loh Buaya would positively contribute toward the multiplier effect in the West Manggarai Regency, specifically improving the local economy of the people living in Labuan Bajo and its neighboring towns or villages. The local community would have a better chance to improve their livelihood through the implementation of sustainable tourism design in Loh Buaya. The information Centre will allow park staff and tourist guides to raise the awareness of the property's Outstanding Universal Values to a broader audience. More importantly, the project will prevent the tourists from directly interacting with the wildlife as some previously did.

There are potential impacts that need to be observed, namely changes in Komodo dragon behavior, over capacity of visitors, and visitor safety. Mitigation

Table 0.5. The impact of project on protection and management.

Impact	Mitigation measure
Change of the Komodo behavior	*Avoid the close contact between visitor & Komodo* • The interaction between visitors and Komodo can be minimize by adding physically barrier • Elevated pathway as proposed by the project also can avoid/minimize direct contact with the Komodo
Visitor safety and Habitat disturbance	*Standard operating procedure of visitor management should be developed, related to :* • There should be a maximum number/quota of visitor per day, based on the infrastructure and staff capacity • Maximum number visitor of trekking group should be formulized based on the capacity of tour guide • Arrange a schedule of trekking • Impose a maximum time for trekking. It seems, the KNP has been preparing a draft of the Decree of Head of KNP on Carrying capacity of visitor at Loh Buaya Resort, KNP on April 2021.
Potentially negative impact of waste	Standard operating procedure on waste management should develop, in which is all inorganic waste should manage outside of the national park.
Potential introduction of alien species	● Install warning boards to enable people to identify the toad and report any suspected occurrences to Komodo National Park officials for any suspected presence ● Work together with tour agents and boat operators to monitor and inspect ships that dock in the Komodo National Park area to ensure that they do not accidently bring the species from outside

Impact	Mitigation measure
	the national Park. The inspection should be conducted by the KNP, when the ship arrives at the port.

Other Environment (Non OUV) and Social Impact of the development Project

Negligible Impact on Herpetofauna

Herpetofauna species react differently to disturbance, some are adapters, some are sensitive and can avoid the places temporarily (Hamer & Mcdonnell 2010). Loh Buaya has at least five species of endemic reptiles (1 species of gecko, 2 species of skinks and 2 species of snake) one of which are protected species, the Timor reticulated snake *Malayophyton timoriensis*. In addition, Komodo National is home to the green and blue variant of white-lipped island pit viper (*Trimeresurus insularis*) (Uetz et al. 2020). Most reptiles are cryptic in nature, especially small bodied reptiles and snakes. Although the construction may pose a risk to sensitive species, such as the Timor python and White-lipped island pit viper, causing them to move out temporarily but not detrimental to their survival (Parent & Weatherhead 2000). It is expected that the population will rebound after construction has completed and habitat restored to its former quality.

The summary the impact of the project the OUV and Non OUV is presented in Table 6.

Table 0.6. Summary the Impact of the project

Impact Criteria	No impact assessed on OUV	Negligible impact assessed on OUV	Minor impact assessed on OUV	Moderate impact assessed on OUV	Major impact assessed on OUV
A. Values described under criterion (vii)/OUV					
1. Mangrove Ecosystem					
2. See grass & Coral Reef					
3. White sandy beaches					
4. Deciduous Monsoon and Quasy-mountane forest ecosystem					
5. Savanna ecosystem					
B. Values described under criterion (x)/OUV					
1. Komodo dragons					
(a) Population					
(b) Behavior					

Impact Criteria	No impact assessed on OUV	Negligible impact assessed on OUV	Minor impact assessed on OUV	Moderate impact assessed on OUV	Major impact assessed on OUV
(c) Reproductive activities					
(d) Minimal of thermal resources					
2. Terrestrial mammals					
3. Avifauna					
4. Marine fauna & Flora : Dolphins & Sea turtles					
C. Impact on Integrity					
1. Disturbance of habitat of Komodo Dragon					
2. Habitat fragmentation & patch isolation					
3. Disturbance of habitat of Terrestrial mammals					
D. Impact on the protection and management of the national park					
Positive impact due to Increasing Multiplier Effect on Local Economy				Positive Impact	
Positive impact of Expanding Tourist Motivations for Visiting Komodo National Park				Positive Impact	
Negative impact of visitors due to the change of Komodo behavior					
Negative impact on large number of visitor					
Potential introduction of alien species					

Impact Criteria	No impact assessed on OUV	Negligible impact assessed on OUV	Minor impact assessed on OUV	Moderate impact assessed on OUV	Major impact assessed on OUV
Non OUV					
Impact Criteria on Non OUV	**No impact assessed**	**Negligible impact assessed**	**Minor impact assessed**	**Moderate impact assessed**	**Major impact assessed**
1. Herpetofauna					

Chapter I. Introduction

1.1. Background

Komodo National Park, located in West Manggarai Regency, East Nusa Tenggara Province, is one of the conservation areas that has extraordinary natural beauty because it is composed of small islands with various unique terrestrial and underwater ecosystems (Hironimus et al., 2019). The park is also home to horses, wild buffalo, deer, wild boar, snakes, monkeys, various types of birds and the endemic Komodo dragon (*Varanus komodoensis*), which is the main ecotourism attraction for both foreign and domestic visitors. Several species of fauna are listed as globally threatened on the IUCN Red List, including the yellow crested cockatoo (CR) and the large blue whale (EN). The landscape of the park is dominated by the savanna ecosystem with patches of deciduous monsoon forest and quasi-cloud forest in high elevation areas, and provides a habitat for various types of protected flora and fauna. In order to protect the habitat of the Komodo dragon, this area was designated a National Park in 1980, and in 1986 by UNESCO, it was included in the Man and Biosphere Reserve. Furthermore, UNESCO designated it as a world heritage site (World Heritage Site) in 1991. For this reason, the Indonesian government pays special attention to Komodo dragons that are very vulnerable to extinction.

The total size of the Komodo National Park World Heritage Property, consisting of three different land use (Komodo National Park, Mbeliling and Nggorang Protection and Production Forests, and Wae Wuul/Mburak Nature Reserve), is 219,322 ha - as per its inscription on the WH List in 1991. However, at the time of the inscription, the boundary designation and demarcation (Forest Estate Gazetment) of the property was not yet fully stipulated (*penetapan*). In addition, some of the maps used at the time of the inscription were of limited quality, leading to initial errors in defining the boundaries and the correct size of the property. With the use of Global Positioning System (GPS), Geographical Information System (GIS) and Remote Sensing technology, the boundaries of the property have been redefined, with the current size of the property being actually bigger than the originally inscribed property (Table 1.1) . The new boundaries of the site are currently being legalized, a process that is expected to be finalized in 2022. A document to explain the changes in the size of KNP is currently being drafted by the Ministry of Environment and Forestry, and will soon be submitted to the WHC for examination. As the new boundary has not yet been stipulated, both the EIA and EMP document still refer for their analysis to the previous gazetted size of the KNP, which is 173,300 ha (306/Kpts-II/1992 and 172/Kpts-II/2000).

For assessing the impact of the 'project' on the OUV, the EIA and EMP only refer to size of the Komodo National Park, and not the size of the whole WH property. This was decided by the EIA and EMP teams after discussing with the KNP office, as both the Mbeliling dan Nggorang Protection Forest and the Wae Wuul/Mburak Nature Reserve are managed by different authorities, i.e. Forest Management Unit/Kesatuan Pemangkuan Hutan (KPH) and Provincial Office of Natutal Resouces Conservation Agency (Balai Konservasi Sumberdaya Alam/BKSDA).

Table 1.1 Area difference between Incription and Current World Heritage Site of KNP.

KNP World Heritage Site	KNP (ha)	Mbeliling dan Nggorang Protection Forest (ha)	Wae Wuul/Mburak Nature Reserve (ha)	Total (ha)
Inscription	185,322.50	31,000.00	3,000.00	219,322.50
Currently	190,728.50	27,878.82	1,484.84	220,092.20
			Difference:	769.68

KNP is a predominantly international tourist destination, whereas during 2010-2019, the proportion of the foreigner visitor was approximately 80% (KNP, 2020). During the last decade, the number of visitors has shown a dramatic increase. In 2010, the total number of visitors was 44492 people, increasing to 221703 in 2019. Even during the Covid-19 pandemic in 2020, there were only 51618 people (KNP, 2020). When normal conditions return, it is predicted that visitor visits will increase drastically. Assuming the rate of increase is the same as before the Covid-19 pandemic, visitors in 2030 are estimated to reach more than 381,000 visitors.

Since 2017, the Komodo National Park area has become one of the national strategic areas to be developed as a leading for the national economy based on biodiversity protection (Suraji et al., 2020). Currently, the Indonesian government is developing an Integrated Tourism Master Plan in Labuan Bajo and Flores which includes Rinca Island. In compiling the master plan, Indonesia considered a very careful policy through the concept of sustainable tourism development, namely ensuring environmental preservation, creating an inclusive society and providing a sustainable economic impact on local communities. The development of the area, which is one of the seven wonders of the world, is expected to be able to become a positive example for sustainable tourism and the protection of endangered wildlife. The project focussing on the improvement of the quality of facilities and infrastructure in Komodo National Park (KNP) will take place in the Loh Buaya area (Rinca Island), an area which has been designated as land and marine tourism use zone under the park's zoning system. This zone includes the 'Komodo dragon observation' location at Loh Buaya and the bay located directly in front of that site. The project aims to improve the quality of facilities and infrastructure that are currently present in the site. The design of the project has taken into consideration disaster risk resilience and climate change. The design includes increased accessibility in the entrance area (such as elevated paths and piers) and infrastructure improvements in several existing buildings (such as Loh Buaya jetty, offices, information center, accommodation, research center and cafeteria). The design is in line with the Komodo National Park Medium Term Management Plan 2016-2025 which is based on the Komodo National Park Management Master Plan 2000-2025.

Improving the quality of facilities and infrastructure in Loh Buaya, Rinca Island, aims to control the flow of tourism in an integrated manner. The construction of an elevated pathway from the jetty to the information center aims to minimize humans interacting with the movement of Komodo dragons in their natural habitat. This will contribute positively to the safety of tourists from the potential of being attacked or bitten by dragons. Komodo dragons in tourist areas tend not to be afraid of humans, leading to the potential of conflict if interactions between humans (tourists) are not minimized or limited.

The improvement of the quality of Loh Buaya facilities and infrastructure received the attention of the President of the Republic of Indonesia through the issuance of Regulations for the Acceleration of Implementation of National Strategic Projects which include the National Tourism Strategic Area Program (KSPN). A directive from the President of the Republic of Indonesia highlights the importance of integrating the Komodo National Park area with other tourist spots in the Province of NTT. The directive also underlines the importance of nature conservation by paying attention to the carrying capacity of the Komodo National Park so as not to endanger its unique natural environment. The President is of the view that a clear separation is needed between conservation and tourism zones in the region (Setneg, 2019). This to ensure that the OUV of the property will be maintained for future generations.

The increase in the number of tourists visiting Komodo National Park has had an impact on significant economic growth, particularly in West Manggarai Regency and its surrounding areas. The economic chain has an impact on the livelihoods of the tourist community, including tour operators who operate 157 tour boats,

the involvement of 94 guides from local communities, the occupancy rate of 1,136 hotel rooms, the birth of four star hotels (Republika, 2019). Every Rp. 1 that comes out, is able to generate 60 times the regional economy (Wiratno, 2020).

Based on the Operational Guidelines for the Implementation of the World Heritage Convention, and IUCN World Heritage Advice Note, the Government of Indonesia has implemented a number of activities to identify, evaluate, prevent, and mitigate the potential environmental and social impacts of development on the Outstanding Universal Value (OUV) of the property. The GOI through the Komodo National Park Authorities have further put many efforts into ensuring that the management (safeguarding)of the property is sustainable and long-term. To address potential risks to the OUV by the increase in tourism, the GOI has committed to taking several actions, including implementing carrying capacity control, improving IT-based safety and security, improving infrastructure, and empowering local communities. The management of Komodo National Park is currently shifting from the concept of mass tourism to quality tourism. With these considerations, it is hoped that the planned infrastructure improvement will have a positive impact on the long-term protection of the OUV.

1.2. Objectives of EIA

The proposed development on Loh Buaya, hereafter called "project" includes both in-situ renovation work as well as some additional new infrastructure that has been carefully designed as not to cause any impact on the OUV of the property. This study assesses in detail the impacts of the improvement of infrastructure in Loh Buaya, as well as provides a number of mitigation measures to ensure that the impact to the OUV of the property remains negligible. It is hoped that the EIA document will provide clarity regarding the strong commitment of the GOI in maintaining the Komodo National Park's Outstanding Universal Values for all future generations of mankind.

1.3. Objectives of EMP

This document constitutes the Environmental Management Plan (EMP) which will outline the planning for environmental management, impact mitigation and environmental monitoring of the Loh Buaya project. The EMP aims to monitor and mitigate negative impacts on the OUV that are caused during the three main project phases, i.e. pre-development/construction, development/construction and post-development/ construction. The EMP identifies in detail which environmental variables are used to monitor impact, which monitoring methodology is used, how mitigation measures are identified and implemented, as well as the resources required for their implementation.

1.4. Method of OUV identification and Impact Assessment

Identification of OUV criteria vii (ecosystem) and criteria x (habitat) is carried out by using the interpretation of Sentinel 2A satellite imagery data in 2019 based on Google Earth Engine (GEE) and various maps from reliable publications (reports and journals). While the aspect of biological, ecological and behavior of Komodo dragon is carried out by taking into account references from journals, reports from national parks and interviews with national park officials.

Chapter II Development Plans

2.1. Komodo National Park Zoning System

Komodo National Park was established based on the Decree of the Minister of Forestry No.306 / Kpts-II / 92 dated February 29, 1992 concerning the land use changes of the Komodo Island, Rinca Island, Padar Island covering an area of 40,728 ha and also the appointment of its surrounding marine waters covering an area of 132,572 hectares located in Manggarai Regency, East Nusa Tenggara Province, became a National Park with the name Komodo National Park (Attachment 2.1). Apart from the three main islands, the park also included 26 smaller islands in its surrounding areas. Geographically, KNP is situated at 119.35° - 119.82° Longitude East and 08.41°- 08.85° Latitude South (Figure 2.1)

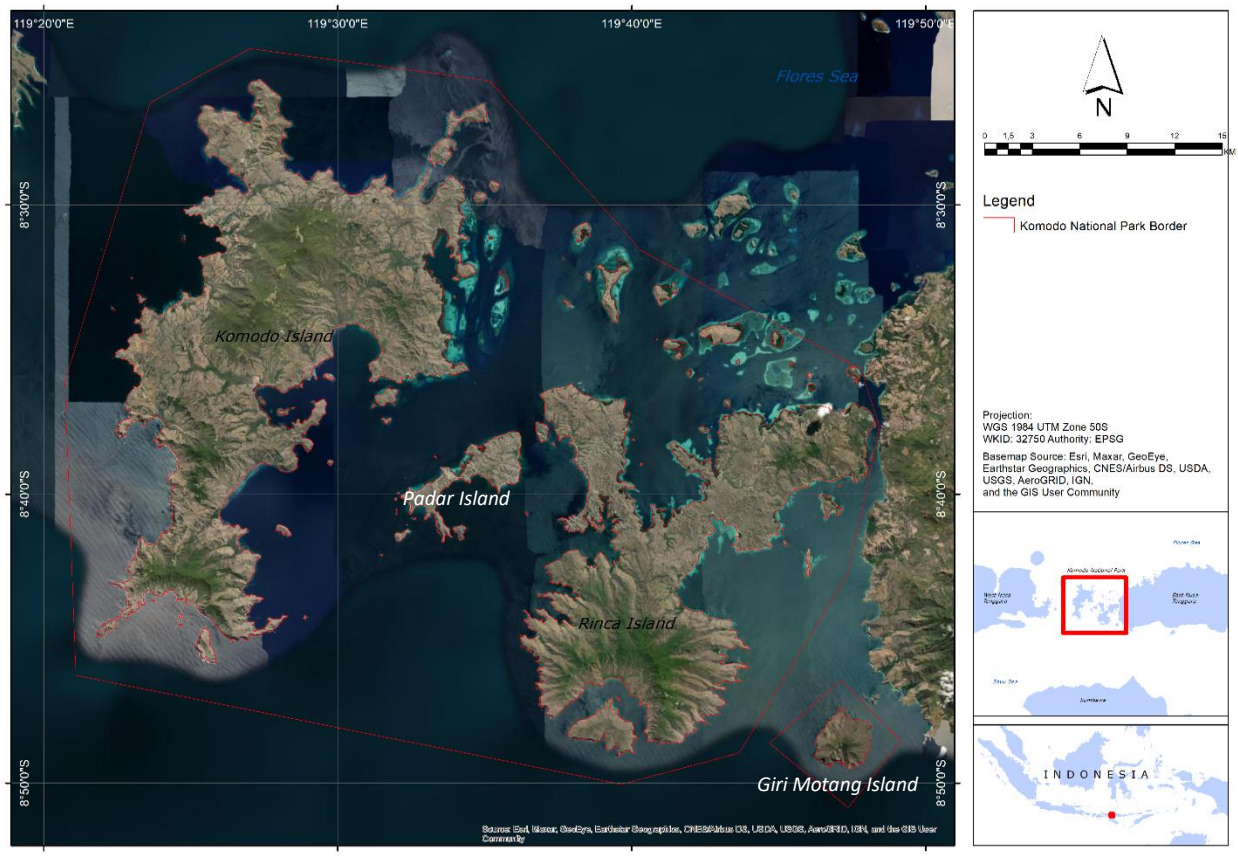

Figure 2.1 Komodo National Park

For management guide, Komodo National Park is divided into several zones namely Core zone, Wilderness zone, Marine protected zone, Terrestrial tourism use zone, Marine tourism use zone, Terrestrial Traditional Use Zone, Special Pelagic Zone and Special Settlement Zone (Figure 2.2). According to the Decree of the Director General of Forest Protection and Nature Conservation Number SK.21/IV-SET/2012 dated February 24, 2012, the description of the designation for each zoning is explained in Table 2.1.

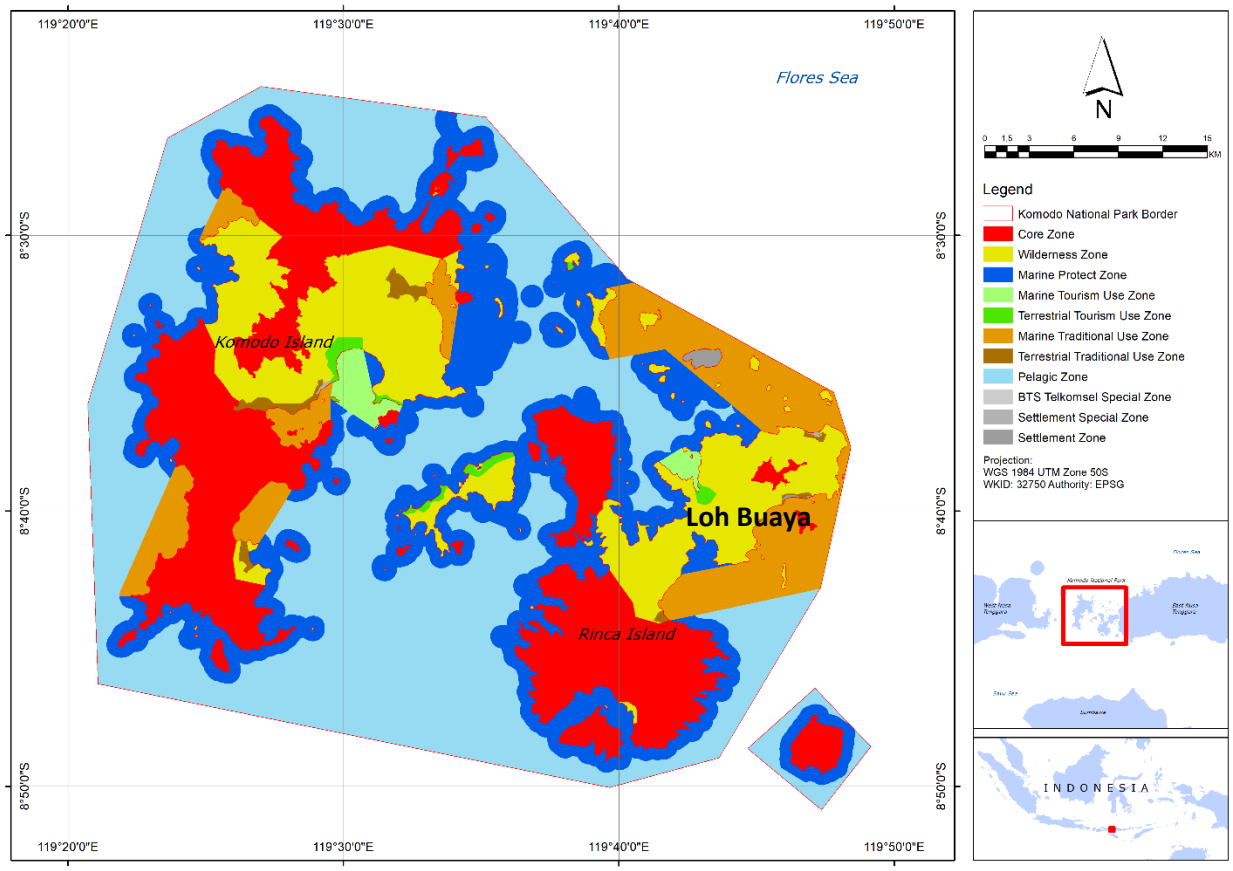

Figure 2.2 Komodo National Park Zoning

Table 2.1 KNP Zones & its utilization

Zone	Utilization/Purpose	Area (Ha)
Core Zone (*Zona Inti*)	This zone is absolutely protected. No disturbance of human activities is allowed, except from those related to science, education and research	34,11
Wilderness Zone (*Zona Rimba*)	No human activities are allowed in this zonezone, except for limited natural tourism activities	22,187
Marine Protected Zone (*Zona Perlindungan Bahari*)	Only limited natural tourism activities are allowed in this zone, and harvesting of marine products isnot permitted in this zone.	36,308
Terrestrial Tourism Use Zone (*Zona Pemanfaatan Wisata Daratan*)	This zone has been designated for the purpose of terrestrial nature tourism	824
Marine Tourism Use Zone (Zona *Pemanfatan Wisata Bahari*)	This zone has been designated for the purpose of marine nature tourism	1,584

Zone	Utilization/Purpose	Area (Ha)
Terrestrial Traditional Use Zone (*Zona Pemanfaatan Tradisional Daratan*)	This is a zone where human activities can be carried out by the indigenous/local communities to accommodate their basic needs. A use permit is issued by the Head of the National Park to indigenous/local communities who would like to conduct activities in this zone.	879
Marine Traditional Use Zone (*Zona Pemanfaatan Tradisional Bahari*)	This is a zone where indigenous/local communities can be carry out activities to accommodate their basic needs. In this zone, the people can collect marine products using environmentally friendly tools.	17,308
Special Pelagic Zone (*Zona Khusus Pelagis*)	In this zone, fishing and the extraction of other marine products that are not protected can be carried out as well as tourism /recreational activities.	59,601
Special Settlement Zone (*Zona Khusus Permukiman*)	In this zone, indigenous/local communities can live and settle while respecting certain regulations imposed by the head of the Komodo National Park in collaboration with the local government.	298
Total Area		173,300

In 2020 based on the Decree of the Director General of Forest Protection and Nature Conservation Number SK.212/KSDAE/SET.3/KSA.0/11/2020 dated November 6th, 2020, the zoning classification changed. Several zones were combined into one single zone to simplify the zoning system, for example Marine and terrestrial use zone changed into Use zone, Marine & traditional terrestrial zone changed into Local community traditional zone. Meanwhile, Special BTS Telkomsel zone was accommodated into the Special zone, while the Special settlement zone was included as well in the Special zone (Table 2.2 and Figure 2.3).

2.2. Infrastructure development project

The proposed project is located in Loh Buaya, a flat area within the Use zone (Figure 2.3). There are already several National Park buildings in this zone such as a jetty, information center, cafeteria, regional section office, resort office, guest and tourist house and a number of footpaths (Figure 2.4). The buildings were built during the period 1985-2013. Many of the buildings are in a poor condition, such as the Resort office building, ranger camp building and Toilet, etc. (Table 2.3).

There has been a lot of criticism regarding the current visitor management at Loh Buaya due to the intense and close interaction between visitors and komodo dragons. This is mostly due to fact that the current footpath/trail is overlapping with the komodo movement route (home range) (Figure 2.4 & Figure 2.5). This situation is endangering visitors and also having a profound impact in changing the behavior of the Komodo dragon (Ardiantiono et al., 2018). The pathway is also occasionally inundated due to flooding during the rainy season, which disturbs the comfort of visitors as well as exposes them in dryer areas to intense interaction with Komodo dragons. While there has been a lot of domestic and international interest in conducting research in Loh Buaya

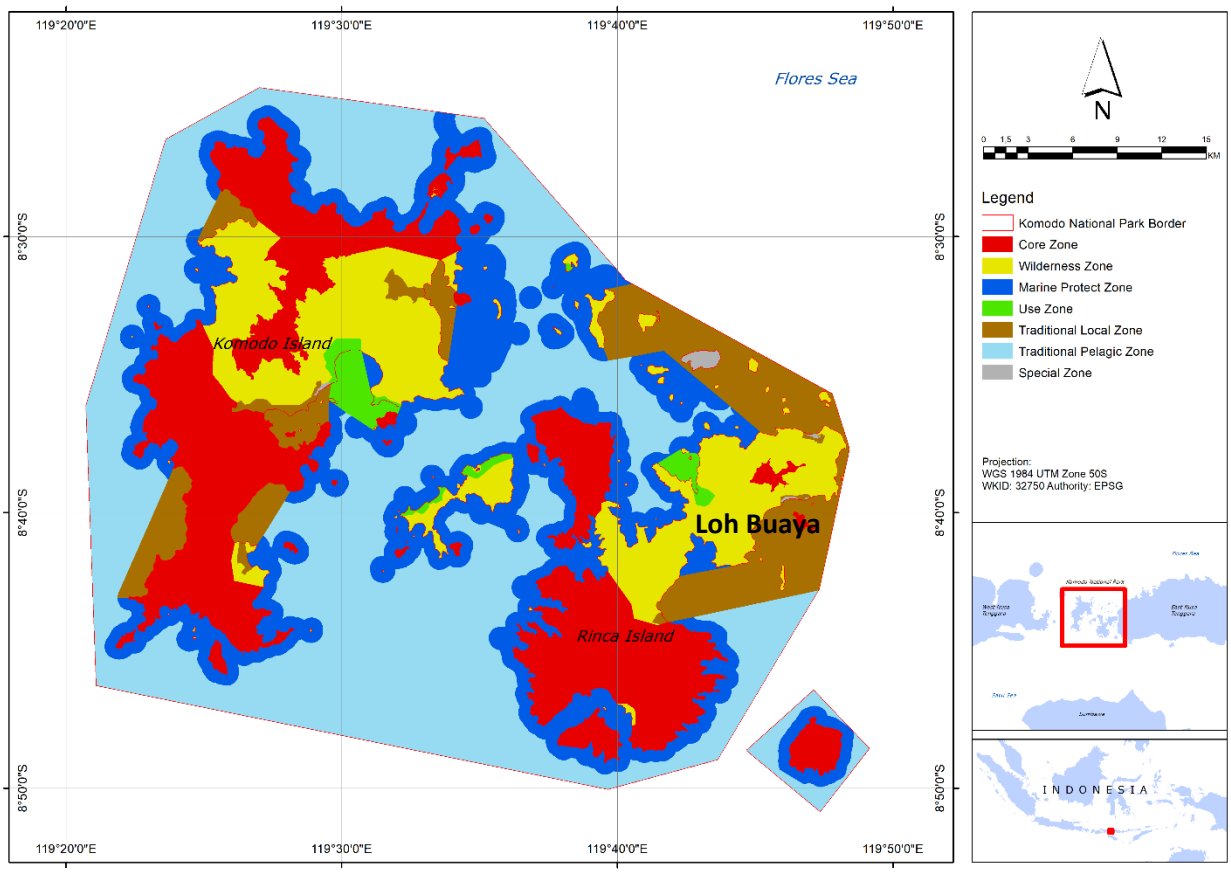

Figure 2.3 Komodo National Park Zoning based on SK 357

on the ecology, evolution, genetics, conservation and also ecotourism of Komodo dragons, there are unfortunately no facilities to accommodate researchers. With the objective to better manage visitors, accommodate and support researchers, and reduce the negative impacts of visitors on the OUV of the property, the Government of Indonesia has decided to improve the existing capacity and quality of the infrastructure in Loh Buaya

Table 2.2 Union of zoning system in Komodo National Park

Zone in 2012 (SK.21/IV-SET/2012)	Zone in 2020 (SK.212/KSDAE/SET.3/KSA.0/11/2020)	Area (Ha)
Core Zone	Core Zone	34,304.81
Wilderness Zone	Wilderness Zone	22,192.28
Pelagic zone	Pelagic Zone	59,601.00
Marine protected Zone	Marine Protected Zone	36,308.00
Traditional Marine Use Zone	Local Community Use Zone	18,172.59
Traditional Terrestrial Use Zone		
Terrestrial Tourist Use Zone	Use Zone	2,408.23
Marine Tourist Use Zone		
Settlement Zone	Special Zone	313,09
Special BTS Telkomsel Zone		

Zone in 2012 (SK.21/IV-SET/2012)	Zone in 2020 (SK.212/KSDAE/SET.3/KSA.0/11/2020)	Area (Ha)
Special Settlement Zone		
Total Area		173,300.00

Figure 2.4 Aerial photo of Loh Buaya and its infrastructure facilities

Figure 2.5 Current footpath (dirt and concrete) in Loh Buaya

Table 2.3 Condition of existing infrastructure in Loh Buaya

No	Building Name	Area (m^2)	Construction year	Longitude East (degree)	Latitude South (degree)	Condition
1	Ticketing office	105	1985	119°43'4.98"	8°39'19.13"	Good
2	Resort Office	200	2010	119°43'4.24"	8°39'19.00"	Moderately damaged
3	Rangers Camp	100	1996	119°43'4.24"	8°39'22.39"	Good
4	Café	102	2013	119°43'3.62"	8°39'20.12"	Good
5	Cafe	99	2013	119°43'4.28"	8°39'20.09"	Good
6	Toilet	90	2013	119°43'4.84"	8°39'20.28"	Damaged
7	Guest House	100	2013	119°43'6.09"	8°39'21.07"	Good
8	Rangers Camp	72	1985	119°43'6.72"	8°39'22.39"	Moderately damaged
9	Pantries	90	2000	119°43'7.40"	8°39'22.93"	Good
10	Generator House	100	2013	119°43'7.25"	8°39'24.11"	Good
11	Section Office	250	2011	119°43'0.30"	8°39'11.89"	Good
12	Jetty	104	1987	119°42'55.76"	8°39'14.29"	Good
13	Gazebo	16	2010	119°43'4.52"	8°39'22.73"	Good
15	Gazebo	16	2010	119°43'5.40"	8°39'24.87"	Good
14	Helipad	63	2013	119°43'2.65"	8°39'21.34"	Moderately damaged
16	Solar cell	1	2005	119°43'5.75"	8°39'24.89"	Moderately damaged

Based on the project plan, the proposed infrastructure will replace all existing buildings, except from the generator house. The planned infrastructure is presented in Table 2.4.

Table 2.4 Planned infrastructure development.

No	**Infrastructure**	**Area (m^2)/Length (m) /Volume (m^3)**	**Position**	
			Longitude East (degree)	Latitude South (degree)
1	Ranger camp	314 m^2	119°43'4.63"	8°39'14.40"
2	Guide camp	314 m^2	119°43'4.94"	8°39'15.64"
3	Researcher camp	314 m^2	119°43'5.90"	8°39'14.76"
4	Plaza Deck	318 m^2	119°42'56.14"	8°39'14.19"
5	Resting Post	468.9 m^2	119°42'59.49"	8°39'29.33"
6	Elevated pathway (2 m height),	695 m (length) 4 m (wide)		
7	Reservoir tank	50 000 liter	119°43'0.59"	8°39'9.47"
8	Distribution pipeline	550 m		
9	Waiting room of visitor	110 m^2	119°42'56.14"	8°39'14.19"
8	Jetty	400 m^2	119°42'54.52"	8°39'13.77"
9	Coastal protection	100 m	119°43'4.98"	8°39'19.13"
10	Information Center	2, 667 m^2	119°43'4.77"	8°39'19.91"

2.3. Stakeholder Consultation & Plan change

The proposed project is guided by several national regulations that aim to protect the natural environment, including Ministerial Regulation No.8/2019 and No.13/2020, stating that: " Construction of buildings in forest areas, including in the National Park, for tourism purposes must take into consideration the landscape and natural conditions and should not disturb the landscape aesthetics as well as environmental harmony by using the adequate design, material type, and ensure the protection of existing ecological processes" (Permen No P.8 /MenLHK/Setjen/Kum.1/3/2019 and No.P.13/MenLHK/Setjen/Kum.1/4/2020).

The layout plan and design for the project in Loh Buaya proposed by the planner have been subjected to the inspection and review of a broad range of relevant stakeholders. This to ensure that the design complies with the regulations above and takes into account both ecological and visitor safety aspects.

As Loh Buaya is situated on a Komodo dragon movement route (home range) the design of the planned infrastructure was carefully planned. This careful planning approach was also used in the marine/coastal area, which includes a mangrove ecosystem, which constitutes the habitat for the long-tail macaque (*Macaca fascicularis*) (Erdmann, 2004) and other mangrove biota (Figure 2.6). The long tail macaque is one of the preys of the Komodo dragon.

Figure 2.6 Movement route of Komodo dragons in Loh Buaya (source: KNP rangers, personal observation/communication)

The process of design change proposed by the planner through various meetings, both formal meetings and informal meetings. In case of informal meetings, every suggestion is recorded in the Minute of Meeting. However, the suggestions at the informal meeting were not recorded. Several formal and informal discussions regarding the design changing process are summarized in Table 2.5.

Table 2. 1. Summary of the stakeholder's meetings regarding the proposed design.

No	Infrastructure	Plan change	The date/ event /One who proposed the change ?
1	Floating deck	From 2 routes to only one route to avoid impact on aquatic biota Note: no formal document available	(04-09-19) Coordination meeting among stakeholders of National Strategic Tourism Area (*Kawasan Strategis Pariwisata Nasional*/KSPN) Labuan Bajo: The staff of Regional Governement of Labuhan Bajo suggest : *"The jetty area has also been added to a floating dock so that it can adjust to sea water conditions in the event of tides"*
2	Entrance Route	Changes to the entrance route to avoid cutting trees	(13-10-20) Coordination Meeting between construction management consultant, Commitment Making Official(*Pejabat Pembuat Komitment*/PPK) contractors and KNP.
3	Water Supply System & Distribution piping	The concept of Jet pump (deep well) was replaced by a water reservoir to avoid eco-hydrological impacts.	(04-09-19) Maulidia, from Regional Infrastructure Development Agency, Ministry of Public Works and Public Housing of the Republic of Indonesia (*Badan Pengembangan Infrastruktur Wilayah*/BPIW): "The construction of a water reservoir on Rinca Island is allowed by observing existing regulations."
		Note: no formal document available	(21-10-19) FGD and Meeting coordination between Consultant, Ministry of Public Works and Public Housing of the Republic of Indonesia (PUPR) and KNP.
4	Camp complex for Ranger, Tourist Guide and Researcher	From two buildings to three buildings and elevated Note: no formal document available	(21-10-19) FGD and Meeting coordination between Consultant, Ministry of Public Works and Public Housing of the Republic of Indonesia (PUPR) and KNP.
5	Elevated pathway	From non-elevated to elevated pathway	(21-10-19) FGD and Meeting coordination between Consultant, Ministry of Public Works and Public Housing of the Republic of Indonesia (PUPR) and KNP.
6	Material of elevated pathway and Jetty	Concrete to woods	(060320) Meeting for the Acceleration of Development of Natural Resources and Infrastructure in Loh Buaya: by the Directorate General of Nature Resources and Ecosystem Conservation.

No	Infrastructure	Plan change	The date/ event /One who proposed the change ?
			" Regarding the building design from the Ministry of Public Works and Housing, the design should consider minimizing the use of concrete material and replacing it with wood."
		Note: no formal document available	(07-042-0) Discussion on the Development of Safety Facilities and Infrastructure for Loh Buaya Beach: Head of Working Unit (Kasatker), River Basin Territory Center, Ministry of Public Works (*Badan Wilayah Sungai*/BWS) of Nusa Tenggara II - Mr. Alfred " The 4 m wide pathway uses ironwood, as an intermediate path, not a concrete plate pier, only the foundation uses concrete."
		Note: no formal document available	(10-11-20) Site survey and review by consultant, Taskforce Ministry of Public Works and Public Housing (PUPR) and construction management consultant.
7	Fence of the elevated pathway	Emergency door of fence along the elevated pathway Note: no formal document available	(17-02-21), reviewed by consultant and Commitment Making Official (*Pejabat Pembuat Komitment*/PPK)
8	Information center	Border: from ponds to wall Note: no formal document available	(11-09-20) reviewed by construction management consultant and consultant.
9	Information building	No fence to equipped with fence Note: no formal document available	(11-09-20) reviewed by construction management consultant and consultant.
10	Displacing of Information center building	Shifting to avoid tree cutting Note: no formal document available	(19-11-20) between consultant and construction management consultant, proposed by KNP

Based on the recommendations and inputs to avoid negative impacts of the design on the OUV and natural values of the property, the planners did modify the design and layout of the tourism infrastructure development plan

a. Floating deck

Planners have added a floating deck to the jetty for ship landings, so that it does not disturb aquatic biota and can follow the dynamics of changing water levels (Figure 2.7).

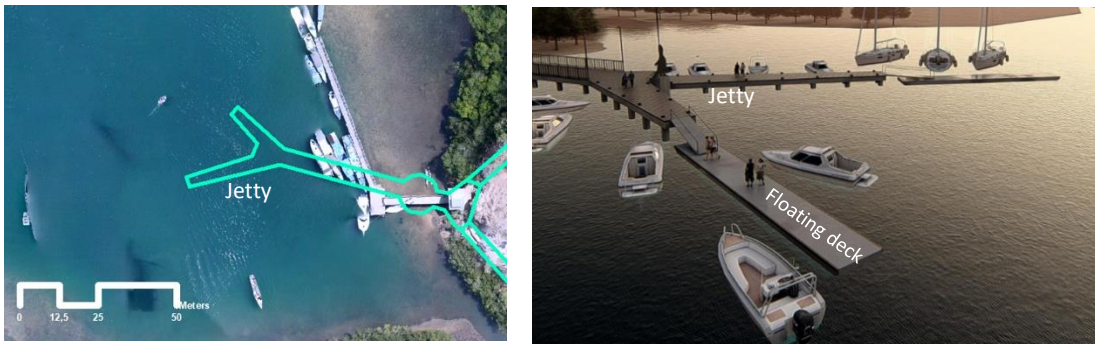

Figure 2. 1. (a) Lay out of Jetty, (b) Illustration of floating deck in Jetty

b. Entrance access changes

The planner proposed a separation between the entry and exit routes. While the separation would help to facilitate the improved management of tourist flows, it was assessed by the Park Authorities that the construction would result in cutting down a number of trees in both the mangrove ecosystem and savanna ecosystem. The following changes were incorporated in the design to avoid any potential negative impacts to the mangrove and savanna ecosystem:

(a) The pathway (footpath) near the entry of the Loh Buaya site has been repositioned to will avoid having to cut down trees in the savanna ecosystem.
(b) Minimize mangrove damage by cutting mound at the entry route and using the existing line for the exit.
(c) By incorporating the above changes in the design, the potential impacts to the mangrove and savanna ecosystems, and their OUV value, have been mitigated.

The changes in the path design are presented in Figure 2.8.

c. Coastal protection

The coastal protection will be built at the suggestion of KNP, considering the natural occurrence of seawater abrasion in the jetty area. The construction of coastal protection wall is carried out by removing some of the top soil layer of the mound at the entry route, trimming some of the mangrove branches, and stockpiling some of the mudflats. The soil on the top of the mound will be removed off about 2 meters wide by 50 meters long and 60 meters for KNP entry and exit routes (Figure 2.9).

d. Water Supply System (WSS)

The Water Supply System (WSS) is very important to maintain the availability of water for National Park staff based in Loh Buaya as well as visiting tourists. The planners proposed a WSS with a capacity of 50 m^3 distributed with underground pipe lines, in which water is supplied from deep wells. The location of the WWS was planned to be constructed in location A (Figure 2.9). As requested by the Park Authorities, the construction site was shifted to location B. The reason for the shift is due to the fact that location A is exactly on the movement route and basking area of Komodo dragons (Figure 2.6). The other reason is that WSS in position A will disturb the beauty of the landscape, because it is at the top of a hill which is visible from the entrance gate and jetty.

The Park Authorities also asked the planner to modify the proposed water supply system. There is a concern that a de ep well for water extraction will disrupt the sustainability of water sources and related eco-hydrology in Pulau Rinca. It was therefore decided to use water supplied from Labuan Bajo by ship.

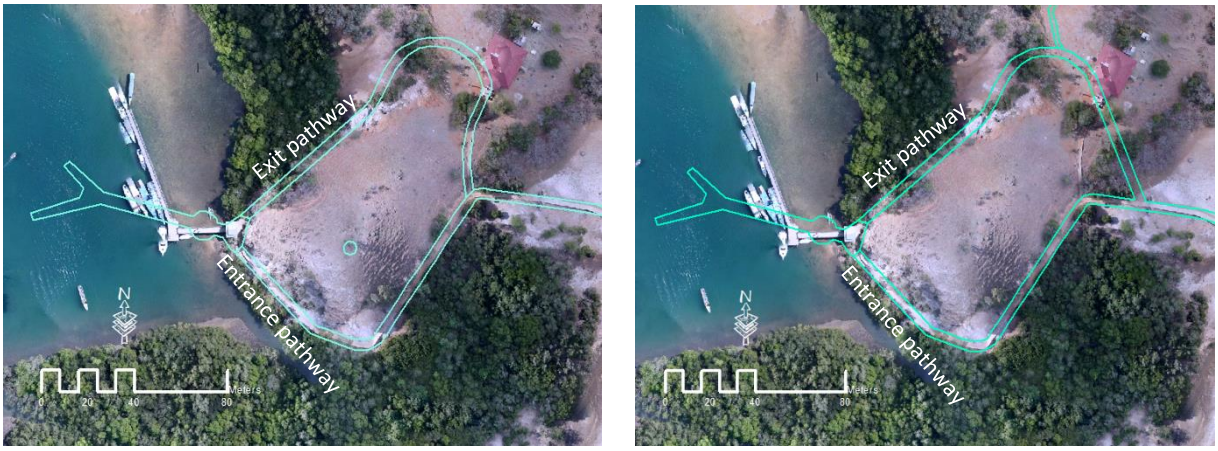

Figure 2. 2. Overlay High resolution with the plan of entrance access, (a) Initial design, (b) Revision design

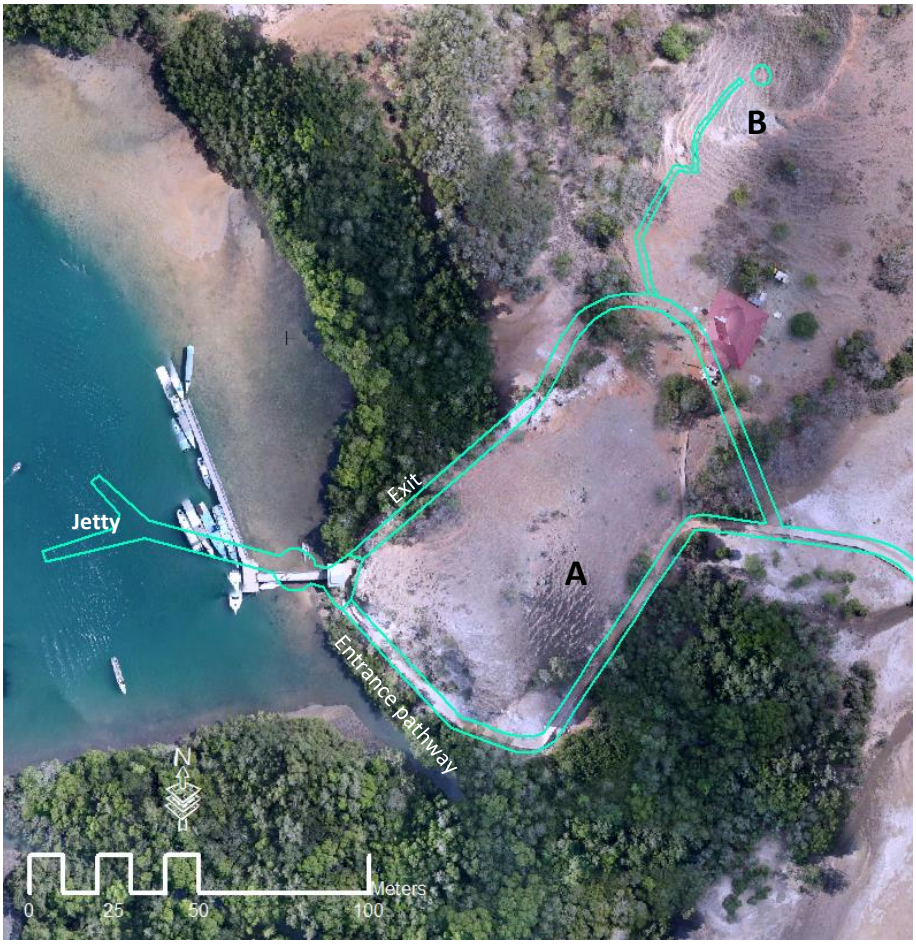

Figure 2. 3. Water Reservoir Position Shifting from A to B

e. Camp for rangers, tour guides and researchers

At present there are no special lodgings for employees, guides or researchers. They currently stay at the resort office, section office or guesthouse, depending on availability. The planner proposed that two buildings for accommodating respectively rangers and guides would be constructed. However, the National Park Authorities proposed for inclusion of one additional building for accommodating researchers, taking into account the importance of research in managing and protecting the OUV of the property. All three buildings will be connected by an elevated deck and pathway with other facilities (Figure 2.10) to avoid human interaction with Komodo dragons and ensure the safety of park staff, guides, and researchers.

Figure 2. 4. Design of camp for ranger, tour guide & scientist: (a) Initial design plan (b) Revision design

f. Elevated Pathway

Currently, the footpath connecting facilities in Loh Buaya, both for the circulation of tourists and the management of the area, uses a combination of dirt and concrete track/trail, resulting in a high possibility of human-Komodo dragon encounters (Figure 2.11). Aside from the possible danger to tourists from these encounters, regular interaction between dragons and tourists will also change the behavior of dragons. To mitigate the impacts of human-dragon encounters, the National Park Authorities asked the planner to design an elevated pathway (above 2 meters), allowing the Komodo dragons to move under the elevated pathway without being disturbed by humans. This proposed change will ensure the safety, comfort of tourists and visitors as well as allowing water to flow without a barrier from the upland to the sea. The elevated pathway will be built on the exact location of the existing footpath. It will only shift slightly from the existing footpath near the Information Center because it needs to adjusts to the updated layout of the building.

In addition, the Park Authorities requested the planner to add exit doors in the elevated pathway guardrail to anticipate an emergency evacuation in case a Komodo dragon would manage to enter on the elevated pathway. The Park Authorities further recommended that the elevated pathway would be covered with wood to ensure that its aesthetics are well integrated with the surrounding nature (Figure 2.12)

Figure 2. 5. (a) Existing pathway from UAV imagery, (b) Design illustration of elevated pathway

Figure 2. 6. (a) Elevated pathway with concrete material, (b) Elevated pathway (wood material)

g. Information Center

The design of the Information Center underwent several changes based on the inputs of the National Park Authorities to ensure that the building did not impact the natural values of the property:

- ✔ **Barrier in the form of a pool**

  The original design of the information center included a pond, as a separator between tourists and Komodo dragons. As suggested by the Park Authorities, the pond was removed and replaced with a wall fence, as the Komodo dragon would be able to swim across and endanger visitors (Figure 2.13).

- ✔ **Information Center Entrance**

  In the initial design, the entrance area did not use stairs, allowing Komodo dragons to enter the building and potentially endanger tourists. At the entrance of the TN entrance area, a door is added (Figure 2.14)

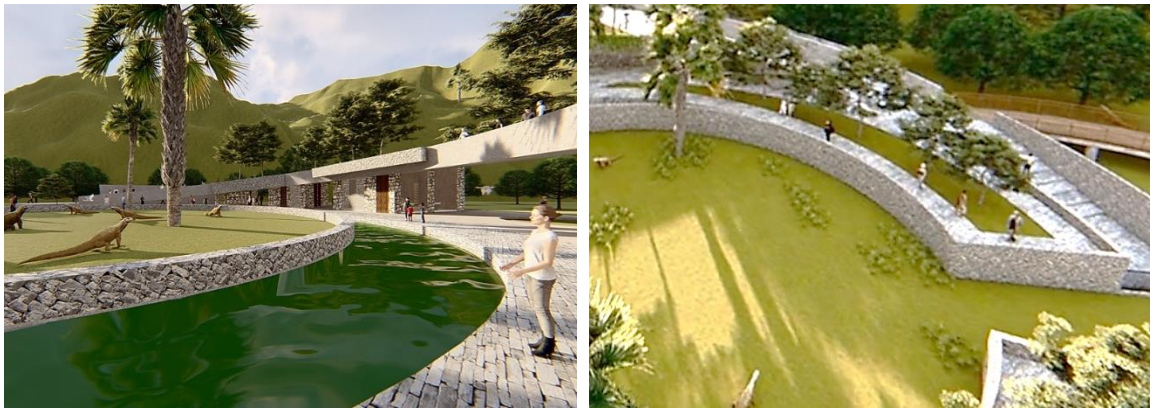

Figure 2. 7. (a) Design illustration of pond as separator, (b) Design illustration of pond is replaced with wall fence as separator

Figure 2. 8. (a) Design Illustration of entrance without door, (b) Design Illustration of entrance with door

✔ **Layout changes**

Apart from the building design, the geographical location of the information center building has also undergone some changes. The suggestion to change the geographical location of the information center was suggested by the Park Authorities with the objective to protect more trees from being felled for the construction. The change in the location is presented in Figure 2.15. In addition, the information center building will be provided with holes to allow the growth of the tree canopy as well as include tree planting pots.

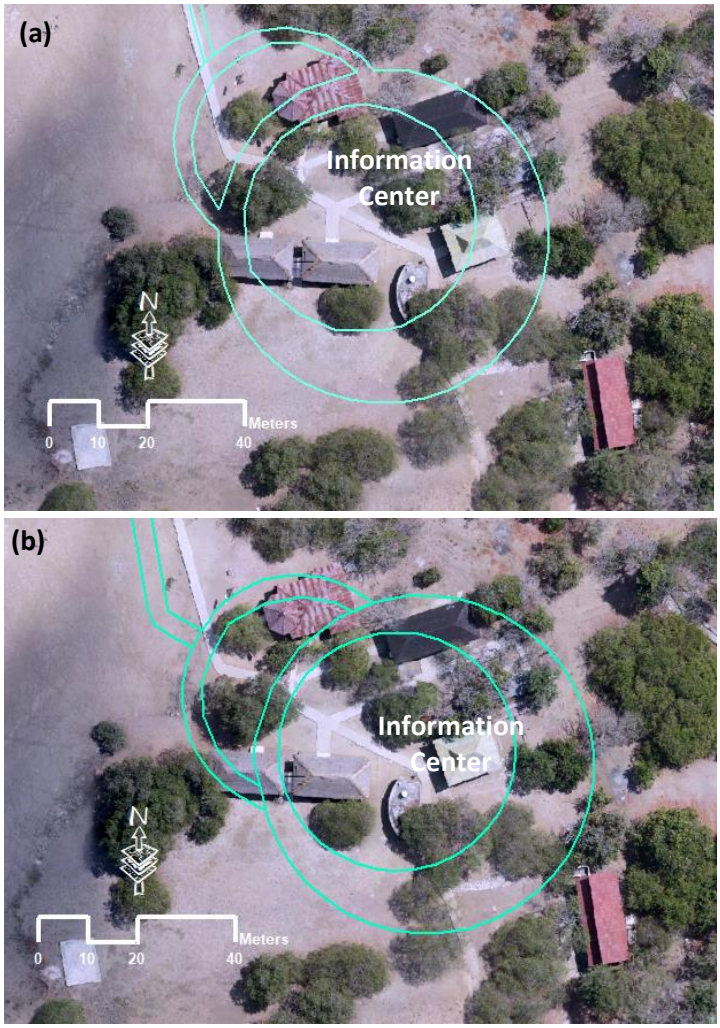

Figure 2. 9. Layout of Information Center (a) Initial design, (b) Revised Design (Background: UAV image taken in 2019)

2.3. Final Decision of the development plan

Based on the inputs from stakeholders through various meetings as described in Chapter 2.2, the planner has changed the layout and modified the design to limit the impact of the design on the natural values of the property. Changes to the original design included:

a. The Jetty is extended with a floating deck.
b. The entry path will use the existing path, but it will be replaced by an elevated pathway.
c. The original geographical location of the WSS was changed. t
d. The water supply will not be provided from a deep well but will be delivered from Labuan Bajo
e. An additional building will be constructed to accommodate researchers
f. The path connecting tourist facilities for tourist management and staff is raised to 2 meters (elevated pathway) and covered with wood
g. The location of the Information Center Building was slightly shifted. In addition, fences were added, the pond was replaced by a wall, and holes and planting pots were added.

All design changes are contained in the new design which is presented in detail in Appendix 1-6. The layout shift is presented in Figure 2.16

Figure 2. 10. The layout plan of the project (a) Initial plan, (b) Final plan

Chapter III Environmental and Social Impact on Outstanding Universal Value

3.1. The Statement of OUV Komodo National Park (UNESCO 2021)

Komodo National Park is considered of Outstanding Universal Value meeting two out of the four natural criteria, criterion (vii) – contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance, and criterion (x) – contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

Brief synthesis

Komodo National Park, located in the center of the Indonesian archipelago, between the islands of Sumbawa and Flores, is composed of three major islands (Rinca, Komodo, and Padar) and numerous smaller ones, all of them of volcanic origin. Located at the juncture of two continental plates, this national park constitutes the "shatter belt" within the Wallacea Biogeographical Region, between the Australian and Sunda ecosystems. The property is identified as a global conservation priority area, comprising unparalleled terrestrial and marine ecosystems and covers a total area of 219,322 ha. The dry climate has triggered specific evolutionary adaptation within the terrestrial flora that range from open grass-woodland savanna to tropical deciduous (monsoon) forest and quasi cloud forest. The rugged hillsides and dry vegetation highly contrast with the sandy beaches and the blue coral-rich waters.

The most remarkable inhabitant of Komodo National Park is the Komodo Lizard, *Varanus komodoensis*. These giant lizards, existing no-where else in the world, are of great scientific interest, especially for their evolutionary implications. Most commonly known as 'Komodo Dragons', due to its appearance and aggressive behavior, the Komodo Lizard, is the largest living species of lizard, growing to an average length of 2 to 3 meters. The species is the last representative of a relic population of large lizards that once lived across Indonesia and Australia. As well as being home to the Komodo dragon, the Park provides a refuge for many other notable terrestrial species such as the orange-footed scrub fowl, an endemic rat, and the Timor deer. The rich coral reefs of Komodo host a great diversity of species, and the strong currents of the sea attract the presence of sea turtles, whales, dolphins and dugongs.

Values

Criterion (vii): Komodo National Park is a landscape of contrast between starkly rugged hillsides of dry savanna, pockets of thorny green vegetation, brilliant white sandy beaches and blue waters surging over coral, unquestionably one of the most dramatic landscapes in all of Indonesia. Demonstrating exceptional natural beauty that is all the more remarkable as a counterpoint to the dominant lushness of vegetation which characterizes vast areas of forested Indonesia, and with which most of the world associates the archipelago. An irregular coastline characterized by bays, beaches and inlets separated by headlands, often with sheer cliffs falling vertically into the surrounding seas which are reported to be among the most productive in the world adds to the stunning natural beauty of landscapes dominated by contrasting vegetation types, providing a patchwork of colors.

Criterion (x): Komodo National Park contains the majority of the world's areas in which wild populations of the Komodo dragon lizard still exist. The largest and heaviest of the world's lizards, the species is widely known for its impressive size and fearsome appearance, its ability to effectively prey on large animals, and a tolerance of extremely harsh conditions. Komodo dragon distributes across the islands of Komodo, Rinca, Gili Motang and some coastal regions of western and northern Flores.

Other fauna recorded in the park area characteristic of the Wallacean zoogeographic region with seven species of terrestrial mammal, including an endemic rat (R*attus rintjanus,* now is *Komodomys rintjanus*) and the crab-eating macaque (*Macaca fascicularis*) and 72 species of birds, such as the lesser sulphur-crested cockatoo (*Cacatua suplhurea*), the orange-footed scrub fowl (*Megapodius reinwardt*), and noisy friarbird (*Phiemon buceroides*). The coral reefs fringing the coast of Komodo are diverse and luxuriant due to the clear water, intense sunlight and rapid exchange of nutrient-rich water from deeper areas of the archipelago. The marine fauna and flora are generally the same as that found throughout the Indo Pacific area, though species richness is very high, notable marine mammals include blue whale (*Balaenoptera muscullus*) and sperm whale (*Physeter catodon*) as well as 10 species of dolphin, dugong (*Dugong dugon*) and five species of sea turtles.

Integrity

Encompassing the rugged topography that reflects the position of the park within the active volcanic "shatter belt" between Australia and the Sunda shelf, the boundaries of the Komodo National Park encircle the main park features, including the outstanding scenery, savanna, upland forest ecosystem (Monsoon & Quasi-mountain forest) and the unique species it hosts: komodo monitor, birds, terrestrial mammals, marine mammals, coral reef-species, and others. The boundaries are considered adequate to secure the habitat and the main ecological processes to preserve them. The extensive marine buffer zone surrounding the park is key to maintaining the integrity and intactness of the property and the number of exceptional species that it hosts.

Illegal fishing and poaching remain the main threats to the values of the property and its overall integrity. There is an extensive marine buffer zone to the park, in which management authority staff has no authority to regulate the type of fishing permitted and to some extent the presence of fishermen from outside the area. This buffer zone, which assists in controlling poaching of the terrestrial species that provide the prey species for the komodo lizard, will become significant in the overall long-term protection of the property.

Protection and management requirements

Komodo National Park is managed by the central government of Indonesia through the Directorate General of Nature Resources and Ecosystem Conservation of the Ministry of Forestry. The history of protection afforded the site goes back to 1938 while official protection began when Ministerial Decree declared the area as a 72,000 ha National Park in March 1980. This area was subsequently extended to 219,322 ha in 1984 to include an expanded marine area and the section of mainland Flores. Comprised of Komodo Game Reserve (33,987 ha), Rinca Island Nature Reserve (19,625 ha), Padar Island Nature Reserve (1,533 ha), Mbeliling and Nggorang Protection Forest (31,000 ha), Wae Wuul and Mburak Game Reserve (3,000 ha) and surrounding marine areas (130,177 ha) the Komodo Biosphere Reserve was accepted under the UNESCO Man and the Biosphere Program in January 1977. In 1990 a national law, elevating the legislative mandate for conservation to the parliamentary and presidential level significantly empowered the legal basis for protection and management.

In order to ensure the effective management and protection of the park and its exceptional landscapes and biota, the park is governed through the 2016-2025 Management Plan and a recently published Sustainable Ecotourism Plan 2018. These plans are important for ensuring the effective zoning system of the park and guaranteeing the sustainability of the ecosystems of the property. The management authority is known for designing specific plans to guide management decisions which will require updating in line with changes to priorities and threats, in particular expected increases in visitor numbers and impacts from tourism.

The Park receives strong support and resources from the central government of Indonesia. As a tourism location known worldwide, the Indonesian Government has a specific program for ecotourism management to promote the park at the international level and to ensure the sustainability of tourism activities. Additionally, in order to address illegal fishing and poaching, regular patrolling of the marine and terrestrial areas is carried out for law enforcement and a number of the problems and impacts associated with these activities have decreased. Community awareness and empowerment programs are being implemented to engage the local

villagers regards to the sustainable use of natural resources and park conservation. Research and study of the unique biological features of the park is also being promoted and supported by the management authority.

Increasing levels of tourism and matters related specifically to the komodo lizard are the major management issues that have been focused on to date. A broadening of the management focus to address issues within the marine area of the park along with other terrestrial species is required to ensure the long-term effective conservation of the property. A focus on the issue of depletion of Komodo monitor prey species stocks has resulted in some success and the same efforts need to be focused on the issues of damaging fishing practices and impacts on other unique species contained within the property.

3.2. Criteria (vii) of OUV identification

To assess the impact of the development in Loh Buaya on criterion (vii), the EIA identified the impact on the following values of the OUV: (a) mangrove Forest, (b) dryland forest (savanna, monsoon & quasi-mountain forest), (c) seagrass, (d) coral reefs, (e) white sandy beaches, and (f) beautiful scenery in the form of hilly landscapes with matrix in the form of savanna and monsoon forest patches in the valleys. These values can be detected and monitored from the satellite imagery.

Vegetation classification based on the analysis of Sentinel 2A satellite imagery from 2019, shows three major terrestrial ecosystems in the Komodo National Park including savanna, upland forest, and mangrove forest. In some areas, parts of the savanna have been exposed to natural erosion and become barren land. Savana is the most dominant ecosystem, including on three largest islands, namely Komodo, Rinca and Padar. (Figure 3.1 and Table 3.1).

Table 3. 1. Terrestrial ecosystem classification in Komodo National Park.

Islands	Area (Ha)					
	Upland Forest	Mangrove	Savanna	Settlement	Barren land	Grand Total
Komodo	10,039.06	166.92	18,174.59	19.79	3,588.74	32,169.82
Padar Besar	13.76	22.24	1,263.35		74.53	1,406.02
Rinca	8,036.23	272.02	11,034.75	18.74	1,143.13	20,718.12
Other Islands	480.06	206.38	2,566.99		354.39	3,854.08
Total	18,569.12	667.56	33,039.67	38.53	5,160.79	58,148.03

Upland forests in Komodo National Park can be divided into 2 types, namely deciduous monsoon forest which is dominated by tamarind trees (*Tamarindus indica*) (Ciofi & De Boer, 2004; Imansyah et al., 2009; Jessop et al., 2004; Jessop et al., 2018) and evergreen forest (quasi-cloud forest) starting at an altitude of 500 m asl (Imansyah et al., 2008; Singleton & Sulaiman, 2002; Purwandana et al., 2020; Purwandana et al., 2015; Erdmann, 2004). In quasi-cloud forests several plant species are found, including rattan (*Callamus* spp.), Bamboo (Bambusa spp.), and various trees species (*Podocarpus nerifolia, Ficus orupacea*, *Terminalia zollingeri, Callophyllum spectobile, Mischocarpus sundaicus, Colona kostermansiana and Glycosmis pentaphylla*. (Anonimous, n.d.; Goodwin et al., 1997). None of this forest class (upland forest) is found in Loh Buaya. As there are also no indirect impacts expected from the construction on upland forests, the EIA does not include any impact assessment on this forest class.

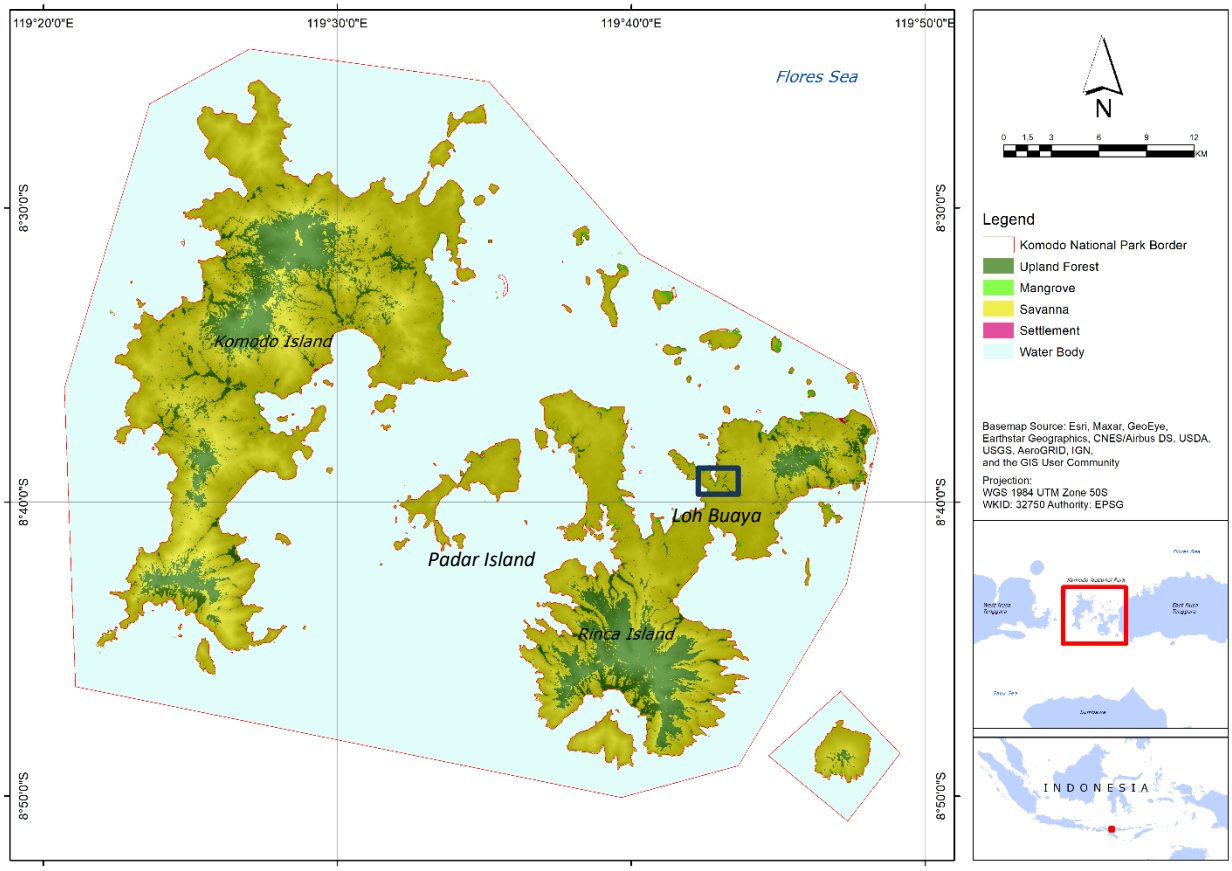

Figure 3. 1. Land cover of Komodo National Park (Sentinel 2A image taken in 2019)

The two main terrestrial ecosystems found in project site in Loh Buaya are mangrove and savanna forests.

The condition of the canopy cover of the mangrove forest in Loh Buaya is good (> 75%), but the tree-stage density is moderate (1100 + 265 individuals / ha). The dominant species are *Rhizopora mucronata, Rhizopora apiculata* and *Sonneratia alba* (Hadi et al., 2019). Both deciduous monsoon forest and mangrove forest have the most suitable thermal quality index as Komodo dragon habitat (Harlow et al., 2010).

Savanna in Loh Buaya is in the form of shrubs, barren land, and tree patches which are dominated by tamarin (Tamarindus indicus) and *bidara* (Zizyphus jujuba). In this ecosystem, Komodo dragons are used to basking and hunting prey.

The marine ecosystems found in vicinity of the project site in Loh Buaya

Apart from terrestrial ecosystems, the coral reefs and seagrass beds can also be detected using satellite imagery. In 2021, UNEP-WCMC, WorldFish Centre, WRI, and TNC published the Global distribution of warm-water coral reefs based on the analysis of satellite data imagery (Figure 3.2) (UNEP-WCMC, WorldFish Centre, WRI, 2021). The analysis shows that coral reefs and seagrass beds in KNP are mostly located in the vicinity of Komodo Island, Padar Island and a number of smaller islands in the southern part and western part of Rinca island. The findings are in accordance with the seagrass distribution in KNP published by Torres-Pulliza et al. (2013).

The natural values of Komodo National Park also include brilliant white sandy beaches, which are very famous among the visitors. An analysis, using satellite imagery, to identify the location of all sandy beaches on Rinca Island has been conducted as part of the EIA.

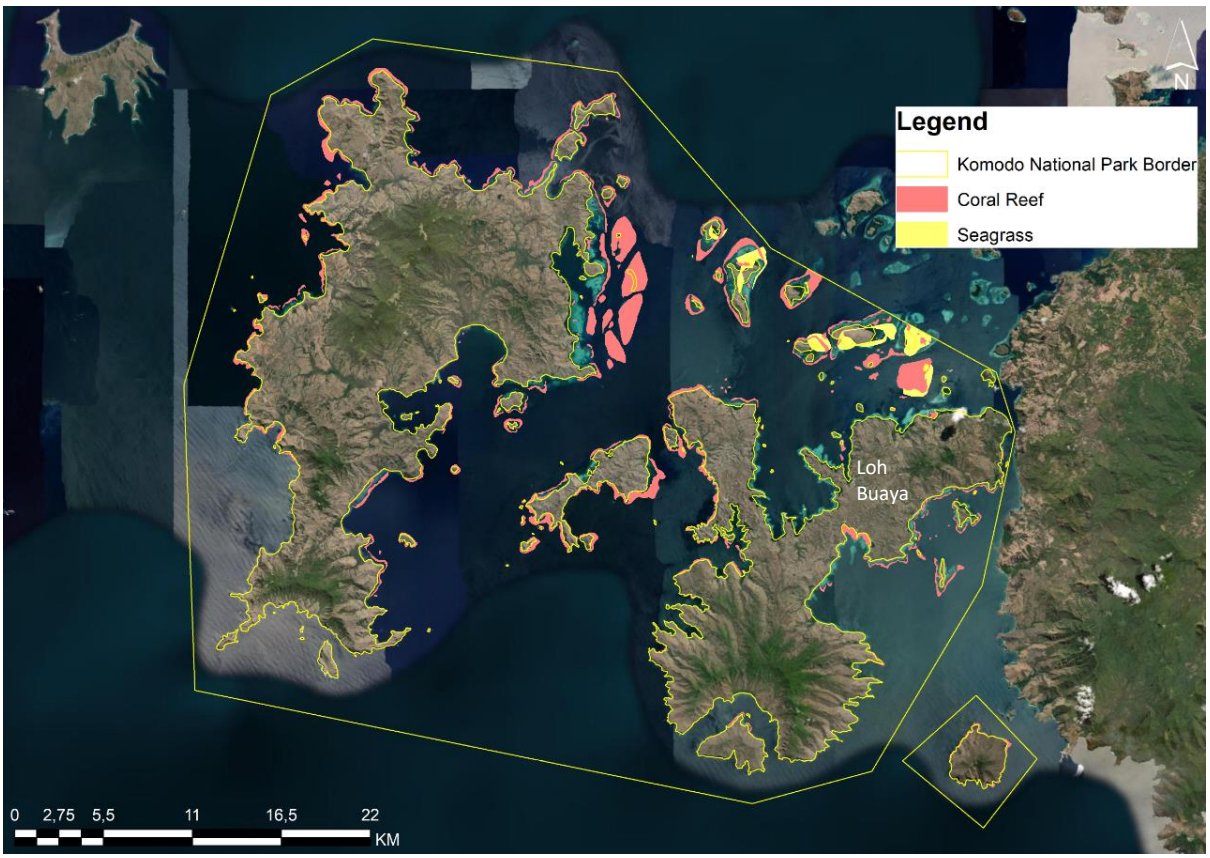

Figure 3. 2. Coral reef and Seagrass spatial distribution in Komodo National Park (Background image: Sentinel 2A, taken in 2020)

3.3. Environmental and Social Impact of the Project on OUV

3.3.1. Impact of the project on Values

3.3.1.1. Impact the project on criterion (vii)

a. Impact of project on Mangrove Ecosystem

The mangrove ecosystem in Loh Buaya will be slightly disturbed by project plans, especially by the construction of part of the entrance elevated pathway. While the pathway here will measure 100 m long and 4 m wide, it is mostly located next to the existing mangrove forest. An overlay of the design/plan with a high resolution image of an unmanned aerial vehicle UAV, shows that the footpath is located very close to the mangrove ecosystem, but will not cut through any trees. The branches of trees that overlap with the pathway will be cut/pruned. The construction mostly involves cutting the mound and only a few savanna bushes. The construction of the elevated pathway will only temporarily disturb the mangrove ecosystem, because mangrove canopy has the capability to form new shoots after pruning (Kathiresan et al., 2019). The elevated exit pathway will not interfere with the mangrove forest because it will be constructed on top of the existing footpath. The new jetty will also not interfere with the mangrove ecosystem as it will be built on the exact location of the old jetty. The site of the new jetty overlapping with the old jetty can be seen in Figure 3.3.

b. Impact of project on Sea Grass & Coral Reefs

As shown in Figure 3.4, coral reefs and seagrass beds are located far from the construction site in Loh Buaya. This is also confirmed by publication of Hadi et al., (2019) that there is neither seagrass nor coral reef at Loh Buaya. The nearest coral reef from Loh buaya is about 1 km distance.

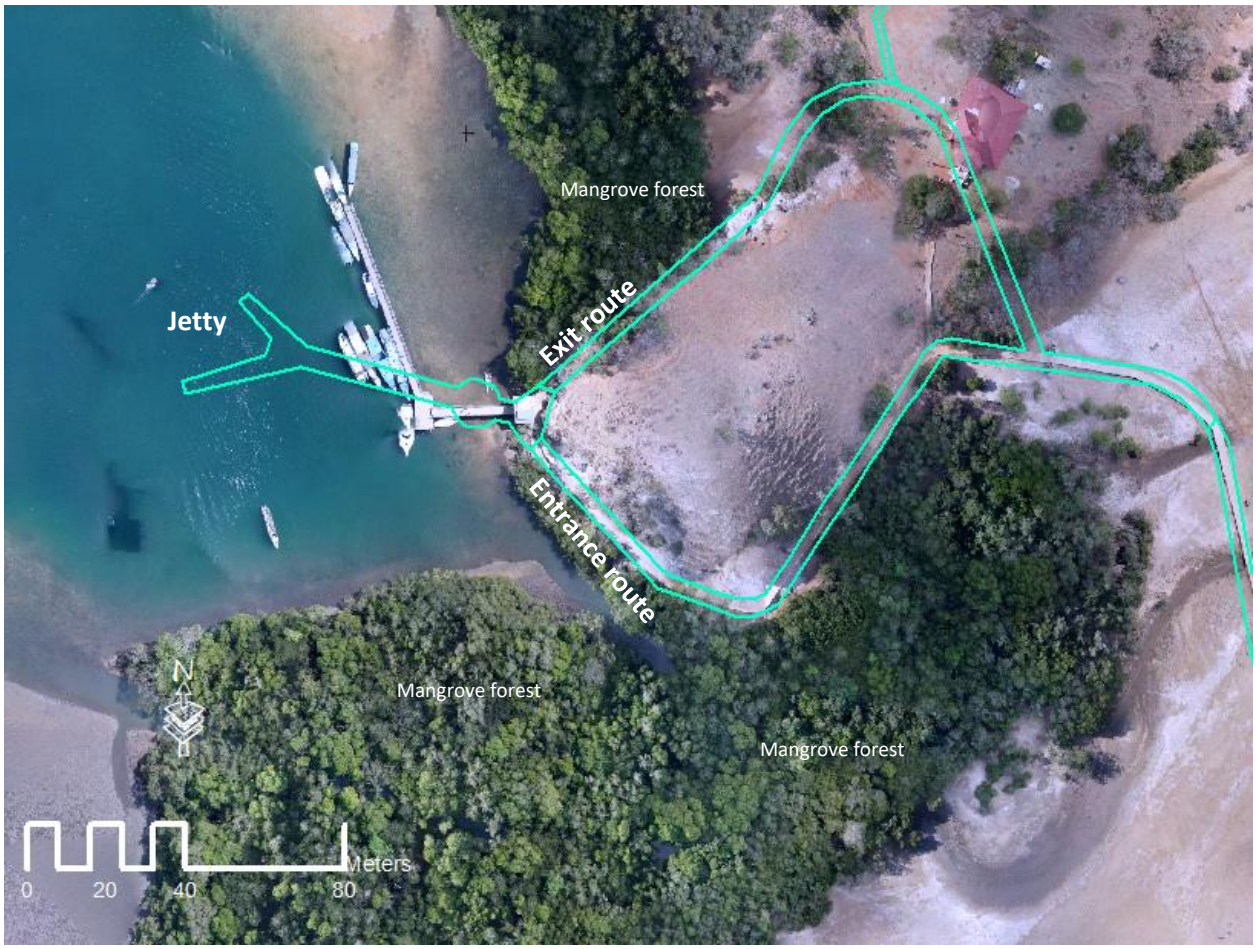

Figure 3. 3. Overlay between the plan and mangrove forest (Background: UAV Imagery taken in 2019)

c. Impact of project on white sandy beaches

The interpretation of the high resolution satellite image shows that none of the white sandy beaches in KNP will be impacted by the project in Loh Buaya. All white sandy beaches in Rinca Island are located in the western and southern part of the island. There are no white sandy beaches in the vicinity of Loh Buaya (Figure 3.4).

d. Impact of project to deciduous monsoon and quasy-mountain forest ecosystem

The project will take place in the flat and lowland savannah area of Loh Buaya and not have any impact on the deciduous and quasi-cloud forest ecosystem, which is located in hilly and high elevation areas of Rinca island (Figure 3.1).

e. Impact of Project to Savanna ecosystem

The part of the building that is built on the savanna grassland and savannah woodlands ecosystem is the information center, ranger, tour guide and researcher camp complex as well as the elevated pathway and plaza deck that connect the infrastructures (Figure 2.16). The elevated pathway to be built is 695 m (2780 m^2) in length when calculated from the entrance area and plaza deck of the complex camp ranger, guide and researcher to information center.

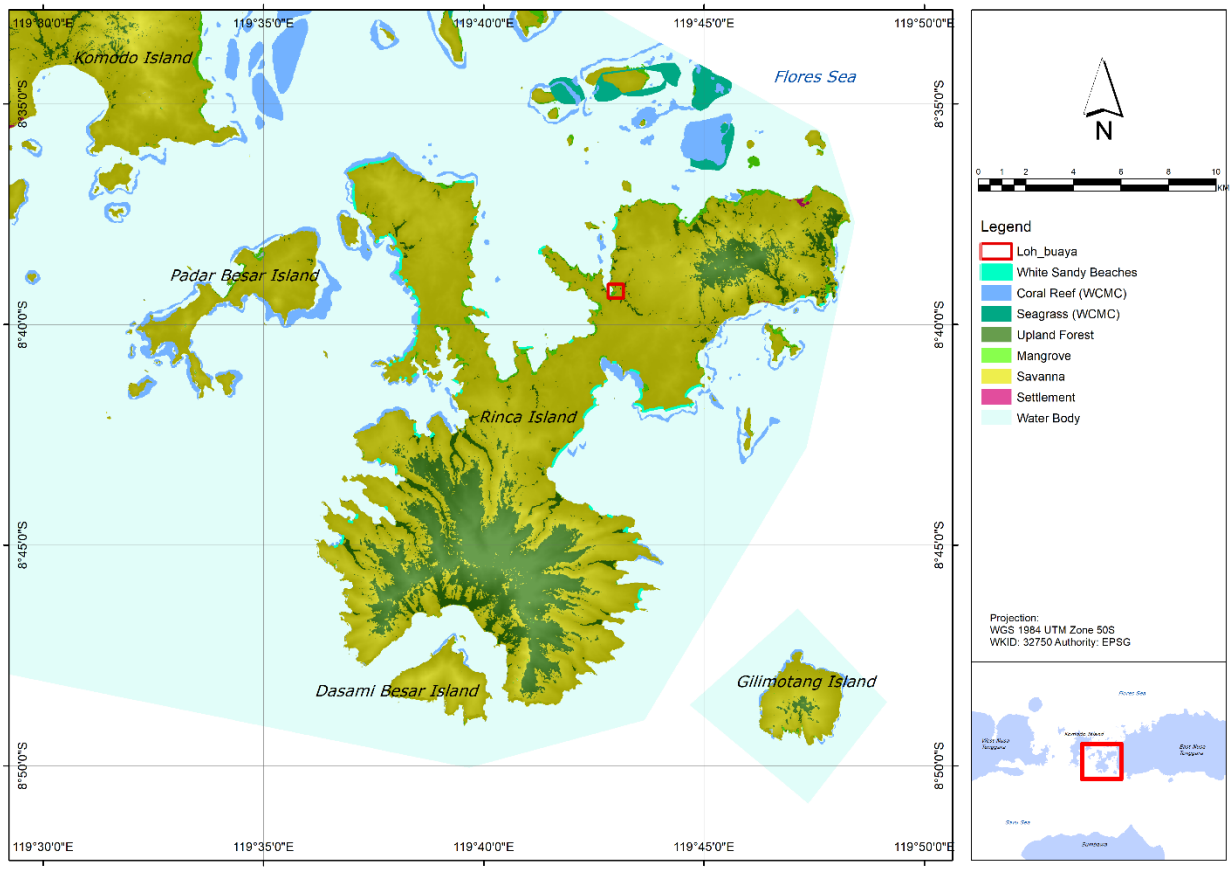

Figure 3. 4. Sandy Beaches in Rinca Island

(a) Impact of Camp Ranger, Tour Guide and Researcher Building complex and its Plaza Deck Development

Three buildings and a plaza that connect the buildings would be built (Figure 3.4). It can be seen clearly in the figure, that the building is built on barren land, grass and 2 clumps of shrubs. So it can be said that the development of this complex has a minimum impact on the ecosystem as a whole in Komodo National Park.

(b) Impact of elevated pathway development

The construction of an elevated pathway to the Information Center Building does not interfere with the ecosystem savanna because it will be built at the same location of the existing pathway (Figure 2.11). Meanwhile, the elevated pathway towards the complex camp ranger, tour guide and researcher will not have a big fragmentation habitat since Komodo dragons easily move below the construction.

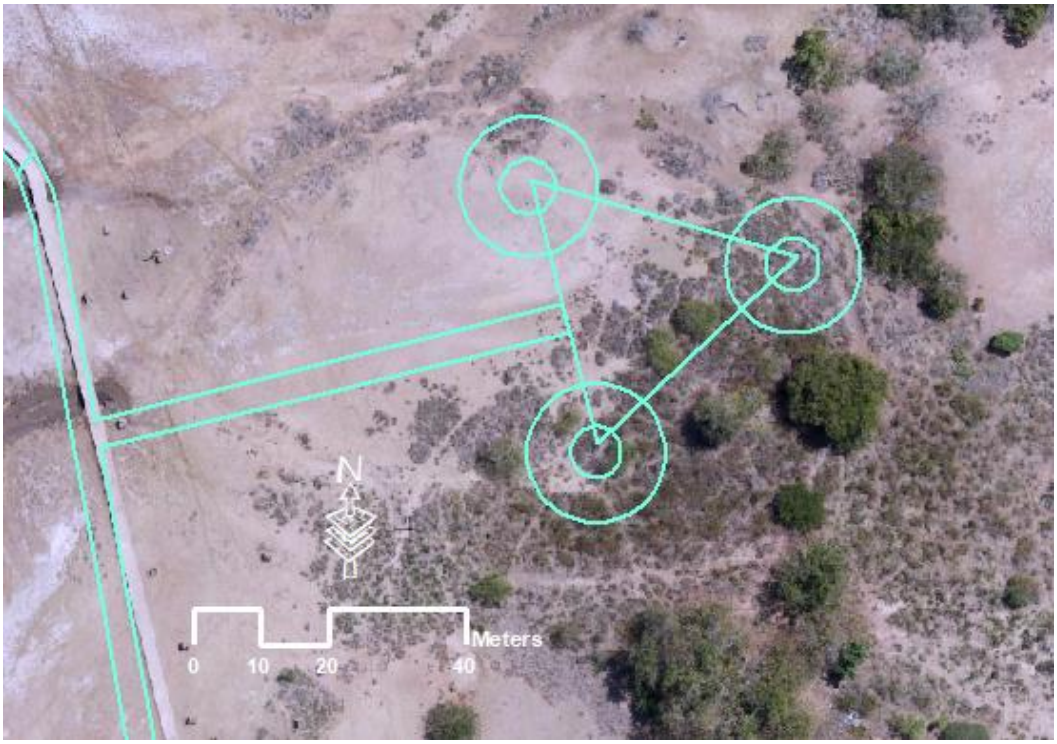

Figure 3. 5. Complex ranger, tour guide and researcher camp (Background: UAV image taken in 2019)

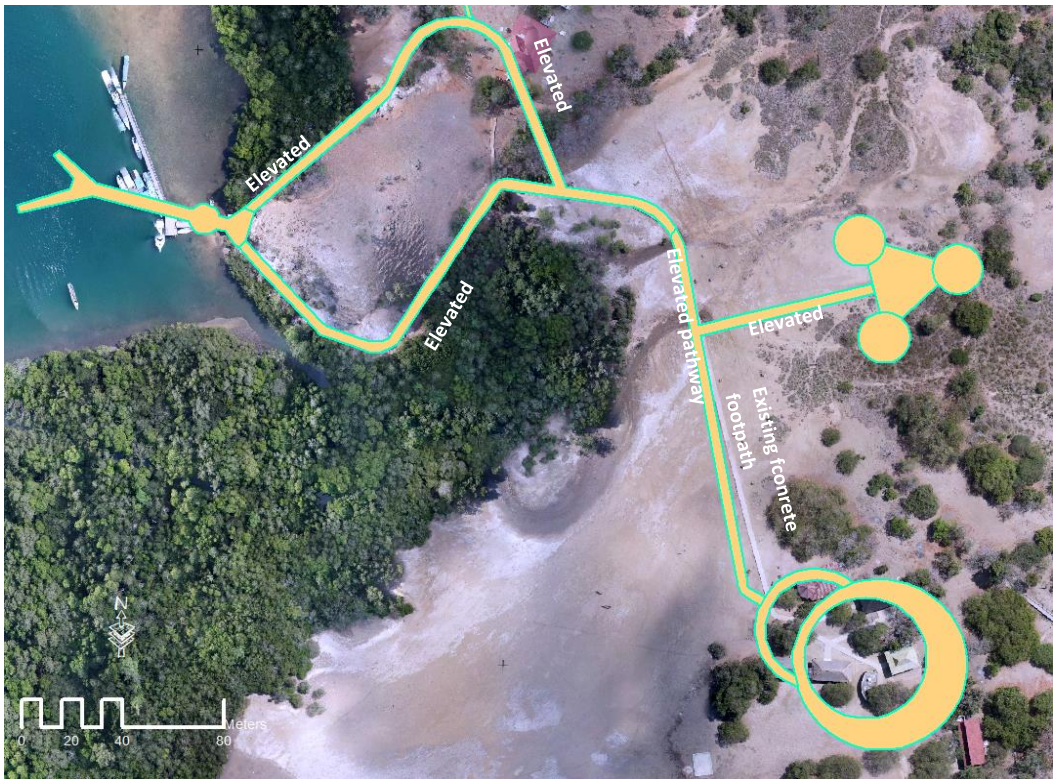

Figure 3. 6. Elevated pathway to replace existing footpath (Background: UAV image taken in 2019)

(c) Impact of Information Center Development to Savannah

The infrastructure will be built on woody savannah with several trees, especially tamarin species. Even though the design has been shifted, it is estimated that there are still 5 trees that will be cut down (Figure 3.7). Compared with the total trees within the deciduous monsoon forest of the park, the impact of the construction on the OUV is negligible.

Figure 3. 7. Information Center infrastructure (blue line) overlay with the UAV image taken in 2019 (Number represent the trees that will be impacted by the project)

Table 3. 2. Impact of project on Criterion (vii)

Values described under criterion (vii)	No impact assessed on OUV	Negligible impact assessed on OUV	Minor impact assessed on OUV	Moderate impact assessed on OUV	Major impact assessed on OUV
Mangrove Ecosystem					

Values described under criterion (vii)	No impact assessed on OUV	Negligible impact assessed on OUV	Minor impact assessed on OUV	Moderate impact assessed on OUV	Major impact assessed on OUV
See grass & Coral Reef					
White sandy beaches					
Deciduous Monsoon and Quasy-mountane forest ecosystem					
Savanna ecosystem					

3.3.1.2. Impact on criterion (x) and mitigation measures

The following species or groups were identified as contributing to the OUV of the property under criterion (x): a) Komodo dragon, b) terrestrial mammals, c) birds, d) marine fauna and flora (non-mammals), e) marine mammals, f) sea turtles. The EIA assessed the impact of the project on all of the above values.

a) Impact of Development on Komodo dragon

The Komodo dragon (*Varanus komodoensis*) is the first and most important component of criterion (x) due to its endemicity and unique evolutionary history. This species is the largest lizard and has an important ecological role as an apex predator in Komodo National Park (Jessop et al. 2006b, 2019, 2020; Purwandana et al. 2016). Based on the fossil records, the Komodo dragon had previously existed more than 3.8 million years ago (Pliocene era) in Australia, and around 900,000 years ago (Pleistocene era) in Indonesia (Hocknull et al. 2009). However, Komodo dragons were discovered as a new species to science quite recently on Komodo Island (1910) and described two years later (Ouwens 1912). The current distribution of Komodo dragon is restricted to five islands located in Komodo National Park [Komodo (311.5 km^2), Rinca (204.8 km^2), Padar (14.1 km^2), Gili Motang (9.5 km^2), and Nusa Kode (7.8 km^2)] and several fragmented populations on Flores Island (Purwandana et al. 2014; Jessop et al. 2018; Ariefiandy et al. 2021).

Komodo National Park authority regularly monitors the population of Komodo dragons, using a mark-recapture method and camera trapping with site occupancy approaches used to estimate Komodo dragon population abundance (Ariefiandy et al. 2013; Purwandana et al. 2014; Balai Taman Nasional Komodo (Komodo National Park Authority) 2019a). There are 11 monitoring sites with 219 fixed locations distributed across five islands within Komodo National Park that are annually monitored. To date, 1,217 individuals of Komodo dragons have been permanently tagged with Passive Integrated Transponder (PIT-tag) for population monitoring purposes, including to observe growth and survival rates (Purwandana et al. 2014; Balai Taman Nasional Komodo (Komodo National Park Authority) - Komodo Survival Program 2019). Komodo dragon population abundance across Komodo National Park over the last five years has shown small fluctuations with a slight decrease reported in 2016. The highest abundance was in 2019 and estimated 3,022 Komodo dragons (95 % CI ranged from 2,292 – 3,983) (Fig. 3.8). There is variation among island-specific abundance across Komodo National Park. The abundance in two large islands (Komodo and Rinca) was much higher (more than tenfold) compared to the three small islands of Gili Motang, Nusa Kode and Padar.

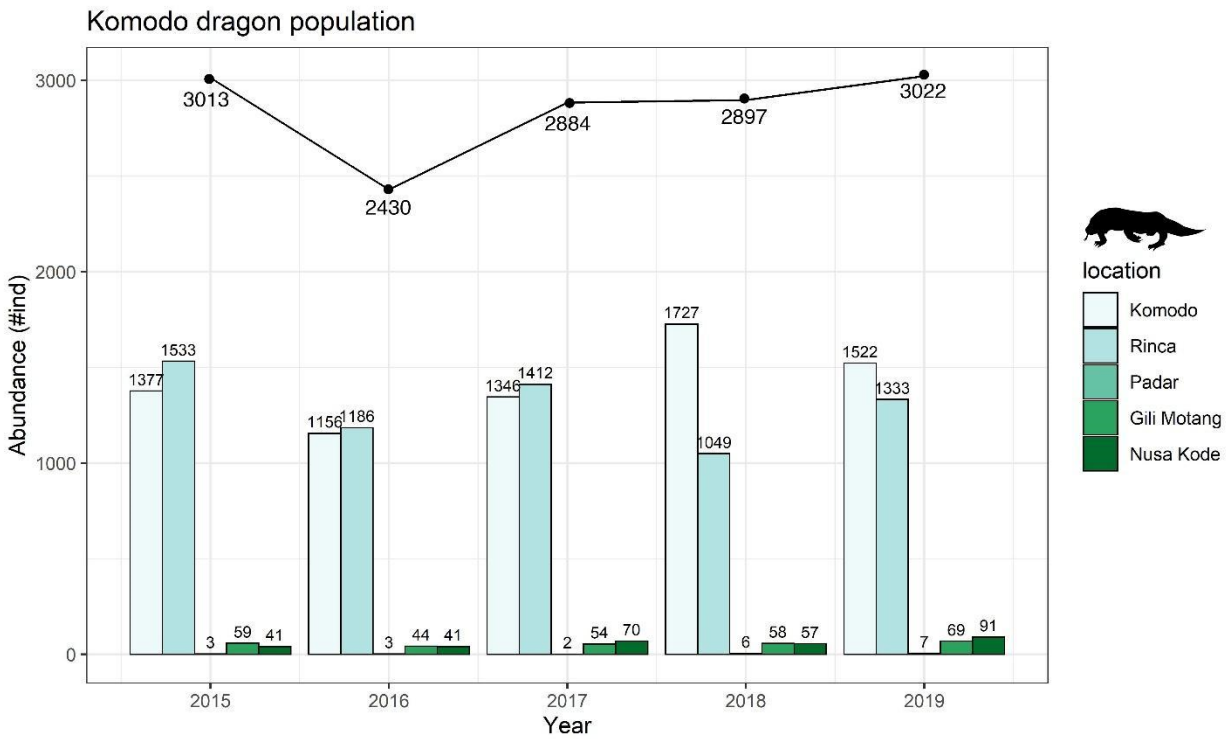

Figure 3. 8. Population trend of Komodo dragon from 2015 to 2019 across five islands in Komodo National Park (Balai Taman Nasional Komodo (Komodo National Park Authority) - Komodo Survival Program 2019).

Small impact on the population of Komodo dragon

Population monitoring has been conducted in Loh Liang and Loh Buaya valley since 2003 using mark-recapture methods (Purwandana et al. 2014; Balai Taman Nasional Komodo (Komodo National Park Authority) - Komodo Survival Program 2019). This intensive monitoring method is maintained at these two terrestrial ecotourism sites to produce high-quality population data. Despite the mean higher abundance in Loh Liang, a much larger and better quality habitat than Loh Buaya, annual changes in abundance at both sites are nearly similar and considered stable over recent decades (Fig. 3.9).

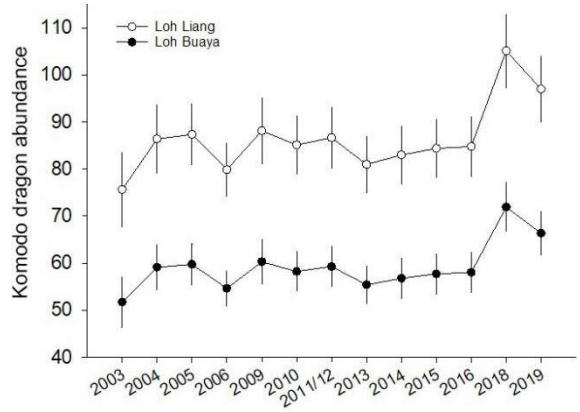

Figure 3. 9. Komodo dragon populations trend across two ecotourism sites in Komodo National Park (Balai Taman Nasional Komodo (Komodo National Park Authority) - Komodo Survival Program 2019).

The project area exhibits a small footprint (0.013 km²) compared to the total local Loh Buaya valley area (5 km²) or that of Rinca Island's area (204.8 km²). The construction activities including mobilization of construction workers, equipment and materials, construction and operation of base camp, set up and operation of material stockpiles and infrastructure construction are

likely to have limited non-lethal and non-permanent effects on the local Komodo dragon population. It is estimated that less than 15 individuals of Komodo dragons are interacting within the infrastructure development area. This represents 23 percent of the total population in the valley (66 ± 5 individuals, in 2019), representing ~1 percent of the total Rinca island population (1,333 ± 181 individuals, in 2019) (Fig. 3.10). It is important to underline that the 15 individual Komodo dragons interacting with the site are already adapted to the presence of human activities and buildings (as there were already buildings on the site - See Chapter 2. Development Plans). The impact of the project to the Komodo dragon is summarized in Table 3.3.

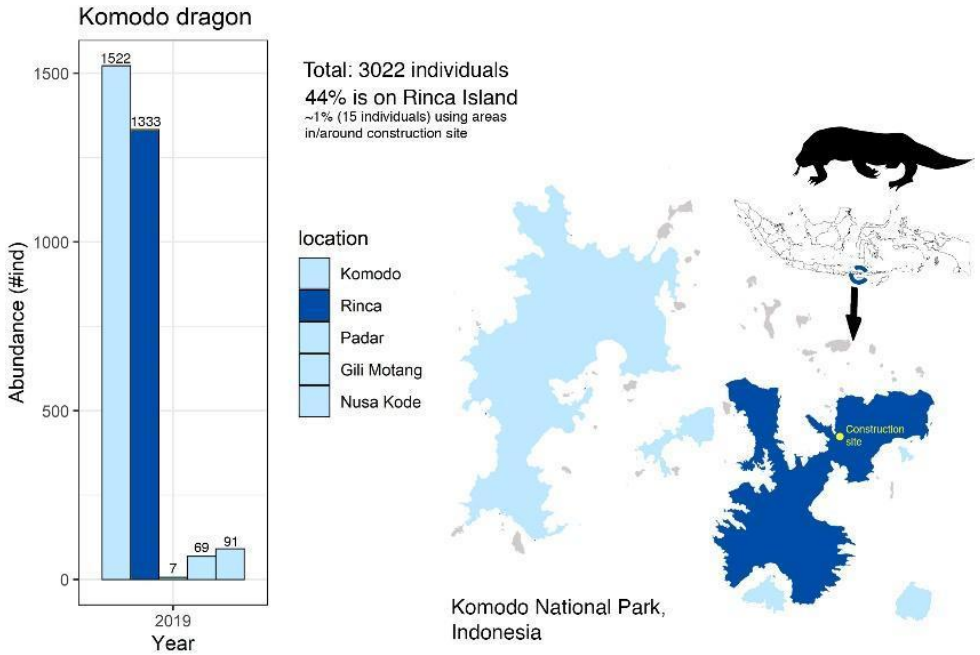

Figure 3. 10. Distribution of Komodo dragon [light and dark blue (Rinca)] with the population data in 2019 and the extremely small proportion (~1%) of the total Komodo dragon population that may interact within the development site in Loh Buaya valley (yellow dot) [Sources of data, (Balai Taman Nasional Komodo (Komodo National Park Authority) - Komodo Survival Program 2019), distribution map is modified from (Balai Taman Nasional Komodo (Komodo National Park Authority) 2019b).

Table 3. 3. The impact of project on the population of Komodo dragons.

Impacts	Mitigation measures
• *Negligible impact on population of Komodo Dragon in loh Buaya valley*	• *Conducted annual population monitoring of Komodo dragon in the national park, including in Loh Buaya valley to support adaptive management approach* Komodo National Park authority will regularly monitor the population of Komodo dragons in collaboration with the Komodo Survival Program (KSP). Mark-recapture method and camera trapping with site occupancy approaches are used to estimate Komodo dragon population abundance (Ariefiandy et al. 2013; Purwandana et al. 2014; Balai Taman Nasional Komodo (Komodo National Park Authority) - Komodo Survival Program 2019). There are 11 monitoring sites with 219 fixed locations distributed across five islands within

Impacts	Mitigation measures
	Komodo National Park that are annually monitored. To date, 1,217 individuals of Komodo dragons have been permanently tagged with Passive Integrated Transponder (PIT-tag) for population monitoring purposes, including to observe growth and survival rates (Purwandana et al. 2014; Balai Taman Nasional Komodo (Komodo National Park Authority) - Komodo Survival Program 2019). Population monitoring has been conducted in Loh Liang and Loh Buaya valley since 2003 using mark-recapture method (Purwandana et al. 2014; Balai Taman Nasional Komodo (Komodo National Park Authority) - Komodo Survival Program 2019). This intensive monitoring method will be maintained at these two sites and result in high-quality population data, allowing managers to monitor any changes in populations. The data will be regularly analyzed by scientists and KNP Authorities to ensure that adaptive management interventions are undertaken when there are any fluctuations in the populations beyond the Limit of Acceptable Change (LAC). ● *Strengthen the daily wildlife monitoring in the Loh Buaya valley, especially in/around the infrastructure, as part of the Resort Based Management* Resort Based Management is a new system developed in 2020 to improve national park management. One of the main functions is to monitor wildlife for at least 3 days during the 10-days shift of the park rangers across all resort offices in the national park. Any wildlife sighting along the consistent transect (1-2.6 km) is recorded (species, number, and behavior) every morning and late afternoon. This data will later be input into the national park centralized database. Regular discussion will be held every three months to check the condition of the wildlife, or any incidence, to determine the proper action as part of the adaptive management approach. Loh Buaya resort also implements this system, and will then monitor and report any changes/risk/impact to the wildlife.
● *Negligible risk of displacement and unlikely changes of behavior due to disturbance* Komodo dragons have excellent site fidelity, homing behavior, and rarely move between valleys (Jessop et al. 2018). The average daily movement for adult Komodo dragons is 573 meters, with the longest daily movement up to	● *Build an elevated pathway (2-m in height) to allow the natural movement of Komodo dragon and prevent interaction with tourists* Besides the first mitigation measure stated in this table, replacing the current dirt pathway visitors access will

Impacts	Mitigation measures
3,000 meters during the breeding season, when males are searching for females (Jessop et al. 2007). It is known that ~15 komodo dragons are observed foraging around the area of the planned project within the Loh Buaya valley (Balai Taman Nasional Komodo (Komodo National Park Authority) 2019a). These komodo dragons are habituated to buildings and tourism activities and appear robust to construction works. Observations of habituation in Komodo dragons have been widely evident in the Loh Buaya ecotourism area since its establishment in 1989. Komodo dragons in high human activity areas also are less wary of humans, have a larger body mass and are in better body condition. To date, there is no significant risk of Komodo dragon extirpation in ecotourism areas, in fact, data shows that local Komodo dragon populations have higher survival rates and densities in ecotourism areas compared to those areas without any human activities elsewhere in Komodo National Park (Purwandana et al. 2014; Ardiantiono et al. 2018). Therefore, it is expected that the project will not cause any behavioral change in the already habituated komodo individuals around the area. Even though it may locally displace a small number of individuals temporarily, it is expected that these individuals will not move to other valleys where they may be at risk of intraspecific competition and aggression.	allow the natural movement of Komodo dragons and other wildlife. ● *Strengthen the daily wildlife monitoring in the Loh Buaya valley, especially in/around the infrastructure, as part of the Resort Based Management* As explained above.
● *Minimal disturbance to reproductive activities* In Loh Buaya valley there are at least six Komodo dragon nests that females Komodo dragon use for laying their eggs, 8% of the total known Komodo dragon nest (74) that have been identified across 7 monitoring sites on Komodo and Rinca Islands (Jessop et al. 2004; Balai Taman Nasional Komodo (Komodo National Park Authority) - Komodo Survival Program 2019; Purwandana et al. 2020). The nearest Komodo dragon nest is located 325 meters away from the project location, the average daily movement of Komodo female	● *Develop the new facilities only on and around the existing infrastructure in Loh Buaya valley* The proposed project is located far from any Komodo dragon nest. All infrastructure development is strictly confined to the proposed areas. ● *Continue the annual monitoring of Komodo dragon nests and female reproductive activities* The annual monitoring is conducted every year from June to December using intensive focal sampling method across consecutive transect grids in the Komodo NP valleys, including in Loh Buaya [as described in (Jessop et al. 2004; Balai Taman Nasional

Impacts	Mitigation measures
dragons during nesting periods is 285 meters (Jessop et al. 2007); thus the project will not disturb this Komodo dragon reproductive activity.	Komodo (Komodo National Park Authority) - Komodo Survival Program 2019)]. This is a joint collaboration between Komodo National Park and the Komodo Survival Program. Multiple observers (5-8) walk 25 meter apart along the parallel transects (different number of transects based on the size and topography of each valley) to monitor previously known nests, find new ones, and identify the status of the nest. Teams collect information on type of nest (Komodo dragon or scrub fowl nest), characteristic of the nest (length, width, #holes, and elevation) and the status of the nest (active – being used vs not active – not being used). For active nests, camera traps are set up to monitor female nesting behavior. This nearest nest to the planned project site (325 meters away) will be part of the monitoring.
● *Minimal loss of thermal resources* Komodo dragons, like most reptiles, are ectotherms which means they need to bask every morning to increase their body temperature into their preferred temperature, around 34-35.6°C (Harlow et al. 2010). Part of the infrastructure development project area will be in an open savanna and contains potential Komodo dragon basking sites. However, even if a small number of these sites are removed, then dragons still have a lot of opportunities to access alternative sites elsewhere in the Loh Buaya valley to bask.	● *Develop the new facilities only on and around the existing infrastructure in Loh Buaya valley* The infrastructure development area exhibits a small footprint (0.013 km²) compared to the total local Loh Buaya valley area (5 km²) or that of Rinca Island's area (204.8 km²) with most of the new infrastructures replacing the existing infrastructure. Thus only an extremely small part of the potential basking sites will be removed.

b) Terrestrial mammals

There are seven species of terrestrial mammals in Komodo National Park, 1) Timor deer (*Rusa timorensis*), 2) Wild boar (*Sus scrofa*), 3) Water buffalo (*Bubalus bubalis*), 4) Long-tailed macaque (*Macaca fascicularis*), 5) Asian/common palm civet (*Paradoxurus hermaphroditus*), 6) Wild horse (*Equus* sp.), and 7) Nusa Tenggara Komodomys (*Komodomys rintjanus*, formerly known as *Rattus rintjanus*).

Minimal impact on the population, habitat, and behavior of terrestrial mammals

Only Timor deer, wild boar, water buffalo, and long-tailed macaque have ever been observed in and around the project (Personal communication with the head of Loh Buaya resort). The Asian palm civet has also been observed in the wider Loh Buaya area (dung abundance per ha: 11.35 ± 0.05) - besides also having been observed in Loh Baru on Rinca Island, and Loh Sebita and Loh Wau on Komodo Island (Jessop et al. 2006a). Civet has a higher habitat preference for deciduous monsoon forest instead of savannah, which may explain that it has never been sighted in and around the project arae. Both wild horses and Nusa Tenggara Komodomys have never been encountered in the location either (Personal communication with the head of Loh Buaya resort).

Komodo NP authority has been working in collaboration with the Komodo Survival Program since 2002 to conduct annual monitoring of Komodo prey species, namely Timor deer, water buffalo, and wild boar. A dung count methodology is used to index prey abundances at 10 sites, including Loh Buaya valley, across Komodo

National Park (Ariefiandy et al. 2016; Balai Taman Nasional Komodo (Komodo National Park Authority) - Komodo Survival Program 2019). Dung abundances act as a proxy of prey abundance to indicate any population change throughout the years. The methods as described in the previous reference, about 20 to 48 of 150-m transects were established in every site. Each transect consisted of 30 1-m circular plots at 5-m interval, then three observers searched and counted groups of dung thoroughly within these plots (Ariefiandy et al. 2016; Balai Taman Nasional Komodo (Komodo National Park Authority) - Komodo Survival Program 2019). The monitoring results suggest that the abundance of three mammal species fluctuates over time, but tends to be stable across all sites (Figure 3.11).

Approximately 10-20 individuals of Timor deer, 15 individuals of water buffalo, 5 individuals of wild boar, and three groups (30 to 60 individuals) of long-tailed macaques may be exposed to any impact listed in the Table 3.4 below. To obtain the actual proportion (% of the total population) of the animals being impacted is challenging because the population monitoring uses dung group abundance as a proxy (Fig. 3.12). However, despite this limitation, the numbers of individuals that may be impacted by the development are considered extremely small or negligible. Moreover, these groups of animals present in Loh Buaya have been adapted to the presence of human activities and buildings since 1989.

Table 3. 4. The impact of project on the population of mammal species.

Impacts	**Mitigation measures**
● *Negligible impact to the behaviour and population of terrestrial mammals* Wild boar is usually nocturnal (active during the night), but only few individuals forage in small parts of the soils or tree roots (Personal communication with the head of Loh Buaya resort). Parts of the new buildings in/close to mangroves may pose a risk to the three groups of macaques (each group is ~20-30 individuals), a) one group use areas around the visitor center, b) one group use areas in the salt pan, and c) one group use the mangrove areas to forage on crabs and other invertebrates. However, as they are habituated to human presence prior to the construction, they will likely to still be in the areas or will move temporarily not far from the construction site. One study showed that the travelling range of the habituated group of macaques range between 100 to 600 m per day (Hambali et al. 2005).	● *Continue the annual population monitoring of Timor deer, wild boar, and water buffalo (Komodo dragon key prey species)* Komodo National Park authority regularly monitors the population of these three mammal species in collaboration with the Komodo Survival Program (KSP). Dung count method is used as explained previously. This monitoring provides critical information to support the NP adaptive management approach and mitigate any potential impacts. ● *Strengthen the daily wildlife monitoring in the Loh Buaya valley, especially in/around the infrastructure, as part of the Resort Based Management* As explained above. ● *Build an elevated pathway (2-m in height) to allow the natural movement of Komodo dragon and other wildlife* Replacing the current pathway visitor access will allow the natural movement of these terrestrial mammal species. In addition, the one mud hole used by the water buffalo will not be disturbed.

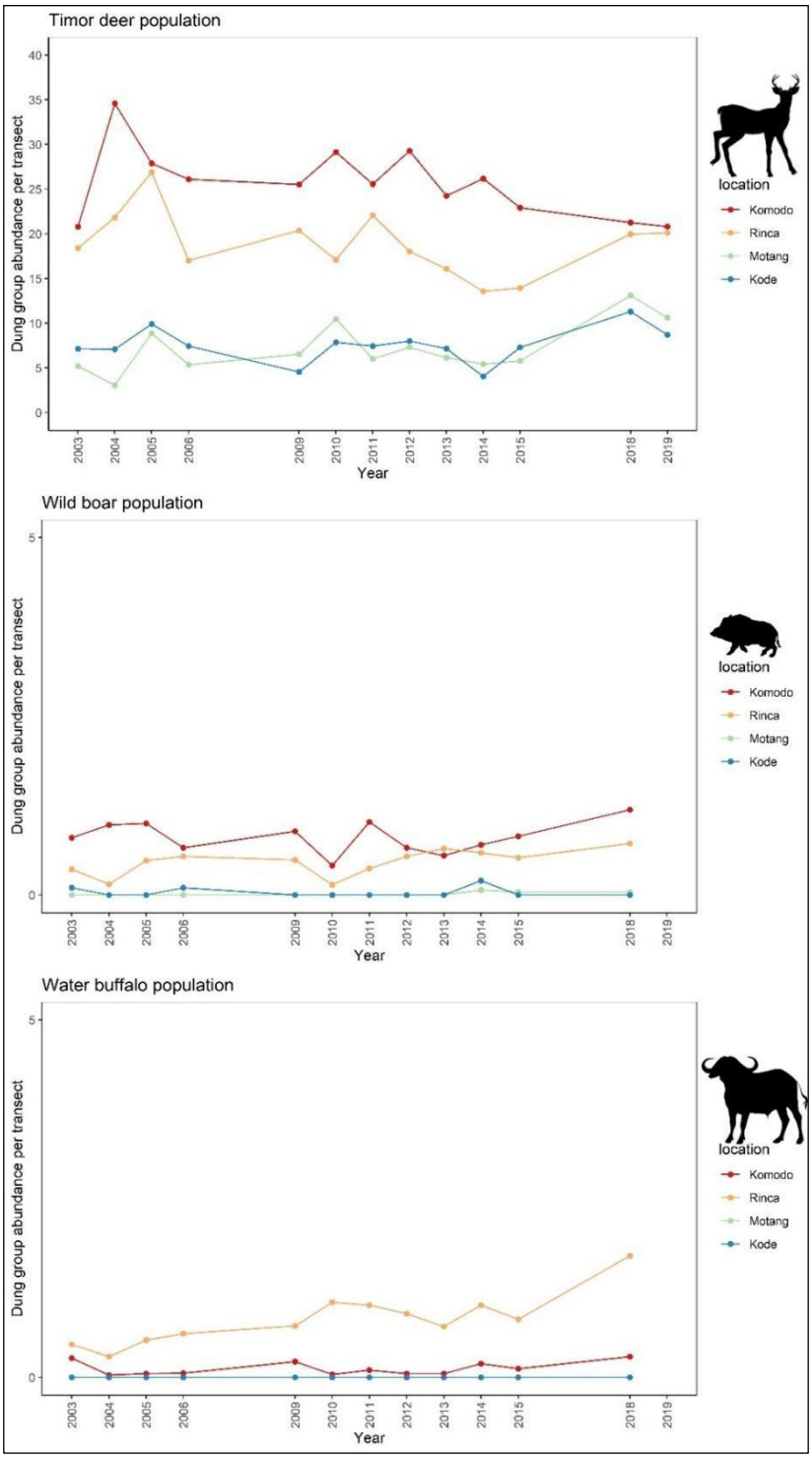

Figure 3. 11. Population trend of the three mammal species in Komodo National Park: Timor deer, wild boar, and water buffalo. Dung group abundance acts as the proxy of the actual abundance (Balai Taman Nasional Komodo (Komodo National Park Authority) - Komodo Survival Program 2019).

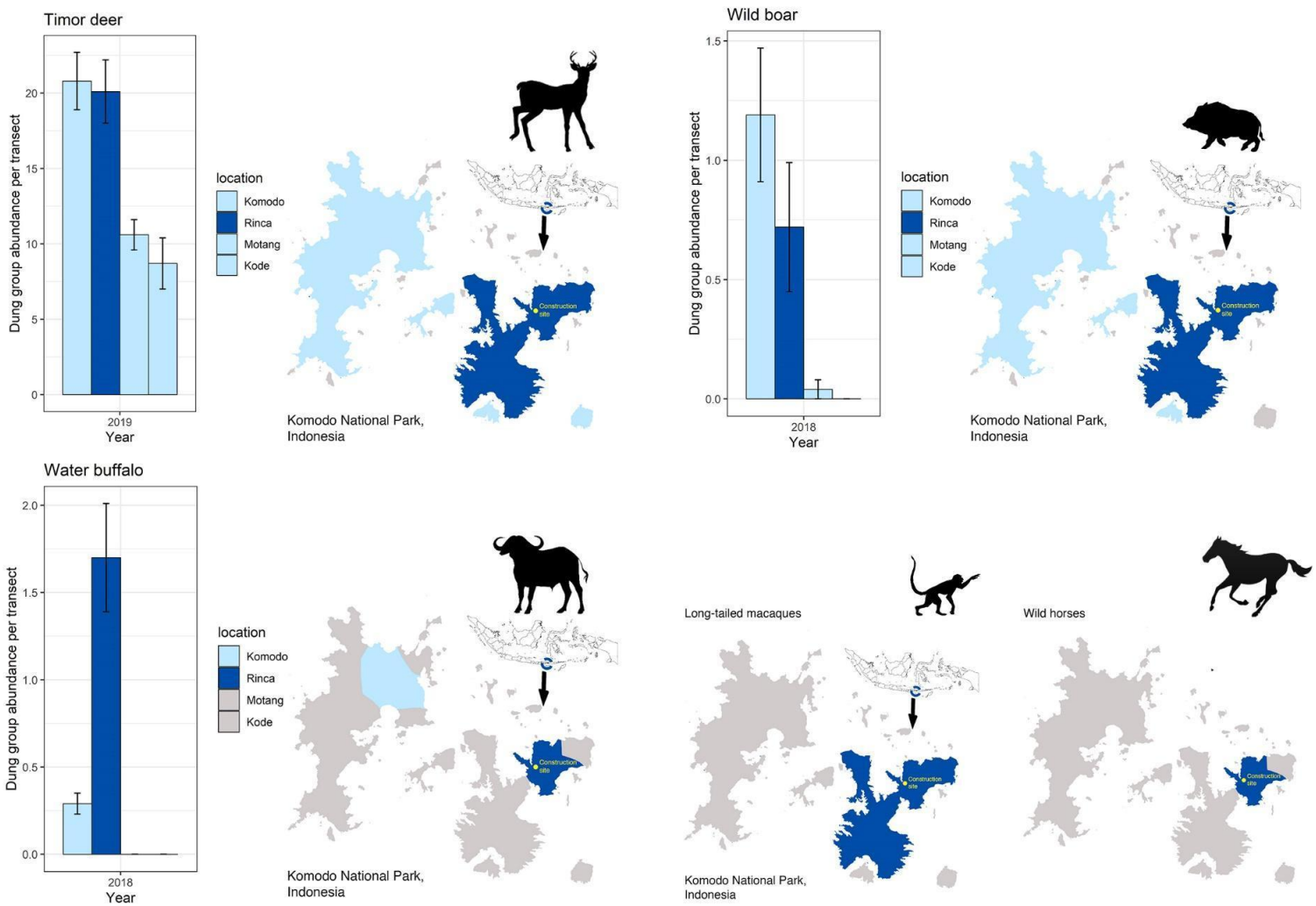

Figure 3. 12. Distribution of terrestrial mammals [light and dark blue (Rinca)] with the population data in 2019. Notes: construction site is in yellow dot [Sources of data, (Balai Taman Nasional Komodo (Komodo National Park Authority) - Komodo Survival Program 2019), distribution map is modified from (Balai Taman Nasional Komodo (Komodo National Park Authority) 2019b).

c) Avifauna diversity

Negligible impact on the population and habitat of birds

There are 72 bird species residing in Komodo National Park, 30 of them were observed in the project site (Table 3.5). About 87% are not-protected and 97% are not threatened (28 in Least Concern – LC and 1 in Near Threatened – NT categories). Most of the species are widely distributed and common in habitat with human presence. Therefore, the impact to the avifauna diversity is deemed negligible. A separate assessment was made for the Lesser sulphur-crested cockatoo because it is listed as Critically-Endangered and the Orange-footed scrub fowl as its nests are important to Komodo dragons. Both of them are also protected species.

Table 3. 5. Bird species observed in the proposed construction site.

Species name	Common name	IUCN status	Protection status
*Cacatua sulphurea**	Lesser sulphur-crested cockatoo	CR	Protected
Megapodius reinwardt	Orange-footed scrub fowl	LC	Protected
Haliastur indus	Brahminy kite	LC	Protected
Haliaeetus leucogaster	White-bellied sea eagle	LC	Protected
*Cinnyris solaris**	Flame-breasted sunbird	LC	Not-protected
*Taeniopygia guttata**	Timor Zebra Finch	LC	Not-protected
Limosa lapponica	Bar-tailed godwit	NT	Not-protected
Sterna albifrons	Little tern	LC	Not-protected
Ardea purpurea	Purple heron	LC	Not-protected
Egretta garzetta	Little egret	LC	Not-protected
Nycticorax nycticorax	Black-crowned night heron	LC	Not-protected
Anas superciliosa	Pacific black duck	LC	Not-protected
Poliolimnas cinerea	White-browed crake	LC	Not-protected
Turnix suscitator	Barred buttonquail	LC	Not-protected
Tringa nebularia	Common greenshank	LC	Not-protected
Tringa tetanus	Common redshank	LC	Not-protected
Geopelia striata	Zebra dove	LC	Not-protected
Ducula concinna	Blue-tailed imperial-pigeon	LC	Not-protected
Ducula bicolor	Pied imperial pigeon	LC	Not-protected

Species name	Common name	IUCN status	Protection status
Ducula aenea	Green imperial-pigeon	LC	Not-protected
Saxicola caprata	Pied bushchat	LC	Not-protected
Passer montanus	Eurasian tree sparrow	LC	Not-protected
Hirundo tahitica	Pacific swallow	LC	Not-protected
Gallus varius	Green junglefowl	LC	Not-protected
Oriolus chinensis	Black-naped oriole	LC	Not-protected
Corvus macrorhynchos	Large-billed crow	LC	Not-protected
Todiramphus chloris	Collared kingfisher	LC	Not-protected
Spilopelia chinensis	Spotted dove	LC	Not-protected
Dicrurus densus	Wallacean drongo	LC	Not-protected
Philemon buceroides	Helmeted friarbird	LC	Not-protected

Notes: (*) endemic to certain areas, *Cacatua suplhurea* is endemic to Wallacea, while *Cinnyris solaris* and *Taeniopygia guttata* are endemic to parts of Lesser Sunda (Timor and East Nusa Tenggara). IUCN status from https://www.iucnredlist.org/ and protection status from the Minister of Environment and Forestry Regulation on Protected Species List No. P.106/Menlhk/Setjen/Kum.1/12/2018.

Minimal impact on the population of the Lesser sulphur-crested cockatoo population (CR)

Komodo National Park harbors one of the largest remaining populations of this species. The rangers have conducted an annual valley-floor census to estimate the bird population size following the methods described in (Imansyah et al. 2016). Every morning and afternoon, birds fly between roosting and feeding sites, and thus they could be observed from high points by looking toward the valleys. Birds are counted in the valleys on Komodo, Rinca, and Bero Islands. The meta-population trend of cockatoo in KNP has been increasing over time, but decreasing on Rinca Island (Figure 3.13). In 2019, it is estimated that there were 883 individuals in KNP, with 33 of them living on Rinca Island (4%). About 6 to 8 individuals per day have been observed to fly across the Loh Buaya valley without stopping in the project site. There are no nesting trees or feeding sites found in or adjacent to the project site [(Balai Taman Nasional Komodo (Komodo National Park Authority) 2019a), Personal communication with the head of Loh Buaya resort] (Figure 3.14). Therefore, the impact of the project is considered non-existing as the species does not use or interact with the project site.

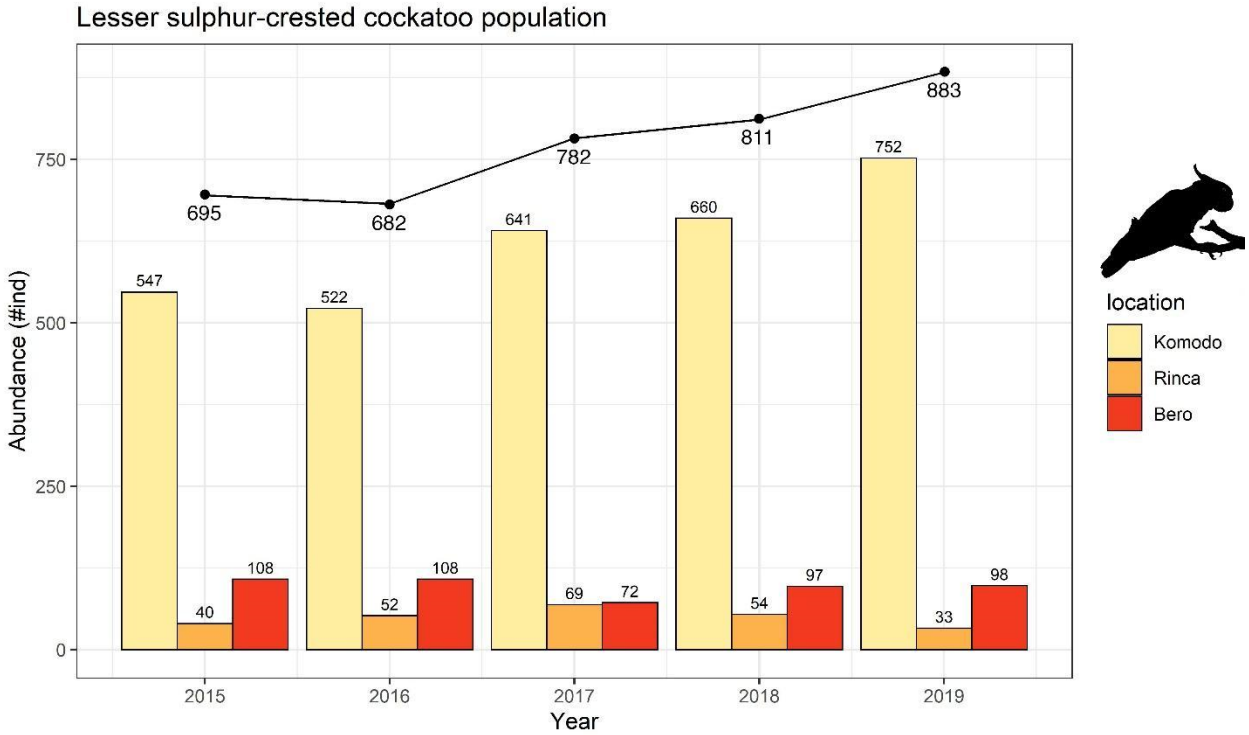

Figure 3. 13. Population trend of the Critically Endangered Lesser sulphur-crested cockatoo population in the Komodo National Park [Source of data, (Balai Taman Nasional Komodo (Komodo National Park Authority) 2019a).

Minimal impact on the population and habitat of the Orange-footed scrub fowl (LC)

This species is found in Komodo, Rinca, Gili Motang, and Nusa Kode Islands (Figure 3.15). Only one out of the eight scrub fowl nesting sites in Rinca Island is located near to the project (~100 m). This site is still active, and monitored annually as part of the joint collaboration between Komodo National Park and KSP to monitor Komodo dragon nesting sites [61% used scrub fowl's nesting sites (Imansyah et al. 2009)]. Orange-footed scrub fowl rarely use the areas in the proposed project site as feeding or resting sites as it is too open, making it vulnerable for predation.

The impact of project on the bird population and habitat as well as the mitigation measure is presented in Table 3.6.

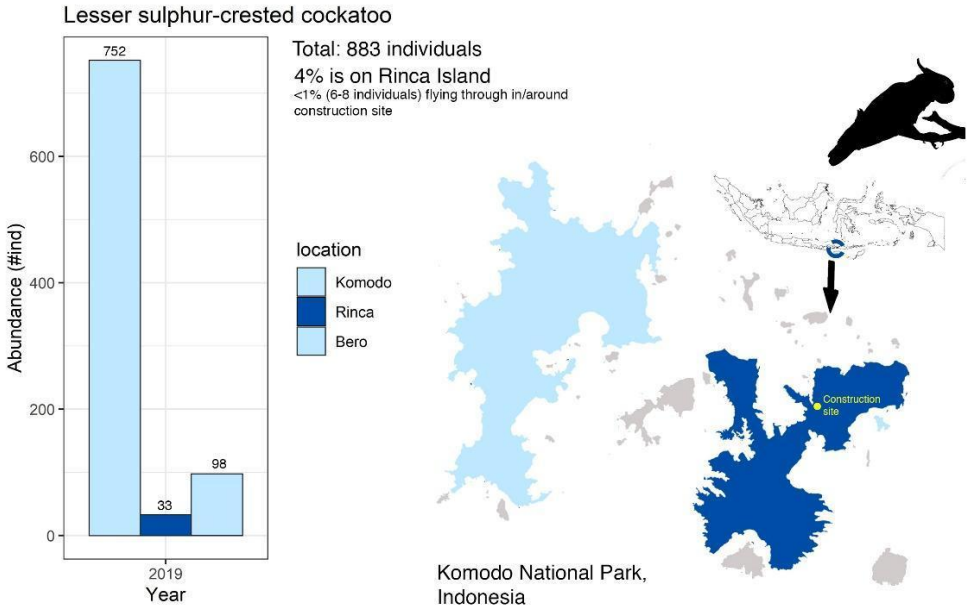

Figure 3. 14. Distribution of the cockatoo [light and dark blue (Rinca)] with the population data in 2019 and the extremely small proportion (<1%) of cockatoo that may be impacted in/around the construction site in Loh Buaya valley (yellow dot) [Sources of data, (Balai Taman Nasional Komodo (Komodo National Park Authority) - Komodo Survival Program 2019), distribution map is modified from (Balai Taman Nasional Komodo (Komodo National Park Authority) 2019b).

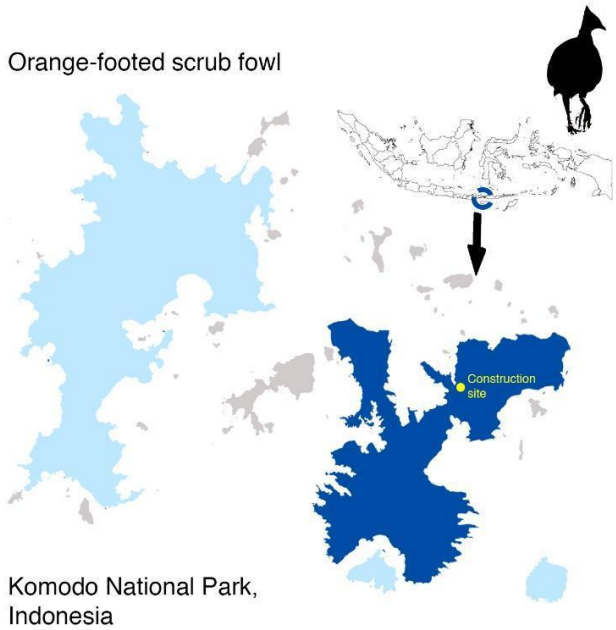

Figure 3. 15. Distribution of the scrub-fowl [light and dark blue (Rinca)]. Notes: the project site is in Loh Buaya valley (yellow dot) [Sources of data, (Balai Taman Nasional Komodo (Komodo National Park Authority) - Komodo Survival Program 2019), distribution map is modified from (Balai Taman Nasional Komodo (Komodo National Park Authority) 2019b). Silhouette of the bird was made from a photo by Judd Patteson in www.BirdsInFocus.com.

Table 3. 6. The impact of project on the bird population and habitat.

Impacts	Mitigation measures
● *No impact on the population of the Lesser sulphur-crested cockatoo and Orange-footed scrub fowl* Data from 2019 indicates that there are 883 individuals in KNP, of which 33 are living on Rinca Island (4%). Only 6 to8 individuals per day fly across the Loh Buaya valley without stopping to rest or feed. There are no nesting trees or feeding sites found in or adjacent to the project site[(Balai Taman Nasional Komodo (Komodo National Park Authority) 2019a), Personal communication with the head of Loh Buaya resort] (Fig. 6). The impact of the project is considered non-existing because the species does not use or interact with the project site. Only one out of the eight scrub fowl nesting sites is located near to the proposed construction site (~100 m). Orange-footed scrub fowl rarely use the areas in the proposed project site as feeding or resting sites as the area is too open, making it vulnerable for predation.	While there is no need for mitigation measures due to the absence of impacts, the following measures will nevertheless be implemented as a precautionary measure: ● *Continue the annual vantage-census of the Lesser sulphur-crested cockatoo* Komodo National Park authority regularly conducts this bird census using the methodology explained previously. This monitoring provides critical information to support the NP adaptive management approach. ● *Continue the annual monitoring of Komodo dragon nests and female reproductive activities* The annual monitoring is conducted every year from June to December using intensive focal sampling method across consecutive transect grids in the Komodo NP valleys, including in Loh Buaya [as described in (Jessop et al. 2004; Balai Taman Nasional Komodo (Komodo National Park Authority) - Komodo Survival Program 2019)]. This is a joint collaboration between Komodo National Park and Komodo Survival Program to monitor Komodo dragon nests, but also at the same time to record Orange-footed scrub fowl nests. ● *Strengthen the daily wildlife monitoring in the Loh Buaya valley, especially in/around the infrastructure, as part of the Resort Based Management* As explained above.

d) Marine fauna and flora

Komodo National Park is famous for its marine life (Lembaga Ilmu Pengetahuan Indonesia (LIPI) (Indonesian Institute of Sciences) 2019). The marine diversity in the Loh Buaya bay close to the project site is considered poor due to the lack of coral reefs and sea grass beds (Personal communication with Mr. Muhammad Ikbal Putera, Komodo National Park and Loh Buaya resort park ranger, Mr. Afandi) (Figure 3.16). A more extensive report on coral reefs can be found in the Integrity section. The main substrate of the sea floor in this area is rock, sand, and mud (Lembaga Ilmu Pengetahuan Indonesia (LIPI) (Indonesian Institute of Sciences) 2019).

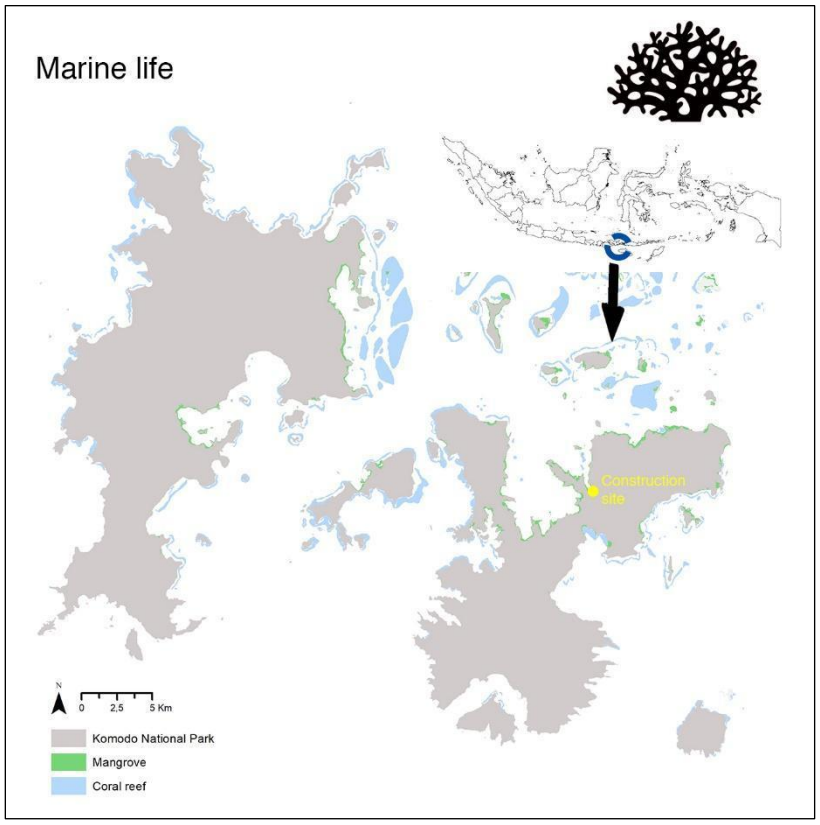

Figure 3. 16. Coral reef and mangrove in Komodo National Park. Absence of coral reef (blue color) closed to the project (yellow dot). [Sources: Coral reef from (UNEP-WCMC with WorldFish Centre and WRI and TNC 2021) and mangroves from the Ministry of Environment and Forestry (2015) http://dbgis.menlhk.go.id/arcgis/rest/services/KLHK/Hutan_Mangrove/MapServer].

e) Marine mammals (dugong, dolphins, etc.)

There are approximately 18 cetacean species in Komodo National Park (Kahn 2001). Two of them are coastal cetacean with reported sighting close to/around Loh Buaya bay, Bottlenose dolphin (*Tursiops truncatus*) and Indo-Pacific humpback dolphin (*Sousa chinensis*) (Kahn 2001). The distance of the sighting is about 4 km (Figure 3.17). Bottlenose dolphins are one of the most common cetaceans observed in the Komodo National Park. This dolphin species was also recently sighted by local community members (Personal communication), however the exact position and species were not confirmed. Because the construction takes place on the existing Jetty.it will not directly affect these marine mammals. Measures need to be taken later to anticipate the increasing number of tourists (Table 3.7).

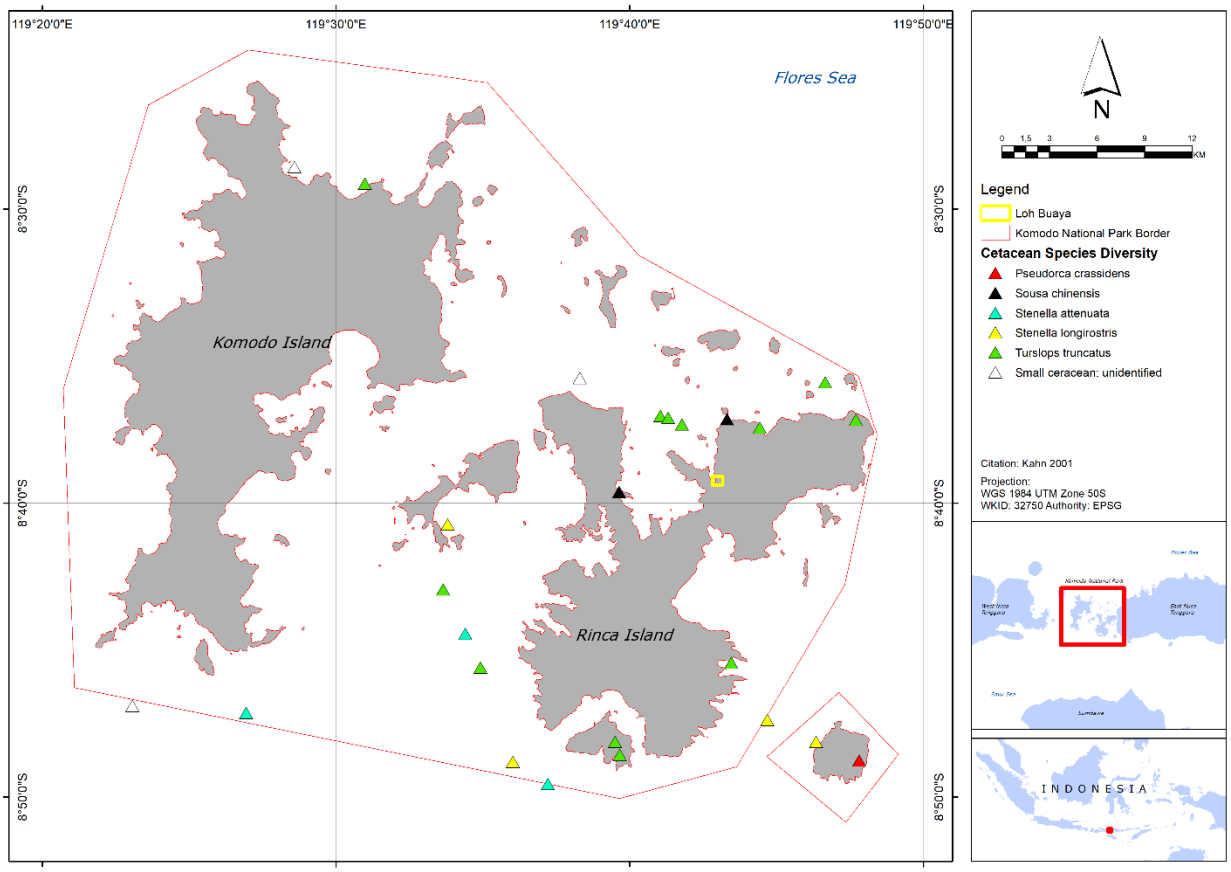

Figure 3. 17. Reported sightings of cetacean diversity in KNP during the survey in 2001 (Kahn 2001)

Table 3. 7. The impact of infrastructure development on marine mammals and its mitigation measures

Impacts	**Mitigation measures**
Minimal disruption to the behavior and local abundance of coastal dolphins Boats sailing to Loh Buaya can cause disturbances that may impact the behaviour and local abundance of dolphins (Constantine et al. 2004; Lusseau 2004; Bejder et al. 2006). However, this risk is already existing some boats are operating in the area. The impact of the boats on marine mammals will be minimized through implementation of certain guidelines as part of the national park management (e.g. speed limit at critical areas of dolphins) (Lusseau 2006; Guerra & Dawson 2016).	● *Strengthen the daily wildlife monitoring in the Loh Buaya valley, especially in/around the infrastructure, as part of the Resort Based Management* As explained above. In addition, during every 10-day, at least one day, rangers will do sea patrol. Currently, this is limited to monitor and prevent fish bombing and other illegal activities with anecdotal reports on marine fauna. In the future, this system must be strengthened by incorporating the regular monitoring and reporting of key marine fauna (e.g. cetacean, manta rays, and seaturtles). ● *Develop and implement operating guidelines for tourist-vessels*

Impacts	Mitigation measures
	Komodo NP must conduct or support research on carrying capacity and cetacean habitat as baselines to develop guidelines for tourist-vessels. This guideline should include a limit on vessel speed at critical habitat areas (Ng & Leung 2003; Hashim & Jaaman 2011) and number of boats able to operate at a certain time. This guideline will help minimize the potential impact posed by the high tourism activities (Lusseau & Higham 2004; Mustika et al. 2015; Guerra & Dawson 2016).

f) Sea Turtles

Two species of seaturtles are found in Komodo National Park, 1) Hawksbill sea turtle (*Eretmochelys imbricata*) and 2) Green seaturtle (*Chelonia mydas*) (Personal communication with Mr. Muhammad Ikbal Putera, Komodo National Park). None of the species use the coastal area of Loh Buaya valley close to the project site as nesting ground because the area consists of mudflats and mangroves (Personal communication with Loh Buaya resort park ranger, Mr. Arfandi) (see Figure 3.3). This area is also very unlikely to be used as a feeding site because of the absence of coral reefs and seagrasses (see Figure 3.2). The main substrate of the seafloor is rock, sand, and mud (LIPI 2019).

3.3.2. Impact on Integrity and mitigation measures

3.3.2.1. Impact on Integrity

The Operational Guidelines of the UNESCO World Heritage Convention in 2019 define integrity as "a measure of the wholeness and intactness of the natural and/or cultural heritage and its attributes. Khalaf (2020) further noted that to examine the conditions of integrity, therefore requires assessing the extent to which the property:

(a) includes all elements necessary to express its Outstanding Universal Value;
(b) is of adequate size to ensure the complete representation of the features and processes which convey the property's significance;
(c) suffers from adverse effects of development and/or neglect.

In examining the impact of project to the integrity of the OUV, we analyses key ecosystem and distribution of OUV in its ecosystem. There are only two key ecosystems in Loh Buaya, the mangrove ecosystem and savanna ecosystem. Mangrove ecosystem are located in the coastal area of Loh Buaya, mostly in the entrance of Loh Buaya Valley. As mentioned in chapter 3. 1, there will be no mangrove tree felling for the project except for pruning of less than 10 mangrove trees. The elevated pathway from the jetty to the entrance of the valley will be using old pathway previously used to enter the valley. Therefor it will remain intact to ensure integrity of the mangrove ecosystem.

The other ecosystem that will be impacted by the project is savanna ecosystem. The savanna ecosystem in Rinca is estimated at 11,034.75 ha. The project will build facilities in the savanna ecosystem with estimated surface of 3,136. 78 m2 (0.314 ha) or 0.028% from the total savanna ecosystem in Rinca island. Most of the facilities will be built on stilts (i.e. elevated), thus minimizing impact of the project on the integrity of the ecosystem. It means that the project will not create any ecological barrier, fragmentation and isolation of the matrix habitat.

Species distributed in mangrove or savanna ecosystem, as well using the habitat for breeding or daily behavior are mostly Komodo dragon and terrestrial mammals. Although there are 30 species of birds residing in the

project area, most of the species are widely distributed and common in habitat with human presence. Therefore, the impact of the project to the integrity of the habitat of birds are deemed negligible.

Since project are mostly occurred on land, as mentioned in 3.2, the impact of the project to the marine life is considered minimal, therefor the integrity of the coastal ecosystem with its marine life is considered not impacted.

a. Komodo dragon

The distribution of Komodo dragon in Rinca are widespread although some are concentrated on several areas i.e. Loh Buaya and Loh Baru (Figure 3.18). As mentioned in the previous chapter 3.2, the number of Komodo dragon that will be impacted by the project is low and mostly animal that has been exposed to human visit for years.

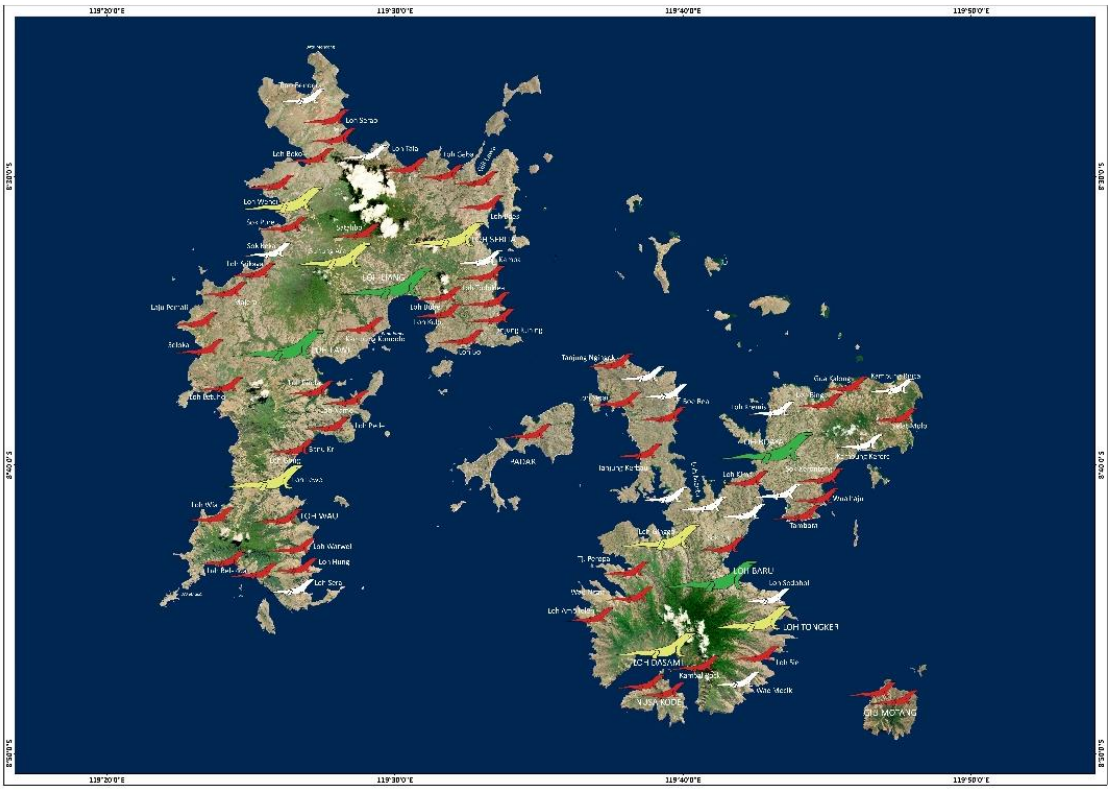

Figure 3. 18. The distribution of Komodo dragon in 4 islands of Komodo National Park (including Rinca island where the project is). The color of the komodo sketch refers to population estimation. Green = more than 50 animals, light green = 25 to 50 animals, red = less than 25, white = present but population unknown (source Komodo National and KSP monitoring).

Only a small number of Komodo dragons have nest near the Loh Buaya valley, and mostly in the upland forest outside the project area. Moreover the closest active mound nest of Orange-footed scrub fowl (Megapodius reinwardt) is about 324 m from the center of the project. Meanwhile the closets active mound nest of Komodo to the center of project area is about 440 m (Figure 3.19). Therefore, no breeding habitat will be impacted.

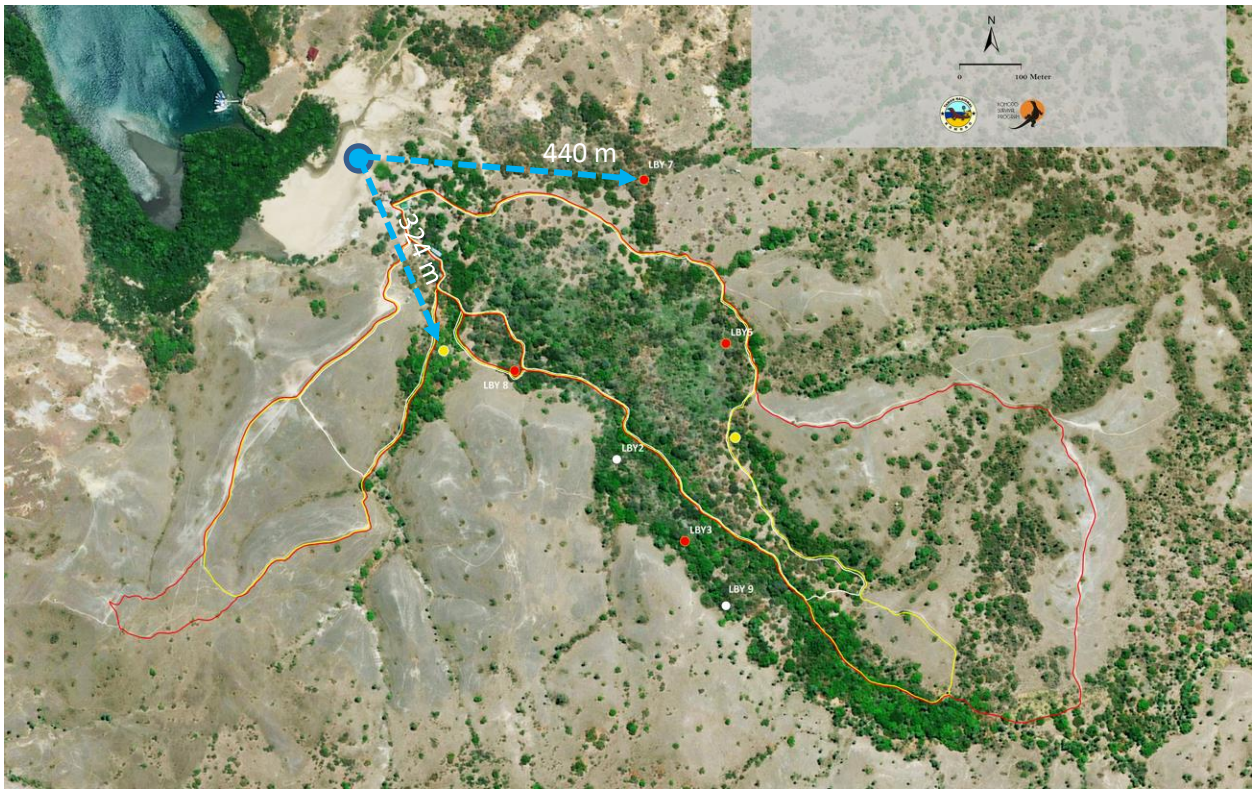

Figure 3. 19. Nest of Orange-footed scrub fowl (Megapodius reinwardt) and Komodo dragon near the project (Blue dot: Center of the project position, Red line: Long track trail, Yellow line: Medium track trail, White line: Short track trail, Yellow dot: Active mound nest of M. reinwardt, Red dot: Active mound nest of Komodo dragon, White dot: In-active mound nest of Komodo dragon) (Source: Komodo National and KSP monitoring report 2021).

b) Terrestrial mammals

From 7 species found in Rinca Island (see chapter 3.2), only four species have ever been observed in the project area which is Timor deer, wild boar, water buffalo and long-tailed macaque. These species are distributed quite widely in Rinca (see Figure 4) except for water buffalo and wild horses which is mostly distributed in the savanna ecosystem. Given that the size of suitable habitat for these species are vast compared to the size of the project, there is no doubt that the integrity of the habitat needed for these species is not impacted by the project.

3.3.2.2. Mitigation measures

Based on the analysis, most of the impact are negligible or minimal. However, we recommend several measures to ensure the integrity of the ecosystem for Komodo dragon and terrestrial mammals:

a. Komodo dragon

Table 3. 8. Impact on Komodo dragon habitat and its mitigation measure

Impacts	**Mitigation measures**
• *Negligible impact on the habitat of Komodo Dragon* • *The project neither create fragmentation nor isolation of habitat, since the infrastructure is raised to 2 meter (elevated)* From a terrestrial biodiversity asset quality perspective, the vegetation composition of the Loh Buaya is dominated by	• *Develop the new facilities only on and around the existing infrastructure in Loh Buaya valley* The location and position of the facilities have been discussed with the National Park Authority to prevent fragmentation and any

Impacts	Mitigation measures
savannah grassland, a large salt pan (*sawah garam*) and a small proportion of deciduous and riparian forest. Thus with this vegetation composition (i.e. predominantly open and semi-arid) the valley is not considered a high-quality habitat for Komodo dragons compared to other valleys in the Komodo National Park. As it stands, this poorer habitat quality explains why Loh Buaya demonstrates lower Komodo dragon and ungulate prey abundance relative to the other areas within the national park (e.g. Loh Liang the other ecotourism area). Although by happenstance, if construction is to take place in Komodo National Park, then using Loh Buaya is arguably environmentally sound due to the intrinsically low habitat quality and reduced environmental assets present within this locality. The new buildings may pose some temporary disruption to feeding behavior and activities (since some of the prey species might move) However, this impact is only temporary and minimal, as the prey and Komodo dragons are expected to move back once the construction has been finalized (See EMP and below 'impact on terrestrial mammals). Komodo dragons associated with human modified landscapes, such as in Loh Buaya, are generally larger, have better body condition, indicating that there is no evidence of detrimental effects of the presence of infrastructure on their feeding behavior (Purwandana et al. 2014; Ardiantiono et al. 2018). The inevitable cutting of few trees may probably reduce the habitat availability of juvenile Komodo dragons that rely on the presence of large trees for shelter and food. However, this potential loss is considered negligible given the low number of trees that will be cut (5 trees), and the high number of other trees as alternatives in the Loh Buaya valley (see Chapter 3)	intrusion to Komodo dragons and other wildlife habitat. The old buildings will be destroyed and replaced by the new facilities, and only one extra new building will be constructed on top of the salt pan (see Chapter 3).

b. Terrestrial mammals

Table 3. 9. Impact on Terrestrial mammals habitat and its mitigation measure

Impacts	Mitigation measures
● *Minimal reduction to the quantity and quality of the terrestrial mammal habitat* ● *The project neither create fragmentation nor isolation of habitat, since the infrastructure is raised to 2 meter (elevated)* The grassland-woodland savannah in Loh Buaya provides food resources (Garini & Imron 2014) and hiding and mating places for the mammals. However, the infrastructure development area exhibits an extremely small footprint (0.013 km^2) compared to the total local Loh Buaya valley area (5 km^2) or that of Rinca Island's area (204.8 km^2). This means the amount of habitat (quantity) potentially impacted is negligible. Moreover, the majority of the facilities will be built on the existing infrastructure, the ones newly built and the construction activities will be mostly limited to the salt pan areas (*sawah garam*), avoiding the important habitat for the terrestrial mammal species, mainly Timor deer and water buffalo. Trees surrounding the project are often used by the deer during the day as shelters from the bright and burning sunlight, and one mud hole is in the area often used by the buffalo.	● *Develop the new facilities only on and around the existing infrastructure in Loh Buaya valley* The location and position of these facilities have been discussed at length with the national park authority to prevent any intrusion to Komodo dragons and other wildlife habitat.

3.3.3. Impact on the protection and management of the park and mitigation measures

3.3.3.1. Impact tourism

Positive impact due to Increasing Multiplier Effect on Local Economy

*During the period 1995-1996, t*ourists spent approximately $0.6 to $1.6 million ($1.1. million ±43%) in the local communities in and adjacent to Komodo National Park. The money was for the majority spent in Labuan Bajo (80%), Sape (19%), and Kampung Komodo (1%) (Walpole and Goodwin, 2000). Each tourist spent approximately $75 to $106 ($90.70 ±$15.70) to Labuan Bajo during their visit (Goodwin and Walpole, 2000). A multiplier effect study conducted by (Wahyuti et al., 2013: 52) stated that the amount of tourist spending in 2013 had increased to $414.93 per person (1 US$= Rp12,000). The money was spent on transportation and recreation (28%), accommodation (35%), restaurant and cafeteria (22%), and shopping in retailers and or souvenir shops (16%).

Komodo National Park generates Non-Tax State Revenues up to US$ 367.79 (Rp4,413,567; 1 US$ = Rp12,000) in 2013 and those revenues had sparked multiplier effect towards the local communities' economy in Labuan Bajo and its surrounding up to US$ 22,502,006.59 (Rp270,024,000,000; 1 US$ = Rp12,000). A follow up study

concluded that the Non-Tax State Revenues generated by the Komodo National Park had significantly multiplied toward the local communities' economy up to US$33,910.34 (Rp458,400,000,000; 1 US$ = Rp13,518) in 2016 (Shinta, 2017) and up to US$37,132.71 (Rp38,000,813,500; 1US$ = Rp14,362) in 2019 (Balai Taman Nasional Komodo, 2019).

The infrastructure improvement in Loh Buaya would enhance the site's tourism carrying capacity which will allow it to have more visitors in greater numbers yet sustainably managed. The presence of tourists visiting Loh Buaya would positively contribute toward the multiplier effect in the West Manggarai Regency, specifically improving the local economy of the people living in Labuan Bajo and its neighboring towns or villages. The local community would have a better chance to improve their livelihood through the implementation of sustainable tourism design in Loh Buaya.

Positive impact of Expanding Tourist Motivations for Visiting Komodo National Park

Komodo National Park as the leading ecotourism destination in Indonesia attracts many tourists' from around the world. The number of tourists visiting Komodo National Park had been gradually increasing during the past ten years; 44,492 (2010), 48,010 (2011), 49,982 (2012), 63,801 (2013), 80,626 (2014), 95,410 (2015), 107,711 (2016), 125,069 (2017), 176,834 (2018), 221,703 (2019) (Putera, 2019; Balai Taman Nasional Komodo, 2020). Considering the ever-increased trend, Komodo National Park management needs to put forward serious efforts in mitigating potential risks of having too many visitors coming to the site.

Putera (2019) mentioned that there were at least five push factors that motivated tourists to visit Komodo National Park: 'learning and excitement' (4.0), 'exploration' (3.9), 'escape and privacy' (2.6), 'tension release' (2.5), and 'social recognition' (2.3). The motivations differ from one another and were influenced by socio-demographic variables, one of which was the country of origin (Putera, 2019). Tourists coming from Europe, North and South America are more motivated based on 'learning and excitement' as well as 'exploration' compared to the Asian tourists who were moved by the 'social recognition' (Putera, 2019). Tourists coming from Europe, North and South America would be more interested in having a longer trekking option, while those coming from Asia would prefer a shorter option and seek an opportunity to get a photo on a specific spot within the park. The research shows a spectrum of tourist motivations that vary from time to time emphasizing the urgency for the managers to understand tourist behavior and to accommodate the information into an applicable action.

The proposed project in Loh Buaya would serve the diverse tourist motivations for visiting Komodo National Park. The project will be able to accommodate different market segmentations, and ensure that the visits to the site will be more sustainable, while at the same time able to satisfy the l needs of the tourists. For instance, the construction of an improved museum and interpretation boards will accommodate the needs of the tourist that wish to learn about the park, as explained in Putera (2019). The information centre will also highlight KNP's four symbols of significance, i.e. World Heritage, Biosphere Reserve, the New 7 Wonders of Nature, and the Komodo National Park. The information centre will allow park staff and tourist guides to raise the awareness of the property's Outstanding Universal Values to a broader audience. More importantly, the project will prevent the tourists from directly interacting with the wildlife as some previously did.

Negative impact of visitors due to the change of Komodo behavior

The high interest of Komodo dragon as part of the attraction of Rinca and Komodo Island has affected the behavior of Komodo dragon. Komodo dragons in both terrestrial tourism zone, i.e. Loh Buaya (in Rinca) and Loh Liang (in Komodo Island) has shown the tendency to not afraid of humans (Ardiationo et al. 2018; Fauzia

2020). Lots of tourist use these change of behavior to get closer to the animal for selfies leading to the potential of conflicts.

Negative impact on large number of visitor

There were at least 400 visitors on average that visited Loh Buaya in 2016. The number surely grew more considering Loh Buaya as the nearest location to see the Komodo dragons from the main town, Labuan Bajo. Loh Buaya became one of the most visited tourist destinations in the park and interaction among human and wildlife sometimes collided with the previous design. In 2030, the number of Visitors to KNP are estimated to reach more than 381,000 visitors. The large number of visitors has the potential to disturb the habitat and also visitor safety, if it is beyond the carrying capacity of the National Park staff to manage it. In addition, the large number of visitors will cause waste problems, which if not managed have the potential to damage the beauty and ecosystem of KNP.

Potential introduction of alien species

One potential impact is the possibility of introduction of alien species which might cause population decline of species of Outstanding Universal Value. There is a concern that the the Asian Black-Spined Toad (*Duttaphrynus melanostictus*) might become invasive in the Komodo National Park and potentially cause negative impacts on the population of Komodo dragon (Reilly et al. 2017) due to the increasing mobility of people from mainland. The toads are abundant in Sape but currenty absent in Labuan Bajo. Although there is no evidence yet on the occurrence of *D. melanostictus* on Rinca, other species that thrive in human habituation are found in abundance, such as *Fejervarya cancrivora* (Kennedi et al. 2020).

3.3.3.2. Mitigation measure

In response to the negative impact of visitors, we suggested mitigation measure as presented in Table 3.10

Table 3. 10. Impact of visitors and its mitigation measure

Impact	Mitigation measure
Change of the Komodo behavior	*Avoid the close contact between visitor & Komodo* • The interaction between visitors and Komodo can be minimize by adding physically barrier • Elevated pathway as proposed by the project also can avoid/minimize direct contact with the Komodo
Visitor safety and Habitat disturbance	*Standard operating procedure of visitor management should be developed, related to :* • There should be a maximum number/quota of visitor per day, based on the infrastructure and staff capacity • Maximum number visitor of trekking group should be formulized based on the capacity of tour guide • Arrange a schedule of trekking • Impose a maximum time for trekking. It seems, the KNP has been preparing a draft of the Decree of Head of KNP on Carrying capacity of visitor at Loh Buaya Resort, KNP on April 2021.
Potentially negative impact of waste	Standard operating procedure on waste management should develop, in which is all inorganic waste should manage outside of the national park.

Potential introduction of alien species	● Install warning boards to enable people to identify the toad and report any suspected occurrences to Komodo National Park officials for any suspected presence ● Work together with tour agents and boat operators to monitor and inspect ships that dock in the Komodo National Park area to ensure that they do not accidently bring the species from outside the national Park. The inspection should be conducted by the KNP, when the ship arrives at the port.

Chapter IV Other environmental (Non OUV) and social impacts of the development project

4.1. Environmental impact on Herpetofauna (Non OUV)

Herpetofauna (other than Komodo dragons)

Loh Buaya has two species of amphibians and 15 species of reptiles. It has the highest number of herpetofauna richness compared to other location in Komodo National Park Aside from the Komodo dragon, there are two other endemic species of reptiles: *Dendrelaphis inornatus* and *Malayopython timoriensis* (Kennedi 2018) (Table 4.1). Loh Buaya has at least five species of endemic reptiles of East Nusa Tenggara/NTT (1 species of gecko, 2 species of skinks and 2 species of snake) one of which are protected species, the Timor reticulated snake *Malayophyton timoriensis*.

Table 4. 1. Amphibian and reptile species observed in the proposed construction site.

Species name	Common name	IUCN status	Protection status
Amphibian			
Fejervarya cancrivora	Crab eating frog	LC	Not-protected
Kaloula baleata	Smooth-fingered narrow-mouthed frog	LC	Not-protected
Reptiles			
Geckoes & Skink			
Gekko gecko	Tokay Gecko	LC	Not-protected
Hemidactylus frenatus	Common-house Gecko	LC	Not-protected
Hemidactylus platyurus	Flat-tailed House Gecko	LC	Not-protected
Cyrtodactylus darmandvillei[E]	Darmandville bow-fingered gecko	NA	Not-protected
Sphenomorphus melanopogon	Lesser Sunda Dark-Throated Skink	LC	Not-protected
Sphenomorphus striolatus[E]	Flores Banded Skink	NA	Not-protected
Cryptoblepharus renschi	Snake-eyed Skink	LC	Not-protected
Emoia similis[E]	Dunn's Emo Skink	NA	Not-protected
Snake		LC	Not-protected
Dendrelaphis inornatus[E]	Lesser Sunda Bronze Back	NA	Not-protected
Lycodon capucinus	Oriental Wolf Snake	LC	Not-protected

Species name	Common name	IUCN status	Protection status
Malayopython timoriensis[E,II,]	Timor python	VU	Protected
Trimeresurus insularis	White-lipped island pit viper	NA	Not-protected
Virgotyphlops braminus	Brahminy blind snake	LC	Not-protected
Monitor Lizard		LC	Not-protected
Varanus komodoensis[E, I]	Komodo dragon	VU	Protected
Varanus salvator[II]	Asia Water Monitor	LC	Not-protected

[E]Endemic of Lesser Sunda Island, I and II refers to CITES Appendix 1 and II

Minimal disturbance to herpetofauna species

Herpetofauna species react differently to disturbance, with some being adapters and some being sensitive, and some avoiding disturbance temporarily (Hamer & Mcdonnell 2010). Loh Buaya has at least five species of endemic reptiles (1 species of gecko, 2 species of skinks and 2 species of snake) one of which has protected status, the Timor reticulated snake *Malayophyton timoriensis*. In addition, Komodo National is home to the green and blue variant of white-lipped island pit viper (*Trimeresurus insularis*) (Uetz et al. 2020). Most reptiles are cryptic in nature, especially small bodied reptiles and snakes. A study in Australia showed that snakes have the ability to evade people and to escape detection (Whitaker & Shine 1999). Snakes in urban areas risk detection and are killed by humans (Shine & Koenig 2001; Yue et al. 2019). In Komodo National Park, local communities at Rinca and Komodo reported 3 species of snake considered as dangerous: *Daboia siamensis*, *Naja sputatrix*, and *Trimeresurus insularis*. The interactions between the community and dangerous reptiles in Komodo and Rinca villages can be categorized as negative interactions in the form of evictions and hitting the animal with wood (Ramadhani et al. 2018). However, this interaction doesn't happen in Loh Buaya, instead, snakes become one of the main tourist attractions with professional rangers and nature guides showing them to herpetofauna enthusiasts (Personal communication with the head of Loh Buaya resort).

The development at Loh Buaya will have negligent effect on the occurrence of reptiles in the area. While habitat change is one of the main factors for global reptiles' – including snake population decline (Shanahan et al. 2000; Reading et al. 2010; Todd et al. 2010), the project will not have a major impact on the habitat . Research has shown that urbanization and human disturbance might change behavior of amphibians and reptiles, with reptiles more negatively impacted than frogs (Hamer & Mcdonnell 2010). In certain species of snake, increasing exposure to human disturbance has caused snakes to become less visible (Parent & Weatherhead 2000). However, other research has shown that restoration of habitat will benefit the population of reptiles (Filippi 2019; Mizsei et al. 2020). Thus, although the construction may pose a risk to sensitive species, such as the Timor python and White-lipped island pit viper, causing them to move out temporarily but not detrimental to their survival (Parent & Weatherhead 2000). It is expected that the population will rebound after construction has completed and habitat restored to its former quality.

4.2. Mitigation Measures

In response to disturbance of herpetofauna we propose a mitigation measure below.

Table 4. 2. The impact of infrastructure development on herpetofauna.

Impacts	**Mitigation measures**
Minimal disturbance to herpetofauna species	• Conduct periodic monitoring of herpetofauna species to detect the possibility of toad in the area and presence of snakes (notably Timor python and White-lipped island pit viper) as part of the Resort Based Management

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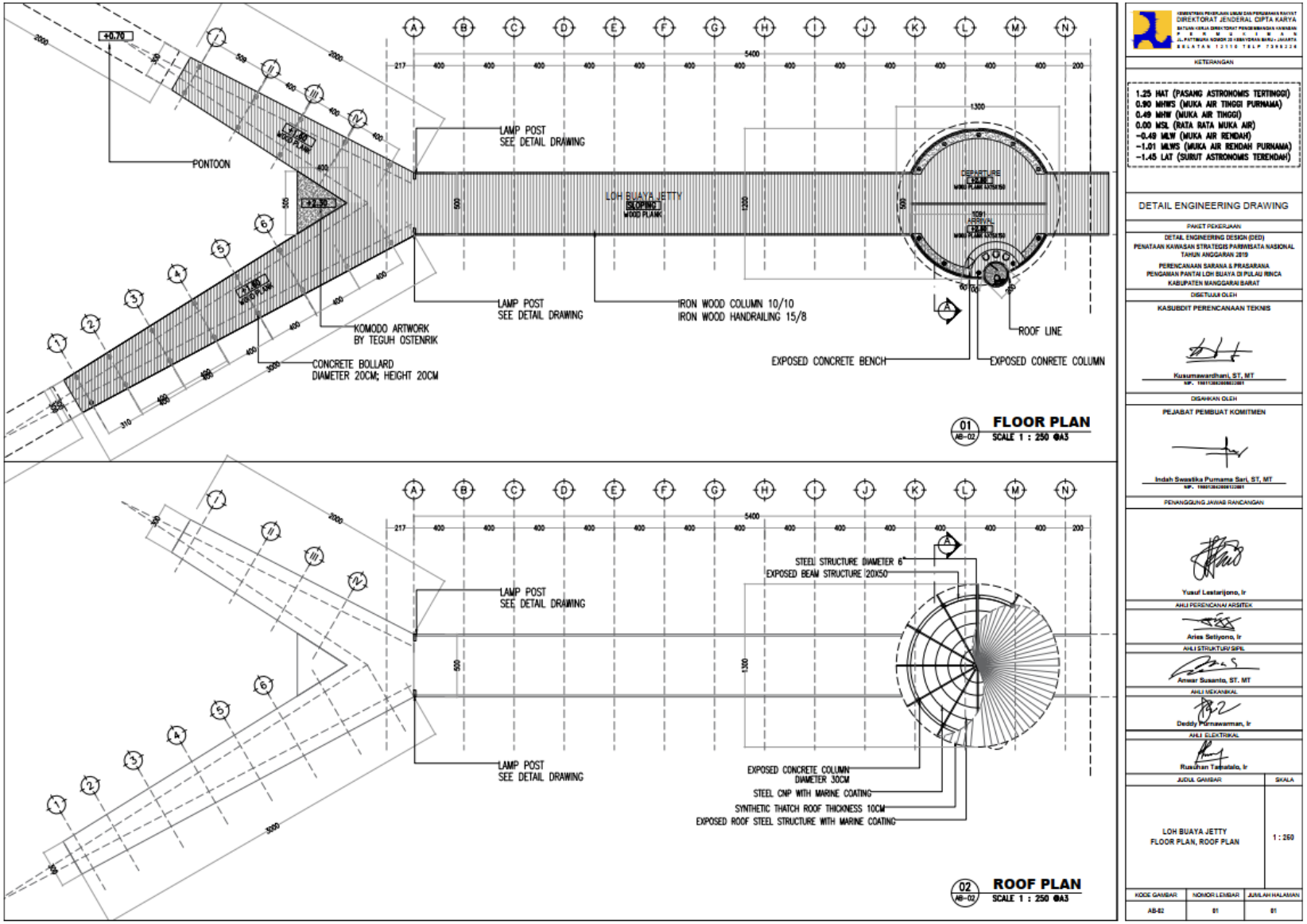
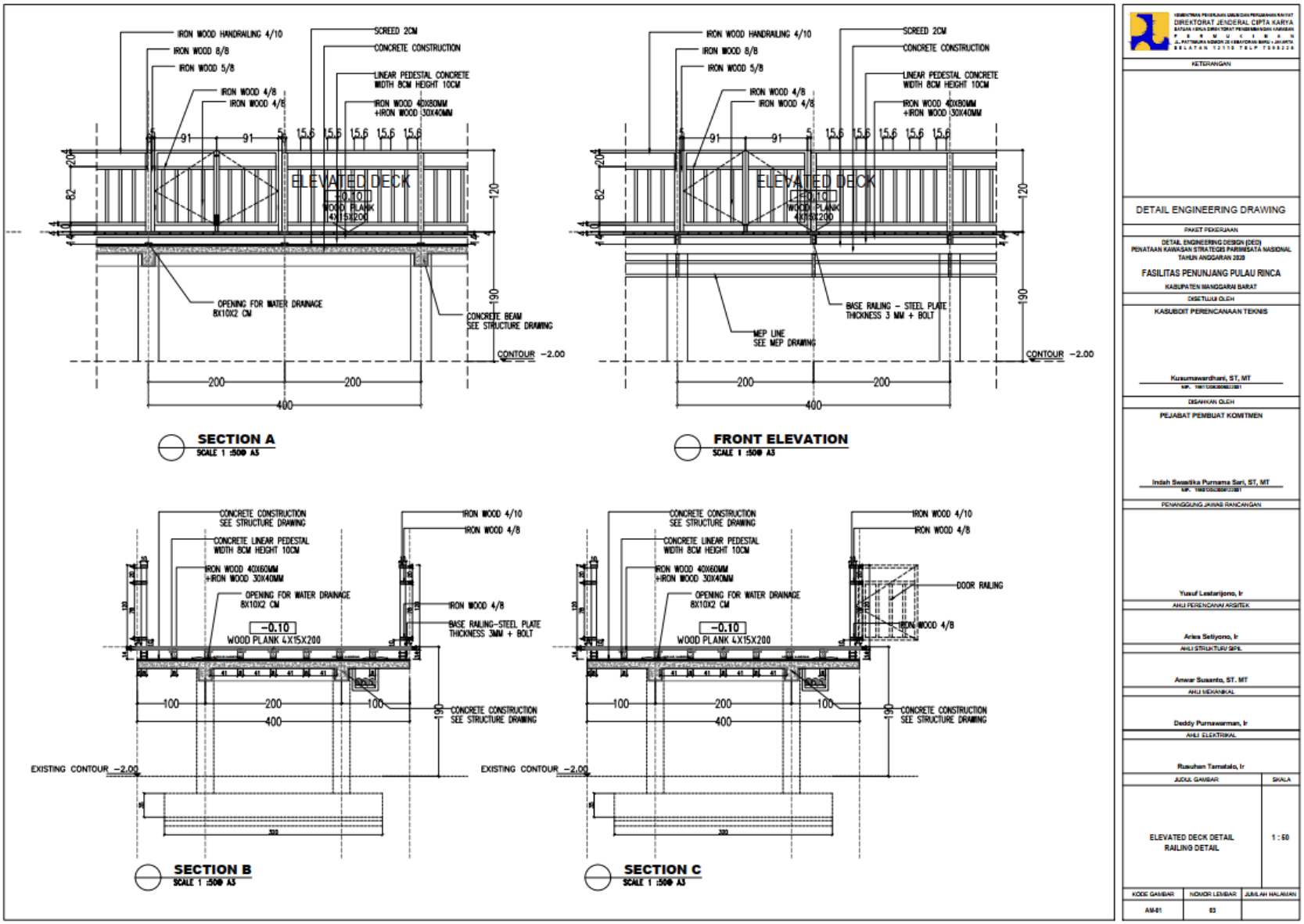
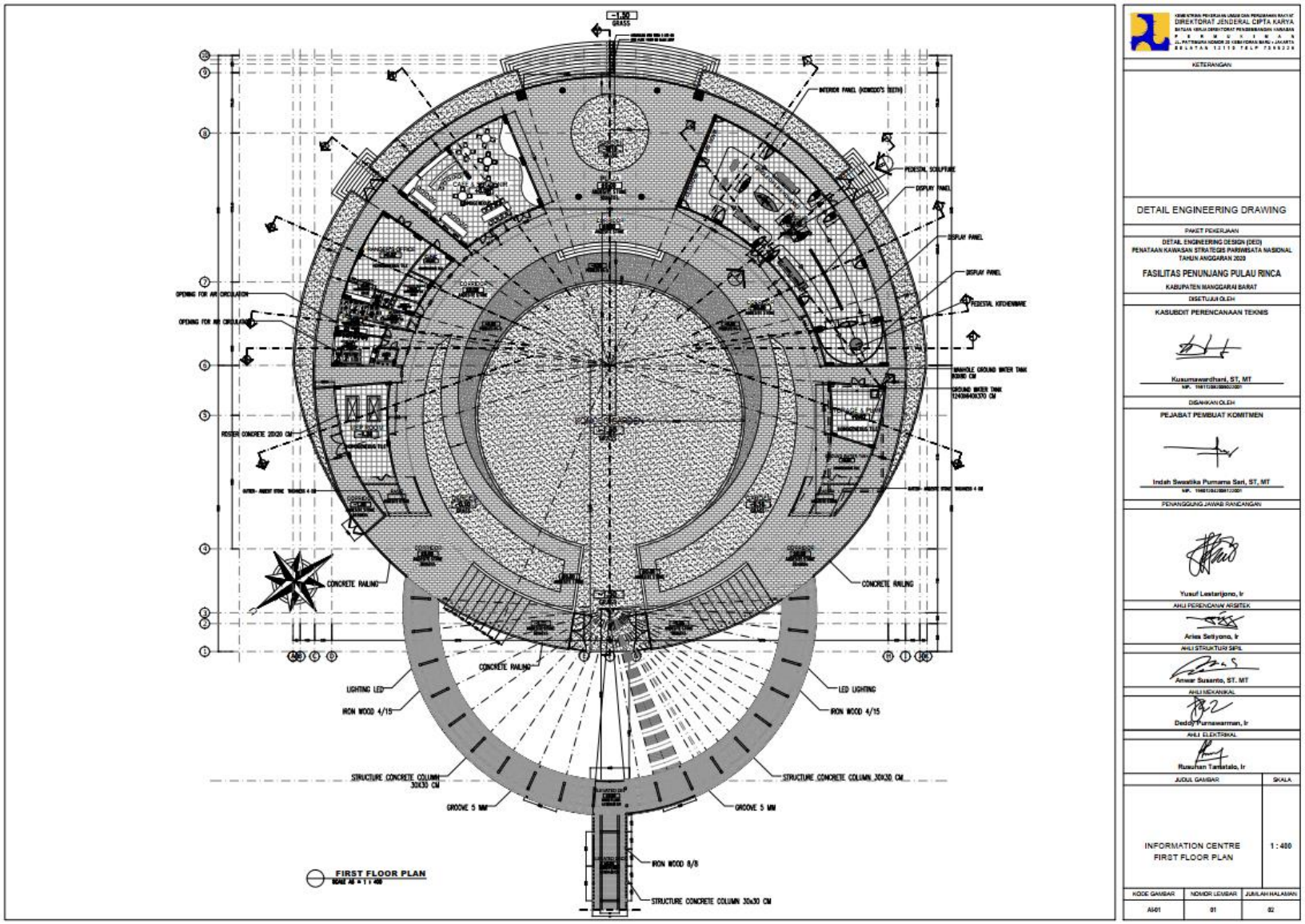
Attachment 1. Jetty and Visitor Waiting Room Plan



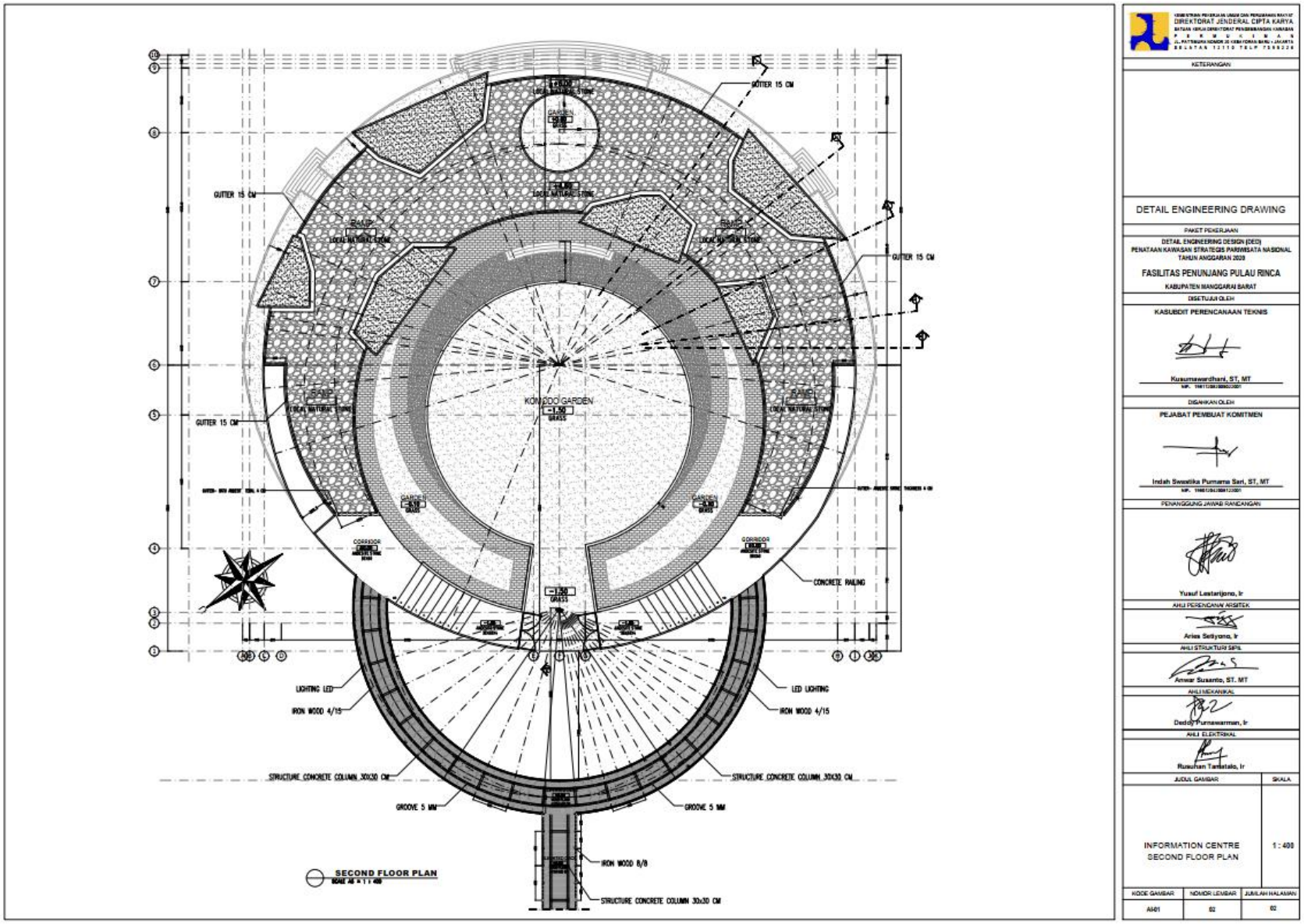
Attachment 2. Elevated Pathway Plan



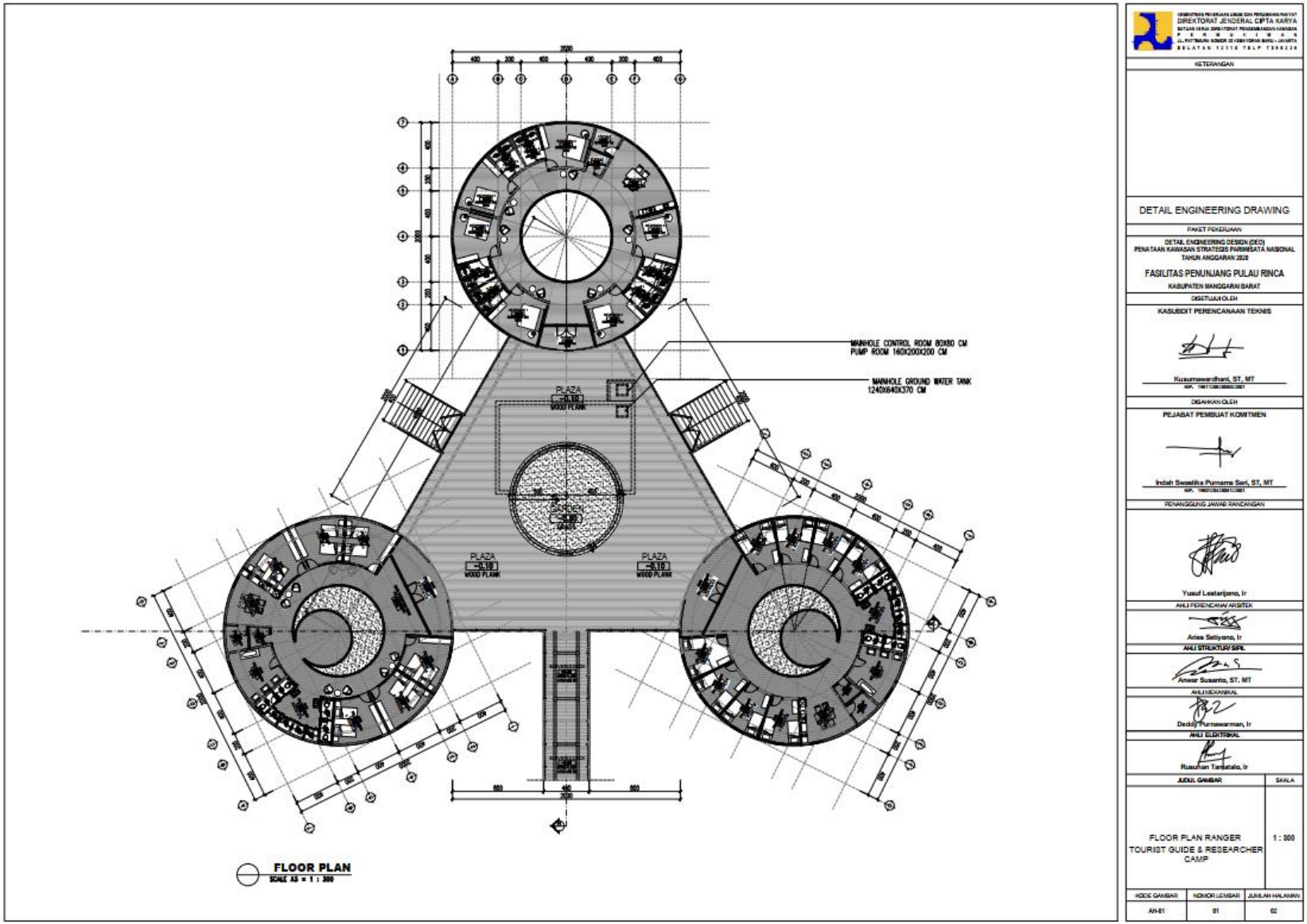
Attachment 3. First Floor of Information Center Plan



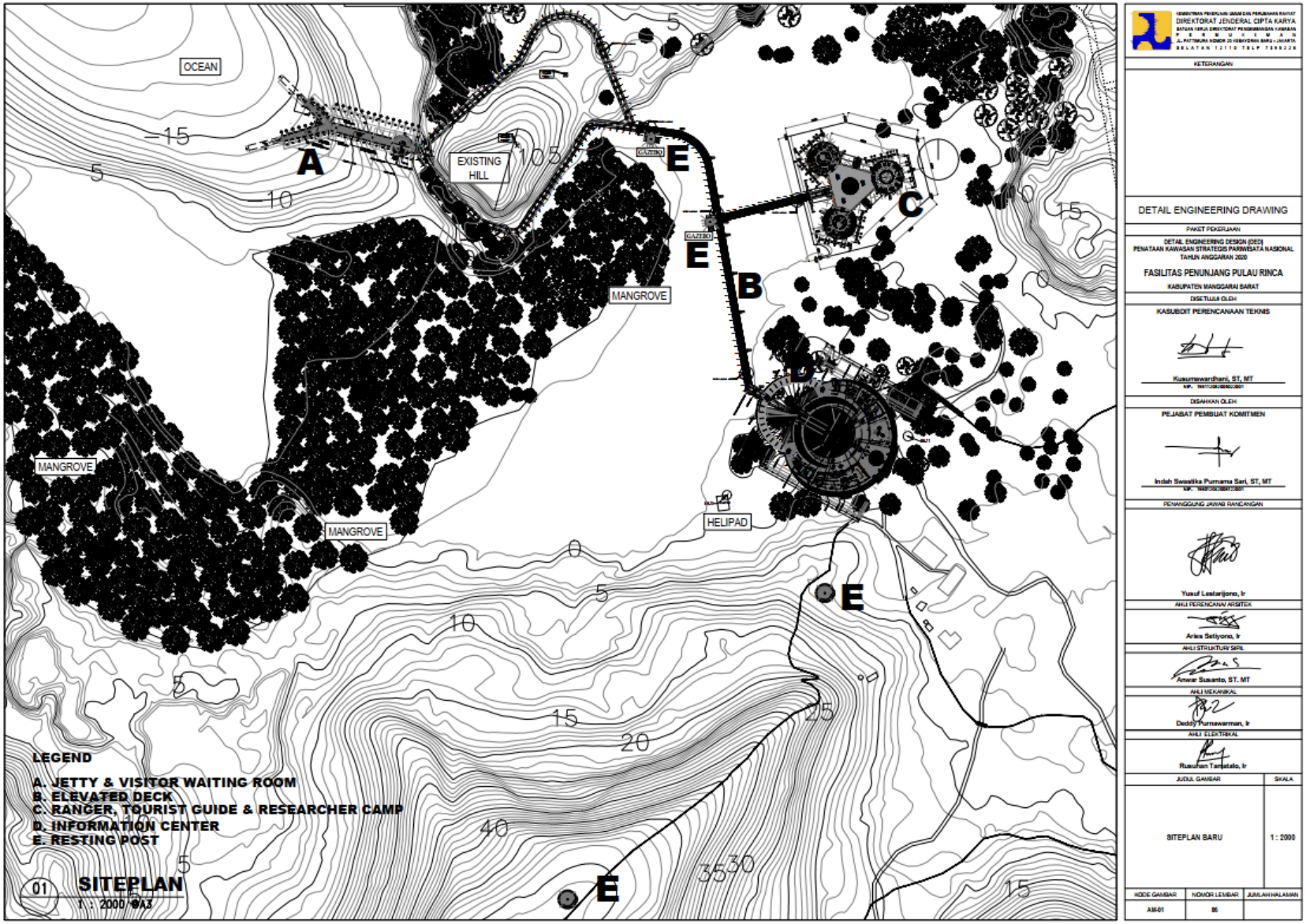
Attachment 4. Secon Floor of Information Center Plan



Attachmen 5. Complex of Ranger, Tour Guide & Researcher Plan



Attachment 6. Site Plan of the Project



MINISTRY OF PUBLIC WORKS AND HOUSING
DIRECTORATE GENERAL OF HUMAN SETTLEMENTS

MINISTRY OF ENVIRONMENT AND FORESTRY
DIRECTORATE GENERAL OF NATURAL RESOURCES AND ECOSYSTEM SERVICES

EMP

ENVIRONMENTAL MANAGEMENT PLAN

TOURISM INFRASTRUCTURE RENOVATION AND DEVELOPMENT IN LOH BUAYA, RINCA ISLAND KOMODO NATIONAL PARK

LABUAN BAJO
NATIONAL TOURISM STRATEGIC AREA

ENVIRONMENTAL MANAGEMENT PLAN (EMP)
OF TOURISM INFRASTRUCTURE RENOVATION AND DEVELOPMENT
IN LOH BUAYA, RINCA ISLAND

KOMODO NATIONAL PARK

MINISTRY OF PUBLIC WORKS AND HOUSING
REPUBLIC OF INDONESIA

2022

PREFACE

Komodo National Park (KNP) consists of Komodo island, Rinca island, Padar island, Gili Motang Island and other several small islands. The KNP is located in West Manggarai District, East Nusa Tenggara Province. The Park was designated a National Park in 1980 and later in 1991, UNESCO designated KNP together with Waewull Nature reserve, Mbeliling and Ngorang Protected areas as a World Heritage Site.

Currently, the Government is developing an Integrated Tourism Master Plan in Labuan Bajo and Flores which includes Rinca Island, in the form of improving infrastructure facilities in Loh Buaya. The Government of Indonesia (GoI) has a plan to renovate and build facilities and infrastructure to improve the quality of KNP management with goal to guarantee the safety and comfort of visitors, and to mitigate any potential negative impacts on the Outstanding Universal Value (OUV) of the property. This plan is in accordance with the Komodo National Park Medium Term Management Plan 2016-2025 which is based on the Komodo National Park Management Master Plan 2000-2025. The development of tourism is expected to contribute to the development of the regional economy.

This Environmental Management Plan (EMP) report is prepared to fulfill the obligations of the state parties in accordance with the operational guidelines of UNESCO, in which the States Parties shall submit specific reports and impact studies each time exceptional circumstances occur or work is undertaken which may have an impact on the Outstanding Universal Value of the property or its state of conservation.

The EMP report was prepared by Ministry of Public Works and Housing (*Kementrian Pekerjaan Umum dan Perumahan Rakyat*/PUPR) as the project implementer in coordination with Komodo National Park, Ministry of Environment & Forestry under the supervision of the West Manggarai Environmental Service, East Nusa Tenggara Province. The EMP aims to monitor and mitigate negative impacts on the OUV that are caused during the three main project phases, i.e. pre-development/construction, development/construction and post-development/ construction. The writing structures of the EMP report refers to the Regulation of the State Minister for the Environment of the Republic of Indonesia No. 16 of 2012 concerning guidelines for the preparation of environmental documents, with a slight modification to focus more on the OUV.

The preparation has been designed by an independent consultant from various fields of science, technical staff of PUPR and then refined by several experts in the field of Landscape Ecology from IPB University (Bogor Agricultural University), Ecologist from the World Conservation Society (WCS) Indonesia Program and the NGO-Komodo Survival Program.

Jakarta, January 2022

Ministry of Public Works and Housing

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GLOSSARY

BKSDA (*Balai Konservasi Sumberdaya Alam*)	:	Natural Resources Conservation Agency
BPOLBF (*Badan Pelaksana Otorita Labuhan Bajo dan Flores*)	:	Authority Implementation Body of Labuhan Bajo & Flores
BPS (*Badan Pusat Statistik*)	:	Indonesia's Central Statistics Agency
CPMU P3TB *(Unit Manajemen Proyek Pusat- Program Pengembangan Pariwisata Terpadu dan Berkelanjutan*)	:	Central Project Management Unit- Integrated and Sustainable Tourism Development Program
Direktorat Jenderal CK (*Cipta Karya*)	:	Directorate General of Human Settlements
Direktorat Jenderal SDA (*Sumber Daya Air*)	:	Directorate General of Water Resource
Ditjen KSDAE (Direktorat Jenderal Konservasi Sumber Daya Alam & Ekosistem)	:	Ditjen KSDAE: The Directorate General of Natural Resources and Ecosystem Conservation
EMP	:	Environmental Management Plan
GEE	:	Google Earth Engine
H-beams	:	shaped like an *H letter*. *H-beam* is a structural *beam* made of rolled *steel*
Herpetofauna	:	Group of reptile & amphibians
HSPD	:	Hydraulic Static Pile Driver
IUCN	:	International Union for Conservation of Nature
KNP/ TNK (*Taman Nasional Komodo*)	:	Komodo National Park
KSDAE (*Konservasi Sumberdaya Alam dan Ekosistem*)	:	Nature Resource and Ecosystem Conservation
KSP	:	Komodo Survival Program
KSPN (*Kawasan Strategis Pariwisata Nasional*)	:	The National Tourism Strategic Area that includes Danau Toba, Borobudur, Lombok-Mandalika, Labuan Bajo and Manado-Likupang.
LCT	:	Landing Craft Tank
MAB	:	Man And Biosphere
NTT (*Nusa Tenggara Timur*)	:	East Nusa Tenggara
LIPI (*Lembaga Ilmu Pengetahuan Indonesia*)	:	Indonesian Institute of Sciences
OUV	:	Outstanding Universal Value
SPAM (*Sistem Penyediaan Air Minum*)	:	Drinking water supply system

PUPR (*Pekerjaan Umum dan Perumahan Rakyat*)	:	Public Works & Housing
RTRWK (*Rencana Tata Ruang Wilayah Kabupaten*)	:	Regional Land Use Planning
Sentinel-2A	:	Earth Observation mission from the Copernicus Programme that systematically acquires optical imagery at high spatial resolution (10 m to 60 m) over land and coastal waters
TPA (*Tempat Pembuangan Akhir*)	:	Final waste disposal
UAV	:	Unmanned Aerial Vehicle
UKL/UPL (*Upaya Pengelolaan Lingkungan/ Upaya Pemantauan Lingkungan*)	:	Environmental Management Plan/Environmental Monitoring Plan
UNEP-WCMC	:	United Nations Environment Program World Conservation Monitoring Centre
UNESCO	:	United Nations Educational Scientific and Cultural Organization
TNC	:	The Nature Conservancy
WCS	:	Wildlife Conservation Society
WF Beam	:	Wide Flange steel, a structural steel section on which the flanges are not tapered, but have equal thickness from the tip to the web and are at right angles at the web
WSS	:	Water Supply System
WRI	:	World Resources Institute

SUMMARY

I. Introduction

In 1991 Komodo National Park (KNP), Waewull Nature Reserve, and Mbeliling and Ngorang Protected Forest were inscribed as Komodo National Park World Heritage. The property is considered to meet two out of the four natural criteria of Outstanding Universal Value (OUV), including criterion (vii) – contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance, and criterion (x) – contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

The following values have been identified under criterion (vii) in the statement of OUV: (a) mangrove forest, (b) dryland forest (savanna, monsoon & quasi-mountain forest), (c) seagrass, (d) coral reefs, (e) white sandy beaches, and (f) beautiful scenery in the form of hilly landscapes with matrix in the form of savanna and monsoon forest patches in the valleys. Meanwhile, the values according to criteria (x) in the SOUV are: a) Komodo dragons, b) terrestrial mammals, c) birds, d) marine fauna and flora (non-mammals), e) marine mammals, f) sea turtles.

The KNP also fulfills the requirements for Integrity, and Protection and Management criteria as the KNP has an area large enough with various ecosystems able to support the ecological processes required for sustaining wildlife populations. The Komodo National Park is managed through a zoning system that was designed taking into account the level of vulnerability and importance of wildlife and ecological processes. The zoning consists of a Core Zone, Wilderness Zone, Marine Protected Zone, Use Zone, Traditional Local (Community) Use Zone, Traditional Pelagic Zone, and Special Zone. Infrastructure development in support of the park management is only allowed in the Use Zone. Meanwhile, there are only limited activities allowed in the Core Zone, Wilderness Zone and Protected Zone under a framework of very strict rules. The zoning system ensures that the integrity and intactness of the KNP is maintained over time. Furthermore, the national park authority carries out the protection, monitoring and management of the area adequately, thereby ensuring the protection of the property as World Heritage.

Currently, the Government is developing an Integrated Tourism Master Plan in Labuan Bajo and Flores which includes Rinca Island. This includes the improvement of infrastructure facilities in Loh Buaya. The Government of Indonesia (GoI) has a plan to renovate and build facilities and infrastructure to improve the quality of the KNP management with objective to guarantee the safety and comfort of visitors, and to mitigate any potential negative impacts of visitors on the OUV of the property. This plan is in accordance with the Komodo National Park Medium Term Management Plan 2016-2025 which is based on the Komodo National Park Management Master Plan 2000-2025. The development of tourism is expected to contribute to the development of the regional economy, improve the welfare of local communities and at the same time conserve the region's unique natural resources and biodiversity.

II. Project Plan: Location, Size and Duration

The renovation and construction activities, which have been carefully designed as not to cause any impact on the OUV of the property, are hereafter called "project". The project is located at Use Zone of Loh Buaya, Rinca's Island, Pasir Panjang Village administrative area, Komodo Sub-district, West Manggarai District, East Nusa Tenggara Province (*Desa Pasir Panjang, Kecamatan Komodo, Kabupaten Manggarai Barat, Provinsi Nusa* Tenggara Timur).

Loh Buaya has several park offices, including a Resort and Section office, as well as other facilities to support ecotourism activities such as Ticketing Office, Rangers Camp, two Cafés, Toilet, Guest House, Rangers Camp, Pantries, Generator House, Jetty, two Gazebos, Helipad, & Solar panels. The infrastructure is quite old and

some buildings are either in a damaged condition or are not optimal to serve additional visitors expected to visit the park in the coming years.

The proposed project will replace all existing buildings, except the generator house. The total project area that include stockpiles (the temporal material storage and dumpsite) will cover area of about 13,336 m^2 (1.34 ha). The area will only cover 0.05 % of the total Use Zone of KNP or 1.03 % of Use Zone area in Loh Buaya. As the area allocated for infrastructure is minimal and in line with the legal framework of the zoning system, there will be no impact on the OUV of the property. The development of the infrastructure will be completed within a period of 15 months. The infrastructure to be built will include a Ranger camp, Guide camp, Researcher camp, Plaza deck, Resting post, Elevated pathway (two meters above the ground), Reservoir tank and its Distribution pipeline, Jetty, Waiting room for visitors, Coastal protection, and Information Center. The Site planning of the project is presented in Figure 1.

Figure 1. The layout and site plan of the project overlaid with UAV image taken in 2019

III. Component of activities plan that might be impact on OUV & environmental

3.1. Pre Construction Stage

The pre-construction stage includes socialization activities/Public consultation, site surveys, and land preparation.

a. Public Consultation

Public consultation meetings were held three times in different places. The first meeting was held on October, 2019, at the Luwansa Beach Resort Labuan Bajo to introduce the regional tourism development plans as part of the National Tourism Strategic Area (Kawasan Strategis Pariwisata Nasional/KSPN). One of the activities proposed under the plans is the renovation and construction of infrastructure in Loh Buaya located in the Use Zone of KNP. Based on the discussion, residents of West Manggarai District agreed and supported the development plan.

The second meeting was held in July 2020, to discuss the preparation of environmental documents. The floor agreed to revise the framework and follow the IUCN World Heritage Advice Note and to include ecological scientists from the Bogor Agricultural University (IPB). Meanwhile, the third meeting was held in September 2020, and was attended by stakeholders of the national park, central, provincial and district government as well as representatives of village communities. At this forum constructive ideas to improve the plan were discussed and adopted. During the meeting two important points were agreed by all stakeholders: (a) The Ministry of PUPR will accommodate local workers in the construction process of the project according to their skill sets, (b) Development of Tourism Villages will be facilitated by Authority Implementation Body of Labuhan Bajo & Flores (BPOLBF/*Badan Pelaksana Otorita Labuhan Bajo dan Flores*) and District Government West Manggarai.

b. Site Survey

A site survey will be conducted in Loh Buaya, Rinca Island. This will include interviews with residents, measurement of several segments in the location, and an update on development design will be conducted to determine the type and the size of the land that will be used. The tourism infrastructure development of Loh Buaya will be carried out mostly on top of existing infrastructure.

c. Land preparation

At the land preparation stage, several activities will be carried out, namely the demolition of the jetty and construction of temporary jetty, transportation and connection road, demolition of existing buildings including existing jetty, preparing the construction of coastal protection and stockpile locations. Demolition is planned to be carried out within one month. Demolition materials in the form of wood and steel will be carried from outside the National Park, while the rubble of demolished infrastructure will be used as a pavement medium for the transportation road upon the inspection there is no dangerous materials in the rubble that can impact the environment such as steel and asbestos. All of the materials and rublle will be retrieved and transported to the mainland once the construction period is complete.

3.2. Construction Stage

a. Jetty

The new jetty that will be built has a unique design in the form of a Komodo dragon's tongue that is split into two distinct tines at the tip. It has a width of 4 m, with a length of 100 m and 80 m, respectively. The construction will be using a bore pile foundation with a full casing of 54 points with a plate made of ironwood. Near the entrance gate, there will be a gazebo that will function as a waiting room for tourists. Both ends of the main jetty will also be connected to a floating jetty.

b. Coastal Protection

A coastal protection will be built at the suggestion of KNP, considering the natural occurrence of seawater abrasion in existing the jetty area. The construction of a coastal protection will be carried out by removing some of the top soil layer of the mound at the entrance and exit route, trimming some of the mangrove branches, and stockpiling some of the mudflats. The soil on the top of the mound will be removed by about 2 meters wide by 50 meters long along the entry pathway and 60 meters alongthe exit pathway.

c. Elevated pathway

An elevated pathway will be built in the existing arrival area (entrance and exit gate). The height of the elevated pathway will follow the contour of the landscape with a maximum height of two meters above the ground. The elevated pathway will be built connecting the arrival area with the ranger camp and information center. Total length of the elevated pathway would be 695 m.

The elevated pathway's construction stages will start from the excavation of the foundation (Volume 330 m^3 and depth 55 cm) and the erection of the micro piles, the reinforcement of the foundations and columns, the castings, the installation of the ironwood floors and handrails.

d. Ranger, Tourist, researcher camp and its plaza deck

The cluster of ranger, tourist, researcher and its plaza will be built on a vacant land with some savannah bushes. The camp building area consists of accommodation for rangers, tourist guides, and researchers covering an area of 1,510 m^2, with effective area of about 1,260 m^2

e. Information Center

The information center building will have several rooms, namely: Warehouse (74 m^2), Men's restroom (20 m^2), Women's restroom (20 m^2), Management office (75 m^2), Clinic (12 m^2), Cafe (65 m^2), Souvenir Shop (70 m^2), Ranger's room (106 m^2), Rangers' toilet (18 m^2), Locker (18.5 m^2), Information center (158 m^2), Plaza and park (582 m^2), and Outside corridor (954 m^2). Information Center site plan and design have been changed to adapt the komodo behavior and to minimizing ecosystem disturbance. Unfortunately, the construction will have to remove 5 trees. To compensate for the cutting of the trees, at least 10 new trees will be planted in the area.

f. Water Suply system

The reservoir of the water supply system to be built is 50 m^3 in size, with a diameter of 5.14 m and a base plate size of 5.68 m. This facility is planned to be built on a hillside, thus, it is necessary to build a foundation to strengthen the slopes, including process of excavation and embankment of soil. Pipes for water distribution to the Ranger, Tourist, researcher camp and information Center will be attached to the elevated pathway.

3. Post construction & Operational Stage

a. Demobilization of workers, equipments and machineries

During the post operation stage, all vehicles, workers, equipment, and machineries will be removed from Loh Buaya. The ecosystem will be returned to its original condition including retrieving all materials from demolishing buildings used as pavers for tranportation and connection roads.

b. Water supply Management

The estimated daily need for clean water for 330 individuals is 19.80 m^3/day. To meet the needs of clean water at the time of operation, clean water will be transported at least two times a week by using boats with tankers of a capacity of 50 m^3.

c. Domestic Waste Management

Handling of waste water is done by using a biotank. The treated water is absorbed back into the soil. Organic and non-organic waste produced will be accommodated in different containers, namely (1) airtight organic waste containers and (2) open non organic waste containers while hazardous and dangerous substances will be put in closed special containers. These two containers will be placed in a strategic location which is not possible to reach by the Komodo dragon, before being transported by pontoon boats by officers to the TPA in Labuan Bajo, or according to the Waste Management Guidelines for the City of Labuan Bajo and Komodo National Park.

IV. Environmental Impacts, Management, Mitigation and Monitoring Plan

Impact the project to OUV, its Mitigation and its Monitoring Plan

a. Pre-construction phase

Activity (Source of impacts)	Impact criteria on OUV	Details on impacts/ magnitude	Environmental Management Plan	Environmental Monitoring plan
Public Consultation	No impact on OUV, but this step is important regarding the acceptability of project by the community, as well as for the improvement of project site plan.	The population with a positive perception is 100% of the interview respondents, namely 10% of the total number of households in Rinca Village (Komodo Hamlet, Bajo Village, Beringin Jaya Village, New Beringin Village) and Kerora Hamlet, Pasir Panjang Village. (45 KK)	Social Approach Conducting public consultation to residents, especially in Rinca Village (Komodo Hamlet, Bajo Village, Beringin Jaya Village, New Beringin Village) and Kerora Hamlet, Pasir Panjang Village, as well as in Komodo District, West Manggarai Regency regarding the plan for structuring the Rinca Island Area Institutional Approach Coordinate with the Environmental Agency of West Manggarai Regency regarding the implementation plan for the socialization of the Rinca Island Regional Arrangement. Coordination with KNP Office, TN Management Section Region I Rinca Island.	a. Documenting procedures/ management efforts related to public consultation b. Documenting every idea to improve the plan of the project during the process
Transportation road construction for mobilization/ demobilization of the equipments and materials	Criteria (vii) – Dry savannah and mangrove ecosystem	The impact is negligible as there is neither clearing the savanna nor cutting of the trees. The road is also constructed without either pavement or barier	To ensure the mobility of the vehicle in accordance with the mobility plan Assign a group of people (consists of natural guides and KNP staff) to conduct daily habitat monitoring to ensure that along the road there is no felling of trees	a. Documenting procedures/ management efforts related to efforts to reduce turbidity and oil/lubricant spills b. Wildlife habitat monitoring
	Criterion (x) – Komodo and – other terrestrial wildlife and birds	Possibility traffic accident between Komodo/other wildlifes and vehicles due to the transportation route is crossing the Komodo dragon movement area.	Installing sign board to remind driver/workers about the komodo dragon movement route a. Ensure that road construction does not create a barrier to the movement of komodo dragons b. Arrange transportation times/frequency to avoid/reduce encounters with komodo dragons	a. Documenting procedures/ management related to efforts of accident reduction of wildlife b. Wildlife monitoring

Activity (Source of impacts)	Impact criteria on OUV	Details on impacts/ magnitude	Environmental Management Plan	Environmental Monitoring plan
			c. Assign ranger to observe the presence of komodo or other wildlife/herpetofauna, especially at the crossing area between road and movement route of komodo d. To set up the maximum speed of vehicle is 15 km/hour and install its signboard as reminding	c. Documenting of any accident happen
		Negligible noise pollution arises from the use of heavy equipment and generator	a. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations b. Regular inspection of vehicles and equipment to ensure the machine/equipment in good condition	a. Measuring the quality of noise during operation b. Documenting the process to reduce noise pollution
		Negligible impact of ambient air pollution from fuel combustion to terrestrial wildlife and birds, considering far distance position of wildlife from exhaust of vehicles. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.	a. Ensure that all vehicles and equipment's have passed emission standardization based on Indonesian regulations b. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution c. Regular watering to reduce dust/particulate matter	Checking vehicle and other equipment's eligibility Monitoring of Air quality Documenting the process to reduce air pollution
Temporary Jetty	Criteria (vii) : mangrove ecosystem	Negligible since there will be no mangrove tree cutting Negligible of oil/lubricant spill into the environment	a. Carry out work according to the plan and be carefully so as not to damage the mangrove ecosystem b. Regular maintenance of tools/equipment's/ machines to avoid damage that can cause oil or lubricant leakage into the mangrove ecosystem.	a. Documenting procedures/ management related to reduce turbidity and oil/lubricant spills b. Measuring water quality before and after construction is completed, c. Comparing water quality before and after with the quality standards set by the government (KepMenLH No.48 of 1996).
	Criteria (vii) : marine ecosystem	Turbidity and Total suspended Solid increase, however it is negligible since tide is low and current wave is very	a. Reduce the turbidity of waters as much as possible b. Regular maintenance of tools/equipment's/ machines to avoid damage that can cause oil or lubricant leakage into the mangrove ecosystem	
Demolishing existing jetty	Criteria (vii) Marine, mangrove, sea grass & Coral Reef ecosystem	The impact is negligible as the distance of coral reef and sea grasses is far from the project. Moreover the current wave at Loh buaya is slow and the tide is also low, so that the increase of turbidity only occurs locally.	a. Placing nets to keep debris from falling into the sea b. Assign a group of people (consists of natural guides and KNP staff) to conduct daily observation of marine fauna	a. Making a documentation of the process to minimize disturbance mangrove and marine ecosystem b. Marine ecosystem and marine fauna observation
	Criteria (x) : marine fauna	The impact is negligible, considering far distance position of marine mammals from the jetty. The closest distance of sighting dolphin is about 4 km.		

Activity (Source of impacts)	Impact criteria on OUV	Details on impacts/ magnitude	Environmental Management Plan	Environmental Monitoring plan
		Turbidity and Total suspended Solid increase, however it is negligible since tide is low and current wave is very slow.		
Demolishing the existing entrance gate and concrete footpath	Criteria (vii) Savannah ecosystem	The impact is negligibly as the area is mostly barren land and the size is small (0.06 ha or 0.005 % of the total savannah in Rinca island) Demolition the existing concrete footpathl will remove barrier of water surface flow in the savannah either from hilly areas or ocean during hight tide.	Ensure all debris will be removed	a. Vegetation monitoring b. Surface water flow observation
	Criteria (x) Komodo, herpetofauna and other terrestrial species	There is positive impact, since demolition will minimize interaction between komodo dan humans.	Ensure all debris will be removed	Wildlife monitoring
		There is a possibility of a conflict between workers and Komodo dragons, because the area is the trajectory of the Komodo dragon's movement. This conflict can endanger both, either humans or Komodo dragons.	a. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform the workers on the presence of komodo b. Install the warning board sign about the danger	Making a documentation of the process to avoid wildlife accident
		The impact is negligible, considering far distance position of wildlife from exhaust of vehicles. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.	a. Ensure that all vehicles and equipment's have passed emission standardization based on Indonesian regulations b. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution c. Do regular watering before and after demolishing the existing building	Vehicle and other equipment's eligibility check Measuring the quality of noise during demolishing Making a documentation to reduce air pollution
		The impact is negligible as the distance of komodo and other terrestrial species are far.	a. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations b. Ensure that all vehicles and equipment are working properly	Checking vehicle and other equipment's eligibility Measuring the quality of air during demolishing Making a documentation to reduce noise pollution
Demolishing existing buildings	Criteria (vii) – Dry savannah and mangrove ecosystem	The impact is negligible since the total area of the existing building is about 0.12 ha or 0.001 % from the total savannah of Rinca island	Limit the number of heavy equipment operate per day (two excavators operate per day)	a. Making a documentation of the process to avoid wildlife accident b. Conducting vegetation monitoring/observation
	Criterion (x) – Komodo & other	Possibility of accident hit by the debris	Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the	Making a documentation of the process to avoid accident of wildlife

Activity (Source of impacts)	Impact criteria on OUV	Details on impacts/ magnitude	Environmental Management Plan	Environmental Monitoring plan
	terrestrial species		presence of wildlife under or near the buildings	
		The impact is negligible as the distance of komodo and other terrestrial species are far.	a. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations b. Regular check and maintenance of vehicles, and equipment's c. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife under or near the buildings	a. Checking vehicle and other equipment's eligibility b. Measuring the quality of noise during demolishing c. Making a documentation of the process to reduce noise pollution
		The impact is negligible, considering far distance position of wildlife from exhaust of vehicles/the outlet. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.	a. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution b. Do regular watering before and after demolishing the existing buildings c. Transport demolition materials (covered by a tarp) as quickly as possible to the temporary dock and then to Labuan Bajo by boat for final disposal, in coordination with the DLHK Manggarai Barat	a. Checking vehicle and other equipment's eligibility b. Measuring the quality of air during demolishing c. Making a documentation of the process to reduce air pollution
Transporting the demolishing materials from the site to dump site/stockpiles	Criteria (vii) – Dry savannah	Negligible toxic effects	a. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution b. Do regular watering before and after demolishing the existing buildings c. Transport demolition materials (covered by a tarp) as quickly as possible to the temporary jetty/dumpsite/stickpiles	a. Checking vehicle and other equipment's eligibility, spare part replacement according to the standard operation b. Measuring the air quality c. Making a documentation of the process to reduce air pollution
	OUV criterion (x) – terrestrial wildlife	Minor disturbance to the terrestrial wildlife	a. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife Ensure the maximum speed of trucks is 30 km per hour b. Designate a specific transportation route for the heavy equipment in the project site, avoiding the area used by the terrestrial wildlife (Komodo dragons, Timor deer, water buffalo, wild boars, and long-tailed macaques) c. Install signboard at crossing area of the transportation road and the movement route of komodo d. Install sign board of speed limit	Making a documentation of the process to reduce accident Recording the accident events that occur if any
		Minor effects to terrestrial wildlife from noise pollution	a. Limit the number of heavy equipment operate per day [two excavators operate per day] b. Ensure that all vehicles and equipment have passed emission	Checking vehicle and other equipment's eligibility Measuring the quality of noise during transportation

Activity (Source of impacts)	Impact criteria on OUV	Details on impacts/ magnitude	Environmental Management Plan	Environmental Monitoring plan
			standardization based on Indonesian regulations	Making a documentation of the process
		The impact is negligible, considering far distance position of wildlife from exhaust of vehicles/the outlet. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.	a. Do regular watering before and after demolishing the existing buildings b. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution	Checking vehicle and other equipment's eligibility Measuring the quality of air during transportation Making a documentation of the process
Transporting the demolishing materials from dump site/stockpiles to temporary jetty	Criteria (vii) – Dry savannah	Negligible toxic effects	a. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution b. Do regular watering before and after demolishing the existing buildings c. Transport demolition waste (covered by a tarp) as quickly as possible to the temporary jetty/dumpsite/stockpiles	Checking vehicle and other equipment's eligibility Measuring the air quality Making a documentation of the process
	Criteria (vii) – mangrove, marine ecosystem, Sea grass & Coral	Negligible toxic effects	a. Proper loading and unloading demolition waste material b. Transport demolition waste materials (covered by a tarp) as quickly as possible to Labuan Bajo by boat for final disposal, in coordination with the DLHK Manggarai Barat	Checking vehicle and other equipment's eligibility Measuring the water quality during demolishing Making a documentation of the process to reduce water pollution
	OUV criterion (x) – marine wildlife	Negligible toxic effects	a. Proper loading and unloading demolition waste material b. Transport demolition waste materials (covered by a tarp) as quickly as possible to Labuan Bajo by boat for final disposal, in coordination with the DLHK Manggarai Barat	Checking vehicle and other equipment's eligibility Measuring the quality of air during demolishing Making a documentation of the process to avoid marine pollution
	OUV criterion (x) – terrestrial wildlife	Minor disturbance to the terrestrial	a. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife b. Ensure the maximum speed of trucks is 15 km per hour c. Designate a specific transportation route for the heavy equipment in the project site, avoiding the area used by the terrestrial wildlife (Komodo dragons, Timor deer, water boffola, wild boars, and long-tailed macaques)	
		Minor effects to terrestrial wildlife from noise pollution	a. Limit the number of heavy equipment operate per day [two excavators operate per day] b. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations	Checking vehicle and other equipment's eligibility Measuring the quality of noise during transportation Making a documentation of the process to avoid noise pollution

Activity (Source of impacts)	Impact criteria on OUV	Details on impacts/ magnitude	Environmental Management Plan	Environmental Monitoring plan
		The impact is negligible, considering far distance position of wildlife from exhaust of vehicles/the outlet. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.	a. Do regular watering before and after demolishing the existing buildings b. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution	Checking vehicle and other equipment's eligibility Measuring the quality of air quality during transportation Making a documentation of the process
Transporting demolition waste from temporary jetty to Labuhan Bajo	Criteria (vii) – seagrass and coral reef	Negligible disturbance to the seagrass and coral reef from transporting demolition waste via the sea routes	a. Transport demolition waste (covered by a tarp) along designated sea routes that do not overlap with coral reef and seagrass ecosystems] b. Store the demolition waste in the hull of the boat c. Ensure the amount of demolition of waste does not exceed the boat and barge capacities	Checking vehicle and other equipment's eligibility Measuring the quality of sea water Making a documentation of the process to reduce marine pollution
	Criterion (x) – marine fauna and flora (non-mammals)	Negligible disturbance to the marine fauna and flora from transporting demolition waste via the sea routes	a. Ensure the maximum speed of boat (e.g. barge of 5 knot) b. Transport demolition waste (covered by a tarp) along designated sea routes that do not overlap with coral reef and seagrass ecosystems] c. Store the demolition waste in the hull of the boat d. Ensure the amount of demolition of waste does not exceed the boat and barge capacities	Checking vehicle and other equipment's eligibility Measuring the quality of sea water Making a documentation of the process to reduce marine pollution
	Criterion (x) – marine mammals and seaturtles	Minor disturbance to the behavior of dolphins and sea turtles from the boat transporting the waste	a. Ensure the maximum speed of boat (e.g. barge of 5 knot) b. Transport demolition waste (covered by a tarp) along designated sea routes that do not overlap with coral reef and seagrass ecosystems] c. Store the demolition waste in the hull of the boat d. Ensure the amount of demolition of waste does not exceed the boat and barge capacities	Checking the eligibility of the ship and other equipment's Making a documentation of the process to reduce marine pollution
Land pre paration for Coastal protection	Criteria (vii) – Dry savannah and mangrove ecosystem	Minor impact since only small area savannah of the mound is removed	Assign a group of people (consists of natural guides and KNP staff) to conduct daily monitoring of savannah ecosystem	Monitoring of vegetation after the project
		The impact is minor since only a small area of the mudflat from the mangrove habitat is buried	Ensure that no hazardous materials fall (spill off) into the mangrove ecosystem Assign a group of people (consists of natural guides and KNP staff) to conduct daily monitoring of mangrove ecosystem	making a documentation of the process to reduce habitat mangrove disturbance

Activity (Source of impacts)	Impact criteria on OUV	Details on impacts/ magnitude	Environmental Management Plan	Environmental Monitoring plan
	Criterion (x) – Komodo & other terrestrial species	The impact is negligible as there is neither clearing the savanna nor cutting of the trees	a. Avoid cutting of the mangrove/savannah trees b. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife	making a documentation of the process to reduce habitat mangrove disturbance
		The impact is negligible as the distance of komodo and other terrestrial species are far.	a. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations b. Ensure that all vehicles and equipment are working properly	Checking Vehicle and other equipment's eligibility Measuring the quality of noise during demolishing Making a documentation to reduce noise pollution
		The impact is negligible, considering far distance position of wildlife from exhaust of vehicles. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.	a. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations b. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution	Checking vehicle and other equipment's eligibility Measuring the quality of air during demolishing Making a documentation to reduce air pollution
Land preparation for water supply system	Criteria (vii) – Dry savannah	The impact is negligible as there is neither clearing the savanna nor cutting of the trees	a. Avoid cutting of the trees b. Avoid cutting down trees/savannahs, especially animal feed plants c. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife	Making a documentation to reduce ecosystem disturbance
	Criterion (x) – fauna	The impact is negligible as there is neither clearing the savanna nor cutting of the trees	Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife	Making a documentation to reduce impact of land preparation on ecosystem
		Minor effects to terrestrial wildlife from noise pollution	a. Limit the number of heavy equipment operate per day [two excavators operate per day] b. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations	Checking eligibility check of vehicle and other equipment's Measure the quality of air quality during land preparation Making a documentation of the process
		The impact is negligible, considering far distance position of wildlife from exhaust of vehicles/the outlet. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.	a. Do regular watering before and after demolishing the existing buildings b. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution	Checking Eligibility of vehicle and other equipment's Measuring the quality of air quality during land preparation Making a documentation of the process
Land preparation of stockpile/dumpsite	OUV criteria (vii) Savannah ecosystem	The impact is negligible as there is neither clearing the savanna nor cutting of the trees	a. Avoid cutting of the trees b. Avoid cutting down trees/savannahs, especially animal feed plants c. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring	Making documentation of the land preparation

Activity (Source of impacts)	Impact criteria on OUV	Details on impacts/ magnitude	Environmental Management Plan	Environmental Monitoring plan
			and inform equipment operators on the presence of wildlife	
	Criterion (x) – terrestrial fauna	The impact is negligible as there is neither clearing the savanna nor cutting of the trees	Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife	Making a documentation of the process
		Minor effects to terrestrial wildlife from noise pollution	a. Limit the number of heavy equipment operate per day [two excavators operate per day] b. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations	Checking eligibility of vehicle and other equipment's Measuring the quality of air quality during land preparation Making a documentation of the process
		The impact is negligible, considering far distance position of wildlife from exhaust of vehicles/the outlet. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as	Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution	Checking eligibility of vehicle and other equipment's Measuring the quality of air quality during land preparation Making a documentation of the process

b. Construction phase

Activity (Source of impacts)	Impact criteria on OUV	Details on impacts/ magnitude	Environmental Management Plan	Environmental Monitoring plan
Mobilization of construction workers, equipments and materials to Loh Buaya	Criteria (vii) – seagrass and coral reef	Negligible disturbance to the seagrass and coral reef from transporting building materials via the sea routes	a. Ensure the building materials do not exceed the carrying capacity of the boat b. Ensure each boat has a designated storage for waste disposal c. Set up "No Dumping to the Ocean" sign in the boats d. Do regular briefing to all the staffs about the regulations in placed e. Transport building materials (covered by a tarp) along designated sea routes that do not overlap with seagrass and coral reef ecosystems in coordination with Komodo National Park and Department of Transportation of Manggarai Barat f. Use mooring systems for boat anchoring	Making a documentation of the process to reduce the impact of mobilization on terrestrial and marine habitat Conducting vegetation and terrestrial wildlife monitoring Conducting observation of marine ecosystem, flora and fauna
	Criterion (x) – marine fauna and flora (non-mammals)	Negligible disturbance to the marine fauna and flora from transporting building materials via the sea routes		
	Criterion (x) – marine mammals and seaturtles	Minor disturbance to the behavior of dolphins and sea turtles from the boat transporting the building materials		

Activity (Source of impacts)	Impact criteria on OUV	Details on impacts/ magnitude	Environmental Management Plan	Environmental Monitoring plan
Construction of basecamp for workers and stockpile	Impact on criterion (x) – terrestrial wildlife:	Minor disturbance as the terrestrial wildlife used to and adapted to the presence of humans	a. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife b. Build a fence surrounding the camp to avoid or reduce contact between the komodo and workers c. Use the equipment that produce low noise and vibration d. Install sign board to remind the workers about the presence of komodo	Making documentation of the process to reduce the impact of construction to terrestrial wildlife
		Potential negative interaction between construction workers living in the project site and Komodo dragons		
		Minor disturbance to the behavior of terrestrial wildlife because of the garbage and food waste produced by construction workers in the base camps	a. Proper placement of the various bins/containers at the worker's camp base on the type of waste namely organic, and non-organic waste b. Install sign board to remind workers to manage waste properly c. Arrange garbage disposal, so that it is not reachable by komodo	
		possibility of a conflict between workers and Komodo dragons, because the area is the trajectory of the Komodo dragon's movement. This conflict can endanger both, either humans or Komodo dragons.	a. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife b. Install sign board to remind the workers about the presence of komodo	Making documentation of the process on how to reduce accident Recording accident if any
		Minor effects as the position of wildlife is far	a. Limit the number of heavy equipment operate per day [two excavators operate per day] b. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations c. Use the tools/machinery with low noise and vibration	Checking eligibility of vehicle and other equipment's Measuring the quality of air quality during land preparation Making a documentation of the process to reduce pollution
		The impact is negligible, considering far distance position of wildlife from exhaust of vehicles/the outlet. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.	a. Do regular watering before and after demolishing the existing buildings b. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution	Checking eligibility of vehicle and other equipment's Measuring the air quality Making a documentation of the process on how to reduce air pollution
	Impact on criteria (vii) – Dry savannah and thorny vegetation	Negligible toxic effects to vegetation from air pollution, considering far distance position of wildlife from exhaust of vehicles/the outlet. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.	a. Do regular watering before and after demolishing the existing buildings b. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution	Checking eligibility of vehicle and other equipment's Measuring the air quality Making a documentation of the process on how to reduce air pollution

Activity (Source of impacts)	Impact criteria on OUV	Details on impacts/ magnitude	Environmental Management Plan	Environmental Monitoring plan
Construction of coastal protection	Criteria (vii) – Dry savannah and mangrove ecosystem	Minor impact since only small area savannah of the mound is removed	Assign a group of people (consists of natural guides and KNP staff) to conduct daily monitoring of savannah ecosystem	Monitoring of vegetation after the project
		The impact is minor since only a small area of the mudflat from the mangrove habitat is buried	a. Ensure that no hazardous materials fall (spill off) into the mangrove ecosystem b. Assign a group of people (consists of natural guides and KNP staff) to conduct daily monitoring of mangrove ecosystem	Making a documentation of the process to reduce habitat mangrove disturbance
	Criterion (x) – Komodo & other terrestrial species	The impact is negligible as there is neither clearing the savanna nor cutting of the trees	a. Avoid cutting of the mangrove/savannah trees b. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife	
		The impact is negligible as the distance of komodo and other terrestrial species are far.	a. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations b. Ensure that all vehicles and equipment are working properly	Checking vehicle and other equipment's eligibility check Measuring the quality of noise during demolishing Making a documentation to reduce noise pollution
		The impact is negligible, considering far distance position of wildlife from exhaust of vehicles. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.	a. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations b. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution	Checking vehicle and other equipment's eligibility
Elevated Pathway	Criteria (vii) Savannah ecosystem	The impact is negligibly as the area is mostly barren land and the size is small (0.06 ha or 0.005 % of the total savannah in Rinca island Moreover,	Ensure that there is no dangerous material left on the site such as metal or spillover of lubricant/oil/fuel.	a. Wildlife monitoring b. Surface water flow observation
		Positive impact : Elevated pathway will remove barrier of water surface flow in the savannah either from hilly areas or ocean during high tide.	ensure that no water barrier is formed during construction	
	Criteria (x) Komodo, herpetofauna and other terrestrial species	There is positive impact, since elevated pathway will minimize interaction between komodo dan humans.	Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform the workers on the presence of komodo	Wildlife monitoring
		There is a possibility of a conflict between workers and Komodo dragons, because the area is the trajectory of the Komodo dragon's movement. This conflict can	a. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform the workers on the presence of komodo	Making a documentation of the process to avoid wildlife accident

Activity (Source of impacts)	Impact criteria on OUV	Details on impacts/ magnitude	Environmental Management Plan	Environmental Monitoring plan
		endanger both, either humans or Komodo dragons.	b. Install the warning board sign about the danger	
		The impact is negligible, considering far distance position of wildlife from exhaust of vehicles. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.	a. Ensure that all vehicles and equipment's have passed emission standardization based on Indonesian regulations b. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution c. Do regular watering before and after demolishing the existing building	Checking vehicle and other equipment's eligibility Measuring the quality of noise during demolishing Making a documentation to reduce air pollution
		The impact is negligible as the distance of komodo and other terrestrial species are far.	a. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations b. Ensure that all vehicles and equipment are working properly	Checking Vehicle and other equipment's eligibility Measuring the quality of air during demolishing Making a documentation to reduce noise pollution
Ranger, Guide and researcher camp and plaza deck	Criteria (vii) Savannah ecosystem	The impact is negligibly as the area is mostly barren land and the size is small (0.126 ha or 0.001 % of the total savannah in Rinca island	Ensure that there is no dangerous material left on the site such as metal or spillover of lubricant/oil/fuel.	Vegetation monitoring
	Criteria (x) Komodo, herpetofauna and other terrestrial species	Minor disturbance as the terrestrial wildlife used to and adapted to the presence of humans	a. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife b. Ensure that there is no dangerous material left on the site such as metal or spillover of lubricant/oil/fuel.	
		There is a possibility of a conflict between workers and Komodo dragons, because the area is the trajectory of the Komodo dragon's movement. This conflict can endanger both, either humans or Komodo dragons.	a. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform the workers on the presence of komodo b. Install the warning board sign about the danger	Making a documentation of the process to avoid wildlife accident Recording wildlife accident if any
		The impact is negligible, considering far distance position of wildlife from exhaust of vehicles. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.	a. Ensure that all vehicles and equipment's have passed emission standardization based on Indonesian regulations b. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution c. Do regular watering before and after demolishing the existing building	Vehicle and other equipment's eligibility check Measuring the quality of noise during demolishing Making a documentation to reduce air pollution

Activity (Source of impacts)	Impact criteria on OUV	Details on impacts/ magnitude	Environmental Management Plan	Environmental Monitoring plan
		The impact is negligible as the distance of komodo and other terrestrial species are far.	a. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations b. Ensure that all vehicles and equipment are working properly c. Ensure the maximum speed of trucks is 30 km per hour d. Limit the number of heavy equipment operate per day e. Use environmental friendly equipment that produce less noise	Checking vehicle and other equipment's eligibility Measuring the quality of air during demolishing Making a documentation to reduce noise pollution
Information Center construction	Criteria (vii) Savannah ecosystem	Based on overlay the site plan and the UAV imagery, there will be 5 trees of tamarin will be cut down.	To compensate the developer should replace the trees (same species trees)	Monitoring the growth of the planted trees by the developers
	Criteria (x) Komodo, herpetofauna and other terrestrial species	Minor disturbance as the terrestrial wildlife used to and adapted to the presence of humans	a. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife b. Ensure that there is no dangerous material left on the site such as metal or spillover of lubricant/oil/fuel.	Wildlife monitoring
		There is a possibility of a conflict between workers and Komodo dragons, because the area is the trajectory of the Komodo dragon's movement. This conflict can endanger both, either humans or Komodo dragons.	a. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform the workers on the presence of komodo b. Install the warning board sign about the danger	Making a documentation of the process to avoid wildlife accident
		The impact is negligible, considering far distance position of wildlife from exhaust of vehicles. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.	a. Ensure that all vehicles and equipment's have passed emission standardization based on Indonesian regulations b. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution c. Do regular watering before and after demolishing the existing building	Checking vehicle and other equipment's eligibility Measuring the quality of noise during demolishing Making a documentation to reduce air pollution
		The impact is negligible as the distance of komodo and other terrestrial species are far.	a. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations b. Ensure that all vehicles and equipment are working properly c. Ensure the maximum speed of trucks is 30 km per hour d. Limit the number of heavy equipment operate per day e. Use environmental friendly equipment that produce less noise	Checking vehicle and other equipment's eligibility Measuring the quality of air during demolishing Making a documentation to reduce noise pollution

c. Post Construction

Activity (Source of impacts)	Impact criteria on OUV	Details on impacts/ magnitude	Environmental Management Plan	Environmental Monitoring plan
Infrastructures operation for tourists	OUV criterion (x) – terrestrial wildlife	Negligible disturbance from potential negative interaction between tourists and Komodo dragons	a. Install a sign board to inform the visitor not to close to komodo dragon b. Assign ranger to guard and guide the visitor	Wildlife monitoring
		Major disturbance to the behavior of terrestrial wildlife because of the garbage and food waste produced mainly by tourists	a. Implement strict regulation on waste management, i.e visitor should bring back the waste. b. Set up designated temporary dumping sites for different types of waste c. Regular Transport waste regularly to Labuan Bajo	Making a documentation of the process to avoid impact of Solid waste to terrestrial wildlife
		Negligible as the water is treated with biotank and the purified water is inserted into soil	a. Ensure the biotank in a good condition b. Ensure no water leakage from rest room	Making a documentation of the process to avoid impact of waste water to terrestrial wildlife Annual monitoring of water quality in Loh Buaya
	Criterion (x) – marine mammals and seaturtles	Minor disturbance to the dolphins and seaturtles from the movement of tourist boats	Quota system to manage the number of boat in Loh Buaya per day	Making a documentation of the process to avoid impact of waste water Annual monitoring of marine ecosystem

CHAPTER I. INTRODUCTION

1.1. Background

Komodo National Park (KNP), concisting of Komodo island, Rinca island, Padar Island, Gili Motang island and other small islands is located in West Manggarai District, East Nusa Tenggara Province. The Park was designated a National Park in 1980, and in 1986 by UNESCO, it was included in the Man and Biosphere Reserve. Furthermore, KNP together with Waewull Nature reserve, Mbeliling and Ngorang Protected Forest was designated as World Heritage by UNESCO in 1991.

The total size of the Komodo National Park World Heritage Property, consisting of three different land use (Komodo National Park, Mbeliling and Nggorang Protection and Production Forests, and Wae Wuul/Mburak Nature Reserve), is 219,322 ha - as per its inscription on the WH List in 1991. However, at the time of the inscription, the boundary designation and demarcation (Forest Estate Gazetment) of the property was not yet fully stipulated (*penetapan*). In addition, some of the maps used at the time of the inscription were of limited quality, leading to initial errors in defining the boundaries and the correct size of the property. With the use of Global Postioning System (GPS), Geographycal Information System (GIS) and Remote Sensing technology, the boundaries of the property have been redefined, with the current size of the property being actually bigger than the originally inscribed property (Table 1.1) . The new boundaries of the site are currently being legalized, a process that is expected to be finalized in 2022. A document to explain the changes in the size of KNP is currently being drafted by the Ministry of Environment and Forestry, and will soon be submitted to the WHC for examination. As the new boundary has not yet been stipulated, both the EIA and EMP document still refer for their analysis to the previous gazetted size of the KNP, which is 173,300 ha (306/Kpts-II/1992 and 172/Kpts-II/2000).

For assessing the impact of the 'project' on the OUV, the EIA and EMP only refer to size of the Komodo National Park, and not the size of the whole WH property. This was decided by the EIA and EMP teams after discussing with the KNP office, as both the Mbeliling dan Nggorang Protection Forest and the Wae Wuul/Mburak Nature Reserve are managed by different authorities, i.e. Forest Management Unit/*Kesatuan Pemangkuan Hutan* (KPH) and Provincial Office of Natutal Resouces Conservation Agency (*Balai Konservasi Sumberdaya Alam*/BKSDA).

Table 1-1. Area difference between Incription and Current World Heritage Site of KNP.

KNP World Heritage Site	KNP (ha)	Mbeliling dan Nggorang Protection Forest (ha)	Wae Wuul/Mburak Nature Reserve (ha)	Total (ha)
Inscription	185,322.50	31,000.00	3,000.00	219,322.50
Currently	190,728.50	27,878.82	1,484.84	220,092.20
			Difference:	769.68

The extensive marine buffer zone surrounding the park is key to maintaining the integrity and intactness of the property and the number of exceptional species. The park boundary of about 173,300 ha area, which contains a variety of terrestrial and aquatic habitats, is considered to be able to protect the integrity and preservation of its biodiversity. Furthermore, national parks carry out protection, monitoring and management of the area properly, thereby ensuring the sustainability of the National Park as a world heritage.

Komodo National Park (KNP) is considered to meet two out of the four natural criteria of Outstanding Universal Value (OUV), Integrity, Protection and management requirements. The OUV includes: (a) criterion (vii) – contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance, and (b) criterion (x) – contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

The following values have been identified under criterion (vii) in the SOUV: (a) mangrove forest, (b) dryland forest (savanna, monsoon & quasi-mountain forest), (c) seagrass, (d) coral reefs, (e) white sandy beaches, and (f) beautiful scenery in the form of hilly landscapes with matrix in the form of savanna and monsoon forest patches in the valleys. Meanwhile, the values according to criteria (x) in the SOUV are: a) Komodo dragons, b) terrestrial mammals, c) birds, d) marine fauna and flora (non-mammals), e) marine mammals, f) sea turtles.

Maintaining the OUV in KNP has become a domestic and international concern, taking into account that the annual numbers of visitors, especially foreign tourists, continues to increase. During the period 2010-2019, 80% of visitors were foreign. In 2010, the annual number of visitors was 44,492. This number increased exponentially to 221,703 visitors in 2019. However, the Covid-19 pandemic reduced the number of visitors again to 51,618 people in 2020 (KNP, 2020). It is however predicted that after the pandemic ends, the number of tourists will increase exponensially again and most likely surpass the total number of visitors during the pre-pandemic. By using the trends in the 2010-2019 period, the number of tourists in 2030 is predicted to reach more than three hundres thousand people. The contribution of tourism to the provincial Gross Domestic Product (GDP) in Nusa Tenggara Timur Province (NTT) is only 0.74% (BPS, 2019). In addition, the economic contribution to local communities of tourism is still relatively limited (Walpole & Goodwin, 2000). Both the local and central government plan to promote and increase tourism in NTT to foster regional economic development as well as to improve the welfare of local communities.

Currently, the Government is developing an Integrated Tourism Master Plan in Labuan Bajo and Flores which includes Rinca Island, in the form of improving infrastructure facilities in Loh Buaya. The Government of Indonesia (GoI) has a plan to renovate and construct facilities and infrastructure to improve the quality of KNP management with goal to guarantee the safety and comfort of visitors, and to mitigate any potential negative impacts on the OUV of the property. The renovation and construction infrastructure plan includes a camp for rangers, researchers and guides and plaza deck, Resting Post, Elevated pathway, Water Supply System/WSS (Reservoir tank and distribution pipeline), waiting room for visitor, Jetty, Coastal protection and Information center. This plan in accordance with the Komodo National Park Medium Term Management Plan 2016-2025 which is based on the Komodo National Park Management Master Plan 2000-2025. The development of tourism is expected to contribute to the development of the regional economy, improve the welfare of local communities and at the same time conserve the region's unique natural resources and biodiversity.

The OUV of KNP is an extraordinary asset, irreplaceable and invaluable both for Indonesia and for all mankind. It needs to be protected, preserved and safeguarded from all disturbances and threats so that it can be passed on to future generations. Paragraph 172 of the Operational Guidelines for the implementation of the World Heritage Convention (UNESCO, 2017) state that countries that have assets that have been designated as WHS must report and monitor any restoration activities or build any facilities that can have an impact on the OUV.

Regulation of the Minister of Environment and Forestry of the Republic of Indonesia Number: P.38/MenLHK/Setjen/Kum.1/7/2019 *concerning Types of Business Plans and/or Activities that are required to have an Environmental Impact Analysis*, states that it is mandatory to have an Environmental Impact

Study (*Analisis Menganai Dampak Lingkungan*/AMDAL) for all activities that can have a significant impact on the environment, except for some activities as stated in article 7, namely:

a. the location of the planned Business and/or Activities is in a district/city that has a detailed Spatial Plan that has been completed with a Strategic Environmental Study that is prepared and implemented in a comprehensive and detailed manner in accordance with the provisions of the Laws and Regulations;
b. the location of the planned Business and/or Activities is in a Protected Area that has a detailed management plan and/or spatial arrangement equipped with a Strategic Environmental Study that is made and implemented in a comprehensive and detailed manner in accordance with the provisions of the Legislative framework.

In relation to infrastructure renovation and development project in Loh Buaya, the Directorate General of Nature Resources and Ecosystem Conservation (*Direktorat Jenderal Jendral Konservasi Sumberdaya Alam & Ekosistem*/ Ditjen. KSDAE) issued a letter of recommendation, on July 13, 2020, addressed to the Head of the Provincial Environment and Forestry Service in NTT, stating that all requirements to apply article 7.b, mentioned above, were fulfilled. This meant that the Ministry of Public Works and Housing (*Kementrian Pekerjaan Umum dan Perumahan Rakyat*/PUPR) program for the construction of natural tourism infrastructure facilities in Loh Buaya, Pulau Rinca, could be exempted from the obligation to undergo an EIA. However, acknowledging the WHC concerns regarding the development in Loh Buaya, the GoI decided to conduct an EIA in line with the Operational Guidelines. The GoI, through PUPR, further also developed an Environmental Management Plan (*Upaya Kelola Lingkungan*/UKL) and Environmental Monitoring Plan (*Upaya Pemantauan Lingkungan*/UPL) (Appendix 1). It is also known as Environmental Management Plan Report (EMP). The purpose of EMP is to monitor and mitigate any impacts on the OUV and natural environment starting from the planning to development/construction and post-development stage of the project. The writing structures of the EMP report refers to the Regulation of the State Minister for the Environment of the Republic of Indonesia No. 16 of 2012 concerning guidelines for the preparation of environmental documents.

1.1. Objectives of EMP

This document constitutes the Environmental Management Plan (EMP) which will outline the planning for environmental management, impact mitigation and environmental monitoring of the Loh Buaya project. The EMP aims to monitor and mitigate negative impacts on the OUV that are caused during the three main project phases, i.e. pre-development/construction, development/construction and post-development/ construction. The EMP identifies in detail which environmental variables are used to monitor impact, which monitoring methodology is used, how mitigation measures are identified and implemented, as well as the resources required for their implementation.

1.2. Statement of the OUV

Komodo National Park is considered of Outstanding Universal Value meeting two out of the four natural criteria, criterion (vii) – contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance, and criterion (x) – contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation.

Brief synthesis

Komodo National Park, located in the center of the Indonesian archipelago, between the islands of Sumbawa and Flores, is composed of three major islands (Rinca, Komodo, and Padar) and numerous smaller ones, all of them of volcanic origin. Located at the juncture of two continental plates, this national park

constitutes the “shatter belt” within the Wallacea Biogeographical Region, between the Australian and Sunda ecosystems. The property is identified as a global conservation priority area, comprising unparalleled terrestrial and marine ecosystems and covers a total area of 219,322 ha. The dry climate has triggered specific evolutionary adaptation within the terrestrial flora that range from open grass-woodland savanna to tropical deciduous (monsoon) forest and quasi cloud forest. The rugged hillsides and dry vegetation highly contrast with the sandy beaches and the blue coral-rich waters. The most remarkable inhabitant of Komodo National Park is the Komodo Lizard, *Varanus komodoensis*. These giant lizards, existing no-where else in the world, are of great scientific interest, especially for their evolutionary implications. Most commonly known as 'Komodo Dragons', due to its appearance and aggressive behavior, the Komodo Lizard, is the largest living species of lizard, growing to an average length of 2 to 3 meters. The species is the last representative of a relic population of large lizards that once lived across Indonesia and Australia. As well as being home to the Komodo dragon, the Park provides a refuge for many other notable terrestrial species such as the orange-footed scrub fowl, an endemic rat, and the Timor deer. The rich coral reefs of Komodo host a great diversity of species, and the strong currents of the sea attract the presence of sea turtles, whales, dolphins and dugongs.

Values

Criterion (vii): Komodo National Park is a landscape of contrast between starkly rugged hillsides of dry savanna, pockets of thorny green vegetation, brilliant white sandy beaches and blue waters surging over coral, unquestionably one of the most dramatic landscapes in all of Indonesia. Demonstrating exceptional natural beauty that is all the more remarkable as a counterpoint to the dominant lushness of vegetation which characterizes vast areas of forested Indonesia, and with which most of the world associates the archipelago. An irregular coastline characterized by bays, beaches and inlets separated by headlands, often with sheer cliffs falling vertically into the surrounding seas which are reported to be among the most productive in the world adds to the stunning natural beauty of landscapes dominated by contrasting vegetation types, providing a patchwork of colors.

Criterion (x): Komodo National Park contains the majority of the world’s areas in which wild populations of the Komodo dragon lizard still exist. The largest and heaviest of the world’s lizards, the species is widely known for its impressive size and fearsome appearance, its ability to effectively prey on large animals, and a tolerance of extremely harsh conditions. Komodo dragon distributes across the islands of Komodo, Rinca, Gili Motang and some coastal regions of western and northern Flores.

Other fauna recorded in the park area characteristic of the Wallacean zoogeographic region with seven species of terrestrial mammal, including an endemic rat (*Rattus rintjanus,* now is *Komodomys rintjanus*) and the crab-eating macaque (*Macaca fascicularis*) and 72 species of birds, such as the lesser sulphur-crested cockatoo (*Cacatua suplhurea*), the orange-footed scrub fowl (*Megapodius reinwardt*), and noisy friarbird (*Phiemon buceroides*). The coral reefs fringing the coast of Komodo are diverse and luxuriant due to the clear water, intense sunlight and rapid exchange of nutrient-rich water from deeper areas of the archipelago. The marine fauna and flora are generally the same as that found throughout the Indo Pacific area, though species richness is very high, notable marine mammals include blue whale (*Balaenoptera muscullus*) and sperm whale (*Physeter catodon*) as well as 10 species of dolphin, dugong (*Dugong dugon*) and five species of sea turtles.

Integrity

Encompassing the rugged topography that reflects the position of the park within the active volcanic “shatter belt” between Australia and the Sunda shelf, the boundaries of the Komodo National Park encircle the main park features, including the outstanding scenery, savanna, upland forest ecosystem (Monsoon &

Quasi-mountain forest) and the unique species it hosts: komodo monitor, birds, terrestrial mammals, marine mammals, coral reef-species, and others. The boundaries are considered adequate to secure the habitat and the main ecological processes to preserve them. The extensive marine buffer zone surrounding the park is key to maintaining the integrity and intactness of the property and the number of exceptional species that it hosts.

Protection and management requirements

In order to ensure the effective management and protection of the park and its exceptional landscapes and biota, the park is governed through the 2016-2025 Management Plan and a recently published Sustainable Ecotourism Plan 2018. These plans are important for ensuring the effective zoning system of the park and guaranteeing the sustainability of the ecosystems of the property. The management authority is known for designing specific plans to guide management decisions which will require updating in line with changes to priorities and threats, in particular expected increases in visitor numbers and impacts from tourism.

The Park receives strong support and resources from the central government of Indonesia. As a tourism location known worldwide, the Indonesian Government has a specific program for ecotourism management to promote the park at the international level and to ensure the sustainability of tourism activities. Additionally, in order to address illegal fishing and poaching, regular patrolling of the marine and terrestrial areas is carried out for law enforcement and a number of the problems and impacts associated with these activities have decreased. Community awareness and empowerment programs are being implemented to engage the local villagers regards to the sustainable use of natural resources and park conservation. Research and study of the unique biological features of the park is also being promoted and supported by the management authority.

1.3. Method of OUV identification and Impact Assessment

Identification of OUV criteria vii (ecosystem) and criteria x (habitat) is carried out by using the interpretation of Sentinel 2A satellite imagery data in 2019 based on Google Earth Engine (GEE) and various maps from reliable publications (reports and journals). While the aspect of biological, ecological and behavior of Komodo dragon is carried out by taking into account references from journals, reports from national parks and interviews with national park officials.

CHAPTER II. IDENTITY OF THE PROJECT & EMP DOCUMENT DEVELOPER

The project will be carried out by the Ministry of Public Works and Housing (*Pekerjaan Umum dan Perumahan Rakyat*/PUPR), namely Directorate General of Water Resouces (*Sumberdaya Air*/SDA) dan Directorate General Housing (*Cipta Karya*/CK). The coordination office take place at Urban Infrastructure Office, NTT Region (*Balai Prasarana Permukiman Wilayah Nusa Tenggara Timur*). The Environmental Management and Environmental Monitoring Plan (UKL/UPL) has been designed by an independent consultant team lead by Mr. Syafri Arif, and assisted technically by the Agricultural University of Bogor under the lead of Professor Lilik Budi Prasetyo, and environmental experts of WCS Indonesia Programme and Komodo Survival Program (For complete team See Appendix 2.2).

CHAPTER III. PROJECT PLAN

3.1. Name and Location of Project

The renovation and construction activities, which have been carefully designed as not to cause any impact on the OUV of the property, are hereafter called "project". The project is located at Rinca's Island in the Pasir Panjang Village administrative area, Komodo Sub-district, West Manggarai District, East Nusa Tenggara Province (*Penataan Kawasan Pulau Rinca, Desa Pasir Panjang, Kecamatan Komodo, Kabupaten Manggarai Barat, Provinsi Nusa Tenggara Timur*).

3.2. Project Development Plan and Condition of Project site

According to Law No. 5, 1990 on Ecosystem and Natural Resources Conservation, national parks are natural conservation areas that comprise native ecosystems, and are managed with a zoning system used for research, science, education, cultivation, tourism and recreation purposes. In order to fulfill this purpose, Komodo National Park is divided into several zones, namely: Core zone, Wilderness Zone, Pelagic zone, Marine Protected Zone, Local Community Use Sone, Use Zone and Special Zone (Decree of the Director General of Forest Protection and Nature Conservation Number, SK.212/KSDAE/SET.3/KSA.0/11/2020 dated November 6th, 2020). The decree was a revision from the Decree of the Director General of Forest Protection and Nature Conservation Number SK.21/IV-SET/2012 dated February 24, 2012. The detailed explanation of each zone is presented in Table 3.1 and Figure 3.1.

Table 3-1. Zonation in KNP

Name of Zone	Zone in 2020 (based on SK.212/KSDAE/SET.3/KSA.0/11/2020)	Area (Ha)
Core Zone	This zone is totally protected. No disturbance of human activities is allowed, except from those related to science, education and research	34,304.81
Wilderness Zone	No human activities are allowed in this zone, except for limited natural tourism activities	22,192.28
Marine Protected Zone	Only limited natural tourism activities are allowed in this zone, and fishing and harvesting of marine products is not permitted in this zone.	36,308.00
Use Zone	This zone has been designated for the purpose of terrestrial/marine nature tourism	2,408.23
Traditional Local (Community) Use Zone	This is a zone where human activities can be carried out by the indigenous/local communities in support of their livelihoods. A permit is issued by the Head of the National Park.	18,172.59
Traditional Pelagic Zone	In this zone, fishing and the harvesting of marine products that are not protected by Indonesian law can be carried out as well as tourism /recreational activities.	59,601.00
Special Zone	In this zone, indigenous/local communities can live and settle while respecting certain regulations imposed by the head of the Komodo National Park in collaboration with the local government.	313,09
Total Area		173,300.00

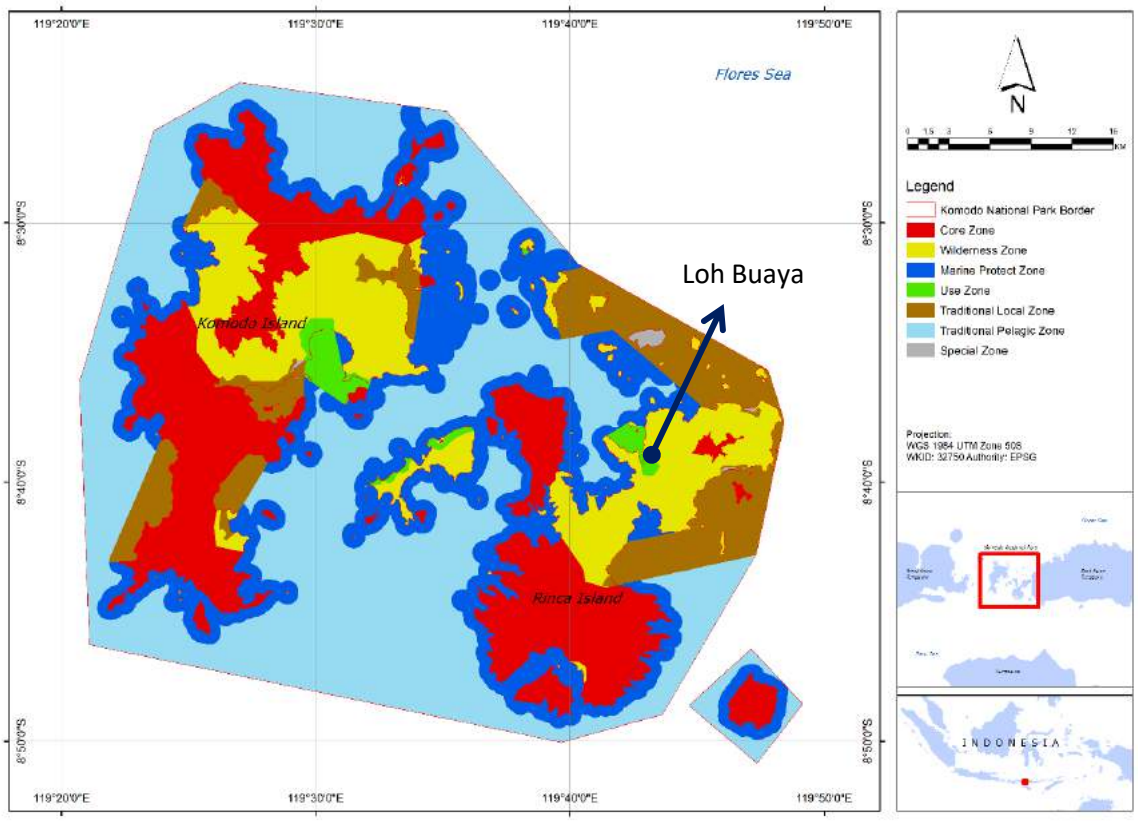

Figure 3-1. Komodo National Park Zoning based on Decree of the Director General of Forest Protection and Nature Conservation Number, SK.212/KSDAE/SET.3/KSA.0/11/2020 dated November 6th, 2020

The project which will be implemented in Loh Buaya, which is situated in the Use Zone. Some of the older infrastructure in poor condition (Table 3.2) will be replaced. The location of the current infrastructure location can be seen in Figure 3.2.

Table 3-2. Condition of existing infrastructure in Loh Buaya

No	Building Name	Area (m^2) /unit	Construction year	Longitude East (degree)	Latitude South (degree)	Condition
1	Ticketing office	105	1985	119°43'4.98"	8°39'19.13"	Old building and it cannot serve visitors optimally
2	Resort Office	200	2010	119°43'4.24"	8°39'19.00"	Moderately damaged
3	Rangers Camp	100	1996	119°43'4.24"	8°39'22.39"	Old building and it cannot serve visitors optimally
4	Café 1	102	2013	119°43'3.62"	8°39'20.12"	Good
5	Café 2	99	2013	119°43'4.28"	8°39'20.09"	Good
6	Toilet	90	2013	119°43'4.84"	8°39'20.28"	Damaged
7	Guest House	100	2013	119°43'6.09"	8°39'21.07"	Physical condition of the building is still good, but less than optimal if it serves a large number of visitors
8	Rangers Camp	72	1985	119°43'6.72"	8°39'22.39"	Very old building, moderately damaged and less than /unitoptimum to serve additional Rangers
9	Pantries	90	2000	119°43'7.40"	8°39'22.93"	Good

No	Building Name	Area (m^2) /unit	Construction year	Longitude East (degree)	Latitude South (degree)	Condition
10	Generator House	100	2013	119°43'7.25"	8°39'24.11"	Good
11	Section Office	250	2011	119°43'0.30"	8°39'11.89"	Good
12	Jetty	104	1987	119°42'55.76"	8°39'14.29"	Old structure and due to its position on shallow mudflat only accommodate a limited type and number of ships
13	Gazebo 1	16	2010	119°43'4.52"	8°39'22.73"	Good
15	Gazebo 1	16	2010	119°43'5.40"	8°39'24.87"	Good
14	Helipad	63	2013	119°43'2.65"	8°39'21.34"	Moderately damaged
16	Solar cell	1	2005	119°43'5.75"	8°39'24.89"	Moderately damaged
17	Footpath	600	-	-	-	Moderately damaged
18	Gate	1	-	-	-	good

Figure 3-2. Aerial photo of Loh Buaya and its existing infrastructure facilities.

Loh Buaya constitutes a flood plain. Certain parts of the area are inundated during the rainy season. The area is also a movement and basking area for the Komodo dragon (Figure 3.3). There are about 15 Komodo dragons that regularly visit and stay in the area – which accounts to 1% of the total population of Komodo dragons in KNP.

Figure 3-3. Movement route of Komodo dragons in Loh Buaya (source: KNP monitoring data and ranger's personal communication).

The area also includes some mangrove forests, which constitutes the habitat for the long-tail macaque (*Macaca fascicularis*) (Erdmann, 2004) and other mangrove biota. The long tail macaque is one of the prey species of the Komodo dragon (Mustari, Juanda, & Jamartin, 2011). Other values that are included under criterion (vii) are situated far from the project location, namely, sea grass, white beach & coral reef (Figure 3.4), and won't suffer from any potential impacts of the project. The land cover of several big islands in KNP is presented in Table 3.3.

3.3. Scale/size and Duration of the Project Plan

Based on the project plan, the proposed infrastructure will replace all existing buildings, except the generator house. The total project area that include stockpiles (the temporal material storage and dumpsite) will cover area of about 13,306 m^2 (1.336 ha) (Figure 3.5). This amount of area is only covers 0.0539 % of the total Use Zone in KNP or 1.03 % of Use Zone in Loh Buaya. The development of various infrastructures is carried out in parallel. The planned infrastructure and its effective area as well as time estimation for complishment is presented in Table 3.4. The project will be completed within 15 months.

Table 3-3 Land cover of several Island in KNP*

Land Cover	Area (Ha)				
	Forest	Mangrove	Savanna	Settlement & Barren Land	Grand Total
Komodo Island	10,039.06	166.92	21,763.34	19.79	31,989.11
Rinca Island	8,036.23	272.02	12,177.88	18.74	20,504.87
Padar Besar Island	13.76	-	1,337.87		1,351.63
Padar Kecil Island	0.05	-	32.15		32.20
Other Islands	480.01	228.62	2,889.23		3,597.86
Total	18,569.12	667.56	38,200.47	38 .53	57,475.67

Note: *(a). the figure does't represent the whole National park boundary, (b) the difference area o feach island may be due to difference resolution of the satellite imageries.

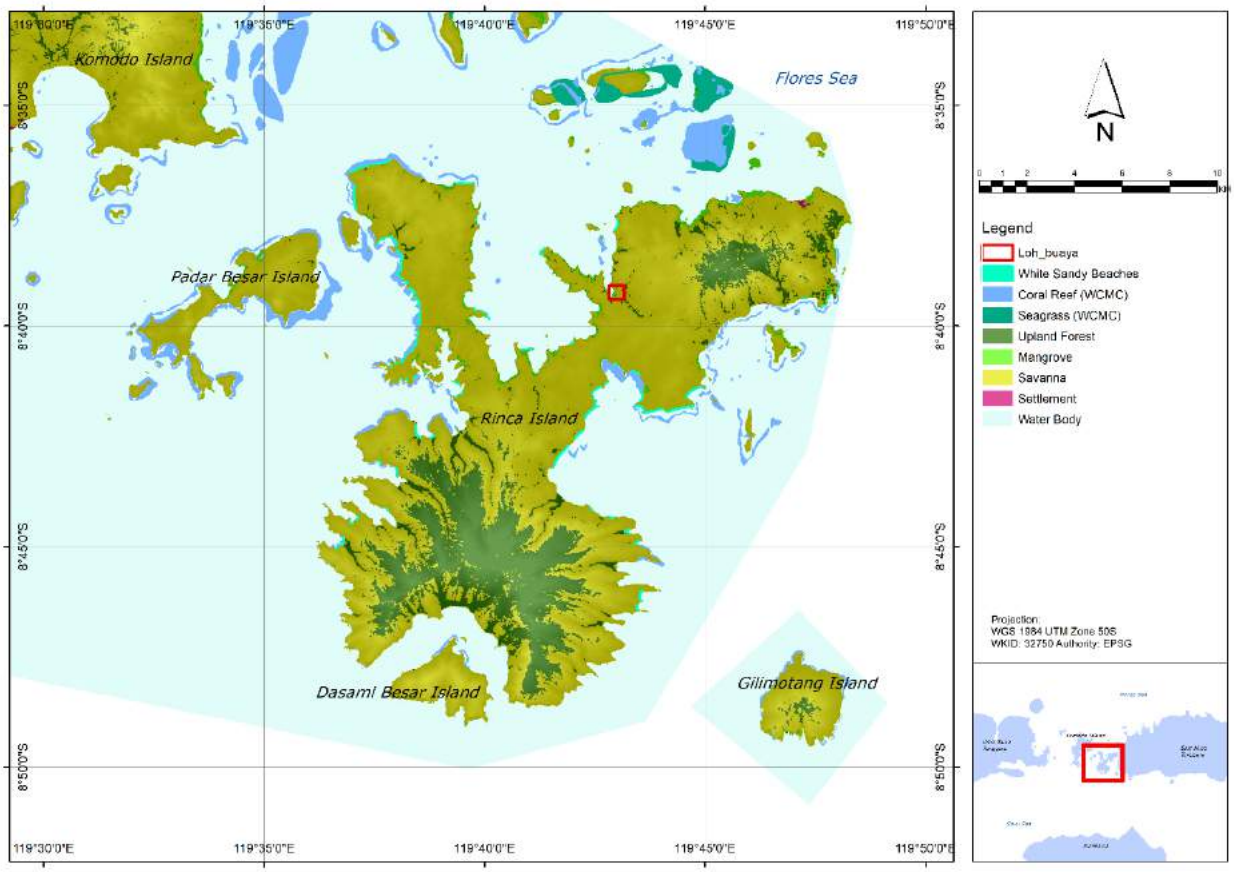

Figure 3-4. OUV under criteria (vii) in Rinca Island

The project is conducted by Ministry of Public Works and Housing, namely: Directorate Water Resources (*Sumberdaya Air*/SDA) and Directorate General of Human Settlements (*Cipta Karya*/CK). Directorate Water Resources responsible for Jetty and Coastal protection construction, meanwhile the Directorate Cipta Karya for the rest of the infrastructures. The timeline for the construction of each infrastructure from the preparation stage to completion is presented in Appendix 3.1. The layout/site plan is presented in Figure 3.5, meanwhile its technical design and drawing is presented in Appendix 3.2.

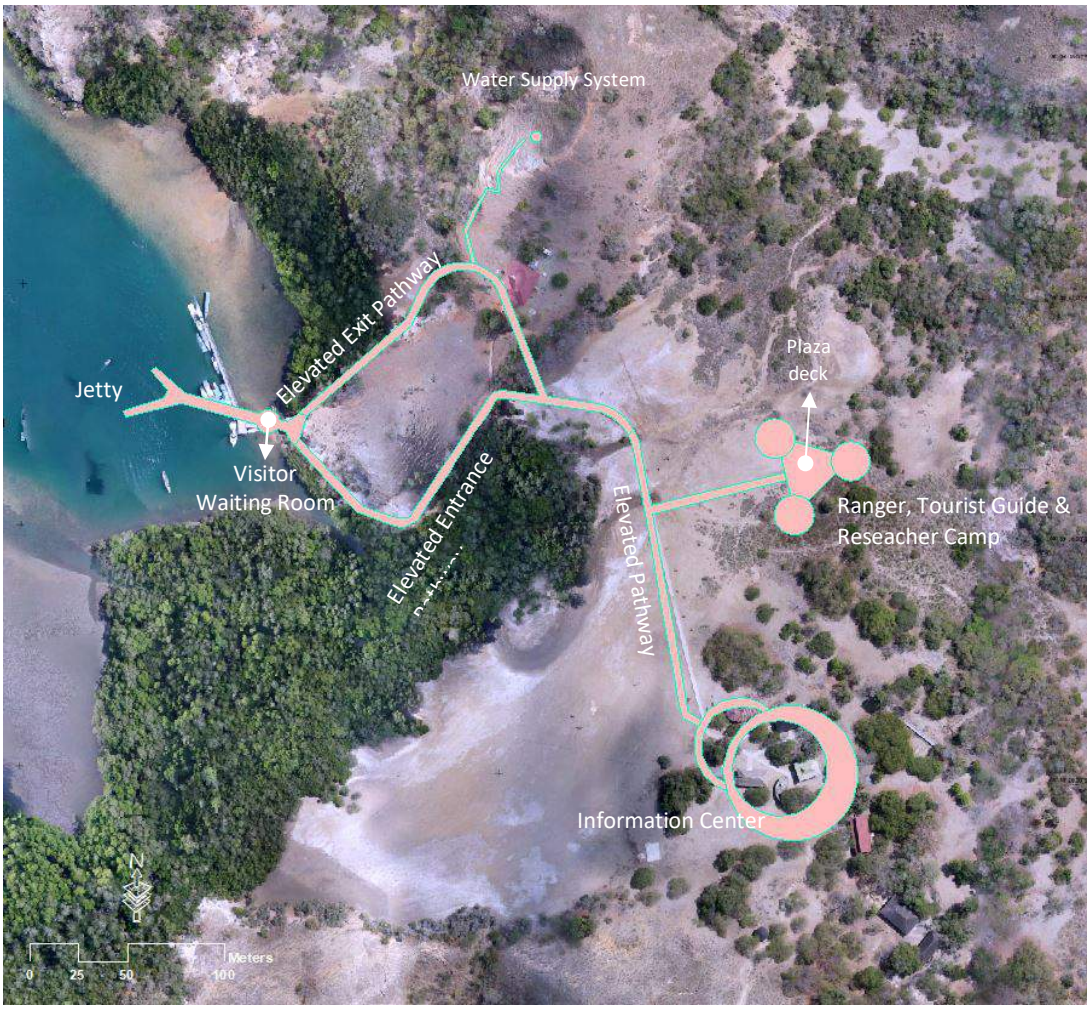

Figure 3-5. The layout plan of the project (site plan)

3.4. Component of the Project

3.4.1. Project suitability to zonation of the park

The Spatial Planning of West Manggarai District is regulated by Regional Regulation No. 9 of 2012 concerning the Spatial Plan of West Manggarai District for 2012-2032. Based on the Regional Land-use Planning (*Rencana Tata Ruang Wilayah Kabupaten*/ RTRW) of West Manggarai District Article 33 paragraph 2, the location of the Rinca Island is designated as a Nature Reserve area. Furthermore, based on the Komodo National Park Zoning Map (Figure 3.1), Loh Buaya is situated in the Use Zone designated for the purpose of nature tourism activities.

Table 3-4. Planned infrastructure development.

No	Infrastructure	Area (m^2)/Length (m) /Volume (m^3)	Position		Duration Estimation of the Development*
			Longitude East (degree)	Latitude South (degree)	
1	Ranger camp	314 m^2	119°43'4.63"	8°39'14.40"	11 months (December 2020-October 2021)
2	Guide camp	314 m^2	119°43'4.94"	8°39'15.64"	11 months (December 2020-October 2021)

No	Infrastructure	Area (m^2)/Length (m) /Volume (m^3)	Position		Duration Estimation of the Development*
			Longitude East (degree)	Latitude South (degree)	
3	Researcher camp	314 m^2	119°43'5.90"	8°39'14.76"	10 months (January 2021-October 2021)
4	Plaza Deck	318 m^2	119°42'56.14"	8°39'14.19"	8 months (February 2021-September 2021)
5	Elevated pathway (two meters' height above the ground),	695 m (length) 4 m (wide)	-	-	12 months (October 2020-September 2021)
6	Waiting room of visitor	110 m^2	119°42'56.14"	8°39'14.19"	5 months (January 2021-May 2021)
7	Information Center	2, 667 m^2	119°43'4.77"	8°39'19.91"	13 months (October 2020-October 2021)
8	Reservoir tank	50,000 liter	119°43'0.59"	8°39'9.47"	6 months (September 2020-February 2021)
9	Distribution pipeline	550 m	-	-	6 months (September 2020-February 2021)
10	Jetty	400 m^2	119°42'54.52"	8°39'13.77"	8 months (November 2020-July 2021)
11	Coastal protection	100 m	119°43'4.98"	8°39'19.13"	5 months (December 2020-April 2021)
Total Estimated construction duration*					15 months

Note: * Including pre construction stage

3.4.2. Principal permission of the activities

The arrangement of the Rinca Island area through improving the quality of existing facilities and infrastructure in the Loh Buaya area has received approval from the Ministry of Public Works and Housing, Secretary General of the National Strategic Project Monitoring and Evaluation Team as stated in the letter No.UM.01.02/33/TPE-PSN/2020 dated 9 April 2020 which was signed by the head of Central Project Management Unit- Integrated and Sustainable Tourism Development Program (*Unit Manajemen Proyek Pusat- Program Pengembangan Pariwisata Terpadu dan Berkelanjutan*/CPMU P3TB) (Appendix 3.3).

3.4.3. Component of activities plan that might be impact on OUV & environmental

3.4.3.1 Pre Construction Stage

The environment quality condition of KNP before the project is presented in Appendix 3.4. These data are collected just before the pre construction stage. The pre-construction stage includes socialization activities, site surveys, and land preparation.

a. Public Consultation & Site Survey

The purpose of public consultation is to obtain inputs regarding the project that will be carried out. On October 21, 2019, a public consultation meeting was held at Luwansa Beach Resort, Labuan Bajo, to introduce the regional tourism development plans as part of the National Tourism Strategic Area [Kawasan Strategis Pariwisata Nasional (KSPN)]. One of the activities discussed during the meeting was the the plans

related to the renovation and construction of infrastructure in Loh Buaya located in the Use Zone of KNP. Participants, including residents of West Manggarai District agreed and supported the plans and proposed project (Appendix 3.5).

On 28 July 2020, a public consultation was conducted to discuss the Preparation of Environmental Documents on Improving the Rinca Island Area through the Zoom Meeting application. Coordinating Ministry for Maritime Affairs and Investment, Ministry of Environment and Forestry, Ministry of Education and Culture, Ministry of Tourism and Creative Economy, and the Ministry of Public Works and Housing, as well as Local Government and Community Leaders attended the meeting. The floor agrees to revise the frame work to follow IUCN guidline of EIA and to include ecological scientists from the Bogor Agricultural University (IPB) (Appendix 3.6). Furthermore, on September 1st, 2020, a public meeting was also held in Kantor Desa Pasir Panjang, Rinca island. The Ministry of Public Works & Housing agreed to include the community as workers in the project (Appendix 3.7).

A site survey will be conducted in Loh Buaya, Rinca Island, on an area of 13,306 m^2 (1.33 Ha) to prepare the project development. Interviews with residents, measurements of several segments in the project site, and updates on the development design will be conducted to determine the type of infrastructure and the area needed for the project development. The tourism infrastructure development in Loh Buaya will be carried out as much as possible on existing building areas, including the jetty.

b. Land preparation

At the land preparation stage, several activities will be carried out, namely making transportation & connection road, demolition of existing buildings including existing jetty, preparing the construction of coastal protection and stockpile locations.

(a) Temporary jetty

This temporary jetty has a length of approximately 75 meters and a width of 6 meters. This facility will be built to the north of the existing jetty, which will be demolished. This location is a mangrove mudflat area, while the transportation route passes through the gap between mangroves so that no mangroves will be cut down and only the branch will be trimmed (Figure 3.6a). The design of the temporary jetty is shown in Appendix 3.8.

The process of making temporary jetty are as follows:

i. Marking locations points by surveyor team.
ii. Drive WF Steel Beam, which is used as column, into soil using vibratory hammer from the barge vessel.
iii. Install bracing using steel H-Beam and cross section using steel sheet pile between columns with welding reinforcement.
iv. After all, bracing and cross section are installed, then install girder using steel H-Beam.
v. Cover the girder with checkered plate that is used for floor plate.

Construction of the temporary jetty uses Wide Flange (WF) Steel Beam, Steel H-Beam, Checkered Plate, Steel Sheet Pile, Angle Bar, Barge Vessel, Crawler Crane, and vibratory hammer. It will take approximately 10 days to complete with average fuel consumption of 200 liters per day.

(b) Transportation & Connecting Road construction

The transportation route connects the temporary jetty and 4 location of temporary stockpile which also part of the area functioned as dumpsite. This transportation line will be used for the mobilization and demobilization of project materials and equipment. The transportation route connects the temporary jetty

and the temporary dumpsites with a three meters width and 737 m length dirt road, meanwhile the connecting road connects the transportation route with several construction spots with a three meters width and 298 m length dirt road (Figure 3.6b). The mobilization and demobilization of project materials and equipment use this route. Estimatimation of materials and type of equipment is presented in Appendix 3.9.

The process of making transportation route are as follows:

i. Marking route pathway by surveyor team.
ii. Clearing and leveling area using excavator and dump truck.

Construction of the access roads uses two excavators and four dump trucks that operate from 8.00 AM – 12.00 PM and 1.00 – 4.30 PM everyday. It will take approximately 7 days to complete with average fuel consumption of 100 liters per day.

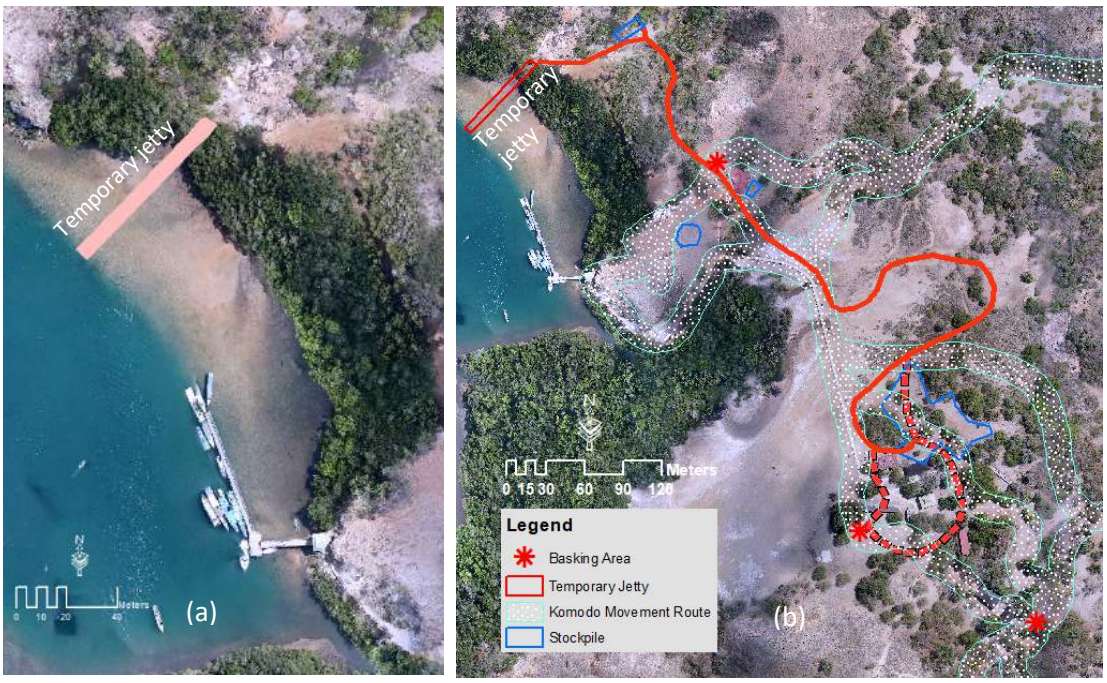

Figure 3-6. (a) Temporary Jetty, (b) Transportation road (red line) and Connecting road (dash red lines) between temporary jetty and stockpile locations

(c) Demolition the existing building

KNP carried out the demolition of buildings (jetty, resort office, ticketing, ranger camp, café, pantries and toilets) through the asset write-off procedure. The demolition material in the form of wood will be taken to the stockpile location which part of the area serves as a dumpsite. There are four stockpile at separated location, which cover of about 3,590 m2 (Figure 3.7b).

- Demolition of existing jetty

The new jetty to be built has a width of four meters, with a length of 100 m and 80 m, respectively. The jetty will be partially built right on the area of the existing jetty, which will be demolished (Figure 3.7a). The demolition of existing jetty will take approximately seven days to complete with average fuel consumption of 100 liters per day. The dismantling process will be carried out manually using manual tools. The volume of demolition material of floor plank and wood structure is about 4.16 m^3 and 29.12 m^3, respectively. The

remaining wood from demolition will be handed over to KNP as assets, which then it will be auctioned off to the public.

- **Demolition of resorts office, section office, ticketing, ranger camp, cafés, pantries and toilets**

The new information center will be built right on the land where existing buildings, namely the resort office, section office ticketing, ranger camps, cafés, pantries and toilet, which all will be demolished (Figure 3.7b). Demolition is planned to be carried out within one month. Demolition materials in the form of wood and steel are carried outside the National Park, while the rubble is used as a pavement medium of transportation road upon the inspection there is no dangerous materials such as steel and asbestos. All of the materials will be retrieved when construction is complete. The estimate demolition materials are presented in Table 3.5.

The process of demolition of resorts office, section office, ticketing, ranger camp, cafés, pantries and toilets are as follows:

i. Dismantling the roof and windows manually using manual tools.
ii. Demolishing building and construction using excavator.
iii. The remaining materials from demolishing process in the form of wood and iron will be collected in stockpiles/temporary dumpsite area before carried outside national park. They will be then transported to Labuan Bajo by a ship (with a full capacity of four tons) that operate daily.
iv. Rubble material will be used as a soil compaction material at the transportation area. The materials will be mixed with the soils cut from the mound (see Coastal protection). The compacted soil be will be dugged and mixed to return it to original condition.

Figure 3-7. (a) Existing jetty and proposed location to build the new jetty (blue line), (b) resort office, ticketing, ranger camp, café, pantries and toilet which will be demolished to build an information center (blue line).

Table 3-5. *Estimated volume/weight of demolition materials of each buildings*

No.	Building Name	Area (m^2)	Estimated demolition materials
1	Ticketing office	105	Concrete: 105 x 0.15 = 15.75 m^3 Steel : 15.75 x 120 = 1.890 kg Wood (rafter, beam & board): 105 x 0.03 = 3.15 m3 Brick Wall : 22.05 m3
2	Resort Office	200	Concrete : 200 x 0.15 = 30.00 m3 Steel : 30 x 120 = 3.600 kg Wood (rafter, beam & board): 200 x 0.03 = 6 .00 m3 Brick Wall : 36.00 m3
10	Section Office	250	Concrete : 250 x 0.15 = 37.50 m3 Steel : 37.50 x 120 = 4.500 kg Wood (rafter, beam & board): 250 x 0.03 = 7.50 m3 Brick Wall : 43.20 m3
3	Rangers Camp 1	100	Concrete : 100 x 0.15 = 15.00 m3 Steel :15.00 x 120 = 1.800 kg Wood (rafter, beam & board): 100 x 0.03 = 3 .00 m3 Brick Wall : 22.50 m3
8	Rangers Camp 1	72	Concrete : 72 x 0.15 = 10.80 m3 Steel : 10.8 x 120 = 1.296 kg Wood (rafter, beam & board): 72 x 0.03 = 2.16 m3 Brick Wall = 19.35 m3
7	Guest House	100	Concrete : 100 x 0.15 = 15.00 m3 Steel : 15.00 x 120 = 1.800 kg Wood (rafter, beam & board): 100 x 0.03 = 3.00 m3 Brick Wall : 22.50 m3
9	Pantries	90	Concrete : 90 x 0.15 = 13.50 m3 Steel : 13.50 x 120 = 1.620 kg Wood (rafter, beam & board) : 90 x 0.03 = 2.70 m3 Brick Wall : 17.10 m3
4	Café 1	102	Concrete : 102 x 0.15 = 15.30 m3 Steel : 15.30 x 120 = 1.836 kg Wood (rafter, beam & board): 102 x 0.03 = 3.06 m3 Brick Wall : 13.05 m3
5	Café 2	99	Concrete : 99 x 0.15 = 14.85 m3 Steel : 14.85 x 120 = 1.782 kg Wood (rafter, beam & board): 99 x 0.03 = 2.97 m3 Brick Wall : 13.05 m3
6	Toilet	90	Concrete : 90 x 0.15 = 13.50 m3 Sreel : 13.5 x 120 = 1.620 kg Wood (rafter, beam & board): 90 x 0.03 = 2.70 m3 Brick Wall : 21.60 m3

The demolition process uses 1 excavator, 2 dump trucks and manual tools (saw, hammer, and hoe). It will take approximately 20 days to complete with average fuel consumption of 100 liters per day. The estimated demolition materials of each building is presented in Table 3.5 above.

- Demolition of existing concrete footpath and gate for elevated pathway construction

Elevated pathway will be built to connect the current arrivals area near the jetty with the information center building and the complex of ranger, reseacher and guide camp. Total length of the elevated pathway would be 695 m long, 4 m wide and 2 m above the ground. Preparation for the construction is carried out by demolishing the existing concrete footpath and gates (Figure 3.8).

The process of demolition of existing concrete footpath and gates are as follows:

i. Demolishing the gate using excavator.
ii. Demolishing the pathway using excavator.
iii. The wood and iron waste from the demolition process will be collected in a temporary dumpsite before carried outside national park.
iv. Rubble material will be used as a soil compaction material in the transportation road area

This stage of work uses 1 excavator and 2 dump trucks. It will take approximately 7 days to be completed by 4 workers, 2 drivers and 1 excavator operator, with an average fuel consumption of 80 liters per day. The the rubble is used as a pavement medium of transportation road upon the inspection there is no dangerous materials such as steel and asbestos

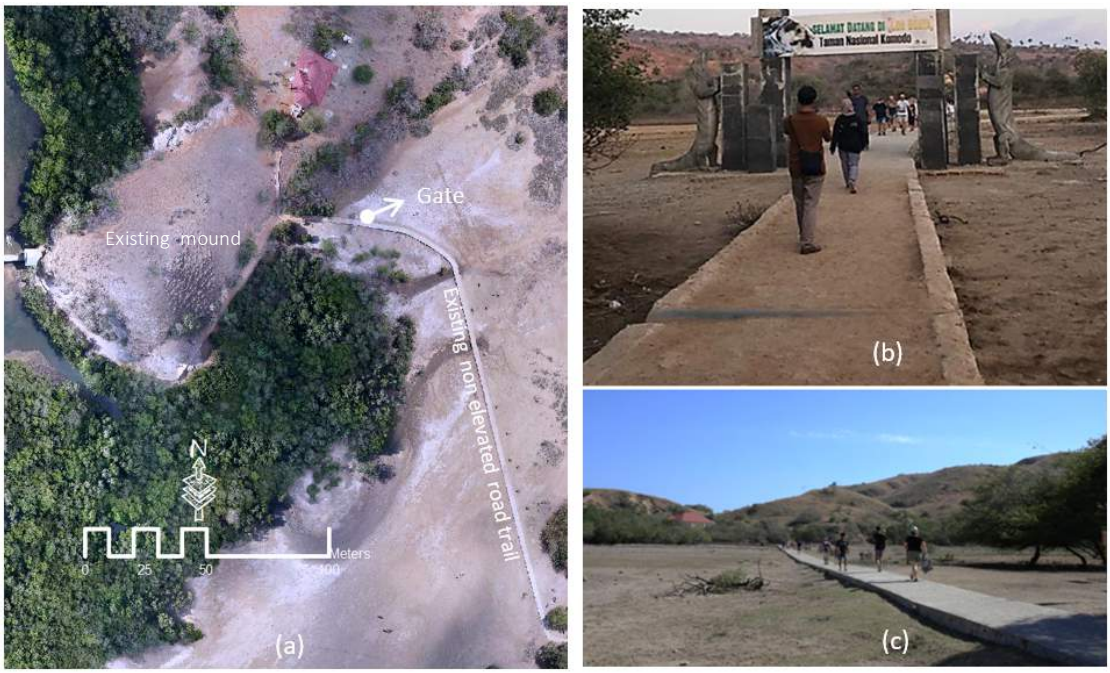

Figure 3-8. Footpath entering KNP (a) UAV image (b & c) gate and existing dirt and concrete footpath (non elevated)

(c) Coastal protection

The coastal protection will be built at the suggestion of KNP, considering the natural occurrence of seawater abrasion in the jetty area. The construction of coastal protection is carried out by removing some of the top soil layer of the mound at the entry route, trimming some of the mangrove branches, and stockpiling some of the mudflats. The soild on the top of the mound will be removed off about two meters wide by 50 meters long and 60 meters for KNP entry and exit routes (Figure 3.9).

The process of land preparation for coastal protection are as follows:

i. Marking locations points and leveling by surveyor team.
ii. Scrap the mound using 1 excavator and manual tools.
iii. Soil compaction and leveling using 1 excavator.
iv. Make lean concrete.

This stage of work uses concrete, boulder stone, geotextile, excavator, dump truck, water tank truck, and concrete mixer. It will take approximately 45-60 days to complete with three operators, four masons, five workers, two vehicle drivers, 15 barge crews, two surveyors and an average fuel consumption of 200 liters per day.

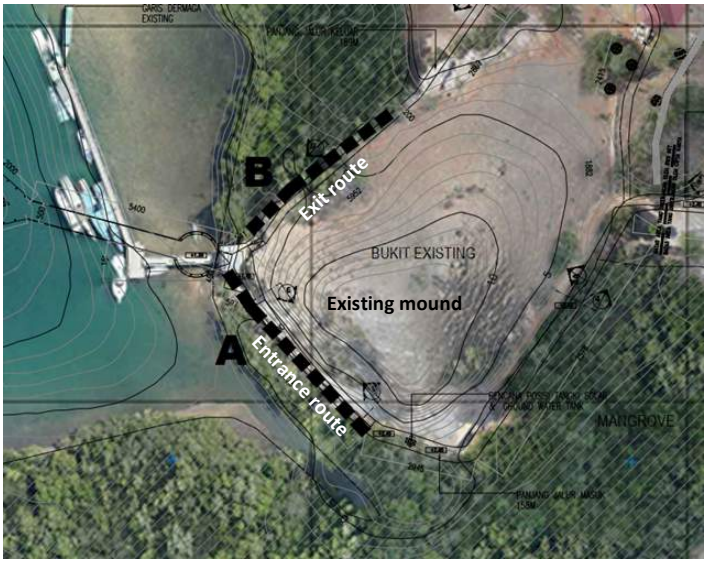

Figure 3-9. Coastal protection (A: Entrance route, B: Exit route).

(d) Water supply system

The reservoir of the water supply system to be built is 50 m^3 in size, with a diameter of 5.14 m and a base plate size of 5.68 m. This facility is planned to be built on a hillside (Figure 3.10), thus, it is necessary to build a foundation to strengthen the slopes, including process of excavation and embankment of soil.

The process of land preparation for water supply system are as follows:

i. Scrap the mound using jack hammer.
ii. Soil fill, compaction and leveling using tamping rammer

This stage of work uses generator, two jack hammers, two tamping rammers and manual tools. It will take approximately 60 days to be completed by 15 workers, with average fuel consumption of 35 liters per day.

(e) Ranger, Tourist Guide and Researcher Camp

Researcher Camp, Ranger, Tourist Guide, and Researcher Camp are to be built on vacant land, and therefore no specific land preparation is conducted.

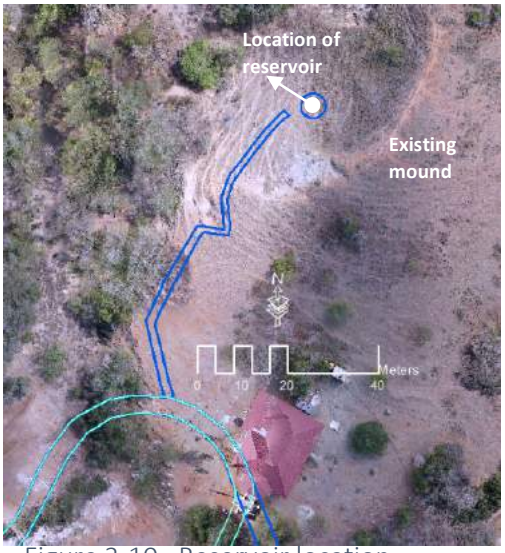

Figure 3-10. Reservoir location

3.4.3.2. Construction Stage

1. Mobilization of construction workers

The mobilization of the workforce is carried out in stages according to the needs of the work. Estimated workforce requirements for the whole project activities are as follows:

- The total workforce is -/+ 200 people came from Directorate General Water Resources and Directorate General of Public Housing whom 60 to 70% will be hired from Rinca Island, Labuan Bajo, and the surrounding area

Skilled workers are brought in from Surabaya, East Java, and its surrounding area. These workers stay in two separate camps. The workers from the Directorate General of Water Resources stay at the existing KNP resort office building area, while the workers from the Directorate General of Human Settlements stay at the existing Guest House and Ranger Camp. Domestic waste management: solid waste is collected at the workers' camp and transported daily using local wooden boat which will used as logistics vessels, and liquid waste is streamed into the existing septic tank

2. Mobilization of equipment and materials

Mobilization of equipment and materials use barges and Landing Craft Tank (LCT) vessels through sea route. The equipment used is imported from Java Island, and the materials are partly locally sourced and imported from Java Island. This trip takes four-five days for delivery and another two–three days to unload the materials on the site. Details of the number of equipment and materials are as follows:

(a) Equipment

The equipment imported is as follows: Hydraulic Static Pile Driver (HSPD) - one Unit, Crawler crane - one unit, Excavator - four Units, Dump Truck - five Units, Mixer Truck - four Units, Self-loader - one Unit, Barges - four Units, Drilling Tools - two Units, Flatbed Trailer 10 tons, water tanks (capacity of 3000 liter).

(b) Material

The types of materials to be mobilized include piles, sand, cement, mountain stone, red stone, iron, wire, nails, tiles, wood, and paint, all of which come from Labuan Bajo. The type and amount of material needed are calculated based on the type and volume of each facility to be built. The materials from outside the

Rinca Island will be carried out by sea transportation using barges/pontoons several time during construction, and daily by local wooden boat. This include 2,900 tons of minipiles; 300 tons of micropiles; 1,800 tons of cement; three tons of sands; 7,800 tons of rocks; 650 tons of boulders; 135 tons of ironwood. The extractive and rock materials (3,200 tons of sands; 7,800 tons of crushed tones; 650 tons of boulders; 135 tons of ironwood) are from licensed locations and transported to Loh Buaya via sea by two wooden ships that operate alternately every day.

For infrastructure construction of the temporary and permanent jetty, two pontoons will be used altenately. The material ready to use is stored in one pontoon until the existing material is used up and replaced with another pontoon containing the material. This pontoon will be positioned in the temporary dock where the boats will anchor.

For construction on land areas, the material is transported by sea until the temporary jetty, then transported using a three - five tons' truck to the stockpile location at the land facility construction site (Figure 3.6b), with a maximum of twice a day. The types and quantities of materials needed during the infrastructure construction of Rinca Island are shown in Appendix 3.9.

3. Construction of operation of base camp and stockpile

The base camp will be built in an area of 3,758 m^2, near the existing Section office. The base camp will function as a site office or temporary office, a place to store materials (stockpile) for the land construction facilityof KNP, and a place to stay for workers who also work as security. Part of the area also used as dumpsite of demolition materials. Basecamp will be built using wood and multiplex with a house model on stilts and surrounded by a 2 m high alluminium fence to anticipate the presence of wildlife.

4. Jetty

The construction of the main jetty in Loh Buaya covers an area of 400 m^2 (100 meters long and 4 meters wide) using a bore pile foundation with a full casing of 54 points with a plate made of ironwood. Near the entrance gate, there is a gazebo that will function as a waiting room for tourists. Both ends of the main jetty will also be connected to a floating jetty (the jetty design is presented in Appendix 3.10).
Construction materials for the jetty are shown in Table 3.6.

Table 3-6. Materials for the construction of the jetty.

No	Material	Dimension
1	1000 mm wide Aluminum Gangway	20 m
2	Gangway bracket	2 units
3	Buoy Module 2.94m x 1.94m x 0.36m	20 units
4	Connector with SS Bolt	108 set
5	Galvanised cleats	40 units
6	Ship Fender 1 Span PE Soft	80 units
7	Buoyancy Pillow for Modular	12 units
8	Tether Bracket	20 units
9	Anchor Rope (Per Point @ 25m)	500 m
10	Tether System	20 units
11	Aluminum Sheet 5mm (122 x 244 cm)	4 units
12	2 ton ballast	20 units
13	Pile	54 units

The type of foundation on the main jetty is divided into three based on the maximum depth of seawater (five m, 10 m, 15 m freestanding). A drill post with a diameter of 1,000 mm has an embedded length of 12 m into the ground, and a drill post with a diameter of 800 mm has an embedded length of 6 m into the ground.

The jetty construction work is carried out in the following stages:

a. Pile drilling and case mounting

The stages of pile drilling and casing installation are as follows:

i. Determinations of drilling point;
ii. Inspection of bore pile equipment (barge, pile drilling machine with auger and crane);
iii. Drilling with drill machine to the specified depth;
iv. Crane service picks up the pipe casing from the stockpile to the transport pontoon, and then it is brought to the bore pile location;
v. A crawler lifts the pipe casing and inserts it into the drill pipe;
vi. After the pipe casing installation is complete, proceed with the installation of reinforcing iron that has been assembled at the iron site;
vii. After the installation of reinforcing iron is complete, proceed with the foundation casting process using a concrete mixer;
viii. Work continues with the installation of formwork and scaffolding for pile caps and beams; and
ix. After installing the scaffolding and formwork, proceed with installing reinforcing steel for the pile cap and jetty beams, then casting beams and pile caps is carried out using a concrete mixer on a barge.

This stage of work uses two units of barges, one unit of bore pile, two units of crane, two units of concrete mixer, two units of tug boats, two units of generators, a vibro hammer, and a theodolite. The workforce consists of three operators, four masons, five workers, two vehicle drivers, 15 barge crews, and two surveyors. This work will take ± 30 days with average fuel consumption of 150 liters per day. The ex-drilled soil is stored in the barge stockpile to be dried and used as pavement for access roads for materials and equipment.

b. Formwork, iron, pile cap & beam casting

The process of working on the formwork, ironing, casting the gazebo is carried out in the following stages:

i. After the foundation casting is complete, proceed with installing formwork and scaffolding for pile caps and beams;
ii. After the scaffolding and formwork are installed, proceed with installing reinforcing steel for the pile cap and pier beams; and
iii. Proceed with casting beams and pile caps using a concrete mixer on the barge.

This stage of work uses four units of drilling machine, two units of wood saw machine, four units of chisel, four units of hammer. The workforce consists of eight carpenters and four workers. This work will take ± 120 days with average fuel consumption of 60 liters per day, and the remaining pieces of formwork wood and reinforcing steel are collected in the stockpile.

c. Formwork, ironing, casting gazebo

The process of working on the formwork, ironing, casting the gazebo is carried out in the following stages:

i. After the foundation casting is complete, proceed with installing formwork and scaffolding for pile caps and beams;

ii. After the scaffolding and formwork are installed, proceed with installing reinforcing steel for the pile cap and pier beams; and
iii. Proceed with casting beams and pile caps using a concrete mixer on the barge.

This stage of work uses two units of barges are used, one unit of bore pile tool, two units of cranes, two units of concrete mixer, two units of tug boat, two units of generator, one unit of vibro hammer, and two units of theodolite. The workforce consists of three operators, four masons, four ironsmiths, five workers, two car drivers, four barge drivers and 15 crews, and two surveyors. This work will take ± 60 days with average fuel consumption of 10 liters per day, and the remaining pieces of formwork wood and reinforcing steel are collected in the stockpile.

d. Ironwood floors and handrail installation

After the age of the concrete is reached, then the work of assembling and installing ironwood floors will continue in the following process:

i. Ironwood is arranged according to the supervisor's instructions and assembled using screws and bolts;
ii. Ironwood is installed by three segments until it is completed;
iii. In parallel with ironwood installation, the handrail assembly is carried out by two-meter segments
iv. After installing the ironwood floors and handrail is complete, the remaining pieces and powder are cleaned

This stage of work uses generators with a capacity of 5KvA, four units of drilling machines, two units of saws, four units of chisels, and four units of hammers. The workforce consists of eight artisans and four workers. This work will take ± 60 days with average fuel consumption of 10 liters per day, and the remaining pieces of ironwood are collected in the stockpile.

e. Gazebo roof installation

Gazebo roof installation is carried out in the following steps:

i. After the age of the concrete is reached, proceed with the assembly and installation of the roof truss before continuing with the lightweight roof works.
ii. After the frame installation is complete, install the techno wood covered with a geomembrane to prevent leakage during the rainy season.
iii. Proceed with installing the synthetic rattan cover

This stage of work uses a generator with capacity of 5KvA, four units of drilling machine, and four units of hammer. The workforce consists of 8 workers. This work will take ± 30 days with average fuel consumption of 10 liters per day, and the rest of the excess material is collected in the stockpile.

5. Coastal protection

The development plan for coastal protection is carried out on the left and right sides of the main jetty with a length of 100 m (40 m to the left and 60 m to the right) (Figure 3.8), with a bottom foundation of 50 – 60 cm wide and 150 – 200 cm tall. The construction of coastal protection is intended to prevent erosion of the road which the Directorate General of Water Resources will build. Design of coastal protection is presented in Appendix 3.11.

This stage of work uses two excavators and two dump trucks with a total workforce of ten workers. This work will take ± 30 days with average fuel consumption of 200 liters per day, and the rest of the excessive material is collected in the stockpile location.

6. Elevated pathway

The construction of land areas includes the construction of concrete road of elevated pathway, covering an area of about 3,000 m^2. The design of the elevated pathway is provided in Appendix 3.12. The elevated pathway's construction stages start from the excavation of the foundation (Volume 330 m^3 and depth 55 cm) and the erection of the micro pile, the reinforcement of the foundation and column, the casting, the installation of the ironwood floors and handrails.

The construction process is carried out in several stages from excavation of foundation and pilling of micro pile, foundation and column reinforcement, foundation and column casting and the last stage is the installation of ironwood floors and handrails.

a. Excavation of foundation and micropile

The process of excavating the foundation and pilling the micro pile is carried out with the following steps:

i. Excavators dig with a bow plank base that has been prepared in size (length, width, and depth).
ii. The soil from the excavation are placed on the side, which can lbe used later for backfill.
iii. After the excavation work is complete, proceed with pilling the micro pile with an excavator

This stage of work uses one unit of excavator, two units of concrete mixer, three units of concrete vibrators, and other tools such as hooks, hoes, baskets, iron pliers, bar bending machines, bar cutters, and screwdrivers. It will approximately 60 days to be completed by one operator, 10 masons, 12 blacksmiths, eight workers, and two drivers, with an average fuel consumption of 150 liters per day. The soil from the excavation will be used as pavement for an access road for material and equipment mobilization.

b. Foundation and column reinforcement

The foundation and column reinforcement process are carried out with the following steps:

i. After the excavation is complete and level, the next stage is lean concrete work.
ii. Assembling the reinforcing iron that has been cut according to the design.
iii. The iron is tied using a wire so that it does not move during casting work.

This stage of work uses a crowbar, bar cutter, and iron pliers. It will take approximately 60 days to be completed by 12 workers. The iron waste will be collected in sacks and stored in a temporary stockpile.

c. Foundation and column casting

After the ironing process is complete, proceed with casting process as follows:

i. Installation of box formwork for the foundation.
ii. Casting with concreate mixer and assisted with an excavator for pouring.
iii. Installation of formwork boxes for columns and continued with column casting.
iv. After casting, the column continued with the installation and preparation of scaffolding.

This stage of work uses two units of concrete mixers, one unit of excavators, one unit of concrete vibrators. It will take approximately 60 days to be completed by 13 workers, with an average fuel consumption of 150 liters per day.

d. Installation of ironwood floors and handrails

The installation process of ironwood floors and handrails is carried out with the following steps:

i. After the age of concrete is reached, then the work of assembling and installing ironwood floors will continue.

ii. Ironwood is arranged according to the supervisor's instructions and assembled using screws and bolts.
iii. Ironwood is installed in three segments and continues until it is finished.
iv. When the ironwood floor is installed, the handrail assembly is also carried out in parallel with two-meter segments.
v. After the work of installing the ironwood floors and handrails, the remaining pieces and dusts are cleaned

This stage of work uses four units of drilling machines, four units of wood saws, four units of chisels, and four units of hammers. It will take approximately 120 days to be completed by 12 carpenters and four workers, with an average fuel consumption of 10 liters per day. The excess ironwood will be collected in the stock pile.

7. Ranger, tourist guide and researcher camp (camp building)

The camp building area consists of accommodation for rangers, guides, and researchers covering an area of 1,510 m^2, with effective area of about 1260 m^2 (Table 3.7). These infrastructures are connected with elevated plaza (plaza deck). The design of the camp building is presented in Appendix 3.13.

Table 3-7. The Camp Building to be built

No	Infrastructure	Effective area Area (m^2)	Total Rooms	Room Capacity (person)
1	Ranger camp	314 m^2	6	12
2	Tourist guide camp	314 m^2	8	16
3	Researcher camp	314 m^2	6	12
4	Elevated Plaza (Plaza deck)	318 m^2	-	-
Total		1,260 m^2	20	40

The construction process is carried out in several stages, namely:

a. Pilling

The pilling process is as follows:

.

i. Marking the pile point by surveyor team
ii. Check the mini pile material to be used.
iii. Check the pilling equipment to be used (crawler crane, HSPD, and generator)
iv. Crane service picks up mini piles from the stockpile to pile point.
v. The mini pile is picked up and attached to the pilling tool (HSPD)
vi. After the mini pile has been attached on HSPD, the surveyor checks the position of the pile if it is straight and upright.
vii. Once ready, the HSPD machine installs the mini pile into the joint connection point.
viii. The mini pile is welded then continues to be installed into the specified depth.
ix. After reaching the specified depth, the remaining mini pile is cut using a concrete cutter, and the pilling work continues to the next point.

This stage of work uses 1 unit of crane, 1 unit of HSPD, one unit of generator, one unit of concrete cutter, two units of transformer welding, and two units of theodolite. It will take approximately 45 days to be

completed by three operators, two welders, two crews, and two surveyors, with an average fuel consumption of 200 liters per day.

b. Pile cap and pedestal column

The construction process of pile cap and pedestal is carried out as follows:

i. Start the pile cap excavation using an excavator and manual tools.
ii. After reaching the specified elevation, proceed with the floorwork construction.
iii. Assemble the reinforcement steel according to the design.
iv. Install the formwork and add reinforcement.
v. After the formwork and reinforcement work is complete, proceed with the casting using a concrete mixer and excavator.

This stage of work uses one unit of excavator, two units of concrete mixer, three units of concrete vibrator, and other tools such as pickaxe, hoes, iron pliers, screwdriver, bar bending machine, and bar cutter machine. It will take approximately 30 days to be completed by one operator, eight masons, 10 blacksmiths, seven workers and two drivers, with an average fuel consumption of 150 liters per day. The wood and reinforcement iron waste will be collected in sack in a temporary dumpsite before carried outside national park.

c. Floor beams and slabs

After casting the pedestal column, proceed with the following work:

i. Install and frame the scaffolding
ii. Install formwork for plates and beams
iii. Assemble iron and wire mesh for floor plates
iv. Casting beams and floor plates

This stage of work uses one unit of excavator, two units of concrete mixer, three units of concrete vibrator, one unit of dump truck and other tools such as pickaxe, hoes, iron pliers, screwdriver, bar bending machine, and bar cutter machine. The work will take approximately 90 days to be completed by one operator, eight masons, 10 blacksmiths, 29 workers and two drivers, with average fuel consumption of 150 liters per day. The wood and reinforcement iron waste will be stored in sack in a temporary dumpsite before carried outside national park.

d. Column and beam

After the concrete age in beam casting is reached, the work continues in the following steps:

i. Round column reinforcement
ii. Install the formwork for column and beams
iii. Beams reinforcement and casting

This stage of work uses one unit of excavator, two units of concrete mixer, three units of concrete vibrator, one unit of dump truck and other tool and equipment such as pickaxe, hoes, iron pliers, screwdriver, bar bending machine, and bar cutter machine. The work will take approximately 75 days to complete with one operator, eight masons, 10 blacksmiths, 29 workers and two drivers, with an average fuel consumption of 150 liters per day. The wood and reinforcement iron waste will be stored in sack in a temporary dumpsite before carried outside national park.

e. Roof installation

After the age of concrete is reached, proceed with the following work:

i. Assemble and install the roof truss, then continues with the light steel roof works.
ii. After installing the roof truss, install the techno wood covered with a geomembrane to prevent leakage during the rainy season.
iii. Proceed with installing the synthetic rattan cover

This stage of work uses 30 sets of scaffolding with several tools including pliers, hammers, hoes and shovels, as well as large staples. The work will take approximately 75 days to be completed by 10 blacksmiths and 7 workers. The excess material will be stored at stockpile area. The wood and steel waste will be stored in sack in a temporary dumpsite before carried outside national park.

f. Light brick wall

The stages of the light brick wall construction process are carried out as follows:

i. After the roof work is complete, proceed with installing light brick walls according to the room divider on the design.
ii. After the wall installation is complete, proceed with the plasterwork, then continue with the base painting work.

This stage of work will take approximately 75 days to complete with 12 masons and six workers. The excess material will be stored in stockpile area. The light brick rubble will be stored in a stockpile location before its carried outside national park.

g. Ceiling and floor ceramics

The stages of the ceiling and floor ceramics installation process are carried out as follows:

i. Install the gypsum on the ceiling truss.
ii. After the installation is complete, proceed with painting the ceiling.
iii. Install ceramics on the floor and wall according to the pattern design.

The stage of work uses ceramic cutter and rubber hammer. It will take approximately 75 days to be completed by 10 masons, six ceiling workers and six workers. The gypsum and ceramic waste will be stored in sack in stockpile before carried outside national park.

h. Interior and exterior painting

The last work is wall painting. For the exterior wall, scaffolding is installed to help with the high wall painting work. This stage of work uses three units of compressor and 30 set of scaffolding. The work will take approximately 75 days to be completed by seven painters and three workers. The remaining material will be stored in stockpile area. The paint can waste will be stored in a temporary dumpsite before carried outside national park.

8. Information center

The information center building will have several spaces as shown in Table 2.6. The design is presented in Appendix 3.14.

Table 3-8. The List of Space/Area in Information Center to be built

No	Infrastructure	Dimension
1	Warehouse	74 m^2
2	Men's restroom	20 m^2
3	Women's restroom	20 m^2
4	Management office	75 m^2
5	Clinic	12 m^2
6	Cafe	65 m^2
7	Souvenir	70 m^2
8	Ranger's room	106 m^2
9	Rangers' toilet	18 m^2
10	Locker	18.5 m^2
11	Information center	158 m^2
12	Plaza and park	582 m^2
13	Outside corridor	954 m^2

The Information Center's site plan, although it has been shifted, will still cut down five tamarind trees. This will be compensated by planting replacement trees. In addition, to give a natural impression, on the 2nd floor the information center infrastructure facility is provided with a tub for planting trees.

The process of developing the Information Center goes through several stages, namely:

a. Pilling

The pilling process is carried out as follows:

i. Marking the pile point by surveyor team
ii. Check the mini pile material to be used.
iii. Check the pilling equipment to be used (crawler crane, HSPD, and generator).
iv. Crane service picks up mini piles from the stockpile to pile point.
v. The mini pile is picked up and attached to the pilling tool (HSPD).
vi. After the mini pile has been attached to HSPD, the surveyor checks the position of the pile if it is straight and upright.
vii. Once ready, the HSPD machine installs the mini pile into the joint connection point.
viii. The mini pile is welded then continues to be installed into the specified depth.
ix. After reaching the specified depth, the remaining mini pile is cut using a concrete cutter, and the pilling work continues to the next point

The pilling work will take approximately 45 days to be completed by three operators, two welders, two crew members and two surveyors. The tool and equipment that will be used include 1 unit of crane, 1 unit of HSPD, one unit of generator, one unit of concrete cutter, two sets of welding travo, and two theodolites. Rubble material will be used as a soil compaction material in the transportation area.

b. Pile cap and pedestal column

This stage of work is carried out as follows:

i. Start the pile cap excavation using an excavator and manual tools.

ii. After reaching the specified elevation, proceed with the floorwork construction.
iii. Assemble the reinforcing iron according to the design.
iv. Install the formwork and add reinforcement.
v. After the formwork and reinforcement work is complete, proceed with the casting using a concrete mixer and excavator.

Pile cap and pedestal column work uses one unit of excavator, two units of concrete mixer, three units of concrete vibrator, and other tool and equipment such as pickaxe, hoe, basket, iron plier, bar bending machine. It will take approximately 45 days to be completed by one operator, 8 masons, 10 blacksmiths, seven workers, and two drivers with an average fuel consumption of 150 liters per day. The remaining material is collected in the stockpile. The light brick rubble will be stored in sack in a temporary dumpsite before carried outside national park.

c. Sloof beam and plate (First Floor)

The sloof beam and plate work is carried out as follows:
Install and frame the scaffolding

i. Install formwork for plates and beams.
ii. Iron and wire mesh assemble for floor plates.
iii. Beams and floor plates casting.

This stage of work will take approximately 75 days to be completed by 30 workers with an average fuel consumption of 150 liters per day. The excess material is collected in the stockpile. The wood and reinforcement iron waste will be stored in sack in a temporary dumpsite before carried outside national park.

d. Column, beam, and plate (Second Floor)

After the age of concrete in the beam casting stage is reached, the work continues as follows:

i. Install scaffolding and proceed with round column reinforcement
ii. Installation of formwork for columns and beams
iii. Beams reinforcement and casting

The equipment used is an excavator, concrete mixer, and dump truck. This process will take approximately 75 days to be completed by 30 workers, with the average fuel used being 150 liters per day. The excess material is collected in the stockpile. The wood and reinforcement iron waste will be stored in sack in a temporary dumpsite before carried outside national park.

e. Light Brick Wall

This stage of work is carried out as follows:

ii. After the roof work is complete, proceed with installing light brick walls according to the room divider on the design.
iii. After the wall installation is complete, proceed with the plasterwork, then continue with the base painting work.

This stage of work will take approximately 60 days to be completed by 12 masons and 6 workers. The excess material is collected in the stockpile. The wood and reinforcement iron waste will be stored in sack in a temporary dumpsite before carried outside national park once every two days depend on the weather and wave condition.

f. Ceiling and floor ceramics

This stage of work is carried out as follows:

i. Install the gypsum on the ceiling truss
ii. After the installation is complete, proceed with painting the ceiling.
iii. Install ceramics on the floor and wall according to the pattern design.

This stage of work will take approximately 60 days to complete with 17 ceiling and ceramic workers assisted by 6 workers. The tool and equipment consist of two units of ceramic cutters and 30 sets of scaffolding. The excess material is collected in the stockpile.

g. Interior and exterior painting

This work is the final stage. For the exterior wall, scaffolding is installed to help with the work in a high area. This process will take approximately 60 days to complete, with seven painters assisted by three workers. The tool and equipment consist of three compressor units and 30 scaffolding sets. The paint can waste will be stored in a temporary dumpsite before carried outside national park.

9. Water supply system (*Sistem Penyediaan Air Minum*/SPAM)

Improvement of drinking water quality is carried out by building a drinking water supply system (SPAM). The SPAM consists of a reservoir with a capacity of 50 m^3 and 144 m^2 area, and 550 meters long drinking water pipeline. Reservoir design is presented in Appendix 3.15. The pipes from SPAM reservoir will be attached to the elevated pathway.

This construction process uses generator set, jack hammer, tamping rammer, manual tools, concrete mixer and welding tool. The work will take approximately 90 days to complete with 15 workers and an average fuel consumption of 35 liters per day.

Table 3-9. Water Supply Requirement During Construction

No.	Source of waste	Numbers of individuals	Waste (l/individu/day)*	Total waste water (l/day)
1.	TNK Employees/Managers, Natural Guides and Cooperative Employees	30	60	1,800
2.	Construction workforce	193	60	11,580
	Total	298	-	17,880

Note *): Minister of Public Works Regulation No: 14/PRT/M/2010 Dated October 25, 2010

10. Demobilization of workers, machinery, vehycles and material

In the final stage after construction, all project workers, machine tools, vehicles and materials will be taken out of the national park. The demolition material used for the pavement will also be cleaned and the condition will be returned to its original state.

3.4.3.3. Operational Stage

During the operation of the Loh Buaya facility in Rinca Island, it is predicted that the number of visitors to Loh Buaya will reach 300 people per day (visit quota per day, BTNK, 2020) and the number of employees/managers of Komodo National Park at Loh Buaya, Natural guides and Cooperative Employees will be 30 people. The estimated daily need for clean water for 330 individuals is 19.80 m^3/day (Table 3.10).

To meet the needs of clean water at the time of operation, clean water is transported at least 2 times a week by using tankers with a capacity of 50 m^3.

Table 3-10. Water Requirement during operationalization

No.	Source of waste	Numbers of individuals	Waste (individu/day)*	Total waste water (l/day)
1.	Management Staff of KNP, Natural guide and Cooperation office staffs	30	60	1.800
2.	Visitors	300	60	18.000
	Jumlah	330	-	19.800

Source: *): Peraturan Menteri Pekerjaan Umum No: 14/PRT/M/2010 Tanggal 25 Oktober 2010.

To accommodate wastewater, some buildings (Information Center, Tour Guide Camp, Reseacher camp, Tourist camp) will be equipped with four biotanks with a capacity of five m^3. Biotank is a conventional technology development with a filtering process as follows;

a) Initial filter, in the first process of wastewater treatment, the sewage will be separated between solid and liquid waste by a filtration system. Thus, black water separation can be carried out perfectly and solid impurities can settle.

b) Water filter, after going through the initial filter, the residual water will flow to the water filter. The function of this filter is to produce clear water that is no longer harmful to the environment. In this filter there are balls or also called bio balls that affect the final result of wastewater treatment.

c) Bacteria decomposing filter is a waste water treatment filter equipped with decomposing bacteria whose job is to decompose the remaining dirt so that it is not harmful to soil and water areas. This filter will be inserted with the concentrated bacterial tablets periodically so that the decomposition process can take place efficiently and effectively.

Meanwhile, base on SNI M-36-1991-2003, the amount of solid waste produced was 0.70 - 0.80 kg /person/day and the density of solid waste was 130.53 kg/m^3. Then the number of 330 people, will produce:

a. Total waste = 330 people x 0.8 kg/person/day = 264 kg/day.
b. Waste volume = 264 kg/day / 130.53 (kg/m3) = 2.02 m^3/day

Organic and non-organic waste produced will be accommodated in different containers, namely (1) airtight organic waste containers and (2) open non-organic waste containers while Hazardous and dangerous substances in closed special containers, these two containers will be placed in a strategic location which is quite far from the reach of Komodo, before being transported by pontoon boat by officers to the TPA in Labuan Bajo, or according to the Waste Management Guidelines for the City of Labuan Bajo and Komodo National Park.

b. Facilities maintenance

Maintenance is intended to repair, replace or rearrange the main facilities and supporting facilities. The types of activities that will be carried out are repairing or replacing damaged parts of the building such as roofs, walls and poles, painting parts of the walls that are already opaque, cleaning the area from dirt in the form of garbage, puddles and other solid waste. The types of facilities that will be maintained are: - Information center/facility building - Rest post - Elevated Pathway - Drinking Water Network.

CHAPTER IV. ENVIRONMENTAL IMPACTS AND ENVIRONMENTAL MANAGEMENT

4.1. Impact the Project to OUV

4.1.1. Pre construction phase: socialization & site survey

This step does not cause any impact to any of the OUV.

4.1.2. Land preparation phase

4.1.2.1. Transportation and connection road construction

1. Impact on Criteria (vii) – Dry savannah and mangrove ecosystem

The savannah ecosystem that will be used for transportation and connection road is about 0.621 ha or 0.005 % of the total savannah ecosystem in Rinca Island. The area is mostly barren land and only small road area under the trees canopy, therefore no tree will be cut down. In addition, this road does not pass through the mangrove habitat (Figure 4.1). Thus, disturbance of this road construction against savannah and mangrove ecosystem (OUV criteria vii) is negligible.

2. Impact on Criteria (x) – Komodo dragon, herpetofaunas, other mammals and birds

(a) Minor disturbance to the terrestrial wildlife because of the equipments (e.g. excavator) movement

There are 15 Komodo dragons (*Varanus komodoensis*) (~1% of the total population in KNP) that use this site for foraging, basking, etc. Approximately 10-20 individuals of Timor deer (*Rusa timorensis*), 15 individuals of water buffalo (*Bubalus bubalis*), 5 individuals of wild boar (*Sus scrofa*), and three groups (30 to 60 individuals) of long-tailed macaques (*Macaca fascicularis*) also use the area. The presence of equipment, in which some of them are heavy equipments, may impede these animal movements or disturb their activities (Figure 4-1). These individuals, including the 15 Komodo dragons, are used to and adapted to the presence of humans, and thus this impact is deemed minor.

To mitigate this minor impact, the number of heavy equipment operating each day is restricted to two per day and during 8.00 – 12.00 AM and 1.00 – 4.30 PM for maximum of seven days. In addition to this restriction, heavy equipment operates only on transportation and connection road, and minimum seven naturalist guides per day are standby in and around the project site to inform the operators when there is Komodo dragon, herpetofaunas or other wildlife present in/close to the road in which the heavy equipment must stop temporarily to allow the animal movement.

4.1.2.2. Temporary jetty

(a) Minor distribution to mangrove and marine ecosystem

Negligible disturbance to Mangrove ecosystem

The transportation road that connects the Temporary jetty and the stokpiles passes through the mangrove ecosystem, although there is no logging of trees. Approximately 0.01 ha will be disturbed, although this amount is very small compared to the 272 ha of mangrove in Rinca Island (Table 3.3).

Negligible disturbance to Marine Ecosystem

Jetty construction will be able to lead turbidity and Total Suspended Solid increase, but the effect of this turbidity is negligible to marine ecosystem as far distance of sea grasses and coral reefs from jetty. Moreover, the wave height, current velocity during high tide and low tide is very low (Figure 4.2).

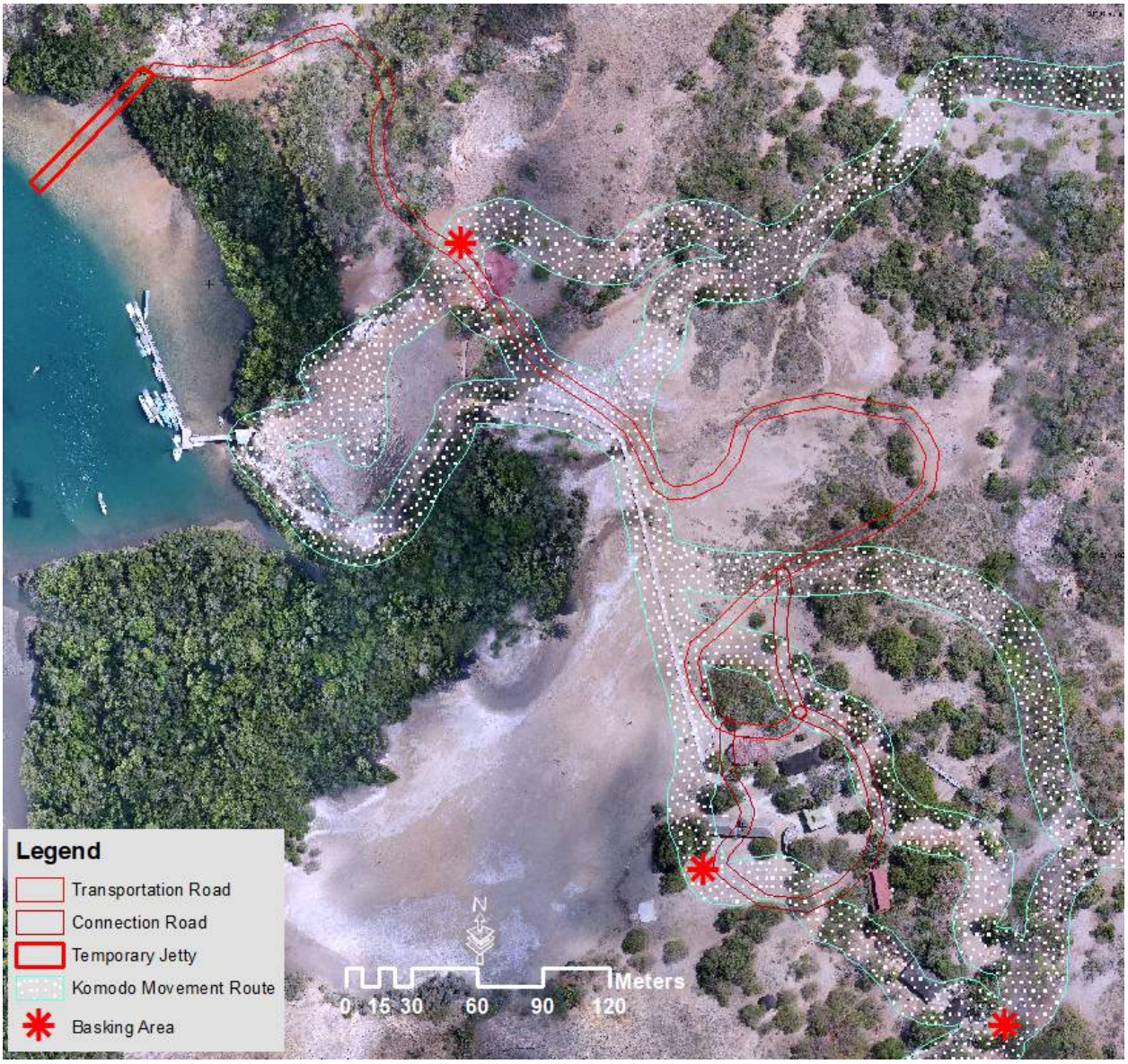

Figure 4-1. the intersection of road (transportation and connection road) and the movement route of Komodo dragons and their basking area

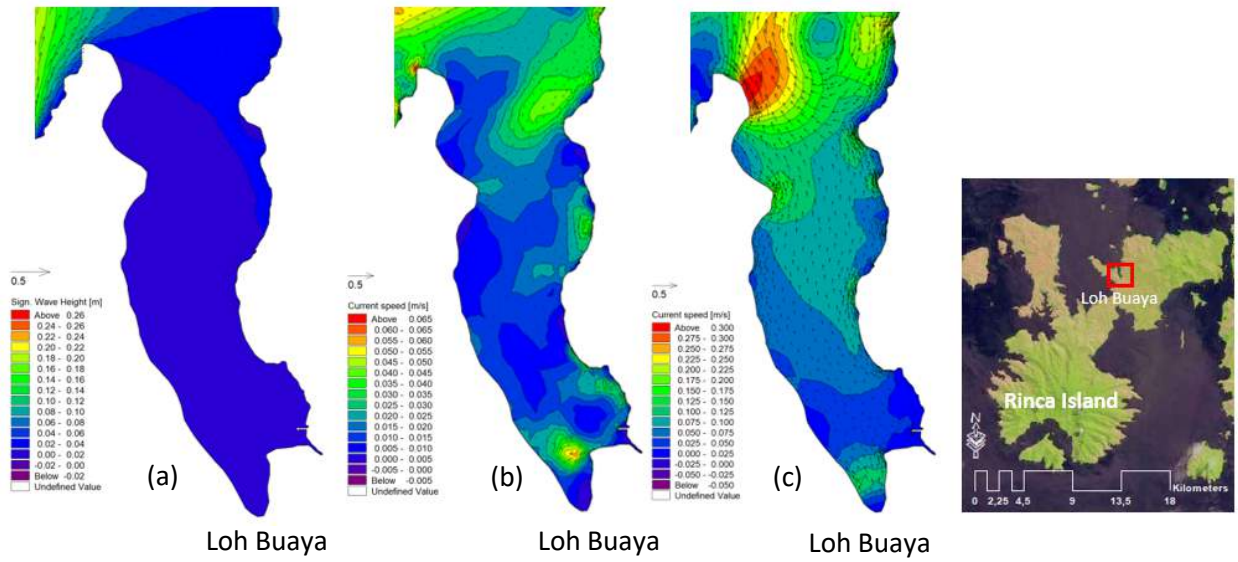

Figure 4-2. (a) Wave height, (b) High tide current speed, (c) Low tide current speed

4.1.2.2. Demolition of existing jetty

1. Impact on Criteria (vii) – Marine ecosystem mangrove, sea grass & Coral Reef

The impact that may occur in the process of demolition the existing jetty is turbidity in the marine ecosystem, but it does not have a major impact on coral reefs and sea grass because of the location of these two ecosystems is very far. The closest distribution of coral reef and seagrass is about 1.4 km from the construction site (Figure 3.4). In addition, demolition will be carried out very carefully by placing nets to keep debris from falling into the sea. Likewise, there is no impact on the coral reefs because they are far from the jetty being destructed.

2. Impact on Criteria (x) – Marine faunas

Jetty demolition will not have a significant impact to marine faunas considering, the biodiversity of fauna near the Jetty is considered very poor (see the initial environmental condition before project in Appendix 3.4). Meanwhile the presence of dolphins is very far from the jetty Based on the Kahn (2001) publication, the nearest distance of the sighting is about 4 km (Figure 4.2).

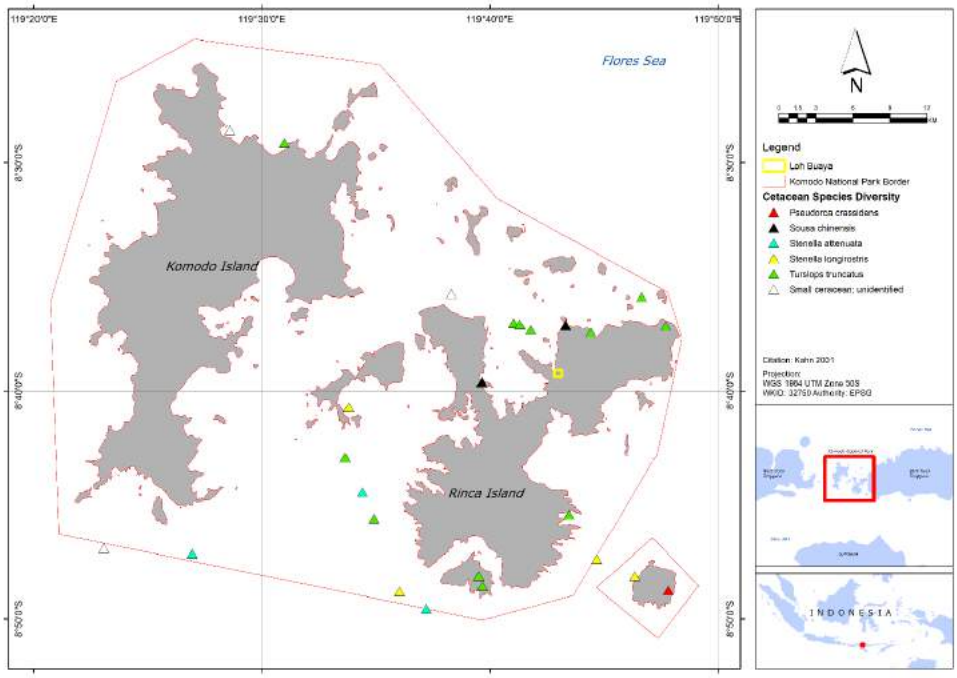

Figure 4-3. Reported sightings of cetacean diversity in KNP during the survey in 2001 (Kahn 2001).

4.1.2.3. Demolishing existing buildings in terrestrial ecosystem namely resort office, ticketing, ranger camp, café, pantries and toilet

1. Impact on criteria (vii) – Dry savannah and mangrove ecosystem

Unmanaged demolition waste will reduce the aesthetic values of the landscape and seascape in and around the proposed site, including the dry savannah and mangrove. This impact is deemed negligible because demolition waste will be transported daily to either to stockpile location or the landfill site of Labuan Bajo.

2. Impact on criteria (x) – terrestrial wildlife

Minor effects to terrestrial wildlife and birds from noise pollution

The operation of heavy equipment and the demolition of the buildings will produce noise. Prior construction, the noise was measured in the project site (45.59 dBA) [S:8°39'20,85"/ E:119°43'05,22"] and entrance gate (45.5 dBA) [S:8°39'13,88"/ E:119°43'00,73"]. The noise disturbance will be monitored to not exceed 50 dB as the national standards for Green Open Space according to the Ministerial Decree of the Minister of Environment No. 48 Year 1996 concerning 'Noise Limit'. The land demolition activity may produce noise exceeding these levels, which may disturb the terrestrial wildlife. Previous studies have shown that noise pollution negatively impacts wildlife, notably birds, in a way disrupting their communication and or causing noise-induced stress (Duquette, Loss, & Hovick, 2021). A study has shown that at levels of 40 dB, birds may react to the noise, but the major impacts (e.g. reduced density, low productivity, and low average survival) occur when the pollution exceed 50 dB (Seiler, 2001).

The impacts of noise pollutions are deemed minor for terrestrial wildlife in the project site because the use of sound-friendly construction equipment [e.g. Hydraulic Static Pile Driver/HSPD that produce no noise and vibration (Dwiretnani & Daulay, 2019)] to minimize the noise disturbance and the activity will only last

for three weeks. Mammals and birds in the project site are already habituated to human activities. Two bird species that require special attention do not use the area extensively: about 6 to 8 individuals (4% of the total population in KNP) of the Critically Endangered Lesser sulphur-crested cockatoo (*Cacatua sulphurea*) per day have been observed to fly across the Loh Buaya valley without stopping in the project site. Moreover, the closest active mound nest of Orange-footed scrub fowl (*Megapodius reinwardt*) is about 324 m from the center of the project. Meanwhile the closets active mound nest of Komodo to the center of project area is about 440 m (Figure 4-3).

Minor disturbance to the terrestrial wildlife because of the heavy equipment (e.g. excavator) movement

There are 15 Komodo dragons (*Varanus komodoensis*) (~1% of the total population in KNP) that use this site for foraging, basking, etc. Approximately 10-20 individuals of Timor deer (*Rusa timorensis*), 15 individuals of water buffalo (*Bubalus bubalis*), 5 individuals of wild boar (*Sus scrofa*), and three groups (30 to 60 individuals) of long-tailed macaques (*Macaca fascicularis*) also use the area. The presence of heavy equipment may impede these animal movements or disturb their activities (Figure 4-1). These individuals, including the 15 Komodo dragons, are used to and adapted to the presence of humans, and thus this impact is deemed minor. To mitigate this minor impact, the number of heavy equipment operating each day is restricted to two per day and during 8.00 – 12.00 AM and 1.00 – 4.30 PM for maximum of seven days. In addition to this restriction, heavy equipment operates only in designated routes and minimum seven naturalist guides per day are standby in and around the project site to inform the operators when there is Komodo dragon or other wildlife present in/close to the routes in which the heavy equipment must stop temporarily to allow the animal movement.

Negligible toxic effects to terrestrial wildlife from air pollution

The use of diesel fuel by vehicles used to demolish existing infrastructure buildings of about 100 liters/day can cause pollution of CO, CO2, SO2 and NOx gases. A study has shown that direct exposure these substances may cause respiratory stress, tissue/organ dysfunction, and even death among animals (Newman & Schreiber, 1988). Considering the distance of wildlife to the project is far, most likely the CO has been oxidized to CO_2, meanwhile other gases have been diluted and dispersed by the air (European Environment Agency, 2016; Kgabi & Mokgwetsi, 2009). High temperatures (≥24°C) make air pollutants, such as particulate matter, to dilute and mix into the air, minimizing its impact to the air quality (Kgabi & Mokgwetsi, 2009). Monthly average temperature in Komodo NP, including in the project site, is 26-30°C (with maximum temperature could reach up to 34°C) (World Weather Online, 2020), and therefore, the impacts of air pollution on wildlife are deemed negligible

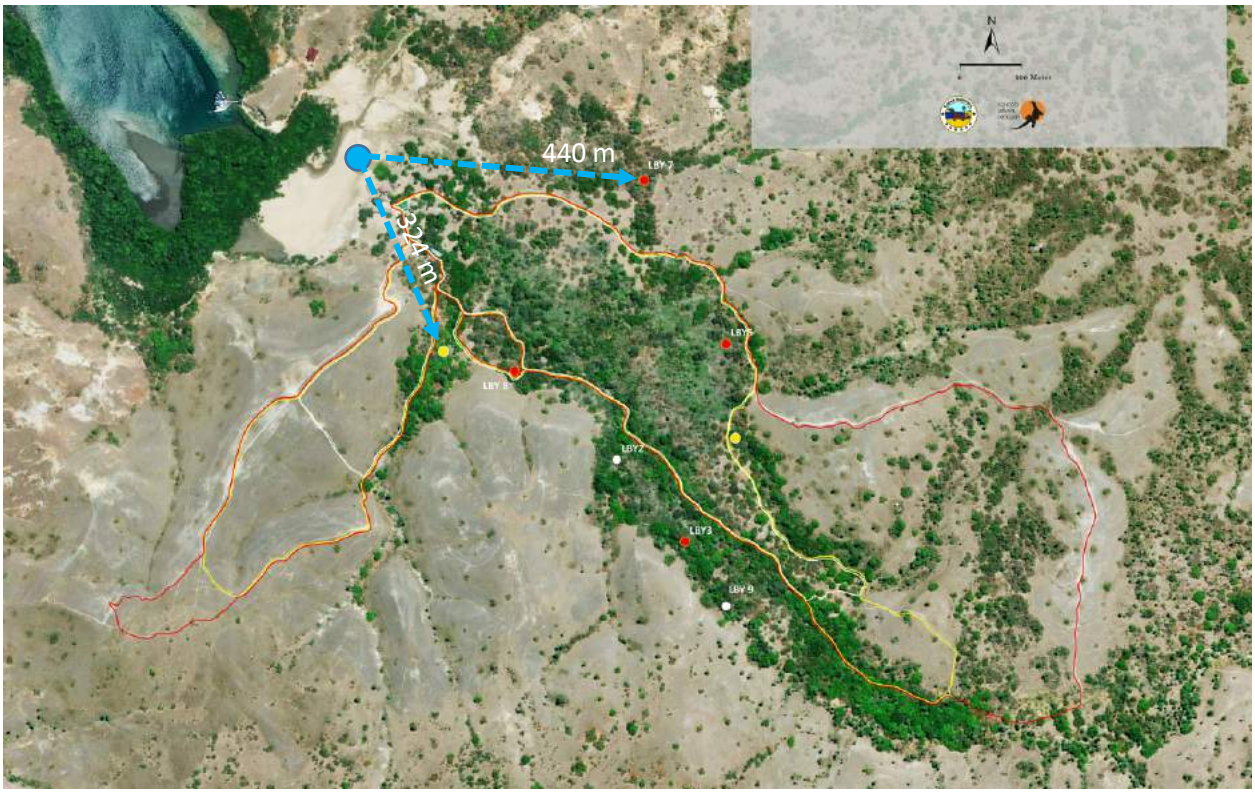

Figure 4-4. Nest of Orange-footed scrub fowl (*Megapodius reinwardt*) and Komodo dragon near the project (Blue dot: Center of the project position, Red line: Long track trail, Yellow line: Medium track trail, White line: Short track trail, Yellow dot: Active mound nest of *M. reinwardt*, Red dot: Active mound nest of Komodo dragon, White dot: In-active mound nest of Komodo dragon) (KNP, 2020)

3. Impact on criteria (vii) – Dry savannah and thorny vegetation

Negligible toxic effects to vegetation from air pollution

Chemical compounds from site preparation activities may pollute the air and subsequently affect the vegetation. These impacts are commonly recorded for agricultural lands, but wild vegetation may react similarly given the ways air pollutant change plant physiology [e.g. sulphur dioxide can disrupt stomatal regulation that inhibits photosynthesis (Kropff, 1987). As a consequence, air pollutants in high concentration for over a long period can expedite senescence and cause delay in plant growth and reproduction (Emberson et al., 2001)]. Even though the tolerance toward certain toxicity level is mainly unknown, as long as the period of exposure is short and the chemical concentration in the air is below legal standards, the impacts on plants are deemed negligible. Moreover, the air pollutions are already diluted due to high temperature in the project site and possibly dispersed by the wind and therefore minimizing its impact to the air quality (European Environment Agency, 2016; Kgabi & Mokgwetsi, 2009) and consequently negligible impact on plants. Monitoring after the project will be conducted to ensure the levels are still below the national standards stipulated in Government Regulation No. 41 Year 1999, SO_2 (900 µg/Nm3), NO_2 (400 µg/Nm^3), CO (30,000 µg/Nm^3), TSP (230 µg/Nm^3), and Pb (2 µg/Nm^3).

4.1.2.4. Land preparation of coastal protection

1. Impact on criteria (vii) mangrove, Savannah & marine ecosystem

Minor disturbance to mangrove

Land preparation for coastal protection will have impact on mangrove habitat, however the impact on mangrove stand can be neglected since no mangrove trees will be cut. The most common species of benthic fauna is *Saccostrea* sp. that live by sticking onto mangrove roots or rocky substrates along the coastal area inundated by seawater. There is no endemic species in the area. Likewise, the impact on savannah is also considerably minor, due to the fact that there will be no bush or tree will be slashed or cut down.

Minor disturbance on marine ecosystem

Preparation of coastal ecosystem will lead to the increase turbidity and Total Suspended Solid (TSS), however it will have a local impact and not spread to a wider area since the tide, and speed of wave current is vey slow (Figure 4.2).

2. Criteria (x) terrestrial faunas

No impact to the terrestrial wildlife

The impact of land preparation of coastal protection to the long-tailed macaques (*Macaca fascicularis*), Timor deer (*Rusa timorensis),* wild boar (*Sus scrofa*), and Komodo dragons (*Varanus komodoensis*) can be neglected since only a very small area of their habitat are disturbed during the preparation prior to the construction.

4.1.2.5. Transporting demolition waste

1. Impact on criteria (vii) – Dry savannah and mangrove

Negligible disturbance to the aesthetic values of the landscape and seascape

Unmanaged demolition waste will reduce the aesthetic values of the landscape and seascape in and around the proposed site, including the dry savannah and mangrove. This impact is deemed negligible because demolition waste is collected to temporary dumpsite and transported daily to the landfill sites of Labuan Bajo.

2. Impact on criteria (vii) – seagrass and coral reef

Negligible disturbance to the seagrass and coral reef from transporting demolition waste via the sea routes

The construction activity of the project will not impact any marine ecosystems because it is conducted on land. In addition, the marine diversity in the Loh Buaya bay, close to the project site, is considered poor due to the lack of coral reefs and sea grass beds (Personal communication with Mr. Muhammad Ikbal Putera, Komodo National Park and Loh Buaya resort park ranger, Mr. Afandi). The main substrate of the sea floor in this area is rock, sand, and mud (Lembaga Ilmu Pengetahuan Indonesia (LIPI) (Indonesian Institute of Science), 2019). The demolition waste will be transported by boats via sea. This waste may potentially fall accidently from the ship into the water along the transportation route from Loh Buaya to Labuan Bajo harbour, destroying the coral reef and or seagrass bed probably presented in the area (far from the project site). This impact is deemed negligible because the demolition waste will be stored in the hull of a wooden

ship (capacity of 4 tons), which makes it impossible for the waste to fall into the sea. Other demolition waste will be transported by a barge (with a boat capacity of 2,000 tons) and covered by tarps. There is no difference in the types of waste carried by the wooden ship and barge.

3. Impact on criterion (x) – marine fauna and flora (non-mammals)

Negligible disturbance to the marine fauna and flora from transporting demolition waste via the sea routes

Field observation closed to the project site documents some species of benthic fauna, plankton (both zooplankton and phytoplankton), nekton (e.g. fish) and invertebrate in the Loh Buaya bay (Appendix 3.4). The most common species of benthic fauna is *Saccostrea* sp. that live by sticking onto mangrove roots or rocky substrates along the coastal area inundated by seawater. There is no endemic species in the area. However, the demolition waste will be transported by boats via sea. This waste may potentially fall accidently from the ship into the water along the transportation routes from Loh Buaya to Labuan Bajo harbour, disturbing the marine fauna and flora probably present in the area. This impact is deemed negligible because the demolition waste will be stored in the hull of a wooden ship (capacity of 4 tons), which makes it impossible for the waste to fall onto the sea. Other demolition waste will be transported by a barge (with a boat capacity of 2,000 tons) and covered by tarps. There is no difference in the types of waste carried by the wooden ship and barge.

4. Impact on criterion (x) – marine mammals and sea turtles

Minor disturbance to the behavior of dolphins and seaturtles from the boat transporting the waste

There are approximately 18 cetacean species in Komodo National Park (Kahn, 2001). Two of them are coastal cetacean with reported sighting close to/around Loh Buaya bay, Bottlenose dolphin (*Tursiops truncatus*) and Indo-Pacific humpback dolphin (*Sousa chinensis*) (Kahn, 2001). Bottlenose dolphins are one of the most common cetaceans observed in the Komodo National Park. This dolphin species is also sighted by local community members (Personal communication), however, the exact position and species has not been confirmed. Another marine fauna is the two species of sea turtles found in Komodo National Park, 1) Hawksbill sea turtle (*Eretmochelys imbricata*) and 2) Green sea turtle (*Chelonia mydas*) (Personal communication with Mr. Muhammad Ikbal Putera, Komodo National Park). None of the species use the coastal area of Loh Buaya valley close to the project site as nesting ground because the area consists of mudflats and mangroves (Personal communication with Loh Buaya resort park ranger, Mr. Arfandi). However, same as above, the activity of boats transporting demolition waste and building materials may pose a disruption to the behavior and food resource of marine mammals and sea turtles that potentially present along the transportation routes.

Research indicates that the presence of vessel may cause disturbance to the dolphin behavior (Lusseau, 2003), such as longer dive duration and departure from the area, but this is only for high-speed vessels (Hashim & Jaaman, 2011; Ng & Leung, 2003). The barge has a maximum speed of 5-6 knot. It is considered a slow-moving vessels and will not cause immediate stress on dolphin (Hashim & Jaaman, 2011; Ng & Leung, 2003). Dolphin population may still be able to sustain the low intensity of vessel traffic, below 5-6 knot (Lusseau, 2003). Operation of vessel will be kept under this standard. Impact on sea turtles is deemed more minimum because the species does not communicate using sounds and mostly spend time underwater.

The demolition waste on the barge will be covered by a tarp to prevent any of it going to the waters, which may reduce the water quality and potential food sources for the dolphins and sea turtles.

4.1.3. Construction phase

4.1.3.1. Construction of basecamp for workers in the project site and stockpile

1. Impact on criterion (x) – terrestrial wildlife:

Minor disturbance to the terrestrial wildlife because of the heavy equipment (e.g. excavator) movement and construction activities

The presence of heavy equipment during construction will impede the movement of terrestrial wildlife and disrupt their activities (e.g. foraging) temporary. These animals include 15 Komodo dragons (*Varanus komodoensis*), approximately 10-20 individuals of Timor deer (*Rusa timorensis*), 15 individuals of water buffalo (*Bubalus bubalis*), 5 individuals of wild boar (*Sus scrofa*), and three groups of long-tailed macaques (*Macaca fascicularis*). These individuals are used to and adapted to the presence of humans, and thus this impact is deemed minor. To mitigate this minor impact, the number of heavy equipment operating each day is restricted to two per day and during 8.00 – 12.00 AM and 1.00 – 4.30 PM for maximum of seven days. In addition to this restriction, heavy equipment operates only in designated routes and minimum seven naturalist guides per day are standby in and around the project site to inform the operators when there is Komodo dragon or other wildlife present in/close to the routes in which the heavy equipment must stop temporarily to allow the animal movement.

Negligible toxic effects to terrestrial wildlife from noise pollution

The operation of heavy equipment during construction activities will produce noise. Prior construction, the noise was measured in the project site (45.59 dBA) [S:8°39'20,85"/ E:119°43'05,22"] and entrance gate (45.5 dBA) [S:8°39'13,88"/ E:119°43'00,73"]. The noise disturbance will be monitored to not exceed 50 dB as the national standards for Green Open Space according to the Ministerial Decree of the Minister of Environment No. 48 Year 1996 concerning 'Noise Limit'. The land demolition activity may produce noise exceeding these levels, which may disturb the terrestrial wildlife. Previous studies have shown that noise pollution negatively impacts wildlife, notably birds, in a way disrupting their communication and or causing noise-induced stress (Duquette et al., 2021). A study has shown that at levels of 40 dB, birds may react to the noise, but the major impacts (e.g. reduced density, low productivity, and low average survival) occur when the pollution exceed 50 dB (Seiler, 2001).

The impacts of noise pollutions are deemed minor for terrestrial wildlife in the project site because the use of sound-friendly construction equipment [e.g. Hydraulic Static Pile Driver that produce no noise and vibration (Dwiretnani & Daulay, 2019)] to minimize the noise disturbance and the activity will only last for two weeks.

Mammals and birds in the project site are already habituated to human activities. Two bird species that require special attention do not use the area extensively: about 6 to 8 individuals (4% of the total population in KNP) of the Critically Endangered Lesser sulphur-crested cockatoo (*Cacatua sulphurea*) per day have been observed to fly across the Loh Buaya valley without stopping in the project site; and only one out of

the eight Orange-footed scrub fowl (*Megapodius reinwardt*) nesting sites in Rinca Island is located near center to the project (~400 m).

Negligible toxic effects to terrestrial wildlife from air pollution

Chemical compounds from construction activities may pollute the air and subsequently affect wildlife. These include SO_2, NO_2, CO, TSP, and Pb. A study has shown that large concentration of these substances over long period may cause respiratory stress, tissue/organ dysfunction, and even death among animals (Newman & Schreiber, 1988), which is not the case for this project since the distance of pollution sources and the wildlife is very far. Moreover, the air pollutions are already diluted due to high temperature in the project site and possibly dispersed by the wind, minimizing its impact to the air quality (European Environment Agency, 2016; Kgabi & Mokgwetsi, 2009) and consequently negligible impact on plants. Monitoring after the project will be conducted to ensure these levels are still below the national standards stipulated in Government Regulation No. 41 Year 1999, SO2 (900 µg/Nm^3), NO2 (400 µg/Nm^3), CO (30,000 µg/Nm^3), TSP (230 µg/Nm^3), and Pb (2 µg/Nm^3).

Potential negative interaction between construction workers living in the project site and Komodo dragons

For 13 months, about less than 50 construction workers will live in the project site at the beginning and end of the project, but during the peak of construction activities, all ~200 construction workers will live in the site. There are 15 Komodo dragons using and foraging around the area of project site within the Loh Buaya valley (Balai Taman Nasional Komodo (Komodo National Park Authority) - Komodo Survival Program, 2019). About 60-70% of the construction workers will be recruited amongst the local community, and it is most likely that the majority of them are familiar with the Komodo dragons and have a good understanding regarding their behavior. Despite this possibility and the fact that Komodo dragon attacks on humans are a rare occurrence, there is still a chance of negative interaction to happen (e.g. sudden reaction of workers can lead to unintended consequences, such as a defensive attack by the Komodo dragon). All construction workers will receive briefing on the Komodo dragon presence and behavior around the site. At least seven natural guides will also standby in and around the project site to monitor the Komodo dragon and inform the workers if they are in a closed proximity.

Minor disturbance to the behavior of terrestrial wildlife because of the garbage and food waste produced by construction workers in the base camps

It is estimated the whole construction will produce 39,998 m^3 of organic waste per month; 14,794 m^3 or non-organic waste per month; and 57.93 of hazardous and toxic waste per month. The likely presence of garbage and food waste by the construction workers may attract long-tailed macaques (*Macaca fascicularis)* to human, making them more aggressive toward human as seen in another area (Hambali, Ismail, Zulkifli, Md-zain, & Amir, 2012). This possible changed behavior is detrimental to both the long-tailed macaques and tourists once the place opens. The wild boars (*Sus scrofa*) that are frequently seen during the night may also visit the project sites, attracted by the smell of food and food waste. The garbage and food waste may provide additional food resources, unhealthy for the wild boars (*Sus scrofa*), and changing their natural feeding behaviors (Lee & Lee, 2019). This garbage may also be accessed by the Timor deer (*Rusa timorensis*) and water buffalo (*Bubalus bubalis*). To mitigate this potential minor disturbance, waste

management system will be implemented (See 3.4.3.3. Operational Stage) to handle organic waste, non-organic waste, and hazardous and toxic waste. The temporary organic waste bin will be also closed and fenced to prevent access by the long-tailed macaques, wild boars, Timor deer, and water buffalo.

2. Impact on criteria (vii) – Dry savannah and thorny vegetation

Negligible toxic effects to vegetation from air pollution

Chemical compounds from site preparation activities may pollute the air and subsequently affect the vegetation. These impacts are commonly recorded for agricultural lands, but wild vegetation may react similarly given the ways air pollutant change plant physiology [e.g. sulphur dioxide can disrupt stomatal regulation that inhibits photosynthesis (Kropff, 1987)]. As a consequence, air pollutants in high concentration for over a long period can expedite senescence and cause delay in plant growth and reproduction (Emberson et al., 2001)]. Even though the tolerance toward certain toxicity level is mainly unknown, as long as the period of exposure is short and the chemical concentration in the air is below legal standards, the impacts on plants are deemed negligible. Moreover, the air pollutions are already diluted due to high temperature in the project site and possibly dispersed by the wind, minimizing its impact to the air quality (European Environment Agency, 2016; Kgabi & Mokgwetsi, 2009) and consequently negligible impact on plants. Regular monitoring will be conducted throughout the construction to ensure these levels are still below the national standards stipulated in Government Regulation No. 41 Year 1999, SO_2 (900 µg/Nm^3), NO_2 (400 µg/Nm^3), CO (30,000 µg/Nm^3), TSP (230 µg/Nm^3), and Pb (2 µg/Nm^3).

Negligible disturbance to the aesthetic values of the landscape

Stock pile will be made to store the building materials. Unmanaged stock pile would reduce the aesthetic values of the dry savannah in the project site. This impact is deemed negligible because it only comprises of 0.5758 hectares, and will be fenced and covered by a tarp during the construction of about 13 months.

4.1.3.2. Transporting building materials & Equipments

1. Impact on criteria (vii) – seagrass and coral reef

Negligible disturbance to the seagrass and coral reef from transporting building materials via the sea routes

The construction activity of the project will not impact any marine ecosystems because it is conducted on land. In addition, the marine diversity in the Loh Buaya bay, close to the project site, is considered poor due to the lack of coral reefs and sea grass beds (Personal communication with Mr. Muhammad Ikbal Putera, Komodo National Park and Loh Buaya resort park ranger, Mr. Afandi). The main substrate of the sea floor in this area is rock, sand, and mud (Lembaga Ilmu Pengetahuan Indonesia (LIPI) (Indonesian Institute of Science, 2019). The building materials will be transported by boats via sea. These materials may potentially fall accidently from the ship into the water along the transportation route from Loh Buaya to Labuan Bajo harbour, destroying the coral reef and or seagrass bed probably presented in the area (far from the project site). This impact is deemed negligible because building materials will not exceed the wooden boat capacity (two wooden boats with 4-ton capacity operate daily during construction) and barge capacity (one barge with 2,000-ton capacity operate six times during construction). Materials are covered by tarp to prevent any of them falling. In addition, the transport route did not overlap with coral ecosystem in Komodo National Park (Figure 4-4).

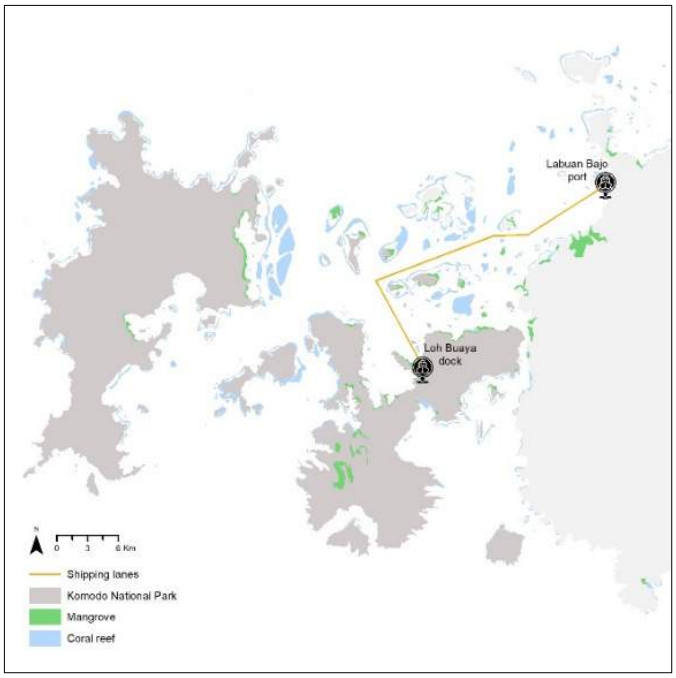

Figure 4-5. Shipping lane to bring building materials from Labuan Bajo to the project site in Loh Buaya.

[Sources: Coral reef from (UNEP-WCMC with WorldFish Centre and WRI and TNC 2021) and mangroves from the Ministry of Environment and Forestry (2015) http://dbgis.menlhk.go.id/arcgis/rest/services/KLHK/Hutan_Mangrove/MapServer].

2. Impact on criteria (x) – marine fauna and flora (non-mammals)

Negligible disturbance to the marine fauna and flora from transporting building materials via the sea routes

Field observation closed to the project site documents some species of benthic fauna, plankton (both zooplankton and phytoplankton), nekton (e.g. fish) and invertebrate in the Loh Buaya bay (Appendix 3.4). The most common species of benthic fauna is *Saccostrea* sp. that live by sticking onto mangrove roots or rocky substrates along the coastal area inundated by seawater. There is no endemic species in the area. However, the building materials will be transported by boats via sea. These materials may potentially fall accidently from the ship into the water along the transportation routes from Loh Buaya to Labuan Bajo harbour, disturbing the marine fauna and flora probably present in the area. This impact is deemed negligible because the building materials will be stored in the hull of a wooden ship (capacity of 4 tons), which makes it impossible for the materials to fall onto the sea. Other building materials will be transported by a barge (with a boat capacity of 2,000 tons) and covered by tarps. There is no difference in the types of materials carried by the wooden ship and barge.

3. Impact on criteria (x) – marine mammals and seaturtles

Minor disturbance to the behavior of dolphins and seaturtles from the boat transporting the building materials

There are approximately 18 cetacean species in Komodo National Park (Kahn, 2001). Two of them are coastal cetacean with reported sighting close to/around Loh Buaya bay, Bottlenose dolphin (*Tursiops truncatus*) and Indo-Pacific humpback dolphin (*Sousa chinensis*) (Kahn, 2001). Bottlenose dolphins are one of the most common cetaceans observed in the Komodo National Park. This dolphin species is also sighted

by local community members (Personal communication), however, the exact position and species has not been confirmed. Another marine fauna is the two species of sea turtles found in Komodo National Park, 1) Hawksbill sea turtle (*Eretmochelys imbricata*) and 2) Green sea turtle (*Chelonia mydas*) (Personal communication with Mr. Muhammad Ikbal Putera, Komodo National Park). None of the species use the coastal area of Loh Buaya valley close to the project site as nesting ground because the area consists of mudflats and mangroves (Personal communication with Loh Buaya resort park ranger, Mr. Arfandi). However, same as above, the activity of boats transporting building materials may pose a disruption to the behavior and food resource of marine mammals and sea turtles that potentially present along the transportation routes.

Research indicates that the presence of vessel may cause disturbance to the dolphin behavior (Lusseau, 2003), such as longer dive duration and departure from the area, but this is only for high-speed vessels (Hashim & Jaaman, 2011; Ng & Leung, 2003). The barge has a maximum speed of 5-6 knot. It is considered a slow-moving vessels and will not cause immediate stress on dolphin (Hashim & Jaaman, 2011; Ng & Leung, 2003). Dolphin population may still be able to sustain the low intensity of vessel traffic, below 5-6 knot (Lusseau, 2003). Operation of vessel will be kept under this standard. Impact on sea turtles is deemed more minimum because the species does not communicate using sounds and mostly spend time underwater. The building materials on the barge will be covered by a tarp to prevent any of it going to the waters, which may reduce the water quality and potential food sources for the dolphins and sea turtles.

1.1.3.3. Construction of jetty

1. Impact on criteria (x) – marine fauna and flora (non-mammals)

Negligible disturbance to the marine fauna and flora from bored piling process and the building materials potentially falling onto the sea

Jetty will be built on top of the sea closed to the mangrove areas. Foundation for the jetty is built through bored piling process. Vertical holes will be drilled using bored piling machine then steel cylinder and rebar cage are inserted into the holes. These holes will then be filled with concrete. The main parts of jetty are made of ironwood. During the construction, nets (polynet rolls) are set up to prevent building materials falling onto the sea. The impacts of bored piling machine and building materials on marine fauna and flora are deemed negligible because this area is considered poor due to the lack of coral reefs and seagrasses (Personal communication with Mr. Muhammad Ikbal Putera, Komodo National Park and Loh Buaya resort park ranger, Mr. Afandi). Main substrate of the sea floor around this area is rock, sand, and mud (Lembaga Ilmu Pengetahuan Indonesia (LIPI) (Indonesian Institute of Science), 2019).

Minor disturbance to the feeding activity of terrestrial wildlife that use mangrove areas

The construction may disrupt the activities of one group of long-tailed macaques (*Macaca fascicularis*) that use the mangrove areas to forage on crabs and other invertebrates. These macaques are diurnal and active on the ground instead of trees (Imron, Satria, & Ramlan, 2018). However, as they are habituated to human presence prior to the construction, they will likely remain in the areas or move temporarily not far from the project site. One study shows that the travelling range of habituated group of macaques range between

100 to 600 m per day (Hambali, Ahmad, Badrul-Munir, Syaizwan, & Aainaa, 2005). Given that the construction of temporary dock only lasts for 30 days, the impact is expected to be minor.

4.1.3.4. Construction of coastal protection

1. Impact on criteria (x) – marine fauna and flora (non-mammals)

Negligible disturbance to the marine fauna and flora from the building materials potentially falling onto the sea

The 100-m coastal protection will be built closed to the mangroves and sea (Figure 3.8). Parts of the natural slope will be removed to minimize mangrove damage. There is a risk that sediments from the land and building materials potentially fall onto the sea during the construction. However, this will be prevented by covering the contour of the slope with a special membrane and then rocks. The impact of this activity on marine fauna and flora is deemed negligible because of the mitigation measures. In addition, the marine area where the project occurs lacks coral reefs and seagrasses (Personal communication with Mr. Muhammad Ikbal Putera, Komodo National Park and Loh Buaya resort park ranger, Mr. Afandi). The main substrate of the sea floor around this area is rock, sand, and mud (Lembaga Ilmu Pengetahuan Indonesia (LIPI) (Indonesian Institute of Science), 2019) with very little biodiversity.

Negligible disturbance to marine ecosystem

Construction of coastal protection will lead to the increase turbidity and Total Suspended Solid (TSS), however it will have a local impact and not spread to a wider area since the tide, and speed of wave current is vey slow (Figure 4.2).

4.1.3.5. Construction of infrastructure on land (ranger camp, guide camp, researcher camp, plaza deck, resting post, elevated pathway, reservoir tank, pipeline system, waiting room of visitor, and information center

1. Impact on criteria (x) – terrestrial wildlife

Minor disturbance to the terrestrial wildlife because of the heavy equipment movement and construction activities

The presence of heavy equipment during construction will impede the movement of terrestrial wildlife and disrupt their activities (e.g. foraging) temporary. These animals include 15 Komodo dragons (*Varanus komodoensis*), approximately 10-20 individuals of Timor deer (*Rusa timorensis*), 15 individuals of water buffalo (*Bubalus bubalis*), 5 individuals of wild boar (*Sus scrofa*), and three groups of long-tailed macaques (*Macaca fascicularis*). These individuals are used to and adapted to the presence of humans, and thus this impact is deemed minor. To mitigate this minor impact, the number of heavy equipment operating each day is restricted to two per day and during 8.00 – 12.00 AM and 1.00 – 4.30 PM for maximum of seven days. In addition to this restriction, heavy equipment operates only in designated routes and minimum seven naturalist guides per day are standby in and around the project site to inform the operators when there is Komodo dragon or other wildlife present in/close to the routes in which the heavy equipment must stop temporarily to allow the animal movement.

Negligible toxic effects to terrestrial wildlife from noise pollution produced during construction

The construction activities (e.g. operation of heavy equipment simultaneously) will produce noise. Prior construction, the noise was measured in the project site (45.59 dBA) [S:8°39'20,85"/ E:119°43'05,22"] and entrance gate (45.5 dBA) [S:8°39'13,88"/ E:119°43'00,73"]. The noise disturbance will be monitored to not exceed 50 dB as the national standards for Green Open Space according to the Ministerial Decree of the Minister of Environment No. 48 Year 1996 concerning 'Noise Limit'. The land demolition activity may produce noise exceeding these levels, which may disturb the terrestrial wildlife. Previous studies have shown that noise pollution negatively impacts wildlife, notably birds, in a way disrupting their communication and or causing noise-induced stress (Duquette et al., 2021). A study has shown that at levels of 40 dB, birds may react to the noise, but the major impacts (e.g. reduced density, low productivity, and low average survival) occur when the pollution exceed 50 dB (Seiler, 2001).

The impacts of noise pollutions are deemed minor for terrestrial wildlife in the project site because the use of sound-friendly construction equipment [e.g. Hydraulic Static Pile Driver that produce no noise and vibration (Dwiretnani & Daulay, 2019)] to minimize the noise disturbance and the activity will only last for two weeks. Mammals and birds in the project site are already habituated to human activities. Two bird species that require special attention do not use the area extensively: about 6 to 8 individuals (4% of the total population in KNP) of the Critically Endangered Lesser sulphur-crested cockatoo (*Cacatua sulphurea*) per day have been observed to fly across the Loh Buaya valley without stopping in the project site; and only one out of the eight Orange-footed scrub fowl (*Megapodius reinwardt*) nesting sites in Rinca Island is located near to the project (~100 m).

Negligible toxic effects to terrestrial wildlife from air pollution produced during construction

Chemical compounds from construction activities may pollute the air and subsequently affect wildlife. These include CO, SO_2, NO_2, CO, TSP, and Pb. A study has shown that large concentration of these substances over long period may cause respiratory stress, tissue/organ dysfunction, and even death among animals (Newman & Schreiber, 1988), which is not the case for this project since the distance of pollution sources and the wildlife is very far. Moreover, the air pollutions are already diluted due to high temperature in the project site and possibly dispersed by the wind, minimizing its impact to the air quality (European Environment Agency, 2016; Kgabi & Mokgwetsi, 2009) and consequently negligible impact on wildlife. Regular monitoring will be conducted throughout the construction to ensure these levels are still below the national standards stipulated in Government Regulation No. 41 Year 1999, SO_2 (900 μg/Nm^3), NO_2 (400 μg/Nm^3), CO (30,000 μg/Nm^3), TSP (230 μg/Nm^3), and Pb (2 μg/Nm^3).

Potential negative interaction between construction workers and Komodo dragons

For 13 months, about less than 50 construction workers will live in the project site at the beginning and end of the project, but during the peak of construction activities, all ~200 construction workers will live in the site. There are 15 Komodo dragons using and foraging around the area of project site within the Loh Buaya valley (Balai Taman Nasional Komodo (Komodo National Park Authority) - Komodo Survival Program, 2019). About 60-70% of the construction workers will be recruited amongst the local community, and it is most likely that the majority of them are familiar with the Komodo dragons and have a good understanding regarding their behavior. Despite this possibility and the fact that Komodo dragon attacks on humans are a

rare occurrence, there is still a chance of negative interaction to happen (e.g. sudden reaction of workers can lead to unintended consequences, such as a defensive attack by the Komodo dragon). All construction workers will receive briefing on the Komodo dragon presence and behavior around the site. At least seven natural guides will also standby in and around the project site to monitor the Komodo dragon and inform the workers if they are in a closed proximity.

2. Impact on criteria (vii) – Dry savannah and thorny vegetation

Negligible toxic effects to vegetation from air pollution

Chemical compounds from site preparation activities may pollute the air and subsequently affect the vegetation. These impacts are commonly recorded for agricultural lands, but wild vegetation may react similarly given the ways air pollutant change plant physiology [e.g. sulphur dioxide can disrupt stomatal regulation that inhibits photosynthesis (Kropff, 1987)]. As a consequence, air pollutants in high concentration for over a long period can expedite senescence and cause delay in plant growth and reproduction (Emberson et al., 2001)]. Even though the tolerance toward certain toxicity level is mainly unknown, as long as the period of exposure is short and the chemical concentration in the air is below legal standards, the impacts on plants are deemed negligible. Moreover, the air pollutions are already diluted due to high temperature in the project site and possibly dispersed by the wind, minimizing its impact to the air quality (European Environment Agency, 2016; Kgabi & Mokgwetsi, 2009) and consequently negligible impact on plants. Regular monitoring will be conducted throughout the construction to ensure these levels are still below the national standards stipulated in Government Regulation No. 41 Year 1999, SO_2 (900 µg/Nm^3), NO_2 (400 µg/Nm^3), CO (30,000 µg/Nm^3), TSP (230 µg/Nm^3), and Pb (2 µg/Nm^3).

Negligible disturbance to the aesthetic values of the landscape, particularly from the rumbles and building materials

Stock pile will be made to store the building materials. Unmanaged stock pile would reduce the aesthetic values of the dry savannah in the project site. This impact is deemed negligible because it only comprises of 0.5758 hectares, and will be fenced and covered by a tarp during the construction of about 13 months.

4.1.4. Operational phase

During operational phase, it is estimated ~300 tourists per day will visit Loh Buaya site. With addition of park rangers and naturalist guides, there will be ~330 people per day in total. The operational phase will be further addressed in the Environmental Impact Assessment document.

4.1.4.1. Infrastructures are operating for tourists

1. Impact on criteria (x) – terrestrial wildlife

Negligible disturbance from potential negative interaction between tourists and Komodo dragons

There are 15 komodo dragons using and foraging around the operating area within the Loh Buaya valley (Balai Taman Nasional Komodo (Komodo National Park Authority) 2019a). The Komodo dragons are habituated to human activities. The presence of elevated pathway for tourists will significantly mitigate any potential negative interaction between tourists and Komodo dragons, and other wildlife.

Minor disturbance to the behavior of terrestrial wildlife because of the garbage and food waste produced mainly by tourists

With ~300 tourists per day, it is estimated that the whole operation would produce 44,293 m^3 of organic waste per month; 16,382 m^3 or non-organic waste per month; and 64.20 kg of hazardous and toxic waste per month. The likely presence of garbage by the tourists may attract wildlife such as long-tailed macaque (*Macaca fascicularis*) to human, making them more aggressive toward human as seen in another area (Hambali et al., 2012). This possible changed behavior is detrimental to both the wildlife and tourists. The garbage and food waste may provide additional food resources, unhealthy for the wild boar (*Sus scrofa*) in the area, and changing their natural feeding behaviors (Lee & Lee, 2019). This garbage may also be accessed by the Timor deer (*Rusa timorensis*) and water buffalo (*Bubalus bubalis*). To mitigate this potential minor disturbance, waste management system will be implemented (See 3.4.3.3. Operational Stage) to handle organic waste, non-organic waste, and hazardous and toxic waste.

The temporary organic waste bin will be also closed and fenced to prevent access by the long-tailed macaques, wild boars, Timor deer, and water buffalo. The waste will be send to labuhan bajo or the nearest place outsite KNP every 10 days.

2. Impact on criteria (x) – marine mammals and seaturtles

Minor disturbance to the behavior of dolphins and sea turtles from the movement of tourist boats

There are approximately 18 cetacean species in Komodo National Park (Kahn, 2001). Two of them are coastal cetacean with reported sighting close to/around Loh Buaya bay, Bottlenose dolphin (*Tursiops truncatus*) and Indo-Pacific humpback dolphin (*Sousa chinensis*) (Kahn, 2001). Bottlenose dolphins are one of the most common cetaceans observed in the Komodo National Park. Another marine fauna are the two species of seaturtles found in Komodo National Park, 1) Hawksbill sea turtle (*Eretmochelys imbricata*) and 2) Green seaturtle (*Chelonia mydas*) (Personal communication with Mr. Muhammad Ikbal Putera, Komodo National Park). None of the species use the coastal area of Loh Buaya valley close to the project site as nesting ground because the area consists of mudflats and mangroves (Personal communication with Loh Buaya resort park ranger, Mr. Arfandi). However, same as above, the activity of tourist boats may pose disruption to the behavior and food resource of marine mammals and seaturtles that potentially present along the transportation routes.

Research indicates that the presence of vessel may cause disturbance to the dolphin behavior (Lusseau, 2003), such as longer dive duration and departure from the area, but this is only for high-speed vessels (Hashim & Jaaman, 2011; Ng & Leung, 2003). It is considered a slow-moving vessels and would not cause immediate stress on dolphin (Hashim & Jaaman, 2011; Ng & Leung, 2003). Dolphin population may still be able to sustain the low intensity of vessel traffic (Lusseau, 2003). Impact on sea turtles is most likely minimum because the species did not communicate using sounds and mostly spend time underwater.

4.2. Environmental Management/Mitigation and Monitoring

As described in the previous chapter, the project activities that will be carried out can have various impacts on the OUV, both in the pre-construction, construction and operation phases. To reduce these impacts, proper management/ mitigation and monitoring is necessary. The environmental management/mitigatiog

program that will be carried out is expected to be able to prevent, control, and overcome the negative impacts that occur. In addition, the management program carried out is also expected to develop a positive impact on the environment.

The environmental monitoring program is intended to determine that management efforts have been carried out properly, and to assess the effectiveness of the management of these impacts, as well as to assess compliance with environmental regulations.

The matrix of environmental management and monitoring efforts is presented in Table 4.1.

Table 4-1. Impact, Environmental and Monitoring Plan

a. Pre-construction phase

Activity (Source of impacts)	Impacts			Management/Mitigation plan			Monitoring plan			
	Impact criteria on OUV	Type of Impact	Details on impacts/ magnitude	Location	Details	Period of management implementation	Details	Period of Monitoring	Location	Institution
Public Consultation	No impact on OUV, but this step is important regarding the acceptability of project by the community, as well as for the improvement of project site plan.	Stake holders and community opinion and understanding on the project	The population with a positive perception is 100% of the interview respondents, namely 10% of the total number of households in Rinca Village (Komodo Hamlet, Bajo Village, Beringin Jaya Village, New Beringin Village) and Kerora Hamlet, Pasir Panjang Village. (45 KK)	Rinca Island and Labuhan Bajo	Social Approach Conducting public consulattion to residents, especially in Rinca Village (Komodo Hamlet, Bajo Village, Beringin Jaya Village, New Beringin Village) and Kerora Hamlet, Pasir Panjang Village, as well as in Komodo District, West Manggarai Regency regarding the plan for structuring the Rinca Island Area Institutional Approach Coordinate with the Environmental Agency of West Manggarai Regency regarding the implementation plan for the socialization of the Rinca Island Regional Arrangement. Coordination with KNP Office, TN Management Section Region I Rinca Island.	Three times, just before project implementation - 21 October 2019 in Labuan Bajo, West Manggarai Barat - 28 July 2020 for preparation of environ-mental impact assessment - 1 September 2020 to discuss improvement of the siteplan of the project	c. Documenting procedures/ management efforts related to public consultation d. Documenting every idea to improve to plan of the project during the process	During the process of public consultation	Site of Public consultation	Developper in coordination with BPOLBF and KNP Authority
Transportation road construction for mobilization/de mobilization of the equipments and materials	Criteria (vii) – Dry savannah and mangrove ecosystem	Habitat disturbance	The impact is negligible as there is neither clearing the savanna nor cutting of the trees. The road is also constructed without either pavement or barier	A long transportation route	To ensure the mobility of the vehicle in accordance with the mobility plan Assign a group of people (consists of natural guides and KNP staff) to conduct daily habitat monitoring to ensure that along the road there is no felling of trees	Every day	c. Documenting procedures/ management efforts related to efforts to reduce turbidity and oil/lubricant spills d. Wildlife habitat monitoring	Wildlife habitat monitoring will be conducted before and after construction	A long transportation route	Developper in coordination with BPOLBF and KNP Authority
	Criterion (x) – Komodo and – other terrestrial wildlife and birds	Possibility accident	Possibility traffic accident between Komodo/other wildlifes and vehicles due to the transportation route is crossing the Komodo dragon movement area.	A long transportation route	Installing sign board to remind driver/workers about the komodo dragon movement route e. Ensure that road construction does not create a barrier to the movement of komodo dragons f. Arrange transportation times/frequency to avoid/reduce encounters with komodo dragons g. Assign ranger to observe the presence of komodo or other wildlife/herpetofauna, sepecially at the crossing area between road and movement route of komodo h. To set up the maximum speed of vehicle is 15 km/hour and install its signboard as reminding	Before construction Every day	d. Documenting procedures/ management related to efforts of accident reduction of wildlife e. Wildlife monitoring f. Documentating of any accident happen	During the project before and after construction During the project	A long transportation route	Developper in coordination with BPOLBF and KNP Authority
		Noise pollution	Negligible noise pollution arises from the use of heavy equipment and generator	A long transportation route construction	c. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations d. Regular inspection of vehicles and equipment to ensure the machine/equipment in good condition	Before construction Every day	c. Measuring the quality of noise during operation d. Documentating the process to reduce noise pollution	before and after construction During the project	A long transportation route construction	Developper in coordination with BPOLBF and KNP Authority
		Air pollution	Negligible impact of ambient air pollution from fuel combustion to terrestrial wildlife and birds, considering far distance position of wildlife from exhaust of vehicles. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.	A long transportation route	d. Ensure that all vehicles and equipments have passed emission standardization based on Indonesian regulations e. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution f. Regular watering to reduce dust/particulate matter	Before construction Every day Every day	Checking vehicle and other equipment's eligibility Monitoring of Air quality Documentating the process to reduce air pollution	Every day during construction Before and after the project Every day during construction	A long transportation route construction	Developper in coordination with BPOLBF and KNP Authority
Temporary Jetty	Criteria (vii) : mangrove ecosystem	Mangrove Ecosystem Disturbance	Negligible since there will be no mangrove tree cutting	Temporary jetty location	c. Carry out work according to the plan and be carefully so as not to damage the mangrove ecosystem	Every day	d. Documenting procedures/ management related to reduce turbidity and oil/lubricant spills	Monotoring of water quality will be made before and	Temporary jetty location	Developper in coordination with BPOLBF

Activity (Source of impacts)	Impacts			Management/Mitigation plan			Monitoring plan			
	Impact criteria on OUV	Type of Impact	Details on impacts/ magnitude	Location	Details	Period of management implementation	Details	Period of Monitoring	Location	Institution
			Negligible of oil/lubricant spill into the environment		d. Regular maintenance of tools/equipments/ machines to avoid damage that can cause oil or lubricant leakage into the mangrove ecosystem.	Regular check based on standard operation procedure	e. Measuring water quality before and after construction is completed, f. Comparing water quality before and after with the quality standards set by the government (KepMenLH No.48 of 1996).	after project completion		and KNP Authority
	Criteria (vii) : marine ecosystem	Marine ecosystem pollution	Turbidity and Total suspended Solid increase, however it is negligible since tide is low and current wave is very	Temporary jetty location	c. Reduce the turbidity of waters as much as possible	Every day				
					d. Regular maintenance of tools/equipments/ machines to avoid damage that can cause oil or lubricant leakage into the mangrove ecosystem	Regular check based on standard operation procedure				
Demolishing existing jetty	Criteria (vii) Marine, mangrove, sea grass & Coral Reef ecosystem	Disturbance of marine ecosystem	The impact is negligible as the distance of coral reef and sea grasses is far from the project. Moreover the current wave at Loh buaya is slow and the tide is also low, so that the increase of turbidity only occurs locally.	Existing jetty	c. Placing nets to keep debris from falling into the sea d. Assign a group of people (consists of natural guides and KNP staff) to conduct daily observation of marine fauna	Before demolishing Every day	c. Making a documentation of the process to minimize disturbance mangrove and marine ecosystem d. Marine ecosystem and marine fauna observation	After the project Before and after the project	Existing jetty	Developper in coordination with BPOLBF and KNP Authority
	Criteria (x) : marine fauna	Marine ecosystem pollution	The impact is negligible, considering far distance position of marine mammals from the jetty. The closest distance of sighting dolphin is about 4 km. Turbidity and Total suspended Solid increase, however it is negligible since tide is low and current wave is very							
Demolishing the existing entrance gate and concrete footpath	Criteria (vii) Savannah ecosystem	Disturbance to savannah ecosystem	The impact is negligibly as the area is mostly barren land and the size is small (0.06 ha or 0.005 % of the total savannah in Rinca island) Demolition the existing concrete footpathl will remove barrier of water surface flow in the savannah either from hilly areas or ocean during hight tide.	Along the existing concrete footpath	Ensure all debris will be removed	After the project	c. Vegetation monitoring d. Surface water flow observation	Before and after the project	Along the existing concrete foothpath	Developper in coordination with BPOLBF and KNP Authority
	Criteria (x) Komodo, herpetofauna and other terrestrial species	Reducing direct and close interaction	There is positive impact, since demolition will minimize interaction between komodo dan humans.	Along the existing concrete footpath	Ensure all debris will be removed	After the project	Wildlife monitoring	Before and after the project	Along the existing concrete footpath	Developper in coordination with BPOLBF and KNP Authority
		Accident	There is a possibility of a conflict between workers and Komodo dragons, because the area is the trajectory of the Komodo dragon's movement. This conflict can endanger both, either humans or Komodo dragons.	Along the existing concrete footpath	c. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform the workers on the presence of komodo d. Install the warning board sign about the danger	Every day Before the construction	Making a documentation of the process to avoid wildlife accident	after the project	Along the existing concrete footpath	Developper in coordination with BPOLBF and KNP Authority
		Air pollution	The impact is negligible, considering far distance position of wildlife from exhaust of vehicles. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.	Along the existing concrete footpath	d. Ensure that all vehicles and equipments have passed emission standardization based on Indonesian regulations e. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution f. Do regular watering before and after demolishing the existing building	Before mobilization the equipment's to project site Before mobilization the equipment's to project site Every day	Vehicle and other equipment's eligibility check	Every day during construction	Along the existing concrete footpath	Developper in coordination with BPOLBF and KNP Authority
							Measuring the quality of noise during demolishing	Before and after the project		
							Making a documentation to reduce air pollution	After the project		
		Noise pollution		Along the existing			Cheking vehicle and other equipment's eligibility	Every day during construction	Along the existing	Developper in coordination

Activity (Source of impacts)	Impacts			Management/Mitigation plan			Monitoring plan			
	Impact criteria on OUV	Type of Impact	Details on impacts/ magnitude	Location	Details	Period of management implementation	Details	Period of Monitoring	Location	Institution
			The impact is negligible as the distance of komodo and other terrestrial species are far.	concrete footpath	c. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations d. Ensure that all vehicles and equipment are working properly	Before mobilization the equipment's to project site	Measuring the quality of air during demolishing Making a documentation to reduce noise pollution	Once during the project Every day during construction	concrete footpath	with BPOLBF and KNP Authority
Demolishing existing buildings	Criteria (vii) – Dry savannah and mangrove ecosystem	Ecosystem distrubance	The impact is negligible since the total area of the existing building is about 0.12 ha or 0.001 % from the total savannah of Rinca island	Demolishing site	Limit the number of heavy equipment operate per day (two excavators operate per day)	Every day	c. Making a documentation of the process to avoid wildlife accident d. Conducting vegetation monitoring/observation	After project	Developer	Developper in coordination with BPOLBF and KNP Authority
	Criterion (x) – Komodo & other terrestrial species	Wildlife accident	Possibility of accident hit by the debris	Demolishing site	Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife under or near the buildings	Every day	Making a documentation of the process to avoid accicent of wildlife	After project	Developer	Developper in coordination with BPOLBF and KNP Authority
		Noise pollution	The impact is negligible as the distance of komodo and other terrestrial species are far.	Demolishing site	d. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations e. Regular check and maintenance of vehicles, and equipments f. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife under or near the buildings	Before mobilization the equipment's to project site	d. Checking vehicle and other equipment's eligibility e. Measuring the quality of noise during demolishing f. Making a documentation of the process to reduce noise pollution	Every day during construction Once during the project After project	Developer	Developper in coordination with BPOLBF and KNP Authority
		Air pollution	The impact is negligible, considering far distance position of wildlife from exhaust of vehicles/the outlet. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.	Demolishing site	d. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution e. Do regular watering before and after demolishing the existing buildings f. Transport demolition materials (covered by a tarp) as quickly as possible to the temporary dock and then to Labuan Bajo by boat for final disposal, in coordination with the DLHK Manggarai Barat	Before mobilization the equipment's to project site	d. Checking vehicle and other equipment's eligibility e. Measuring the quality of air during demolishing f. Making a documentation of the process to reduce air pollution	Every day during construction Once during the project Every day during construction	Developer	Developper in coordination with BPOLBF and KNP Authority
Transporting the demolishing materials from the site to dump site/stockpiles	Criteria (vii) – Dry savannah	Air pollution	Negligible toxic effects	Project site, Loh Buaya, Rinca Island	d. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution e. Do regular watering before and after demolishing the existing buildings f. Transport demolition materials (covered by a tarp) as quickly as possible to the temporary jetty/dumpsite/stickpiles	Every day	d. Checking vehicle and other equipment's eligibility, spare part replacement according to the standard operation e. Measuring the air quality f. Making a documentation of the process to reduce air pollution	Every day during construction Before and after the project Every day	Developer	Developper in coordination with BPOLBF and KNP Authority
	OUV criterion (x) – terrestrial wildlife	Possibility accident of komodo dragon hit by the vehicles	Minor disturbance to the terrestrial wildlife	Project site, Loh Buaya, Rinca Island, especially crossing area between komodo & heavy equipment's	e. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife Ensure the maximum speed of trucks is 30 km per hour f. Designate a specific transportation route for the heavy equipment in the project site, avoiding the area used by the terrestrial wildlife (Komodo dragons, Timor deer, water buffalo, wild boars, and long-tailed macaques) g. Install signboard at crossing area of the transportation road and the movement route of komodo h. Install sign board of speed limit	Every day	Making a documentation of the process to reduce accident Recording the accident events that occur if any	Every day during construction	Developer	Developper in coordination with BPOLBF and KNP Authority

Activity (Source of impacts)	Impacts			Management/Mitigation plan			Monitoring plan			
	Impact criteria on OUV	Type of Impact	Details on impacts/ magnitude	Location	Details	Period of management implementation	Details	Period of Monitoring	Location	Institution
		Noise pollution	Minor effects to terrestrial wildlife from noise pollution	Project site, Loh Buaya, Rinca Island	c. Limit the number of heavy equipment operate per day [two excavators operate per day] d. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations	Every day	Checking vehicle and other equipments eligibility Measuring the quality of noise during transportation Making a documentation of the process	Every day during construction Once during the project Every day during construction		Developper in coordination with BPOLBF and KNP Authority
		Air pollution	The impact is negligible, considering far distance position of wildlife from exhaust of vehicles/the outlet. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.	Project site, Loh Buaya, Rinca Island	c. Do regular watering before and after demolishing the existing buildings d. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution	Every day	Checking vehicle and other equipment's eligibility Measuring the quality of air during transportation Making a documentation of the process	Every day during construction Once during the project Every day during construction	Project site, Loh Buaya, Rinca Island	Developper in coordination with BPOLBF and KNP Authority
Transporting the demolishing materials from dump site/stockpiles to temporary jetty	Criteria (vii) – Dry savannah	Air pollution	Negligible toxic effects	Project site, Loh Buaya, Rinca Island	d. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution e. Do regular watering before and after demolishing the existing buildings f. Transport demolition waste (covered by a tarp) as quickly as possible to the temporary jetty/dumpsite/stickpiles	Every day	Checking vehicle and other equipment's eligibility Measuring the air quality Making a documentation of the process	Every day during construction Once during the project Every day	Project site, Loh Buaya, Rinca Island	Developper in coordination with BPOLBF and KNP Authority
	Criteria (vii) – mangrove, marine ecosystem, Sea grass & Coral	Water pollution	Negligible toxic effects	Project site, Loh Buaya, Rinca Island	c. Proper loading and unloading demolition waste material d. Transport demolition waste materials (covered by a tarp) as quickly as possible to Labuan Bajo by boat for final disposal, in coordination with the DLHK Manggarai Barat	Every day	Checking vehicle and other equipment's eligibility Measuring the water quality during demolishing Making a documentation of the process to reduce water pollution	Every day during construction Once during the project Every day during the project	Project site, Loh Buaya, Rinca Island	Developper in coordination with BPOLBF and KNP Authority
	OUV criterion (x) – marine wildlife	Coastal Marine pollution	Negligible toxic effects	Project site, Loh Buaya, Rinca Island	c. Proper loading and unloading demolition waste material d. Transport demolition waste materials (covered by a tarp) as quickly as possible to Labuan Bajo by boat for final disposal, in coordination with the DLHK Manggarai Barat	Every day	Checking vehicle and other equipment's eligibility Measuring the quality of air during demolishing Making a documentation of the process to avoid marine pollution	Every day during construction Once during the project Every day during construction	Project site, Loh Buaya, Rinca Island	Developper in coordination with BPOLBF and KNP Authority
	OUV criterion (x) – terrestrial wildlife	Possibility accident of komodo dragon hit by the vehicles	Minor disturbance to the terrestrial	Project site, Loh Buaya, Rinca Island, especially crossing area between komodo & heavy equipment's	d. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife e. Ensure the maximum speed of trucks is 15 km per hour f. Designate a specific transportation route for the heavy equipment in the project site, avoiding the area used by the terrestrial wildlife (Komodo dragons, Timor deer, water boffola, wild boars, and long-tailed macaques)	Every day		Every day during construction	Project site, Loh Buaya, Rinca Island, especially crossing area between komodo & heavy equipment's	Developper in coordination with BPOLBF and KNP Authority
		Noise pollution	Minor effects to terrestrial wildlife from noise pollution	Project site, Loh Buaya, Rinca Island	c. Limit the number of heavy equipment operate per day [two excavators operate per day] d. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations	Every day	Checking vehicle and other equipment's eligibility Measuring the quality of noise during transportation Making a documentation of the process to avoid noise pollution	Every day during construction Once during the project Every day during construction	Project site, Loh Buaya, Rinca Island	Developper in coordination with BPOLBF and KNP Authority
		Air pollution Marine/coastal water pollution	The impact is negligible, considering far distance position of wildlife from exhaust of vehicles/the outlet. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.	Project site, Loh Buaya, Rinca Island	c. Do regular watering before and after demolishing the existing buildings d. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution	Every day	Checking vehicle and other equipment's eligibility Measuring the quality of air quality during transportation Making a documentation of the process	Every day during construction	Project site, Loh Buaya, Rinca Island	Developper in coordination with BPOLBF and KNP Authority

Activity (Source of impacts)	Impacts			Management/Mitigation plan			Monitoring plan			
	Impact criteria on OUV	Type of Impact	Details on impacts/ magnitude	Location	Details	Period of management implementation	Details	Period of Monitoring	Location	Institution
Transporting demolition waste from temporary jetty to Labuhan Bajo	Criteria (vii) – seagrass and coral reef	Marine pollution	Negligible disturbance to the seagrass and coral reef from transporting demolition waste via the sea routes	From Labuan Bajo port to the project site, Loh Buaya, Rinca Island and Labuan Bajo	d. Transport demolition waste (covered by a tarp) along designated sea routes that do not overlap with coral reef and seagrass ecosystems] e. Store the demolition waste in the hull of the boat f. Ensure the amount of demolition of waste does not exceed the boat and barge capacities	Every day	Checking vehicle and other equipments eligibility Measuring the quality of sea water Making a documentation of the process to reduce marine pollution	Every day Once during the project Every day	Temporary Jetty	Developper in coordination with BPOLBF and KNP Authority
	Criterion (x) – marine fauna and flora (non-mammals)	Marine pollution	Negligible disturbance to the marine fauna and flora from transporting demolition waste via the sea routes	From Labuan Bajo port to the project site, Loh Buaya, Rinca Island and Labuan Bajo	e. Ensure the maximum speed of boat (e.g. barge of 5 knot) f. Transport demolition waste (covered by a tarp) along designated sea routes that do not overlap with coral reef and seagrass ecosystems] g. Store the demolition waste in the hull of the boat h. Ensure the amount of demolition of waste does not exceed the boat and barge capacities	Every day	Checking vehicle and other equipment's eligibility Measuring the quality of sea water Making a documentation of the process to reduce marine pollution	Every day Once during the project Every day		Developper in coordination with BPOLBF and KNP Authority
	Criterion (x) – marine mammals and seaturtles	Marine pollution	Minor disturbance to the behavior of dolphins and seaturtles from the boat transporting the waste	From the project site, Loh Buaya, Rinca Island to Labuan Bajo	e. Ensure the maximum speed of boat (e.g. barge of 5 knot) f. Transport demolition waste (covered by a tarp) along designated sea routes that do not overlap with coral reef and seagrass ecosystems] g. Store the demolition waste in the hull of the boat h. Ensure the amount of demolition of waste does not exceed the boat and barge capacities	Every day	Checking the eligibility of the ship and other equipments Making a documentation of the process to reduce marine pollution	Before departure After the project		Developper in coordination with BPOLBF and KNP Authority
Land pre paration for Coastal protection	Criteria (vii) – Dry savannah and mangrove ecosystem	Savannah Ecosystem disturbance	Minor impact since only small area savannah of the mound is removed	Coastal protection site	Assign a group of people (consists of natural guides and KNP staff) to conduct daily monitoring of savannah ecosystem	Every day	Monitoring of vegetation after the project	After the project	Coastal protection site	Developper in coordination with BPOLBF and KNP Authority
		Mangrove Ecosystem disturbance	The impact is minor since only a small area of the mudflat from the mangrove habitat is buried	Coastal protection site	Ensure that no hazardous materials fall (spill off) into the mangrove ecosystem Assign a group of people (consists of natural guides and KNP staff) to conduct daily monitoring of mangrove ecosystem	Every day	making a documentation of the process to reduce habitat mangrove disturbance	Every day during construction		Developper in coordination with BPOLBF and KNP Authority
	Criterion (x) – Komodo & other terrestrial species	Habitat disturbance	The impact is negligible as there is neither clearing the savanna nor cutting of the trees	Coastal protection site	c. Avoid cutting of the mangrove/savannah trees d. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife	Every day	making a documentation of the process to reduce habitat mangrove disturbance	After the project completed		Developper in coordination with BPOLBF and KNP Authority
		Noise pollution	The impact is negligible as the distance of komodo and other terrestrial species are far.	Coastal protection site	c. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations d. Ensure that all vehicles and equipment are working properly	Before the project	Checking Vehicle and other equipment's eligibility Measuring the quality of noise during demolishing Making a documentation to reduce noise pollution	Every day during construction Before and after the project After the project		Developper in coordination with BPOLBF and KNP Authority
		Air pollution	The impact is negligible, considering far distance position of wildlife from exhaust of vehicles. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.	Coastal protection site	c. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations d. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution	Before the project	Checking vehicle and other equipment's eligibility Measuring the quality of air during demolishing Making a documentation to reduce air pollution	Every day during construction Once during the project After the project		Developper in coordination with BPOLBF and KNP Authority

Activity (Source of impacts)	Impacts			Management/Mitigation plan			Monitoring plan			
	Impact criteria on OUV	Type of Impact	Details on impacts/ magnitude	Location	Details	Period of management implementation	Details	Period of Monitoring	Location	Institution
Land preparation for water supply system	Criteria (vii) – Dry savannah	Ecosystem disturbance	The impact is negligible as there is neither clearing the savanna nor cutting of the trees	Land preparation for water supply system site	d. Avoid cutting of the trees e. Avoid cutting down trees/savannahs, especially animal feed plants f. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife	Every day	Making a documentation to reduce ecosystem disturbance	Every day	Water supply system site	Developper in coordination with BPOLBF and KNP Authority
	Criterion (x) – fauna	Habitat disturbance and conversion	The impact is negligible as there is neither clearing the savanna nor cutting of the trees	Land preparation for water supply system site	Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife	Every day	Making a documentation to reduce impact of land preparation on ecosystem	Every day		Developper in coordination with BPOLBF and KNP Authority
		Noise pollution	Minor effects to terrestrial wildlife from noise pollution	Land preparation for water supply system site	c. Limit the number of heavy equipment operate per day [two excavators operate per day] d. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations	Every day	Checking vehicle and other equipment's eligibility	everyday		Developper in coordination with BPOLBF and KNP Authority
							Measure the quality of air quality during land preparation	Before and after the project		
							Making a documentation of the process	After the project		
		Air pollution	The impact is negligible, considering far distance position of wildlife from exhaust of vehicles/the outlet. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.	Land preparation for water supply system site	c. Do regular watering before and after demolishing the existing buildings d. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution	Every day	Checking vehicle and other equipment's eligibility	everyday		Developper in coordination with BPOLBF and KNP Authority
							Measuring the quality of air quality during land preparation	Before and after the project		
							Making a documentation of the process	After the project		
Land preparation of stockpile/dump site	OUV criteria (vii) Savannah ecosystem	Ecosystem disturbance	The impact is negligible as there is neither clearing the savanna nor cutting of the trees	Stockpile/dump site	d. Avoid cutting of the trees e. Avoid cutting down trees/savannahs, especially animal feed plants f. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife	Every day	Making documentation of the land preparation	After the project	Stockpile	Developper in coordination with BPOLBF and KNP Authority
	Criterion (x) – terrestrial fauna	Habitat disturbance and conversion	The impact is negligible as there is neither clearing the savanna nor cutting of the trees	Land preparation of stockpile/dump site site	Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife	Every day	Making a documentation of the process	After the project		Developper in coordination with BPOLBF and KNP Authority
		Noise pollution	Minor effects to terrestrial wildlife from noise pollution	Land preparation of stockpile/dump site site	c. Limit the number of heavy equipment operate per day [two excavators operate per day] d. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations	Every day	Checking vehicle and other equipment's eligibility	everyday		Developper in coordination with BPOLBF and KNP Authority
							Measuring the quality of air quality during land preparation	One time		
							Making a documentation of the process	After the project		
		Air pollution	The impact is negligible, considering far distance position of wildlife from exhaust of vehicles/the outlet. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.	Land preparation of stockpile/dump site site	Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution	Every day	Checking vehicle and other equipment's eligibility	everyday		Developper in coordination with BPOLBF and KNP Authority
							Measuring the quality of air quality during land preparation	One time		
							Making a documentation of the process	After the project		

b. Construction phase

	Imapacts			Environmental Management			Environmental Monitoring			
Activity (Source of impacts)	Impact criteria on OUV	Type of Impact	Details on impacts/ magnitude	Location	Details	Period of implementation	Details	Period of Monitoring	Location	Institution
Mobilization of construction workers, equipments and materials to Loh Buaya	Criteria (vii) – seagrass and coral reef	Habitat disturbance	Negligible disturbance to the seagrass and coral reef from transporting building materials via the sea routes	From Labuan Bajo port to the project site, Loh Buaya, Rinca Island and Labuan Bajo	g. Ensure the building materials do not exceed the carrying capacity of the boat h. Ensure each boat has a designated storage for waste disposal i. Set up "No Dumping to the Ocean" sign in the boats j. Do regular briefing to all the staffs about the regulations in placed k. Transport building materials (covered by a tarp) along designated sea routes that do not overlap with seagrass and coral reef ecosystems in coordination with Komodo National Park and Department of Transportation of Manggarai Barat l. Use mooring systems for boat anchoring	During the process	Making a documentation of the process to reduce the impact of mobilization on terrestrial and marine habitat Conducting vegetation and terrestrial wildlife monitoring Conducting observation of marine ecosystem, flora and fauna	During the project Before and after the project Before and after the project	Some point samples along the transportation route	Developper in coordination with BPOLBF and KNP Authority
	Criterion (x) – marine fauna and flora (non-mammals)	Ecological disturbance	Negligible disturbance to the marine fauna and flora from transporting building materials via the sea routes	From Labuan Bajo port to the project site, Loh Buaya, Rinca Island and Labuan Bajo						
	Criterion (x) – marine mammals and seaturtles	Ecological process disturbance	Minor disturbance to the behavior of dolphins and seaturtles from the boat transporting the building materials	From Labuan Bajo port to the project site, Loh Buaya, Rinca Island and Labuan Bajo						
Construction of basecamp for workers and stockpile	Impact on criterion (x) – terrestrial wildlife:	will impede the movement and disrupt their activities (e.g. foraging)	Minor disturbance as the terrestrial wildlife used to and adapted to the presence of humans	Base camp & Stockpiles	e. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife f. Build a fence surrounding the camp to avoid or reduce contact between the komodo and workers g. Use the equipment that produce low noise and vibration h. Install sign board to remind the workers about the presence of komodo	Every day Before the construction During the construction Before construction	Making documentation of the process to reduce the impact of construction to terrestrial wildlife	During the project	Construction of basecamp for workers and stockpile site	Developper in coordination with BPOLBF and KNP Authority
			Potential negative interaction between construction workers living in the project site and Komodo dragons	Base camp & Stockpiles						
			Minor disturbance to the behavior of terrestrial wildlife because of the garbage and food waste produced by construction workers in the base camps	Base camp & Stockpiles	d. Proper placement of the various bins/containers at the worker's camp base on the type of waste namely organic, and non organic waste e. Install sign board to remind workers to manage waste properly f. Arrange garbage disposal, so that it is not reachable by komodo	Every day				
		Accident	possibility of a conflict between workers and Komodo dragons, because the area is the trajectory of the Komodo dragon's movement. This conflict can endanger both, either humans or Komodo dragons.	Base camp & Stockpiles	c. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife d. Install sign board to remind the workers about the presence of komodo	Every day	Making documentation of the process on how to reduce accident Recording accident if any	During the project	Construction of basecamp for workers and stockpile site	Developper in coordination with BPOLBF and KNP Authority
		Noise pollution	Minor effects as the position of wildlife is far	Base camp & Stockpiles	d. Limit the number of heavy equipment operate per day [two excavators operate per day] e. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations f. Use the tools/machinery with low noise and vibration	Every day	Checking vehicle and other equipment's eligibility Measuring the quality of air quality during land preparation Making a documentation of the process to reduce pollution	everyday Before and after the project During the construction	Construction of basecamp for workers and stockpile site	Developper in coordination with BPOLBF and KNP Authority
		Air Pollution	The impact is negligible, considering far distance position of wildlife from exhaust of vehicles/the outlet. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.	Base camp & Stockpiles	c. Do regular watering before and after demolishing the existing buildings d. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution	Every day	Checking vehicle and other equipment's eligibility Measuring the the air quality Making a documentation of the process on how to reduce air pollution	Every day Before and after the project During the project	Construction of basecamp for workers and stockpile site	Developper in coordination with BPOLBF and KNP Authority
	Impact on criteria (vii) –	Air Polllution	Negligible toxic effects to vegetation from air pollution,	Base camp & Stockpiles	c. Do regular watering before and after demolishing the existing buildings	Every day	Checking vehicle and other equipment's eligibility	everyday		Developper in coordination

	Imapacts			Environmental Management			Environmental Monitoring			
Activity (Source of impacts)	Impact criteria on OUV	Type of Impact	Details on impacts/ magnitude	Location	Details	Period of implementation	Details	Period of Monitoring	Location	Institution
	Dry savannah and thorny vegetation		considering far distance position of wildlife from exhaust of vehicles/the outlet. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.		d. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution		Measuring the air quality Making a documentation of the process on how to reduce air pollution	Before and after the project During the project	Construction of basecamp for workers and stockpile site	with BPOLBF and KNP Authority
Construction of coastal protection	Criteria (vii) – Dry savannah and mangrove ecosystem	Savannah Ecosystem disturbance	Minor impact since only small area savannah of the mound is removed	Coastal protection site	Assign a group of people (consists of natural guides and KNP staff) to conduct daily monitoring of savannah ecosystem	Every day	Monitoring of vegetation after the project	After the project	Coastal protection site	Developper in coordination with BPOLBF and KNP Authority
		Mangrove Ecosystem disturbance	The impact is minor since only a small area of the mudflat from the mangrove habitat is buried	Coastal protection site	c. Ensure that no hazardous materials fall (spill off) into the mangrove ecosystem d. Assign a group of people (consists of natural guides and KNP staff) to conduct daily monitoring of mangrove ecosystem	Every day	Making a documentation of the process to reduce habitat mangrove disturbance	After the project completed	Coastal protection site	Developper in coordination with BPOLBF and KNP Authority
	Criterion (x) – Komodo & other terrestrial species	Habitat disturbance	The impact is negligible as there is neither clearing the savanna nor cutting of the trees	Coastal protection site	c. Avoid cutting of the mangrove/savannah trees d. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife	Every day				
		Noise pollution	The impact is negligible as the distance of komodo and other terrestrial species are far.	Coastal protection site	c. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations d. Ensure that all vehicles and equipment are working properly	Before the project	Checking vehicle and other equipment's eligibility Measuring the quality of noise during demolishing Making a documentation to reduce noise pollution	Every day during construction Before and after the project After the project	Coastal protection site	Developper in coordination with BPOLBF and KNP Authority
		Air pollution	The impact is negligible, considering far distance position of wildlife from exhaust of vehicles. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.	Coastal protection site	c. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations d. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution	Before the project	Checking vehicle and other equipment's eligibility	Every day during construction		
Elevated Pathway	Criteria (vii) Savannah ecosystem	Disturbance to savannah ecosystem	The impact is negligibly as the area is mostly barren land and the size is small (0.06 ha or 0.005 % of the total savannah in Rinca island Moreover,	Along the existing concrete footpath	Ensure that there is no dangerous material left on the site such as metal or spill over of lubricant/oil/fuel.	After the project	c. Wildlife monitoring d. Surface water flow observation	Before and after the project	Along the existing concrete footpath	Developper in coordination with BPOLBF and KNP Authority
		Removal hydrological system barrier	Positive impact : Elevated pathway will remove barrier of water surface flow in the savannah either from hilly areas or ocean during hight tide.		ensure that no water barrier is formed during construction					
	Criteria (x) Komodo, herpetofauna and other terrestrial species	Reducing direct and close interaction	There is positive impact, since elevated pathway will minimize interaction between komodo dan humans.	Along the existing concrete footpath	Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform the workers on the presence of komodo	After the project	Wildlife monitoring	After the project		
		Accident	There is a possibility of a conflict between workers and Komodo dragons, because the area is the trajectory of the Komodo dragon's movement. This conflict can endanger both, either humans or Komodo dragons.	Along the existing concrete footpath	c. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform the workers on the presence of komodo d. Install the warning board sign about the danger	Every day Before the construction	Making a documentation of the process to avoid wildlife accident	After the project		
		Air pollution	The impact is negligible, considering far distance position of wildlife from	Along the existing			Checking vehicle and other equipment's eligibility	Every day		

	Imapacts			Environmental Management			Environmental Monitoring			
Activity (Source of impacts)	Impact criteria on OUV	Type of Impact	Details on impacts/ magnitude	Location	Details	Period of implementation	Details	Period of Monitoring	Location	Institution
			exhaust of vehicles. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.	concrete footpath	d. Ensure that all vehicles and equipments have passed emission standardization based on Indonesian regulations e. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution f. Do regular watering before and after demolishing the existing building	Before mobilization the equipment's to project site Before mobilization the equipment's to project site Every day	Measuring the quality of noise during demolishing Making a documentation to reduce air pollution	Before and after the project Every day during construction		
		Noise pollution	The impact is negligible as the distance of komodo and other terrestrial species are far.	Along the existing concrete footpath	c. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations d. Ensure that all vehicles and equipment are working properly	Before mobilization the equipment's to project site	Checking vehicle and other equipment's eligibility Measuring the quality of air during demolishing Making a documentation to reduce noise pollution	Every day Before and after the project Every day during construction		
Ranger, Guide and researcher camp and plaza deck	Criteria (vii) Savannah ecosystem	Habitat disturbance	The impact is negligibly as the area is mostly barren land and the size is small (0.126 ha or 0.001 % of the total savannah in Rinca island	Ranger, Guide and researcher camp and plaza deck site	Ensure that there is no dangerous material left on the site such as metal or spill over of lubricant/oil/fuel.	After the construction	Vegetation monitoring	Before and after the project	Ranger, Guide and researcher camp and plaza deck site	Developper in coordination with BPOLBF and KNP Authority
	Criteria (x) Komodo, herpetofauna and other terrestrial species	will impede the movement and disrupt their activities (e.g. foraging)	Minor disturbance as the terrestrial wildlife used to and adapted to the presence of humans	Ranger, Guide and researcher camp and plaza deck site	c. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife d. Ensure that there is no dangerous material left on the site such as metal or spill over of lubricant/oil/fuel.	During the construction			Ranger, Guide and researcher camp and plaza deck site	Developper in coordination with BPOLBF and KNP Authority
		Accident	There is a possibility of a conflict between workers and Komodo dragons, because the area is the trajectory of the Komodo dragon's movement. This conflict can endanger both, either humans or Komodo dragons.	Ranger, Guide and researcher camp and plaza deck site	c. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform the workers on the presence of komodo d. Install the warning board sign about the danger	Every day Before the construction	Making a documentation of the process to avoid wildlife accident Recording wildlife accident if any	During the project	Along the existing concrete pathway	Developper in coordination with BPOLBF and KNP Authority
		Air pollution	The impact is negligible, considering far distance position of wildlife from exhaust of vehicles. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.	Ranger, Guide and researcher camp and plaza deck site	d. Ensure that all vehicles and equipments have passed emission standardization based on Indonesian regulations e. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution f. Do regular watering before and after demolishing the existing building	Before mobilization the equipment's to project site Before mobilization the equipment's to project site Every day	Checking vehicle and other equipment's eligibility Measuring the quality of noise during demolishing Making a documentation to reduce air pollution	Every day Before and after the project Every day	Along the existing concrete pathway Along the existing concrete pathway After the project	Developper in coordination with BPOLBF and KNP Authority Developper in coordination with BPOLBF and KNP Authority Developper in coordination with BPOLBF and KNP Authority
		Noise pollution	The impact is negligible as the distance of komodo and other terrestrial species are far.	Along the existing concrete pathway	f. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations g. Ensure that all vehicles and equipment are working properly h. Ensure the maximum speed of trucks is 30 km per hour i. Limit the number of heavy equipment operate per day	Before mobilization the equipment's to project site	Checking vehicle and other equipment's eligibility Measuring the quality of air during demolishing Making a documentation to reduce noise pollution	Every day Before and after the project Every day during construction	Ranger, Guide and researcher camp and plaza deck	Developper in coordination with BPOLBF and KNP Authority

	Imapacts			Environmental Management			Environmental Monitoring			
Activity (Source of impacts)	Impact criteria on OUV	Type of Impact	Details on impacts/ magnitude	Location	Details	Period of implementation	Details	Period of Monitoring	Location	Institution
					j. Use environmental friendly equipment that produce less noise					
Information Center construction	Criteria (vii) Savannah ecosystem	Habitat disturbance	Based on overlay the site plan and the UAV imagery, there will be 5 trees of tamarin will be cut down.	Information center construction site	To compensate the developer should replace the trees (same species trees)	After the project	Monitoring the growth of the planted trees by the developers	3 years after the project	Information Center construction site	Developper in coordination with BPOLBF and KNP Authority
	Criteria (x) Komodo, herpetofauna and other terrestrial species	will impede the movement and disrupt their activities (e.g. foraging)	Minor disturbance as the terrestrial wildlife used to and adapted to the presence of humans		c. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform equipment operators on the presence of wildlife d. Ensure that there is no dangerous material left on the site such as metal or spill over of lubricant/oil/fuel.	During the construction	Wildlife monitoring	Before and after the project		
		Accident	There is a possibility of a conflict between workers and Komodo dragons, because the area is the trajectory of the Komodo dragon's movement. This conflict can endanger both, either humans or Komodo dragons.		c. Assign a group of people (consists of natural guides and KNP staff) to conduct daily wildlife monitoring and inform the workers on the presence of komodo d. Install the warning board sign about the danger	Every day Before the construction	Making a documentation of the process to avoid wildlife accident	After the project		
		Air pollution	The impact is negligible, considering far distance position of wildlife from exhaust of vehicles. Moreover, pollutant concentration is becoming very low due to dilution by atmosphere as well as oxidation process.		d. Ensure that all vehicles and equipments have passed emission standardization based on Indonesian regulations e. Ensure that all vehicles and equipment are working properly, and therefore not creating air pollution f. Do regular watering before and after demolishing the existing building	Before mobilization the equipment's to project site Before mobilization the equipment's to project site Every day	Checking vehicle and other equipment's eligibility Measuring the quality of noise during demolishing Making a documentation to reduce air pollution	Every day Before and after the project After the project		
		Noise pollution	The impact is negligible as the distance of komodo and other terrestrial species are far.	Along the existing concrete footpath	f. Ensure that all vehicles and equipment have passed emission standardization based on Indonesian regulations g. Ensure that all vehicles and equipment are working properly h. Ensure the maximum speed of trucks is 30 km per hour i. Limit the number of heavy equipment operate per day j. Use environmental friendly equipment that produce less noise	Before mobilization the equipment's to project site	Checking vehicle and other equipment's eligibility Measuring the quality of air during demolishing Making a documentation to reduce noise pollution	Every day Before and after the project Every day during construction		

c.Post Construction

	Impacts			Management plan			Monitoring plan			
Activity (Source of impacts)	Impact criteria on OUV	Type of Impact	Details on impacts/ magnitude	Location	Details		Details	Period of Monitoring	Location	Institution
Infrastructures operation for tourists	OUV criterion (x) – terrestrial wildlife	Behaviour of Komodo	Negligible disturbance from potential negative interaction between tourists and Komodo dragons	Project site, Loh Buaya, Rinca Island	c. Install a sign board to inform the visitor not to close to komodo dragon d. Assign ranger to guard and guide the visitor	Loh Buaya, Rinca Island	Wildlife monitoring	After the project	Loh Buaya, Rinca Island	KNP
		Solid waste	Major disturbance to the behavior of terrestrial wildlife because of the garbage and food waste produced mainly by tourists	Project site, Loh Buaya, Rinca Island	d. Implement strick regulation on waste management, i.e visitor should bring back the waste. e. Set up designated temporary dumping sites for different types of waste f. Regular Transport waste regularly to Labuan Bajo		Making a documentation of the process to avoid impact of Solid waste to terrestrial wildlife	After the project	Loh Buaya, Rinca Island	KNP
		Water waste	Negligible as the water is treated with biotank and the purified water is inserted into soil	Project site, Loh Buaya, Rinca Island	b. Ensure the biotank in a good condition c. Ensure no water leakage from rest room		Making a documentation of the process to avoid impact of water waste to terrestrial wildlife Annual monitoring of water quality in Loh Buaya	After the project	Loh Buaya, Rinca Island	KNP
	Criterion (x) – marine mammals and seaturtles	Marine mammals and sea turtles disturbance	Minor disturbance to the dolphins and seaturtles from the movement of tourist boats	Project site, Loh Buaya, Rinca Island	Quota system to manage the number of boat in Loh Buaya per day		Making a documentation of the process to avoid impact of waste water Annual monitoring of marine ecosystem	After the project	Loh Buaya, Rinca Island	KNP

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List of Attachment

Appendix 1.1	Recommendations for Environmental Management (UKL) and Environmental Monitoring Efforts (UPL
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Appendix 1.1. Recommendations for Environmental Management (UKL) and Environmental Monitoring Efforts (UPL)

KEMENTERIAN LINGKUNGAN HIDUP DAN KEHUTANAN
DIREKTORAT JENDERAL
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13 Juli 2020

Nomor : S.576/KSDAE/KK/KSA.1/7/2020
Lampiran : 1 (satu) berkas
Hal : Pengecualian AMDAL terhadap Pembangunan Sarana Prasarana Wisata di TN Komodo

Kepada Yth.
Kepala Dinas Lingkungan Hidup dan Kehutanan
Provinsi Nusa Tenggara Timur
di
Kupang

Sehubungan dengan surat Kepala Balai Taman Nasional Komodo Nomor S. 756/T.17/TU/REN/7/2020 tanggal 10 Juli 2020 hal Arahan Penapisan Kedua di Pulau Rinca Kabupaten Manggarai Barat yang tembusannya disampaikan kepada Saudara, dengan ini kami sampaikan hal–hal sebagai berikut:

1. Memperhatikan surat Kepala Balai TN Komodo, Saudara menyampaikan surat Nomor DLHK.660/50/I/2020 tanggal 8 Juli 2020 hal Arahan Penapisan Kedua di Pulau Rinca Kabupaten Manggarai Barat yang ditujukan kepada Balai Prasarana Permukiman Wilayah Nusa Tenggara, yang tembusannya disampaikan juga kepada Menteri LHK dan Kepala Balai TN Komodo.
2. Berkenaan dengan poin 1 di atas:
   a. Berdasarkan Peraturan Menteri LHK Nomor: P.38/Menlhk/Setjen/Kum.1/7/2019 tentang Jenis Rencana Usaha dan/atau Kegiatan yang Wajib Memiliki Analisis Mengenai Dampak Lingkungan Hidup, kami sampaikan hal-hal sebagai berikut:
      1) Pasal 7 ayat (1): Rencana usaha dan/atau kegiatan yang berdampak penting terhadap lingkungan hidup dikecualikan dari kewajiban menyusun AMDAL, diantaranya jika lokasi rencana usaha dan/atau kegiatannya berada pada kawasan lindung yang memiliki rencana pengelolaan dan/atau penataan ruang kawasan lindung detail yang dilengkapi dengan Kajian Lingkungan Hidup Strategis yang dibuat dan dilaksanakan secara komprehensif dan rinci sesuai dengan ketentuan Peraturan Perundang-undangan.
      2) Pasal 10 ayat (1): Rencana Usaha dan/atau Kegiatan selain sebagaimana tercantum dalam Lampiran I yang merupakan bagian tidak terpisahkan dari Peraturan Menteri ini, yang berbatasan langsung atau berada dalam kawasan lindung sebagaimana dalam Pasal 3 ayat (3) huruf b, dapat dikecualikan dari kewajiban memiliki Amdal setelah mendapatkan penetapan pengecualian wajib Amdal dari instansi yang berwenang dan bertanggung jawab terhadap pengelolaan kawasan lindung.
   b. Sesuai dengan poin 2.a di atas, kami menyampaikan bahwa kegiatan tersebut termasuk dalam kegiatan yang dikecualikan dari kewajiban AMDAL. Hal ini mengingat lokasinya yang berada di dalam kawasan lindung yang telah dilengkapi dengan:
      1) Rencana Pengelolaan Taman Nasional Komodo (SK Dirjen KSDAE Nomor SK. 254/KSDAE/SET/KSA.1/9/2016 tanggal 13 September 2016) dan Penataan Zonasi Taman Nasional Komodo (SK Dirjen PHKA Nomor SK.21/IV-SET/2012 tanggal 24 Februari 2012). Dokumen Rencana Pengelolaan dan Penataan Zonasi merupakan dokumen hasil kajian lingkungan yang disusun dengan kehati-hatian dengan memperhatikan prinsip kelestarian lingkungan, yang dalam hal ini merupakan mekanisme penapisan untuk kemungkinan terjadinya kerusakan lingkungan, dan dipandang setara dengan penapisan-penapisan dalam proses AMDAL.
      2) Desain Tapak Pengelolaan Pariwisata Alam yang telah disahkan (SK Direktur PJLHK Nomor SK. 38/PJLHK/PJLWA/KSA.3/7/2018 tanggal 26 Juli 2018).
      3) *Site Plan, Desain Engineering Detail* (DED), dan AMDAL Sarana Prasarana Wisata Alam yang telah sesuai ketentuan dan telah disetujui Dirjen KSDAE.

c. Mengingat bahwa dokumen-dokumen sebagaimana poin 2.b telah tersedia, maka pada dasarnya untuk kegiatan pembangunan sarana prasarana wisata alam di Loh Buaya Pulau Rinca TN Komodo oleh Kementerian PUPR dapat dikecualikan dari kewajiban menyusun Amdal. Untuk itu agar Saudara dapat mempedomani dokumen tersebut sebagai dasar pertimbangan dalam memberikan rekomendasi Upaya Pengelolaan Lingkungan Hidup (UKL) dan Upaya Pemantauan Lingkungan Hidup (UPL) atas Dokumen UKL-UPL serta selanjutnya penerbitan Izin Lingkungan.

3. Mempertimbangkan status TN Komodo sebagai Warisan Alam Dunia (*Natural World Heritage*), perlu kami sampaikan bahwa dalam penilaian dokumen UKL-UPL di Pulau Rinca TN Komodo agar juga memenuhi 8 prinsip, serta memperhatikan nilai *Outstanding Universal Value* (OUV) TN Komodo. Adapun 8 prinsip tersebut adalah:
   (1) Melakukan Kajian Lingkungan yang ketat pada awal proses pengambilan keputusan;
   (2) Melibatkan ahli Konservasi Wardun, kawasan konservasi dan keanekaragaman hayati;
   (3) Lakukan kajian dampak lingkungan dan sosial terhadap nilai OUV, termasuk efek langsung, tidak langsung dan kumulatif;
   (4) Mengidentifikasi dan merekomendasikan opsi alternatif untuk merekomendasikan opsi yang paling berkelanjutan kepada pembuat keputusan;
   (5) Mengidentifikasi langkah-langkah mitigasi berdasarkan hierarki mitigasi;
   (6) Harus ada bab dalam dokumen UKL-UPL yang fokus kepada Warisan Dunia;
   (7) Kajian harus melakukan konsultasi publik, dan hasil harus dipublikasi
   (8) Mengusulkan dan mengimplementasikan rencana pengelolaan lingkungan, yang harus diaudit secara independen.

   Sedangkan OUV TN Komodo sebagai kawasan warisan dunia adalah:
   (1) Memiliki ekosistem savanna, pantai, perairan yang spektakuler di dunia;
   (2) Memiliki satwa komodo yang merupakan satu-satunya kadal terbesar di dunia.

Demikian, atas perhatian dan kerjasama Saudara diucapkan terima kasih.

Direktur Jenderal,

Ir. Wiratno, M.Sc
NIP. 19620328 198903 1 003

Tembusan:
1. Menteri Lingkungan Hidup dan Kehutanan (*sebagai laporan*).
2. Wakil Menteri Lingkungan Hidup dan Kehutanan.
3. Gubernur Nusa Tenggara Timur.
4. Bupati Manggarai Barat.
5. Sekretaris Jenderal Kementerian LHK.
6. Sekretaris Jenderal Kementerian PUPR.
7. Deputi Bidang Koordinasi Pariwisata dan Ekonomi Kreatif Kemenko Bidang Kemaritiman dan Investasi.
8. Direktur Jenderal Planologi Kehutanan dan Tata Lingkungan, Kementerian LHK.
9. Direktur Jenderal Cipta Karya, Kementerian PUPR.
10. Direktur Jenderal Sumber Daya Air, Kementerian PUPR.
11. Direktur Pemanfaatan Jasa Lingkungan Hutan Konservasi.
12. Kepala Balai Taman Nasional Komodo.

PEMERINTAH PROVINSI NUSA TENGGARA TIMUR
DINAS LINGKUNGAN HIDUP DAN KEHUTANAN
Jl. S.K. Lerik, Kelapa Lima Kupang-NTT PO BOX 132
Telepon. (0380) 832517- Fax 833102 Kupang 85228

Kupang, 28 Juli 2020

Nomor : DLHK.660/ 157 /I/2020
Lampiran : -
Hal : Arahan Dokumen Lingkungan Kegiatan Pembangunan Sarana Prasarana Wisata di Taman Nasional (TN) Komodo.

Kepada
Yth. Kepala Balai Prasarana Permukiman Wilayah Nusa Tenggara Timur
di –
Kupang

Menindaklanjuti Surat Direktur Jenderal Konservasi Sumber Daya Alam dan Ekosistem Nomor S.576/KSDAE/KK/KSA.1/7/2020 Tanggal 13 Juli 2020 perihal Pengecualian AMDAL terhadap Pembangunan Sarana Prasarana Wisata di TN Komodo, maka disampaikan hal-hal sebagai berikut:

1. Rencana Usaha dan/atau Kegiatan Pembangunan Sarana dan Prasarana Wisata di TN Komodo dikecualikan dari kewajiban Amdal mengingat lokasi kegiatan telah dilengkapi dengan:
   a. Rencana Pengelolaan Taman Nasional Komodo dan Penataan Zonasi Taman Nasional Komodo;
   b. Desain Tapak Pengelolaan Pariwisata Alam yang telah disahkan;
   c. *Site Plan, Desain Engineering Detail* (DED) dan AMDAL Sarana Prasarana Wisata Alam yang telah disetujui oleh Dirjen KSDAE.
2. Berdasarkan poin 1 (satu) di atas, maka Rencana Usaha dan/atau Kegiatan Pembangunan Sarana dan Prasarana Wisata di TN Komodo, Pulau Rinca Kabupaten Manggarai Barat Provinsi NTT **wajib dilengkapi dengan dokumen Upaya Pengelolaan Lingkungan Hidup dan Upaya Pemantauan Lingkungan Hidup (UKL-UPL)** dengan melingkup komponen kegiatan pada sisi darat dan sisi laut terdiri dari:
   a. Pembangunan sarana dan prasarana pengaman pantai Loh Buaya
   b. Pembangunan Fasilitas Penunjang Wisata Kawasan Strategis Pariwisata Nasional (KSPN) Pulau Rinca;
   c. Pembangunan *Reservoir* SPAM Pulau Rinca.
3. Terkait kewenangan pemeriksaan UKL-UPL, sesuai Undang-undang Nomor 23 Tahun 2014 tentang Pemerintahan Daerah, bahwa pengelolaan wilayah laut paling jauh 12 (dua belas) mil laut diukur dari garis pantai ke arah laut lepas dan/atau ke arah perairan kepulauan merupakan kewenangan Provinsi Nusa Tenggara Timur. Mengingat ruang lingkup kegiatan Saudara juga berada pada wilayah laut maka pemeriksaan dokumen UKL-UPL dilakukan oleh **Dinas Lingkungan Hidup dan Kehutanan Provinsi NTT**.
4. Selanjutnya mengingat status TN Komodo sebagai Warisan Alam Dunia (*World Natural Heritage*) maka Saudara selaku Pemrakarsa dalam penyusunan dokumen UKL-UPL **wajib** memperhatikan nilai *Outstanding Universal Value* (OUV) TN Komodo yang meliputi 8 prinsip yaitu:

a. Melakukan kajian lingkungan yang ketat pada awal proses pengambilan keputusan;
b. Melibatkan ahli konservasi wardun, kawasan konservasi dan keanekaragaman hayati;
c. Melakukan kajian dampak lingkungan dan sosial terhadap nilai OUV, termasuk efek langsung, tidak langsung dan kumulatif;
d. Mengidentifikasi dan merekomendasikan opsi yang paling berkelanjutan kepada pembuat keputusan;
e. Mengidentifikasi langkah-langkah mitigasi berdasarkan hierarki mitigasi;
f. Harus ada bab dalam dokumen UKL-UPL yang fokus pada warisan dunia;
g. Mengusulkan dan mengimplementasikan rencana pengelolaan lingkungan, yang harus diaudit secara independen.

5. Perlu disampaikan bahwa berdasarkan Undang-Undang Nomor 32 Tahun 2009 tentang Perlindungan dan Pengelolaan lingkungan hidup, pasal 109 menyatakan bahwa setiap orang yang melakukan usaha dan/atau kegiatan tanpa memiliki izin lingkungan dipidana dengan pidana penjara paling singkat 1 (satu) tahun dan paling lama 3 (tiga) tahun dan denda paling sedikit Rp.1.000.000.000 (satu miliar rupiah) dan paling banyak Rp.3.000.000.000 (tiga miliar rupiah).
6. Untuk informasi lebih lanjut unsur staf Balai Prasarana Permukiman Wilayah NTT dapat menghubungi Sekretariat Komisi Penilai Amdal Provinsi NTT dengan Sdr. Umbu 081339355800 (HP 0811383741), Sdri. Fendi (081339449036).

Demikian untuk maklum, atas kerja sama yang baik disampaikan terima kasih.

KEPALA DINAS LINGKUNGAN HIDUP DAN KEHUTANAN
PROVINSI NUSA TENGGARA TIMUR

Ir. FERDY J. KAPITAN, M.Si
Pembina Utama Madya
NIP. 19660220 199203 1 007

Tembusan:
1. Menteri Lingkungan Hidup dan Kehutanan RI di Jakarta;
2. Menteri Pekerjaan Umum dan Penataan Ruang RI di Jakarta;
3. Gubernur Nusa Tenggara Timur di Kupang (sebagai laporan);
4. Sekretaris Daerah Provinsi Nusa Tenggara Timur di Kupang;
5. Bupati Manggarai Barat di Labuan Bajo;
6. Direktur Pencegahan Dampak Lingkungan Usaha dan kegiatan, Dirjen Planologi Kehutanan dan Tata Lingkungan, Kementerian Lingkungan Hidup dan Kehutanan RI di Jakarta;
7. Kepala Balai Taman Nasional Komodo di Labuan Bajo;
8. Kepala Badan Otorita Pariwisata di Labuan Bajo;
9. Kepala Dinas Lingkungan Hidup dan Kebersihan Kabupaten Manggarai Barat NTT di Labuan Bajo;
10. Kepala P3E Bali – Nusa Tenggara di Denpasar.

Appendix 2.1. A complete description of the identity of the initiator and implementer of UKL/UPL

KEMENTERIAN PEKERJAAN UMUM DAN PERUMAHAN RAKYAT
DIREKTORAT JENDERAL CIPTA KARYA
BALAI PRASARANA PERMUKIMAN WILAYAH NUSA TENGGARA TIMUR
SATUAN KERJA BALAI PRASARANA PERMUKIMAN WILAYAH NUSA TENGGARA TIMUR
Jalan Polisi Militer No. 1 Kupang - NTT, Telp./Fax. (0380) 8431826, email : bppw_ntt@pu.go.id

Lampiran : Surat Penugasan Balai Prasarana Permukiman Wilayah NTT
Nomor : 107.1/ST/Cb19/PP/2020
Tanggal : 14 Juli 2020

TIM UKL-UPL
PENATAAN KAWASAN PULAU RINCA
DI DESA PASIR PANJANG, KECAMATAN KOMODO
KABUPATEN MANGGARAI BARAT, PROVINSI NUSA TENGGARA TIMUR

1. TENAGA AHLI

Ketua : Syafri Arif, S.Hut, MSi. (Manajemen Lingkungan/Kehutanan)

Anggota : Suci Wulandhani, SP, MSi.(Biologi)
Haslina, ST, MT. (Kimia)
Firman Sutomo, SP. MSi. (Hidrologi)
Wirawan Muqtadir Kautzar Djamil, SE. (Sosial Ekonomi Budaya)
Muh. Zulfikar A, SKM. (Kesmas)
Rezki Bages, ST. (Planologi)
Hasriyani Hafid, S.Kel, MSi. (Hidrooceanografi)
Aswin Renaldy, S.KM (K3)

2. TENAGA PENDUKUNG

Jabbar (Computer)
Rahayu (Sekretariat/administrasi)

Ditetapkan : di Kupang
Pada Tanggal : 14 Juli 2020

DODDY P. H. SOETOPO, ST. MT.
NIP. 19850714 201012 1 003

Appendix 2.2. Team of Revision and adjustment of EMP Document

KEMENTERIAN PEKERJAAN UMUM DAN PERUMAHAN RAKYAT
DIREKTORAT JENDERAL CIPTA KARYA
Jl. Pattimura No.20 Kebayoran Baru. Jakarta Selatan. 12110 Telp. 72797427

Nomor	:	PR 0201-Dc/969	Jakarta, 27 September 2021
Sifat	:	Penting	
Lampiran	:	1 (satu) berkas	
Hal	:	Penyesuaian Dokumen UKL-UPL Penataan Kawasan Pulau Rinca dan Penyusunan *Integrated Tourism Master Plan* (ITMP) Labuan Bajo	

Yth.
Direktur Jenderal Konservasi Sumber Daya Alam dan Ekosistem
Kementerian Lingkungan Hidup dan Kehutanan
di –
Tempat

Menindaklanjuti surat Direktur Jenderal KSDAE Kementerian Lingkungan Hidup dan Kehutanan (LHK) nomor: S.628/KSDAE/KK/KSA.1/8/2021 tanggal 23 Agustus 2021 perihal Penyelesaian Perbaikan UKL UPL Penataan Kawasan Pulau Rinca dan Penyusunan *Integrated Tourism Master Plan* (ITMP) Labuan Bajo, bersama ini kami sampaikan beberapa hal sebagai berikut:

1. Direktorat Jenderal Cipta Karya Kementerian PUPR melalui Balai Permukiman dan Prasarana Wilayah (BPPW) Nusa Tenggara Timur telah menyusun dokumen Upaya Pengelolaan Lingkungan Hidup (UKL) dan Upaya Pemantauan Lingkungan Hidup (UPL) Penataan Kawasan Pulau Rinca yang telah disahkan dengan Keputusan Kepala Dinas Penanaman Modal dan Pelayanan Terpadu Satu Pintu Provinsi Nusa Tenggara Timur nomor: DPMPTSP.669/32/PTSP/IX/2020 tentang Izin Lingkungan Hidup terhadap Rencana Usaha dan/atau Kegiatan Penataan Kawasan Pulau Rinca di Desa Pasir Panjang Kecamatan Komodo, Kabupaten Manggarai Barat Provinsi Nusa Tenggara Timur yang diprakarsai oleh Balai Prasarana Permukiman Wilayah Nusa Tenggara Timur.
2. Dokumen EIA Penataan Kawasan Loh Buaya Pulau Rinca KSPN Labuan Bajo telah disampaikan dari Ditjen Cipta Karya kepada Ditjen KSDAE sesuai surat nomor: PR.01.02- DC/102 tanggal 3 Februari 2021 dan telah dilakukan reviu oleh Ditjen KSDAE sesuai dengan *IUCN Advice Note on Environmental Assessment*.
3. Berdasarkan Prinsip Penilaian Dampak Warisan Dunia yang tertuang dalam *IUCN Advice Note on Environmental Assessment,* rencana pengelolaan lingkungan merupakan bagian tidak terpisahkan dari dokumen EIA, sehingga diperlukan penyesuaian pada dokumen UKL-UPL tersebut dalam hal:
   a) Rona Lingkungan Kawasan Loh Buaya Pulau Rinca dalam Lampiran Nomor 7 Dokumen UKL-UPL yang memuat kondisi eksisting flora, fauna, dan lansekap kawasan sebagai *Outstanding Universal Value (OUV)*.
   b) Matriks Upaya Kelola Lingkungan dalam Lampiran Tabel 6 yang memuat rincian kegiatan manajemen dampak lingkungan yang dilaksanakan dari tahapan prakonstruksi hingga pasca konstruksi.
   c) Kerangka penulisan dokumen UKL-UPL yang disesuaikan dengan *Environment Management Plan* (EMP) sesuai *IUCN Advice Note on Environmental Assessment*.

4. Penyesuaian dokumen tersebut saat ini dalam proses finalisasi oleh Tim Penyesuaian UKL-UPL yang terdiri dari Prof. Lilik Budi Prasetyo (Ahli Ekologi Lansekap), Mr. Koen Meyers (Ahli Warisan Dunia), Dr. Titiek Setyawati (Ahli Ekologi Kehutanan), dan Sheherazade, M.Sc (Ahli Ekologi Satwa Liar), Tim dari Direktorat Pengembangan Kawasan Permukiman, dan Balai PPW Provinsi NTT sesuai Keputusan Direktur Pengembangan Kawasan Permukiman Nomor: 50/KPTS/CK/2021 tanggal 19 Agustus 2021 tentang Tim Penyesuaian Dokumen UKL-UPL Penataan Kawasan Pulau Rinca di Desa Pasir Panjang Kecamatan Komodo Kabupaten Manggarai Barat Provinsi Nusa Tenggara Timur yang diperkirakan akan selesai pada awal Oktober 2021.

5. Hasil Penyesuaian dokumen UKL-UPL akan disampaikan kepada Kementerian LHK untuk dikirimkan kepada *World Heritage Center* (WHC) dan direview kembali oleh IUCN. Bersamaan dengan hal tersebut, penyesuaian dokumen UKL-UPL memerlukan rekomendasi teknis dari DLHK Provinsi NTT untuk disahkan sebagai amandemen Izin Lingkungan Hidup terhadap Rencana Usaha dan/atau Kegiatan.

6. Sebagai upaya perlindungan *Outstanding Universal Value (OUV)* Taman Nasional Komodo, diperlukan dokumen *Integrated Tourism Master Plan* (ITMP) Labuan Bajo yang disusun oleh Badan Pengembangan Infrastruktur Wilayah (BPIW) Kementerian PUPR dan saat ini dalam tahap *Inception Report*. Penyusunan dokumen ITMP tersebut dilaksanakan secara terpadu dan terintegrasi melalui kolaborasi dengan Kementerian/Lembaga dan pemangku kepentingan terkait.

Demikian kami sampaikan, atas perhatian dan kerjasama yang baik diucapkan terima kasih.

Direktur Jenderal Cipta Karya

Diana Kusumastuti

NIP. 196707171996032002

Dokumen ini telah ditandatangani secara elektronik menggunakan aplikasi Peruri yang dikelola oleh Badan Siber dan Sandi Negara

Tembusan Yth.:

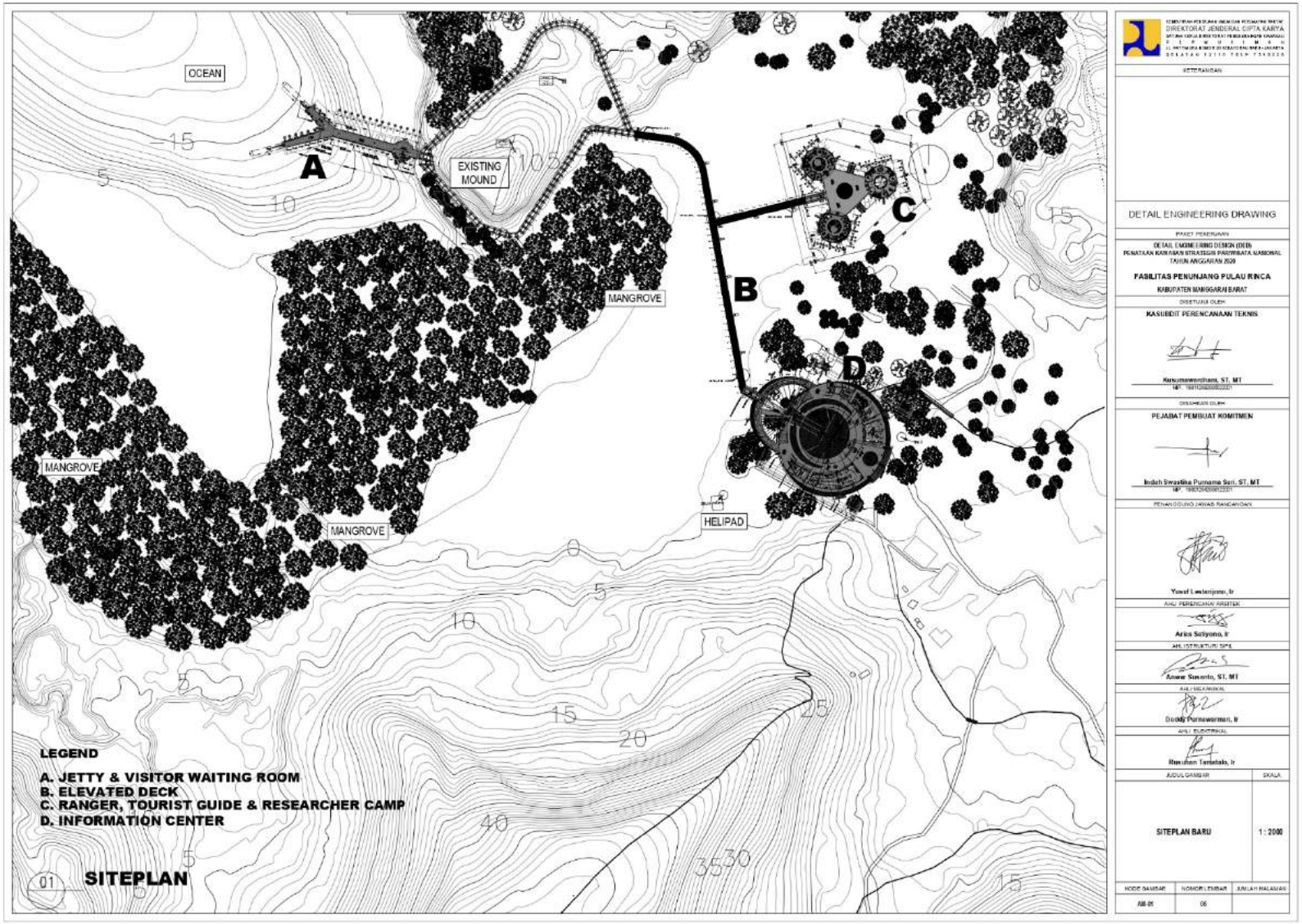
1. Menteri Pekerjaan Umum dan Perumahan Rakyat (sebagai laporan);
2. Kepala Badan Pengembangan Infrastruktur Wilayah (BPIW);
3. Staf Ahli V Menteri PUPR Bidang Teknologi, Industri, dan Lingkungan.

Appendix 3.1. Detail construction schedule

Stage of development	Duration (days)	2020				2021									
		Month				Month									
		9	10	11	12	1	2	3	4	5	6	7	8	9	10
Pre-construction stage															
b. Land preparation															
(a) Transportation route and connecting road construction	7														
(b) Demolition of existing jetty	7														
(c) Demolition of resort office, ticketing, ranger camp, café, and toilet	20														
(d) Coastal protection	45-60														
(e) Elevated desk	7														
(f) Water supply system	60														
(g) Ranger, Tourist Guide and Researcher Camp	-														
Construction stage															
1. Mobilization of construction workforce	-														
2. Mobilization-Demolization of Equipment and Materials															
(a) Equipment															
(b) Material															
3. Construction and operation of base camp and stockpile															
4. Temporary jetty	10														
5. Jetty & visitor waiting rom															
(a) Pile drilling and case mounting	30														
(b) Formwork, iron, pile cap and beam casting	120														
(c) Formwork, ironing, casting gazebo	60														
(d) Ironwood floor and handrail installation	60														
(e) Gazebo roof installation	30														
6. Coastal protection	30														
7. Elevated deck & Plaza deck															

Stage of development	Duration (days)	2020				2021									
		Month				Month									
		9	10	11	12	1	2	3	4	5	6	7	8	9	10
(a) Excavation of foundation and micro pile	60														
(b) Foundation and column reinforcement	60														
(c) Foundation and column casting	60														
(d) Installation of ironwood floors and hand railing	120														
8. Ranger, guide and researcher camp															
(a) Piling	45														
(b) Pile cap and pedestal column	30														
(c) Floor beams and slabs	90														
(d) Column and beam	70														
(e) Roof installation	75														
(f) Light brick wall	75														
(g) Ceiling and floor ceramics	75														
(h) Interior and exteror painting	75														
9. Information center															
(a) Piling	45														
(b) Pile cap and pedestal column	45														
(c) Sloof beam and plate (first floor)	75														
(d) Column, beam, and plate (second floor)	75														
(e) Light brick wall	60														
(f) Ceiling and floor ceramics	60														
(g) Interior and exterior painting	60														
10. Water supply system	90														
11. Resting post	30														
12. Guardhouse	30														

Appendix 3.2. Technical drawing of the site plan of the project



Appendix 3.3. Approval of the Rinca Island Arrangement Plan in the Komodo National Tourism Strategic Area and Surrounding Areas

KEMENTERIAN PEKERJAAN UMUM DAN PERUMAHAN RAKYAT
SEKRETARIAT JENDERAL
TIM PEMANTAUAN DAN EVALUASI PROYEK STRATEGIS NASIONAL
Jalan Pattimura No. 20 Kebayoran Baru – Jakarta Selatan Telp. 7394222

Nomor : UM.01.02/33/TPE-PSN/2020 Jakarta, 9 April 2020
Lampiran : -
Hal : **Masukkan Klarifikasi Rencana Penataan Pulau Rinca di Kawasan Strategis Pariwisata Nasional Komodo dan Sekitarnya**

Kepada Yth.
Plt. Deputi Bidang Koordinasi Pariwisata dan Ekonomi Kreatif
Kementerian Koordinator Bidang Kemaritiman dan Investasi
di tempat

Menindaklanjuti Surat Plt. Deputi Bidang Koordinasi Pariwisata dan Ekonomi Kreatif Kementerian Koordinator Bidang Kemaritiman dan Investasi Kemenko Maritim dan Investasi, tanggal 16 April 2020, perihal Laporan Rapat Koordinasi *State of Conservation* Taman Nasional Komodo dan Persiapan Penyampaian Klarifikasi ke Pusat Warisan Dunia, bersama ini kami sampaikan bahwa Penataan Pulau Rinca dilaksanakan dalam rangka mendukung pengembangan Kawasan Strategis Pariwisata Nasional (KSPN) Komodo dan sekitarnya melalui **peningkatan kualitas Sarana dan Prasarana yang telah ada di kawasan Loh Buaya, Pulau Rinca**. Berikut adalah **rencana kegiatan** peningkatan kualitas yang telah disusun secara komprehensif dengan melibatkan stakeholder terkait (konsep desain terlampir), antara lain yaitu:

1. Dermaga Loh Buaya berada pada lokasi dermaga eksisting
2. Bangunan pengaman pantai berfungsi sebagai talud pengaman pantai serta jalan setapak untuk akses masuk dan keluar ke kawasan wisata tersebut.
3. *Elevated Deck* berada pada jalur jalan lingkungan eksisting, berfungsi sebagai jalan akses yang menghubungkan dermaga, pusat Informasi serta penginapan ranger, guide dan peneliti. Di desain setinggi 2 meter agar tidak menggangu aktivitas komodo dan hewan lain yang melintas.
4. Bangunan Pusat Informasi berada pada lokasi eksiting yang mengintegrasikan bangunan yang ada berupa pusat informasi, kafetaria, kantor seksi wilayah, kantor resort dan guest house di kawasan wisata tersebut. Di desain menyatu dengan *elevated deck* agar wisatawan dapat melihat komodo dari akses yang juga berfungsi sebagai atap bangunan
5. Bangunan penginapan untuk para *Ranger*, *Guide* dan Peneliti yang dilengkapi dengan pos peneliti dan pemantauan habitat komodo.

Demikian kami sampaikan, atas perhatian dan kerjasamanya kami ucapkan terima kasih.

Ketua CPMU P3TB

Ir. Taufik Widjoyono, M.Sc
NIP. 195608181982111001

Tembusan Yth.:
1. Kepala Badan Pengembangan Infrastruktur Wilayah, Kementerian PUPR
2. Direktur Jenderal Cipta Karya, Kementerian PUPR

Appendix 3.4. The initial environmental condition of KNP

I. Lingkungan Fisik Kimia

1.1. Iklim

a. Tipe Iklim

Schmidt dan Ferguson menentukan tipe iklim berdasarkan perbandingan antara BK dan BB. Berdasarkan tipe iklim Schmidt Ferguson, tipe iklim di wilayah Manggarai Barat bervariasi dari tipe B (Basah) sampai tipe E (agak kering). Stasiun Labuan Bajo yang mewakili wilayah Kecamatan Komodo dan sekitarnya mempunyai tipe iklim E (agak kering), Stasiun Werang yang mewakili Kecamatan Sano Ngng dan sekitarnya termasuk tipe D (sedang), Stasiun Ranggu yang merepresentasikan wilayah Kecamatan Kuwus di sekitarnya mempunyai tipe iklim C (agak basah); dan Stasiun Compang yang mewakili wilayah Kecamatan Macang Pacar dan sekitarnya mempunyai tipe iklim B (basah).

b. Temperatur Udara

Rata-rata suhu udara tahunan bervariasi, cukup tinggi sekitar 27,6 ^{o}C terjadi pada tahun 2016, sedangkan re rata suhu terendah pada tahun 2015, yaitu 26,7 ^{o}C. Perbedaan re rata suhu antara suhu udara tertinggi tahun 2016 dan terendah tahun 2015 sebesar 0,9 ^{o}C, mengambarkan daerah ini termasuk beriklim kering. Untuk jelasnya disajikan pada Tabel 2.1.

c. Kelembaban Udara

Rata-rata kelembaban udara tahunan tertinggi yaitu 81.1 %, terjadi pada tahun 2015 dan tahun 2016, sedangkan re rata kelembababn udara tahunan terendah yaitu 73.0 %, terjadi pada tahun 2009. Perbedaan re rata kelembaban udara tertinggi dengan kelembaban udara terendah yaitu 8.1 %. Untuk jelasnya disajikan pada Tabel 2.2.

Tabel 1.1. Kondisi Temperatur Udara di Labuan Bajo dan Sekitarnya

Tahun	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Januari	27.4	27.1	28.1	27.3	26.9	27.0	27.2	27.3	27.9	27.2	26.9
Februari	26.7	27.1	28.2	24.4	27.0	27.3	27.0	26.2	26.8	26.1	27.2
Maret	26.8	27.0	28.4	27.5	26.6	27.4	27.7	27.2	28.1	27.1	27.7
April	26.9	27.8	28.3	26.5	27.4	27.5	27.8	26.9	28.2	27.3	27.9
Mei	27.3	27.7	27.9	27.8	27.0	27.4	27.6	26.7	28.0	27.4	28.0
Juni	26.3	26.4	27.6	26.1	26.1	26.9	27.3	26.6	26.7	26.6	27.3
Juli	26.6	26.5	27.0	26.7	26.0	26.3	26.1	25.7	26.8	26.5	26.8
Agutus	26.6	26.6	26.8	26.8	24.2	26.0	26.3	25.4	28.4	26.7	26.6
September	27.4	27.5	26.9	27.1	26.8	26.2	26.1	26.2	27.6	27.3	27.2
Oktober	28.1	27.9	27.9	29.3	28.2	28.5	27.4	26.5	27.5	28.2	28.1
Nopember	28.9	28.5	28.5	29.3	28.5	28.5	28.1	28.4	28.5	27.8	28.2
Desember	27.8	28.8	27.3	29.0	28.3	27.5	27.7	28.3	27.0	27.4	28.1
Re rata	27.2	27.4	27.7	27.3	26.9	27.2	27.1	26.7	27.6	27.1	27.5

Sumber: Badan Metereologi Klimatologi dan Geofisika, Stasiun Meterorologi Komodo, 2019.

Tabel 1.2. Kondisi Kelembaban Udara di Labuan Bajo dan Sekitarnya

Tahun	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Januari	82.0	85.0	81.0	84.6	85	87	85	87	83	88	88
Februari	86.0	86.0	84.0	77.0	81	83	87	84	84	83	86
Maret	86.0	83.0	79.0	86.0	83	85	84	85	85	87	84
April	81.0	79.0	82.0	82.0	74	82	82	86	81	82	78
Mei	73.0	78.0	84.0	78.0	72	83	82	81	81	78	71
Juni	73.0	73.0	75.0	68.0	68	83	78	76	81	80	72
Juli	66.0	69.0	78.0	72.0	65	77	78	78	80	75	71
Agutus	70.0	70.0	76.0	67.0	64	74	74	79	76	72	75
September	71.0	71.0	82.0	67.0	73	71	77	77	75	74	79
Oktober	75.0	71.0	79.9	67.0	76	74	77	81	81	76	79
Nopember	76.0	36.0	77.0	72.0	75	79	80	78	79	83	86
Desember	81.0	76.0	84.6	78.0	80	85	86	82	88	86	88
Re rata	76.6	73.0	80.2	74.8	74.6	80.2	80.8	81.1	81.1	80.3	79.75

Sumber: Badan Metereologi Klimatologi dan Geofisika, Stasiun Meterorologi Komodo. 2019.

d. Curah Hujan

Pola curah hujan dapat diklasifikasikan menjadi 3 pola, yaitu: monsunal (monsoon), ekuatorial (equator) dan loka (Aldrian dan Susanto, 2003; Tjasyono, 2004; Sipayung et al.,). Pola curah hujan di Manggarai Barat dapat diklasifikasikan sebagai pola hujan monsoon, karena memiliki grafik berbentuk huruf "V", dimana terjadi perbedaan yang jelas antara musim hujan dan musim kemarau. Musim kemarau yang ditandai dengan hujan minimum terjadi pada saat bulan Juni, Juli dan Agustus atau pada saat terjadinya angin monsoon timur, yaitu pada saat matahari berada di garis balik utara. Sebaliknya pada saat terjadinya angin monsoon barat (November-Januari), terjadi hujan yang berlimpah (Sipayung et al.). Gambaran mengenai kondisi curah hujan dan hari hujan yang jatuh di wilayah tapak kegiatan dan sekitar lokasi wisata

Pulau Rinca di Kampung Wae Kesambi, Desa Pulau Rinca, Kecamatan Komodo, Kabupaten Manggarai Barat, ditunjukkan pada Tabel 2.3 dan Tabel 2.4.

Tabel 1.3. Jumlah Curah Hujan di Labuan Bajo dan Sekitarnya

Tahun	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	Re Rata
Januari	322	444	-	379	346.8	412.3	250.7	143.1	368.4	28.9	229.4	292.46
Februari	383	622	-	511	174.8	283.3	123.4	139.1	138.2	85.5	115.4	257.57
Maret	679	411	-	498	297.8	144.0	92.3	196.6	42.5	354.9	72.3	278.84
April	199	170	-	411	36.1	98.5	92.9	157.7	37.5	51.0	29.7	128.34
Mei	59	224	-	79	38.6	160.6	54.3	49.3	80.3	70.6	2.1	81.78
Juni	17	1	-	16	54.5	69.0	38.6	10.1	156.8	65.7	7.9	43.66
Juli	0	9	-	5	0	86.8	32.0	8.7	37.4	13.6	6.4	19.89
Agutus	10	0	-	0	4	30.9	5.3	14.3	37.6	0.9	1.2	10.42
September	26	19	-	0	7.1	11.4	0	0.7	5.5	11.2	0.0	8.09
Oktober	268	92	-	252	59	50.4	6.6	14.3	115.0	15.6	4.6	87.75
Nopember	924	205	-	317	88.6	111.8	49.3	27.6	62.8	227.9	134.2	214.82
Desember	393	212	-	189	191.9	322.2	240.0	84.9	324.0	127.4	92.7	217.71
Jumlah	**3280**	**2409**	**-**	**2657**	**1299.2**	**1781.2**	**985.4**	**846.4**	**1406**	**1053.2**	**695.9**	**1492.11**

Sumber: Badan Metereologi Klimatologi dan Geofisika, Stasiun Meterorologi Komodo. 2019.

Hasil analisis menunjukkan bahwa re rata curah hujan tahunan tertinggi terjadi pada tahun 2008 yaitu 3280 mm/tahun dengan jumlah hari hujan 140 hari dan curah hujan terendah tejadi pada tahun 2018 yaitu 695.9 mm/tahun dengan jumlah hari hujan 73 hari. Hari hujan tertingi terjadi pada tahun 2016 dengan jumlah 144 hari hujan dan terendah terjadi pada tahun 2018 dengan 73 hari hujan. Rata-rata curah hujan tahunan selama 10 tahun adalah berkisar 1492 mm/tahun.

Tabel 1.4. Jumlah Hari Hujan di Labuan Bajo dan Sekitarnya

Tahun	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
Januari	15	18	-	11	20	23	18	16	15	20	17
Februari	18	24	-	13	15	13	10	14	20	11	13
Maret	27	17	-	14	19	9	9	20	12	15	8
April	10	9	-	16	5	7	9	20	11	10	6
Mei	2	17	-	4	3	10	3	5	10	7	1
Juni	2	1	-	2	3	4	3	3	8	9	1
Juli	0	1	-	1	0	5	3	3	6	5	1
Agutus	2	0	-	0	1	2	2	6	7	2	1
September	3	4	-	0	2	1	0	1	2	3	0
Oktober	16	7	-	13	8	9	1	5	15	7	2
Nopember	26	11	-	21	12	7	6	9	13	16	13
Desember	19	11	-	12	14	20	16	11	25	18	10
Jumlah	140	120	-	107	120	110	80	113	144	123	73

Sumber: Badan Metereologi Klimatologi dan Geofisika, Stasiun Meterorologi Komodo, 2019.

1.2. Kualitas Udara dan Bising

a. Kualitas Udara

Udara ambien pada lokasi Wisata Pulau Rinca dan sekitarnya merupakan salah satu komponen lingkungan hidup yang diperkirakan akan terkena dampak saat berlangsung kegiatan Penataan Kawasan Wisata Pulau Rinca. Perubahan rona lingkungan udara ambien saat kegiatan tersebut berlangsung dapat bersumber dari emisi gas buang dan resuspensi debu saat mobilisasi peralatan, konstruksi dan pengoperasian Kawasan Wisata Pulau Rinca. Dampak terhadap kualitas udara ambien ini dapat ditelaah dari perubahan konsentrasi beberapa parameter uji kualitas udara terhadap rona awalnya, seperti: SO_2, NO_2, CO, Pb dan TSP.

Berkaitan dengan rencana telaah dampak terhadap kualitas udara ambien pada Kawasan Wisata Pulau Rinca dan Sekitarnya maka telah dilakukan pengujian sampel udara untuk menggambarkan rona awal di lokasi kegiatan, yaitu Area Loh Buaya Taman Nasional Komodo pada titik koordinat S:8°39'20,85"/ E:119°43'05,22" (UA-4) dan area gerbang selamat datang pada titik koordinat S:8°39'13,88"/ E:119°43'00,73" (UA-5). Data hasil pengujian kualitas udara ambien pada lokasi tersebut seperti yang terdapat dalam Tabel 2.5.

Tabel 1.5. Data Kualitas Udara Ambien di Kawasan Pulau Rinca

No	Parameter	Satuan	Baku Mutu**	Hasil Uji	
				UA-4	UA-5
1	Sulfur Dioksida (SO_2)*	µg/Nm^3	900	49,62	50,27
2	Karbon Monoksida (CO)	µg/Nm^3	30000	420	690
3	Nitrogen Dioksida (NO_2)*	µg/Nm^3	400	27,63	30,60
4	Partikulat (TSP)*	µg/Nm^3	230	29,00	29,40
5	Timbal (Pb)*	µg/Nm^3	2	<0,05	<0,05

Sumber: Hasil pengujian yang bekerjasama dengan PT. Global Quality Analalitical, Oktober 2019 (Terakreditasi KAN Nomor: LP-756-IDN)

** Standar kualitas udara berdasarkan PP RI No. 41/1999.

Pada Tabel 1.5 ditunjukkan bahwa nilai parameter uji kualitas udara ambien cukup bervariasi namun semuanya masih jauh dibawah baku mutu yang ditetapkan. Perbedaan konsentrasi paramater uji di masing-masing lokasi pengukuran sangat tergantung pada kondisi lingkungan dan aktivitas masyarakat di sekitarnya. Secara detail, kualitas udara ambien berdasarkan nilai beberapa parameter uji diuraikan sebagaimana berikut.

Total Suspended Particulate (TSP). Partikulat atau TSP di udara dihasilkan oleh kegiatan mekanis atau alami berupa dispersi debu tanah oleh angin dan sebagainya. Ukuran partikel cukup rendah pada semua lokasi sampling yaitu, 29,00 μg/Nm^3 sampai 29,40 μg/Nm^3. Debu dapat menyebabkan gangguan sistem pernafasan, iritasi mata dan gangguan pandangan. Kandungan debu dalam udara ambien pada Kawasan Pulau Rinca dan sekitarnya cukup rendah, semuanya berada dibawah baku mutu yang ditetapkan, yaitu 230 μg/Nm^3 berdasarkan PPRI No. 41/1999. Resuspensi debu akibat kegiatan transpotasi dan peristiwa alami seperti dispersi partikel halus dari daun tanaman akibat tiupan angin.

Sulfur Dioksida (SO_2). Sulfur dioksida merupakan salah satu komponen polutan udara yang bersumber dari hasil pembakaran bahan yang mengandung sulfur seperti pada mesin kendaraan bermotor, generator listrik, atau pembakaran sampah organik. Pada konsentrasi tertentu, gas ini dapat menyebabkan gangguan terhadap lingkungan hidup, seperti iritasi pada saluran pernafasan manusia, gangguan terhadap vegetasi dan dapat meningkatkan keasaman air hujan. Kandungan gas SO_2 dalam udara ambien sebesar 49,62 μg/Nm^3 (UA-4) sampai 50,27 μg/Nm^3 (UA-5), Konsentrasi SO_2 ini masih jauh dibawah baku mutu yang ditetapkan sebesar 900 μg/Nm^3 sehingga tidak akan berdampak terhadap manusia dan lingkungan hidup lainnya. Sumber utama diperkirakan dari asap mesin diesel dan kendaraan motor maupun mobil yang beroperasi di sekitar lokasi wisata Pulau Rinca.

Nitrogen Dioksida (NO_2). Gas nitrogen dioksida dapat bersumber dari alam, hasil pembakaran bahan organik atau asap kendaraan bermotor. Pada konsentrasi tertentu, gas ini dapat menimbulkan iritasi hingga pendarahan paru-paru pada manusia dan gangguan terhadap vegetasi serta kerusakan bangunan fisik. Disamping itu, NO_2 berkontribusi pada penurunan tingkat keasaman air hujan. Hasil pengujian kualitas udara menunjukkan bahwa konsentrasi gas ini masih jauh dibawah baku mutu yang ditetapkan yaitu sebesar 27,63 μg/Nm^3 (UA-4) sampai 30,60 μg/Nm^3 (UA-5). Belum ada dampak yang dilaporkan dengan konsentrasi NO_2 tersebut atau masih wajar. Sumber utama gas NO_2 ini diperkirakan dari reaksi fotokimia di udara.

Karbon Monoksida (CO). Gas CO bersumber dari hasil pembakaran tidak sempurna bahan organik, seperti pembakaran bensin atau solar pada kendaraan bermotor, mesin solar, atau kayu. Pada konsentrasi tertentu, gas ini dapat menimbulkan efek racun terhadap tubuh manusia dengan gejala seperti sakit kepala, pusing, dan sesak nafas. Kandungan gas ini dalam udara ambien sebesar 420 μg/Nm^3 (UA-4) sampai 690 μg/Nm^3 (UA-5). Konsentrasi tersebut masih jauh dibanding baku mutu yang ditetapkan yaitu 30000 μg/Nm^3 sehingga paparannya tidak akan berdampak secara signifikan terhadap manusia dan komponen lingkungan hidup lainnya. Sumber utama gas CO ini diperkirakan dari kegiatan transpotasi atau emisi gas buang dari mesin atau kendaraan yang beroperasi di sekitar lokasi pengukuran.

Timbal (Pb). Timbal merupakan salah satu unsur logam berat yang berbahaya bagi kesehatan manusia. Sumber utama Pb dalam udara ambien adalah hasil pembakaran pada mesin kendaraan bermotor dan mobil yang menggunakan bahan bakar bensin yang menggandung bahan aditif *tetraethyl lead*. Keberadaan Pb di udara pada konsentrasi tertentu dapat menyebabkan gangguan kesehatan, seperti kurang nafsu makan, sakit kepala, anemia, kelumpuhan anggota badan, kejang atau gangguan penglihatan. Pb yang terdeteksi dalam udara ambien sebesar <0,05 μg/Nm^3 sampai <0,05 μg/Nm^3 pada semua lokasi sampling. Kandungan Pb ini masih dibawah baku mutu yang ditetapkan yaitu 2 μg/Nm^3, namun keberadaannya menunjukkan bahwa masih ada penggunaan bahan bakar yang mengandung bahan aditif senyawa Pb pada kendaraan yang beroperasi di sekitar Kawasan Pulau Rinca dan paparan secara terus menerus dan sifat kumulatif logam ini dapat menjadi ancaman yang potensil bagi kesehatan masyarakat.

b. Bising

Pengukuran bising dilakukan pada lokasi yang sama saat pengukuran kualitas udara ambien. Hasil pengukuran menunjukkan bahwa nilai bising pada lokasi Kawasan Pulau Rinca dan sekitarnya berkisar 47,3-51,0 dBA (Tabel 1.6). Nilai bising ini masih dibawah baku mutu bising berdasarkan Keputusan Menteri Negara Lingkungan Hidup No.48/MENLH/11/1996 sehingga masih dinilai cukup baik.

Tabel 1.6. Hasil Pengukuran Bising di Kawasan Pulau Rinca dan Sekitarnya

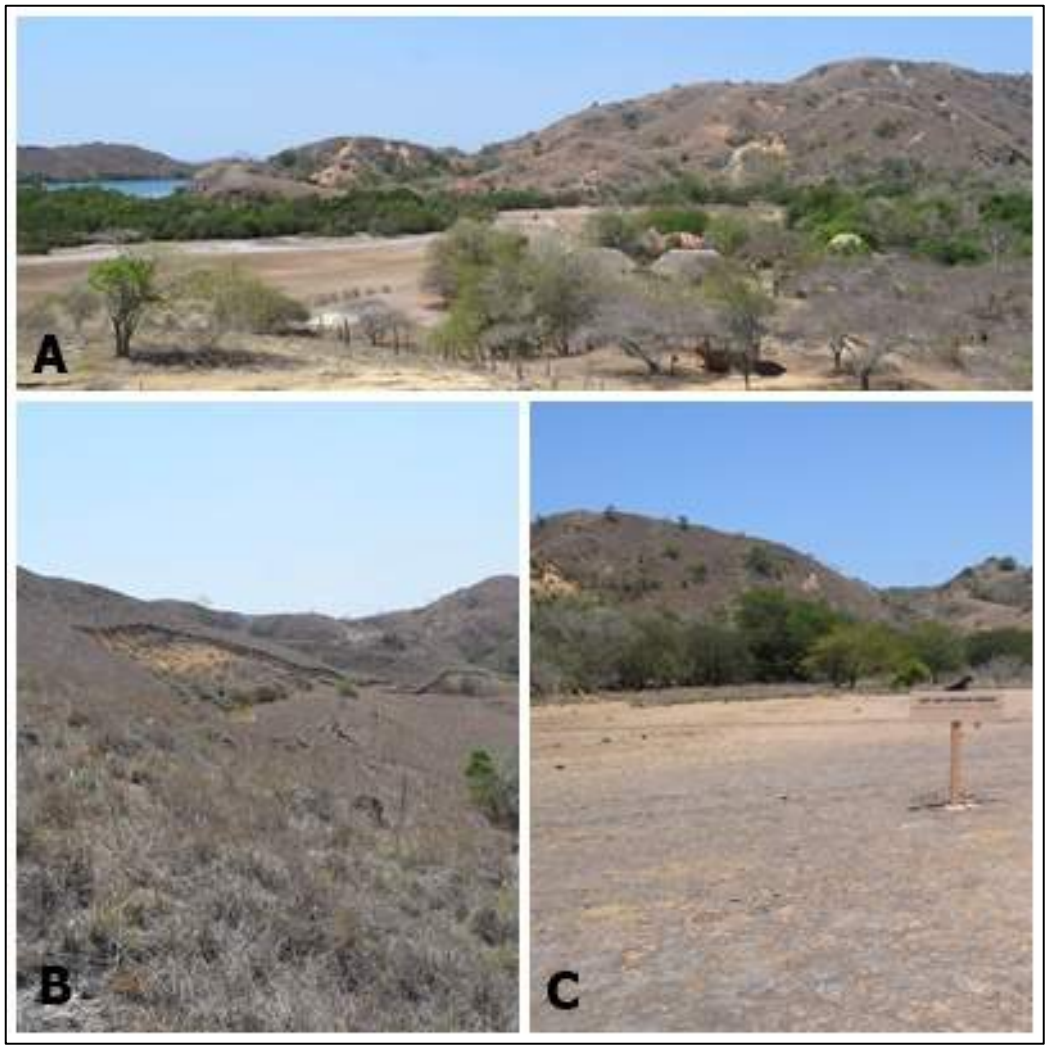
No	Lokasi	Titik Kordinat	Satuan	NAB*	Hasil
1	Area Loh Buaya TNK	S: 08° 39' 20.85" E: 119° 43' 05,22"	dBA	70	45,59
2	Area Gerbang Selamat Datang	S: 08° 39' 13.88" E: 119° 43' 00,73"	dBA	70	45,5

Sumber: Hasil Pengukuran Lapangan, Oktober Tahun 2019.
* Standar Bising, berdasarkan Kep. No. 48/MENLH/11/1996

1.3. Geologi

a. Geomorfologi

Geomorfologi wilayah Pulau Rinca terdiri atas morfologi pegunungan dan perbukitan vulkanik, perbukitan karstik dan dataran alluvium. Morfologi pegunungan didominasi oleh batuan vulkanik dengan kemiringan lereng 41-60%, perbukitan vulkanik dan perbukitan karstik memiliki kemiringan lereng 26-40%, sedangkan dataran alluvium dominan memiliki lereng <8% (Gambar 1.1). Dataran alluvium dimanfaatkan sebagai pusat wisata Loh Buaya.



Gambar 1.1. Kenampakan morfologi pegunungan dan perbukitan vulkanik (A), Perbukitan Karstik (B) dan Dataran Aluvium (C).

Dataran alluvium pantai masih sangat aktif dipengaruhi oleh pasang surut air laut, upaya konservasi pesisir pantai secara vegetatif dengan penanaman pohon bakau harus lebih ditingkatkan agar dapat mencegah banjir rob dan tindakan konservasi mekanik juga dapat dilakukan dengan menambahkan bangunan penghalang air pasang.

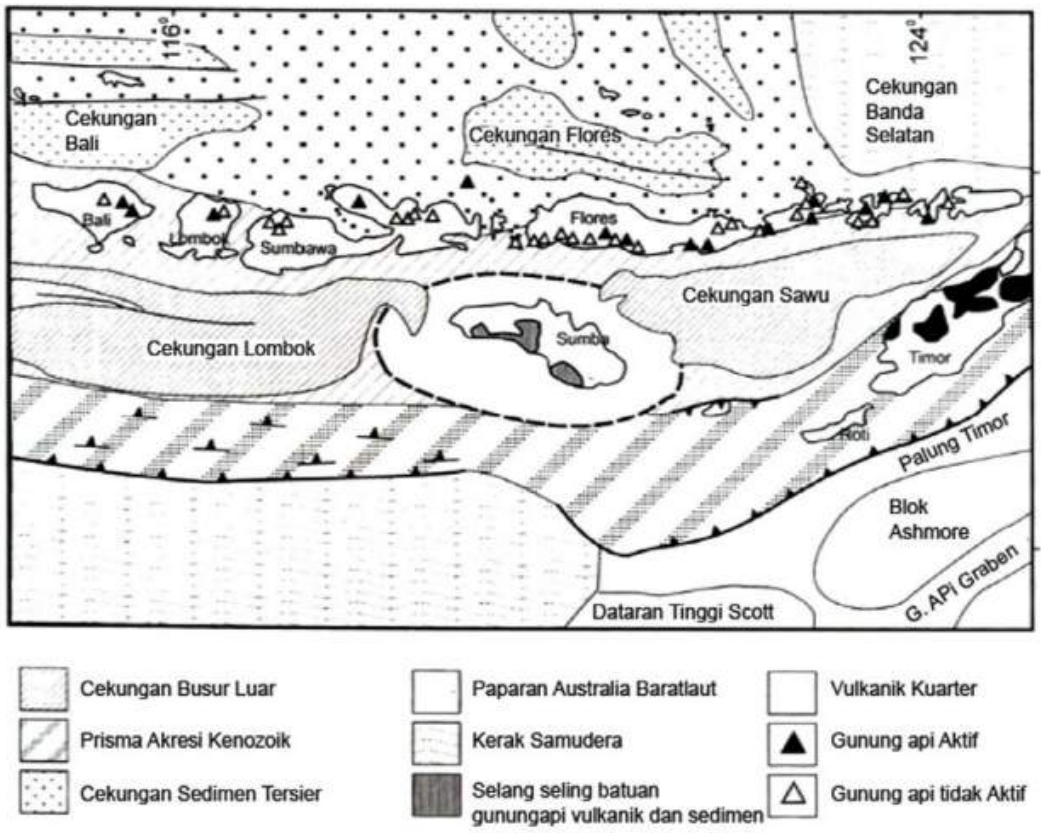
b. Struktur geologi,

Berdasarkan kerangka tektonik dari Darman dan Sidi (2000), kepulauan Indonesia terbentuk dari interaksi tiga lempeng utama, yaitu Indo-Australia, Eurasia, dan Lempeng Pasifik. Interaksi tiga lempeng tektonik utama ini menciptakan kompleks tektonik dan pembentukan gunungapi aktif dan purba di Kepulauan Nusa Tenggara (Gambar 1.2) sebagai akibat dari subduksi Lempeng Indo-Australia di bawah Busur Sunda-Banda selama Tersier Atas dimana subduksi ini membentuk busur vulkanik dalam. Busur vulkanik dalam termasuk ke dalam kepulauan Gunungapi Banda. Gunungapi yang masih aktif adalah gunung Sangeang dan Wai Sano di Pulau Flores. Batuan gunungapi yang berumur Tersier di wilayah timur mulai Pulau Komodo sampai Pulau Flores menempati jalur bagian utara. Patahan aktif terdapat terutama di Pulau Sumbawa terdiri dari beberapa sesar normal dan kelurusan yang umumnya berarah timurlaut-

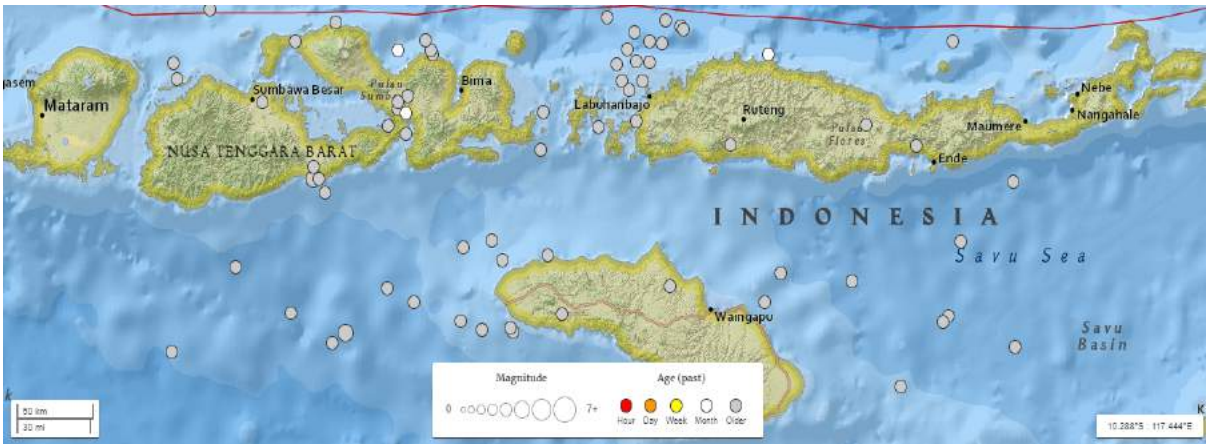
baratdaya dan baratlaut-tenggara. Struktur tersebut umumnya terdapat pada batuan gunungapi (batuan vulkanik) dan sedimen Tersier.

Dampak terhadap struktur geologi yang terdapat di wilayah kajian ditunjukkan dengan aktivitas gempa tektonik yang sering terjadi di Pulau Komodo, Pulau Sumbawa, Pulau Sumba dan Pulau Flores, dengan magnitude gempa 4.1-4.9 (Gambar 1.3).

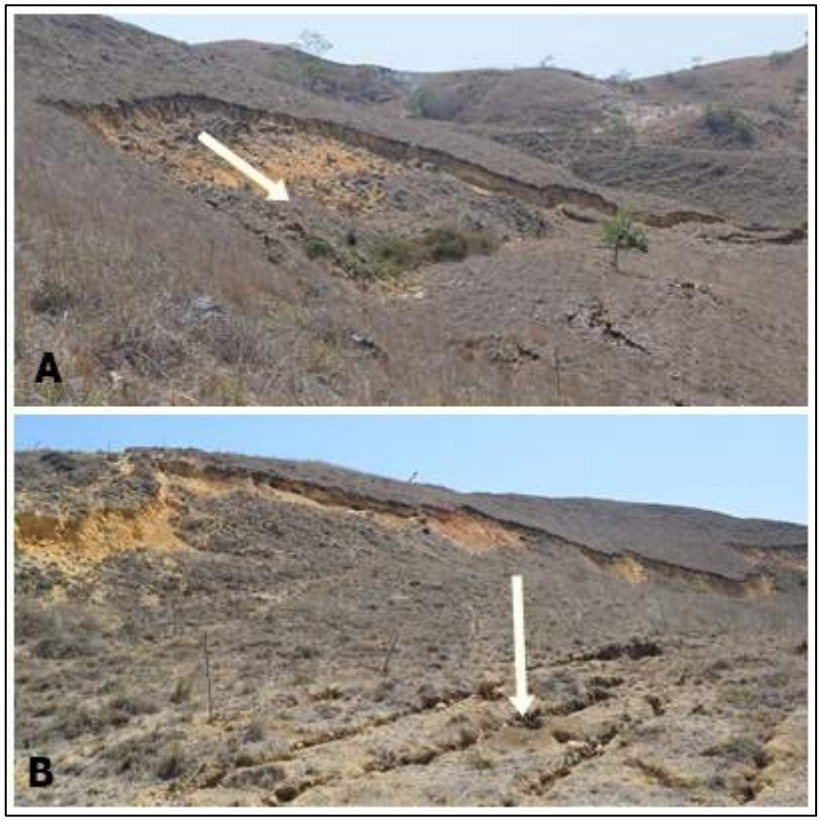
Aktivitas gempa meskipun dalam magnitude yang kecil tetap harus diwaspadai karena dapat mengakibatkan bencana longsor akibat terganggunya stabilitas batuan terutama pada musim penghujan. Salah satu longsor jenis longsor yang ditemukan pada lereng perbukitan karstik adalah longsor multi rotasional (Gambar 2.4). Kejadian longsor harus menjadi fokus perhatian dalam mengembangan pusat wisata agar tidak menjadi bencana di kemudian hari. Proses mitigasi bencana harus diterapkan dengan melakukan studi kelayakan bencana, terutama memetakan area-area yang rawan longsor dan disertai dengan manajemen konservasi.



Gambar 1.2. Kerangka Tektonik Kepulauan Nusa Tenggara (Darman dan Sidi, 2000).



Gambar 1.3. Peta gempa tektonik di wilayah kajian Tahun 2019-2020 (USGS, 2020)

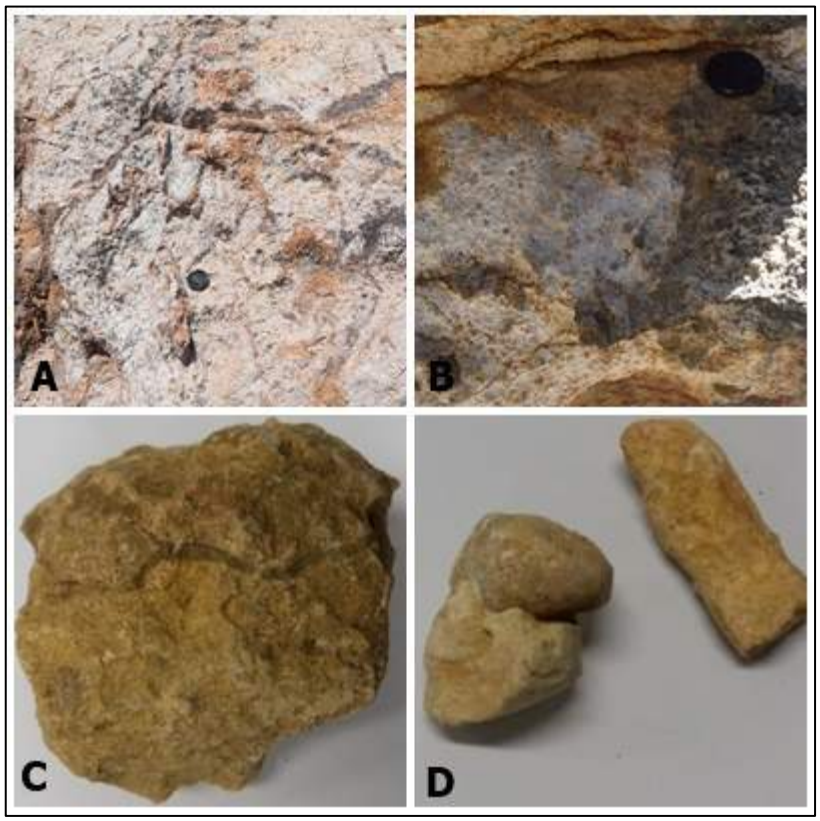


Gambar 1.4. Kenampakan longsor multi rotasional pada lereng perbukitan karstik

c. Lithologi,

Batuan vulkanik pada Busur-Dalam Banda dari Kepulauan Nusa Tenggara terdapat batuan tertua berumur Miosen Awal yang ditemukan 150 km di atas zona miring gempa (Rahardian dan Purwanto, 2014). Formasi batuan yang terdapat pada area kajian pengembangan Taman Nasional Komodo (Ratman dan Yasin, 1978), adalah (1) Formasi Tmv (Tersier Miosen Vulkanik), terdiri atas batuan gunungapi lava dan breksi yang bersifat dasitik, umumnya berwarna kelabu tua, pejal dan dicirikan oleh kuarsa berukuran 0,5-20cm, mengandung sisipan tufa dasitik dan tufa gampingan. Setempat mengandung banyak urat kuarsa, batuannya terkresikkan, mengalami mineralisasi, dan pengurangan *shear strenght* akibat struktur geologi

yang pernah terjadi diwilayah kajian (Gambar 1.5). Jenis tanah yang dapat terbentuk dari batuan induk Formasi Tmv adalah Dystropepts dan Troporthent (2) **Formasi Tmpl** (Batugamping tufaan), terdiri atas batugamping tufaan, batugamping pasiran, tufa dan napal tufaan. Berlapis baik, dan berwarna putih kekuningan. Foraminifera plankton dan cangkang moluska dijumpai melimpah (Gambar 1.5). Jenis tanah yang terbentuk dari batuan induk Formasi Tmpl adalah jenis tanah Rendoll dan Tropudalfs.



Gambar 1.5. Batuan vulkanik berupa batuan beku masam dan breksi vulkanik (A dan B), Batuan vulkanik banyak mengalami retakan (A) dan penuruan stabilitas (B). Batuan Karbonat (C) dan kandungan fosil foram besar yang banyak dijumpai dilokasi kajian (D). Batuan karbonat dengan kandungan foram yang besar mudah mengalami penurunan daya dukung (stabilitas rendah)

Dikaitkan dengan kondisi Iklim Nusa Tenggara Timur yang memiliki bulan kering 7-8 bulan dalam setahun. Bulan kering terjadi antara April sampai dengan Oktober dan bulan basah antara November sampai Maret. Curah hujan tahunan sebesar 400-2000 mm/tahun, Suhu maksimum 35-38°C, dan suhu minimum 13-15 ^{o}C. Kondisi ini memberikan pengaruh yang sangat kecil terhadap penurunan stabilitas batuan, tetapi dengan kondisi batuan yang telah mengalami penurunan daya tahan (penurunan *shear strength*) akibat banyaknya retakan-retakan pada tubuh batuan, walaupun curah hujan kecil, hal ini tetap harus menjadi perhatian penting karena dapat menurunkan stabilitas batuan terhadap kejadian bencana longsor dan runtuhan terutama pada wilayah pegunungan dan perbukitan. Hasil FGD dengan jagawana di Loh Buaya; meskipun curah hujan rata-rata tahunan rendah, tetapi pada saat kejadian hujan dapat mencapai jumlah hujan bulanan rata-rata 939mm/bln, terutama di bulan Januari-Maret (BMKG, 2012). Hal ini sangat mempengaruhi daya ikat air pada jenis tanah Alfisol dengan kandungan liat yang tinggi, sehingga tanah menjadi mudah untuk bergerak (longsor) seperti yang terjadi pada Gambar 1.4.

1.4. Transportasi Laut

Pulau Rinca, Pulau Komodo dan Pulau Padar merupakan Kawasan Taman Nasional Komodo yang dikelola oleh Pemerintah Pusat. Pulau Rinca terletak di sebelah barat Pulau Flores, yang dipisahkan oleh Selat Molo. Pulau ini juga merupakan bagian dari Situs Warisan Dunia UNESCO, karena merupakan Kawasan Taman Nasional Komodo Bersama dengan Pulau Komodo, Pulau Padar dan Gili Motang. Secara administratif, pulau-pulau ini termasuk wilayah Kecamatan Komodo, Kabupaten Manggarai Barat, Provinsi Nusa Tenggara Timur.

Untuk pencapaian ke Pulau Rinca atau pulau-pulau lainnya yang terdapat di sekitarnya dapat dilakukan dari Labuan Bajo. Ketersediaaan jaringan prasarana dan pelayanan transportasi relatif baik dengan kinerja pelayanan yang baik dan pola pergerakan internal berpusat di Labuan Bajo. Beberapa dermaga yang terdapat di Labuan Bajo yang digunakan sebagai lokasi tambat kapal wisata, dapat dilihat pada Tabel 1.7. Dermaga tersebut merupakan bagian dari Pelabuhan Nusantara Labuan Bajo yang terdiri dari 6 (enam) dermaga dan 3 (tiga) diantaranya khusus melayani rute pelayaran wisata.

Untuk pencapaian destinasi pariwisata Komodo, khususnya kedua pulau wisata tersebut ada 3 (tiga) dermaga yang digunakan sebagai lokasi tambatan kapal pesiar/speed boat yang terbuat dari kayu ataupun fiber glass, kapal phinisi, kapal safari, yacht atau kapal wisata lainnya dengan tonase kecil dan sedang, yaitu: Dermaga Putih, Dermaga KP3 dan Dermaga Pink.

Tabel 1.7. Dermaga yang digunakan sebagai lokasi tambat kapal wisata di Labuan Bajo

No.	Nama Dermaga	Konstruksi	Fungsi Dermaga
1.	Putih	Kayu	Lokasi tambatan dan bongkar muat kapal-kapal pesiar dengan beragam tonase.
2.	KP3	Beton	Lokasi tambatan kapal wisata yg terbuat dari kayu ataupun fiber glass, dan lokasi tambatan kapal pengawas pantai dan perairan.
3.	Pink	Kayu	Lokasi tambatan serta lokasi embarkasi/ debarkasi penumpang dari kapal-kapal wisata bertonase kecil dan sedang (kapal phinisi, kapal safari, yacht, dsb.).

Sumber: Hasil pengamatan, 2019.

Kapal wisata yang beroperasi di Labuan Bajo, umumnya dikelola oleh travel wisata atau perseorangan. Sistem penyewaan kapal wisata yang disediakan oleh travel, yaitu penyewaan long trip atau on board beberapa hari. Selain itu travel yang ada juga melayani sewa kapal dengan sistem full day trip, sehingga wisatawan yang berkunjung ke Pulau Rinca atau pulau lainnya tidak perlu menginap di atas kapal. Adapun rute yang ditawarkan yaitu berawal dari pelabuhan Labuan Bajo ke Pulau Rinca dan berakhir kembali di pelabuhan Labuan Bajo. Untuk menjangkau Pulau Rinca (dermaga Loh Buaya) dari Pelabuhan Labuan Bajo, pelayaran yang dilakukan akan ditempuh dalam waktu 2-3 jam. Hingga saat ini jumlah fasilitas angkutan laut (kapal/perahu) yang terdapat di Labuan Bajo, seperti kapal motor sebanyak 813 unit, perahu motor tempel sebanyak 216 unit dan perahu tanpa motor sebanyak 576 unit.

Wisata Komodo yang umum dikunjungi oleh wisatawan terdapat pada Pulau Rinca (Loh Buaya) dan Pulau Komodo (Loh Liang). Jumlah pengunjung Pulau Rinca (Loh Buaya) sebagai salahsatu lokasi wisata internasional pada Tahun 2016 tercatat 107.711 wisatawan. tahun 2017 tercatat 125.069 wisatawan, tahun 2018 tercatat 176.830 wisatawan, dan hingga Nopember 2019 jumlah pengunjung Pulau Rinca (Loh

Buaya) mencapai 58.427 orang yang terdiri dari wisatawan manca negara (wisman/turis) sebanyak 35.918 orang, wisatawan nusantara (wisnu) sebanyak 22.311 orang dan wisatawan lokal 195 orang. Sedangkan jumlah pengunjung Pulau Komodo (Loh Liang) mencapai 49.821 orang yang terdiri dari wisatawan manca negara (wisman/turis) sebanyak 35.133 orang dan wisatawan nusantara (wisnu) sebanyak 14.688 orang.

Gambar 1.6. Salahsatu Dermaga Sewa Kapal di Labuan Bajo (Sumber:https://www.gotravelaindonesia.com/sewa-kapal -labuan-bajo/)

Gambar 1.7. Jenis-Jenis Kapal/Perahu Yang Melayani Rute Pelayaran Dari Labuan Bajo Ke Pulau Rinca (Loh Buaya) Dan Pulau Komodo (Loh Liang)

Gambar 1.8. Dermaga Kapal/Perahu di Pulau Rinca (Loh Buaya)

Wisatawan yang berkunjung ke Pulau Rinca hanya dapat berjalan kaki/trekking sesuai dengan jalur trekking yang telah disediakan. Dalam melakukan trekking setiap kelompok wisatawan akan didampingi oleh seorang ranger atau pawang Komodo sebagai guide, yang akan memberikan pengarahan untuk berada tidak jauh-jauh darinya karena Komodo merupakan hewan berbahaya.

Guna mendukung aktifitas pariwisata, saat ini di Labuan Bajo, terdapat 84 unit hotel (47 berbintang, 17 melati, 19 losmen dan 1 hostel), fasilitas kuliner di 72 lokasi (38 restoran dan 34 rumah makan).

Gambar 1.9. Jalur Trekking yang terdapat di Pulau Rinca (Loh Buaya)

Sumber: Pengamatan lapangan dan https://www.gotravelaindonesia.com/sewa-kapal-labuan-bajo/ serta https://www.dari laut.id/konservasi/Komodo-salah-satu-taman-nasional-tertua-di-indonesia.

1.5. Kualitas Air

Kualitas air di sekitar lokasi rencana Penataan Kawasan Pulau Rinca di lakukan sampling pada dua lokasi yaitu air laut dan air permukaan.

Tabel 1.7a. Lokasi Pengambilan Sampel Air Laut dan Air Sumur

Stasiun	Lokasi	Titik koordinat
AL-1	Air Laut (Dermaga Pulau Rinca)	S: 08° 39' 13,12" E: 119° 42' 54,81"
AS	Air Sumur (Loh Buaya)	S: 08°39'23,73" E: 119°43'05,76"

Sumber: Hasil Analisis TIM UKL-UPL Penataan Kawasan Pulau Rinca, 2020.

Parameter uji kualitas air meliputi parameter fisik, kimia, dan mikrobiologi. Penetapan mutu sampel air didasarkan sumber air. Air laut sesuai dengan Kep.51/menLH/2004n sedangkan Air Sumur berdasarkan Permenkes No. 32/2017. Hasil analisis kualitas air laut dan air sumur, diperlihatkan pada Tabel 2.7b dan Tabel 1.7c.

Tabel 1.7b. Hasil Analisis Kualitas Air Laut (Dermaga Pulau Rinca)

Job Number : 18202091		Date :	August 7, 2020
Customer : Balai Prasarana Permukiman Wilayah NTT		Attention :	-
		Coordinate :	South 08° 39' 13.12" East 119° 42' 54.81"

Customer Sampling Point	:	**Air Laut (Dermaga Pulau Rinca)**		
Date Sampled	:	16-Jul-20	Laboratory Sample ID. :	18202091-12
Time Sampled	:	16:52	Date Received :	22-Jul-20
Sample Matrix	:	Water	Time Received :	13:00

NO	TEST DESCRIPTION	SAMPLE RESULT	REGULATORY LIMIT*	UNIT	METHOD
	Physical Properties:				
1	Odor	Natural	Natural	-	Organoleptic
2	Brightness	2	Mangrove:-	m	Visual
3	Total Suspended Solid, TSS	4,0	Mangrove: 80	mg/L	SMEWW 22nd ed. (2012):2540 D
4	Temperature	29,4	28-32	°C	SMEWW 22nd ed. (2012):2550 B
5	Garbage	None	None	-	Visual
6	Tubidity	<0.01	< 5	NTU	5.4-IK-GQA-WQ-046
7	Oil Layer	None	Nihil	-	Visual
	Physical Properties:				
1	pH	7,69	7 - 8,5	-	SMEWW 22nd ed. (2012):4500-H^+ B
2	Dissolve Oxygen, DO•*	6,3	>5	mg/L	SNI 06-6989.14-2004
3	Biological Oxygen Demand, BOD_5*	1,3	20	mg/L	SNI 6989.72:2009
4	Salinity	27	Mangrove: 34	‰	SMEWW 22nd ed. (2012):2520 B
5	Total Amoniac, NH_3-N	0,032	0,3	mg/L	SMEWW 22nd ed. (2012):4500-NH_3
6	Sulfide, H_2S	< 0.0007	0,01	mg/L	SMEWW 22nd ed. (2012):4500-S^{2-} F
7	Total Fenol Solution	< 0.002	0,002	mg/L	SMEWW 22nd ed. (2012):5330 C
8	Nitrogen, Nitrate as N (NO_3-N)*	< 0.01	0,008	mg/L	SMEWW 22nd ed. (2012):5330 C
9	Surfactant, MBAS	0,024	1	mg/L	SMEWW 22nd ed. (2012):5540 C
10	Oil and Grease	< 1	1	mg/L	SMEWW 22nd ed. (2012):5520 D
11	Cyanide, CN*	< 0.002	0,5	mg/L	SMEWW 22nd ed. (2012):6710 C
12	Fosfat (PO4-P)	0,001	0,015	mg/L	SMEWW 22nd ed. (2012):6710 C
	Dissolve Metal Properties:				
17	Arsenic, As	< 0.00006	0,012	mg/L	SMEWW 22nd ed. (2012):3120 B
18	Mercury, Hg	< 0.00009	0,001	mg/L	SMEWW 22nd ed. (2012):3112 B
19	Cadmium, Cd	0,0008	0,001	mg/L	SMEWW 22nd ed. (2012):3120 B
20	Chromium hexavalent, Cr^{6+}*	< 0.001	0,005	mg/L	SMEWW 22nd ed. (2012):3120 B
21	Nickel, Ni*	0,025	0,05	mg/L	SMEWW 22nd ed. (2012):3120 B
22	Cooper, Cu	0,006	0,008	mg/L	SMEWW 22nd ed. (2012):3120 B
23	Lead, Pb	< 0.0002	0,008	mg/L	SMEWW 22nd ed. (2012):3120 B
24	Zinc, Zn	0,004	0,05	mg/L	SMEWW 22nd ed. (2012):3120 B
	Biological Properties :				
1	Coliform Total	40	1000	MPN/100 mL	SNI 2332.1:2005

- (*) Sea Water Quality Standard Regulation, Kep. 51/MenLH/2004, Attachment III

- The test results relate only to the items tested

Tabel 1.7c. Hasil Analisis Kualitas Air Sumur (Loh Buaya)

JOB GQA	:	18202091	Date	:	August 7, 2020
Customer	:	Balai Prasarana Permukiman Wilayah NTT	Attention	:	-
			Coordinate	:	South 08° 39' 23.73"
					East 119° 43' 05.76"
Customer Sampling Point	:	**Air Sumur (LOH BUAYA)**			
Date Sampled	:	18-Jul-20	Laboratory Sample ID.	:	18202091-15
Time Sampled	:	11:46	Date Received	:	22-Jul-20
Sample Matrix	:	Water	Time Received	:	13:00

NO	TEST DESCRIPTION	SAMPLE RESULT	REGULATORY LIMIT**	UNIT	METHOD
	Physical Properties:				
1	Odor	Tidak berbau	Tidak berbau	-	Organoleptic
2	Total Dissolved Solid, TDS*	552	1000	mg/L	SNI 06-6989.27-2005
3	Turbidity*	0,2	25	NTU	5.5-IK-GQA-027
4	Taste	Tidak berasa	Tidak berasa	-	Organoleptic
5	Temperature•*	29,8	Suhu udara ± 3	-	5.5-IK-GQA-003
6	Color*	<1	50	TCU	5.4-IK-GQA-WQ-046
	Chemical Anorganic Properties:				
1	Mercury, Hg*	<0.00009	0,001	mg/L	SNI 6989.78:2009
2	Arsenic, As*	<0.00006	0,05	mg/L	SNI 06-6989.54-2005
3	Iron, Fe*	0,022	1	mg/L	SNI 6989.4-2009
4	Fluoride, F^-*	0,043	1,5	mg/L	SNI 06-6989.29-2005
5	Cadmium, Cd*	0,0009	0,005	mg/L	SNI 06-6989.38-2005
6	Hardness Total as $CaCO_3$*	317,8	500	mg/L	SNI 06-6989.12-2004
7	Chromium hexavalent, Cr^{6+}*	<0.001	0,05	mg/L	SNI 6989.71:2009
8	Manganese, Mn*	0,009	0,5	mg/L	SNI 6989.5-2009
9	Nitrogen, Nitrate as N (NO_3-N)*	0,020	10	mg/L	5.4-IK-GQA-WQ-043
10	Nitrogen, Nitrite as N (NO_2-N)*	<0.004	1	mg/L	SNI 06-6989.9-2004
11	pH•*	8,3	6.5 - 8.5	-	5.5/IK/GQA/023
12	Selenium, Se*	<0.006	0,01	mg/L	US EPA 7741 A
13	Zinc, Zn*	0,006	15	mg/L	SNI 6989.7.2009
14	Cyanide, CN*	<0.002	0,1	mg/L	5.4-IK-GQA-WQ-058
15	Sulphate, SO_4^{2-}*	11,00	400	mg/L	SNI 6989.20:2009
16	Lead, Pb*	<0.0002	0,05	mg/L	SNI 6989.46:2009
	Chemical Organic Properties:				
1	Surfactants, MBAS*	<0.014	0,05	mg/L	SNI 06-6989.51-2005
2	Total Organic Matter, $KMnO_4$*	2,10	10	mg/L	SNI 06-6989.22-2004
	Biological Properties:				
1	Total Coliform*	<1.8	50	MPN/100 mL	APHA 9221 B ed 22nd
2	E. Coli*	0	0	MPN/100 mL	APHA 9221 E ed 22nd

- (*) Accreditade by KAN
- (**) Clean Water Standard Quality Regulation, PerMenKes No. 32/2017
- The test results relate only to the items tested
- References sampling SNI 6989.58:2008

a. Parameter Fisik

Kualitas air sumur penduduk berdasarkan parameter fisik masih tergolong alami. Suhu air sumur penduduk yaitu sekitar 29,8 ºC. Kandungan Turbidity air sumur penduduk sekitar 0,2 NTU, lebih rendah dibanding baku mutu yang ditetapkan, yaitu NTU. Padatan terlarut (TDS) air sumur masih dibawah baku mutu yang ditetapkan, yaitu 552 mg/L (baku mutu: 1000 mg/L).

Kondisi fisik air laut di wilayah studi relatif masih baik berdasarkan parameter suhu, kekeruhan dan padatan tersuspensi (TSS). Suhu air laut masih normal, yaitu 29,4 °C dan tampak masih jernih dengan tingkat kekeruhan sekitar <0,01 NTU (baku mutu: <5 NTU). Padatan tersuspensi berkisar antara 4,0 mg/L,

lebih rendah dibanding baku mutu yang ditetapkan sebesar 80 mg/L. Hasil pengujian kondisi fisik air lainnya adalah bau masih alami, tampak cerah, dan tidak ditemukan lapisan minyak.

b. Parameter Kimia

Tingkat kemasaman sampel air laut masih berada pada kisaran pH air laut pada umumnya, yaitu pH 7,69 (baku mutu: 7 – 8,5). Oksigen terlarut masih mendukung kehidupan biota perairan di dalamnya, yaitu berkisar antara 6,0 – 6,3 mg/L (baku mutu: 5 mg/L), sementara BOD_5 sekitar 1,3 mg/L. Konsentrasi BOD_5 ini masih jauh dibawah baku mutu yang ditetapkan sebesar 20 mg/L. Nilai dua parameter terakhir menggambarkan bahwa air laut di wilayah studi belum tercemar oleh limbah organik. Pada bagian lain, kandungan fosfat air laut yaitu mencapai 0,01 mg/L sementara baku mutu hanya 0,015 mg/L.

Kualitas air sumur penduduk masih tergolong baik berdasarkan semua parameter kimia yang diujikan. Air sumur penduduk sedikit bersifat basa, yaitu sekitar 8,3. Kemasaman air ini masih pada kisaran baku mutu pH yaitu 6,5 – 9. Tiga parameter terakhir cukup menggambarkan bahwa air sumur penduduk di wilayah studi belum tercemar oleh limbah organik maupun anorganik. Nilai paramater kimia lainnya masih memenuhi baku mutu yang ditetapkan, bahkan beberapa di antaranya sangat rendah atau dibawah batas deteksi alat/metode uji, seperti logam berat, nitrit, nitrat, sianida serta minyak dan lemak.

c. Parameter Mikrobiologi

Kandungan bakteri *coliform* pada sampel air dalam wilayah studi masih sangat rendah, yaitu dalam sampel air laut kurang dari <1.8 MPN, sementara dalam air sumur penduduk 50 MPN/100 mL. Kandungan *coliform* tersebut, masih jauh lebih rendah dibanding baku mutu yang ditetapkan sebesar 1000 MPN/100 mL Sumber *coliform* ini diduga berasal *septic tank* yang mengalami kebocoran atau secara langsung dari tinja manusia atau kotoran hewan yang masuk atau merembes ke badan air.

1.6. Hidrologi

a. Daerah Aliran Sungai

Daerah Aliran Sungai yang biasa disingkat DAS adalah suatu wilayah daratan yang merupakan satu kesatuan dengan sungai dan anak-anak sungainya, yang berfungsi menampung, menyimpan dan mengalirkan air yang berasal dari curah hujan ke danau atau ke laut secara alami, yang batas di darat merupakan pemisah topografis dan batas di laut sampai dengan daerah perairan yang masih terpengaruh aktivitas daratan (Pasal 1 PP No 37 Tentang Pengelolaan DAS).

DAS merupakan suatu daerah yang terhampar disisi kiri dan kanan suatu aliran sungai dimana semua anak sungai yang terdapat di sebelah kanan dan kiri sungai bermuara ke suatu sungai induk, selanjutnya ke danau atau laut. Seluruh hujan yang turun diatas daerah tangkapannya akan mengisi sungai yang terdapat di dalam DAS tersebut. Semua air yang mengalir melalui sungai bergerak meninggalkan daerah-daerah tangkapan sungai dengan atau tampa memperhitungkan jalan yang di tempuh sebelum mencapai limpasan (run off).

Rencana kegiatan Penataan Kawasan Pulau Rinca di Kecamatan Komodo, Kabupaten Manggarai Barat, Provinsi Nusa Tenggara Timur, berada pada DAS Buaya (Keppres No.12 Tahun Tahun 2012 Tentang Penetapan Wilayah Sungai). Luas DAS Buaya adalah 1764.88 ha, pada DAS tersebut tidak terdapat sungai besar yang mengalir sepanjang tahun, namun hanya sungai kecil dan musiman yang mengalir saat terjadi musim hujan. Peta DAS Buaya ditunjukkan pada Gambar 1.10.

a. Sungai

Karakteristik sungai bagian hulu merupakan awal dari aliran sungai, debit air relatif kecil dan dipengaruhi curah hujan, kondisi dasar sungai berbatu, aliran sungai mengalir di atas batuan induk, aliran sungai cenderung lurus, tidak pernah terjadi banjir.

STUDI AMDAL
PENATAAN KAWASAN
PULAU RINCA
KECAMATAN KOMODO
KABUPATEN MANGGARAI BARAT
PROVINSI NUSA TENGGARA TIMUR

PETA DAERAH ALIRAN SUNGAI

Skala: 1:26,088

PETA DAS BUAYA

Projection: Transverse Mercator
Datum: WGS 1984

PETA SITUASI PROV. NUSA TENGGARA TIMUR

LEGENDA:

- DAS Buaya
- Sungai
- Garis Kontur Interval 25m

Sumber:
- Peta RBI Skala 1: 50.000 diterbitkan Oleh Bakosurtanal Tahun 2006
- Keppres No. 12 Tahun 2012 tentang Penetapan Wilayah Sungai
- Analisis Geospasial Tahun 2020

Karakteristik sungai bagian tengah merupakan lanjutan dari hulu sungai, lembah sungai berbentuk U, aliran air tidak terlalu deras, proses erosi sudah tidak dominan, proses-proses transportasi hasil erosi dari hulu.Karakteristik sungai bagian akhir adalah bagian akhir sungai menuju laut, aliran air permanen, terdapat pengendapan dalam alur sungai, sering terjadi banjir, aliran sungai berkelok-kelok, terdapat danau tapal kuda, erosi sungai arah ke samping, badan sungai melebar.

Sungai Buaya sebagai salahsatu sungai musiman yang berada di Pulau Rinca secara keseluruhan memiliki panjang 4,584 km. Faktor-faktor penting yang mempengaruhi aliran air permukaan pada tapak proyek adalah curah hujan, bentuk wilayah, tekstur tanah, dan vegetasi. Curah hujan merupakan penentu terpenting terhadap aliran air permukaan di daerah tersebut. Sebagai daerah hilir dari suatu sistem daerah tangkapan hujan, maka tapak proyek disamping menerima air hujan yang jatuh di atasnya, juga menerima pula masukan aliran air permukaan dari daerah hulunya. Hujan yang jatuh langsung di atas tapak proyek merupakan sumber pengisian sungai yang mengalir pada tapak proyek. Pada daerah hilir yang merupakan daerah sekitar tapak proyek sering terjadi genangan saat terjadi hujan lebat disertai dengan pasang air laut.

b. Limpasan Permukaan

Jumlah dan kecepatan limpasan permukaan selain bergantung kepada luas areal tangkapan, juga yang tidak kalah pentingnya kepada koefisian run off dan intensitas hujan maksimum. Limpasan permukaan dengan jumlah dan kecepatan yang besar sering menyebabkan pemindahan atau pengangkutan massa tanah secara besar-besaran pula. Inilah yang sering diistilahkan dengan banjir.

Pendugaan limpasan permukaan bergantung pada tiga hal. Pertama, bergantung kepada berapa jumlah maksimum curah hujan per satuan waktu (intensitas maksimum). Kedua, bergantung kepada berapa dari curah hujan tersebut yang menjadi limpasan permukaan (nilai faktor limpasan permukaan). Besarnya nilai faktor ini selain bergantung kepada topografi terutama kemiringan lereng dan tekstur tanah, juga bergantung kepada tipe penutupan lahan serta pengelolaannya. Selain itu besarnya debit limpasan permukaan ditentukan oleh faktor ketiga yakni luas areal tangkapan *(catchment area).*

Tapak lokasi kegiatan penataan Kawasan Pulau Rinca dipengaruhi oleh wilayah DAS yang berbentuk bulu burung dimana kedua cabang anak sungainya bertemu dibagian hilir dekat dengan pantai yang merupakan daerah pedataran. Itu sebabnya maka pada daerah pedataran ini yaitu pada bagian barat lokasi penataan selalu terjadi genangan air pada setiap musim penghujan.

1.7. Ruang, Tanah dan Lahan

a. Lahan

Jenis penutupan lahan di Kecamatan Komodo, Kabupaten Manggarai Barat, berdasarkan Analisis Sistem Informasi Geografi (SIG) tahun 2020 meliputi tutupan yang berstatus lindung dan berstatus areal budidaya. Secara rinci dapat dilihat pada Tabel 1.8 dan Gambar 1.11.

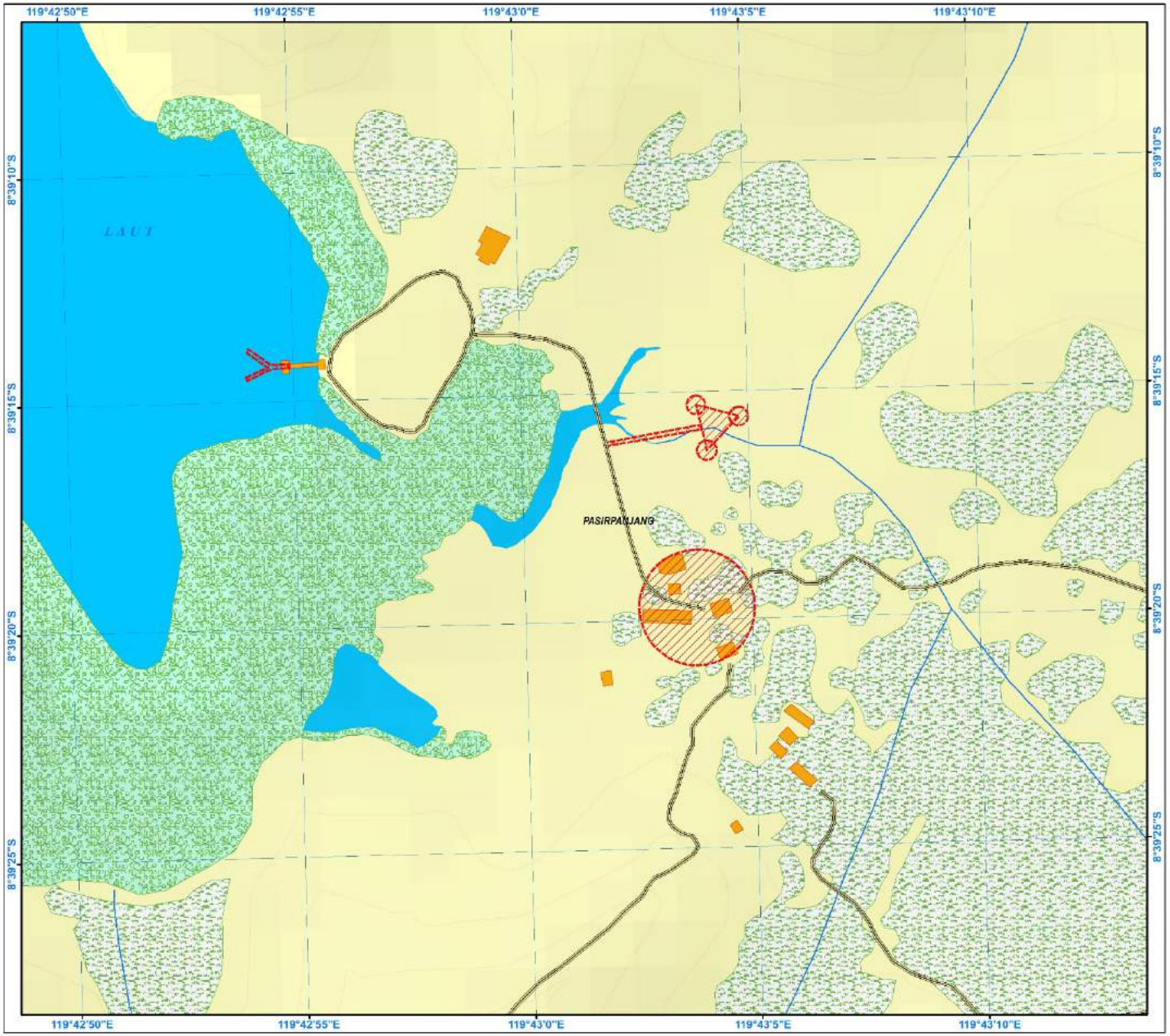
Tabel 1.8. Penutupan Lahan Kecamatan Komodo Kabupaten Manggarai Barat

No	Penutupan Lahan	Luas (Ha)	Persentase (%)
1	Hutan Lahan Kering Primer	4517.0	26.9
2	Hutan Mangrove Primer	29.7	0.2
3	Permukiman	1036.0	6.2
4	Tanah Terbuka	144.8	0.9
5	Rumput	3029.0	18.0
6	Hutan Mangrove Sekunder	570.4	3.4
7	Hutan Lahan Kering Sekunder	403.4	2.4
8	Semak Belukar	1098.0	6.5

9	Tubuh Air	1.1	0.0
10	Pertanian Lahan Kering	1721.0	10.2
11	Pertanian Lahan Kering Campur	877.5	5.2
12	Sawah	3256.0	19.4
13	Tambak	37.9	0.2
14	Bandara/Pelabuhan	93.3	0.6
Total		16815.0	100

Sumber: Penutupan Lahan, KLHK, Tahun 2017.

Berdasarkan data Badan Pusat Statistik (BPS) Kabupaten Manggarai Barat telah merilis data kecamatan serta jenis penggunaan tanah di Kabupaten Manggarai Barat. Selain itu, berdasarkan Surat Keputusan Menteri Kehutanan



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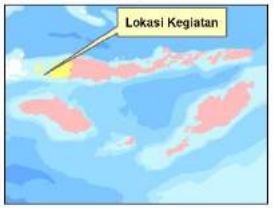
PULAU RINCA
KECAMATAN KOMODO
KABUPATEN MANGGARAI BARAT
PROVINSI NUSA TENGGARA TIMUR

PETA TUTUPAN LAHAN

Skala: 1:2,400

Coordinate System: WGS 1984 UTM Zone 52S
Projection: Transverse Mercator
Datum: WGS 1984

PETA SITUASI PROV. NUSA TENGGARA TIMUR



LEGENDA:

- Lokasi Rencana Kegiatan
- Bangunan Eksisting
- Jalan Eksisting
- Garis Kontur Interval 25m
- Sungai
- Garis Pantai
- Batas Desa/Kelurahan

Tutupan Lahan

- Belukar
- Mangrove
- Tanah Terbuka

Sumber:
- Peta RBI Skala 1: 50.000 diterbitkan Oleh Bakosurtanal Tahun 2006
- Peta Ditital Administrasi Indonesia (Podes) SP_2013 oleh BPS
- Analisis Geospasial Tahun 2020

No. 423 tahun 1999, luas Kawasan hutan di Manggarai Barat adalah 74.850 ha. Besarnya usulan perubahan Kawasan hutan pada tahun 2013 adalah 2.782,34 ha, sehingga luas kawasan setelah pengusulan adalah 72.067,66 ha (Pemerintah Provinsi NTT, 2013). Dari luasan tersebut, kurang lebih 60.297 ha diantaranya ditetapkan sebagai areal KPHP Model Manggarai Barat berdasarkan Surat Keputusan Menteri Kehutanan No.973/MenhutII/2013. Dalam Keputusan tersebut, wilayah KPHP Manggarai Barat terdiri dari Kawasan Hutan Lindung (HL) seluas ± 27.113 Ha, Hutan Produksi (HP) ± 18.163 Ha dan Hutan Produksi Terbatas (HPT) ± 14.571 Ha (Tabel 1.9).

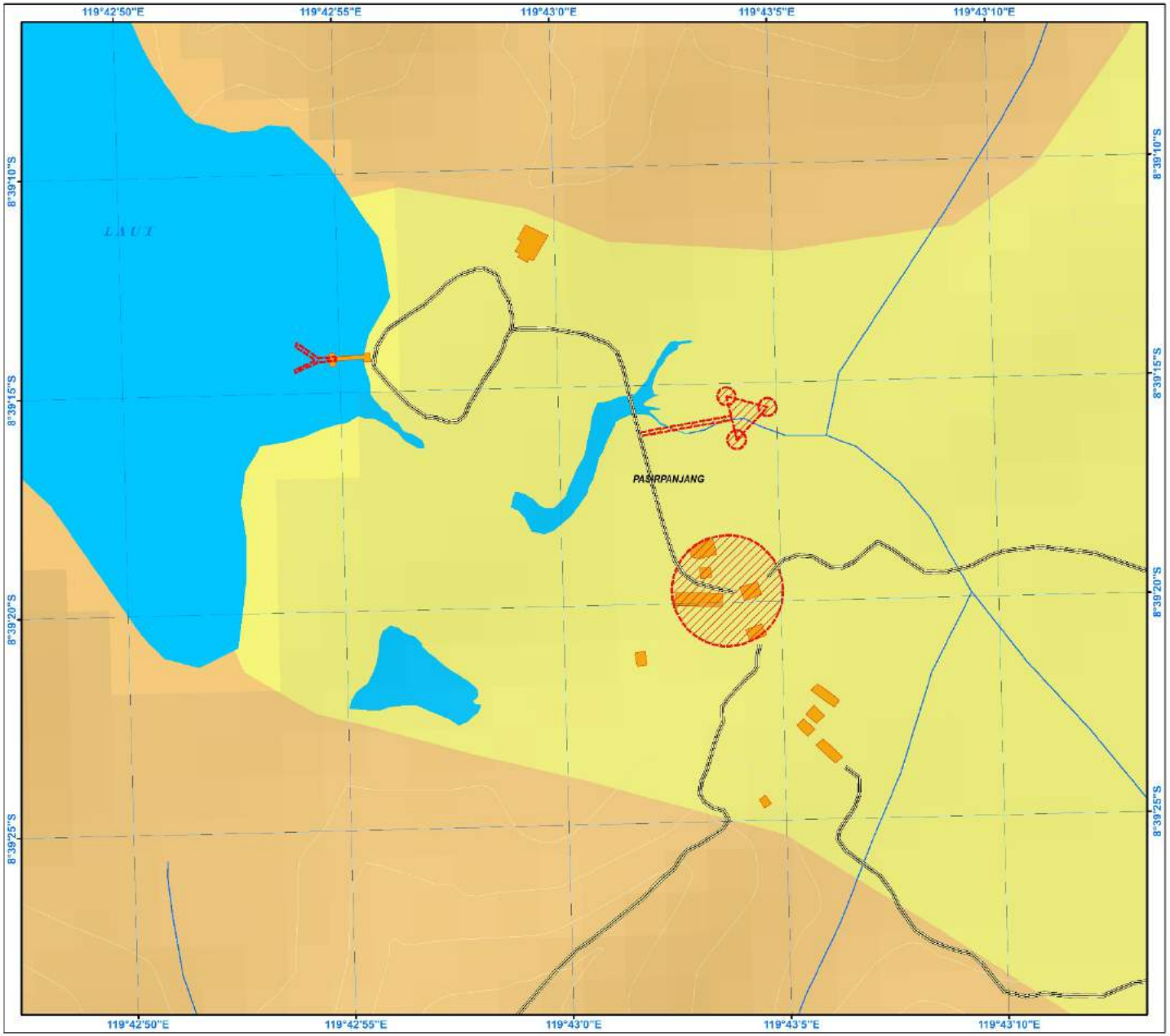
Tabel 1.9. Penutupan Lahan Kecamatan Komodo Kabupaten Manggarai Barat

Kecamatan		Perkampungan	Sawah		Tegalan/ Ladang	Perkebunan	Kebun Campur	Hutan			Semak/ Alang-alang, Padang rumput	Danau/ Kolam/ Rawa	Tanah Rusak/ Tandus	Lainnya
			2 x	1 x				Lebat	Belukar	Sejenis				
1	Komodo	156	472	1 821	992	218	679	9 372	20 112	1 772	44 410	-	4	-
2	Boleng	63	245	626	612	120	390	5 669	13 506	734	20 005	-	2	-
3	Sano Nggoang	119	546	93	994	294	1 552	9 189	20 466	46	21 745	474	-	-
4	Mbeliling	*)	*)	*)	*)	*)	*)	*)	*)	*)	*)	*)	*)	*)
5	Lembor	109	3 983	772	9 321	-	7 974	879	5 912	5 833	11 771	-	-	-
6	Welak	78	363	332	5 877	-	4 894	596	2 028	929	7 848	-	-	-
7	Lembor Selatan	*)	*)	*)	*)	*)	*)	*)	*)	*)	*)	*)	*)	*)
8	Kuwus	124	750	868	4 225	1 097	3 228	1 487	3 105	-	5 960	-	-	-
9	Ndoso	*)	*)	*)	*)	*)	*)	*)	*)	*)	*)	*)	*)	*)
10	Macang Pacar	138	249	321	3 323	470	1 640	4 998	9 741	233	5 792	-	-	-
Jumlah		787	6 608	4 833	25 344	2 199	20 357	32 190	74 870	9 547	117 531	474	6	-
Persentase (%)		0.27	2.24	1.64	8.60	0.75	6.91	10.92	25.40	3.24	39.88	0.16	0.00	0,00

Sumber: BPS Kabupaten Manggarai Barat, Tahun 2018.

b. Tanah

Jenis tanah yang berkembang dilokasi studi dan sekitarnya adalah Inceptisol dan Mollisol. Jenis Tanah Inceptisol dengan klasifikasi Great Group Typic Epipaquepts dan Tanah Mollisol dengan klasifikasi Great Group Typic Haplustolls. Tapak proyek berada pada kriteria Typic Epipaquepts sedangkan Typic Haplustolls tersebar di sekitar lokasi rencana tapak proyek. Sebaran jenis tanah ditunjukkan pada Gambar 1.12 dan padanannya pada Tabel 1.10.



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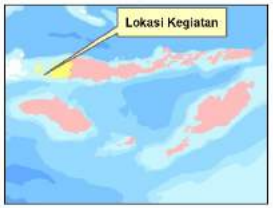
PETA JENIS TANAH

Skala: 1:2,500

Coordinate System: WGS 1984 UTM Zone 52S
Projection: Transverse Mercator
Datum: WGS 1984

PETA SITUASI PROV. NUSA TENGGARA TIMUR



LEGENDA:

- Lokasi Rencana Kegiatan
- Bangunan Eksisting
- Jalan Eksisting
- Garis Kontur Interval 25m
- Sungai
- Garis Pantai
- Batas Desa/Kelurahan
- Typic Epipaquepts
- Typic Haplustolls

Sumber:
- Peta RBI Skala 1: 50.000 diterbitkan Oleh Bakosurtanal Tahun 2006
- Peta Ditital Administrasi Indonesia (Podes) SP_2013 oleh BPS
- Land System Oleh REPPPROT Tahun 1990
- Analisis Geospasial Tahun 2020

Tabel 1.10. Padanan jenis tanah berdasarkan beberapa sistem klasifikasi

No.	PPT Bogor (1978-1982)	FAO/UNESCO (1974)	Soil Taxonomy, USDA (1975-1990)
1.	Aluvial	Fluvisol	Inceptisol
2.	Renzina	Renzina	Mollisol

Sumber : Hasil analisis, Tahun 2020.

(1). Inceptisol

Inceptisol adalah jenis tanah yang perkembangannya lebih dipengaruhi oleh faktor lokal, yaitu topografi yang merupakan dataran rendah atau cekungan dan hampir selalu tergenang air. Ciri-ciri tanah Inceptisol adalah solum tanah sedang, warna kelabu hingga kekuningan, tekstur geluh hingga lempung, struktur berlumpur hingga masif, konsistensi lekat dan bersifat asam (pH 4.5 – 6.0). Karena air tanah yang tinggi, Inceptisol berada dalam keadaan tereduksi pada bagian tanah yang yang selalu jenuh air. Tidak ada oksigen bebas atau terlarut karena itu tanah berwarna biru kelabu.

(2). Mollisol

Tanah yang termasuk ordo Mollisol merupakan tanah dengan tebal epipedon lebih dari 18 cm yang berwarna hitam (gelap), kandungan bahan organik lebih dari 1%, kejenuhan basa lebih dari 50%. Agregasi tanah baik, sehingga tanah tidak keras bila kering. Kata Mollisol berasal dari kata Mollis yang berarti lunak. Padanan dengan sistem kalsifikasi lama adalah termasuk tanah Chernozem, Brunizem, Renzina.

Tanah ini merupakan tanah organik diatas bahan berkapur yang memiliki tekstur lempung seperti vertisol. Tanah renzina memiliki kadar lempung yang tinggi, teksturnya halus dan daya permeabilitasnya rendah sehingga kemampuan menahan air dan mengikat air tinggi. Tanah rendzina berasal dari pelapukan batuan kapur dengan curah hujan yang tinggi. Tanah jenis ini memiliki kandungan Ca dan Mg yang cukup tinggi, bersifat basa, berwarna hitam, serta hanya mengandung sedikit unsur hara.

Mollisol adalah tanah dengan epipedon mollik. Walaupun demikian tidak semua tanah yang mempunyai epipedon mollik diklasifikasikan sebagai Mollisol. Misalnya pada tanah Vertisol juga dapat ditemukan epipedon mollik tetapi mempunyai sifat yang plastis dengan mengembang mengkerut, sehingga sifat mollik menjadi kurang nyata. Epipedon mollik juga dapat ditemukan pada Inceptisol, tetapi gelas vulkanik dan horizon kambik yang masam lebih banyak pengaruhnya terhadap profil tanah dari pada epipedon mollik. Demikian pula tanah yang memiliki epipedon yang memenuhi syarat sebagai epipedon mollik tetapi terbentuk sebagai akibat pengapuran, tidak dapat diklasifikasikan sebagai Mollisol. Mollisol dapat mempunyai horison albik, agrilik, kalsik dan nartik.

(3). Sifat Fisika Tanah

Sifat fisik tanah merupakan salah satu faktor lingkungan yang mempengaruhi pertumbuhan tanaman ataupun erat kaitan dengan pengaruh terhadap kemampuan menahan struktur bangunan. Oleh karena itu dilakukan pengambilan sampel tanah tidak terganggu (menggunakan ring sampel) untuk dianalisa di Laboratorium Tanah Fakultas Pertanian Universitas Hasanuddin. Sifat fisik tanah yang dianalisa ialah (1) tekstur, (2) kerapatan lindak (*bulk density*), (3) *particle density*, (4) distribusi pori-pori tanah, dan (5) permeabilitas.

(4). Sifat Kimia dan Kesuburan Tanah

Untuk keperluan penilaian status kesuburan/kimia tanah di lokasi studi Kawasan Puncak Waringin, dilakukan pengambilan sampel tanah komposit dan dianalisa di Laboratorium Kimia Tanah Fakultas Pertanian Universitas Hasanuddin. Parameter uji kesuburan/kimia tanah yang di analisa dan diukur, yaitu

(1) reaksi tanah (pH), (2) Bahan organik (C), nitrogen (N) dan nisbah C/N, (3) kandungan P_2O_5, (4) basa-basa dapat tukar Ca, Mg, K dan Na, (5) kapasitas tukar kation (KTK) dan (6) kejenuhan basa (KB).

(5). Erosi Tanah

Erosi adalah suatu peristiwa hilang atau terkikisnya tanah atau bagian tanah dari suatu tempat yang terangkut ke tempat lain, yang disebabkan oleh pergerakan air atau angin. Di daerah tropis basah seperti Indonesia, erosi terutama disebabkan oleh air. Erosi air timbul apabila terdapat aksi dispersi dan tenaga pengagkut oleh air hujan yang mengalir dipermukaan tanah. Metode untuk menghitung laju erosi tanah digunakan metode USLE (*Universal Soil Loss Equation*) (Wischmeier dan Smith, 1978), menurut rumus:

$$A = R.K.L.S.C.P$$

dimana: A adalah laju kehilangan tanah (ton/ha/tahun), R adalah faktor erosivitas hujan, K adalah faktor erodibilitas tanah, L adalah faktor panjang lereng, S adalah faktor faktor kemiringan lereng (S), C adalah faktor penutupan lahan dan P adalah faktor tindakan konservasi tanah khusus.

Dari hasil pendugaan diperoleh laju erosi dilokasi rencana kegiatan penataan Kawasan Pulau Rinca adalah sebesar 26 ton/ha/tahun dengan nilai erosi yang dapat dibiarkan *(tolerable soil loss*, TSL) sebesar 22 ton/ha/tahun.

1.8. Hidrooceanografi

a. Batimetri

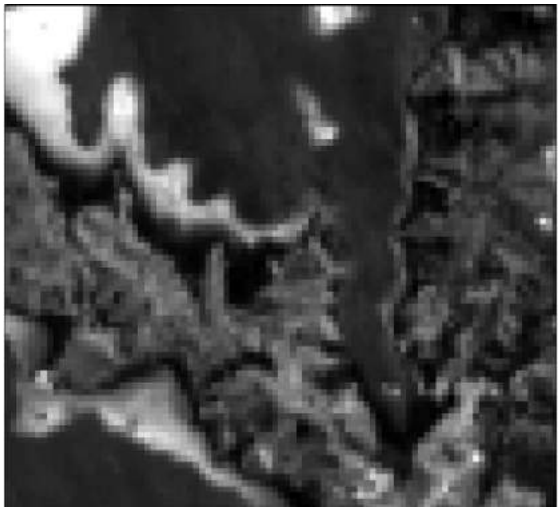
Batimetri adalah ukuran kedalaman daerah perairan laut yang diukur dari atas permukaan air sampai ke dasar laut. Kedalaman suatu perairan laut merupakan hal yang dinamis terutama pada wilayah pesisir. Daerah pesisir umumnya cepat mengalami perubahan topografi dasar laut sehingga diperlukan berbagai informasi mengenai kedalaman secara kontinyu (Setiawan *et al.* 2014). Peta batimetri berisi informasi kedalaman suatu daerah perairan. Pemetaan batimetri memiliki peran yang sangat penting dalam aplikasi kelautan. Informasi batimetri dapat menggambarkan tentang kondisi struktur dan bentuk dasar perairan dari suatu daerah. Informasi mengenai batimetri dapat dimanfaatkan untuk aktivitas manusia seperti berenang, menangkap ikan, keselamatan pelayaran, navigasi, dan aktivitas lainnya yang berhubungan dengan laut (Alsubaie 2012).

Teknologi pemetaan batimetri telah mengalami banyak perkembangan seiring dengan semakin banyaknya permintaan atas informasi batimetri. Teknologi pemetaan batimetri ini tidak hanya berkembang baik dari metode yang digunakan tetapi juga dari sisi piranti penduga kedalaman. Piranti penduga batimetri pada awalnya menggunakan tab tambang yang telah diberi pemberat pada ujungnya. Piranti penduga batimetri kemudian berkembang dengan ditemukannya *echo sounder* yang bekerja dengan menggunakan metode akustik untuk mengukur kedalaman suatu perairan. Seiring dengan perkembangan teknologi, pengukuran batimetri saat ini dapat dilakukan dengan penginderaan jauh satelit. Penggunaan penginderaan jauh satelit dianggap lebih efisien dan efektif karena mampu merevisi dan mengkompilasi peta batimetri yang telah ada. Penggunaan metode penginderaan jauh ini juga dapat menyajikan informasi mengenai fenomena yang terjadi di lautan secara dinamis dan kontinyu (Wahyuningram 2007).

Banyak metode yang telah dikembang untuk mengestimasi kedalaman suatu perairan agar mendekati sebenamya, seperti metode Lyzenga (1978, 1981), Jupp (1988) dan yang terbaru dengan metode Stumpf *et al.* (2003). Metode Stumpf menggunakan model rasio dengan membandingkan reflektansi pada 2 panjang gelombang yang berbeda. Stumpf berasumsi dengan membanding 2 buah faktor reflektansi panjang gelombang perairan air dengan kanal yang berbeda akan mengurangi efek dari albedo perairan yang selama ini menjadi masalah utama dalam pemetaan batimetri. Albedo adalah rasio antara radiasi/sinar matahari yang tiba di permukaan bumi dengan yang dipantulkan kembali ke ruang angkasa (Foken 2008). *Absorpsi* (penyerapan) dan *scattering* (hamburan) merupakan 2 faktor yang mempengarahi nilai albedo. Perbedaan substrat, kualitas air, dan kedalaman menyebabkan nilai *absorpsi* dan *scaterring* yang berbeda (Stump, 2003).

Ekstraksi nilai digital untuk mendapatkan nilai kedalaman pada kegitatan ini menggunakan citra landsat 8 OLI. Data ini dapat diakses pada laman merupakan https://earthexplorer.usgs.gov. Data citra yang digunakan dalam kegiatan ini adalah akuisisi tanggal 15 Juni 2019 path row 114/66. Pengolahan citra dimulai dengan pemotongan citra (*cropping*) yang bertujuan menyesuaikan lokasi citra dengan wilayah pengamatan. Langkah berikutnya adalah *masking* yang bertujuan memisahkan antara badan air dengan daratan menggunakan kanal NIR 2 (770-895 mn) karena kanal ini dapat membedakan nilai reflektansi antara badan air dengan daratan secara efektif (Digital Globe 2009). Hasil analisis citra ditunjukkan pada Gambar 1.13 dan Gambar 1.14.

Gambar 1.13. Citra Landsat 8 OLI path row 114/66



Gambar 1.14. Cropping Citra Loh Buaya Pulau Rinca

Pengolahan citra untuk menghasilkan data batimetri dibagi menjadi 2 langkah yaitu langkah awal dan langkah lanjutan. Langkah awal yaitu melakukan koreksi radiometrik dan geometrik. Koreksi radiometrik dilakukan untuk memperbaiki nilai piksel agar sesuai dengan yang seharusnya. Kemudian citra satelit perlu dikoreksi geometrik, namun karena sudah dilakukan, koreksi geometrik tidak perlu dilakukan.

Langkah lanjutan adalah citra yang telah terkoreksi dengan baik (geometrik dan radiometrik) kemudian dikonversi dan diekstraksi agar dapat dihitung kedalaman perairan tersebut. Awalnya nilai digital number dikonversi *menjadi Top of the Atmosphere* (TOA). Nilai *Digital Number* (DN) pada citra dapat dipengarahi oleh beberapa faktor, antara lain proses absorpsi dan hambur balik yang terjadi di atmosfer. Diperlukan kalkulasi *Digital Number* untuk mengkonversi *Digital Number* (DN) menjadi *Top of the Atmosphere (TOA)* (persamaan 4) yaitu: Band

$$L_{\lambda Pixel,Band} = \frac{K_{Band} \quad x \quad q_{Pixel,Band}}{\Delta\lambda_{Band}}$$

Keterangan :

$L_{\lambda Pixel,Band}$ = nilai TOA Radiance (W-m-2-sr-1-µm-1)

K_{Band} = faktor kalbrasi dari setiap kanal 6 qPixel

$Q_{Pixel,Band}$ = nilai Digital Number (DN) masing-masing kanal

$\Delta_{\lambda Band}$ = nilai efektif tiap kanal

Kemudian dilanjutkan konversi dari nilai radiansi spectral menjadi nilai reflektansi yang akan dijadikan sebagai dasar perhitungan nilai kedalaman perairan.

$$P\lambda_{Pixel,Band} = \frac{L_{\lambda Pixel,Band} \quad d_{ES}^2 \quad \pi}{Esun_{\lambda Band} Cos(\theta_\alpha)}$$

Keterangan :

$P\lambda_{Pixel,Band}$ = nilai rata-rata reflektansi tiap kanal

$L_{Pixel,Band}$ = pixel citra spectral *top-of atmosphere* radiansi pada setiap kanal

d^2_{ES} = jarak bumi matahari dalam satuan autronomis (AU) pada saat

$E_{sun\lambda Band}$ = nilai iradiasi matahari pada tiap kanal

θ_α = sudut zenith matahari

b. Pendugaan kedalaman

Stumpf *el al.,* (2003) menggunakan perbandingan kanal dalam pendugaan kedalaman yaitu *Blue/Green, Blue/Yellow, Blue Red Green/Red, Green/Yellow and Yellow/Red* dan didapat perbandingan kanal terbaik adalah *Blue/Green.* Sedangkan kanal dalam pendugaan kedalaman dalam kegiatan ini ditambah dengan kanal *Coastal Blue yang diperuntukkan mengestimasi kedalaman.* Dengan menggunakan rasio dari kedalaman relatif yang kemudian disesuaikan dengan regresi linier dengan data DEMNAS. Dari setiap regresi linear yang dihasilkan kemudian ditentukan koefisien m_1 dan konstanta m_0 *dengan persamaan :*

$$Z = m_1 \left(\frac{\ln(nRw(\lambda i)}{\ln(nRw(\lambda j)} \right) - m_0$$

Keterangan :

Z = estimasi kedalaman

m_1 = koefisien kalibrasi

m_0 = faktor koreksi kedalaman nol (0)

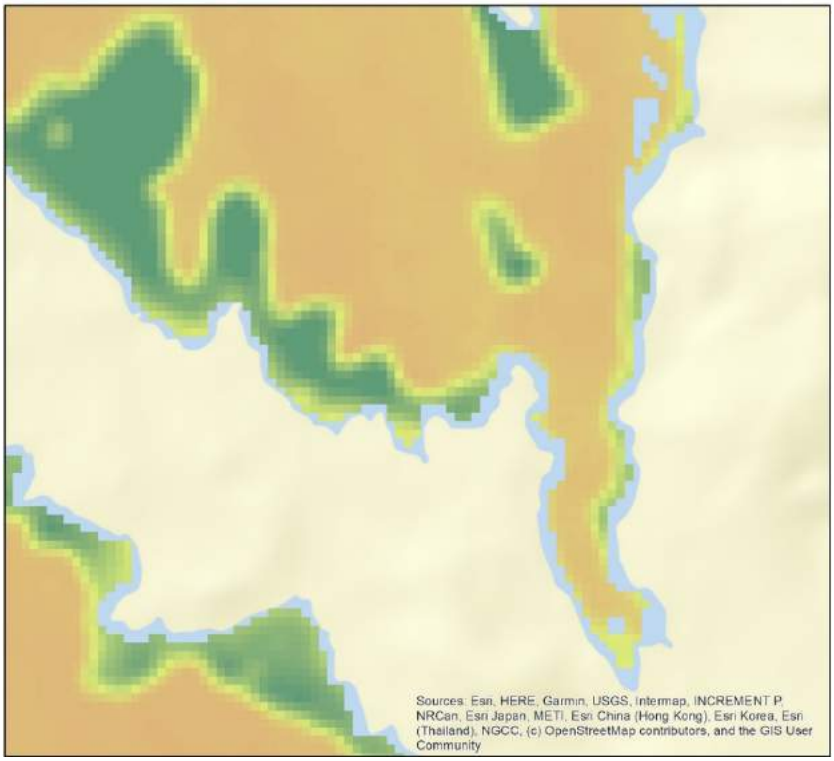
Rw(λ) = reklektansi perpanjangan gelombang yang meninggalkan air

n = konstanta untuk menjaga nilai rasio tetap postif

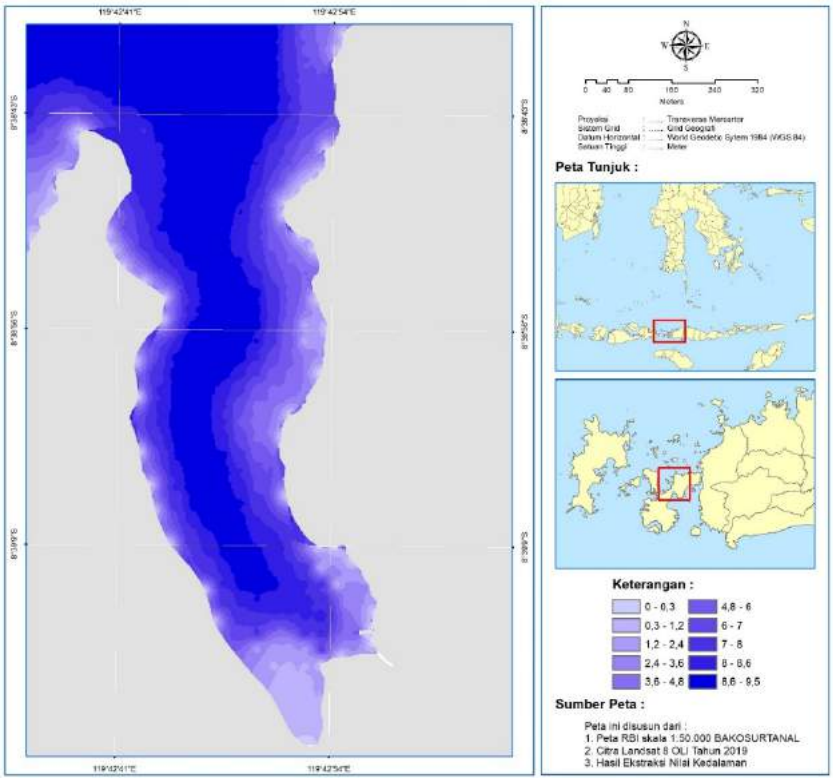
Hasil analisis ditunjukkan pada Gambar 1.15. Teknik pemetaan dengan menggunakan

penginderaan jauh merupakan cara yang dipandang efektif dan efisien, terutama di berbagai daerah yang masih belum ada datanya atau daerah tersebut berubah dengan cepat. Namun, teknik pendugaan batimetri dengan menggunakan penginderaan jauh ini juga memiliki kelemahan yaitu keterbatasannya dalam penetrasi perairan antara 15-20 m tergantung tingkat kecerahan perairan tersebut (Wouthuyzen 2001).

Peta batimetri dengan akurasi yang baik dihasilkan berdasarkan pemilihan model kedalaman yang baik pula. Model kedalaman tersebut didapat berdasarkan regresi linear dengan koefisien determinasi (R^2). Dari persamaan regresi linear, kemudian digunakan untuk menghasilkan peta batimetri dari sebuah citra. Peta Batimetri di lokasi studi ditunjukkan pada Gambar 1.16.



Gambar 1.15. Hasil Pendugaan Kedalaman menggunakan metode Stumpf



Gambar 1.16. Peta Batimetri Loh Buaya Pulau Rinca

c. Pasang Surut

Pasang surut merupakan gerak naik-turun permukaan laut secara teratur (periodik) sebagai akibat gaya tarik bulan dan matahari terhadap bumi. Dibandingkan dengan bulan, matahari memiliki ukuran (massa) jauh lebih besar dibandingkan dengan ukuran bulan, jarak matahari terhadap bumi pun lebih jauh dibandingkan dengan jarak bulan terhadap bumi. Namun demikian, naik-turunnya permukaan laut dipengaruhi oleh jarak antara planet dibandingkan dengan ukurannya. Oleh karena itu, bulan yang jaraknya terhadap bumi jauh lebih dekat memiliki peranan yang lebih penting dibandingkan matahari dalam mempengaruhi fenomena alam tersebut.

Pola dan tipe pasang surut di indonesia berbeda-beda, umumnya tipe pasang surut dapat dilihat dengan nilai formzal, F= $\frac{K1+O\ 1}{M2+S2}$, dimana (tidal constants) sebagai berikut:

K1 Amplitudo komponen pasang surut tunggal utama yang disebabkan oleh gaya tarik bulan dan matahari

O1 Ampitudo komponen pasang surut tunggal utama yang disebabkan oleh gaya tarik bulan

M2 Amplitudo komponen pasang surut ganda utama yang disebabkan oleh gaya tarik bulan

S2 Amplitudo komponen pasang surut ganda utama yang disebabkan oleh gaya tarik matahari

Penentuan tipe pasang-surut dapat dilihat dari nilai F dengan rentang nilai antara 0 sampai > 3 (Tabel 1.11).

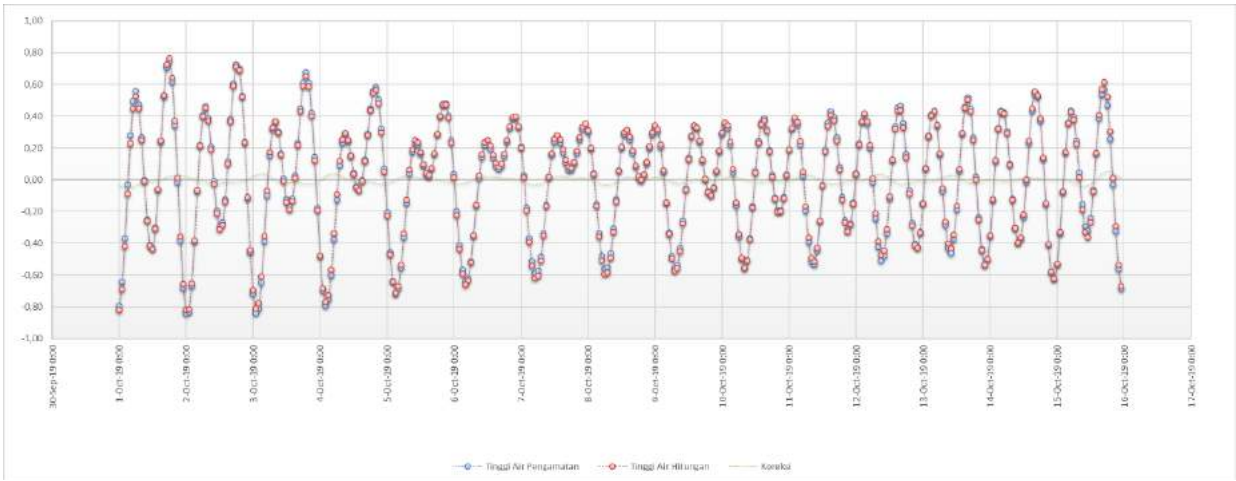
Tabel 1.11. Nilai F, Formzal untuk tipe-tipe pasang surut di Indonesia

Nilai F	Jenis Pasang-surut	keterangan
$0 < F \leq 0,25$	Semidiurnal	Ditemukan 2 kali surut dan 2 kali pasang dalam sehari dengan rentang pasut yang kurang lebih sama
$0,25 < F \leq 1,5$	Mixed semidiurnal	Ditemukan 2 kali surut dan 2 kali pasang dalam sehari dengan rentang pasut yang tidak sama
$1,5 < F \leq 3,0$	Mixed diurnal	Ditemukan satu kali surut dan satu kali pasang dalam sehari tapi kadang dua kali surut dan dua kali pasang dengan rentang pasut yang sangat berbeda
$F > 3,0$	Diurnal	Ditemukan satu kali surut dan satu kali pasang dalam sehari

Secara sederhana, durasi pasang sarut (dua kali pasang dan dua kali surut) sekitar 24 jam, karena setiap periode pasang atau surut kurang lebih enam jam sekali. Oleh karena itu, sebaiknya puntuk mengetahui rentang pasang-surut sesaat diperlukan waktu pengamatan 15 jam, tetapi dapat dilakukan kurang dari jumlah jam tersebut namun tergantung pada posisi air saat pengamatan. Jumlah jam tersebut di atas dapat memberi gambaran rentang pasang-surut dari air surut rendah sampai air pasang tinggi.

Data pasang surut yang digunakan dalam kegiatan ini adalah data Badan Informasi Geospasial (BIG) khususnya Pusat Jaring Kontrol Geodesi dan Geodinamika. Data ini di unduh pada laman http://tides.big.go.id. Ketersediaan data ini sudah di upayakan oleh BIG agar data pasut dengan rentang waktu minimal 18,6 tahun tersebut tersedia dalam kondisi baik. Salah satu cara yang diupayakan adalah dengan melakukan pemasangan dan pemantauan stasiun pasut yang tersebar di wilayah tanah air. Pemilihan lokasi pemasangan sangat berpengaruh pada kondisi staisun pasut itu sendiri. Sehingga kriteria pembangunan stasiun pasut menjadi faktor penting dalam penyediaan instrument pengamatan pasut. Salah satu kriteria yang dimaksud adalah pada lokasi yang aman, permanen dan mudah diakses, agar stasiun pasut yang dikelola BIG dapat bertahan lama (SNI 7924:2013).

Data pasang surut yang diolah dalam kegiatan ini adalah hasil pengamatan tanggal 1 – 15 Oktober 2019. Data pengamatan mulai terekam pada tanggal 1Oktober 2019 jam 00.00 waktu setempat. Data ini setiap satu jam akan selalu diperbaharui, hingga mencapai 360 jam atau 15 hari perekaman data (Gambar 1.17).



Gambar 1.17. Grafik Pasang Surut Loh Buaya Pulau Rinca

Berdasarkan data pasang surut perekaman 15 hari tersebut diatas, kemudian akan dilakukan pengolahan data lanjutan. Pengolahan data ini menggunakan metode admiralty untuk mendapatkan 9 konstanta harmonis pasang surut perairan Loh Buaya Pulau Rinca. Adapun hasil analisis konstanta pasang surut ini disajikan pada Tabel 1.12.

Berdasarkan konstanta harmonik pasang surut di atas, karakteristik pasang surut baik tipe maupun tunggang pasang surut dan elevasi muka air laut maksimum, rata-rata saat pasang purnama dan rata-rata saat pasang perbani dapat diketahui. Pada umumnya sifat pasut di suatu perairan ditentukan dengan menggunakan rumus Formzahl, yang berbentuk:

Tabel 1.12. Hasil Analisis Konstanta Pasut

No	Symbol	Parameter			Aplitudo	Phase	Phase
		Z0	A	B	Sentimeter	der/jam	rad/jam
0	Z0	0,0004			0,0004		
1	M2		-0,4255	0,1271	0,4441	163,3637	2,8512
2	S2		-0,1612	0,0418	0,1666	165,4716	2,888
3	N2		-0,0578	0,0765	0,0959	127,052	2,2175
4	K2		0,0066	-0,064	0,0643	275,8542	4,8146
5	K1		-0,1455	0,1152	0,1856	141,6223	2,4718
6	O1		-0,1312	-0,0971	0,1633	216,5109	3,7788
7	P1		0,1364	0,129	0,1878	43,4125	0,7577
8	M4		-0,0002	-0,0001	0,0002	201,9688	3,525
9	MS4		-0,0001	-0,0001	0,0001	210,7034	3,6775

$$F = (K1 + O1)/(M2 + S2)$$

F = Nilai Formzahl

Ki dan 01 = konstanta pasut harian utama

M2 dan S2 = konstanta pasut ganda utama

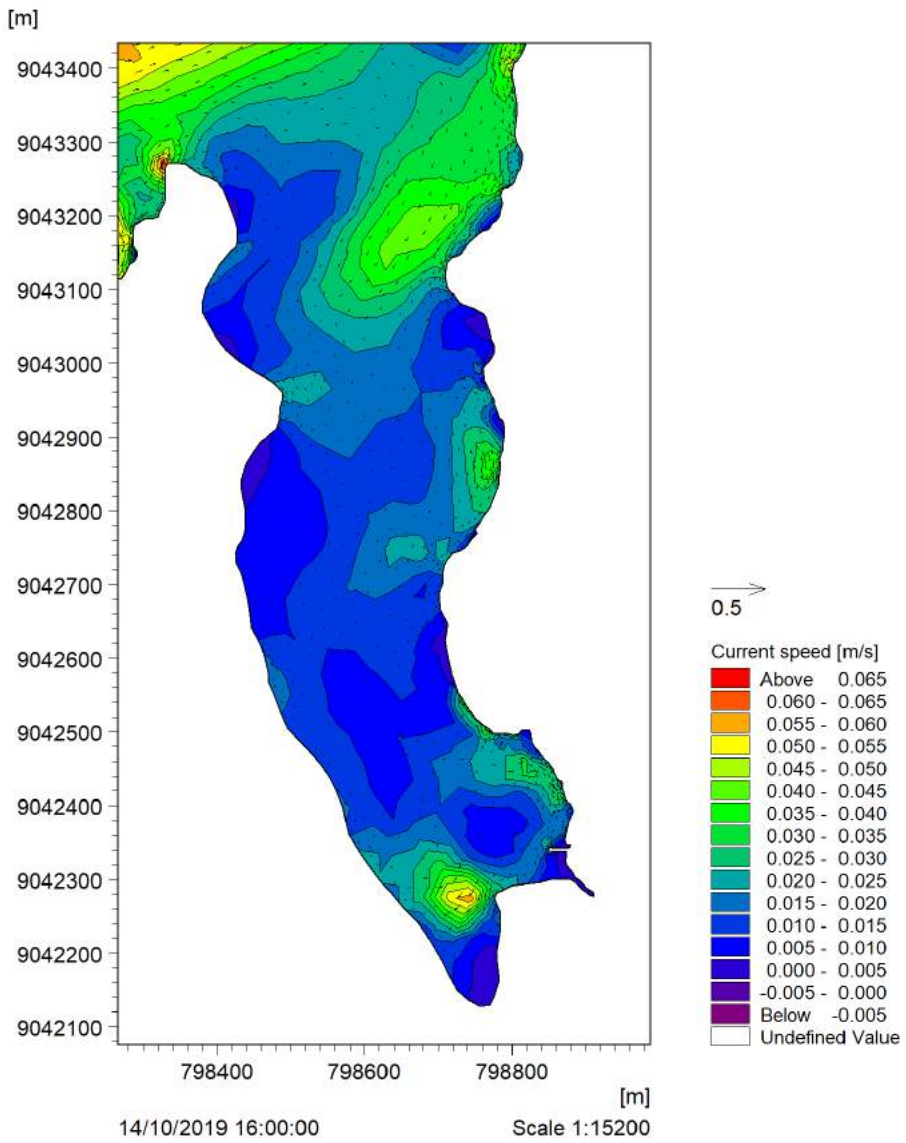
$$F = \frac{A(K_1) + A(O_1)}{A(M_2) + A(S_2)}$$

$$= \frac{0,186 + 0,163}{0,444 + 0,167} = 0,571$$

Hasil analisa formzahl tersebut di atas, diperoleh nilai F dari pasang surut adalah 0,571 yang berarti tipe pasang surutnya adalah tipe campuran cenderung ke harian ganda (semi diurnal), yang dicirikan dengan terjadinya air pasang dan surut dominan dua kali sehari.

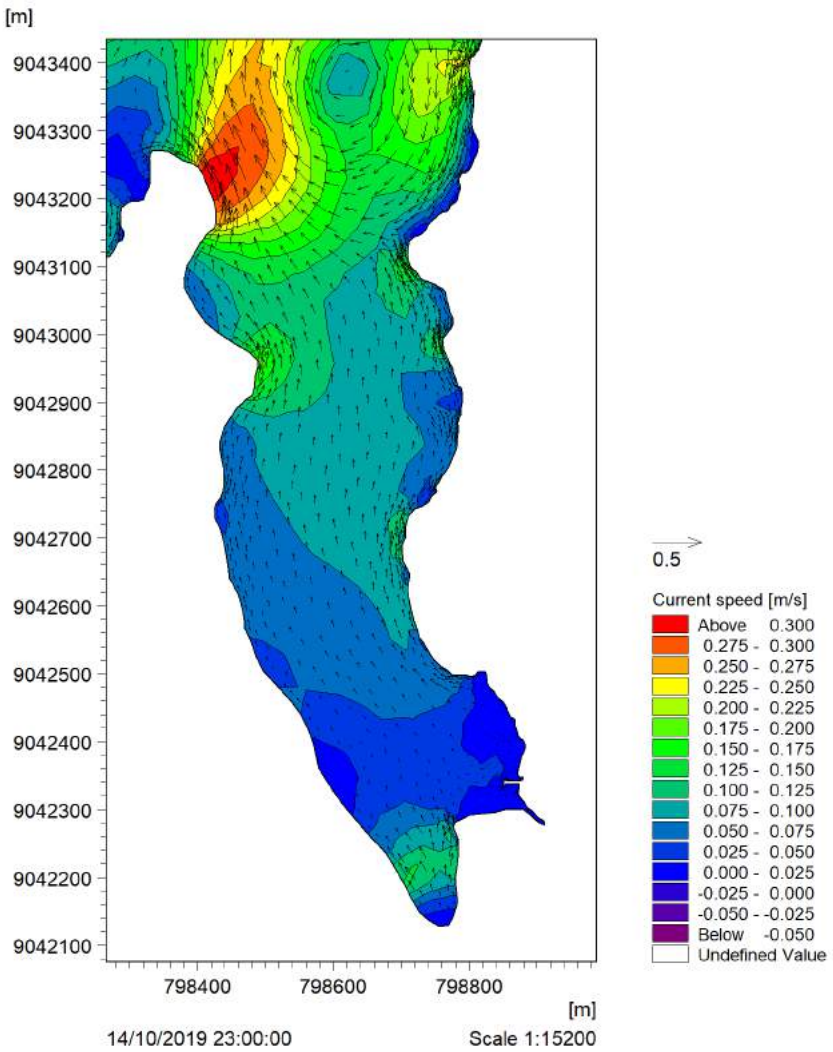
d. Pola Arus

Pola pergerakan arus di lokasi studi diperoleh dari hasil simulasi hidrodinamika menggunakan software DHI MIKE. Untuk mendapatkan pola arus, dalam simulasi menggunakan data batimetri yang digabung dengan data DEMNAS, dan data pasang surut Oktober 2019. Simulasi pola pergerakan arus dilakukan untuk mengetahui pola arus di sekitar wilayah kajian. Gambaran simulasi pola arus ditampilkan dalam dua kondisi yakni pada waktu pasang dan surut (Gambar 1.18 dan Gambar 1.19).



Gambar 1.18. Arah dan Kecepatan Arus Pada Saat Pasang

Berdasarkan hasil simulasi, Arah dan kecepatan arus Loh Buaya yang berbentuk teluk pada saat pasang mengarah dari arah timur kemudian berbelok masuk menuju arah selatan. Sebaran kecepatan arus tertinggi berada pada bagian selatan wilayah kajian, dengan kecepatan 0,065 m/s. Kecepatan arus cenderung menurun dan menyusuri garis pantai sampai ke dermaga Loh Buaya.



Gambar 1.19. Arah dan Kecepatan Arus Pada Saat Surut

Berdasarkan hasil simulasi, arah dan kecepatan arus memperlihatkan arus pada saat surut mengarah dari selatan menuju utara. Kecepatan arus dari dalam dermaga Loh Buaya 0,025 m/s kemudian bergerak keluar menyusuri pantai dengan kecepatan yang semakin meninggi yakni sampai pada 0,3 m/s. Dari hasil simulasi kecepatan arus pada perairan Loh Buaya tergolong dalam dalam kategori lambat (Tabel 1.13).

Tabel 1.13. Kategori Kecepatan Arus

No	Kecepatan Arus (m/detik)	Kategori
1	0 - 0,25	Lambat
2	0,25 - 0,50	Sedang
3	0,50 - 1	Cepat
4	>1	Sangat Cepat

Sumber : Harahap dalam Ihsan, 2009.

e. Gelombang

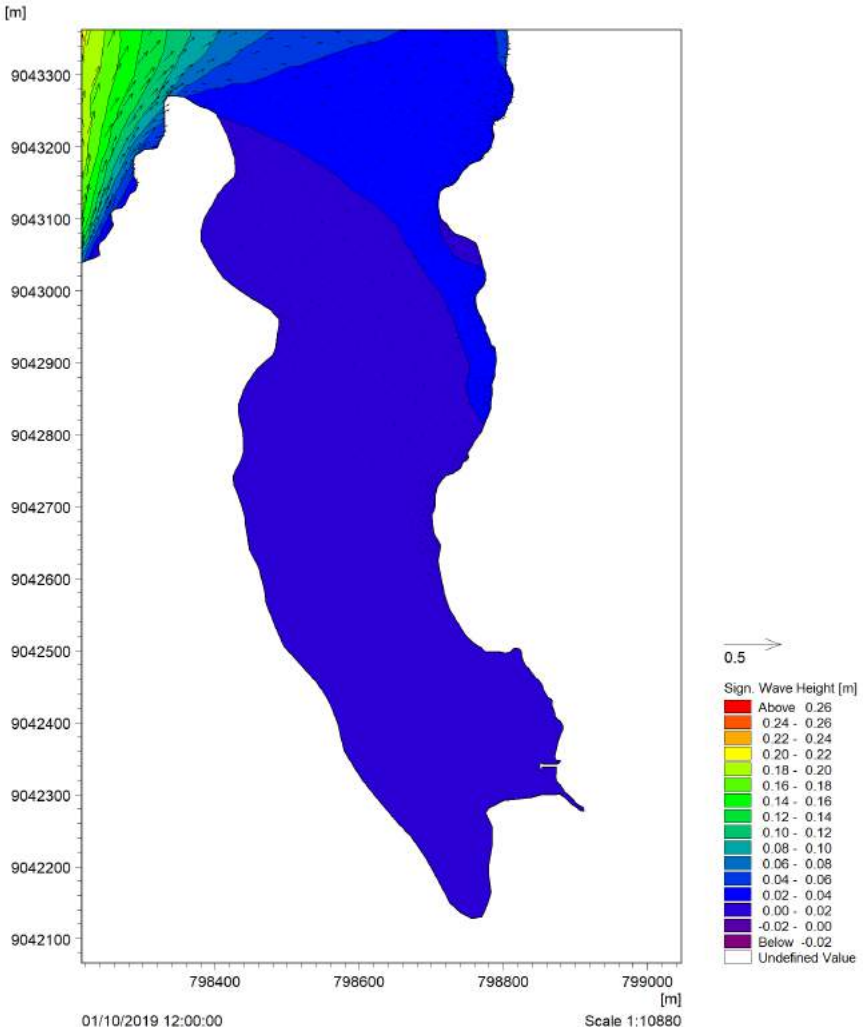
Pemodelan gelombang menggunakan *software* DHI MIKE 21 modul SW (*Spektral Wave*). Dalam pemodelan gelombang, menggunakan data batimetri, data arah dan kecepatan angin, serta data garis pantai. Berdasarkan hasil pemodelan gelombang diketahui bahwa pada lokasi kajian, arah datang gelombang dari arah barat daya kemudian terjadi pembelokan arah menuju ketenggara yang terlihat seperti kurva. Tinggi gelombang yang berada di luar teluk 0,26 – 0,02 meter yang kemudian berbelok masuk kedalam teluk dengan semakin terjadi peredaman tinggi gelombang yang diakibatkan oleh adanya mulut teluk. Tinggi gelombang kemudian semakin teredam sampai kedalam dermaga Loh Buaya (Gambar 1.20).

Karakteristik gelombang pada wilayah pelabuhan Labuan Bajo menurut WMO,UK,2012 dalam Hardjono 2018, tergolong dalam kondisi *Smooth*. Dengan morfologi pantai yang berbentuk teluk, maka kondisi gelombang sepanjang tahun pada perairan pelabuhan Loh Buaya akan relative tenang (Tabel 1.14).

Tabel 1.14. Karakteristik Gelombang

WMO Sea State Code	Wave Height	Characteristics
0	0	Calm (Glassy)
1	0 to 0,1 metres	Calm (rippled)
2	0,1 to 0,5 metres	Smooth (wavelets)
3	0,5 to 1,25 metres	Slight
4	1,25 to 2,5 metres	Moderate
5	2,5 to 4 metres	Rough
6	4 to 6 metres	Very rough
7	6 to 9 metres	High
8	9 to 14 metres	Very high
9	over 14 metres	Phenomenal

Sumber : WMO,UK,2012 dalam Hardjono, 2018.



Gambar 1.20. Arah dan Tinggi Gelombang Loh Buaya

2.2. Komponen Biologi

Taman Nasional Komodo (TNK) ditetapkan sebagai Warisan Alam Dunia dan sebagai Cagar Biosfir oleh UNESCO. Letaknya di Bio-Region Wallacea, TNK sangat penting artinya dalam menunjang pelestarian keanekaragaman flora dan fauna di kawasan itu. Ekosistem yang dimiliki tidak dijumpai di kawasan taman nasional manapun di Indonesia. Salah satu satwa khas TNK adalah komodo (*Varanus komodoensis*), yang merupakan reptilia purba dengan nilai konservasi tinggi dan merupakan *flagship species* TNK. Satwa ini menghuni pulau-pulau utama dalam gugus kepulauan TNK, salah satunya Pulau Rinca (Mustari *et al*., 2010).

Rencana pembangunan fasilitas penunjang wisata Pulau Rinca bertujuan untuk menunjang dan meningkatkan fasilitas objek wisata di Pulau Rinca, sehingga para pengunjung baik wisatasan domestik maupun mancanegara dapat merasa lebih nyaman. Tidak bisa dipungkiri, di dalam proses pembangunan fasilitas penunjang wisata Pulau Rinca tersebut dapat mempengaruhi lingkungan di sekitarnya, termasuk makhluk hidup atau komponen biologinya. Komponen biologi yang diamati di lokasi rencana pembangunan fasilitas penunjang wisata Pulau Rinca Kecamatan Komodo, yaitu meliputi flora, fauna dan hidrobiota (biota air) yang ada di lokasi tersebut.

2. OUV

Komodo National Park (KNP) is inscribed as a World Heritage property in 1991 as having two natural criteria, criterion (vii) – contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance, and criterion (x) – contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science or conservation. The project is taking place in an area of 1.3 ha in the Tourist Use Zone of the national park in Loh Buaya. Below are more details on the project environment that could be potentially affected. Data regarding project environment was collected before and during the first stage of the construction [September 2020] based on direct observation, field studies, and literature review.

Outstanding Universal Values

Values – Criterion (vii)

Komodo National Park is a landscape of contrast between starkly rugged hillsides of dry savanna, pockets of thorny vegetation, brilliant white sandy beaches and blue waters surging over coral, unquestionably one of the most dramatic landscapes in all of Indonesia. Demonstrating exceptional natural beauty that is all the more remarkable as a counterpoint to the dominant lushness of vegetation which characterizes vast areas of forested Indonesia, and with which most of the world associates the archipelago. An irregular coastline characterized by bays, beaches and inlets separated by headlands, often with sheer cliffs falling vertically into the surrounding seas which are reported to be among the most productive in the world adds to the stunning natural beauty of landscapes dominated by contrasting vegetation types, providing a patchwork of colors.

The exceptional beautify of Komodo National Park is attributed to the climate and its geological history. It is part of the islands along the line of a tectonic subduction between the Sunda and Sahul self, resulted in generally steep and rugged landscapes (Letouzey et al. 1990; Claudino-Sales 2019). The climatic conditions support the dry savannah ecosystem. Annual rainfall of Komodo National Park is less than 1000 mm. Long dry season occurs from April to October with mean daily temperature is 40°C, while rainy season occurs during monsoon between November and March. This season is characterized by heaviest rainfall, highest humidity, strongest winds, and lowest temperature (Claudino-Sales 2019). Closed to the project site in Loh Buaya, the common trees include *Ziziphus mauritana* (Indian jujube/*Bidara*) dan *Schleichera oleosa* (Kusum tree/*Kesambi*). Mangroves around the dock include *Ceriops tagal*, *Rhizophora* sp., *Avicennia marina*, and *Sonneratia alba*. Other plants are listed in the Table 2.1. They are common species, usually found in other places as well. There is no endemic nor protected flora found in/around the project site.

Table 2.1. Flora found in/around the project site in Loh Buaya.

Species name	Common name	IUCN status	Protection status
Tamarindus indica	Tamarind	LC	Not-protected
Ziziphus mauritiana	Indian jujube	LC	Not-protected
Schleichera oleosa	Kusum tree	LC	Not-protected
Ceiba pentandra	Kapok tree	LC	Not-protected
Sterculia foetida	Java olive tree	NA	Not-protected
Albizia lebbeck	Indian Siris	LC	Not-protected
Bauhinia purpurea	Orchid tree	LC	Not-protected
Alstonia scholaris	Blackboard tree	LC	Not-protected

Species name	Common name	IUCN status	Protection status
Borassus flabellifer	Doub palm	NA	Not-protected
Ficus benjamina	Benjamin fig	LC	Not-protected
Morinda sp.	Wild mulberry	NA	Not-protected
Gramineae	Grasses	NA	Not-protected
Cyperus rotundus	Coco-grass	LC	Not-protected
Leucaena leucocephala	Jumbay	NA	Not-protected
Asplenium nidus	Bird's nest fern	NA	Not-protected
Rhizophora apiculata	Mangrove	LC	Not-protected
Rhizophora mucronata	Loop-root mangrove	LC	Not-protected
Sonneratia alba	Mangrove	LC	Not-protected
Ceriops tagal	Spurred mangrove	LC	Not-protected
Avicennia marina	Grey mangrove	LC	Not-protected

Notes: IUCN status from https://www.iucnredlist.org/ and protection status from the Minister of Environment and Forestry Regulation on Protected Species List No. P.106/Menlhk/Setjen/Kum.1/12/2018.

Outstanding Universal Values

Values – Criterion (x)

Terrestrial fauna and flora - The KNP is the home of Komodo (*Varanus komodoensis*), a world's largest lizard existing nowhere else in the world. It is the first and most important component of criterion (x) due to its endemicity and unique evolutionary history. The current distribution of Komodo dragon is restricted to five islands located in Komodo National Park [Komodo (311.5 km^2), Rinca (204.8 km^2), Padar (14.1 km^2), Gili Motang (9.5 km^2), and Nusa Kode (7.8 km^2)] and several fragmented populations on Flores Island (Purwandana et al. 2014; Jessop et al. 2018; Ariefiandy et al. 2021). Komodo National Park authority regularly monitors the population of Komodo dragons, using a mark-recapture method and camera trapping with site occupancy approaches used to estimate Komodo dragon population abundance (Ariefiandy et al. 2013; Purwandana et al. 2014; Balai Taman Nasional Komodo (Komodo National Park Authority) - Komodo Survival Program 2019). There are 11 monitoring sites with 219 fixed locations distributed across five islands within Komodo National Park that are annually monitored. Komodo dragon population abundance across Komodo National Park over the last five years has shown small fluctuations with a slight decrease reported in 2016. The highest abundance was in 2019 and estimated 3,022 Komodo dragons (95 % CI ranged from 2,292 – 3,983). There is variation among island-specific abundance across Komodo National Park. The abundance in two large islands (Komodo and Rinca) was much higher (more than tenfold) compared to the three small islands of Gili Motang, Nusa Kode and Padar. It is estimated that less than 15 individuals of Komodo dragons are interacting within the project site area. This represents 23 percent of the total population in the valley (66 ± 5 individuals, in 2019), representing ~1 percent of the total Rinca island population (1,333 ± 181 individuals, in 2019).

Other faunas in KNP are endemic rat (*Komodomys rintjanus*), the crab-eating macaque (*Macaca fascicularis*), more than 30 species of herpetofauna including the endemic and protected snake (*Malayopython timorensis*), and 72 species of birds, such as the lesser sulphur-crested cockatoo (*Cacatua suplhurea*), the orange-footed scrub fowl (*Megapodius reinwardt*), and noisy friarbird (*Phiemon buceroides*). Approximately 10-20 individuals of Timor deer, 15 individuals of water buffalo, 5 individuals of wild boar, and three groups (30 to 60 individuals) of long-tailed macaques have ever been observed in and around the project site (Personal communication with the head of Loh Buaya resort) (Table 2.2). Bat species, *Pteropus vampyrus* and *Dobsonia peronii*, are known to roost on Rinca Island (*P. vampyrus* – on a mangrove

island in front of Kampung Rinca and *D. peronii* in a cave closed to the village), but far from the project site. They may fly over the project site without necessarily stop by because lack of potential feeding trees.

Table 2.2. Mammals found in/around the project site in Loh Buaya.

Species name	Common name	IUCN status	Protection status
Rusa timorensis	Timor deer	VU	Protected
Sus scrofa	Wild boar	LC	Not-protected
Bubalus bubalis	Water buffalo	NA	Not-protected
Macaca fascicularis	Long-tailed macaque	VU	Not-protected
Pteropus vampyrus	Large flying-fox	NT	Not-protected
*Dobsonia peronii**	Western Naked-backed Fruit Bat	LC	Not-protected

Notes: (*) *D. peronii* is endemic to Bali and Lesser Sunda. IUCN status from https://www.iucnredlist.org/ and protection status from the Minister of Environment and Forestry Regulation on Protected Species List No. P.106/Menlhk/Setjen/Kum.1/12/2018.

There are 72 bird species residing in Komodo National Park, 30 of them were observed in the project site (Table 2.3). About 87% are not-protected and 97% are not threatened (28 in Least Concern – LC and 1 in Near Threatened – NT categories). Most of the species are widely distributed and common in habitat with human presence. One protected bird species that fly over the project site is the lesser sulphur-crested cockatoo (~6-8 individuals or <1% of the total population – 883 individuals in the KNP). Another protected bird species is orange-footed scrub fowl with only one out of the eight nesting sites is located near to the project site (~100 m).

Table 2.3. Birds found in/around the project site in Loh Buaya.

Species name	Common name	IUCN status	Protection status
*Cacatua sulphurea**	Lesser sulphur-crested cockatoo	CR	Protected
Megapodius reinwardt	Orange-footed scrub fowl	LC	Protected
Haliastur indus	Brahminy kite	LC	Protected
Haliaeetus leucogaster	White-bellied sea eagle	LC	Protected
*Cinnyris solaris**	Flame-breasted sunbird	LC	Not-protected
*Taeniopygia guttata**	Timor Zebra Finch	LC	Not-protected
Limosa lapponica	Bar-tailed godwit	NT	Not-protected
Sterna albifrons	Little tern	LC	Not-protected
Ardea purpurea	Purple heron	LC	Not-protected
Egretta garzetta	Little egret	LC	Not-protected
Nycticorax nycticorax	Black-crowned night heron	LC	Not-protected
Anas superciliosa	Pacific black duck	LC	Not-protected
Poliolimnas cinerea	White-browed crake	LC	Not-protected
Turnix suscitator	Barred buttonquail	LC	Not-protected
Tringa nebularia	Common greenshank	LC	Not-protected
Tringa tetanus	Common redshank	LC	Not-protected
Geopelia striata	Zebra dove	LC	Not-protected
Ducula concinna	Blue-tailed imperial-pigeon	LC	Not-protected

Species name	Common name	IUCN status	Protection status
Ducula bicolor	Pied imperial pigeon	LC	Not-protected
Ducula aenea	Green imperial-pigeon	LC	Not-protected
Saxicola caprata	Pied bushchat	LC	Not-protected
Passer montanus	Eurasian tree sparrow	LC	Not-protected
Hirundo tahitica	Pacific swallow	LC	Not-protected
Gallus varius	Green junglefowl	LC	Not-protected
Oriolus chinensis	Black-naped oriole	LC	Not-protected
Corvus macrorhynchos	Large-billed crow	LC	Not-protected
Todiramphus chloris	Collared kingfisher	LC	Not-protected
Spilopelia chinensis	Spotted dove	LC	Not-protected
Dicrurus densus	Wallacean drongo	LC	Not-protected
Philemon buceroides	Helmeted friarbird	LC	Not-protected

Notes: (*) endemic to certain areas, *Cacatua suplhurea* is endemic to Wallacea, while *Cinnyris solaris* and *Taeniopygia guttata* are endemic to parts of Lesser Sunda (Timor and East Nusa Tenggara). IUCN status from https://www.iucnredlist.org/ and protection status from the Minister of Environment and Forestry Regulation on Protected Species List No. P.106/Menlhk/Setjen/Kum.1/12/2018.

Marine fauna and flora - Komodo National Park is famous for its marine life (Lembaga Ilmu Pengetahuan Indonesia (LIPI) (Indonesian Institute of Science) 2019), a habitat for 18 cetacean species with two species -Bottlenose dolphin (*Tursiops truncatus*) and Indo-Pacific humpback dolphin (*Sousa chinensis*)- reside around Loh Buaya bay. The marine diversity in the Loh Buaya bay close to the project site is considered poor due to the lack of coral reefs and sea grass beds (Personal communication with Mr. Muhammad Ikbal Putera, Komodo National Park and Loh Buaya resort park ranger, Mr. Afandi). The main substrate of the sea floor in this area is rock, sand, and mud (Lembaga Ilmu Pengetahuan Indonesia (LIPI) (Indonesian Institute of Science) 2019). Field observation in the area documented some species of benthic fauna, plankton (both zooplankton and phytoplankton), nekton (e.g. fish) and invertebrate in the Loh Buaya bay (Table 2.4). The most common species of benthic fauna is *Saccostrea* sp. that live by sticking onto mangrove roots or rocky substrates along the coastal area inundated by seawater. There is no endemic species found.

Table 2.4. Marine fauna and flora found in the Loh Buaya bay.

Types	Species name	Common name	IUCN status	Protection status
Benthos	*Anadara gubernaculum*	Hairy ark cockle	Not evaluated	Not protected
	Cerithidea sp			Not protected
	Chlamys sp	Scallop	Not evaluated	Not protected
	Conomurex (Strombus) luhuanus	Strawberry conch	Not evaluated	Not protected
	Gari truncata	Truncate sunset clam	Not evaluated	Not protected
	Nerita sp	Nerite/sea snail		Not protected
	Periglypta (Antigona) puerpera	Youthful venus	Not evaluated	Not protected

Types	Species name	Common name	IUCN status	Protection status
	Polymesoda sp	Marsh clam		Not protected
	Saccostrea sp	Oyster		Not protected
	Tellina sp	Sunset shell	Not evaluated	Not protected
	Vasticardium angulatum		Not evaluated	Not protected
	Vasticardium flavum	Flavum heart cockle	Not evaluated	Not protected
Zooplankton	*Cyclops* sp		Not evaluated	Not protected
	Nauplius sp		Not evaluated	Not protected
	Paraeuchaeta (Euchaeta) hebes		Not evaluated	Not protected
Nekton	*Abudefduf bengalensis*	Bengal sergeant	Least concern	Not protected
	Amphiprion sp	Clownfish/anemonefish		Not protected
	Caesio caerulaurea	Blue and gold fusilier	Least concern	Not protected
	Lethrinus sp	Emperor		Not protected
	Pterois sp	Lionfish		Not protected
	Lutjanus sp	Snapper		Not protected
	Moolgarda sp	Mullet		Not protected
	Ostorhinchus chrysopomus	Spotted-gill cardinalfish	Not evaluated	Not protected
	Siganus sp	Rabbitfish		Not protected
	Terapon jarbua	Crescent grunter	LC	Not protected
	Toxotes sp	Archerfish		Not protected
Phytoplankton	*Asterionella notata*		Not evaluated	Not protected
	Asterionella formosa		Not evaluated	Not protected
	Bacteriastrum sp		Not evaluated	Not protected
	Ceratium inflexum		Not evaluated	Not protected
	Chaetoceros sp		Not evaluated	Not protected
	Climacosphenia moniligera		Not evaluated	Not protected
	Cymbella tumida		Not evaluated	Not protected
	Navicula sp		Not evaluated	Not protected

Types	Species name	Common name	IUCN status	Protection status
	Nitzschia closterium		Not evaluated	Not protected
	Nitzschia plana		Not evaluated	Not protected
	Nitzschia sp		Not evaluated	Not protected
	Pleurosigma naviculaceum		Not evaluated	Not protected
	Rhabdonema adriaticum		Not evaluated	Not protected
	Rhizosolenia calcar-avis		Not evaluated	Not protected
	Rhizosolenia sp		Not evaluated	Not protected
	Sticholonche zanclea		Not evaluated	Not protected
	Synedra ulena		Not evaluated	Not protected
	Thalassionema sp		Not evaluated	Not protected
	Thalassiothrix sp		Not evaluated	Not protected

Seawater closed to Loh Buaya dock was sampled and analyzed. The temperature was 29.4°C, turbidity was <0.01 NTU, Total Dissolved Solids (TDS) was 4 mg/L, \ (details on analyses can be found on Table 2.5. The last two numbers were below the national standards (turbidity < 5 NTU and TDS is 80 mg/L) based on the Minister of Environment Decree No. 51 Year 2004 concerning Sea Water Quality. Based on the other characteristics, the seawater is still in a good condition.

Table 2.5. Condition of seawater in Loh Buaya bay.

Characteristics	National standards
Temperature: 2.4°C	
Turbidity: <0.01 NTU	<5 NTU
TDS: 4 mg/L	80 mg/
pH: 7.69	7-8.5
Dissolved Oxygen: 6-6.3 mg/L	5 mg/L
Biochemical Oxygen Demand: 1.3 mg/L	20 mg/L
Phosphate concentration: 0.01 mg/L	0.015 mg/l
Coliform bacteria: < 1.8 MPN	

3. Non OUV

3.1. Social and economy condition

The closest village to the project is Pasir Panjang on Rinca Island. It has 438 households [3.3% of the total Komodo district (13,046 households)] of 1,688 residents (man – 855 and woman – 833) (Badan Pusat Statistik Kabupaten Manggarai Barat (Statistics of Manggarai Barat Regency) 2020). They are mainly comprised of Bajo and Manggarai ethnic groups. Others include Bima, Komodo, and Bugis. The main livelihood of the residents is fishing.

a). Sosialisasi Rencana Penataan Pulau Rinca

Proses kegiatan sosialisasi merupakan aspek yang turut menentukan proses intermalisasi dan adaptasi sosial suatu ide atau gagasan kepada Masyarakat. Pengetahuan masyarakat terhadap Rencana kegiatan Penataan Pulau Rinca di Desa Pasir Panjang, Kecamatan Komodo dapat di lihat pada Tabel 3.1.

Tabel 3.1. Pengetahuan Masyarakat Sekitar dan Sumber Informasi Terhadap Rencana Kegiatan Penataan Pulau Rinca, Di Desa Pasir Panjang, Kecamatan Komodo, Kabupaten Manggarai Barat.

No.	Uraian	Responden N = 20)	Persentase (%)
1.	Apakah Masyarakat mengetahui Rencana Kegiatan Penataan Pulau Rinca di Desa Pasir Panjang, Kecamatan Komodo :		
	a. Ya, Tahu	4	20,00
	b. Tidak tahu	16	60,00
2.	Sumber informasi rencana Kegiatan Penataan Pulau Rinca di Desa Pasir Panjang, Kecamatan Komodo		
	a. Pemerintah Desa / Kecamatan	2	10,00
	b. Pemrakarsa Balai Prasarana Permukiman Wilayah NTT	1	5,00
	c. Dinas Terkait Kabupaten Manggarai Barat	0	0,00
	d. Tokoh Masyarakat dan Warga Lainnya	1	5,00

Sumber: Data Primer Setelah Diolah, Tahun 2020.

Pada Tabel 3.1 memperlihatkan bahwa baru sekitar 20,00 % masyarakat (responden) yang sudah mengetahui rencana kegiatan Penataan Pulau Rinca di Desa Pasir Panjang, Kecamatan Komodo, sedangkan sekitar 60,00 % responden yang belum mengetahui rencana kegiatan penataan Pulau Rinca.

Sumber informasi yang diperoleh oleh masyarakat yang mengetahui rencana kegiatan penataan Pulau Rinca bersumber dari pemerintah desa dan kecamatan yaitu 10,00 % dan dari pihak Pemrakarsa kegiatan (Balai Prasarana Permukiman Wilayah Nusa Tenggara Timur) yaitu 5,00 %, dinas terkait Kabupaten Manggarai Barat yaitu 0,00 % dan sumber informasi lainnya adalah dari tokoh masyarakat dan masyarakat lainnya yaitu 5,00 %.

b). Sikap dan Persepsi Masyarakat Terhadap Kegiatan Penataan Pulau Rinca.

Rencana kegiatan Penataan Pulau Rinca di Desa Pasir Panjang, Kecamatan Komodo memunculkan berbagai macam tanggapan dan persepsi dari penduduk sekitar, antara lain; khawatiran terjadinya persepsi perubahan keaslian alam pada wilayah pulau Rinca disebabkan kegiatan pembangunan pada lokasi Pulau Rinca, serta terjadinya kerusakan alam laut akibat kegiatan pembangunan dipulau Rinca. Tabel 3.2 memperlihatkan persepsi masyarakat sekitar terhadap rencana kegiatan Penataan Pulau Rinca di Desa Pasir Panjang, Kecamatan Komodo.

Tabel 3.2. Sikap dan Persepsi Responden di Sekitar Lokasi Rencana Kegiatan Penataan Pulau Rinca di Desa Pasir Panjang, Kecamatan Komodo, Kabupaten Manggarai Barat.

No.	Uraian	Responden (N = 20)	Persentase (%)
1.	Sikap dan Persepsi Responden Terhadap Rencana Kegiatan Penataan Pulau Rinca di Desa Pasir Panjang, Kecamatan Komodo :		
	a. Mendukung	5	25,00
	b. Tidak Mendukung	6	30,00
	c. Terserah Pemerintah	9	45,00
2.	Alasan Mendukung Kegiatan Penataan Pulau Rinca di Desa Pasir Panjang, Kecamatan Komodo :		
	a. Membuka lapangan kerja dan kesempatan berusaha warga sekitar	4	20,00
	b. Mengurangi pengangguran warga sekitar	2	10,00
3.	Alasan Tidak mendukung		
	a. Tidak pernah ada sosialisasi pada masyarakat sekitar di Desa Pasir Panjang	6	30,00
	b. Akan merubah keaslian alam pulau rinca	2	10,00
	c. Tidak akan memberikan manfaat kepada masyarakat sekitar (dusun Kerora)	2	10,00
	d. Penataan pulau rinca hanya menguntungkan investor, sehingga lebih bermanfaat apabila dananya digunakan untuk bantuan masyarakat dipulau rinca	1	5,00

Sumber: Data Primer Setelah Diolah, Tahun 2020.

Pada Tabel 3.2 menunjukkan bahwa masyarakat (responden) yang menyatakan mendukung kegiata Penataan Pulau Rinca sebanyak 5 orang atau 25,00 %, dimana responden yang mendukung memberi alasan, bahwa kegiatan tersebut dapat memberikan manfaat yang positif, karena dapat menciptakan kesempatan kerja dan kesempatan berusaha bagi penduduk lokal di Desa Pasir Panjang yaitu 4 Orang atau 20,00 %, serta akan mengurangi pengangguran warga sekitar sekitar yaitu 2 Orang atau 10,00 %. Sedangkan yang menyatakan tidak mendukung sebanyak 6 orang atau 30,00 %, dengan alasan tidak pernah ada sosialisasi kepada masyarakat sekitar di Desa Pasir Panjang 6 orang atau 30,00 %, akan merubah keaslian alam pulau rinca 2 orang atau 10,00 %, tidak akan memberikan manfaat pada masyarakat sekitar khususnya dusun kerora 2 orang atau 10,00 %, penataan Pulau Rinca hanya akan menguntungkan investor, sehingga lebih bermanfaat apabila dananya digunakan untuk bantuan masyarakat dipulau Rinca 1 orang atau 5,00 %, dan responden yang menyatakan terserah pemerintah 9 orang atau 45,00.

c). Saran dan Tanggapan Masyarakat Terhadap Kegiatan Penataan Puncak Waringin

Berbagai saran dan tanggapan disampaikan oleh warga masyarakat sekitar lokasi kegiatan, berkaitan dengan rencana kegiatan Penataan Pulau Rinca di Desa Pasir Panjang dalam upaya menekan kekhawatiran terjadinya dampak negatif yang dapat menyebabkan kerugian pada warga, antara lain; agar lebih mengutamakan warga sekitar untuk direkrut sebagai tenaga kerja terutama tukang dan buruh bangunan pada saat konstruksi pembangunan fasilitas yang akan dibangun dan pada tahap operasional pulau Rinca agar memberdayakan masyarakat sekitar sebagai pemandu wisata. Adapun saran dan tanggapan masyarakat secara detail disajikan dalam Tabel 3.3.

Tabel 3.3. Saran dan Tanggapan Masyarakat (responden) terhadap Rencana Kegiatan Penataan Pulau Rinca di Desa Pasir Panjang , Kecamatan Komodo, Kabupaten Manggarai Barat.

No.	Saran dan Tanggapan responden	Responden (N = 20)	Persentase (%)
1.	Mengharapkan agar ada sosialisasi terhadap masyarakat sekitar mengenai rencana Penataan Pulau Rinca agar masyarakat sekitar mengetahui rencana yang akan dilaksanakan.	7	35,00
2.	Mengutamakan perekrutan tenaga kerja bagi warga sekitar sebagai tenaga kerja konstruksi penataan dan memberikan kesempatan kepada warga sekitar untuk menjadi pemandu wisata pada saat operasional Pulau Rinca	10	50,00
3.	Memberikan kesempatan kepada BUMDES Desa Pasir Panjang untuk terlibat dalam pengelolaan kegiatan pada tahap operasional Pulau Rinca.	3	15,00

Sumber : Data Primer Setelah Diolah, Tahun 2020.

d. Situs Budaya dan Arkeologi

Situs budaya dan arkeologi adalah peninggalan sejarah berupa budaya masa lalu dan benda-benda atau bangunan bersejarah yang dilindungi dan dipelihara oleh Negara atau pemerintah karena memiliki nilai sejarah yang tak ternilai seperti bangunan mesjid tua, candi, benteng pertahanan, rumah adat, makam raja-raja, makam pahlawan nasional dan benda-benda bersejarah lainnya.

Berdasarkan hasil survey lapangan menunjukkan bahwa pada lokasi rencana penataan kawasan pulau rinca (Loh Buaya), Desa Pasir Panjang, Kecamatan Komodo tidak terdapat peninggalan cagar budaya dan benda-benda ataupun bangunan bersejarah berupa situs budaya maupun situs arkeologi, sehingga rencana penataan pulau rinca (Loh Buaya) tidak akan mengganggu situs budaya maupun situs arkeologi.

3.2. Komponen Kesehatan Masyarakat

Kesehatan masyarakat memiliki peran penting dalam upaya peningkatan kualitas sumber daya manusia, penanggulangan kemiskinan dan pembangunan ekonomi. Indeks Pembangunan Manusia meletakkan kesehatan adalah salah satu komponen utama pengukuran selain pendidikan dan pendapatan.

Kondisi umum kesehatan Indonesia dipengaruhi oleh faktor lingkungan, perilaku, dan pelayanan kesehatan. Sementara itu pelayanan kesehatan terdiri dari beberapa komponen antara lain ketersediaan dan mutu fasilitas pelayanan kesehatan, obat dan perbekalan kesehatan, tenaga kesehatan, pembiayaan dan manajemen kesehatan. Fasilitas pelayanan kesehatan dasar, yaitu Puskesmas yang diperkuat dengan Puskesmas Pembantu dan Puskesmas Keliling, telah didirikan di hampir seluruh wilayah Indonesia, namun pemerataan dan keterjangkauan pelayanan kesehatan masih menjadi kendala.

Gambaran potensi dampak dan keterkaitan (*asosiasi*) antara parameter lingkungan dengan masyarakat yang terpajan, maka dilakukan pendekatan Analisis Dampak Kesehatan Lingkungan, yang dapat menggambarkan kondisi pengukuran pada sumber dampak, media emisi/ ambien, masyarakat yang terpapar (*biomarker*), dan dampak interaksi (*prevalensi* dan *Insidensi* penyakit, kejadian keracunan, dan kecelakaan).

Setiap usaha dan atau kegiatan pembangunan yang dilaksanakan oleh pemerintah maupun swasta pada umumnya akan memberikan dampak baik positif maupun negatif terhadap lingkungan, salah satunya adalah aspek kesehatan manusia yang berada di sekitar kegiatan, baik secara langsung maupun tidak langsung. Kegiatan yang dapat menimbulkan berbagai masalah kesehatan antara lain diakibatkan menurunnya tingkat kualitas sanitasi lingkungan, kualitas udara dan kebisingan dan berkurangnya

ketersediaan air bersih yang dapat mengakibatkan timbulnya berbagai jenis penyakit sehingga menganggu kesehatan manusia.

a) Angka Kesakitan *(Morbidity*)

Morbiditas merupakan derajat sakit yang biasanya dinyatakan dalam angka *prevalensi* atau *insidensi* yang umum. Angka kesakitan merupakan indikator penting dalam rangka penilaian dan perencanaan program untuk menurunkan kesakitan dan kematian di suatu wilayah. Angka kesakitan mencerminkan keadaan kesehatan yang sesungguhnya sebab mempunyai hubungan yang erat dengan faktor lingkungan seperti kemiskinan, kurang gizi, penyakit infeksi, perumahan, air minum yang sehat, kebersihan lingkungan dan pelayanan kesehatan.

Tabel 3.4 ditunjukkan data 10 Penyakit Tertinggi di Wilayah Kerja Puskesmas Labuan Bajo Kecamatan Komodo, Kabupaten Manggarai Barat, Provinsi Nusa Tenggara Timur. Berdasarkan Tabel 2.28, kasus tertinggi di wilayah kerja Puskesmas Labuan Bajo, Kabupaten Manggarai Barat adalah ISPA yaitu sebesar 29,83%, Observasi Febris 13%, Influenza 9,94%, dan Gastritis Akut 9,21%. Sedangkan peyakit dengan kasus terendah adalah Dyspersia 4,68%, Faringitis Akut 4,88%, Vulnus Laceratum 5,78% dan Infeksi Saluran Kemih 6,54%.

Tabel 3.4. Data 10 Penyakit/ Keluhan di Wilayah Kerja Puskesmas Labuan Bajo Kecamatan Komodo, Kabupaten Manggarai Barat, Provinsi Nusa Tenggara Timur

No	Penyakit	Jumlah	%
1	Infeksi Saluran Pernapasan Atas	4.911	29.83
2	Observasi Febris	2.141	13.00
3	Influenza	1.636	9.94
4	Gastritis Akut	1.517	9.21
5	Myalgia	1.463	8.89
6	Diare	1.195	7.26
7	Infeksi Saluran Kemih	1.077	6.54
8	Vulnus Laceratum	952	5.78
9	Faringitis Akut	803	4.88
10	Dyspepsia	770	4.68
	Total	**16465**	**100**

Sumber: BPS Manggarai Barat, 2019.

Adapun Hasil survei Keluhan kesehatan yang dirasakan masyarakat di Desa Labuan Bajo, Kecamatan Komodo yang merupakan lokasi studi disajikan pada Tabel 3.5.

Tabel 3.5. Jumlah Kasus Demam Berdarah (DBD) Per Desa di Puskesmas Labuan Bajo Tahun 2018

Desa/Kelurahan	DBD

	Jumlah Kasus	Meninggal
Labuan Bajo	58	0
Wae Kelambu	138	2
Gorontalo	61	1
Pulau Rinca	69	0
Golo Bilas	22	0
Nggorang	5	0
Watu Nggelek	1	0
Pasir Panjang	0	0
Pasir Putih	0	0
Papa Garang	1	0
komodo	7	0
Seraya	0	0
Jumlah	**362**	**3**

Sumber: BPS Manggarai Barat, 2019.

b) Angka Kematian (Mortality)

Pada Tabel 3.6 ditunjukkan bahwa di lokasi Desa Pasir Panjang jumlah kelahiran hidup sebanyak 40 jiwa dan angka kematian ibu di lokasi tersebut selama tahun 2018 sebanyak 0 jiwa. Hal ini berarti bahwa selama 1 tahun terakhir tidak terdapat kasus kematian ibu yang bersumber dari kehamilan, persalinan dan masa nifas.

Tabel 3.4. Jumlah Kematian Ibu Per Desa di Puskesmas Labuan Bajo

Desa/Kelurahan	Jumlah Lahir Hidup	Jumlah Kematian Ibu			
		Kematian Ibu Hamil	Kematian Ibu bersalin	Kematian Ibu Nifas	Jumlah Kematian Ibu
Labuan Bajo	208	0	0	1	1
Wae Kelambu	169	0	0	0	0
Gorontalo	134	0	0	0	0
Pulau Rinca	209	0	0	0	0
Golo Bilas	125	0	0	0	0
Nggorang	50	0	0	0	0
Watu Nggelek	24	1	0	0	0
Pasir Panjang	40	0	0	0	0
Pasir Putih	50	0	0	0	0
Papa Garang	30	0	0	0	0
komodo	44	0	0	0	0
Seraya	11	0	0	0	0
Jumlah	1094	1	0	1	1

Sumber: BPS Manggarai Barat, 2019.

c. Fasilitas dan Tenaga Kesehatan

Sarana dan prasarana kesehatan yang terdapat di sekitar lokasi proyek perlu dicermati terutama terkait dengan rasio jumlah sarana dan kecukupan tenaga kesehatan terhadap jumlah penduduk. Hal ini penting untuk memberikan gambaran tentang aspek pelayanan kesehatan sebagai salah satu faktor yang turut memberikan kontribusi terhadap status kesehatan masyarakat di sekitar lokasi proyek. Pada Tabel 3.7 disajikan data fasilitas kesehatan yang tersedia di wilayah kerja Puskesmas Labuan Bajo Kecamatan Komodo, Kabupaten Manggarai Barat, Provinsi Nusa Tenggara Timur.

Tabel 3.7. Fasilitas Kesehatan yang tersedia di Wilayah Kerja Puskesmas Labuan Bajo Kecamatan Komodo, Kabupaten Manggarai Barat, Provinsi Nusa Tenggara Timur

Fasilitas Kesehatan	Jumlah
Puskesmas	1
Pustu	3
Poskeses	9
Polindes	0
Posyandu	38
Total	52

Sumber: BPS Manggarai Barat, 2019.

Berdasarkan Tabel 2.39, fasilitas kesehatan yang tersedia yaitu Puskesmas 1 unit, Pustu 3 unit, Poskesdes 9 unit, Polindes tidak ada dan Posyandu Sebanyak 38 unit.

Adapun tenaga kesehatan yang tersedia di Kecamatan Komodo di sajikan pada Table 3.8.

Tabel 3.8. Fasilitas Kesehatan yang tersedia di wilayah kerja Puskesmas Labuan Bajo Kecamatan Komodo, Kabupaten Manggarai Barat, Provinsi Nusa Tenggara Timur

Tenaga Kesehatan	Jumlah
Dokter Umum	3
Dokter Spesialis	1
Dokter Gigi	1
Apoteker	1
Teknis Medis	3
Bidan	48
Perawat	72
Perawat Gigi	2
Ahli gizi	6
Ahli Sanitasi	2
Ahli Kesehatan Masyarakat	1

Farmasi	2
Tenaga Non Kesehatan	12

Sumber: BPS Manggarai Barat, 2019.

Berdasarkan Tabel 3.8, tenaga kesehatan yang tersedia di Puskesmas Labuan Bajo yaitu Dokter Umum 3 Orang, Dokter Spesialis 1 Orang, Dokter Gigi 1 orang, Apoteker 1 Orang, Teknis Medis 3 orang, Bidan 48 orang, Perawat 72 orang, Perawat Gigi 2 Orang, Ahli Gizi 6 Orang, Ahli Sanitasi 2 Orang, Ahli Kesehatan Masyarakat 1 orang, Farmasi 2 Orang, dan Tenaga Non Kesehatan 12 Orang.

Adapun untuk fasilitas Kesehatan di Desa Pasir Panjang Kecamatan Komodo dengan wilayah Pulau Rinca, wilayah tersebut masih sangat kurang fasilitas kesehatan sehingga pertolongan pertama pada kesehatan masyarakat pada lokasi tersebut masih kurang baik, dengan demikian perlu dilakukan perbaikan untuk dapat melayani kesehatan masyarakat setempat.

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Appendix 3.5. Record of Public Consultation on 21 October 2019

NOTA DINAS

Kepada Yth.	:	Direktur Pengembangan Kawasan Permukiman
Tembusan	:	1. Kasubdit Perencanaan Teknis, Direktorat PKP
		2. Kasubdit Wilayah III, Direktorat PKP
Dari	:	Kasatgas KSPN
Perihal	:	Konsultasi Publik Pelaksanaan Kegiatan Kawasan Strategis Pariwisata Nasional (KSPN) Labuan Bajo
Tanggal	:	22 Oktober 2019

I. Hasil Diskusi

Dalam Kegiatan Pembahasan Konsultasi Publik Pelaksanaan Kegiatan Kawasan Strategis Pariwisata Nasional (KSPN) Labuan Bajo, telah dibahas beberapa hal sebagai berikut:

1. Ketua CPMU menyampaikan 4 (empat) aspek pengembangan pariwisata:
   1) Kelembagaan dan perizinan
   2) Infrastruktur
   3) Pariwisata dapat menggerakkan masyarakat lokal dalam peningkatan kesejahteraan
   4) Pengembangan swasta untuk berinvestasi
2. Pak Yori per usulan kegiatan
   1) Dermaga Labuan Bajo dalam desain dinamakan "Dermaga Nusantara Tangga Bajo" tetapi dapat diubah oleh Bupati untuk menyesuaikan. Dalam kawasan dermaga terdapat kegiatan reklamasi sebenayak 6 (enam) m dari tepi pantai untuk kebutuhan pembangunan *waterfront*. Presiden menginginkan untuk diperbanyak tanaman hijau dan bunga, fasilitas dan untuk kegiatan kuliner diharapkan akan terjadi dengan sendirinya melalui perkampungan warga yang berada di sekitar tempat wisata. Sekolah pariwisata dibutuhkan untuk mendukung pembangunan sehingga masyarakat menjadi tenaga terlatih yang dapat berpartisipasi dalam kegiatan pariwisata.
   2) Potensi kapal pesiar yang datang
   3) Kegiatan yang akan dilaksanakan di Pulau Rinca adalah pembangunan kawasan dermaga, dan bangunan bangunan pusat informasi beserta fasilitasnya. Desain dermaga baru terinspirasi lidah Komodo dan stick ranger, bangunan pusat informasi didesain menyerupai badan komodo sedang tidur dan terbuat dari batu, serta desain gazebo yang seperti rumah adat wae rebo sebagai tempat penginapan ranger, tamu dan lainnya. Gerbang juga akan dibuat sesuai arsitektur manggarai, dengan dibuat nuansa agak hening dan sedikit menyeramkan. Tiang pancang dermaga akan terbuat dari beton dan plat dari kayu karena mengambil konsep premium. Penempatan Pusat informasi, tempat souvernir, coffeshop dan klinik dipusatkan dalam plaza yang nantinya akan dibangun. Bangunan-bangunan yang didesain diharapkan menjadi ikon dan menjadi hal yang mudah diingat oleh wisatawan. Akan ada juga sculpture Komodo dekat dermaga. Dermaga pulau rinca konsepnya akan dibuat senatural mungkin.
   4) Goa Batu Cermin, eksisting saat ini menggunakan lantai coneblock dan toilet yang ada sekarang terlihat kurang sesuai. Penataan akan difokuskan pada bagian depan

(plaza) dan juga jalan setapak menuju Goa Batu Cermin. Contoh di Singapura ada kebun binatang yang dibuka pada malam hari, Kawasan Goa Batu Cermin akan diberi lighting untuk menambahkan nuansa seram untuk malam hari. Menteri PUPR meminta agar tempat parkir diperluas namun tidak mengganggu aset masyarakat. Desain bangunan yang akan dibuat menggunakan arsitektur berupa kumpulan batu, dan kemudian disusun menjadi satu bangunan, ada pusat informasi tentang Goa Batu Cermin disertai dengan tampilan video, kuliner seperti kopi khas setempat.

5) Pusat cindera mata puncak Bukit Waringin, lokasi dekat bandara, mengambil arsitektur Manggarai, akan ada amphitheater dan juga tempat pelatihan tenun dan semacamnya. Saat ini sudah dibangun 10 (sepuluh) rumah tenun di Sumba dan wisatawan sangat menikmati tempat tersebut. Para pengerajin lokal harus berkembang dan inovatif, sampai kini kegiatan tersebut sudah melalui proses konsultasi publik sebanyak dua kali bersama dengan Kemenko Kemaritiman dan Kementerian Pariwisata. Flores merupakan peninggalan budaya megalitikum yang identic dengan bebatuan, ada tiga tempat yang merupakan peninggalan budaya megalitikum, yaitu Nias, Flores dan Toraja. *Viewing deck* dalam proses pengerjaan dan akan dijadikan spot selfie dengan membayar tiket ditempat souvernir.

3. Tanggapan

1) Balai Prasarana Permukiman Wilayah Nusa Tenggara Timur

Kapasitas SPAM di Pulau Rinca sebesar 2-3 L/detik, sedangkan di Goa Batu Cermin belum tersedia sistem perpipaan air minum. Kebutuhan air minum diproyeksikan mencapai 60 L/detik yang akan mengakomodir Goa Batu Cermin, Kawasan wisata dan Kawasan pelabuhan. Tim Perencana perlu menganalisa sambungan eksisting perpipaan di Kawasan Batu Cermin hingga Pantai Marina-Bukit Pramuka. Kabupaten Manggarai Barat sudah memiliki Tempat Pemrosesan Akhir (TPA) di tahun 2018 dengan kapasitas yang diproyeksikan hingga 10 (sepuluh) tahun kedepan yang belum dimanfaatkan secara maksimal dikarenakan lokasi yang cukup jauh dan kondisi jalan yang kurang baik. Terdapat Instalasi Pengolahan Lumpur Tinja (IPLT) yang berada di dekat Kawasan dermaga yang memiliki kapasitas 5000 KK. Toilet umum yang direncanakan memerlukan sistem jaringan yang memudahkan pengelolaan atau pemeliharaan.

2) Balai Wilayah Sungai Nusa Tenggara II Kupang

Pulau Rinca tidak memiliki Cekungan Air Tanah (CAT) sehingga tidak dimungkinkan dilakukan pengeboran. Jenis tanah di pulau tersebut merupakan jenis tanah poros dan kapur sehingga metode yang cocok dilakukan adalah *geo membrane*. Konsep yang saat ini digunakan oleh Balai Taman Nasional Komodo (TNK) adalah konservasi air tanah di beberapa titik. Saat ini BWS sedang mempelajari desain dermaga Pulau Rinca untuk menentukan bangunan air yang diperlukan seperti bangunan pemecah gelombang. Dalam desain promenade bersinggungan dengan bangunan pelindung air yang maish menjadi aset BWS. Oleh sebab itu, diperlukan penganjuan rekomendasi teknis kepada Direktorat Jenderal Sumber Daya Air.

3) Balai Pelaksanaan Jalan Nasional X Kupang

Di Provinsi Nusa Tenggara Timur tidak mengenal prinsip ganti rugi tanah sehingga konsep yang digagas Tim Perencana harus mengakomodir permasalahan tanah (akuisisi). Untuk Jalan Soekarno-Hatta dan jalan menuju Kawasan Batu Cermin tidak perlu dilakukan pelebaran jalan karena akan mengakibatkan dampak sosial sehingga lebar eksisting perlu dioptimalkan. Sedangkan Jalan Pede – Jayakarta

sudah memiliki lebar jalan yang cukup sehingga hanya perlu mendesain trotoar premium. Dalam desain harus memperhatikan skema jaringan utilitas (PLN dan PDAM) agar tetap melayani kebutuhan masyarakat.

4) Direktorat Rumah Swadaya, Ditjen Penyediaan Perumahan
   Direktorat Rumah Swadaya telah mengidentifikasi ± 600 unit rumah yang akan dijadikan *homestay* dengan mempertimbangkan persyaratan yang ada. Adapun kendala yang teridentifikasi antara lain kebutuhan air minum yang belum terpenuhi dan beberapa rumah yang disewakan pemiliknya kepada warga negara asing.
5) Unit Penyelenggara Pelabuhan Labuan Bajo
   UPP Labuan Bajo memiliki tugas dalam pengaturan lalu linta pelayaran untuk memastikan keamanan dan keselamatan pelayaran. Dalam perencanaan dermaga di Pulau Rinca harus menggunakan peraturan yang ada dan menganalisa metode pelaksanaan pembangunan dermaga.
6) Direktorat Kepelabuhanan, Ditjen Perhubungan Laut, Kemenhub
   PT. Pelindo telah melakukan survey dan dalam tahap penyusunan dokumen *feasibility study* di 3 (tiga) lokasi sesuai surat Gubernur NTT. Target dokumen studi dan penetapan lokasi di tahun 2019 sedangkan pembangunan baru akan dimulai tahun 2020. Penataan di dermaga Zona 3 eksisting harus menunggu selesai dibangunnya dermaga baru dan dilakukan secara bertahap.
7) Badan Otorita Pariwisata Labuan Bajo
   Masterplan Labuan Bajo yang dibuat oleh BOP akan diberikan kepada Kementerian PUPR sebagai bahan perencanaan. Harus dilakukan koordinasi lintas kementerian terkait pengelolaan kawasan dan juga daya dukung wisatawan di Pulau Rinca.
8) Balai Taman Nasional Komodo
   Kawasan Taman Nasional Komodo berada di kawasan lindung dan merupakan cagar biosfer. Semua pembangunan sarana prasarana untuk menunjang transportasi, komunikasi, kebutuhan dasar dan lain sebagainya diperbolehkan melalui mekanisme perjanjian kerja sama Kawasan strategis (PKS Strategis). Bangunan-bangunan yang akan direnovasi atau dibongkar memerlukan surat dari Kementerian PUPR. Selain itu, diperlukan scenario pengaturan pengunjunga selama konstruksi berlangsung. Arahan dari kunjungan Presiden adalah pembangunan wisata premium difokuskan di Pulau Komodo namun kunjungan wisatawan akan dibatasi dan dialihkan ke Pulau Rinca. Saat ini KLHK sedang menyusun regulasi terkait wisata premium beserta klausul maknanya. Sedangkan Balai TNK saat ini telah memiliki program anggaran berkaitan peningkatan dermaga, penambahan fasilitas prasarana dan sarana dan kebutuhan air minum dalam DIPA sehingga Kementerian PUPR perlu menetapkan fokus pembangunan yang akan dilaksanakan agar program dan anggaran di Balai TNK dapat dihapus. Direktorat PSPAM DJCK sudah pernah melakukan pembahasan PKS Bersama Pemda dan PDAM Kab. Manggarai Barat beserta Balai TNK untuk menyediakan kebutuhan air. Selain itu, Balai TNK memiliki PKS dengan PLN mengenai penggunaan genset di Pulau Rinca dan mesin diesel di Pulau Komodo. Desain yang disampaikan oleh Tim Perencanannya berpotensi mengubah perilaku Komodo menjadi lebih negatif dan membahayakan ranger beserta pengunjung sehingga desain perlu disesuaikan kembali.
9) Bupati Manggarai Barat
   Bappeda harus segera menginventarisasi aset. Dalam desain perencanaan dianjurkan untuk menambah unsur-unsur kebudayaan Manggarai Barat dan

tanaman yang dapat dikembangkan seperti Kayu Munting. Dinas terkait meninjau kembali IPAL yang menimbulkan bau tidak sedap dan mengganggu warga sekitar.

10) Pak Danial

Di Kawasan Batu Cermin terdapat aset milik Pemerintah Daerah. Akses menuju Goa Batu Cermin diharapkan tidak hanya dari 1 (satu) jalur di timur tetapi juga dari akses barat.

11) Camat Komodo

Perencanaan pengembangan KSPN perlu disosialisasikan kepada masyarakat sekitar. Pada jalur pantai sering dilakukan pembersihan sampah yang mencapai 3-4 ton sehingga desain perencanaan perlu menganalisa skenario pembuangan sampah dan akses kendaraan pengangkut sampah.

12) Lurah Labuan Bajo

Terdapat IPAL didekat permukiman warga yang mengeluarkan bau tidak sedap sehingga dalam perencanaan ruang publik perlu memperhatikan hal tersebut. Selain itu di Puncak Waringin perlu membuat akses pejalan kaki dari bawah.

13) Perwakilan Pelaku Usaha

Saran untuk pengembangan di Kawasan Goa Batu Cermin adalah taman mini, wahana bermain anak-anak, pusat souvernir dan kantin yang tidak terlalu tinggi.

14) Perwakilan Masyarakat

Tema wisata di Kawasan Batu Cermin selain goa adalah wisata alam seperti pemandangan diatas bukit untuk melihat sunset dan perkotaan serta keanekaragaman fauna seperti ayam hutan, ular, dan lain-lain. Pohon-pohon yang akan ditanam harus pohon lokal.

15) Perencanaan pengembangan KSPN juga perlu dipublikasikan kepada DPRD. Belum pernah ada kolam renang milik publik dan hal tersebut perlu diakomodir dalam desain perencanaan Kawasan Goa Batu Cermin. (Masyarakat Kawasan Goa Batu Cermin)

4. Tindak lanjut dari masing-masing usulan kegiatan adalah:
   1) Penataan Kawasan Pantai Marina-Bukit Pramuka
      a. Diajukannya rekomendasi teknis kepada Ditjen Sumber Daya Air.
      b. Penyesuaian desain Jalan Soekarno Hatta atas dan bawah dengan menggunakan ruang milik jalan eksisting serta mengakomodir permasalahan akusisi lahan dan jaringan utilitas.
      c. Desain perencanaan perlu menganalisa skenario pembuangan sampah dan akses kendaraan pengangkut sampah.
      d. Menganalisa kebutuhan akses menuju Jalan Soekarno Hatta atas dan Puncak Waringin dari Jalan Soekarno Hatta bawah untuk pejalan kaki.
   2) Pengembangan Kawasan Batu Cermin
      a. Menganalisa kebutuhan air hingga ke Goa Cermin.
      b. Penyesuaian desain jalan menggunakan ruang milik jalan eksisting dan mengakomodir jaringan utilitas.
      c. Perlu ada kajian atau *Feasibility Study* (FS) terhadap potensi wisata Batu Susun.
      d. Pengembangan difokuskan pada wisata Goa Batu Cermin, sehingga wisatawan mendapatkan tema wisata yang sesuai sebagai *geopark tourism*.
   3) Fasilitas Penunjang Wisata Pulau Rinca
      a. Perencanaan dermaga di Pulau Rinca harus menggunakan peraturan yang ada dan menganalisa metode pelaksanaan pembangunan dermaga.

b. Peningkatan kapasitas pelayanan air bersih
c. Desain dermaga yang direncanakan dapat menampung kapal wisatawan yang berjumlah banyak
d. Desain bangunan-bangunan di pulau rinca, khususnya loh buaya dibuat menyesuaikan tema wisata komodo, dan tidak mempengaruhi atau merubah perilaku komodo
e. Dalam melakukan kegiatan pengaturan lalu lintas pelayaran di pulau rinca, diperlukan desain pos jaga
f. Perlu dibuatkan Perjanjian Kerja Sama (PKS) yang mengikat berbagai pihak, didalamnya tertuang mengenai pengelolaan, aset, kewenangan, tugas masing-masing pihak dan lainnya

KASATGAS KSPN

Ir. Adjar Prayudi, MCM., MCE

Konsultasi Publik Pelaksanaan Kegiatan Kawasan Strategis Pariwisata Nasional (KSPN)
Labuan Bajo
21 Oktober 2019

Suasana konsultasi publik di Luwansa Beach Resort

Appendix 3.6. Public consultation on 28 July 2020

KEMENTERIAN PEKERJAAN UMUM DAN PERUMAHAN RAKYAT
DIREKTORAT JENDERAL CIPTA KARYA
DIREKTORAT PENGEMBANGAN KAWASAN PERMUKIMAN
Jl. Pattimura No. 20, Kebayoran Baru, Jakarta Selatan 12110. Telp. 021-7397754

Nomor : PR 0501-CK/58 Jakarta, 30 Juli 2020
Lampiran : 1 (satu) berkas
Sifat : Penting
Hal : **Hasil Konsultasi Publik Penyusunan Dokumen Lingkungan Peningkatan Kualitas Kawasan Pulau Rinca**

Yth. Bapak/Ibu
(daftar terlampir)
di-
Tempat

Sehubungan dengan konsultasi publik penyusunan dokumen lingkungan peningkatan kualitas kawasan Pulau Rinca di Loh Buaya, Desa Pasir Panjang, Kecamatan Komodo, Kabupaten Manggarai Barat, sesuai undangan Direktur Pengembangan Kawasan Permukiman (PKP) Nomor UM.01.02-Ck/145 dilaksanakan pada hari Selasa, 28 Juli 2020 melalui *video conference*, bersama ini kami sampaikan beberapa hal sebagai berikut:

1. Pembahasan dibuka oleh Direktur PKP dan dihadiri oleh perwakilan dari Kementerian Koordinator Bidang Kemaritiman dan Investasi, Kementerian Lingkungan Hidup dan Kehutanan, Kementerian Pendidikan dan Kebudayaan, Kementerian Pariwisata dan Ekonomi Kreatif, Kementerian Pekerjaan Umum dan Perumahan Rakyat, Pemerintah Daerah dan Tokoh Masyarakat.

2. Pokok bahasan dalam pembahasan adalah sebagai berikut:
   a. Arahan dari Ketua Harian Komisi Nasional Indonesia untuk UNESCO (KNIU) dan Direktur Kawasan Konservasi;
   b. Pemaparan desain peningkatan kualitas sarana dan prasarana wisata alam di Kawasan Loh Buaya, Pulau Rinca oleh Tim Perencana KSPN Labuan Bajo;
   c. Progres penyusunan dokumen lingkungan oleh Kepala Balai Prasarana Permukiman Wilayah Nusa Tenggara Timur;
   d. Pemaparan muatan dokumen lingkungan oleh Tim Penyusun Dokumen Lingkungan; dan
   e. Diskusi masukan dari *stakeholder* terkait dokumen lingkungan Peningkatan Kualitas Kawasan Pulau Rinca KSPN Labuan Bajo.

3. Secara umum hasil pembahasan adalah sebagai berikut:
   a. Penyusunan dokumen lingkungan berdasarkan Permen LH Nomor 16 Tahun 2012 tentang Pedoman Penyusunan Dokumen Lingkungan Hidup.
   b. Muatan dalam dokumen lingkungan harus memperhatikan dampak pembangunan terhadap habitat dan perilaku komodo.
   c. *Outstanding Universal Value* (OUV) yang merupakan fokus dari dokumen *Environment Impact Assessment* (EIA), perlu dimasukan dalam kajian dokumen lingkungan.
   d. Kegiatan peningkatan kualitas sarana dan prasarana wisata alam di Kawasan Loh Buaya, Pulau Rinca berada dalam Zona Pemanfaatan.

4. Tindak lanjut yang akan dilakukan antara lain:
   a. Penajaman dokumen lingkungan dan dokumen EIA dengan melibatkan ahli kehutanan dan konservasi serta masyarakat.
   b. Dokumen lingkungan dan dokumen EIA diharapkan dapat selesai pada pertengahan bulan Agustus 2020.

Demikian kami sampaikan, atas perhatian dan kerjasamanya diucapkan terima kasih.

Direktur
Pengembangan Kawasan Permukiman

Ir. Didiet Arief Akhdiat, M.Sc
NIP. 196111021990031001

Tembusan Yth:
1. Direktur Jenderal Cipta Karya, Kementerian Pekerjaan Umum dan Perumahan Rakyat (sebagai laporan);
2. Direktur Jenderal Konservasi Sumber Daya Alam dan Ekosistem, Kementerian Lingkungan Hidup dan Kehutanan;
3. Direktur Jenderal Kebudayaan, Kementerian Pendidikan dan Kebudayaan; dan
4. Direktur Jenderal Sumber Daya Air, Kementerian Pekerjaan Umum dan Perumahan Rakyat.

Lampiran Surat No. : PR 0301-CK/08
Tanggal : 30 Juli 2020
Hal : **Hasil Konsultasi Publik Penyusunan Dokumen Lingkungan Peningkatan Kualitas Kawasan Pulau Rinca**

Kepada Yth :

Kementerian Koordinator Bidang Kemaritiman dan Investasi

1. Asisten Deputi Infrastruktur Dasar, Perkotaan, dan Sumber Daya Air, Bidang Koordinasi Infrasruktur dan Transportasi
2. Asisten Deputi Planologi Kehutanan dan Tata Lingkungan, Bidang Koordinasi Pengelolaan Lingkungan dan Kehutanan
3. Asisten Deputi Pengelolaan Daerah Aliran Sungai dan Konservasi Sumber Daya Alam, Bidang Koordinasi Pengelolaan Lingkungan dan Kehutanan
4. Asisten Deputi Pengembangan Pariwisata Berkelanjutan, Bidang Koordinasi Pariwisata dan Ekonomi Kreatif

Kementerian Lingkungan Hidup dan Kehutanan

5. Direktur Kawasan Konservasi, Ditjen Konservasi Sumber Daya Alam dan Ekositem
6. Direktur Pemanfaatan Jasa Lingkungan Hutan Konservasi, Ditjen Konservasi Sumber Daya Alam dan Ekositem
7. Direktur Pemolaan dan Informasi Konservasi Alam, Ditjen Konservasi Sumber Daya Alam dan Ekositem
8. Direktur Pencegahan Dampak Lingkungan Usaha dan Kegiatan, Ditjen Planologi Kehutanan dan Tata Lingkungan
9. Kepala Balai Taman Nasional Komodo

Kementerian Pendidikan dan Kebudayaan

10. Duta Besar/Wakil Delegasi Tetap RI untuk UNESCO, Prof. Dr. Surya Rosa Putra
11. Direktur Pelindungan Kebudayaan, Ditjen Kebudayaan
12. Direktur Pengembangan dan Pemanfaatan Kebudayaan, Ditjen Kebudayaan
13. Ketua Harian Komisi Nasional Indonesia untuk UNESCO (KNIU)

Kementerian Pariwisata dan Ekonomi Kreatif/Badan Pariwisata dan Ekonomi Kreatif

14. Direktur Kelembagaan, Bidang Sumber Daya dan Kelembagaan
15. Direktur Infrastruktur Ekonomi Kreatif, Bidang Pengembangan Destinasi dan Infrastruktur
16. Direktur Pengembangan Destinasi Regional II, Bidang Pengembangan Destinasi dan Infrastruktur
17. Direktur Utama Badan Otoritas Pariwisata Labuan Bajo Flores

Kementerian Pekerjaan Umum dan Perumahan Rakyat

18. Direktur Sungai dan Pantai, Ditjen Sumber Daya Air
19. Direktur Air Tanah dan Air Baku, Ditjen Sumber Daya Air
20. Direktur Air Minum, Ditjen Cipta Karya
21. Kepala Balai Wilayah Sungai Nusa Tenggara II
22. Kepala Balai Prasarana Permukiman Wilayah Nusa Tenggara Timur
23. Tim Perencanaan Peningkatan Kualitas Kawasan Pulau Rinca
24. Tim Penyusun Dokumen Lingkungan Peningkatan Kualitas Kawasan Pulau Rinca

Pemerintah Daerah dan Tokoh Masyarakat

25. Kepala Dinas Lingkungan Hidup dan Kehutanan Provinsi NTT
26. Sekretaris Daerah Kabupaten Manggarai Barat
27. Kepala Dinas Pariwisata Kabupaten Manggarai Barat
28. Kepala Dinas Lingkungan Hidup dan Kehutanan Kabupaten Manggarai Barat
29. Kepala Kantor Pelayanan Kekayaan Negara dan Lelang Kupang
30. Pater Marsel Agot
31. Romo Vikep
32. Forum Kerukunan Antar Umat Beragama (FKUB) Kabupaten Manggarai Barat
33. Majelis Ulama Indonesia (MUI) Kabupaten Manggarai Barat
34. Marsianus Syukur
35. Yohanes B. Bos
36. Ahmad Arifiandy (Komodo Survival Program)
37. Ferri Adu (Kader Konservasi TN Komodo)

SARAN/TANGGAPAN KEGIATAN KONSULTASI PUBLIK
PENYUSUNAN DOKUMEN LINGKUNGAN PENINGKATAN KAWASAN PULAU RINCA
KECAMATAN KOMODO KABUPATEN MANGGARAI BARAT
PROVINSI NUSA TENGGARA TIMUR
VIA VIDEO CONVERENCE
HARI/TANGGAL: SELASA, 28 JULI 2020

No.	Saran/Tanggapan
Dinas Lingkungan Hidup Prov. NTT	
1.	Apakah kualitas lingkungan yg mau dikaji utk geogisik kimia yakni kualitas udara, air laut, kebisingan, penyediaan air bersih sdh ada atau blum?
2.	Aspek biologi tentang mangrove, biota perairan dan komodo sbg ekosistem esensial sy harap sdh ada datanya
3.	Aspek sosekbud wilayah pulau rinca umumnya dan loh buaya khususnya
4.	Kesehatan masyarakat di loh buaya dan sekitarnya.
Lukito Awang-Kepala Balai Taman Nasional Komodo	
1.	Kata Pengantar: bahwa Loh Buaya Pulau Rinca sebagai bagian dari kawasan TN Komodo. Secara administratif terletak di desa pasir panjang, pulau Rinca.
2.	kata pengantar dan hal 2.: jumlah komodo 3.020 +- 425 ekor (BTNK, 2019)..... (bukan 5 ribuan)
3.	hal 3. Luas kawasan 173.300 ha ....(bukan 200rb)
4.	hal 3: unggas scrub berkaki oranye = burung gosong kaki-merah (sepertinya banyak kalimat terjemahan dari dokumen lama berbahasa Inggris. Bahasa-nya bahasa Inggris terjemahan).
5.	Hal 5. Direktorat KSDAE, KLHK bukan PHKA lagi
6.	hal 5. Luasan Kawasan yang ditulis luasan cagar biosfer bukan TNK.
7.	perlu ditambahkan dasar adanya penataan kawasan wisata di pulau rinca. Mengapa loh Buaya dan mengapa harus ditata.
8.	hal 9: kawasan ini dikelola oleh Balai TN Komodo bukan oleh Pemda dibawah dinas pariwisata dan kebudayaan.
9.	Balai TN Komodo adalah Unit Pelaksana Teknis (UPT) yang bertanggung jawab langsung ke Direktorat Jenderal KSDAE, KLHK.
10.	hal 12: apakah akan ada penggalian air tanah atau sesuai rencana yang didiskusikan untuk mendapatkan air dari labuan Bajo.
11.	hal. 12: bagaimana dengan alur masuk wisatawan? Apakah di dermaga sementara juga?
12.	Tabel: pendekatan yang dilakukan dalam mengatasi dampak lebih pada pencegahan. Belum ada uraian tindakan pengendalian dan pemulihan jika

No.	Saran/Tanggapan
	dampak terjadi terutama terkait dampak pada kualitas air, biota laut dan gangguan pada satwa darat.
13.	pada bagian mana ada penerapan 8 prinsip kajian lingkungan sesuai standar IUCN. yang kita sebut EIA
Koen Meyer	
1.	Banyak kelemahan. 1) ini bukan renovasi tapi pembangunan. Harus ada penjelasan antara pembangunan yng ada saat ini dan yang mau di bangun, termasuk luas areal, bahan pembangunan, dll. 2) tidak jelas dari dokumen apa OUV di tempat yng mau di bangun (scoping) dan apa dampak terhadap OUV, termasuk cumulative impact, 3) tidak ada referensi ke IUCN WH advice note dan bagaimana UKL-UPL mengikuti langkah 2 di advice note, termasuk identifikasi alternatif.
2.	Dan harus juga ekplorasi juga precautionary approach dan opsi zero intervensi.
3.	Dan juga tidak ada analyse dampak perubahan jumlah wisatawan dan limits of acceptable change.
4.	Saya bisa melakukan assessment lebih terinci terhadap dokumen kalau mau.
5.	Malam bapak/ibu, diatas adalah bbrp catatan dari pa koen meyer terkait dokumen UKL/UPL. Berkenaan dgn hal tsb mohon kiranya penyusunan dokumen melibatkan ahli konservasi yg di rekomendasi pa awang yaitu pa haryanto dan pa dones juga pa koen (ahli wardun). Pa awang dan pa Dody bisa koordinasi lebih lanjut agar sesuai harapan semua pihak
6.	Saya sdh mencoba menghub pak Doddy BPPW. Agar tim UKL UPL juga melibatkan pakar konservasi dari IPB.... Belum ada respon. Karena kalo saya baca draft UKL UPL nya..pembobotan lebih ke dampak manusia. Tidak kepada ekosistem kawasan konservasi warisan dunia.
7.	Dari awal saya sdh kasih nomor hape beliau2 agar dimasukkan dalam tim.... Agar kajian lingkungannya lebih mengarah kepada kelola kawasan konservasi/ warisan dunia.
8.	Pak Dody.. mohon di akomodir. Dari awal sdh saya sampaikan jg mohon libatkan Tim Konservasi yaitu Pak Haryanto Putro dan Pak Dones dari IPB Bogor.
9.	Kemarin sewaktu baca draft-nya. Banyak yg kontrol kopi terjemahan dari google. Data bnyak yg gak pas. Tidak up-to-date, padahal sudah kami kirimkan data2 dari TNKomodo yg baru....

Appendix 3.7. Record of Public Consultation on 1 September 2020

KEMENTERIAN PEKERJAAN UMUM DAN PERUMAHAN RAKYAT
DIREKTORAT JENDERAL CIPTA KARYA
BALAI PRASAANAPERMUKIMAN WILAYAH NUSA TENGGARA TIMUR
SATUAN KERJA PELAKSANAAN PRASARANA PERMUKIMAN WILAYAH III NUSA TENGGARA TIMUR
Jalan Polisi Militer No. 1 Kupang - NTT, Telp./Fax. (0380) 8431826, email: bppw_ntt@pu.go.id

Nomor : UM.01.02/PPPW.III-NTT/05/2020 Labuan Bajo, 28 Agustus 2020
Lampiran : 1 (Satu) Lembar
Perihal : Undangan Kegiatan Sosialisasi Pekerjaan Penataan KSPN Fasilitas Penunjang Wisata Pulau Rinca Kabupaten Mangarai Barat Tahun Anggaran 2020-2021

Kepada Yth,
(*Daftar Undangan Terlampir*)
di -
Tempat.

Sehubungan dengan pelaksanaan pekerjaaan Penataan KSPN Fasilitas Penunjang Wisata Pulau Rinca Kabupaten Mangarai Barat Tahun Anggaran 2020-2021. Maka dengan hormat kami mengundang Bapak/Ibu/Saudara/i, untuk mengikuti Kegiatan Sosialisasi, yang akan diadakan pada :

Hari : Selasa
Tanggal : 01 September 2020
Jam : 09.00 - 13.00 WITA
Tempat : Kantor Desa Pasir Panjang, Pulau Rinca – Kec. Komodo Kabupaten Manggarai Barat

Demikian, kami sampaikan atas perhatian Bapak/Ibu/Saudara/i kami ucapkan terima kasih.

Kepala Satuan Kerja
Pelaksanaan Prasarana Permukiman Wilayah III
Provinsi NTT

Denny Surya Martha, ST, M.Sc
NIP. 19820410 200912 1 002

Lampiran Undangan
Nomor : UM.01.02/PPPW.III-NTT/05/2020
Tanggal : 28 Agustus 2020

Disampaikan Kepada Yth.

Pemerintah Provinsi Nusa Tenggara Timur :

1. Kepala Bappeda Prov. NTT di Kupang
2. Kepala Dinas PUPR Prov. NTT di Kupang
3. Kepala Dinas Lingkungan Hidup Prov. NTT di Kupang

Pemda Kabupaten Manggarai Barat :

1. Bupati Kabupaten Manggarai Barat di Labuan Bajo
2. Kepala BP4D Kabupaten Manggarai Barat di Labuan Bajo
3. Kepala Dinas PUPR Kabupaten Manggarai Barat di Labuan Bajo
4. Kepala Dinas Lingkungan Hidup dan Pertamanan Kabupaten Manggarai Barat di Labuan Bajo
5. Kepala Dinas Pariwisata Kabupaten Manggarai Barat di Labuan Bajo
6. Kepala Dinas Perhubungan Kabupaten Manggarai Barat di Labuan Bajo
7. Kepala Kepolisian Resor (Polres) Kabupaten Manggarai Barat di Labuan Bajo
8. Komandan Kodim 1612 di Kabupaten Manggarai
9. Kepala Kejaksaan Negeri Kabupaten Manggarai Barat di Labuan Bajo
10. Direktur PDAM Kabupaten Manggarai Barat di Labuan Bajo
11. Kepala Kantor Syahbandar Labuan Bajo di Kabupaten Manggarai Barat
12. Camat Komodo di Labuan Bajo
13. Kepala Desa Pasir Panjang Pulau Rinca Kec. Komodo di Kabupaten Manggarai Barat
14. Perwakilan Tokoh Masyarakat dan Tokoh Adat Labuan Bajo di Kabupaten Manggarai Barat
15. Perwakilan Tokoh Pemerhati Lingkungan Labuan Bajo di Kabupaten Manggarai Barat

Instansi Pusat :

1. Kepala Balai Wilayah Sungai Nusa Tenggara II Provinsi NTT di Kupang
2. Kepala Balai Taman Nasional Komodo Kabupaten Manggarai Barat di Labuan Bajo
3. Kepala Balai Prasarana Pemukiman dan Wilayah Provinsi NTT di Kupang
4. Direktur Badan Otorita Pariwisata Labuan Bajo di Kabupaten Manggarai Barat

DAFTAR HADIR

Hari / Tanggal : Selasa 1 September 2020.
Waktu : 09.00
Tempat : Kantor Sanggar Budaya.
Agenda : SOSIALISASI PENGANGGARAN DI LOH BUAYA.

No	Nama	Jabatan	Paraf
1	H. MUCHTAR	Kepala Desa	
2	Laurensius L. Tanamdi	Staf Supan II	
3	Apriano Kalaba	Staf BWS NT II	
4	Yulius Tanof	Staf PJSA NT. II	
5	Fiermus Pjalli Kapa	Staf PJSA NT. II	
6	Dik Bodeg	BMKanado	
7	Ibrahim Hamsd	Sekdes	
8	I. Gusti. putu suara	Bintamtibmas	
9	Abdul Yusuf	Dishub	
10	Zainudin	staf BTNK	
11	Richard T. Santoni	Kabid PISPA BPAD	
12	SAMAILA.	Kades Golo Mori	
13	CHRIS MESIMA	Sekretaris (DISPARBUD)	
14	Alfonsus Gunandr	Kabid Pariwisata	
15	Egilia Azun	staf teknik pentunjuk kue mbeliling	
16	Edelbertus L. Hardi	Kabag Teknik Perumda Wae Mbeliling	
17	Made Pri Mardika	Bahasa Pasir Panjang	
18	Stephanus Herson · KAM. Tanggar		
19	Vidia wati	P.J. Puskesmas P. Panjang	
20	Thomas A. Sukiman	DPMKPP	
21	Maria C.A Wandur	DPMKPP	
22	R.R Handilani	PT. Karya Pembangunan Nusa PT. Jelajah kuro	
23	Agus Budi Santoso	PT. KAIC ECO PT. KAO	
24	Chairullah	PPK PKP	
25	Hasrel Agot	Toma	
26	Hosianus C. Fedy Adu	Staf konservasi	
27	Syamsumarlin	PPK SUPAN II	
28	Felix Melsia	Pelaksana Supan II	
29	WABEP EL H	Staf PKP	
30	Yosafat CW	Staf air minum	
31	Faisal Rizaldy	Staf DKP	
32	Fidelis Elvis Hemal	Kantor Camat Komodo	

No	Nama	Jabatan	Paraf
33	Yohanes R. Campus	Sekcam Komodo	
34	HASYUN	POL. PP	
35	Engelbertus Vane	BOPLBF	
37	Elizabeth	BOPLBF	
38	Arguli AR	MK KSPN RINCA	
39	Geny Mitsus	Sekwan PM - MB.	
40	ADJIE WIBIKOHO	CV. SARONDE	
41	HERN.	PT. Syarif	
42	AUDIK. S.	PT. Selomari	
43	Hardi	CV. Archiologic	
44	Herp Purwanto	MK. KSPN P. RINCA	
45	Alfred Lokas	Fraktur P/Ka/Jefung TP. Mari	
46	Dominy Surya Manthe	Kasdim PPPW III / NTT-Flores	
47	I Nyoman Sukada	Danramil Komodo	
48	SUKANDA	Waka Polres	
49	Wilhelmus Anwang	Ka. Balai TNK.	
50	Ar	BPAD	
51	Muk. Ujan	BTNK	
52	Ar Fandi	BTNK	
53	Jimbanus R. Ngunu.	BTNK	
54			

NOTULENSI

ACARA: Sosialisasi Penataan Kawasan Pulau Rinca

HARI/ TANGGAL	LOKASI	MODERATOR
Selasa, 01 September 2020	Balai Desa Pasir Panjang	Perangkat Desa Pasir Panjang

NARASUMBER

1. Kepala Balai Taman Nasional Komodo
2. Kepala Satuan Kerja PPPW III NTT, Kementerian PUPR
3. Kepala Satuan Kerja PJSA Nusa Tenggara II, Kementerian PUPR
4. Kepala Syahbandar Labuan Bajo/ Kepala Kantor UPP Kelas II Labuan Bajo
5. Wakapolres Manggarai Barat

DAFTAR HADIR INSTANSI

1. Bappeda Kab Manggarai Barat
2. Dinas PUPR Kab Manggarai Barat
3. Dinas LH Kab Manggarai Barat
4. Pemda Kab Manggarai Barat
5. BOP Labuan Bajo Flores
6. Dinas Pariwisata Kab Manggarai Barat
7. Dinas Perhubungan Kab Manggarai Barat
8. Kodim 1612
9. PDAM Kab Manggarai Barat
10. Kecamatan Komodo
11. Masyarakat Desa Pasir Panjang

NOTULENSI RAPAT

Paparan

1. Dibuka oleh H. Muchtar - Kepala Desa Pasir Panjang

- Masyarakat Desa Pasir Panjang mendukung sepenuhnya pembunganan sarana prasana wisata Loh Buaya Pulau Rinca
- Pembangunan berada di kawasan Loh Buaya

Kepala Balai Taman Nasional Komodo

- Pembangunan berada di Loh Buaya pembangunan sarana dan prasarana pariwisata
- Bangunan bangunan yang sebelumnya terpisah pisah, akan diintegrasikan menjadi satu bangunan
- Suhu tanah pada bulan november sampai februari tinggi. pada masa itu merupakan masa penetasan telur komodo
- taman nasional komdo diharapkan untuk dijaga bersama

Pak Alfred Kasatker NVT Pelaksana Jaringan Sumber Air Nusa Tenggara II

- Ada 2 kegiatan dari Sumber Daya Air dan Cipta Karya
- Diharapkan juga ada kontrol dari pemerhati lingkungan
- Paket pekerjaan dermaga sudah dilakukan kontrak dan dijadwalkan untuk bekerja sejak tangal 9 Juli
- Pekerjaan dilakukan dengan meperhatikan protokol kesehatan Covid-19. para pekerja di

karantina terlebih dahulu

- Pembangunan hanya dilakukan di lokasi pemanfaatan wisata
- Pembangunan mematuhi rambu rambu yang telah ditetapkan agar tetap menjaga lingkungan
- Bahan bahan menggunakan yang ramah lingkungan dan pembiayaan perbaikan lingkungan pasca kontruksi
- Pekerjaan dijadwalkan 300 hari kalender
- Pekerjaan meliputi peningkatan kualitas dermaga, dan pengaman jalur masuk pelabuhan dari abrasi pantai, jalan akan ditinggikan agar komodo tetap bisa lalu lalang dan pengunjung tetap bisa aman dan nyaman

Pak Marlin PPK BWS

- Pembangunan sarana dan prasarana pengaman pantai
- Pembangunan akan mendatangkan segi positif untuk masyarakat sekitar
- Pembangunan dermaga dan elevated deck sampai ke patung komodo.
- Pembanguan dermaga akan meningkatkan kapasitas kapal yang bisa berlabuh
- Elevated deck akan membuat komodo dapat bebas lalu lalang dan pengunjung juga aman dan nyaman
- Pembangunan setelah selesaik akan diserahkan ke Taman Nasional Komodo
- Pembangunan hanya meningkatkan sarana yang ada

Pak Denny Kasatker Wilayah III BPPW NTT

- Sosialisasi dilakukan agar masarakat di Pulau Rinca paham paham yang akan dibangun, fungsinya apa dan untuk siapa
- CIpta Karya akan membangun dengan peningkatan fasilitas yang sudah ada
- Tidak ada pembangunan hotel dan tempat penginapan komersil seperti isu yang beredar
- Pembangunan sudah memperhatikan dengan hati hati agar tidak merusak lingkungan dan mata pencaharian

Pak Heru, PPK PKP satker Wil III BPPW NTT

- Akan dibangun pusat informasi, pengianapan ranger, peneliti dan pemandu wisata, pos jaga ranger,
- Pemabgnunan untuk menunjang kawasan konservasi dan wisata
- Bangunan dibangun di tempat yang sudah ada, tidak membangun di tempat baru
- Bangunan informasi bertujuan untuk menggabungkan bangunan yang terpisah pisah menjadi terintegrasi menjadi satu bagian
- Jalan jermbah dibuat dengan ditinggikan agar komodo bisa lalu lalang dan pengunjung tetap bisa lalu lalang di atasnya
- Penginapan untuk pemandu wisata, ranger dan peneliti
- Ada tahapan Pra kontruksi berupa sosialisasi dan setelah itu dilakukan pengukuran awal
- Pembangunan direncanakan 10 bulan, dan ada masa pemeliharaan selama 6 bulan dan setelah itu akan diserahkan ke Taman Nasional Komodo

Pak Ferly PPK Air Minum Satker Wil III BPPW NTT

- Pekerjaan pembangunan Reservoir 50 m3 dan jaringan perpipaan sepanjang 550 m
- Pembangunan jaringan air akan melayani bangunan penginapan dan bangun pusat informasi

NOTULENSI RAPAT

Kepala Syahbandar

- Presiden mempunyai perhatian besar kepada Labuan Bajo. Hanya Labuan Bajo yang dimasukkan ke dalam Kawasan pariwisata super premium
- Sektor Sumber Daya Air diharapkan berkordinasi dengan kementerian perhubungan. harus ada ijin pembangunan dan ijin operasi. pembangunan di Pulau Rinca harus kordianasi dengan perhubungan karena merupakan kewenangan kementerian perhubungan
- Pembangunan dermaga pulau rinca sebagai feeder untuk pelabuhan waterfront zona 3 yang merupakan pelabuhan pariwisata terbesar di asia tenggara
- Diharapkan ada penginapan untuk petugas dari syahbandar, karena dulu sudah diusulkan
- Manfaat pembangunan ini nantinya untuk masyarakat sekitar

Diskusi

1. Pak Edi - Tokoh Pemuda Desa

- Dampak pembangunan kawasan premium di labuan Bajo belum dirasakan oleh masyarakat Pulau Rinca. masyarakat di Pulau Rinca ingin merasakan dampak dari pengembangan pariwisata.
- Masyarakat dari Desa Rinca menginginkan adanya pembangunan untuk desa Wisata Pulau Rinca karena di desa rinca juga tidak kalah menarik, perlu dibangun :
    - Pusat Informasi
    - Sumber Air Bersih
    - TPA
    - Art Shop
    - Wisata Kuliner
    - pengaman di belakang kampung rinca
    - Promosi desa Rinca

Pak Asgar - Masyarakat Desa

- Masyarakat juga ikut mejaga kelestarian Komodo
- Sumber Daya Manusia dan Sumber Daya Alam masyarakt desa rinca perlu diperhatikan, karena ditakutkan masyarakat desa rinca tidak akan bisa bersaing dengan masyarakat lain agar bisa merasakan pariwiisata premium nantinya.
- Setelah pembangunan seperti apakah nantinya peraturan yang akan diberlakukan dipulau rinca? apakah masyarakat lokal tetap bisa melaut dengan bebas
- Perlu dipertimbangkan partisipasi SDM masyarakat dalam pembangunan di pulau Rinca

Pak Ramli - Masyarakat Desa

- Tidak ada efek negatif yang akan ditimbulkan dari pembangunan, tetapi pembangunan itu akan menjadi penentu keberlangsungan kehidupan masyarakat di Pulau Rinca
- Diperkirakan dengan adanya pusat informasi, pekerjaan pemandu wisata akan hilang karena tidak perlu didampingi lagi oleh masyarakat lokal. karena keadaaan eksisting masih natural

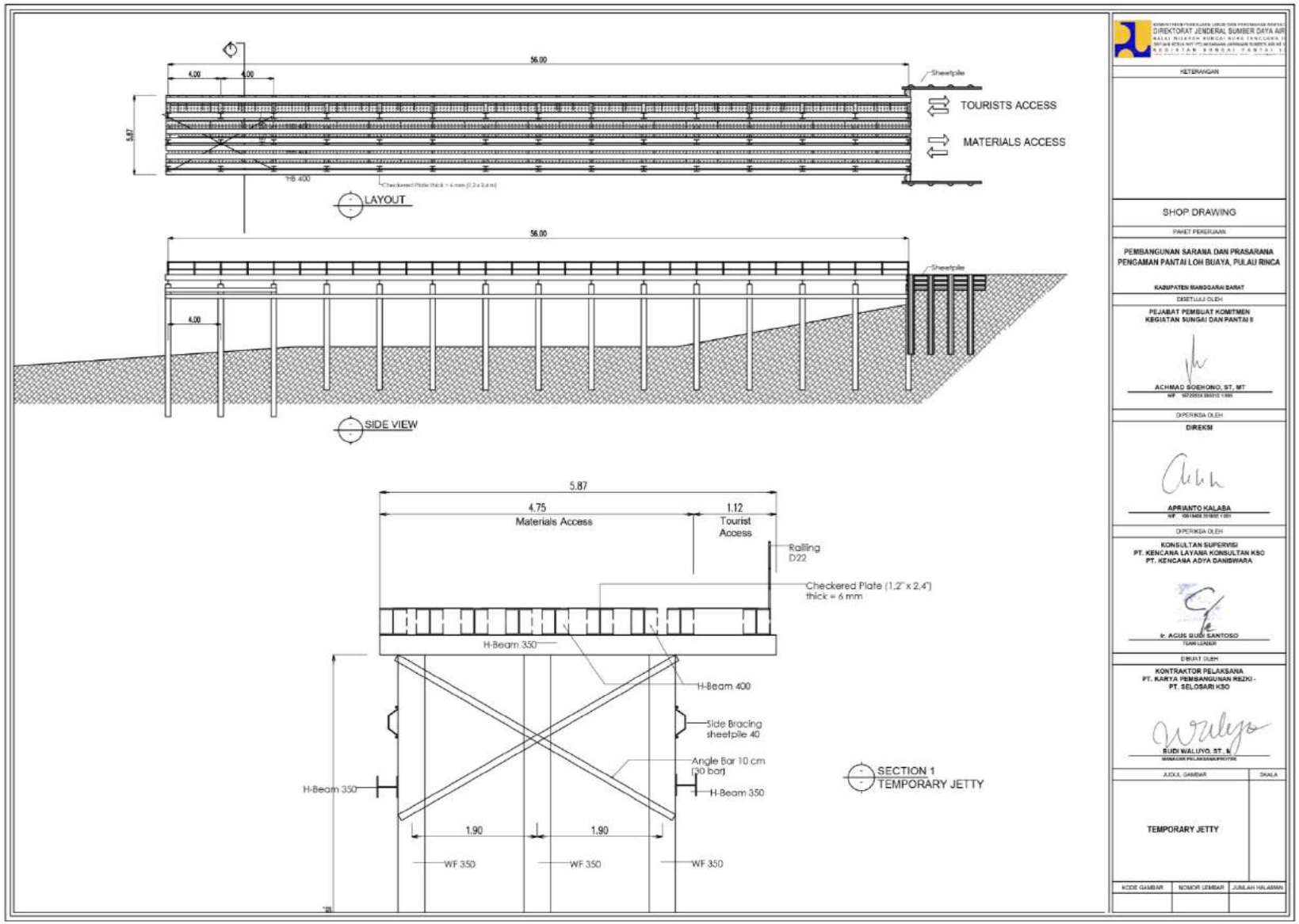
Pak Mustafa - Masyarakat Desa

- Masyarakat tidak keberatan dengan pembangunan di Loh Buaya, harapannya masyarakat di desa pasir panjang juga menjadi premium.
- Pekerjaan harus melibatkan masyarakat lokal. jangka pendek saat pembangunan dan jangka

NOTULENSI RAPAT	
	panjang untuk bekerja di TNK • Jika ada kualifikasi pendidikan untuk pekerja, maka masyarakat desa akan tidak bisa masuk • Kebanyakan masyarakat putus sekolah karena tidak ada biaya, tetapi pulau rinca mauk kawasan premium. dihapkan ada kerjasama dengan kampus kampus agar masyarakat rinca bisa melanjutkan pendidikan • Kawasan wisata di sekitar desa diharapkan juga dikembangkan agar berdampak langsung ke masyarakat desa. diharapkan adanya pembangunan jalur trekking • Pertemuan G20 membuat kawasan ekonomi khusus yang rumornya ada di desa golomory, daerah pengembanganya sampai ke daerah Taman Nasional Komodo di pulau Moang dan Pulau bero yang merupakan zona inti (rimba). Pak Safrudin - Masyarakat Desa • Jangan hanya pariwisata yang diperhatikan, tetapi masyarakatnya juga • Direncanakan ada pengmbangan 2 (dua) unit usaha untuk BUMDES yang butuh modal Pak Ahmad - Masyarakat Desa • Dana untuk pembangunan sudah besar, masyarakat meminta sebagian untuk pembangunan pagar kampung dan suplai air bersih • Pagar yang rusak mengaikibatkan komodo bisa masuk ke kampung • Masyarakat di desa kesulitan air tetapi di loh buaya dibuatkan penampungan air bersih
2.	Kepala Balai TNK • Jangan termakan isu, eksistensi TNK sudah menjadi tanggung jawab balai TNK • Untuk Pengembangan desa, sudah ada dana desa, pagar sudah dibuatkan dan sudah diserahterimakan • Jika masyarakat kompak dan desa menjadi maju wisatawan akan datang dengan sendirinya • Jalur trekking diperbolehkan, jika bisa dari loh buaya bisa tembsu ke pasir panjang • BUMDES akan dibicarakan di tingkat daerah Kasatker BWS • Masyarakat tetap bisa melaut dan tidak akan terganggu • Tenaga kerja lokal akan diakomodir sesuai dengan kehaliannya Pak Denny kasatker Wil II NTT • Terima kasih akan dukungannya terhadap pembangunan ini, dan kepercayaan masyarakat akan dijaga • Pengembangan desa pasir panjang diluar Tupoksi Kementerian PUPR. • Masyarakat harus bisa memahami peluang • Pemintaan alokasi dana untuk desa tidak bisa karena ada undang undang yang mengatur dan ada pertanggungjawabannya • Pemerintah pusat sudah membentuk BOP labuan Bajo. BOP merupakan peluang untuk menyampaikan rancangangan dan rencana untuk kepentingan desa. jadi melalui BOP Labuan Bajo bisa disalurkan asipirasinya agar bisa disampaikan di pusat. ada alurnya. ○ harapan masyarakat bisa didengar oleh yang memiliki kewenanganya • Masyarakat dan pemda harus bisa menangkap peluang peluang yang ada • Aspirasi harus disampaikan ke pihak yang tepat Bappeda • Bisa melalui kepala desa untuk membuat proposal yang ditujukan ke bupati dan dprd • Desa wisata sudah dipikrkan di tingkat kabupaten dan sudah disampaikan ke dinas terkait • Ada konsep wisata 3A. atraksi, aksesibilitas, dan akomodasi. jika belum ada kunjungan di

NOTULENSI RAPAT	
	lokasi ini berarti belum adanya kekompakan dari masyarakat terkait pariwisata. bisa dibicarakan dengan pemda • Terkait pagar, desa mempunyai otonomi dan sudah diberi penganggaran. Wakapolres • Polri dan TNI mendukung • Pemanaatan tenaga lokal perlu menjadi catatan • Masyarakat bisa mempelajari keahlian tenaga ahli yang didatangkan • Masyarakat harus bisa mendukung, seperti menjaga kebersihan dan budaya lokal, agar wisatawan bisa tertarik. Pak Feri - Aktivis • Masyarkat harus cerdas dengan bisa membuat proposal yang tepat penyampaiannya ke dinas yang tepat
KESIMPULAN	
• Pihak Kementerian PUPR akan mengakomodir tenaga kerja lokal dalam proses kontruksi sesuai dengan keahliannya • Pengembangan Desa Wisata akan difasilitasi oleh BOP Labuan Bajo Flores dan Pemda Kab. Manggarai Barat	

Appendix 3.8. The design of the temporary jetty



Appendix 3.9. The types and quantities of equipment's and materials needed during the project infrastructure construction of Rinca Island

a) List of Equipment's

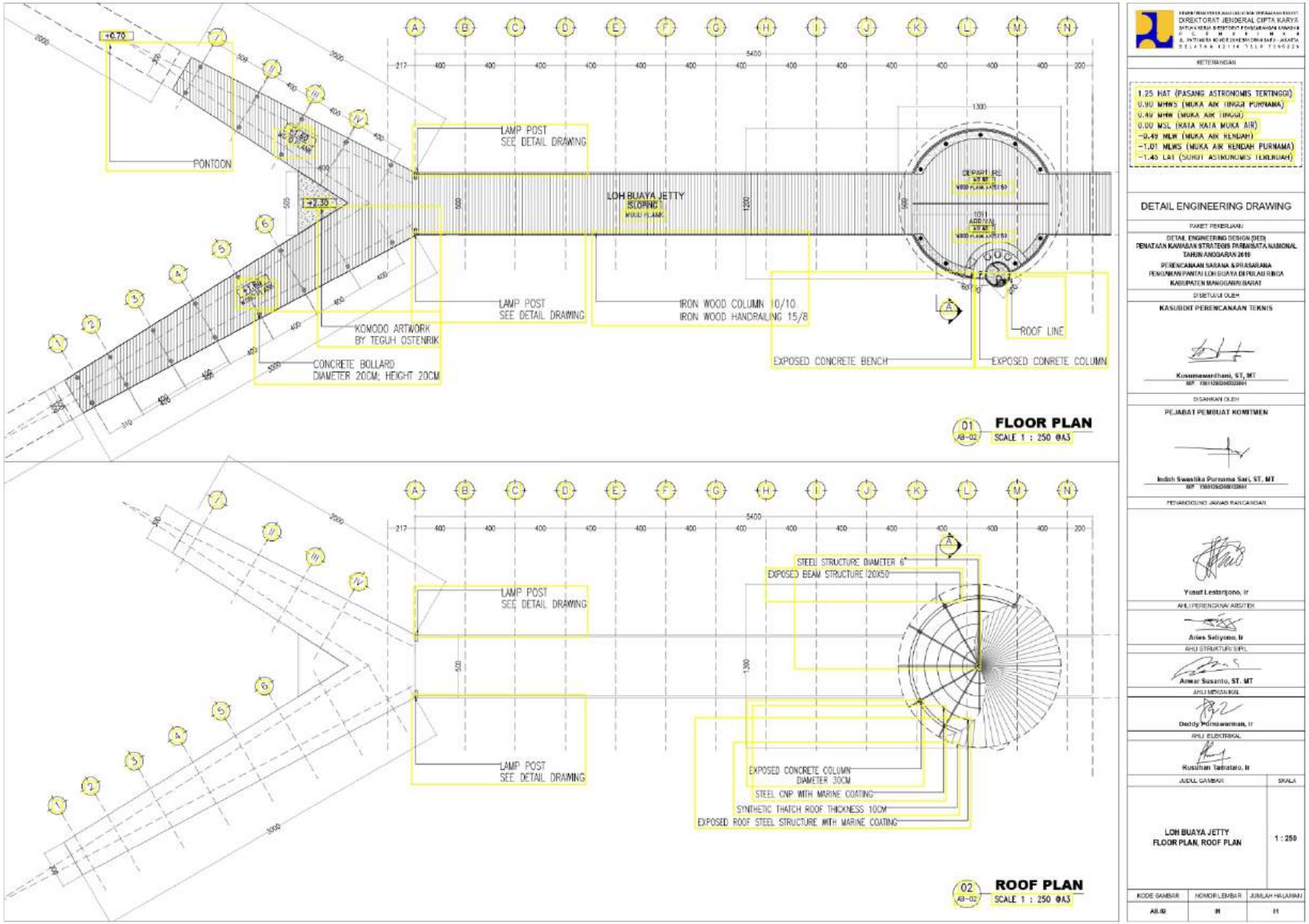
No	Name of Equipment	Total Unit	Function	Average time usage (/day/construction stage)	Average fuel consumption
1.	Hydraulic Static Pile Driver (HSPD)	1 Unit	For mini pile 30x30cm driving at the ranger, guide and researcher camp and information center	Average usage per day 8 hours	Average fuel consumption per day ± 400 lt
2.	Crawler Crane	1 Unit	Crawler crane P&H 335. For mini pile transport and supporting HSPD	Average usage per day 8 hours	Average fuel consumption per day ± 30 lt
3.	Excavator	5 Unit	For excavation work, loading material, and micropile driving	Average usage per day 8 hours	Average fuel consumption per day ±100 lt
4.	Dump Truck	5 Unit	Dump Truck capacity of 6 Tons, for transporting material from the temporary jetty to stockpile area and from stockpile area to site area	Average usage per day 8 hours	Average fuel consumption per day ±10 lt
5.	Mixer Truck	2 Unit	For concrete casting work	Average usage per day 6 hours	Average fuel consumption per day ±15 lt
6.	Flatbed Trailer 10 Tons	1 Unit	for transporting from the temporary jetty to stockpile	Average usage per day 6 hours	Average fuel consumption per day ±20 lt
	Water Tank Truck	1 unit	for clean water transportation	Average usage per day 6 hours	Average fuel consumption per day ±10 lt
7.	Bore Pile (Drilling Machine)	1 Unit	For pie foundation drilling work	Average usage per day 8 hours	Average fuel consumption per day ±150 lt
8.	Barge Vessel	4 Unit	- For mobilization of materials and equipment to Rinca - For pier foundation drilling platform	-	-

No	Name of Equipment	Total Unit	Function	Average time usage (/day/construction stage)	Average fuel consumption
9	Vibratory Hammer	1 unit	- Drive WF Steel Beam, which is used as column - Mounted on excavator		
10	Jack Drill	3 Unit	To cut mini pile, concrete and scrape the hill	-	-
11	Tamping Rammer	2 unit	For soil compaction	Average usage per day 8 hours	Average fuel consumption per day ±10 lt
12	Generator	2 Unit	For power source	Average usage per day 24 hours (each generator ±12 hours)	Average fuel consumption per day ±70 lt
13	Cutting Wheel	3 Pcs	For cutting reinforcement bar		
14	Hand Grinder	6 Pcs	For cutting tiles, andesite stone, and local stone		
15	Drilling Machine	6 Pcs	For drilling		
16	Circular Saw	2 Pcs	For cutting wood		
17	Bar Cutter	1 Unit	For cutting reinforcement bar		
18	Bar Bender	1 Unit	For bending reinforcement bar		
19	Concrete Vibrator	4 Unit	For eliminating air pocket during casting concrete process		
20	Theodolite	2 unit	Survey instrument measurement		

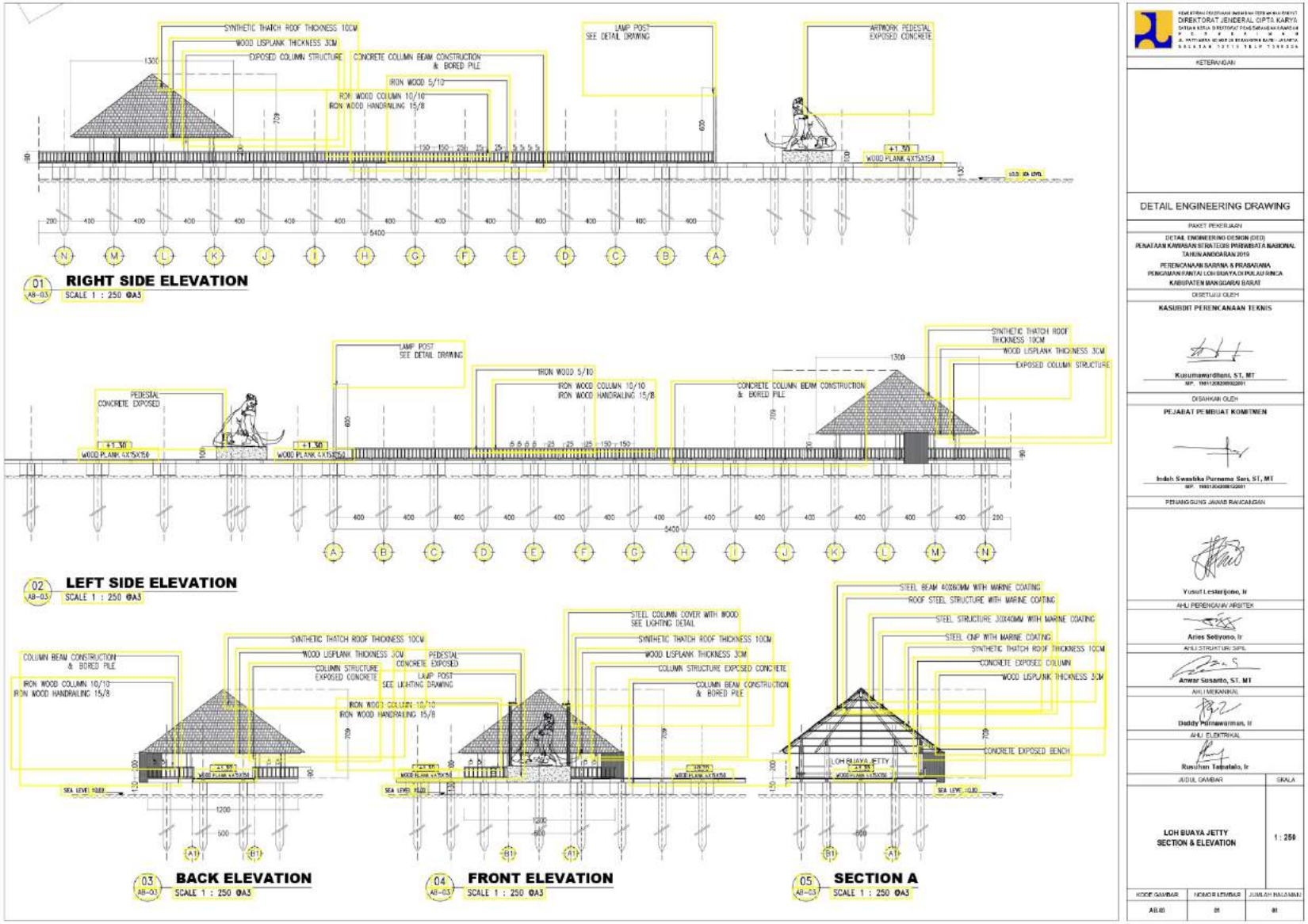
b) List of Materials

No.	Materials	Unit	Quantity
1	Reinforced Concrete	m^3	4,350
2	Boulder Stone	m^3	1,830
3	Ironwood	m^2/m^3	4,000 / 190
4	Pipe Casing Diameter 0.60	m	1,115
5	Mini Pile 30 x 30	m	13,608
6	Wide Flange (WF) Steel Beam	kg	9,920
7	Andesite Stone	m^2	1,830
8	Local Stone	m^2	1,283
9	Homogeneous Tile	m^2	2,166
10	Synthetic thatch roof	m^2	1,660
11	Indoor Paint	m^2	3,745
12	Outdoor Textural Paint	m^2	3,523
13	Bengkirai / Merbau Wood	m^2	200
14	Light brick wall	m^2	3,732

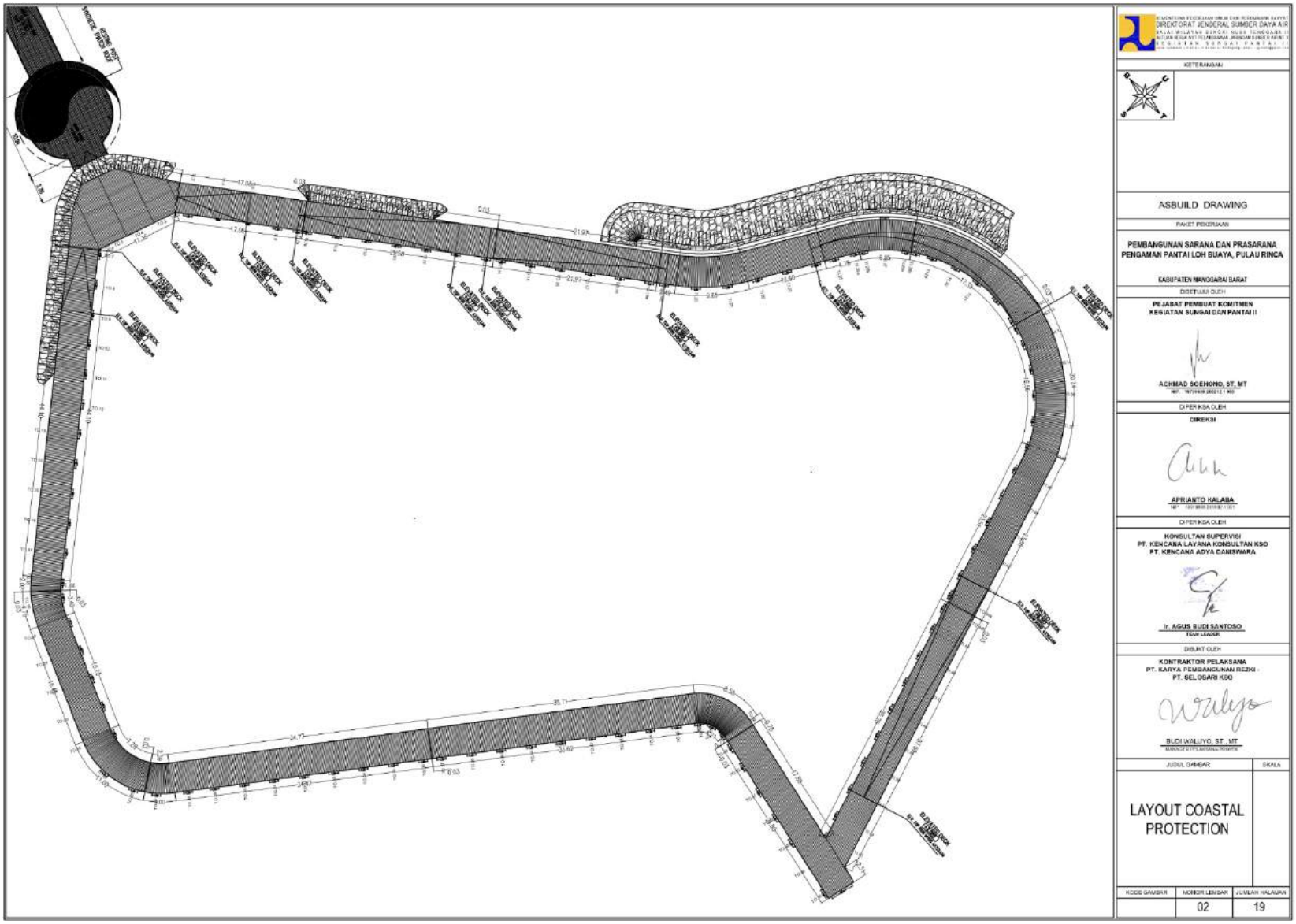
Appendix 3.10. The design of jetty



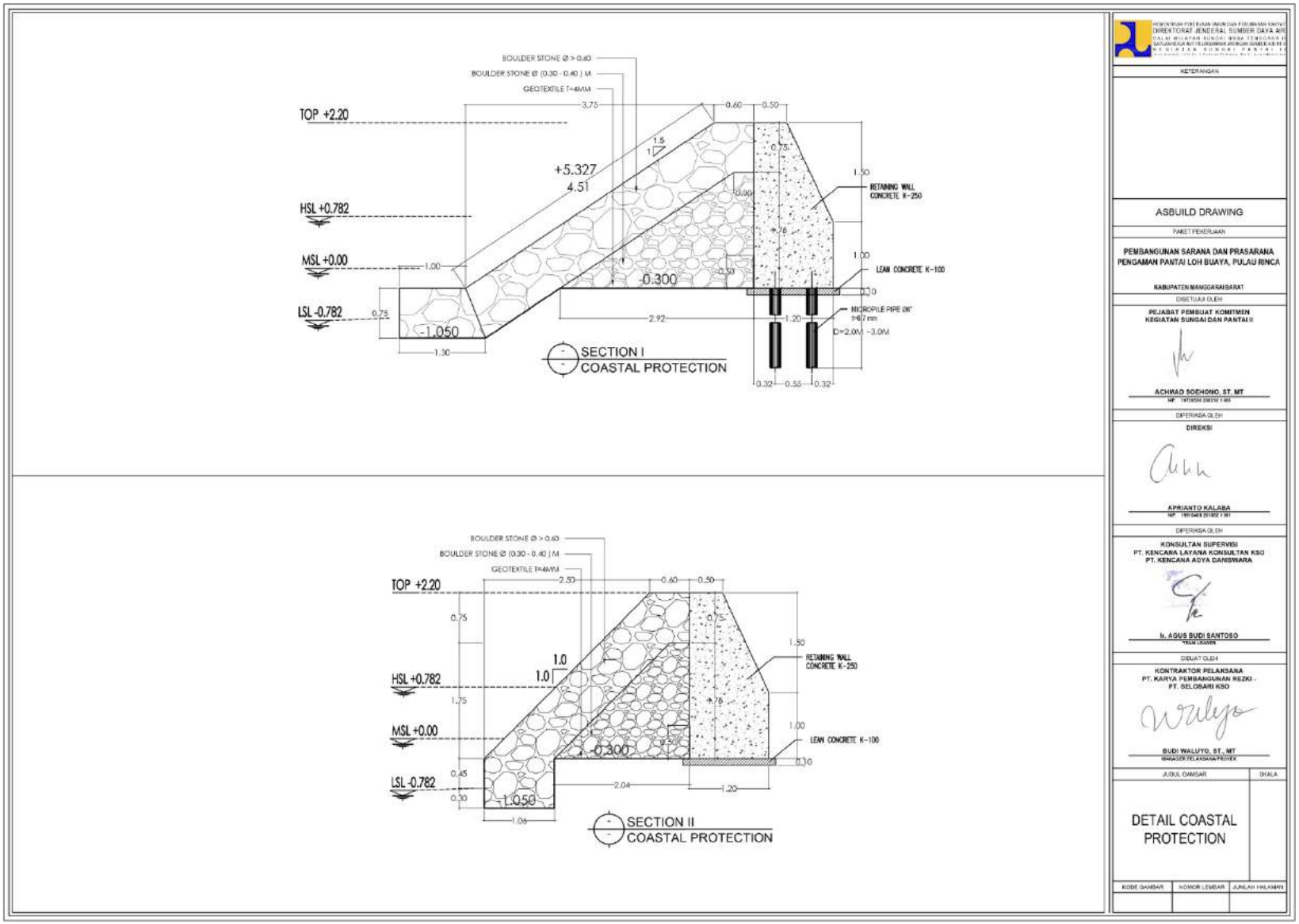
Continue …. The design of jetty (Elevation section: right & left side)



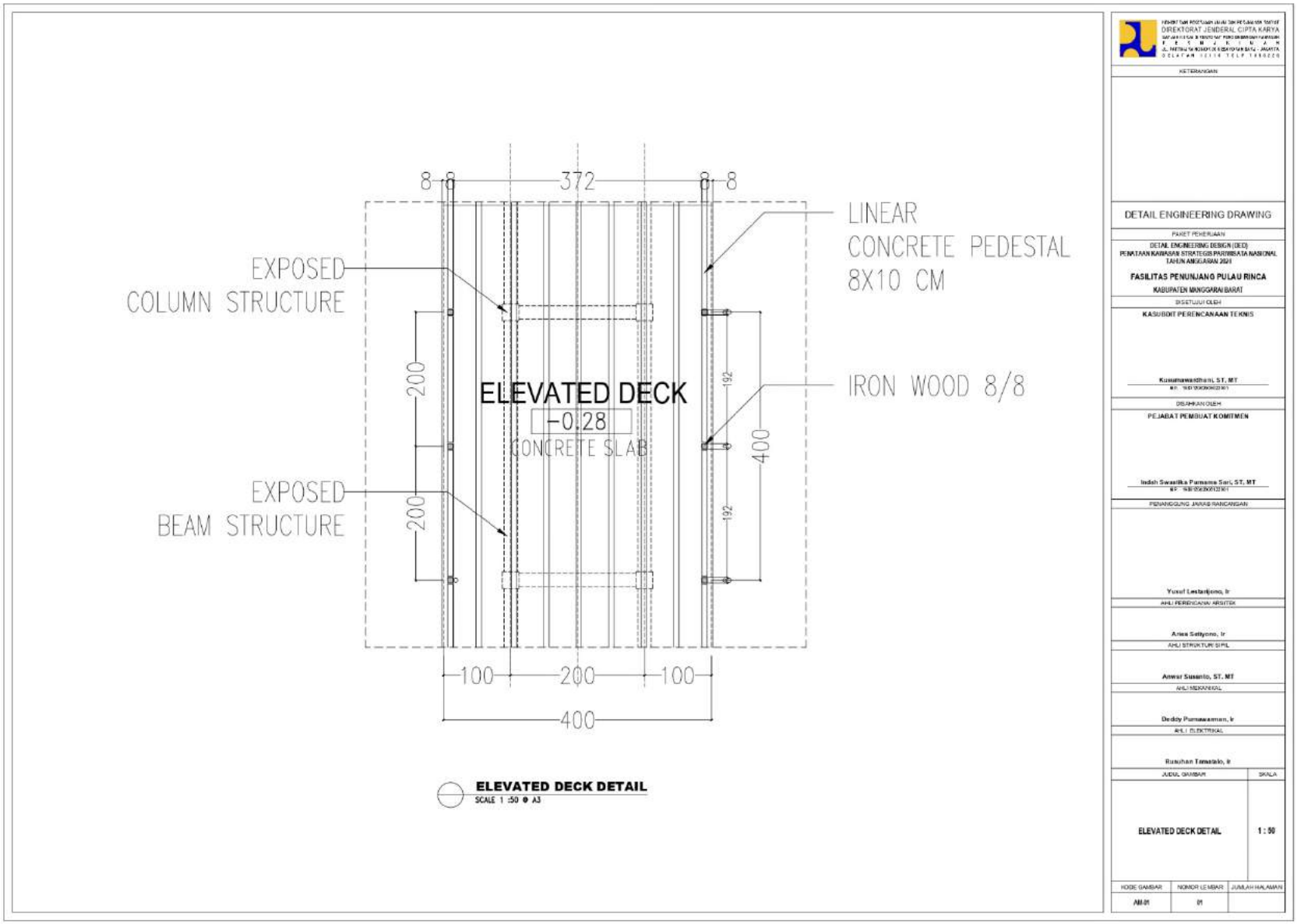
Appendix 3.11. Design of coastal protection



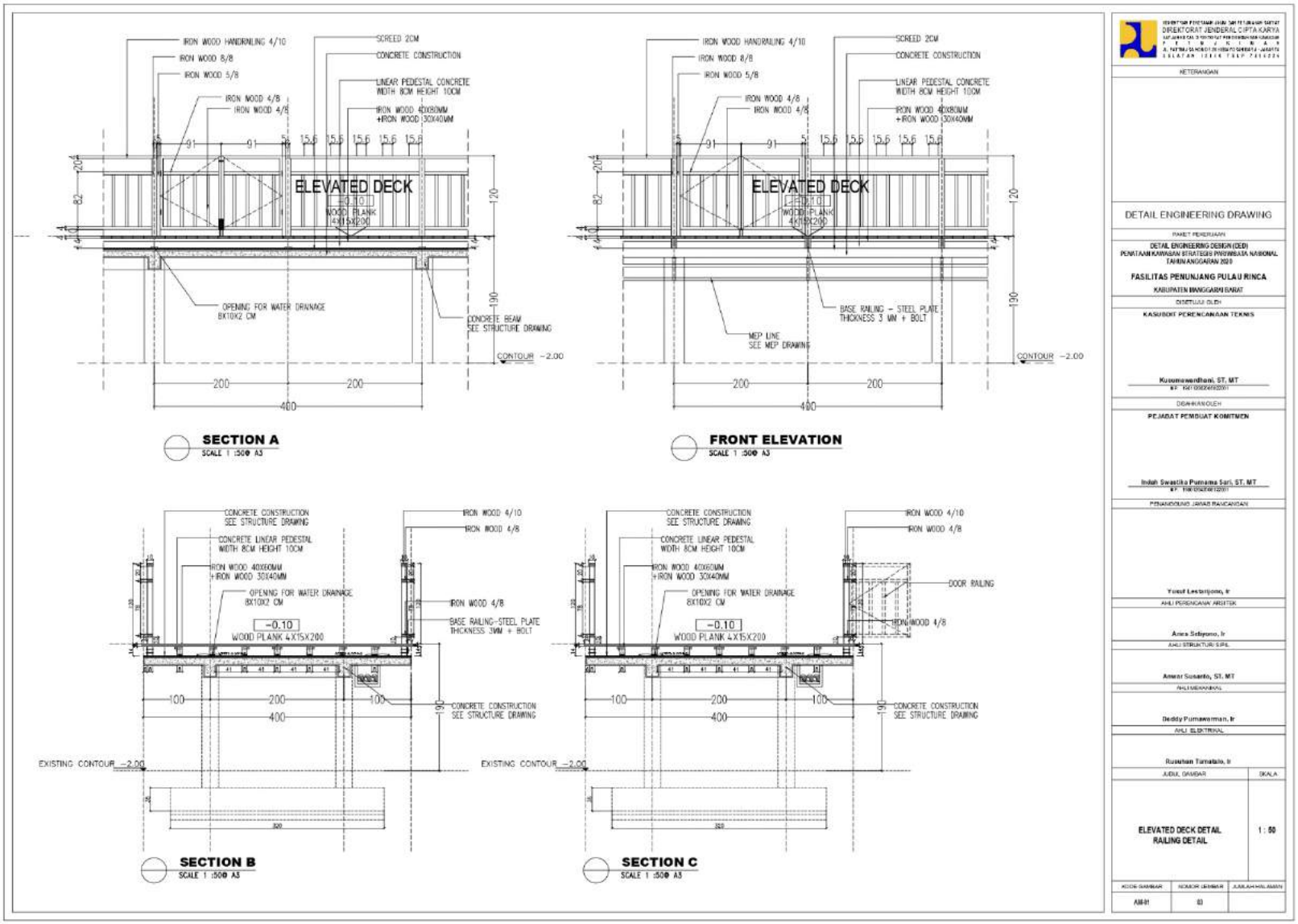
Continue ... Design of coastal protection: Detail elevation section



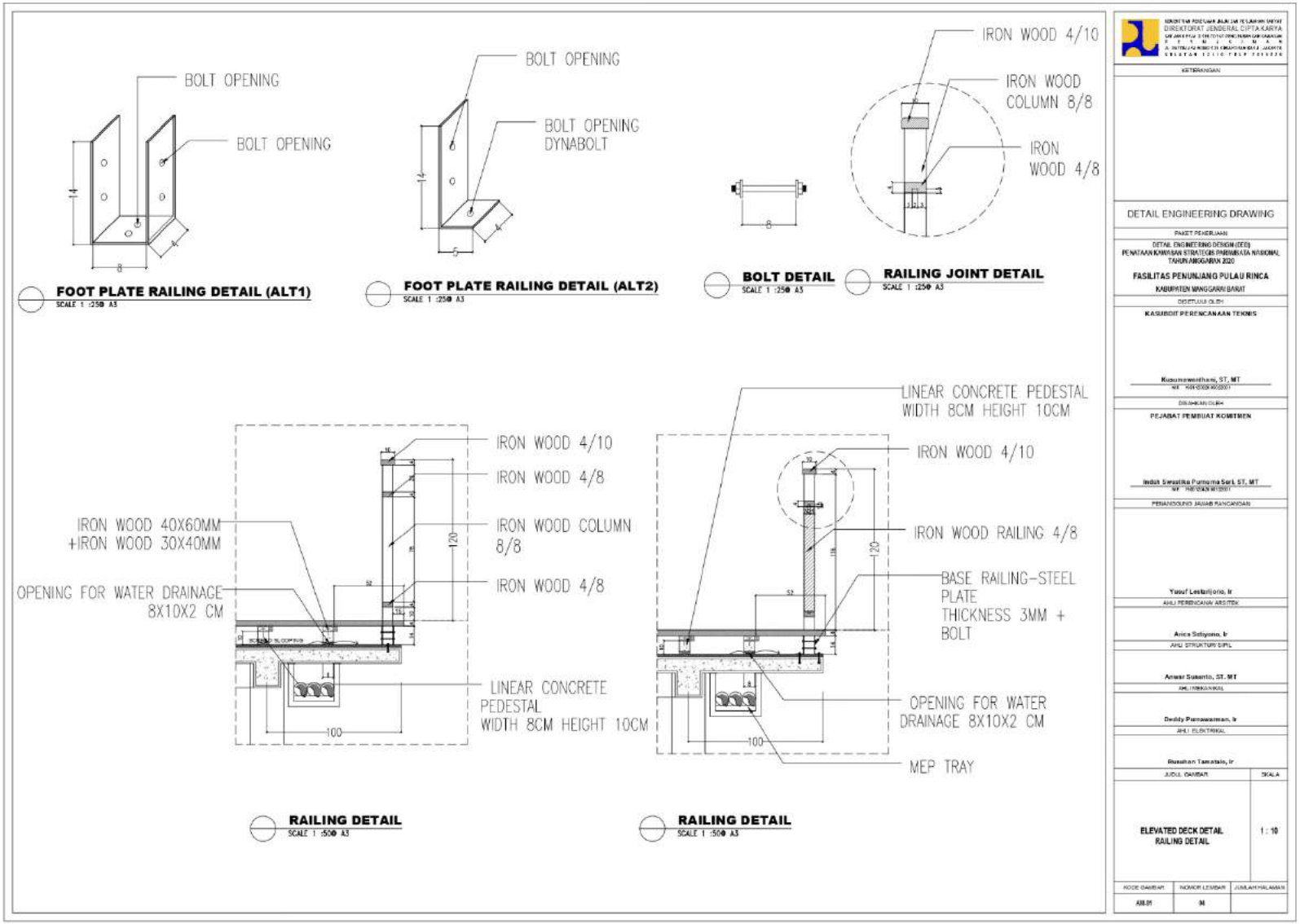
Appendix 3.12. The design of the elevated deck



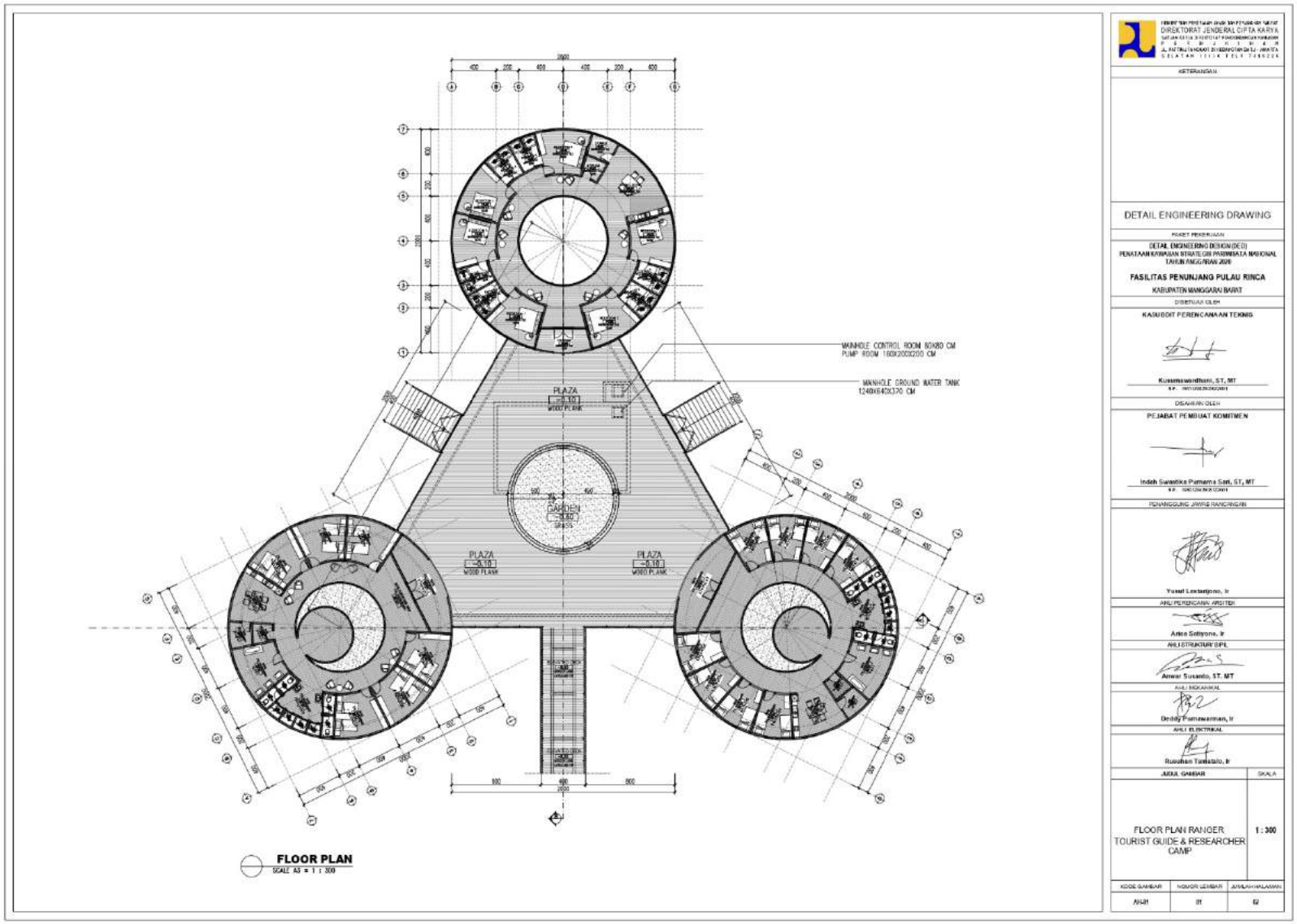
Continue ... The design of the elevated deck (Vertical section)



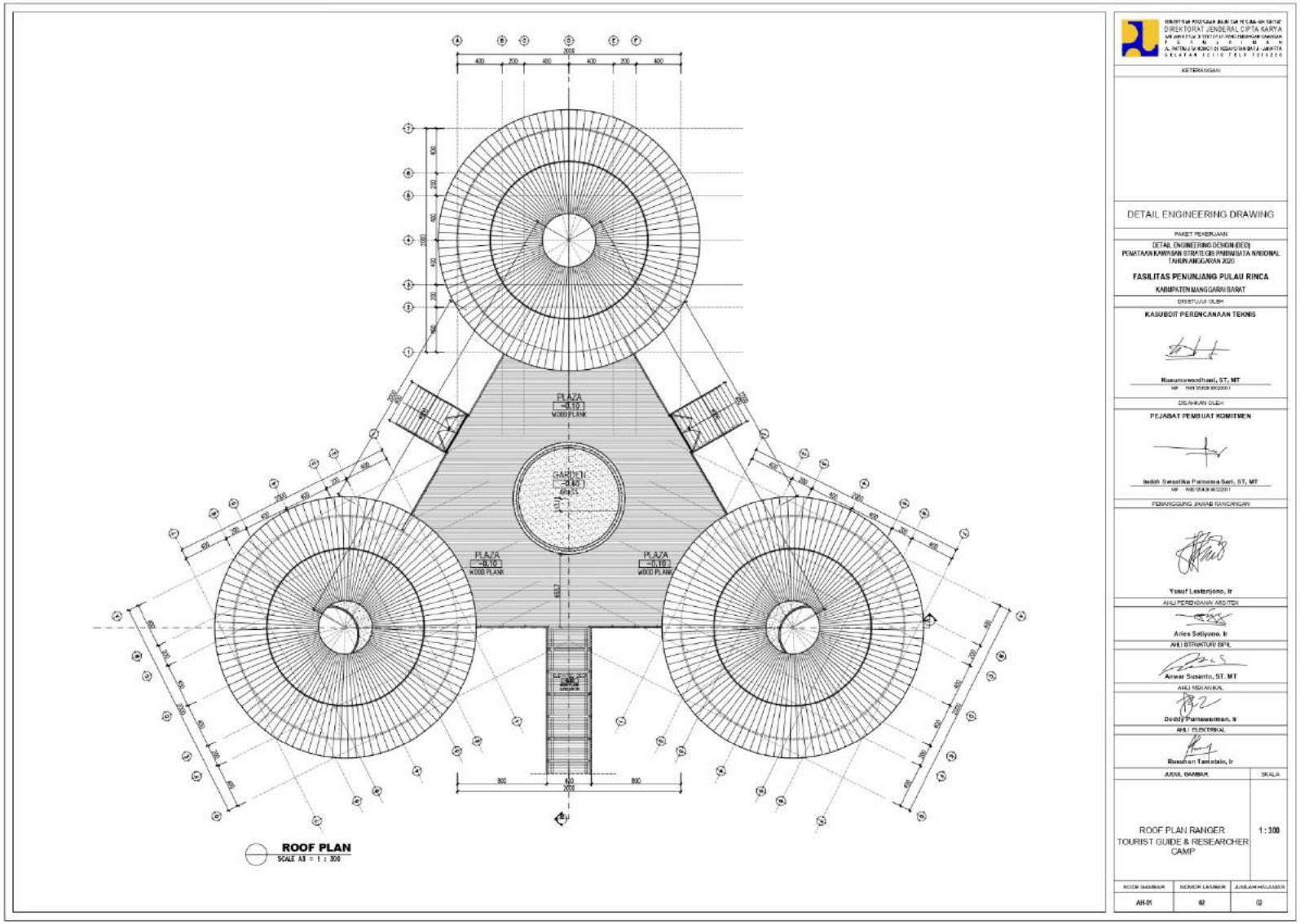
Continue... The design of the elevated deck (detail railing)



Appendix 3.13. The design of the camp building (Floor Plan)

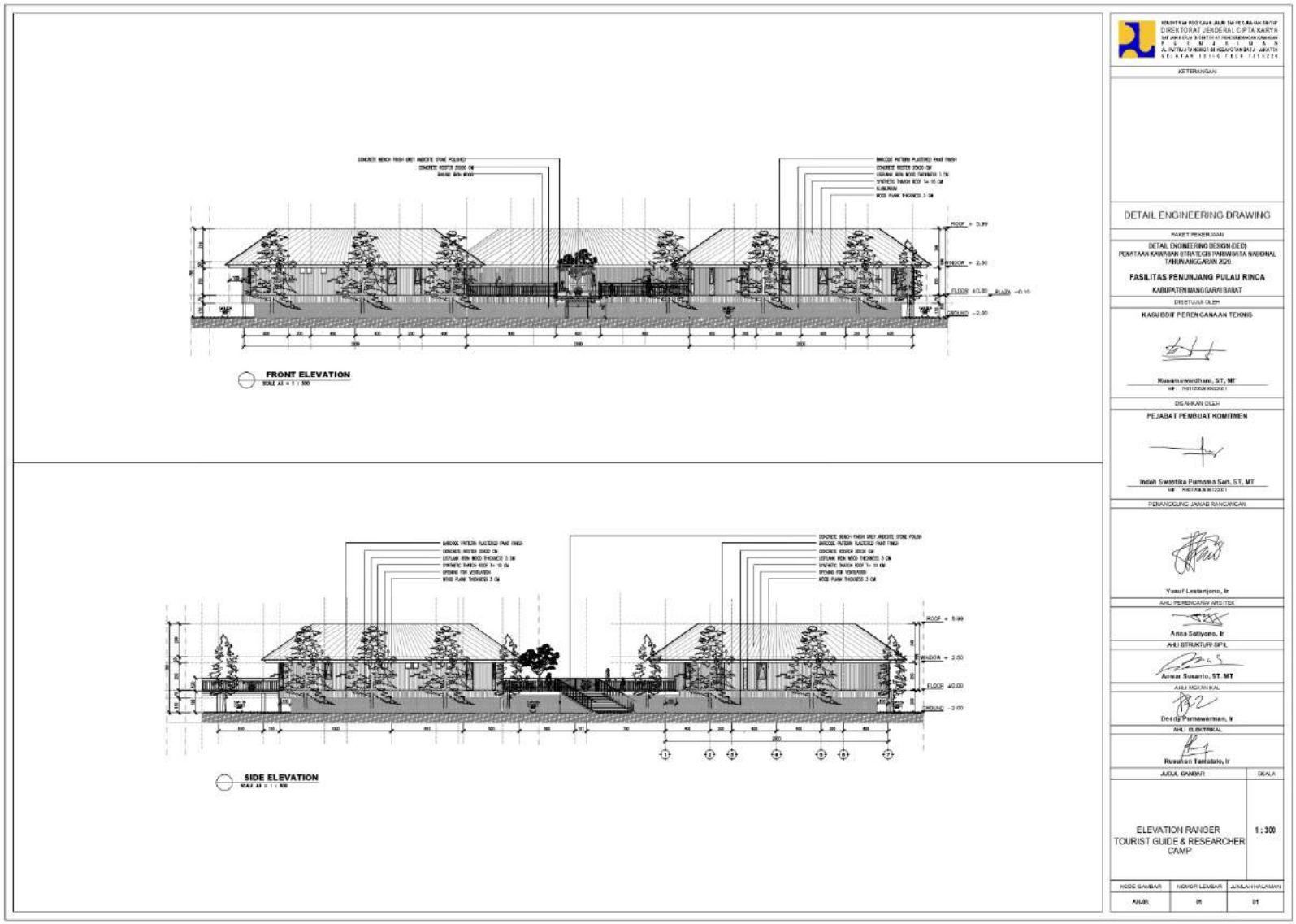


Continue... The design of the camp building (Roof Plan)

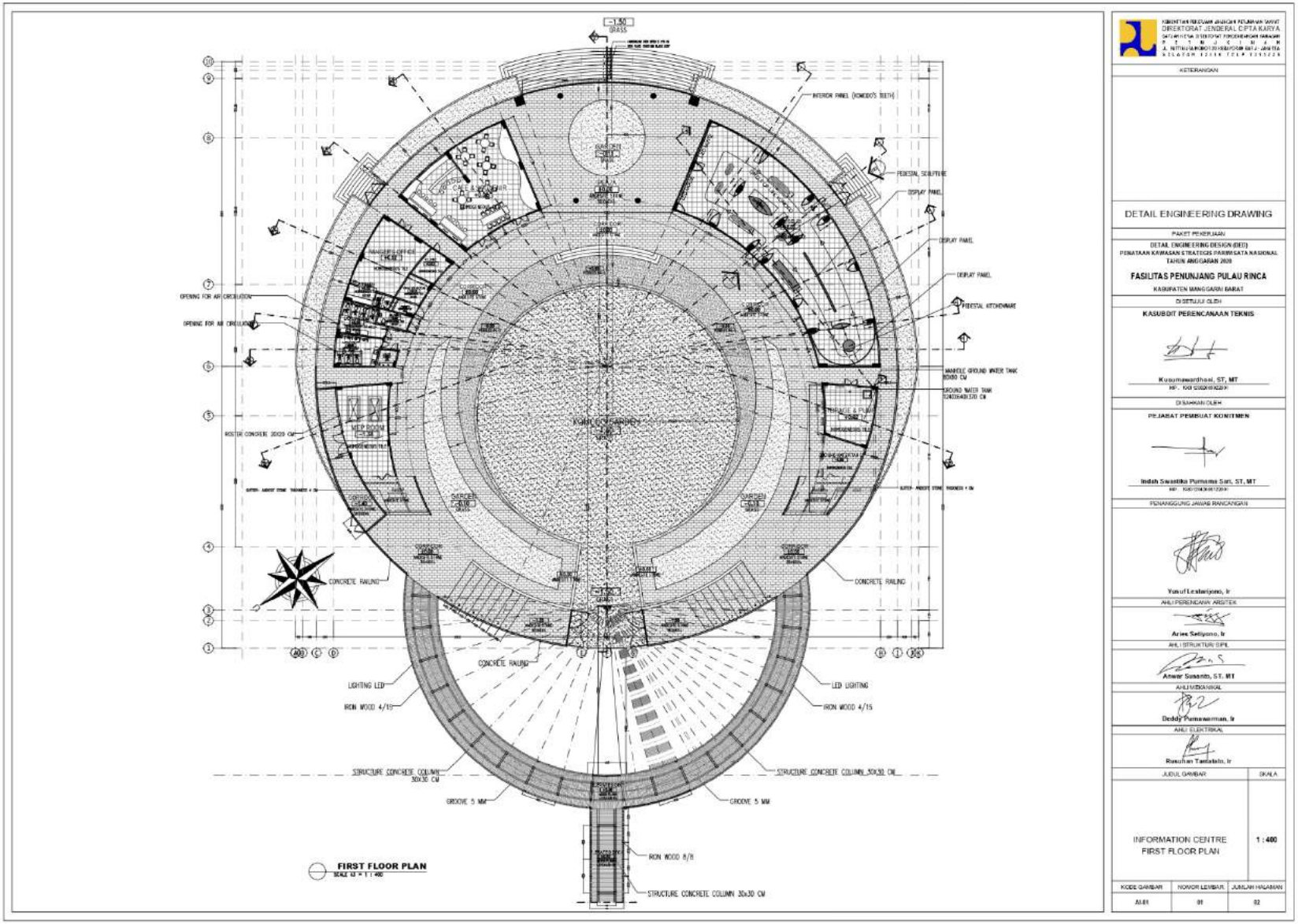


Continue ... The design of the camp building (Elevation section)

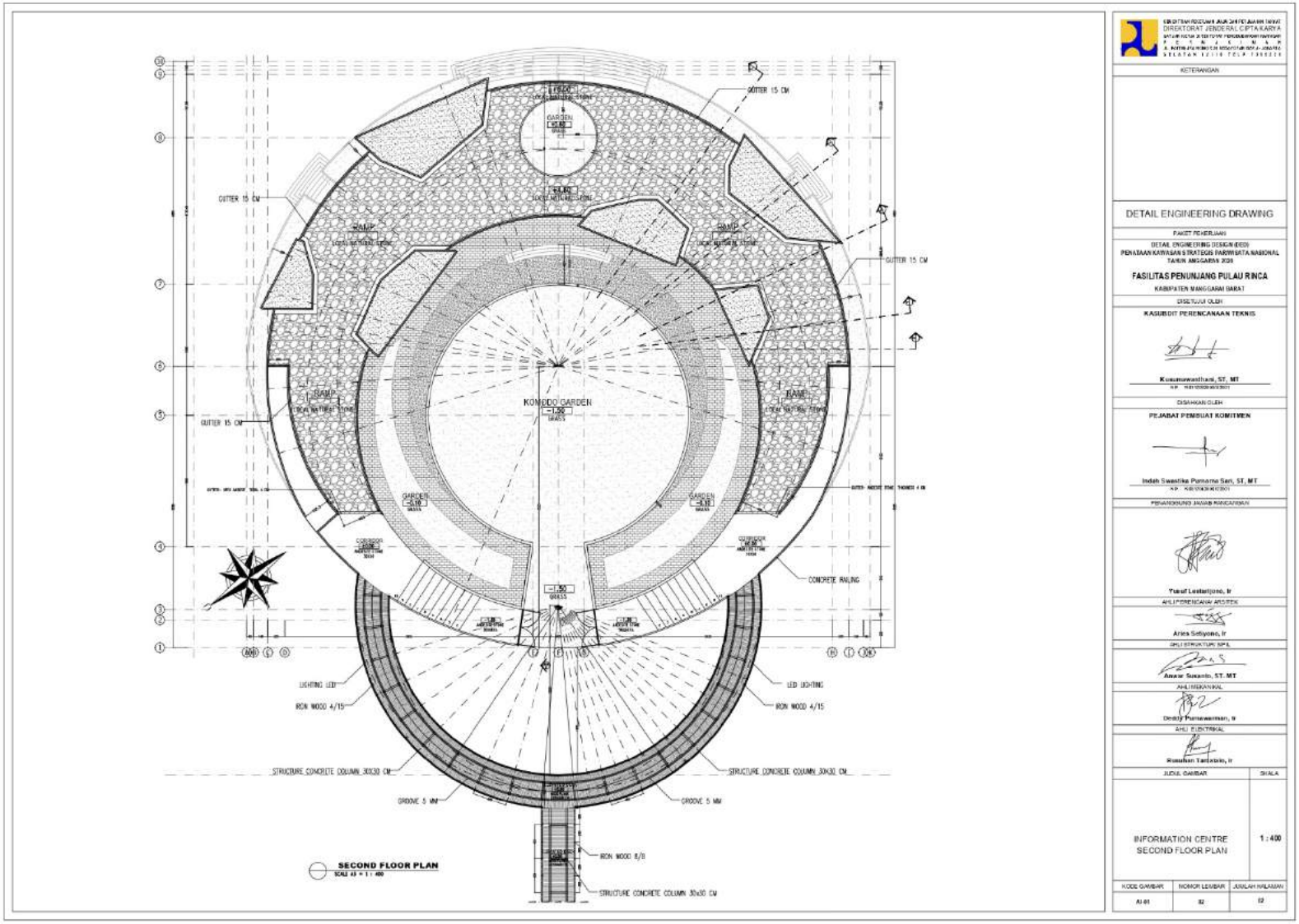
Continue... The design of the camp building (Font & Side Elevation section)



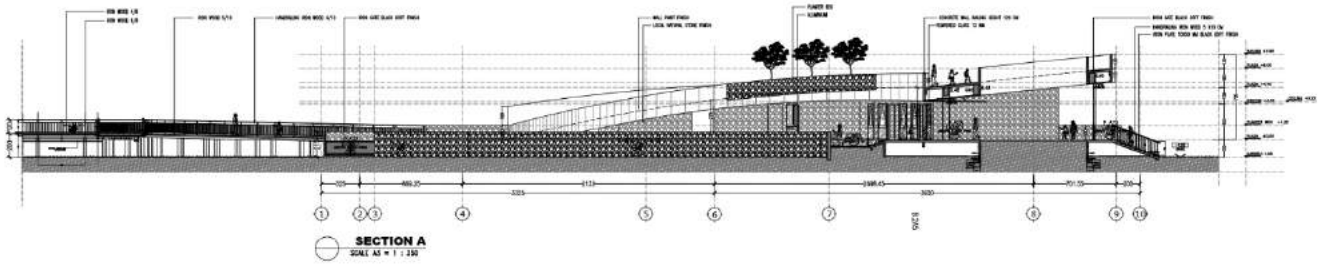
Appendix 3.14. Information center first floor



Continue... Information center second floor



Continue... Information center vertical view



DIREKTORAT JENDERAL CIPTA KARYA

KETERANGAN

DETAIL ENGINEERING DRAWING

PAKET PEKERJAAN

DETAIL ENGINEERING DESIGN (DED)
PENATAAN KAWASAN STRATEGIS PARIWISATA NASIONAL
TAHUN ANGGARAN 2026

FASILITAS PENUNJANG PULAU RINCA

KABUPATEN MANGGARAI BARAT

DISETUJUI OLEH

KASUBDIT PERENCANAAN TEKNIS

Kusumawardhani, ST, MT

DISAHKAN OLEH

PEJABAT PEMBUAT KOMITMEN

Indah Swastika Purnama Sari, ST, MT

PENANGGUNG JAWAB RANCANGAN

Yusuf Lestarijono, Ir

AHLI PERENCANA ARSITEK

Arles Setiyono, Ir

AHLI STRUKTUR SIPIL

Anwar Susanto, ST, MT

AHLI MEKANIKAL

Deddy Purnawarman, Ir

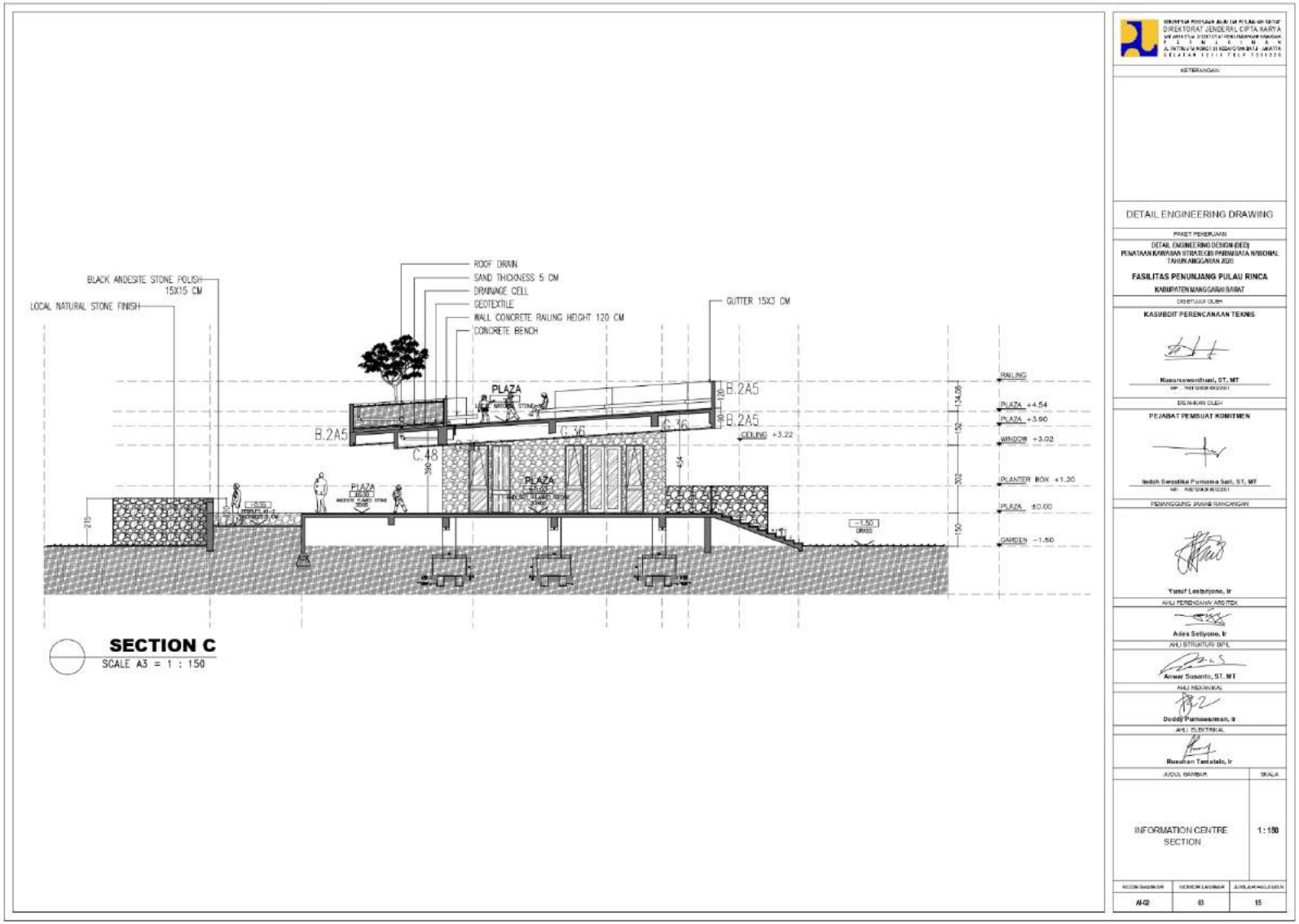
AHLI ELEKTRIKAL

Rusdhan Tamatalo, Ir

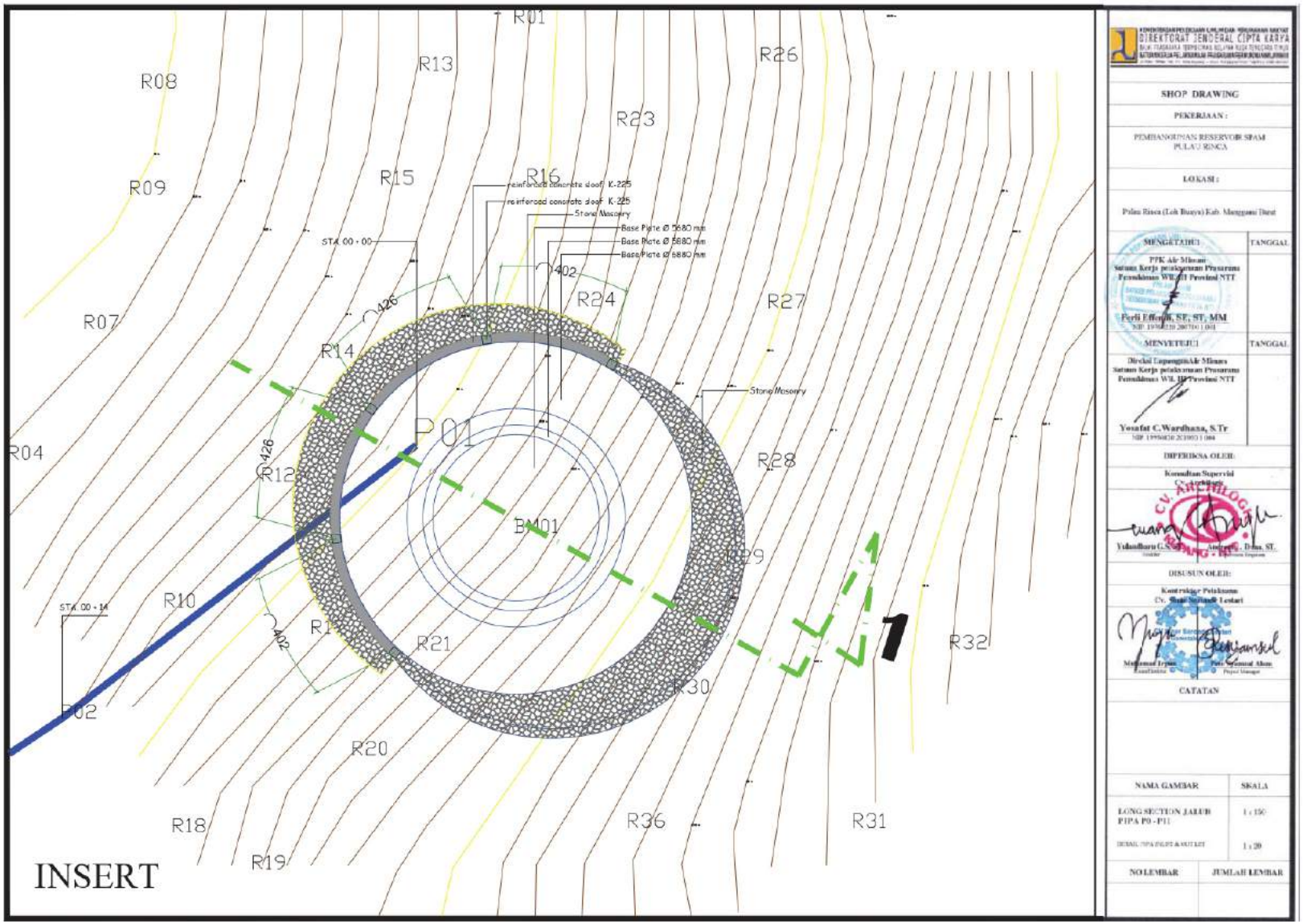
JUDUL GAMBAR	SKALA
INFORMATION CENTRE SECTION	1 : 350

KODE GAMBAR	NOMOR LEMBAR	JUMLAH HALAMAN
AI-02	01	15

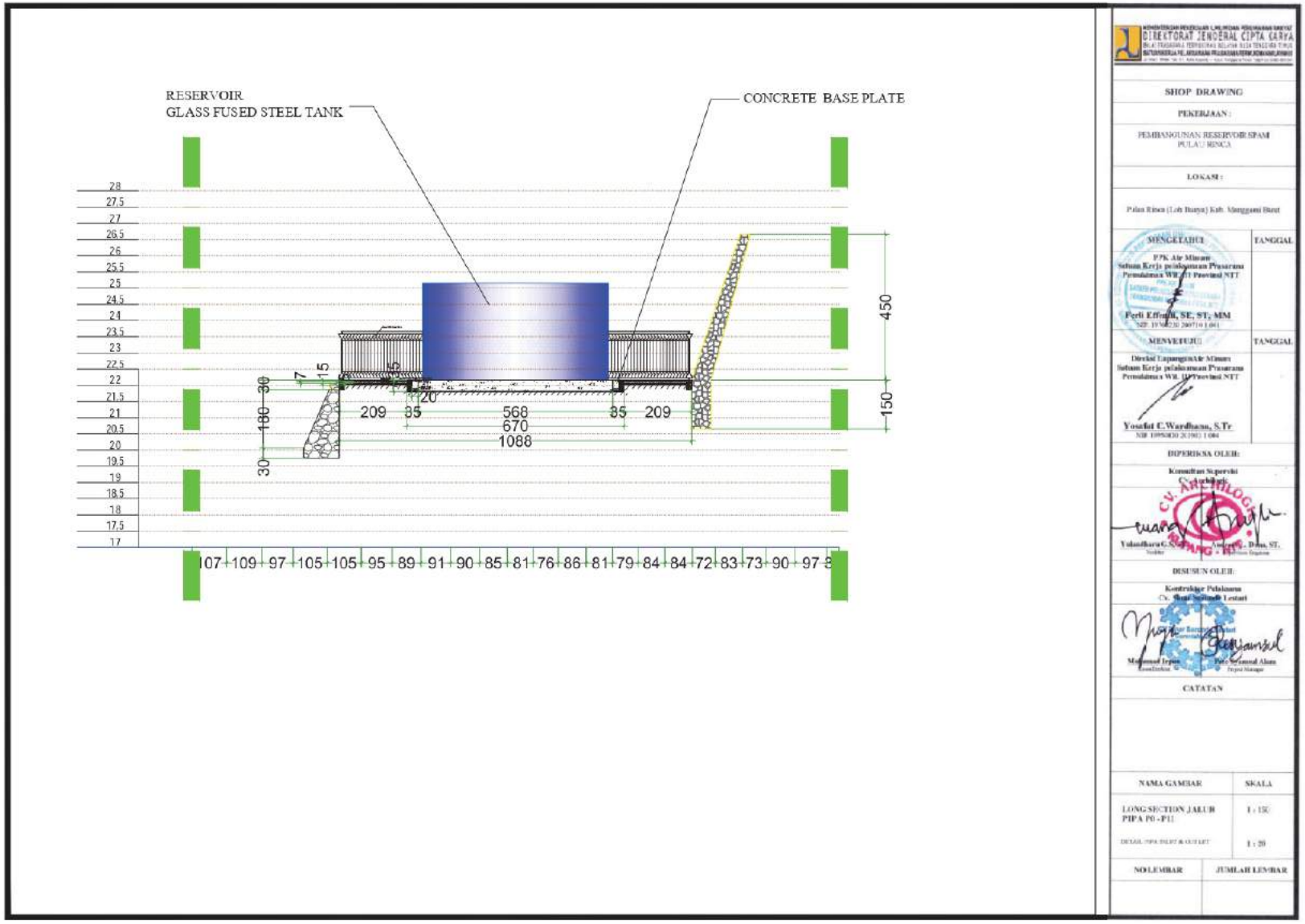
Continue... Information center vertical view



Appendix 3.15. Water reservoir



Continue... Water reservoir (Vertical section)



MINISTRY OF PUBLIC WORKS AND HOUSING
DIRECTORATE GENERAL OF HUMAN SETTLEMENTS

MINISTRY OF ENVIRONMENT AND FORESTRY
DIRECTORATE GENERAL OF NATURAL RESOURCES AND ECOSYSTEM SERVICES

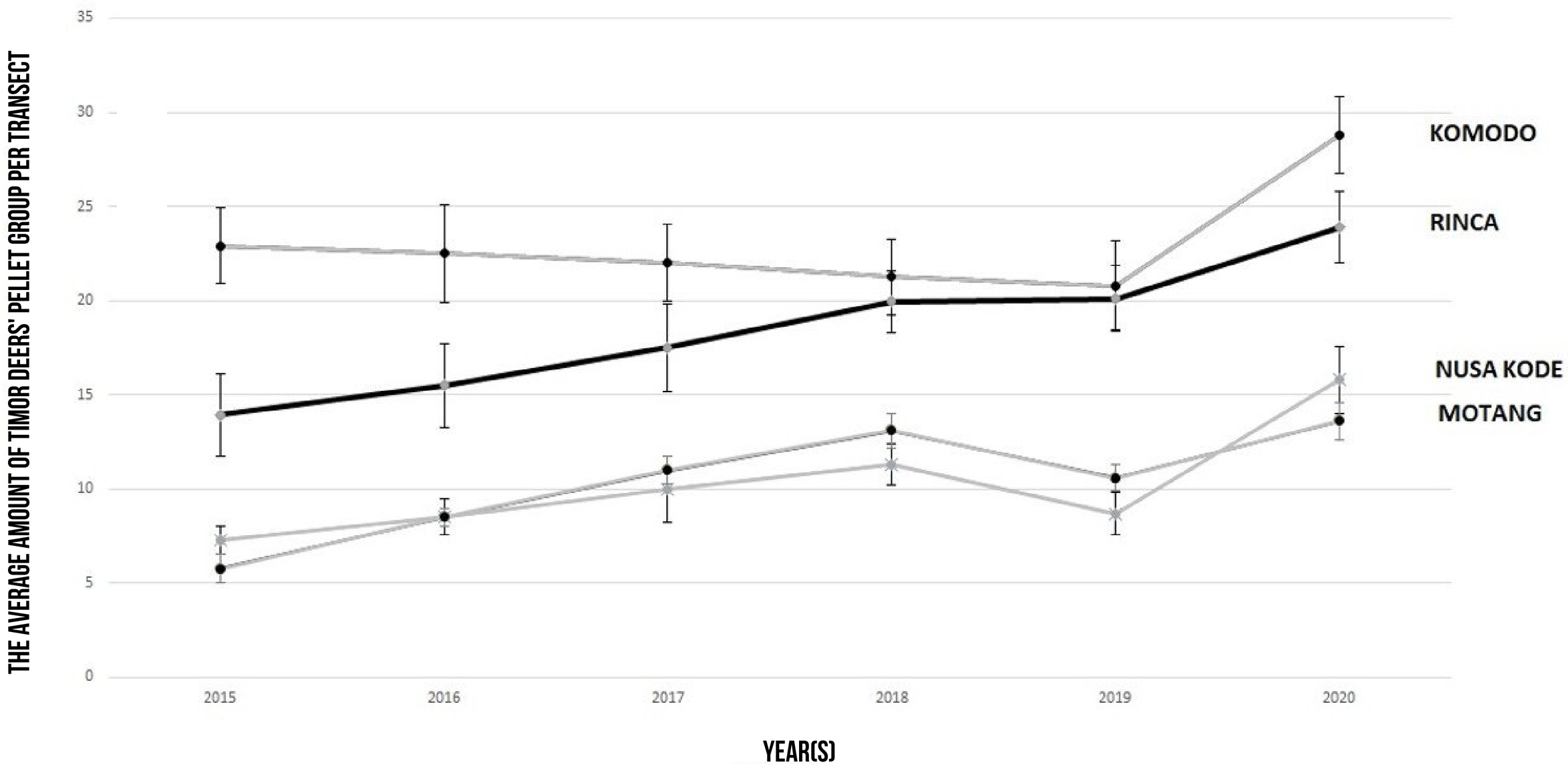
EMP ENVIRONMENTAL MANAGEMENT PLAN

LABUAN BAJO

NATIONAL TOURISM STRATEGIC AREA

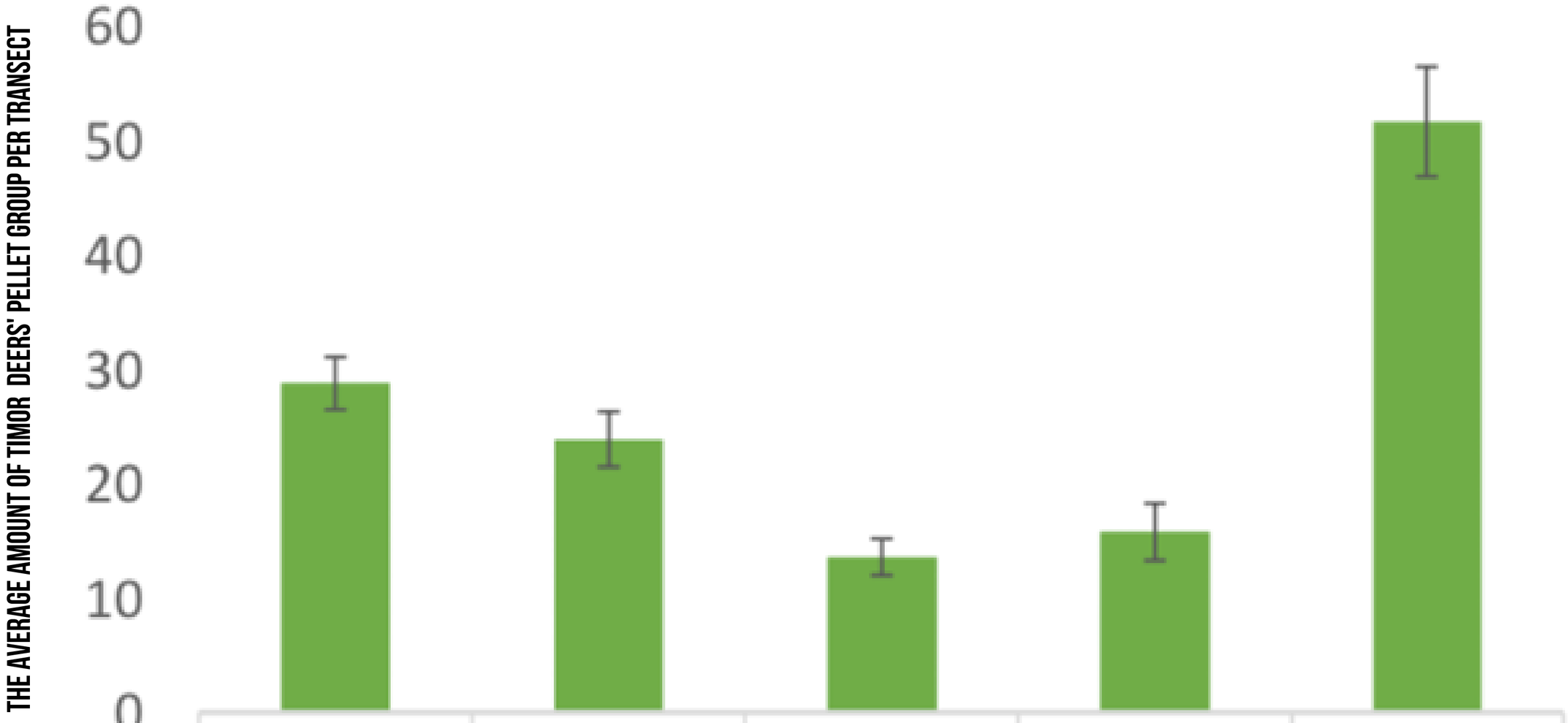
www.pu.go.id

THE TREND OF TIMOR DEERS' POPULATION IN KOMODO NATIONAL PARK (2015 - 2020)



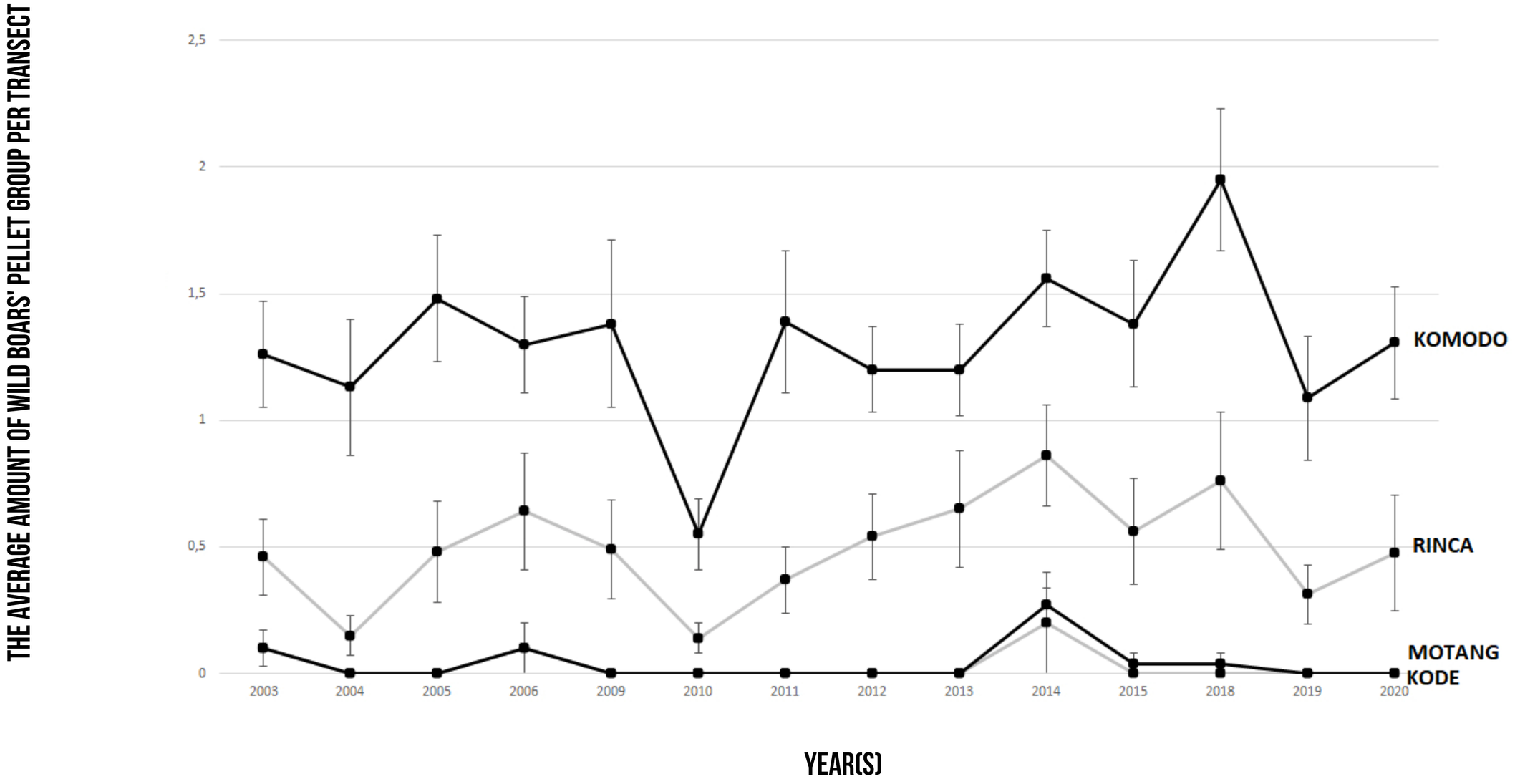
Reference: Komodo National Park and Komodo Survival Program Data (2021

THE COMPARISON INDEX OF TIMOR DEERS' POPULATION DENSITY IN KOMODO NATIONAL PARK YEAR 2020



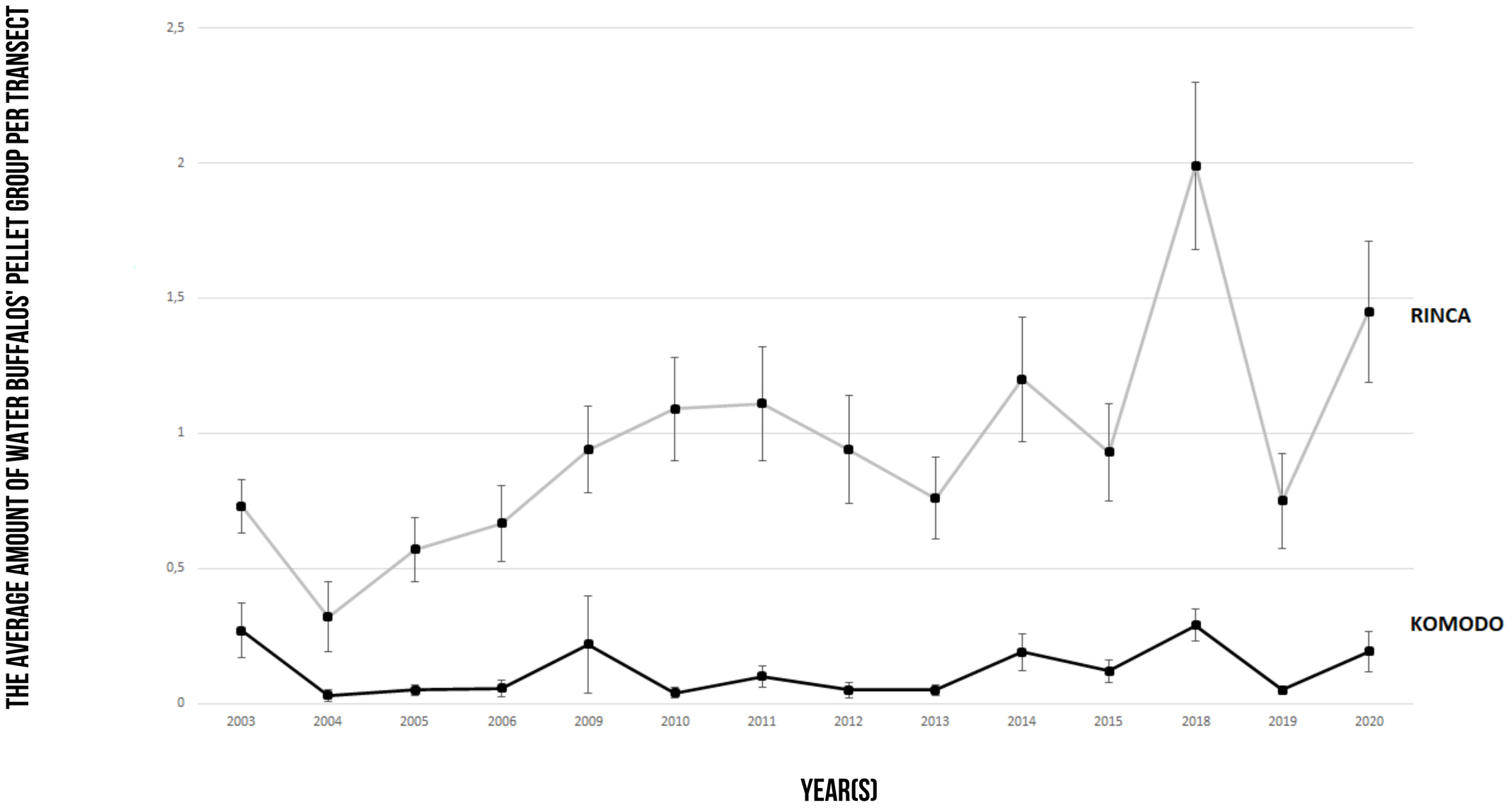
	KOMODO ISLAND	RINCA ISLAND	GILI MOTANG ISLAND	NUSA KODE ISLAND	PADAR ISLAND
avg/tr	28,8	23,90	13,6	15,8	51,7

THE TREND OF KOMODO DRAGONS' PREYS (WILD BOARS) IN KOMODO NATIONAL PARK (2002 - 2020)

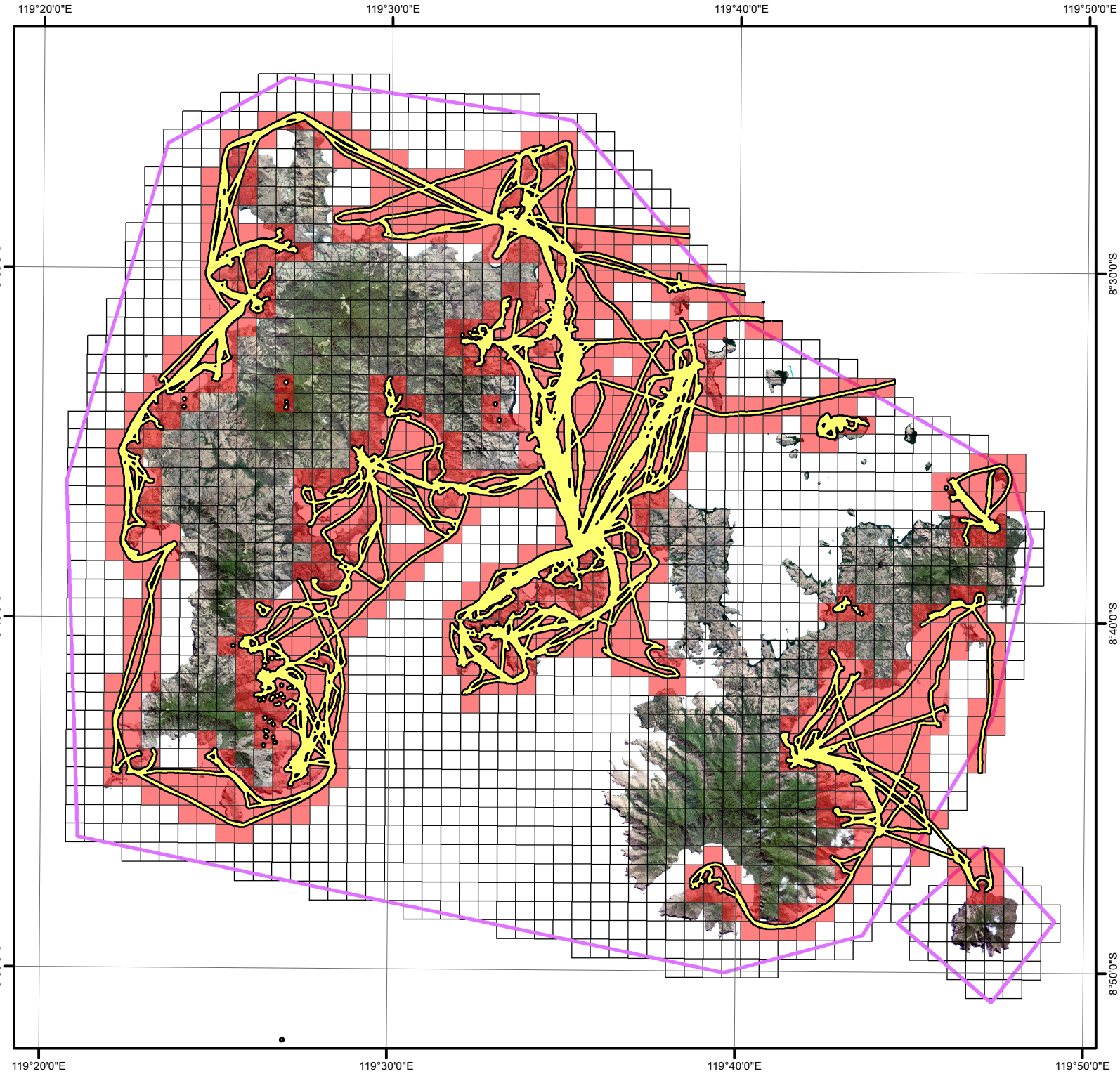


Reference: The Annual Partnership Report of Komodo National Park and Komodo Survival Program Period 2020 - 2021

THE TREND OF KOMODO DRAGONS' PREYS (WATER BUFFALOS) IN KOMODO NATIONAL PARK (2002 - 2020)



Reference: The Annual Partnership Report of Komodo National Park and Komodo Survival Program Period 2020 - 2021



PETA HASIL KEGIATAN RESORT BASE MANAGEMENT (RBM) TRIWULAN II TAHUN 2021

TAMAN NASIONAL KOMODO

KABUPATEN MANGGARAI BARAT
PROVINSI NUSA TENGGARA TIMUR

Skala 1 : 280.000

U

0 1,75 3,5 7 10,5 14 17,5 km

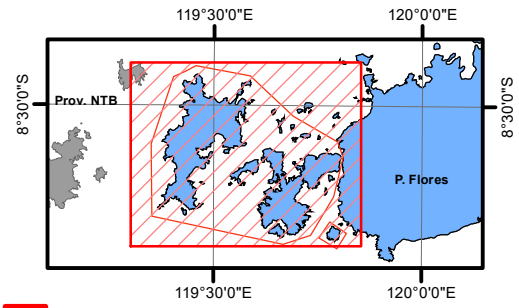
SUMBER :

1) Peta Rupa Bumi Indonesia skala 1 : 25.000 Lembar 2007522, 2007611, 2007612, 2007621, 2007244, 2007333, 2007334, 2007343, 2007242, 2007331, 2007332, 2007341, 2007224, 2007313, 2007314 dan 2007323
2) Surat Keputusan Direktorat Jenderal PHKA No. 65/Kpts/Dj-V/2001 tentang Zonasi TN Komodo. Ditjen PHKA Departemen Kehutanan Republik Indonesia
3) Keputusan Menteri Kehutanan Nomor : 306/kpts-II/92 tanggal 29 Februari 1992
4) Keputusan Menteri Kehutanan dan Perkebunan nomor : 002/Kpts-II/2000.
5) Surat Keputusan Dirjen PHKA No. SK.21/IV-Set/2012 tanggal 24 Februari 2012, tentang Zonasi Taman Nasional Komodo.
6) SK Menteri LHK Nomor 357/Mnlhk/Setjen/PLA.0/5/2016 tentang Perubahan Peruntukan Kawasan Hutan dst.nya Provinsi Nusa Tenggara Timur
7. Data kegiatan Konsinyasi RBM Triwulan I dan II 2021

LEGENDA

- Batas Taman Nasional
- Sungai dan anak sungai
- RBM TRIWULAN II - (23.829 Ha) BUFFER AREA 100 m
- RBM TRIWULAN II - Luas 77.500 Ha (GRID KK INVENTARISASI/100 Ha)
- GRID KK INVENTARISASI PER-100 Ha

Citra TN Komodo (Bing 2021).tif
RGB
Red: Band_1
Green: Band_2
Blue: Band_3



- Batas Areal Taman Nasional Komodo
- Provinsi Nusa Tenggara Timur

Sumber: RBI skala 1:250.000

KEMENTERIAN LINGKUNGAN HIDUP DAN KEHUTANAN
DIREKTORAT JENDERAL KONSERVASI SUMBERDAYA ALAM DAN EKOSISTEM
BALAI TAMAN NASIONAL KOMODO

KEPALA BALAI	TENAGA GIS
(LUKITA AWANG NISTYANTARA, S.Hut, M.Si) NIP.19750112 200003 1 003	THOMAS DAVID CARVALLO, S.Hut NIP.-

Outline for the Future Marine Management of the Komodo National Park World Heritage Site

Cover picture: manta ray in the Komodo National Park World Heritage site
© UNESCO/Michelle Vanmaele

March 2020

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1. Introduction

1.1. Aim of the outline

This document focuses primarily on the marine environment and current marine management activities in the Komodo National Park and summarises the key outputs of a workshop held in Labuan Bajo in November 2019. The report is intended to guide potential actions and improvements that can be made to the management of the Komodo National Park to ensure that the marine aspects of the Outstanding Universal Value of the World Heritage Site can be conserved for future generations, whilst also supporting sustainable regional economic initiatives.

The outline builds on the Best Practice Guide for World Heritage Marine Sites developed by UNESCO in 2015 and translated to Indonesian in 2017[1]. The 2019 workshop builds on a first Marine World Heritage training held in Labuan Bajo in December 2017.

1.2. The Outstanding Universal Value of Komodo National Park

Komodo National Park (KNP) is located in the centre of the Indonesian archipelago, between the islands of Sumbawa and Flores. The World Heritage property covers 219,322 ha and comprises three major islands (Rinca, Komodo, and Padar) and 147 small islands scattered through the Park; all of them of volcanic origin. Located at the juncture of two continental plates, this national park constitutes the "shatter belt" within the Wallacea Biogeographical Region, between the Australian and Sunda ecosystems.

Komodo National Park was inscribed on the World Heritage List in 1991 under Criterion (vii) – Beauty- and (x) –Iconic species- and is identified as a global conservation priority area, comprising unparalleled terrestrial and marine ecosystems[2]. The retrospective Statement of Outstanding Universal Value (OUV) can be found in Appendix 9.1. This is the official description of the values for which the Komodo National Park was inscribed on the World Heritage List, as adopted by the World Heritage Committee.

Whilst the Komodo dragon *(Varanus komodoensis)* is the most well-known feature, the marine biodiversity is a major part of the site's Outstanding Universal Value with rich coral reefs hosting a great diversity of marine species, including sea turtles, whales, dolphins and dugongs. The National Park is recorded to have 1,000 species of fish, 10 species of dolphins and 8 whale species, dugongs with turtle nesting occurring for the Green Sea Turtle (*Chelonia mydas)* and the Hawksbill Sea Turtle (*Eretmochelys imbricate*) (Taman Nasional Komodo & World Wildlife Fund, 2017).

1.3. Social and economic importance of Komodo National Park's marine component

The marine values attract visitors to the area and importantly provide for activities that retain visitors for multi-day visits and return visitation to the region, thus providing significantly greater economic benefits. The marine attractions include scuba diving and snorkelling, marine fauna viewing, swimming, live aboard boats, and experiencing the remote islands and environments of Komodo. Diving is currently the third most sought-after activity in Labuan Bajo, is growing in popularity and may soon outstrip the Komodo dragon as Labuan Bajo's primary visitor magnet (Swisscontact, 2015a).

The marine visitor opportunities are increasingly becoming the focus of the tourism product for Komodo, and protection of these assets will be fundamental to a long-term sustainability of the

[1] https://unesdoc.unesco.org/ark:/48223/pf0000235316_ind
[2] http://whc.unesco.org/en/list/609

tourism industry. The marine environment faces many other challenges that will be further exacerbated with increased visitation including unsustainable fishing, litter, degradation of water quality, and the impacts of coastal development and other human activities.

1.4. Labuan Bajo Workshop

The UNESCO World Heritage Marine Programme convened a workshop from 25 to 28 November 2019 in Labuan Bajo, Flores to undertake capacity building to support marine management of the Komodo National Park World Heritage site by bringing together key expertise from the UNESCO Marine World Heritage network.

Participants included Komodo National Park staff, members of Komodo National Park marine division, marine staff from the Ujung Kulon National Park World Heritage site (Indonesia), marine experts from World Heritage marine sites in Philippines, Ecuador and Australia, and UNESCO staff from the Regional Sciences Bureau in Jakarta and the World Heritage Marine Programme. The workshop Agenda, expected outcomes and the list of participants is found in Appendices 9.2 and 9.3.

During the workshop a number of interactive sessions were undertaken including;

- An initial attempt to map the spatial distribution of Outstanding Universal Value, human uses and potential conflicts across Komodo (maps).
- Working through a generic management outline for an ecological value (coral reefs) considering pressures, management objectives, targets and actions.
- Brainstorming issues and suggestions for Komodo future management.
- Consideration of future management priorities using the UNESCO best practice framework.

2. Komodo National Park: International obligations and legislative context

2.1. Governance

There are three principal levels of government administration in Indonesia: National, Provincial and District. The government at national level is responsible for the management of national parks in Indonesia through the Ministry of Environment and Forestry. The province and district have their own local government and legislative body and play a key role in delivering services to the Indonesian community. Legislation is made at all three levels of Government.

Komodo National Park is administered by the Komodo National Park Management Office (*Balai Taman Nasional Komodo*) under the Directorate-General of Conservation of Nature Resources and Ecosystem (KSDAE) of the Ministry of Environment and Forestry. Komodo National Park is located in West Manggarai district in East Nusa Tenggara province. The park office is located in Labuan Bajo, the capital of the West Manggarai district, a city with a population of roughly 30,000 people in 2015 (Remmer, 2018).

The Komodo National Park was one of the first five national parks declared in Indonesia in 1980 and has been progressively added to, and complemented by the creation of adjoining conservation reserves.

The Park is managed in accordance with the following plans:

- 2010-2014 Strategic Plan
- 25 Year Master Plan for Management (2000-2025 Management Plan)
- Management zoning: the reserve is split into nine different management zone types (Decree No. SK.21/IV/SET/2012 of the Directorate General of Forest Protection and Nature Conservation)
- Masterplan Ecotourism Komodo National Park 2017 and 2018 Sustainable ecosystem management at Komodo National Park

2.2. World Heritage Site

Komodo National Park was inscribed on the UNESCO World Heritage List in 1991 in recognition of the site's **Outstanding Universal Value**. Once a site becomes a World Heritage property, the State Party must ensure that effective and active measures are taken for its protection, conservation and presentation as specified in the Operational Guidelines for the implementation of the World Heritage Convention[3]. In other words, becoming a World Heritage site is not only joining a prestigious list, it also comes with certain **responsibilities**. Inscribing a site on the World Heritage List is the beginning, and not the end of the story.

Governments and its agencies at all levels have the responsibility to ensure that the National Park has sufficient resources, staff and training to manage the property up to World Heritage standards. States Parties should do so in close collaboration with property managers, the agency with management authority and other partners, local communities and indigenous peoples, rights-holders and stakeholders in property management, by developing, when appropriate, equitable governance arrangements, collaborative management systems and redress mechanisms.

Site managers and local authorities continuously need to work towards managing, monitoring and preserving a World Heritage property.

States Parties have an obligation to regularly prepare reports about the state of conservation and the various protection measures put in place at their sites[4]. If a site is up for review by the World Heritage Committee, the World Heritage Centre will inform the State Party that a state of conservation report is due. These reports allow the World Heritage Committee to assess the conditions at the sites and, eventually, to decide on the necessity of adopting specific measures to resolve recurrent problems. One of such measures could be the inscription of a property on the List of World Heritage in Danger. The Committee can also request the State Party to invite a Reactive Monitoring mission to the property. All documents, reports and decisions are publicly available[5].

The statement of Outstanding Universal Value is the essential reference point for monitoring and evaluating the State of Conservation of a site[6]. The World Heritage Committee uses it as the benchmark against which they weigh any decision regarding a sites' state of conservation, danger listing or deletion from the World Heritage List. Making Outstanding Universal Value the central focus of your management actions from the start will facilitate your World Heritage reporting activities. The statement of Outstanding Universal Value for the Komodo National Park is available in Appendix 1.

[3] http://whc.unesco.org/en/guidelines/
[4] https://whc.unesco.org/en/soc/
[5] For Komodo National Park see http://whc.unesco.org/en/list/609/documents/
[6] For Komodo National Park see http://whc.unesco.org/en/list/609/

Note

As specified in article 172 of the Operational Guidelines, States Parties to the Convention are to inform the World Heritage Centre of their intention to undertake or to authorize in a World Heritage site major restorations or new construction which may affect the Outstanding Universal Value of the property. Notice should be given as soon as possible (for instance, before drafting basic documents for specific projects) and before making any decisions that would be difficult to reverse, so that the Committee may assist in seeking appropriate solutions to ensure that the Outstanding Universal Value of the property is fully preserved. Any development proposal should be subject to an Environmental Impact Assessment which assesses possible impacts on the Outstanding Universal Value as per the IUCN World Heritage Advice Note on Environmental Assessment[7].

2.3. Biosphere Reserve

Biosphere Reserves are internationally designated sites recognized by UNESCO's Man and the Biosphere (MAB) Programme that include terrestrial, marine and coastal ecosystems.

As of 2020, there are 701 Biosphere Reserves distributed around the world. Each Biosphere Reserve fulfils three basic functions – providing for conservation of significant biodiversity, stimulating sustainable local development in harmony with established conservation objectives, and supporting these processes through international networking, research, education and public engagement. Biosphere Reserves also comply with a specific zonation arrangement by which each reserve is spatially organized into one or more core, buffer and transitional areas. Core areas are normally recognized as protected areas by law, while other zones may or may not be. In this sense, Biosphere Reserves are not conventional protected areas, but rather more expansive units of management within which specific conservation objectives are achieved within a wider, integrated management framework.

The *Komodo Biosphere Reserve* was established under the UNESCO Man and the Biosphere Programme in January 1977, comprising Komodo Game Reserve (33,987 ha), Rinca Island Nature Reserve (19,625 ha), Padar Island Nature Reserve (1,533 ha), Mbeliling and Nggorang Protection Forest (31,000 ha), Wae Wuul and Mburak Game Reserve (3,000 ha) and surrounding marine areas (130,177 ha). In 2014, the Biosphere Reserve was significantly enlarged, and a new management framework developed in order to allow the site to better fulfil its three functions.

Today, the Komodo Biosphere Reserve covers an area of more than 1.1 million hectares stretching from the entire western part of Flores in the east to the eastern tip of Sumbawa in the west. In conformity with Biosphere Reserve zonation principles, Komodo's core area now corresponds to the national park around which it is developed, surrounded by buffer and transitional areas. Activities of the Biosphere Reserve are coordinated by the Komodo National Park authority, while a coordinating committee with membership by multiple stakeholders in the wider region has been established to support the integrated management and development of the site.

[7] https://www.iucn.org/sites/dev/files/import/downloads/iucn_advice_note_environmental_assessment_18_11_13_iucn_template.pdf

3. Komodo National Park: current status and future challenges

3.1. Trends, pressures and drivers

Komodo National Park and surrounding areas have been identified by the Indonesian Government as a tourism priority focus area. The Indonesian Government has identified five 'super-priority destinations': Borobudur (Central Java), Lake Toba (North Sumatra), Mandalika (West Nusa Tenggara), Labuan Bajo-Flores (East Nusa Tenggara), and Likupang (North Sulawesi)[8]. This project is part of a broader national government initiative to establish ten new tourist hubs to replicate the economic effects of tourism in Bali nationally. To reach this goal visitor numbers are targeted to grow to 500,000 international tourists and 1,000,000 domestic tourists.

More than 55% of tourists coming to Komodo are international and there has been a rapid rise in visitation in the last decade. Visitor data 2018 and 2019 from Tourism Office of West Manggarai District demonstrate this rapid rise from only 350 visitors in 1975 to an annual visitation of 221,703 in 2019[9]. If the promotion of the region is successful, the visitation could grow to a targeted 500,000 international tourists in the near future (Taman Nasional Komodo & World Wildlife Fund, 2017). The local regional population is also growing steadily in step with the development of tourism in the region, and currently about 1,800 people live in village communities within the national park boundaries.

To manage Labuan Bajo and its surrounding as a super priority destination, based on Presidential Decree No. 32 of 2018 dated 5 April 2018, the government established the Labuan Bajo Flores Tourism Authority Agency (Badan Otorita Pariwisata Labuan Bajo Flores (BOPLBF). This includes initiatives for a number of infrastructure and tourist facilities constructed in and around Labuan Bajo.

To meet the surge in tourist demand, the government will expand the local airport, Komodo Airport, into an international airport. At the moment the airport is connected through Jakarta and Bali with a total of nine flights per day. It has also allowed cruise ships and yachts to berth here and cruise ship visitation is now a significant proportion of the Parks annual visitation.

The pressures on the marine environment are expected to rapidly escalate due to the following drivers:

- The growth of the population of Labuan Bajo and surrounding towns and villages
- Increased demand for marine products to service the local population and visitor demands
- Increasing coastal development and associated impacts on water quality and litter
- Increased visitation that will result in significantly more boats, divers, and visitors to key visitor sites
- A progressive spread of tourism activities into 'new' more remote areas as it becomes busier and traditional dive sites become overcrowded
- Increased popularity of cruise ships.

Given the above drivers, the key pressures and concerns for the Outstanding Universal Value of the KNP marine environment include:

- Physical damage to coral reefs from anchors and divers (including from unexperienced/new divers and snorkelers)
- Illegal fishing practices (e.g. dynamite or poison fishing and poaching)

[8] The Jakarta Post January 17, 2020 accessed online on the 6 March 2020
[9] Source: Komodo National Park. Data is based on tourist's visit. No record on tourist data.

- Unsustainable extraction of fish and other marine products
- Impacts to marine water quality from land based (e.g. siltation, village pollution and sewage) and boat based (sullage) sources
- Litter and plastic pollution (from land and boat)
- Impacts to marine fauna (e.g. turtle egg removal, take of sharks and mantas)
- Climate change (increased water temperatures causing heat stress on corals[10]).
- Coastal development (loss of habitat, increased population).

Another social impact of increasing visitation could be overcrowding leading to reduced eco-tourism visitor experience and damage to the Komodo tourism 'product' which is based around experiencing the natural untouched marine features.

3.2. Komodo National Park management capacity and financial resources

Effective natural resource management is reliant on sufficient resources to undertake the suite of activities that are required for the management of World Heritage sites. Resources generally comprise:

- Financial (Government allocations plus revenue from Park) to support salaries and major management costs (e.g. fuel, maintenance)
- Staff (sufficient people, appropriately trained and qualified)
- Appropriately located offices, workshops and accommodation
- Equipment (computers, boats, vehicles, diving equipment, monitoring equipment, etc.)

Table 1 KNP Visitation, management budgets, and visitor fee revenue over the last 10 years

YEAR	KNP Funding (Actual M. Rup.)	Annual visits to KNP	KNP Funding Resource per visitor (M. Rup.)	Annual return from visitor fees (M. Rupiah)	Visitor fees per visitor (M. Rupiah)	Source
2009	7,944	36,534	0.22	678	0.02	KNP Office
2010	11,670	44,672	0.26	1,484	0.03	KNP Office
2011	14,550	48,010	0.30	2,992	0.06	KNP Office
2012	15,190	49,982	0.30	3,320	0.07	KNP Office
2013	20,700	63,801	0.32	4,414	0.07	KNP Office
2014	17,395	80,626	0.22	5,490	0.07	KNP Office
2015	17,045	95,410	0.18	19,288	0.20	KNP Office
2016	13,444	107,711	0.12	22,816	0.21	KNP Office
2017	39,999	125,069	0.32	29,095	0.23	KNP Office
2018	29,249	176,834	0.17	33,124	0.19	KNP Office
2019	20,718	221,703	0.09	38,001	0.17	KNP Office

The principal source of funding for these requirements is the Government, however this may be supported by funding and activities by NGOs, research institutions, donors and other groups.

[10] See projected climate change impacts for Komodo's coral reefs in the 2018 UNESCO scientific assessment: http://whc.unesco.org/en/news/1878/

Whilst KNP does get some benefit from the revenue from visitor fees, not all funds are returned for management.

Table 1 outlines management budgets, visitation and visitor fee revenue over the last ten years.

Key points:

1. Funding for KNP increased steadily from 2009 to a peak in 2017 but has subsequently reduced to almost half this amount in 2019
2. The visitation has increased markedly over the last ten years, but budgets have not grown proportionately (Figure 1)
3. The amount of funding related to visitation has significantly decreased over the last ten years (see Figure 2)

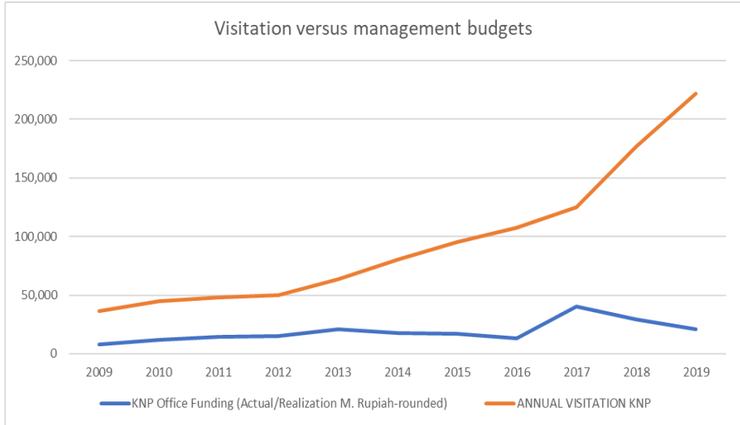

Figure 1 KNP budgets compared with visitation to the Park

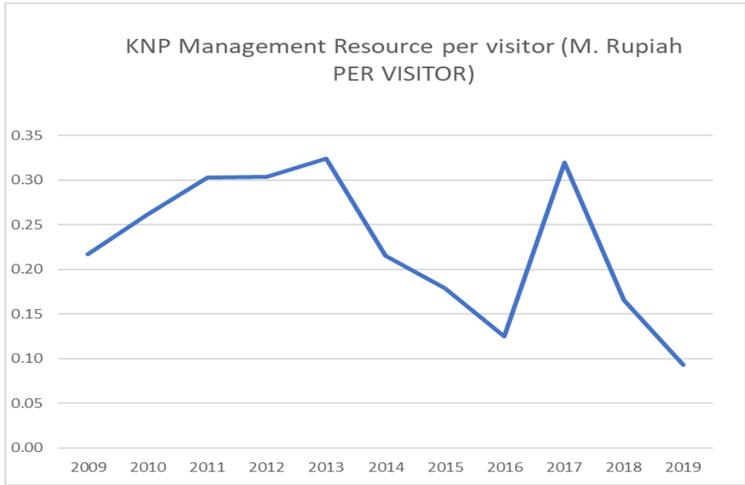

Figure 2 Management funding for KNP per visitor to the Park

Currently there are insufficient management resources to manage the KNP's marine area effectively. Key management activities are either not undertaken or are inadequate. The Park is

large and, as visitation and other activities increase, the limited staff resources for KNP are increasingly stretched.

The funding available for management per visitor has dropped in half over the last ten years. Increasing number of tourism boats, and visitors require close management if the impacts of these activities are to be managed effectively and degradation of the marine environment avoided.

There is a strong case and need for an injection of resources including:

- Increased overall management budget allocations to KNP that reflect predicted visitation (i.e. there should not be a time lag, otherwise budgets will always be insufficient)
- Additional management staff with appropriate qualifications and skills to deliver the full suite for management activities (with a priority on marine management expertise)
- Additional equipment, particularly boats and marine infrastructure (e.g. moorings, signage) capable of servicing the broader marine area quickly and efficiently.
- Return of all (or a significant component of) revenue generated in the Park by tourism entry fees and licences to the management agency to facilitate administration, monitoring and on ground management of tourism activities.

3.3. Knowledge gaps

'Knowledge' of the environment, its processes, human activities, impacts and trends is critical to effective management of the World Heritage Property and its OUV. Knowledge is generally informed by both research and monitoring programs. These are both important and there is a strong interaction between the two programs. The role of environmental research and monitoring is to understand the structure and functioning of ecosystems and the implications of human usage on the environment. This allows any undesirable impacts of human activity on the environment to be managed more effectively. Research should be focused on identifying and filling gaps in basic knowledge of the ecological and social values and processes of an area and on understanding the natural and anthropogenic pressures on these values. Research can be broadly classified as:

- Inventory: 'snap-shot' descriptions of the ecological and social values of an area;
- Baseline: the variability, in space and time, of the ecological and social values of an area;
- Process: research linking natural or human 'forcing factors' with changes in the ecology or human use of an area; the ultimate target being clear cause-effect links but this may not always be possible; and
- Prediction: models, risk assessments and other attempts to predict the future responses of natural systems to existing or proposed pressures from natural or human sources.

Monitoring provides ongoing information about interactions between the natural system and human usage. Monitoring trends in key indicators (i.e. performance measures) to assess changes in the natural system, human uses and pressures is an essential component of management. Monitoring provides an assessment of the effectiveness of management in meeting objectives by providing the basis for status reports against management targets, detecting undesirable trends and, if necessary, providing the trigger for remedial action.

The design of monitoring programs should reconcile the spatial and temporal scales of the values being impacted with the spatial and temporal scales of the identified activity or pressure/s. Monitoring parameters should also be clearly linked to a specific human pressure-value pathway and should provide information sufficiently 'early' in this pathway to allow effective implementation of remedial action. Similarly, monitoring programs should be designed to ensure the minimum detectable difference of the monitoring parameter/s (i.e. the 'sensitivity' of the monitoring program in detecting change) is reconciled with the time and space scales of decline and remedial action.

Currently KNP does not have specific research programs about the current condition and trend of the marine environment and the marine OUV (e.g. habitats of species, abundance and variety of species, behaviour, etc. for coral reefs, mangroves, megafauna). There is a need for biodiversity surveys, regular reef checks, small and large fish monitoring, sea turtles monitoring, mangrove forest mapping (identification and monitoring) and oceanographic research (e.g. on the dynamic currents for which Komodo is famous). More research is also needed on the impacts of climate change on ecosystems and communities (sea level rise, coral bleaching, etc.).

There is a need for research on the current condition and trend of human uses of the KNP. Currently there is no specific social research looking at impacts from tourism, fishing industry, waste and marine debris, and the relationship between humans and wildlife. There is a need for studies on tourism valuation, tourists' willingness to pay (WTP), human-wildlife relationship, and tourist carrying capacity system.

In terms of management capacity, there is a need for training for the Park Rangers on marine and tourism management in general, which might allow to streamline several existing plans in one overall framework, on how to evaluate current management plans and how to use OUV as a baseline to measure management effectiveness.

Given that resources for monitoring and research are limited it is critical that the limited resources that are available are diverted to programs that deliver knowledge that is most important in respect to management. A common issue in natural resource management is that research and monitoring programs historically have focused on things that:

- areas or processes that are convenient/easy to work on; or
- natural values that are 'charismatic' or have greater public interest; or
- areas of a particular researcher's specialty or interest; or
- where external funding is available.

This can lead to research and monitoring occurring on 'popular' and well researched aspects, rather than on critical knowledge gaps that are necessary and important for management. The key point is that whilst all research and monitoring may have value, it is important to rationally review and determine what is the greatest knowledge need to inform and improve management effectiveness. This prioritization process needs to take account of three critical elements:

- an assessment of the importance of the ecological values (their ecological, biodiversity and social significance);
- an assessment of the pressures (i.e. their intensity, spatial scale, temporal scale and consequence and probability); and
- the adequacy of current knowledge.

It is recommended that Komodo National Park undertake a process to determine priorities for research and monitoring to drive future programs and prioritization of management resources. Frameworks for determining research and monitoring priorities exists and have been used for other World Heritage Properties[11].

[11] A strategic framework for marine research and monitoring in the Shark Bay World Heritage property. C.J. Simpson, J.G. Colman, A.K. Hill, 2002

4. Guidance towards a Best Practice Framework for Komodo National Park

The workshop used the general structure of the Best Practice Guide for World Heritage Marine Sites developed by UNESCO in 2015 (UNESCO, 2015)[12]. This guide was developed for site managers based on best practices and management success stories from many other World Heritage marine sites. Whilst all World Heritage sites are different in cultural and environmental settings, there are generic issues which are common to all sites. Underlying the guide is a focus on ensuring the Outstanding Universal Value for which the property was inscribed is safeguarded for current and future generations. The guide also provides a framework for ensuring an effective management approach.

Based on the workshop discussions, the current status of KNP has been broadly considered below against the four Steps outlined in the guide to enable a structured way of addressing current challenges, and determining areas where management could be strengthened to ensure the Outstanding Universal Value of the Komodo National Park World Heritage site is maintained into the future.

4.1. STEP 1 Where are you today?

The principal goal of all World Heritage marine management is the preservation of the assets for which the site was inscribed on the World Heritage List, collectively known as its Outstanding Universal Value (OUV). When a site is inscribed on the World Heritage List, the State Party takes the responsibility to ensure the site's exceptional features will be conserved so they endure through government transitions, and so the OUV is the logical foundation for management planning and action.

The OUV is central to any World Heritage site and serves as the reference point against which the state of conservation of a World Heritage site is monitored and evaluated. It is the benchmark on which the World Heritage Committee makes decisions to inscribe a site on the UNESCO *List of World Heritage in Danger List* when the OUV is substantially deteriorating, or to scrap a site from the list all together if the exceptional values are irrevocably lost.

The OUV can be distilled into the core elements to identify measurable objectives for your site that can guide all your management actions, legislation and regulations, incentives, spatial planning and zoning, surveillance and monitoring, enforcement and compliance, and resolution of conflicts.

Best Practice OUTCOME	**Status for Komodo**	***Recommendations***
Clear goals and objectives derived from your OUV that define what you manage for;	Whilst KNP does have plans and documents that outline clear goals and objectives, these are not explicitly linked to the OUV. There are also some potential inconsistencies with Government objectives for the Region with a strong current push for a significant expansion of tourism and coastal development. Potentially this regional development could conflict with the overall goal of protecting the OUV if not managed appropriately.	*Review Park management plans and policies, to ensure that they clearly and explicitly use World Heritage OUV as an underlying goal of Park management and ensure alignment between OUV, management objectives and actions.* *There needs to be consideration of how the Governments goals of social and economic development for the Region can be best integrated and implemented to ensure a stronger fundamental emphasis on protecting the Komodo OUV and environmental values on which tourism will be based in the future. Where appropriate regional plans and policies may need review to ensure they are compatible with, and support, the Parks objectives.*
An understanding of your planning boundaries and your implementation boundaries;	Planning boundaries are well understood for the Komodo protected areas. However, there are environmental issues and impacts to the Park that are external to the boundaries of protected areas. As the local population builds, tourism increases and coastal development issues particularly relating to marine water quality and waste management will become more important to manage to protect the OUV.	*The long-term protection of the KNP will not only be a function of how well the Park is managed within its boundaries, but also a function of broader environmental protection outside the Park, in particular in the light of current and future development plans for the region promoted by different government agencies.* *Long term regional environmental planning and implementation of regional environmental strategies should be implemented with a focus on protecting regional marine water quality and improving waste management, and ensuring the sustainable management of local fisheries.* *Effective partnerships with local communities, NGOs and all stakeholders should be strengthened. Educational programs to educate and involve young people should be developed. Nearby schools should explore to join the UNESCO Associated Schools Network.*

[12] https://unesdoc.unesco.org/ark:/48223/pf0000235316_ind

Best Practice OUTCOME	Status for Komodo	Recommendations
Spatial and temporal distribution of key features of your OUV and their current condition;	Whilst there is a broad understanding of the spatial distribution of the ecological and aesthetic features, more comprehensive environmental information on the distribution of features and the OUV to inform management would be useful and should be encouraged wherever possible.	*Limited resources for environmental surveys and knowledge development should be focused on assessing ecological status, and periodic monitoring of high-risk sites in the Park to inform the effectiveness of management activities (such as education, compliance, licensing). Monitoring objectives should also be clearly linked with management objectives.*
Spatial and temporal distribution of human activities that (might) affect the OUV;	Given the potential threats posed by current human use, a priority focus should be on assessing and monitoring the condition and status of high use areas. This is important as it enables management to take timely action to control human activities to ameliorate the impacts before they become significant to the maintenance to the OUV. Whilst there have been past monitoring programs for human activities (e.g. TNC program), there is currently no comprehensive program across the Park to monitor, store and regularly assess human use data. Given the rapid rise in both visitor numbers and rapid spatial changes in use (i.e. where operators find new dive sites for example), this is a major impediment to an effective best practice management model. This should be a priority area for improving the management of Komodo to monitor changes in pressures in real time, and ensuring management is responsive to changes in human uses.	*Develop a structured human use monitoring program considering;* • *Key pressures on ecological values* • *Usage patterns -numbers of visitors/ operators/boats, types of activities* • *Spatial distribution of activities* • *Predicted changes in human use and likely 'hotspots'* • *The range of agency data collection currently occurring through the various Government agencies and tiers of Government (i.e. maximise cooperation through formal data sharing arrangements and to minimise duplication of data collection).* • *Potential partners for low costs data collection opportunities such as tourism operators, citizen science programs, remote data (e.g. GPS reporting), and through Government administrative activities (e.g. as a condition of licencing for operations within the Park).* • *Past data collection (i.e. take opportunities to build on past datasets (where relevant) to enable long term data series* • *Processes to review and store data to is publicly available and easily accessed for management purposes* • *Formal processes for the regular review of human use, to establish trends and need for management intervention.*

Best Practice OUTCOME	Status for Komodo	Recommendations
Assessment of conflicts and opportunities that define where to prioritize management action;	This is strongly related to the above point. Without a structured program to collect and store human use data, it is difficult to prioritise management actions to where they are most needed. If the above program is developed, the next step is to have a structured way of assessing the patterns and changes in use to inform management priorities. Ideally this should be done on a regular basis (e.g. annual) to assess progress with a structured process to formally review management plans and policies every 3-5 years.	*As above. The performance management system should include process to review trends and emerging issues, to enable proactive management measure to be implemented before major impacts occur to the Komodo values.* *This process needs to regular, formalised (i.e. developing agency reports tracking changes) and transparent (i.e. available to the community, stakeholders etc).*

4.2. STEP 2 Where do you want to be?

The most challenging issue for State Parties with responsibility for World Heritage marine sites is how to balance the conservation of the site's irreplaceable values with the increasing or shifting demands for socio-economic development and uses. Decisions may be taken in reaction to economic development driven by commercial forces without a full understanding of the long-term implications of these decisions. Given the global significance of World Heritage marine sites, their irreplaceable value for humanity, and the rapid increases in tourism and associated infrastructure developments that often result from such designation, World Heritage marine sites are particularly vulnerable when a clear vision for the future is not clearly enunciated.

This step is about looking to the future and gaining an understanding of socio-economic and environmental trends and likely scenarios for the World Heritage Site. It requires a good understanding of current human uses and development, status of the OUV, and how pressures and threatening processes are likely to change in the future and the likely impacts of these pressures on the OUV.

Considering different possible future scenarios for the site enables managers to understand the implications of the decisions made today. Knowing where you are going enables you to steer away from reactive, case-by-case decision making toward an approach in which the sum of all your combined efforts moves you toward your desired future. For all World Heritage marine sites, the desired future reflects a status in which the site's OUV is sustainably conserved and protected.

Best Practice OUTCOME	Status for Komodo	Recommendations
A trend scenario illustrating what your OUV will look like if present conditions continue without new management interventions;	This has not been undertaken for Komodo. The Carrying Capacity Project is considering limits on eleven dive sites but trend scenarios for the complete World Heritage site have not been undertaken. The emerging future is one of significant increases in tourism and regional development. This emerging scenario needs to be more fully considered in light of the likely impacts on the OUV. There is concern from stakeholders that current plans and management arrangements do not fully acknowledge and take account of the new policy to promote and develop the Region. These plans may not be sufficient to protect the World Heritage values in this new high use scenario.	*There needs to be a consideration of the future development of the Region and the implications for Komodo in terms of visitation, use of the Park for tourism, demands on natural resources (i.e. water, fish, wood etc), natural resource impacts (e.g. marine water quality, litter).* *Likely trends and scenarios for the World Heritage site need to be developed as part of management planning processes, to determine the management actions and interventions that will be required to ensure long term protection of the OUV.* *Trends in OUV should also be linked to impacts on social and economic benefits.*
Alternative spatial scenarios illustrating distribution of human activities depending on the objective you prioritize;	This has not been undertaken for Komodo. The Carrying Capacity Project is considering limits on individual dive sites but an issue is that as dive sites become crowded operators are moving to new previously 'undiscovered sites'. The reality is that spatial use is changing quickly as visitation increases and more natural experiences are sought. Managers may find it difficult to keep pace with these changes and may be a step behind in dealing with impacts from tourism.	*As a part of the above broad process, a finer scale consideration of the likely trends in spatial use and intensity of use in the Park should be undertaken (e.g. location of fishing, illegal poaching, access local communities inside the Park). This would be important to inform the development of the next management plan for the KNP, and in particular changes to spatial management of human use through spatial controls and management zoning. It would also allow making sure that local communities can benefit more from tourism activities. Good decisions on revised zonation or regulation of activities require sufficient information on likely trends in spatial use and intensity of use.*
A desired future for your World Heritage marine site that provides the basis for identifying and selecting management measures.	This has not been undertaken for Komodo. The Carrying Capacity Project is considering limits on individual dive sites but an issue is that as dive sites become crowded operators are moving to new previously 'undiscovered sites'. The reality is that spatial use is changing as visitation increases and more natural experiences are sought.	*As a part of the above broad process, a finer scale consideration of the likely trends in spatial use and intensity of use in the Park should be undertaken. This could be done through field surveys (aerial/boat/land based/digital surveys of users) and through anecdotal sources (e.g. expert/stakeholder forums). Ideally an accurate baseline 'picture' needs to be established which can then be regularly monitored to allow for trends to be identified. This would be important to inform the development of the next management plan for the KNP, and in particular changes to spatial management of human use through spatial controls and management zoning.*

4.3. STEP 3 How will you get there?

In managing World Heritage marine sites, the central focus is on human activities and their effects on the OUV of your site, both today and in the future. We cannot 'manage' the environmental processes, but we can control and influence the human activities occurring in and around the World Heritage marine site. We can influence where, when, how, and at what scale these activities occur in order to minimize their effects on critical elements of the OUV. We can even decide not to let them take place within the site at all.

The management plans and actions that are implemented should collectively work toward the conservation of the OUV. Therefore, management actions in your site should be connected to the goals and objectives set for the World Heritage Site and to indicators that will help you measure their effectiveness. Typically, a combination of different management actions will be implemented to achieve the desired future scenario identified in the previous step. In most situations, existing knowledge can provide information about the pros and cons of each possible management action and help you reduce the range of options that are practical and feasible. Since all activities, as well as the functioning of the marine and coastal ecosystem itself, occur in space and time, management actions that specify where and when human activities can or should occur will be an essential part of any management toolbox. Spatial and temporal management measures are typically implemented through a zoning system and aim in particular to minimize conflicts between protection and human use or among the human activities themselves.

Best Practice OUTCOME	Status for Komodo	Recommendations
A set of management measures that will lead to your site's desired future;	There are a range of plans in place for Komodo. However, these need to be reviewed to consider the rapidly changing patterns of development and human use, and to ensure management strategies are sufficient to protect the OUV in this changing economic landscape.	*Strategic planning is needed to develop a shared vision within the various tiers of Government and agencies. This planning needs to focus on the ultimate outcomes that are desired for the Region (social, economic and*

Best Practice OUTCOME	Status for Komodo	Recommendations
	Current plans are very much terrestrially focussed and do not adequately deal with the emerging issues and requirements for more intensive marine management associated with rapid escalation in marine use.	*environmental) with a realistic consideration of how these could be met.* *Strategic objectives that drive various levels of Government are needed to ensure that environmental values, on which social and economic development is largely based, are not ultimately degraded.* *Management plans need review to ensure an appropriate focus on marine management pressures, activities, issues and management requirements.*
A set of incentives that can stimulate implementation of the management measures;	This wasn't discussed specifically at the workshop, however, is important from a broad perspective in generating positive actions for protection of the World Heritage Site.	*Consider the incentives that may be applicable to stimulate action for the protection of Komodo into the future.*
A cost-effective and efficient compliance monitoring system;	Monitoring of park activities does occur in the Park, however, is restricted in the marine environment by limitations in staff resources, equipment, and financial resources; and complicated by the complexity of Government responsibilities for activities and legislative mechanisms. Building a stronger culture to ensuring compliance and enforcing restrictions on human activities is critical to protecting the OUV. There is a strong link between monitoring of human use and compliance. In fact, a knowledge of what activities are occurring, when and where is instrumental to planning and implementing education, information and where required enforcement activities.	*With expanding tourism use, large number of operators and greater pressures, a much stronger emphasis on effective compliance is recommended. Other World Heritage sites have learnt that without a very structured and firm control of tourism activities impacts will occur. Actions to strengthen the compliance system is recommended. This should start with a review to consider Government tiers/agency responsibilities for compliance, the adequacy of legislative mechanisms, agency culture towards enforcement, resources and implementation. This closely related to actions relating to human use monitoring discussed earlier.*

Best Practice OUTCOME	Status for Komodo	Recommendations
A list of the institutional arrangements, including partnerships, that collectively bring the authority and resources needed to ensure implementation of management actions;	Komodo has a complex Governance arrangement. This is not unusual for World Heritage sites and is commonly the scenario across the World. There are three tiers of Government (National, Provincial and District) who have various roles and responsibilities for activities both within and activities outside the Park which have impacts on the management of the Park. There are also agencies within the National Government (particularly the Ministry of Environment and Forestry, Ministry of Tourism, Ministry of National Development Planning (BAPPENAS) and Ministry of Public Works), and other partners such as Police for law enforcement and the Ministry of Transportation for boat permits. These agencies have differing legislative responsibilities and objectives which impact directly on the management of Komodo. Concerns have been raised about potential inconsistencies and conflicts between the various roles and responsibilities within Government. How these are being brought together to ensure a shared vision and a compatible suite of cross Government management initiatives that contribute to positive outcomes for the World Heritage site is a major concern for the future.	*Whilst the management and protection of Komodo is the responsibility for the Ministry of Environment and Forestry, this agency will not be successful in achieving its objectives without the support of the various Government entities that play a role in management of development and activities that may influence and impact upon Komodo.* *Strategic planning and developing Government mechanisms to achieve this into the future was a key consideration in workshop discussions. The successful integration of Government activities towards common objectives for Komodo represents a challenge but one that is particularly important for the future as the Region grows.*
A clear "elevator pitch" and plan for using the World Heritage brand to engage partners and attract resources.	The use of the World Heritage brand is limited currently and this represents an opportunity to build support and partners to assist in protecting the area.	*Consider ways in which Komodo can better use the World Heritage brand to develop support, partners, resources and assistance in addressing management challenges and meeting long term objectives.*

4.4. STEP 4 What are you achieving?

The development of management plans and implementation of management actions are an essential foundation for the Site. However, changes in human activities, the environment are inevitable, and management may not be effective in conserving the OUV. The planning and management of World Heritage marine sites should be conducted as an iterative and ongoing process called "adaptive management." If your management system is sufficiently robust and adaptive, it can help ensure that your site's OUV endures through changing circumstances. Change influences both the state of your site's OUV and the impact of the actions you take to protect it.

Change can take many forms, including environmental change, shifting political priorities, or new economic realities. For example, climate change might influence the location of important species in the site over the coming decades. Technological change might make the exploitation of previously inaccessible resources possible in the site. New development projects might influence the amount of pollutants discharged from land-based sources and subsequently alter the environmental quality of certain locations in your site or features that make up your OUV. The availability of this new information may change your understanding of your site's OUV, and this may lead you to adjust your management actions.

All of these changes, while usually external to the management process, are likely to affect the desired outcomes you have identified for the conservation of the OUV. It is therefore essential that you regularly monitor the State of Conservation of your site, the impact of your management actions, and changes in conditions in and around your site. Based on the results, you are likely to adapt your goals, objectives, and management actions. The adaptive process relies on changes being made in a timely manner and hence the monitoring, review and adaption cycles need to be frequent and built into the management model for the Site.

Best Practice OUTCOME	**Status for Komodo**	***Recommendations***
An effective monitoring and evaluation system;	There has been historical ecological and human use monitoring in Komodo, and management agency and NGOs are undertaking programs currently. These are an excellent start to building a performance assessment model, however there are aspects of the system that are missing and need development to ensure an effective monitoring and evaluation system that links to a broader performance management framework for the Park. To develop a structured performance assessment framework the starting point is management plans that are outcome based and structured to clearly identify management targets and potential performance indicators.	*It is recommended that consideration be given to developing outcome-based targets/objectives linked to clear monitoring objectives, performance indicators, options for obtaining monitoring data (e.g. agency, citizen science programs, NGOs). There is a major opportunity to build and utilise the considerable interest in the tourism industry for citizen science. To progress this, it is recommended that a purpose-built monitoring program that monitors pressures and values (biological, social and economic), and is used to evaluate management effectiveness.* *These elements can be developed as part of management planning process with the involvement of stakeholders and experts in these areas. This process would consider how current (and past) data informs management and the assessment of performance.*
An understanding of whether you are achieving your objectives or are at least moving in the right direction;	Clear targets and outcome-based management objectives are needed to facilitate performance assessment processes. This supported with appropriate monitoring is required to enable an assessment of whether objectives are being met.	*It is recommended that as part of a management planning process (or as a separate Workshop process), a monitoring program for Komodo's marine area be established and prioritised in relation to a ranking of ecological values, assessment of risk (based on current and future human activity), and importance of data to inform management.* *This should be supported by a structured monitoring program that enables a regular (e.g. 3-5 years) assessment of the status of the values to inform changes required in management.* *Include a marine component in the Management Effectiveness Tracking Tool (METT).*
A set of priorities that define the adaptations you need to make to your management actions;	The 'feedback loop' for management (i.e. the stage of a *best practice framework* where you assess your management performance and make the necessary changes to your management approach) isn't formally expressed or a clear focus of the existing management plans or programs. Existing management plans are long term (i.e. 25 year plans) and fixed without the flexibility to make changes to management approach.	*A flexible and adaptable agency that can respond quickly to emerging trends should be the long-term end point.* *However, before this can be achieved there are a series of steps that must be undertaken first:* • *Appropriately structured management plans that allow a level of management flexibility to adapt and use new approaches and technologies where appropriate.* • *Structured monitoring programs (ecological and human use) sourcing sufficient data to make assessments (see above)* • *Structured processes to review data and assess its implications*

Best Practice OUTCOME	Status for Komodo	*Recommendations*
		• *Process to engage senior decision makes to identify performance* • *Processes to amend management approach or take affirmative actions to address emerging issues* *An Assessment of management effectiveness should follow the IUCN framework (https://www.iucn.org/content/evaluating-effectiveness-a-framework-assessing-management-effectiveness-protected-areas).*
A short list of research needed to inform future management.	Currently very limited.	*As part of a management planning process, identify the priority research needs based on assessment of pressures, values and the adequacy of current knowledge to inform management. An example model used previously for World Heritage Areas that could be considered is: A strategic framework for marine research and monitoring in the Shark Bay World Heritage property. C.J. Simpson, J.G. Colman, A.K. Hill, 2002. https://library.dbca.wa.gov.au/static/FullTextFiles/922521.pdf*

5. Future challenges and priorities for improving the management of Komodo National Park's marine area

Chapter 4 reviewed the existing management framework for Komodo against the UNESCO Best Practice Framework based on input from participants at the workshop and suggestions from stakeholders on how the management of Komodo could be improved.

Workshop participants were given the opportunity to consider what parts of the framework they believed were the highest priority to address moving forward to maximise management outcomes for the Komodo values. The results for this discussion are shown in *Table 2*.

The key areas of priority identified were:

- The need for Government to undertake high level strategic planning (i.e. across-Government programs and regional considerations)
- The need for management planning to consider marine OUV and provide a foundation to support a best practice management framework for the KNP
- An urgent need for Government to allocate sufficient resources for management of the national park's marine component
- Improvements in Governance and institutional frameworks to ensure a consistent vision and processes for management of the area
- Improvements in performance assessment and monitoring frameworks including the development of improved understanding of the spatial distribution of human use and pressures

Table 2 Priorities for improvement of the current management arrangements against the Best Practice Framework, based on workshop discussion and participant inputs.

URGENCY TO ADDRESS	BEST PRACTICE STEP	*OUTPUTS from Best Practice Guide*	Question posed to the stakeholders and managers of marine areas of Komodo
HIGHEST PRIORITY	STEP 2 Where do you want to be?	*3. A desired future for your World Heritage marine site that provides the basis for identifying and selecting management measures.*	***Do we need to amend our current vision, strategic objectives and overall management approach to guide future management and protection of Komodo?***
	STEP 1 Where are you today?	*4. Spatial and temporal distribution of human activities that (might) affect the OUV.*	***Do we need to know more about the human activities: who does what and where, and monitoring changes in use?***
	STEP 3 How will you get there?	*1. A set of management measures that will lead to your site's desired future.*	***Do we need to review and amend the Komodo management plan to ensure the future conservation of the marine values?***
	STEP 4 What are you achieving?	*1. An effective monitoring and evaluation system.*	***Do we have a clear structure and process to regularly assess whether the objectives of marine areas are being met?***
	STEP 1 Where are you today?	*1. Clear goals and objectives derived from your OUV that define what you manage for.*	***Do the management plans for Komodo need to be amended to make the OUV central to and drive future management direction?***
	STEP 3 How will you get there?	*3. A cost-effective and efficient compliance monitoring system.*	***Do we need to take action to improve the level of compliance with the rules and regulation in the marine areas?***

URGENCY TO ADDRESS	BEST PRACTICE STEP	*OUTPUTS from Best Practice Guide*	Question posed to the stakeholders and managers of marine areas of Komodo
MEDIUM PRIORITY	STEP 3 How will you get there?	*4. A list of the institutional arrangements, including partnerships, that collectively bring the authority and resources needed to ensure implementation of management actions.*	***Do we need more resources and greater management authority to ensure the conservation of the marine environment?***
	STEP 4 What are you achieving?	*2. An understanding of whether you are achieving your objectives or are at least moving in the right direction.*	***Do we need to know more about whether the marine environment is stable, declining or improving?***
	STEP 1 Where are you today?	*5.Assessment of conflicts and opportunities that define where to prioritize management action.*	***Do we need to know more about where conflicts are happening (now and likely to happen in the future) to prioritise management?***
	STEP 4 What are you achieving?	*3. A set of priorities that define the adaptations you need to make to your management actions.*	***Do we need to determine our management priorities and review our approach for management?***
	STEP 3 How will you get there?	*5. A clear "elevator pitch" and plan for using the World Heritage brand to engage partners and attract resources.*	***Can Komodo get greater benefit of the World Heritage brand in promoting and managing the marine area?***
	STEP 3 How will you get there?	*2. A set of incentives that can stimulate implementation of the management measures.*	***Do we need to develop more incentives for stakeholders and users to encourage better compliance and support for the marine park?***

URGENCY TO ADDRESS	BEST PRACTICE STEP	OUTPUTS from Best Practice Guide	Question posed to the stakeholders and managers of marine areas of Komodo
LOWER PRIORITY	STEP 4 What are you achieving?	*4. A short list of research needed to inform future management.*	***Do we need to determine the research priorities for the marine environment? Are the key needs clear and written down?***
	STEP 1 Where are you today?	*3. Spatial and temporal distribution of key features of your OUV and their current condition.*	***Do we need to know more about the spatial distribution of the marine values and OUV such as fish, corals, marine mammals etc?***
	STEP 2 Where do you want to be?	*1. A trend scenario illustrating what your OUV will look like if present conditions continue without new management interventions.*	***Do we need to better understand the trends in the parks marine environment to predict the outlook for the marine environment?***
	STEP 2 Where do you want to be?	*2. Alternative spatial scenarios illustrating distribution of human activities depending on the objective you prioritize.*	***Do we need to make changes to the current zoning for the marine areas to ensure the future protection and management of the Park?***
	STEP 1 Where are you today?	*2. An understanding of your planning boundaries and your implementation boundaries.*	***Do the outer Park/Reserve boundaries need to be amended to better incorporate the marine values of Komodo?***

6. Proposed steps towards improving the marine management of the Komodo National Park World Heritage Site

Three strategic priorities are highlighted that could improve the future management of the Komodo National Park for consideration by the Indonesian Government:

- Short Term: improving the effectiveness of marine management operations;
- Consolidated strategic direction and need for improved governance and coordination;
- Review of Management Plans and Operational Guidance documents with focus on marine.

1. Short Term: improving the effectiveness of marine management operations

KNP has a committed workforce that is working diligently to ensure the values of the Park are maintained. However, a number of areas have been identified where protection of the Outstanding Universal Value and other marine values could be significantly improved through more effective operational capacity, and the delivery of management programs such as compliance. This is an urgent need given that there is clear evidence that tourism, fishing and other human activities have increased, and continue to increase, in intensity such that they are progressively impacting on the values. These pressures will continue to build as Labuan Bajo is strongly promoted as a priority tourism destination, and as the local population grows to support the economic growth of the region. It is critical that a clear understanding is established in respect to the status (i.e. condition) of the environmental values, trends and how these changes are impacting on the environmental, social and economic values of the area.

Currently the local managers have limitations in respect to staff and financial resources, technical capacity, operational equipment, and assistance in addressing difficult marine management issues. A key issue is that the annual Park management budget is not directly linked to the visitation and lags behind the incremental and rapid growth in use of the Park. Ideally staff, equipment and financial resources should be in place to deal with the increasing activity and pressure to enable appropriate control and management of activities. If it takes several years to build a case for additional resources, it may well be too late with damage to the natural environment already significant and irreversible. Whilst the majority of visitation is marine focussed, a very small proportion of the budget is allocated for marine management, perhaps because the management plan is not very focused on marine.

Increased tourism has obvious economic benefits, however the impact on the KNP and managers is significant, and with rapid changes in use and pressures generally means that management is constantly trying to ‘catch up’ to cope.

Specific Action Required

Take immediate action to improve the effectiveness of Park management through:

- *An increased priority on marine management including greater financial, staff and equipment to facilitate marine education, compliance, and monitoring.*
- *Conduct a risk assessment to understand the current condition and trend of values and pressures, which would allow setting up the baseline monitoring, clearly linking monitoring objectives to management objectives.*

- *Operational budgets that are linked to predicted visitation and number of tourism operators for the coming year. There should be a direct link where budgets reflect annual visitation and revenue.*
- *Building capacity in legislative and enforcement programs, monitoring programs, and tourism management.*
- *Greater control over tourism operators (e.g. licences) in the Park, with increased focus on enforcement and tighter controls on operator standards, activities and impacts. This could be done through an online registration system for boat permits, environmental and operation standards for boat operators.*
- *An increased focus on compliance on all activities in the Park to drive positive changes in user behaviour.*
- *Increased focus on a coordinated human use monitoring program to track changes in spatial uses that will enable managers to respond in real time to emerging issues, impacts and to inform management activities (e.g. education program, compliance activities, monitoring and reporting).*
- *Resources for installation and maintenance of moorings for dive sites to minimise coral damage from anchoring. Currently there is an estimated 1000 tourist vessels yet only 20 moorings for use on key dive sites and tourist locations. There also needs to be an assessment how many moorings should be installed, and where, because more moorings lead to more visitors and thus more pressures.*

2. Consolidated strategic direction and need for improved governance and coordination

Whilst the direct day to day responsibility for protection of Komodo's natural 'jewels' sits primarily with local National Park management staff, the local managers have no control over the escalating pressures on the Park. Managers have major challenges dealing with the current level of use and the workshop identified impacts that are currently occurring. There are positive actions that can be implemented to improve the effectiveness of local management and improve the protection of the Komodo values. However, even with these improvements, managers are unlikely to be able to cope with the systemic impacts and issues arising from a major increase in the numbers of visitors, the increasing spatial spread of activities, and significant increases in the number of tourism operations.

The Labuan Bajo area has been identified as a tourism priority area with Government initiatives to increase the number of visitors to drive economic and social benefits to the Country, Region and local community. There is much public discussion currently within Government and the media on future tourism policy, visitation targets and how best to maximise community return form this industry. As the National Park is the major attraction in the region it would be safe to assume that there will be a significant and ongoing increase in visitation and associated pressures on Komodo. The presence of villages within the Park represents an ongoing and increasing pressure on the Park. This is a complex social issue, yet the impacts on the Park are real and need to be managed to minimise impacts on the Parks OUV.

The long-term sustainability of Komodo in the face of increasing tourism and associated development is a real concern for the managers, local tourism operators, NGOs and experts who attended the 2019 workshop. Of the 42 main dive sites, 50% are currently considered to be impacted by illegal fishing and anchoring. The unrestricted increase in the number of tourism operators and boats is a concern, and the national park managers appear to have little ability to limit or manage this growth. Government initiatives to increase tourism are a priority to promote economic growth and improve community outcomes. This is entirely understandable however the current policy and management framework is unlikely to ensure the long-term maintenance of the Komodo values. **The maintenance of Komodo's Outstanding Universal Value is essential to the long-term success of Labuan Bajo as a tourism destination. If not managed effectively the positive economic benefits of tourism will be short-lived.**

To achieve a sustainable future for Komodo there needs to be improved coordination across the three tiers of Government with a common objective of protecting the 'jewels' on which a successful future tourism development will be founded upon. Coordination is also required between different entities at each level e.g. MoEF, MoT, MoPW, MoP and so on at the national level. The workshop identified areas where there could be improved policy and strategic coordination across government to achieve more sustainable outcomes for Komodo. It is recommended that consideration be given by Government to reviewing and identifying how a consolidated vison could be developed for the region which ensures the protection of the jewels of the Region, and how the three tiers of Government can be better aligned and coordinated to achieve a long term sustainable use of the area.

Specific Action Required

Review the current policy and governance arrangements for the management of development, tourism and other human activities in the Labuan Bajo area with the objective that governance models should:

- *Place a primary strategic focus on the maintenance of the natural assets of the area which are the primary draw for the tourism industry.*
- *Ensure tourism and development policies for the area involve conservation agencies to ensure they are appropriately balanced and consider the likely impacts on the natural environment, and the capacity of agencies to manage increases in human use.*
- *Facilitate funding allocation models that deliver adequate and timely resources for management of human activities in the park and avoid 'a time lag' between increased use and increase in management resources. If the Park receives more visitors, it should also receive more resources to adequately manage those visitors.*
- *Deliver effective administration and management of activities in the region with effective communication, cooperation and partnerships between the three tiers of Government and between agencies.*
- *Ensure adequate legislative powers and support for management agencies to ensure effective compliance and management of human use.*
- *Establishing effective education, partnership and stewardship programs, so that stakeholders can be educated about the benefits derived from conserving and maintaining the World Heritage values.*

3. **Review of Management Plans and Operational Guidance documents with focus on marine**

The Worksop identified four key areas where the management plans for the area could be improved. It was identified that plans needed to more clearly and directly link the World Heritage OUV to the Park visions, management objectives and targets. There was also a need to have an increased focus on the management of the Park's marine environment which is likely to bear the brunt of future increased visitation, pressures and impacts. Plans ideally need to be outcome-based and structured around a best practice approach to natural resource management. This should include consideration of the adequacy of the current management zoning in light of the emerging changes in marine spatial use and the likely future escalation of tourism activities in the Park. This allows for clearer and more focussed management, and provides a better framework for performance assessment.

The workshop identified that a review of the KNP Management Plan was a key priority to update management approaches and provide a management framework that was flexible and adaptable to increases in pressures. If pressures were static and use not expected to increase, current management plans may be adequate. However, this is not the case with visitation climbing in recent years and the spatial footprint of human activities expanding rapidly.

Specific Action Required

Undertake a review of the Komodo National Park Management Plan in consultation with key stakeholders and the community. This process should include:

- *Build broad local community support and stewardship for the protection of the Park.*
- *Explicitly integrate the World Heritage Outstanding Universal Value for Komodo into management plans.*
- *Document human use and ecological values of the Park to provide a foundation for spatial management, monitoring and reporting*
- *An increased emphasis on the condition and trend of marine values underpinning OUV, their management and conservation, and the challenges arising through increased use of the marine environment*
- *Consider the challenges, potential impacts/scenarios and possible management solutions associated with the predicted escalation in tourism of the Park, and the projected impacts of climate change.*
- *Review the management zoning currently applied to the Park in light of changes in use patterns and intensity of activities, and possible impacts due to climate change.*
- *Update management plans, and associated policies and operational procedures that address the key requirements of a best practice management model.*

7. References

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8. Acknowledgements

The UNESCO World Heritage Centre's Marine Programme thanks all experts, World Heritage marine managers and participants of the 2019 Labuan Bajo workshop who provided their insights and shared some of their experiences. Special attention was given to the gender balance of the workshop participants. Special thanks are due to Mr Andrew Hill who developed this document for UNESCO. Sincere thanks are likewise due to the Komodo National Park for the arrangements made for the 2019 Labuan Bajo workshop, and for the provision of the data on visitation and available budgets. The contents in this document do not constitute a statement of policy, decision or position on behalf of the United Nations Educational, Scientific and Cultural Organization (UNESCO).

9. Appendices

9.1. Appendix 1: Statement of Outstanding Universal Value

SITE:	Komodo National Park
COUNTRY:	Indonesia
REGION:	Indian Ocean
YEAR OF INSCRIPTION:	1991
SIZE:	2 193,22 km²

Retrospective Statement of Outstanding Universal Value (2013)
Source: 37COM 8E: http://whc.unesco.org/archive/2013/whc13-37com-8E-en.pdf

Brief synthesis

Komodo National Park, located in the center of the Indonesian archipelago, between the islands of Sumbawa and Flores, is composed of three major islands (Rinca, Komodo, and Padar) and numerous smaller ones, all of them of volcanic origin. Located at the juncture of two continental plates, this national park constitutes the “shatter belt” within the Wallacea Biogeographical Region, between the Australian and Sunda ecosystems. The property is identified as a global conservation priority area, comprising unparalleled terrestrial and marine ecosystems and covers a total area of 219,322 ha. The dry climate has triggered specific evolutionary adaptation within the terrestrial flora that range from open grass-woodland savanna to tropical deciduous (monsoon) forest and quasi cloud forest. The rugged hillsides and dry vegetation highly contrast with the sandy beaches and the blue coralrich waters.
The most remarkable inhabitant of Komodo National Park is the Komodo Lizard, *Varanus komodoensis*. These giant lizards, existing no-where else in the world, are of great scientific interest, especially for their evolutionary implications. Most commonly known as 'Komodo Dragons', due to its appearance and aggressive behavior, the Komodo Lizard, is the largest living species of lizard, growing to an average length of 2 to 3 meters. The species is the last representative of a relic population of large lizards that once lived across Indonesia and Australia. As well as being home to the Komodo dragon, the Park provides a refuge for many other notable terrestrial species such as the orange-footed scrub fowl, an endemic rat, and the Timor deer. The rich coral reefs of Komodo host a great diversity of species, and the strong currents of the sea attract the presence of sea turtles, whales, dolphins and dugongs.

Criterion (vii): Komodo National Park is a landscape of contrasts between starkly rugged hillsides of dry savanna, pockets of thorny green vegetation, brilliant white sandy beaches and blue waters surging over coral, unquestionably one of the most dramatic landscapes in all of Indonesia. Demonstrating exceptional natural beauty that is all the more remarkable as a counterpoint to the dominant lushness of vegetation which characterizes vast areas of forested Indonesia, and with which most of the world associates the archipelago. An irregular coastline characterized by bays, beaches and inlets separated by headlands, often with sheer cliffs falling vertically into the surrounding seas which are reported to be among the most productive in the world adds to the stunning natural beauty of landscapes dominated by contrasting vegetation types, providing a patchwork of colours.

Criterion (x): Komodo National Park contains the majority of the world’s areas in which wild populations of the Komodo dragon lizard still exist. The largest and heaviest of the world’s lizards, the species is widely known for its impressive size and fearsome appearance, its ability to effectively prey on large animals, and a tolerance of extremely harsh condition. The population, estimated at around 5,700 individuals is distributed across the islands of Komodo, Rinca, Gili Motong and some coastal regions of western and northern Flores. Other fauna recorded in the park are characteristic of the Wallacean zoogeographic region with seven species of terrestrial mammal, including an endemic rat (*Rattus rintjanus*) and the crab-eating macaque (*Macaca fascicularis*) and 72 species of birds, such as the lesser sulphur-crested cockatoo (*Cacatua sulphurea*), the orange-footed scrub fowl (*Megapodius reinwardt*), and noisy friarbird (*Philemon buceroides*). The coral reefs fringing the coast of Komodo are diverse and luxuriant due to the clear water, intense sunlight and rapid exchange of nutrient-rich water from deeper areas of the archipelago. The marine fauna and flora are generally the same as that found throughout the Indo Pacific area, though species richness is very high, notable marine mammals include blue whale (*Balaenoptera musculus*) and sperm whale (*Physeter catodon*) as well as 10 species of dolphin, dugong (*Dugong dugon*) and five species of sea turtles.

Integrity

Encompassing the rugged topography that reflects the position of the park within the active volcanic “shatter belt” between Australia and the Sunda shelf, the boundaries of the Komodo National Park encircle the main park features, including the outstanding scenery and the unique species it hosts; komodo monitor, birds, marine mammals, coral reef-species, and others. The boundaries are considered adequate to secure the habitat and the main ecological processes to preserve them. The extensive marine buffer zone surrounding the park is key to maintaining the integrity and intactness of the property and the number of exceptional species that it hosts. Illegal fishing and poaching remain the main threats to the values of the property and its overall integrity. There is an extensive marine buffer zone to the park, in which management authority staff has authority to regulate the type of fishing permitted and to some extent the presence of fishermen from outside the area. This buffer zone, which assists in controlling poaching of the terrestrial species that provide the prey species for the komodo lizard, will become significant in the overall long-term protection of the property.

Protection and management requirements

Komodo National Park is managed by the central government of Indonesia through the Directorate General of Forest Protection and Natural Conservation of the Ministry of Forestry. The history of protection afforded the site goes back to 1938 while official protection began

when Ministerial Decree declared the area as a 72,000 ha National Park in March 1980. This area was subsequently extended to 219,322 ha in 1984 to include an expanded marine area and the section of mainland Flores. Comprised of Komodo Game Reserve (33,987 ha), Rinca Island Nature Reserve (19,625 ha), Padar Island Nature Reserve (1,533 ha), Mbeliling and Nggorang Protection Forest (31,000 ha), Wae Wuul and Mburak Game Reserve (3,000 ha) and surrounding marine areas (130,177 ha) the Komodo Biosphere Reserve was accepted under the UNESCO Man and the Biosphere Programme in January 1977. In 1990 a national law, elevating the legislative mandate for conservation to the parliamentary and presidential level significantly empowered the legal basis for protection and management. In order to ensure the effective management and protection of the park and its exceptional landscapes and biota, the park is governed through the 2000-2025 Management Plan and a 2010-2014 Strategic Plan, which will require revision and updating. These plans are important for ensuring the effective zoning system of the park and guaranteeing the sustainability of the ecosystems of the property. The management authority is known for designing specific plans to guide management decisions which will require updating in line with changes to priorities and threats, in particular expected increases in visitor numbers and impacts from tourism. The Park receives strong support and resources from the central government of Indonesia. As a tourism location known worldwide, the Indonesian Government has a specific program for ecotourism management to promote the park at the international level and to ensure the sustainability of tourism activities. Additionally, in order to address illegal fishing and poaching, regular patrolling of the marine and terrestrial areas is carried out for law enforcement and a number of the problems and impacts associated with these activities have decreased. Community awareness and empowerment programs are being implemented to engage the local villagers regards to the sustainable use of natural resources and park conservation. Research and study of the unique biological features of the park is also being promoted and supported by the management authority. Increasing levels of tourism and matters related specifically to the komodo lizard are the major management issues that have been focused on to date. A broadening of the management focus to address issues within the marine area of the park along with other terrestrial species is required to ensure the long-term effective conservation of the property. A focus on the issue of depletion of Komodo monitor prey species stocks has resulted in some success and the same efforts need to be focused on the issues of damaging fishing practices and impacts on other unique species contained within the property.

9.2. Appendix 2: Workshop Agenda

United Nations Educational, Scientific and Cultural Organization · World Heritage Convention

MARINE WORLD HERITAGE WORKSHOP
Protecting the Outstanding Universal Value of Komodo National Park World Heritage site

Komodo National Park - Indonesia
25 - 29 November 2019

Venue: Bintang Flores Hotel, Labuan Bajo

Objectives:

Capacity building in support of the development of the marine management of the Komodo National Park World Heritage site by bringing together key expertise from the UNESCO marine World Heritage network.

Key outputs include:

1. Participants understand the concept of Outstanding Universal Value (OUV) and what it means to be a World Heritage site, in particular the Komodo National Park.
2. Definition of the challenges in maintaining the OUV of Komodo (threats and solutions)
3. Strengthened capacity at the Komodo National Park on monitoring / research on Komodo National Park's OUV
4. Strengthened capacity at the Komodo National Park on data management (data collection, data storage and data analysis)
5. Partnership in World Heritage marine site management (local community, local government, NGO, university)
6. Strengthened capacity at the Komodo National Park on conservation outreach and education
7. Action plan for the protection of Komodo National Park's OUV, including finalization of extended outline for marine management plan

Participants

About 35:

- 25 participants from Komodo (15 staff of Komodo NP and 10 members of Komodo NP marine division)
- 2 marine staff from Ujung Kulon National Park (Indonesia)
- 4 international participants (Great Barrier Reef, Puerto-Princesa Subterranean River National Park, Galapagos Islands, Range to Reef)
- 1 interpreter
- 1 photographer
- 2 UNESCO (UNESCO Jakarta and UNESCO World Heritage Marine Programme)

Programme

Sunday 24 November

Afternoon: Arrival in Labuan Bajo international experts and managers

Evening: informal dinner with guests staying at the Bintang Flores Hotel

Monday 25 November

Venue: Bintang Flores Hotel, Labuan Bajo, Indonesia

08:30 Welcome
Pak Awang, Director, Komodo National Park World Heritage Site

Introduction round participants

09:15 Context and objectives of the meeting

09:30 Presentation and Q&A: **The concept of Outstanding Universal Value (OUV)**, what it means to be a World Heritage site (applied to the Komodo National Park) and examples of how other World Heritage marine sites have used OUV as a guiding star in their management.
(Based on: Indonesian translation of the Best Practice Guide)
(https://unesdoc.unesco.org/ark:/48223/pf0000235316_ind) Situs perairan warisan dunia: mengelola secara efektif kawasan konservasi perairan yang paling ikonis di dunia
Robbert Casier, World Heritage Centre, UNESCO

09:45 Coffee break

10:00 **Working session 1: Outstanding Universal Value**
Read the OUV Statement Komodo National Park. Tease apart statement of OUV Komodo National Park to specify key elements. Spatial analysis of OUV.
Robbert Casier, World Heritage Centre, UNESCO

10:30 **Working session 2**: **Challenges in maintaining the OUV sustainably**
Exercise on marine megafauna (whales, mantas, dolphins) and coral reef. Develop 1-page table on current condition, pressures, management objective, management strategies, performance measures, desired trend and target.
Dr Andrew Hill, Range to Reef Environmental

12:15 Lunch Break

14:00 Presentation and **working session 3**: **Monitoring and research** in the Great Barrier Reef: principles and lessons learned (focus on corals, seagrass, and water quality). How to set up an OUV monitoring and research programme? How to develop a basic inventory of marine species in Komodo in ways that allows to establish a baseline against which future conservation actions can be evaluated.
Katherine Martin, Great Barrier Reef Marine Park Authority (GBRMPA)

15:30 Coffee break

15:45 Presentation and **working session 4**: **Data management** in the Great Barrier Reef (data collection, data storage and data analysis) and how to organize data management in the Komodo National Park
Katherine Martin, Great Barrier Reef Marine Park Authority (GBRMPA)

17:30 Wrap up and concluding remarks

19:00 Dinner

Tuesday 26 November

Venue: Bintang Flores Hotel, Labuan Bajo, Indonesia

08:30 Recap (Where are we today, Where do we want to be, How do we get there)
Robbert Casier, World Heritage Centre, UNESCO

08:40 Komodo National Park: current partnerships and management arrangements with partners (dive industry, NGOs, etc).
Komodo National Park World Heritage Site

09:00 Presentation and Q&A: Partnerships for the management of the **Puerto-Princesa Subterranean River National Park** (Philippines). Examples from a World Heritage marine site which is auto-financed (1.3 million USD per year) and applies community-based tourism to share benefits derived from tourism across local communities.
Elizabeth Maclang, Puerto-Princesa Subterranean River National Park

09:30 **Working session 5**: **Partnerships in the Komodo National Park**: Where do we want to be and how do we get there? Discussion on partnerships in the Komodo National Park, current situation, what works well and what does not. Experiences from the other World Heritage marine sites present.
Elizabeth Maclang, Puerto-Princesa Subterranean River National Park

10:30 Coffee break

10:45 Presentation and Q&A: **Galapagos National Park** World Heritage site (Ecuador): Partnerships with the dive sector and fishing industry. Regulation of dive industry, dive protocols in place.
Eduardo Espinoza, Head of Marine Ecosystem Monitoring Program, Galapagos National Park.

11:15 Presentation and Q&A: **Great Barrier Reef** World Heritage site (Australia): Partnerships including with the dive sector. Regulation of dive industry, dive protocols in place.
Katherine Martin, Great Barrier Reef Marine Park Authority (GBRMPA)

11:45 Lunch

14:00 **Working session 6: Partnerships and diving** in the Komodo National Park. Where do we want to be and how do we get there? Discussion on partnerships and dive

tourism in the Komodo National Park, what works well and what does not. Where do we want / need to be? Experiences from the other World Heritage marine sites present.
Robbert Casier, World Heritage Centre, UNESCO

15:15 Coffee Break

15:30 Komodo National Park: current zoning arrangements
Komodo National Park World Heritage Site

15:45 Presentation and Q&A: **Zoning** of the Galapagos marine reserve and lessons learned from over 10 years of cooperation with artisanal fishers that led to a new zoning plan in 2016 (including one third no-take zones)
Eduardo Espinoza, Head of Marine Ecosystem Monitoring Program, Galapagos National Park.

16:15 **Working session 7:** Zoning in the Komodo National Park. Where are we now and where do we want to be? Discussion on zoning in the Komodo National Park, current situation, what works well and what does not. Where do we want / need to be? Experiences from the other World Heritage marine sites present.
Eduardo Espinoza, Head of Marine Ecosystem Monitoring Program, Galapagos National Park.

17:30 Wrap up and concluding remarks

19:00 Dinner

Wednesday 27 November

Visit to Komodo National Park

Exchange between Komodo National Park Staff and marine managers on marine data collection, cooperation between dive sector and the Park (citizen science data collection, coral health monitoring, marine megafauna monitoring). Visit to coral reef monitoring sites.

Night at the Loh Liang Ranger station.

Thursday 28 November

Visit to Komodo National Park (continuation)

Komodo National Park offices (including infrastructure for research and data management, zoning, surveillance, etc.). Exchanges between World Heritage marine managers, experts, and Komodo National Park Staff on practical issues of management.

- Official entry – ticketing office
- Areas with tourism
- Local community
- Ranger station in KNP
- Loh Liang visitors center of Komodo National Park
- Park facilities (research, surveillance, etc.)

Friday 29 November

Venue: Bintang Flores Hotel, Labuan Bajo, Indonesia

08:30 Recap workshop so far
Robbert Casier, World Heritage Centre, UNESCO

09:00 Presentation and Q&A: Marine management plan requirements for Komodo National Park
What are the key dates, deadlines and current requirements for marine management Komodo National Park?
By: Komodo National Park

09:30 **Working session 8**: Marine management plan for Komodo National Park / Action plan
Objective: advance the work toward a marine management plan taking into account the discussions so far.
Dr Andrew Hill, Range to Reef Environmental

10:30 Coffee break

10:45 **Working session 8 (continuation)**

12:00 Wrap up and concluding remarks

Lunch

15:15 Departure flight Labuan Bajo experts

9.3. Appendix 3: Workshop participants

Name	Institution
Pak Dwi	Komodo National Park
Yenius MC Resi	Komodo National Park
Rijal Mewar	Komodo National Park
Nasmawi	Komodo National Park
Kamal	Komodo National Park
Nadma Yunita Banamtuan	Komodo National Park
Margaretha Prisita Nur	Komodo National Park
Ande Kefi	Komodo National Park
Novita Yanti Sidabutar	Komodo National Park
Arif Ardianto Sofian	Komodo National Park
Maria Rosdalima Panggur	Komodo National Park
Fahri Ikhlas, S. Hut	Komodo National Park
Ikhwan Syahri, S. Hut	Komodo National Park
Rawuh Pradana	Komodo National Park
Susan Stephanie	Dock
Khaifin	WWF Indonesia
Danang Pramudyo Herlambane	BOPLBF
Adiska Octa Paramita	Swiss contact
Muhammad Ikbal Putera, S.Hut	Komodo National Park
Juvensius Nampung	P3Kom
Luke J Cox	Gamawisri / Diving
Prima	Gamawisri
Andy Harvey	Mantawatch
Mohamad Azat Sudirman	Ujung Kulon National Park
Mumu Muawalah	Ujung Kulon National Park
Elizabeth A. Maclang	Puerto Princesa Subterranean River National Park
Eduardo Espinoza	Galapagos National Park
Katherine Martin	Great Barrier Reef
Andrew Hill	Range to Reef Environmental
Siti Rachmania	UNESCO Jakarta
Robbert Casier	UNESCO World Heritage Marine Programme

Mr Awang, Head of Komodo National Park, could unfortunately not participate due to a last-minute government commitment.

9.4. Appendix 4: A potential marine management plan structure for Komodo National Park

1. Introduction to Komodo-its values and importance

2. Management Context

(i.e. history, legislative context and management framework)

2.1. World Heritage: Outstanding Universal Values

2.2. Biosphere Reserve

2.3. Other International commitments

2.4. National context and legislative framework

2.5. Responsibilities of Government agencies and tiers of Government

2.6. Outcome-based management

3. Values and Definition of Komodo

3.1. Definition of the area, reserves and tenure

3.2. Current condition and trend of values of Komodo

4. Vision and strategic objectives

5. Generic Management programs

5.1. Administrative frameworks

5.1.1. Protected areas legislation and policy

5.1.2. Zoning

5.1.3. Human resources

5.1.4. Licensing and permits

5.1.5. Finance management

5.2. Education and interpretation

5.3. Surveillance and enforcement

5.4. Infrastructure management

5.5. Research

5.6. Monitoring

5.7. Community participation in management

5.8. Waste and sewerage management

6. Management of the ecological values

6.1. Geomorphology (Criterion vii of Outstanding Universal Value)

6.2. Marine water quality (OUV vii)

6.3. Coral communities (OUV vii, x)

6.4. Intertidal communities (OUV vii, x)

6.5. Seagrass and macroalgal communities (OUV vii, x)

6.6. Sandy beaches (OUV vii)

6.7. Terrestrial vegetation (OUV vii, x)

6.8. Komodo Dragon (OUV ix)

6.9. Land Birds (OUV x)

6.10. Other terrestrial fauna (OUV x)

6.13. Marine Turtles (OUV x)

6.14. Sea and shorebirds (OUV x)

6.15. Fish (OUV x)

6.16. Marine megafauna (e.g. Mantas, Dugong, whales & dolphins) (OUV x)

7. Management of the socio-economic values

7.1. Marine nature-based tourism (e.g. diving, snorkelling, wildlife watching)

7.2. Marine harvesting (e.g. fish for consumption, crustaceans, coral, aquarium trade)

7.3. Terrestrial Harvesting (e.g. timber, fauna by local villages)

7.4. Cruise ship management

7.5. Park Villages and Communities

7.6. Sports and recreational fishing

7.7. Subsistence fishing and food gathering

7.8. Research opportunities

7.9. Aesthetic values (OUV vii)

7.10 Cultural values/traditional use

7.11 Wilderness/Remoteness

8. Performance assessment

8.1. Assessment of management effectiveness

8.2. Long-term outlook of likely and future trends in Outstanding Universal Value

An e*xample of management table for the Aldabra Atoll World Heritage marine site (Seychelles) is provided here which employs a best practice management framework, and involves a risk assessment approach to develop outcome based management actions.*

Example Table: Management of Coral Reef Communities in the Aldabra Atoll World Heritage site (Seychelles)

Current condition	Coral reef communities are in a good condition
Existing and potential pressures	• Invasive marine pests • Localised water quality impacts from field station (septic tank leaching) • Coral bleaching/mass mortality due to SST elevation • Trampling • Localised damage from small boats • Mooring damage • Anchoring damage • Diver damage • Localised water quality impacts from field station (fuel transfer and storage, toxic chemical storage and disposal) • Oil spill from shipping.
Current major pressure/s	• Invasive marine pests • Localised water quality impacts from field station (septic tank leaching) • Trampling • Mooring and anchoring.
Management objective	To ensure the diversity and abundance of coral communities are not significantly impacted by invasive marine pests or human activities in the protected area.

Management strategies	1. Assess the nature, level and potential impacts of human activities, on coral communities within the protected area. (H-KMS) 2. Undertake research to develop a cost-effective monitoring protocol to estimate annual coral recruitment within the protected area and investigate the implications for coral reef resilience and connectivity. (H-KMS) 3. Educate staff and visitors about the ecological importance of coral communities and the potential detrimental effects of trampling, anchoring and boating activities on these communities. (M) 4. Continue to undertake research to characterise the coral species and distribution within the protected area. (M) 5. Monitor the distribution and abundance of *Terpios hoshinota* in the protected area at least every three years. (H) 6. Continue to monitor coral cover and health, recruitment, as well as coral recovery post the 1998 major coral bleaching event. (H) 7. Install permanent moorings in areas of highest risk of anchoring damage and if necessary restrict anchoring activities in these areas. (H)		
Performance measures	1. Diversity 2. Abundance.	**Desired trend**	1. Constant 2. Constant.
Target/s	1. No loss of coral diversity as a result of human activity in the protected area. 2. No loss of coral abundance as a result of human activity in the protected area.		

9.5. Appendix 5: The World Heritage Convention and its operations

Roles and responsibilities

The **Convention concerning the Protection of the World's Cultural and Natural Heritage**, adopted in 1972 and commonly known as the World Heritage Convention was founded on the premise that certain places on Earth are of Outstanding Universal Value (OUV) and as such should form part of the common heritage of humanity. As of February 2020, the convention has been ratified by 193 countries, the States Parties to the Convention. Operationally, the following groups play a role in managing and conserving World Heritage Sites:

The **States Parties** - In ratifying the Convention, countries take on obligations to identify and protect sites nominated to the World Heritage List, and to protect their national heritage, both natural and cultural. The States Parties are also encouraged to integrate the sites into the day-to-day life of the public, and support scientific and technical conservation research. Countries must also report regularly to the World Heritage Committee on the state of conservation of their World Heritage properties. These reports are crucial in assessing the condition of the sites, provide support to the site managers and resolve recurrent problems. Each country has a formal World Heritage representative, the **National Focal Point**, mandated with implementing Convention activities within the country, and being the channel for information between the Secretariat, countries and other stakeholders.

The **World Heritage Committee** meets once a year, and consists of representatives from 21 of the States Parties to the Convention elected by their General Assembly. At its first session, the Committee adopted its Rules of Procedure of the World Heritage Committee. The Committee is responsible for the implementation of the World Heritage Convention, defines the use of the World Heritage Fund and allocates financial assistance upon requests from States Parties. It has the final say on whether a property is inscribed on the World Heritage List.

It examines reports on the state of conservation of inscribed properties and asks States Parties to take action when properties are not being properly managed. It also decides on the inscription or deletion of properties on the List of World Heritage in Danger.

The **General Assembly** of States Parties to the World Heritage Convention meets during the sessions of the General Conference of UNESCO. During its session, the General Assembly determines the uniform percentage of contributions to the World Heritage Fund applicable to all States Parties, and elects new members to the World Heritage Committee to replace the outgoing members.

The **World Heritage Centre**, established in 1992, is the focal point and coordinator within UNESCO for all matters related to World Heritage. Ensuring the day-today management of the Convention, the Centre organizes the annual sessions of the World Heritage Committee and its Bureau, provides advice to States Parties in the preparation of site nominations, organizes international assistance from the World Heritage Fund upon request, and coordinates both the reporting on the condition of sites and the emergency action undertaken when a site is threatened. The Centre also organizes technical seminars and workshops, updates the World Heritage

List and database, develops teaching materials to raise awareness among young people of the need for heritage preservation, and keeps the public informed of World Heritage issues. The World Heritage Marine Programme is located within the World Heritage Centre and is one of the Centre's six thematic programmes.

Advisory Bodies: Three international non-governmental or intergovernmental organizations are named in the Convention to provide independent advice to the World Heritage Committee in their respective areas of expertise. Their roles include evaluation of properties nominated for inscription on the World Heritage List, monitoring the state of conservation of World Heritage natural properties, reviewing requests for international assistance, and providing input and support for capacity building activities. These Advisory Bodies are:

The **International Union for Conservation of Nature (IUCN)** - is an international, non-governmental organization that provides the World Heritage Committee with technical evaluations of natural heritage properties and, through its worldwide network of specialists, reports on the state of conservation of listed properties. With more than 1000 members, IUCN was established in 1948 and is located in Gland, Switzerland.

The **International Council on Monuments and Sites (ICOMOS)** - provides the World Heritage Committee with evaluations of cultural and mixed properties proposed for inscription on the World Heritage List. It is an international, non-governmental organization founded in 1965, with an international secretariat in Paris.

The **International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM)** - is an intergovernmental body which provides expert advice on how to conserve listed properties, as well as training in restoration techniques. ICCROM was set up in 1956 and is located in Rome.

The Fund for the Protection of the World Cultural and Natural Heritage of Outstanding Universal Value, called "**the World Heritage Fund**", was established under Art. 15 of the World Heritage Convention. Its resources consist primarily of assessed contributions by the States Parties of the Convention and may be used only for such purposes as the World Heritage Committee shall define.

The **World Heritage emblem** represents the interdependence of the world's natural and cultural diversity. It is used to identify properties protected by the World Heritage Convention and inscribed on the official World Heritage List, and represents the universal values for which the Convention stands. Designed by Belgian artist Michel Olyff, it was adopted as the official emblem of the World Heritage Convention in 1978. While the central square symbolizes the results of human skill and inspiration, the circle celebrates the gifts of nature. The emblem is round, like the world, a symbol of global protection for the heritage of all humankind.

Becoming a World Heritage site

Only countries that have signed the World Heritage Convention, pledging to protect their natural and cultural heritage, can submit nomination proposals for properties on their territory to be considered for inclusion in UNESCO's World Heritage List. World Heritage sites are identified through a rigorous, multi-year nomination, evaluation and inscription process that is based on a set of specific criteria.

The first step a country must take is to make an 'inventory' of its important natural and cultural heritage sites located within its boundaries. This 'inventory' is known as the Tentative List, and provides a forecast of the properties that a State Party may decide to submit for inscription in the next five to ten years and which may be updated at any time. It is an important step since the World Heritage Committee cannot consider a nomination for inscription on the World Heritage List unless the property has already been included on the State Party's Tentative List.

By preparing a Tentative List and selecting sites from it, a State Party can plan when to present a nomination file. The World Heritage Centre offers advice and assistance to the State Party in preparing this file, which needs to be as exhaustive as possible, making sure the necessary documentation and maps are included. The nomination is submitted to the World Heritage Centre for review and to check it is complete. Once a nomination file is complete the World Heritage Centre sends it to the appropriate Advisory Bodies for evaluation.

A nominated property is independently evaluated by the two Advisory Bodies mandated by the World Heritage Convention: the International Council on Monuments and Sites (ICOMOS) and the International Union for Conservation of Nature (IUCN), which respectively provide the World Heritage Committee with evaluations of the cultural and natural sites nominated. The third Advisory Body is the International Centre for the Study of the Preservation and Restoration of Cultural Property (ICCROM), an intergovernmental organization which provides the Committee with expert advice on conservation of cultural sites, as well as on training activities.

Once a site has been nominated and evaluated, it is up to the intergovernmental World Heritage Committee to make the final decision on its inscription. Once a year, the Committee meets to decide which sites will be inscribed on the World Heritage List. It can also defer its decision and request further information on sites from the States Parties.

Inscribing a site on the World Heritage List is the beginning, and not the end of the story. Site managers and local authorities continuously need to work towards managing, monitoring and preserving the World Heritage properties.

States Parties have an obligation to regularly prepare reports about the state of conservation and the various protection measures put in place at their sites. These reports allow the World Heritage Committee to assess the conditions at the sites and, eventually, to decide on the necessity of adopting specific measures to resolve recurrent problems. One of such measures could be the inscription of a property on the List of World Heritage in Danger.

The Periodic Reporting process provides an assessment of the application of the World Heritage Convention by the States Parties. It also provides updated information about the sites to record possible changes in the state of conservation of sites. The Periodic Reports – submitted by the States Parties themselves – are prepared on a regional basis and are examined by the World Heritage Committee on a pre-established schedule based on a six-year cycle. The results are included in the report of the World Heritage Committee to the General Conference of UNESCO.