DATASETS METADATA / INTERPRETATION

Table of Contents

Near-real time

Active fires (VIIRS)

Thermal activity detected by the VIIRS sensors on the NOAA/NASA Suomi NPP, NOAA-20, and NOAA-21 satellites.

This live dataset presents remotely sensed thermal activity from VIIRS satellites for the last 24 hours in a first layer, and in the last week in a second one. VIIRS Thermal Hotspots and Fire Activity is a product of NASA's Land, Atmosphere Near real-time Capability for EOS (LANCE) Earth Observation Data, part of NASA's Earth Science Data.

The VIIRS active fires data (VNP14IMGT) is the latest fire monitoring product to FIRMS (Fire Information for Resource Management System), which identifies global fire locations in near-real time. Information is collected from the Visible Infrared Imaging Radiometer Suite (VIIRS) sensor, and processed with a fire detection algorithm to flag active fires.

Each fire alert has a confidence value of low, nominal, or high to help users gauge the quality of individual hotspot/fire pixels. **Here we are only presenting high confidence detections with a fire radiative power higher than 10 MW**.

The VIIRS thermal activity layer can be used to visualize and assess wildfires worldwide. However, it should be noted that this dataset contains many "false positives" (e.g., oil/natural gas wells or volcanoes) since the satellite will detect any large thermal signal. Fire points in this service are generally available within 3 1/4 hours after detection by a VIIRS device. LANCE estimates availability at around 3 hours after detection.

Even though these data displays as point features, each point in fact represents a pixel that is >= 375 m high and wide. A point feature means somewhere in this pixel at least one "hot" spot was detected which may be a fire.

VIIRS is a scanning radiometer device aboard the Suomi NPP, NOAA-20, and NOAA-21 satellites that collects imagery and radiometric measurements of the land, atmosphere, cryosphere, and oceans in several visible and infrared bands. This dataset is a subset of the overall VIIRS imagery, in particular from NASA's VNP14IMG_NRT active fire detection product.

The 375-m data complements the 1-km Moderate Resolution Imaging Spectroradiometer (MODIS) Thermal Hotspots and Fire Activity layer; they both show good agreement in hotspot detection but the improved spatial resolution of the 375 m data provides a greater response over fires of relatively small areas and provides improved mapping of large fire perimeters.

Attribute information:

- **Latitude and Longitude:** The center point location of the 375 m (approximately) pixel flagged as containing one or more fires/hotspots.
- **Satellite:** Whether the detection was picked up by the Suomi NPP satellite (N) or NOAA-20 satellite (1) or NOAA-21 satellite (2).
- **Confidence:** The detection confidence is a quality flag of the individual hotspot/active fire pixel. This value is based on a collection of intermediate algorithm quantities used in the detection process. It is intended to help users gauge the quality of individual hotspot/fire pixels. Confidence values are set to low, nominal and high. Low confidence daytime fire pixels are typically associated with areas of sun glint and lower relative temperature anomaly (<15K) in the mid-infrared channel I4. Nominal confidence pixels are those free of potential sun glint contamination during the day and marked by strong (>15K) temperature anomaly in either day or nighttime data. High confidence fire pixels are associated with day or nighttime saturated pixels. **Only high confidence detections are presented in this platform**. Low confidence nighttime pixels occur only over the geographic area extending from 11 deg E to 110 deg W and 7 deg N to 55 deg S. This area describes the region of influence of the South Atlantic Magnetic Anomaly which can cause spurious brightness temperatures in the mid-infrared channel I4 leading to potential false positive alarms. These have been removed from the NRT data distributed by FIRMS.
- **FRP:** Fire Radiative Power. Depicts the pixel-integrated fire radiative power in MW (MegaWatts). FRP provides information on the measured radiant heat output of detected fires. The amount of radiant heat energy liberated per unit time (the Fire Radiative Power) is thought to be related to the rate at which fuel is being consumed (Wooster et. al. (2005)). Only events with fire radiative power higher than 10 MW are shown in this platform**.**
- **DayNight:** D = Daytime fire, N = Nighttime fire
- **Hours Old**: Derived field that provides age of record in hours between Acquisition date/time and latest update date/time. 0 = less than 1 hour ago, 1 = less than 2 hours ago, 2 = less than 3 hours ago, and so on. In this platform, only events captured in the last 24 hours are shown.

Caution: Not all fires are detected. There are several reasons why VIIRS may not have detected a certain fire. The fire may have started and ended between satellite overpasses. The fire may have been too small or too cool to be detected in the 375-meter pixel. Cloud cover, heavy smoke, or tree canopy may completely obscure a fire. It is not recommended to use active fire locations to estimate burned area due to spatial and temporal sampling issues. When zoomed out, this data layer displays some degree of inaccuracy because the data points must be collapsed to be visible on a larger scale. Zoom in for greater detail. This layer is provided for informational purposes and is not monitored 24/7 for accuracy and currency.

Near real time data is not checked thoroughly before it is posted on LANCE. NASA's goal is to get vital fire information to its users as soon as possible. However, the data is screened by a confidence algorithm which seeks to help users gauge the quality of individual hotspot/fire points. High confidence fire pixels (shown in this platform) are associated with day or nighttime saturated pixels.

We acknowledge the use of data and imagery from LANCE FIRMS operated by the NASA/GSFC/Earth Science Data and Information System (ESDIS) with funding provided by NASA/HQ (NASA Data & Information Policy).

Source: NASA FIRMS LANCE - VNP14IMG_NRT active fire detection
Scale/Resolution: 375-meter

Recent earthquakes

This dataset presents recent earthquake information (magnitude, location, etc.) from the USGS Prompt Assessment of Global Earthquakes for Response (PAGER) program.

Events are updated as frequently as every 5 minutes and are available up to 30 days with the following exceptions:

- Events with a Magnitude LESS than 4.5 are retained for 7 days
- Events with a Significance value ('sig' field, see below) of 600 or higher are retained for 90 days

In addition to event points, a Shake Map is also displayed. It has been dissolved by Shake Intensity to reduce the layer complexity.

The layer's presented data includes:

- **Events by Magnitude and Depth:** The event's seismic magnitude value (only those higher than 5.5 are labelled) and depth of epicentre.
    - **Contains Significance Level:** An event's significance is determined by factors like magnitude, max MMI, 'felt' reports, and estimated impact.
- **Shake Intensity:** The Instrumental Intensity or Modified Mercalli Intensity (MMI) for available events

This data is provided for informational purposes and is not monitored 24/7 for accuracy and currency. Refer to USGS source for more advanced information.

Source: USGS PAGER program

Vegetation Health Index / Drought intensity (10-day update)

The Vegetation Health Index (VHI) illustrates the severity of drought based on the vegetation health and the influence of temperature on plant conditions. This layer updates every 10 days.

The Vegetation Health Index (VHI) illustrates the severity of drought based on the vegetation health and the influence of temperature on plant conditions. The VHI is a composite index and the elementary indicator used to compute the seasonal drought indicators in ASIS: Agricultural Stress Index (ASI), Drought Intensity and Weighted Mean Vegetation Health Index (Mean VHI).

If the index is below 40 (denoting extremely dry conditions), different levels of vegetation stress, losses of crop and pasture production might be expected. Indexes above 85 represent extremely wet conditions.

VHI combines both the Vegetation Condition Index (VCI) and the Temperature Condition Index (TCI). The TCI is calculated using a similar equation to the VCI but relates the current temperature to the long-term maximum and minimum, as it is assumed that higher temperatures tend to cause a deterioration in vegetation conditions. A decrease in the VHI would, for example, indicate relatively poor vegetation conditions and warmer temperatures, signifying stressed vegetation conditions, and over a longer period would be indicative of drought.

In ASIS, VHI is computed in two temporal granularities: dekadal and monthly. The dekadal/monthly VHI raster layer published is further updated in the following 5 dekads (improve data precision, remove cloud pixel etc.).

Phenomenon Mapped: Vegetation Health Index
Time Interval: 10-day
Cell Size: 1 km
Pixel Type: 32-bit Signed Integer
Data Projection: WGS 1984
Mosaic Projection: WGS 1984 Web Mercator
Update Cycle: 10-days + 5 days lag

You can also consult this and other related datasets in FAO’s web application

Recommended citation: © FAO - Agricultural Stress Index System (ASIS), https://www.fao.org/giews/earthobservation/, [Date accessed].

Source: Food and Agriculture Organization’s Global Information and Early Warning System on Food and Agriculture (GIEWS)

Streamflow forecast / Flood Risk (10-day)

This layer provides a 10-day river streamflow forecast with a 3-hour interval from the Group on Earth Observations (GEO) Global Water Sustainability (GEOGLOWS) hydrologic model version 2.

The GEOGLOWS ECMWF Streamflow System provides a daily 51-member ensemble streamflow forecast for around 7 million reaches across the globe. The model uses gridded surface runoff provided by the European Centre for Medium-range Weather Forecasting (ECMWF) Integrated Forecast System (IFS) version 48R1. The runoff is mapped to vector catchment boundaries and routed using Matrix Muskingum Cunge method implemented in the RAPID software. A subset of TDX-Hydro reaches are used as the stream network and catchment boundaries. This animation layer shows the first 10-days of a 15-day forecast at 3-hr intervals. Additionally, a 80-yr historical simulation was produced based on ECMWF's ERA5 dataset. From this historical simulation, return periods for each reach are calculated and used to colour the stream segments when/where events exceed the 2, 10, 25, and 50-year return periods.

Dataset Name: GEOGLOWS 2.0 ECMWF Streamflow Model (10-Day Forecast)

Source: GEOGLOWS

Active Hurricanes, Cyclones and Typhoons

This dataset describes the observed path, forecast track, and intensity of current tropical cyclone activity (hurricanes, typhoons, cyclones) with data from the US National Hurricane Center (NHC) and Joint Typhoon Warning Center (JTWC).

This dataset presents hurricane tracks and positions, providing information on where the storm has been, where it is currently located, and where it is predicted to go. Each storm location is depicted by the sustained wind speed, according to the Saffir-Simpson Scale. It should be noted that the Saffir-Simpson Scale only applies to hurricanes in the Atlantic and Eastern Pacific basins; however, all storms are still symbolized using that classification for consistency.

Update frequency:

- This dataset checks the source for updates every 15 minutes. Tropical cyclones are normally issued every six hours at 5:00 AM EDT, 11:00 AM EDT, 5:00 PM EDT, and 11:00 PM EDT (or 4:00 AM EST, 10:00 AM EST, 4:00 PM EST, and 10:00 PM EST).

- Public advisories for Eastern Pacific tropical cyclones are normally issued every six hours at 2:00 AM PDT, 8:00 AM PDT, 2:00 PM PDT, and 8:00 PM PDT (or 1:00 AM PST, 7:00 AM PST, 1:00 PM PST, and 7:00 PM PST).
- Intermediate public advisories may be issued every 3 hours when coastal watches or warnings are in effect, and every 2 hours when coastal watches or warnings are in effect and land-based radars have identified a reliable storm centre. Additionally, special public advisories may be issued at any time due to significant changes in warnings or in a cyclone. For the NHC data source you can check the RSS Feeds.
- North Pacific and North Indian Ocean tropical cyclone warnings are updated every 6 hours, and South Indian and South Pacific Ocean tropical cyclone warnings are routinely updated every 12 hours. Times are set to Zulu/UTC.

Interpretation of data

- ***Forecast location***: Represents the official NHC forecast locations for the center of a tropical cyclone. Forecast center positions are given for projections valid 12, 24, 36, 48, 72, 96, and 120 hours after the forecast's nominal initial time. Click here for more information. Forecast points from the JTWC are valid 12, 24, 36, 48 and 72 hours after the forecast's initial time.
- ***Forecast track:*** This element aids in the visualization of an NHC official track forecast, the forecast points are connected by a red line. The track lines are not a forecast product, as such, the lines should not be interpreted as representing a specific forecast for the location of a tropical cyclone in between official forecast points. It is also important to remember that tropical cyclone track forecasts are subject to error, and that the effects of a tropical cyclone can span many hundreds of miles from the center. Click here for more information.
- ***The Cone of Uncertainty:*** Cyclone paths are hard to predict with absolute certainty, especially days in advance. The cone represents the probable track of the centre of a tropical cyclone and is formed by enclosing the area swept out by a set of circles along the forecast track (at 12, 24, 36 hours, etc). The size of each circle is scaled so that two-thirds of the historical official forecast errors over a 5-year sample fall within the circle. Based on forecasts over the previous 5 years, the entire track of a tropical cyclone can be expected to remain within the cone roughly 60-70% of the time. It is important to note that the area affected by a tropical cyclone can extend well beyond the confines of the cone enclosing the most likely track area of the centre. Click here for more information. It includes an advisory 'Danger Area' polygon created by JTWC, where wind speeds exceed 34 Knots.
- ***Coastal Watch/Warning:*** Coastal areas are placed under watches and warnings depending on the proximity and intensity of the approaching storm.
    - *Tropical Storm Watch* is issued when a tropical cyclone containing winds of 34 to 63 knots (39 to 73 mph) or higher poses a possible threat, generally within 48 hours. These winds may be accompanied by storm surge, coastal flooding,

and/or river flooding. The watch does not mean that tropical storm conditions will occur. It only means that these conditions are possible.

- *Tropical Storm Warning* is issued when sustained winds of 34 to 63 knots (39 to 73 mph) or higher associated with a tropical cyclone are expected in 36 hours or less. These winds may be accompanied by storm surge, coastal flooding, and/or river flooding.
- *Hurricane Watch* is issued when a tropical cyclone containing winds of 64 knots (74 mph) or higher poses a possible threat, generally within 48 hours. These winds may be accompanied by storm surge, coastal flooding, and/or river flooding. The watch does not mean that hurricane conditions will occur. It only means that these conditions are possible.
- *Hurricane Warning* is issued when sustained winds of 64 knots (74 mph) or higher associated with a tropical cyclone are expected in 36 hours or less. These winds may be accompanied by storm surge, coastal flooding, and/or river flooding. A hurricane warning can remain in effect when dangerously high water or a combination of dangerously high water and exceptionally high waves continue, even though winds may be less than hurricane force.

Scale/Resolution: The horizontal accuracy of these datasets is not stated but it is important to remember that tropical cyclone track forecasts are subject to error, and that the effects of a tropical cyclone can span many hundreds of miles from the centre.

This map is provided for informational purposes and is not monitored 24/7 for accuracy and currency. Please always refer to national or regional entrusted authorities for most reliable data.

Source: NOAA National Hurricane Center (NHC) for the Central + East Pacific and Atlantic, and the Joint Typhoon Warning Center for the West + Central Pacific and Indian basins.

Fishing Activity (Weekly AIS-Tracked Vessels)

Global dataset of automatic identification system-based apparent fishing effort and fishing vessel events, including fishing, encounters, loitering and port-visits. Updated every week, with a 72-hour lag.

This dataset visualizes fishing-related vessel-based human activity at sea, combining data from the publicly available automatic identification system (AIS) and integrating it with information acquired through vessel monitoring systems (VMS). Both AIS and VMS combine global positioning with a transmitter to regularly broadcast vessel location. Powered by satellite technology and machine learning, the dataset merges these types of vessel tracking data to provide a view of global human activity at sea. **It is to note that this dataset only displays data**

on vessels that are detectable through the use of GPS systems (geo-positioning system is available and activated). There is thus fishing activity that is not detected via this means (GPS not activated).

Fishing vessels are identified via a neural network classifier, vessel registry databases, and manual review by Global Fishing Watch and regional experts. Data is binned into grid cells 0.01 (or 0.1) degrees on a side and measured in units of hours. The time is calculated by assigning an amount of time to each AIS detection (which is the time to the previous position) and then summing all positions in each grid cell.

Data is made available for consumption in this platform thanks to SDGs Today. For more information on how data has been processed, please consult here.

Unit of Analysis: Apparent fishing effort - 100th degree, vessel presence - point location, fishing events - point location

Geographic Coverage: Global

Granularity Level: Apparent fishing effort - 100th degree, vessel presence - point location, fishing events - point location

Update Interval - Time Frame: Most recent 7 days, 72 hours delayed

Methodology: View GFW's publication Tracking the global footprint of fisheries here.

Source Inputs: The primary source for these Global Fishing Watch datasets is the automatic identification system (AIS). The International Maritime Organization and other management bodies require large ships, including many commercial fishing vessels, to broadcast their position with AIS in order to avoid collisions. Each year, more than 400,000 AIS devices broadcast vessel location, identity, course and speed information. Ground stations and satellites pick up this information, making vessels trackable even in the most remote areas of the ocean. While only two percent of the world's roughly 2.9 million fishing vessels carry AIS, they are responsible for over half of the fishing effort that takes place more than 100 nautical miles from shore, and as much as 80 percent of the fishing that occurs on the high seas. The number of fishing vessels with AIS is increasing by 10 to 30 percent each year, making this technology more and more informative with time. Using additional machine learning and artificial intelligence techniques, Global Fishing Watch is then able to estimate vessel identity and activity, including apparent fishing, encounters, loitering events, and port visits.

Terms of Use: view the Terms of Use here.

Contact Information: support@globalfishingwatch.org

Additional Disclaimers: Global Fishing Watch APIs are intended for non-commercial use. Any and all references to activity events, including fishing, encounters, loitering, and port visits should be understood in the context of Global Fishing Watch's algorithms, which are best efforts to determine apparent vessel activity events based on AIS data collected via satellites and terrestrial receivers. As AIS data varies in completeness, accuracy and quality, it is possible that some events are not identified. It is also possible that some events are identified but are incorrect or do not indicate actual fishing, transshipment, or port access. For these reasons, Global Fishing Watch qualifies all designations of events, including synonyms of event terms such as "fishing effort," "fishing" or "fishing activity," as apparent rather than certain. Any/all Global Fishing Watch information about apparent events should be considered an estimate and must be relied upon solely at your own risk. Global Fishing Watch is constantly improving processes to make sure event algorithms and designations are as accurate as possible. Additional data caveats may be found in the Global Fishing Watch API documentation.

To access the full dataset click here. To learn more about methodologies and technologies used by Global Fishing Watch, click here. To consult additional information, click here.

Source: Global Fishing Watch

Coral bleaching alerts

Current bleaching conditions around the world using daily updated data from NOAA's Coral Reef Watch program.

Coral reefs are one of the most diverse and ecologically important areas of the world. However, many reefs are threatened by ocean temperatures that are increasingly becoming warmer than the coral animals' natural tolerance. When water is too warm, corals will expel the algae (zooxanthellae) living in their tissues causing the coral to turn completely white. This is called coral bleaching. When a coral bleaches, it is not dead. Corals can survive a bleaching event, but they are under more stress and are subject to mortality.

Corals experience thermal stress, the main cause of bleaching, when sea surface temperatures exceed 1°C (1.8°F) above the maximum summertime mean. This stress worsens as the heat anomaly persists. Degree Heating Week (DHW) shows how much heat stress has accumulated in an area over the past 12 weeks (3 months) by adding up any temperature exceeding the bleaching threshold during that time period. When DHW reaches 4°C-weeks (7.2°F-weeks), significant coral bleaching is likely, especially in more sensitive species. When DHW is 8°C-weeks (14.4°F-weeks) or higher, widespread bleaching and mortality from thermal stress may occur.

The US National Oceanic and Atmospheric Administration's Coral Reef Watch program uses satellite data to provide current reef environmental conditions to quickly identify areas at risk for coral bleaching. The data displayed in this map is derived from satellite-based measurements of ocean temperature. These "virtual stations" are not actual buoys or in situ stations transmitting data. Spatial analyses for reef locations around the world are derived from 5 km resolution raster data.

There are 213 points for the virtual stations around the world along with polygons describing the major tropical coral reef systems.

Each station has several variables:

- **Alert Level:** an index of the likelihood of coral bleaching, scaled from 0 (no heat stress) to 4 (coral mortality likely) based on the attributes below;
- **Sea surface temperature:** average temperature of the ocean surface derived from satellite measurements;
- **Temperature anomaly:** a comparison of the current surface temperature to the 1981-2010 historical average;
- **Hotspots:** number of degrees above the coral's threshold tolerance;
- **Degree Heating Weeks:** accumulated thermal stress experienced by corals.

Source: NOAA's Coral Reef Watch

Protection and Management

World Database of Protected Areas

The World Database on Protected Areas (WDPA) is the most comprehensive global database on terrestrial and marine protected areas.

The World Database on Protected Areas (WDPA) is the most comprehensive global database of marine and terrestrial protected areas, updated on a monthly basis, and is one of the key global biodiversity datasets being widely used by scientists, businesses, governments, international secretariats and others to inform planning, policy decisions and management.

The WDPA is a joint project between UN Environment and the International Union for Conservation of Nature (IUCN). The compilation and management of the WDPA is carried out by UN Environment World Conservation Monitoring Centre (UNEP-WCMC), in collaboration with governments, non-governmental organisations, academia and industry. There are monthly updates of the data which are made available online through the Protected Planet website where the data is both viewable and downloadable.

Data and information on the world's protected areas compiled in the WDPA are used for reporting to the Convention on Biological Diversity on progress towards reaching the Aichi Biodiversity Targets (particularly Target 11), to the UN to track progress towards the 2030 Sustainable Development Goals, to some of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) core indicators, and other international assessments and reports including the Global Biodiversity Outlook, as well as for the publication of the United Nations List of Protected Areas. Every two years, UNEP-WCMC releases the Protected Planet Report on the status of the world's protected areas and recommendations on how to meet international goals and targets.

Many platforms are incorporating the WDPA to provide integrated information to diverse users, including businesses and governments, in a range of sectors including mining, oil and gas, and finance. For example, the WDPA is included in the Integrated Biodiversity Assessment

Tool, an innovative decision support tool that gives users easy access to up-to-date information that allows them to identify biodiversity risks and opportunities within a project boundary.

The reach of the WDPA is further enhanced in services developed by other parties, such as the Global Forest Watch and the Digital Observatory for Protected Areas, which provide decision makers with access to monitoring and alert systems that allow whole landscapes to be managed better. Together, these applications of the WDPA demonstrate the growing value and significance of the Protected Planet initiative.

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UNEP-WCMC and IUCN (year), Protected Planet: [insert name of component database; The World Database on Protected Areas (WDPA)/The Global Database on Protected Areas Management Effectiveness (GD-PAME)] [On-line], [insert month/year of the version downloaded], Cambridge, UK: UNEP-WCMC and IUCN. Available at: www.protectedplanet.net.

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Source: UN Environment World Conservation Monitoring Centre

Wetlands of International Importance (Ramsar Sites)

This dataset shows the location of Ramsar Sites. Please note that the polygon layer is not yet complete; the Secretariat of the Convention on Wetlands is collecting this data on an on-going basis.

This data has been provided by the Secretariat of the Convention on Wetlands on 16 November 2023 and updated at uneven periods. The content presented is "as-is" based on available data and does not imply the expression of any opinion whatsoever on the part of the Convention on Wetlands or the Secretariat of the Convention. Each Contracting Party submitting data through the Ramsar Sites Information Service (RSIS) is the owner of the data. The Secretariat of the Convention is not responsible for any result arising from use of this data or interpretation of this data by third parties.

Source: The Convention on Wetlands Secretariat and Ramsar Sites Information Service

Natural Values

RESOLVE Ecoregions and Biomes

The Ecoregions dataset, updated in 2017, offers a depiction of the 846 terrestrial ecoregions that represent our living planet.

Ecoregions, in the simplest definition, are ecosystems of regional extent. Specifically, ecoregions represent distinct assemblages of biodiversity —all taxa, not just vegetation— whose boundaries include the space required to sustain ecological processes. Ecoregions provide a useful basemap for conservation planning in particular because they draw on natural, rather than political, boundaries, define distinct biogeographic assemblages and ecological habitats within biomes, and assist in representation of Earth's biodiversity.

This dataset is based on recent advances in biogeography —the science concerning the distribution of plants and animals. The original ecoregions dataset has been widely used since its introduction in 2001, underpinning the most recent analyses of the effects of global climate change on nature by ecologists to the distribution of the world's beetles to modern conservation planning.

The 846 terrestrial ecoregions are grouped into 14 biomes and 8 realms. Six of these biomes are forest biomes and remaining eight are non-forest biomes. For the forest biomes, the geographic boundaries of the ecoregions (Dinerstein et al., 2017) and protected areas (UNEP-WCMC 2016) were intersected with the Global Forest Change data (Hansen et al. 2013) for the years 2000 to 2015, to calculate percent of habitat in protected areas and percent of remaining habitat outside protected areas. Likewise, the boundaries of the non-forest ecoregions and protected areas (UNEP-WCMC 2016) were intersected with Anthropogenic Biomes data (Anthromes v2) for the year 2000 (Ellis et al., 2010) to identify remaining habitats inside and outside the protected areas. However, this intersection and related data are not presented in this platform.

The updated Ecoregions 2017 is the most up to date (as of February 2018) dataset on remaining habitat in each terrestrial ecoregion.

Source: Bioscience, An Ecoregions-Based Approach to Protecting Half the Terrestrial Realm (Dinerstein et al., 2017). DOI: https://doi.org/10.1093/biosci/bix014

Key Biodiversity Areas (points and polygons)

Global Dataset containing the current boundaries (16,015) and points (318) for Key Biodiversity Areas (KBAs). This dataset contains the September 2023 edition of The World Database of Key Biodiversity Areas (WDKBA) Spatial Dataset.

Key Biodiversity Areas (KBAs) are 'sites contributing significantly to the global persistence of biodiversity', in terrestrial, freshwater and marine ecosystems. Data on the KBAs are managed in the World Database on Key Biodiversity Areas (WDKBAs). For further details, see www.keybiodiversityareas.org.

Methodology

Sites qualify as global KBAs if they meet one or more of 11 criteria, clustered into five categories: A - threatened biodiversity; B - geographically restricted biodiversity; C- ecological integrity; D - biological processes; and, E - irreplaceability. The KBA criteria can be applied to species and ecosystems in terrestrial, inland water and marine environments. Although not all KBA criteria may be relevant to all elements of biodiversity, the thresholds associated with each of the criteria may be applied across all taxonomic groups (not micro-organisms) and ecosystems.

The different criteria address different ways in which sites contribute significantly to the global persistence of biodiversity. Sites are assessed against all relevant criteria for which data are available and those, which meet the thresholds under one of the criteria or sub-criteria sufficient for the site, become recognised as KBAs.

Source: BirdLife International (2023) World Database of Key Biodiversity Areas. Developed by the KBA Partnership: BirdLife International, International Union for the Conservation of Nature, American Bird Conservancy, Amphibian Survival Alliance, Conservation International, Critical Ecosystem Partnership Fund, Global Environment Facility, Re: wild, NatureServe, Rainforest Trust, Royal Society for the Protection of Birds, Wildlife Conservation Society and World Wildlife Fund. September 2023 version. Available at http://keybiodiversityareas.org/kba-data/request

Global Reforestation Potential

Total potential tree cover and restoration potential.

The map on opportunities for restoration on degraded lands was derived in 2009 using data on potential forest areas and current extent of forests and woodlands according to global 250 m resolution satellite imagery.

Potential forest areas include the extent where forest can grow according to climatic conditions and without considering human influence. Dry areas such as the Sahel were not included, although trees play an important role there, because of their very low potential forest density.

For the current extent of forest and woodlands, three types of forests were considered: closed forests (canopy cover greater than 45 percent), open forests (canopy cover between 25 and 45 percent), and woodlands (canopy cover between 10 and 25 percent). Lands with less tree cover were considered to be either naturally non forested or converted former forests or woodlands.

The restoration opportunities were identified by comparing the maps of potential and current forest extent in light of information about current land-use. Some datasets used included population density, urbanized or industrial areas, and cropland distribution. Intact forest landscapes and managed natural forests and woodlands were considered to have no need or potential for restoration. Deforested and degraded forest lands were divided into three categories, resulting in a map of restoration opportunity areas:

- Wide-scale restoration: Less than 10 people per square kilometre and potential to support closed forest.
- Mosaic restoration: Moderate human pressure (between 10 and 100 people per square km).

- Remote restoration: Very low human pressure (density of less than one person per square km within a 500-km radius).

The remaining areas correspond to croplands and densely populated landmarks that do not offer extensive restoration opportunities in terms of area, but would benefit otherwise from having trees planted in strategic places to protect and enhance agricultural productivity and other ecosystem functions. For additional information click here.

Limitations

The results must be interpreted with caution. The map is based on significant simplifications due to limited data. Only pre-existing information was used. Good information was available on land cover, land use, population density, and other factors. Yet many important factors could not be considered for lack of data, such as resource tenure and land use dynamics.

The map shows wider landscapes where restoration opportunities are more likely to be found, not the location of potential individual restoration sites. Many features of the landscape are not visible at this map's spatial resolution, and local context could not be considered. No ground validation was conducted.

The map does not prescribe any particular type of restoration intervention. It only shows lands with characteristics that indicate restoration opportunities.

The results are globally consistent, but pertain only to lands capable of supporting forests or woodlands. They should not be compared with UN Food and Agriculture Organization global assessments as assumptions, methods, data sources, and definitions are different.

The assessment is intended to inform the policy making process at the global level. It should be complemented by further investigation at regional and national scales, where more detailed information is needed and available.

Source: Bronson W. Griscom, Justin Adams, Peter W. Ellis, Richard A. Houghton, Guy Lomax, Daniela A. Miteva, William H. Schlesinger, David Shoch, Juha V. Siikamäki, Pete Smith, Peter Woodbury, Chris Zganjar, Allen Blackman, João Campari, Richard T. Conant, Christopher Delgado, Patricia Elias, Trisha Gopalakrishna, Marisa R. Hamsik, Mario Herrero, Joseph Kiesecker, Emily Landis, Lars Laestadius, Sara M. Leavitt, Susan Minnemeyer, Stephen Polasky, Peter Potapov, Francis E. Putz, Jonathan Sanderman, Marcel Silvius, Eva Wollenberg, Joe Fargione. (2017). Global Reforestation Potential Map.

Terrestrial species richness / Threatened terrestrial species

Gridded dataset for terrestrial species richness and number of threatened species at the global level.

This is a gridded dataset of terrestrial species richness based on the raw IUCN ranges for amphibians, birds, mammals and reptiles from 2023. Species richness is a count of the number of species potentially occurring in each grid cell. The raw IUCN ranges were intersected with a grid of 865 km2 hexagon cells, clipped to the coastline. Marine-only species were excluded from the analyses. As the species ranges have not been refined (for example, by altitude and landcover), there may be a fair amount of unsuitable habitat in the raw ranges, resulting in errors of commission.

The data is biased towards vertebrates as these are currently the terrestrial taxonomic groups that have been comprehensively assessed and for which there are polygon maps. The analyses are only relevant for terrestrial areas, as marine areas will only be represented by birds and mammals. Analyses are measures of biodiversity calculated for each cell of an equal area grid. This required the ranges to be filtered, for example to exclude ranges where the species is deemed extinct.

Each species richness analysis based on range polygons has been performed for:

1. All Red List Categories
2. Threatened species - species assessed as:
    a. CR (Critically Endangered)
    b. EN (Endangered)
    c. VU (Vulnerable)

Each analysis was exported to a raster in the Mollweide projection, a projection that preserves equal areas across the globe. The raster cell size is 900 km2 (30 km square). The raster was reprojected to WGS84 and symbolised (in ArcMap) using the Standard Deviations (2.5) stretch, and then vectorized with QGIS.

Source and suggested citation: IUCN 2023. IUCN Red List of Threatened Species. Version 2023-1 < www.iucnredlist.org >

Recorded number of marine species richness / Recorded number of threatened marine species

Gridded dataset for marine species richness and number of threatened species at the global level.

This is a gridded dataset of marine species richness based on species occurrence data from two global aggregators, Ocean Biodiversity Information System (OBIS) of IOC-UNESCO and Global Biodiversity Information Facility (GBIF) provided through species grids, an open-access service developed and offered by the OBIS secretariat of IOC-UNESCO.

The dataset was produced by aligning all species occurrence data with the World Register of Marine Species (WoRMS) taxonomic backbone and selecting only marine species. Richness was calculated by aggregating species occurrences on a geohash grid with precision 4, which corresponds to grid cells with a width of approximately 39 km at the equator. IUCN Red List categories were retrieved using the *rredlist R* package.

Source and suggested citation:

- OBIS (2024). Species grids (version 0.1.0). https://github.com/iobis/speciesgrids
- GBIF.org (1 May 2024) GBIF Occurrence Data https://doi.org/10.15468/dl.ubwn8z
- OBIS (25 October 2023) OBIS Occurrence Snapshot. Ocean Biodiversity Information System. Intergovernmental Oceanographic Commission of UNESCO. https://obis.org.
- World Register of Marine Species. Available from https://www.marinespecies.org at VLIZ. Accessed 2024-05-01. doi:10.14284/170.
- IUCN. 2023. The IUCN Red List of Threatened Species. Version 2023-1. https://www.iucnredlist.org. Accessed on 13 May 2024.
- Gearty W, Chamberlain S (2022). rredlist: IUCN Red List Client. R package version 0.7.1, https://CRAN.R-project.org/package=rredlist.

Coral reefs

Global map of shallow, tropical coral reefs gridded at 500-m resolution.

This is a dataset of reef locations based on 500-meter resolution gridded data reflecting shallow, tropical coral reefs of the world. This dataset is only used for informational purposes, on an unofficial basis, and must not be used in litigation. While efforts have been made to ensure that this data are accurate and reliable, we cannot assume liability for any damages or misrepresentations caused by any inaccuracies in the data, or as a result of the data used on a particular system. We make no warranty, expressed or implied, nor does the fact of distribution constitute such a warranty.

Source: Organizations contributing to the data and development of the map include the Institute for Marine Remote Sensing, University of South Florida (IMaRS/USF), Institut de Recherche pour le Développement (IRD), UNEP-WCMC, The World Fish Center, and the World Resources Institute. The composite dataset was compiled from multiple sources, incorporating products from the Millennium Coral Reef Mapping Project prepared by IMaRS/USF and IRD.

Saltmarshes

This dataset provides global location and extent of a critical coastal blue carbon ecosystem: saltmarshes. The data is compiled and maintained by Ocean+ Habitats, a collaboration led by the UNEP World Conservation Monitoring Centre (UNEP-WCMC). These habitats play vital roles in carbon sequestration, shoreline protection, biodiversity support, and fisheries productivity.

This dataset displays the extent of our knowledge regarding the distribution of saltmarshes globally, drawing from occurrence data (surveyed and/or remotely sensed). Saltmarshes are ecosystems located in the intertidal zone of sheltered marine and estuarine coastlines. These ecosystems comprise brackish, shallow water with salt-tolerant plants such as herbs, grasses and shrubs, and are commonly found at temperate and high latitudes. Saltmarshes are of ecological importance as they underpin the estuarine food web. In particular, saltmarshes serve as nesting, nursery and feeding grounds for numerous species of birds, fish, molluscs and crustaceans, including commercially important fish species such as herring (Clupea harengus), and are also home to a number of Endangered and Critically Endangered species.

Creation methodology: The UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC) collated and integrated saltmarsh occurrence datasets from 50 data providers globally, with support from Conservation International and The Nature Conservancy. This composite dataset was sourced from peer-reviewed articles, reports, and databases created by non-governmental and governmental organisations, universities, research institutes, and independent researchers globally. Data were collected using remote sensing and field-based survey methods, with data quality ranging from high-resolution maps to low resolution representations.

Version: 6.1 (March 2021)

Geographic scope: Global, coastal and nearshore areas

Data collection date: 1973 – 2015

Use Constraints / Licensing:

The dataset is provided for public use with appropriate attribution. Users must cite Ocean+ Habitats and UNEP-WCMC when using or reproducing the data. For detailed terms, refer to the Ocean+ Habitats Terms of Use.

Suggested Citation:

- UNEP-WCMC. (Year). *Ocean+ Habitats: Global Distribution of Saltmarshes and Seagrasses*. Retrieved from https://habitats.oceanplus.org/
- Mcowen C, Weatherdon LV, Bochove J, Sullivan E, Blyth S, Zockler C, Stanwell-Smith D, Kingston N, Martin CS, Spalding M, Fletcher S (2017). A global map of saltmarshes (v6.1). Biodiversity Data Journal 5: e11764. Paper DOI: https://doi.org/10.3897/BDJ.5.e11764. Data DOI: https://doi.org/10.34892/07vk-ws51

Source: Ocean+ Habitats (UNEP-WCMC)

Seagrasses

This dataset shows the global distribution of seagrasses. The data were compiled by UNEP World Conservation Monitoring Centre in collaboration with many collaborators (e.g. Frederick Short of the

University of New Hampshire), organisations (e.g. the OSPAR Convention for the Northeast Atlantic sea), and projects (e.g. the European project Mediterranean Sensitive Habitats "Mediseh"), across the globe.

This dataset was created from multiple sources (in 128 countries and territories), including maps (of varying scales), expert interpolation and point-based samples. Before inclusion in the dataset, occurrence records were reviewed using published reports, peer-reviewed literature and expert consultation.

Version: 7.1 (March 2021)

Data collection date: 1934-2020

Geographic range: Global

Limitations: Validation (of version 1) was also undertaken through a global seagrass workshop comprising experts from 23 countries. As the dataset contains overlapping polygons, a dissolve operation (by ISO3) in GIS is required before surface area calculations are carried out. Based on recent genetic and morphometric analysis, Halophilla johnsonii, Halophila hawaiiana, Halophila ovata and Halophila minor are now considered to be morphological variations of, and therefore conspecific with, Halophila ovalis. Zostera mucronata, Zostera muelleri and Zostera novazelandica are now considered to be morphological variations of, and therefore conspecific with, Zostera capricorni. Note that the older components of the dataset (particularly in version 1) are likely to have been fitted to the best shoreline data available at the time, i.e. ESRI's "Digital Chart of the World" and “MundoCart digital database (both derived from Operational Navigation Charts). As a result, there may be placement errors when mapped onto recent shoreline datasets (e.g. GSHHD, Open Street Map), e.g. Belize.

Suggested Citation:

- UNEP-WCMC, Short FT (2021). Global distribution of seagrasses (version 7.1). Seventh update to the data layer used in Green and Short (2003). Cambridge (UK): UN Environment Programme World Conservation Monitoring Centre. Data DOI: https://doi.org/10.34892/x6r3-d211

Other cited reference(s):

- Green EP, Short FT (2003). World atlas of seagrasses. Prepared by UNEP World Conservation Monitoring Centre. Berkeley (California, USA): University of California. 332 pp. URL: https://archive.org/details/worldatlasofseag03gree
- Belluscio A, Panayiotidis P, Gristina M, Knittweis L, Pace ML, Telesca L, Criscoli A, Apostolaki ET, Gerakaris V, Fraschetti S, Spedicato MT, Lembo G, Salomidi M, Mifsud R, Fabi G, Badalamenti F, Garofalo G, Alagna A, Ardizzone GD, Martin CS, Valavanis V (2013). Task 1.1. Seagrass beds distribution along the Mediterranean coasts. In: Mediterranean Sensitive Habitats (MEDISEH), final project report (Eds. M Giannoulaki, A Belluscio, F Colloca, S Fraschetti, M Scardi, C Smith, P Panayotidis, V Valavanis, MT Spedicato). DG - MARE, specific contract SI2.600741. Heraklion (Greece): Hellenic Centre for Marine Research. 557 pp. URL: http://mareaproject.net/download/71

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- OSPAR Commission. (2015). OSPAR Threatened and/or Declining Habitats 2015. URL: http://www.ospar.org/work-areas/bdc/specieshabitats/list-of-threatened-declining-species-habitats. Data URL: http://www.emodnet-seabedhabitats.eu/download

Glaciers

This dataset provides global location and extent of world glaciers, drawing data from GLIMS Glacier Database - Randolph Glacier Inventory (7.0).

The Randolph Glacier Inventory (RGI) is a global set of glacier outlines intended as a snapshot of the world's glaciers outside of ice sheets (i.e. Greenland and Antarctic ice sheets). It provides a single outline for each glacier from approximately the year 2000. The RGI is not suitable for measuring glacier-by-glacier rates of area change. However, it can be used to estimate glacier volumes; rates of elevation change at regional and global scales; and glacier responses to climatic forcing. RGI version 7.0 was developed by the "Working Group on the Randolph Glacier Inventory (RGI) and its role in future glacier monitoring" of the International Association of Cryospheric Sciences (IACS). The glaciological community contributes glacier mapping data to the Global Land Ice Measurements from Space (GLIMS) database. A subset of the glacier outlines in GLIMS are then extracted and reprocessed to produce the RGI. Please click here for more information.

The GLIMS dataset can be accessed via WMS using this URL. In using the GLIMS dataset, make sure data is properly attributed. For more information on citing GLIMS, please see this webpage. Field names in the downloaded file are documented here.

Sources / suggested citation:

- Raup, B.H.; A. Racoviteanu; S.J.S. Khalsa; C. Helm; R. Armstrong; Y. Arnaud (2007). "The GLIMS Geospatial Glacier Database: a New Tool for Studying Glacier Change". Global and Planetary Change 56:101--110. (doi:10.1016/j.gloplacha.2006.07.018)
- GLIMS and NSIDC (2005, updated 2018): Global Land Ice Measurements from Space glacier database. Compiled and made available by the international GLIMS community and the National Snow and Ice Data Center, Boulder CO, U.S.A. DOI:10.7265/N5V98602
- Cogley, Graham (submitter); Kienholz, Christian; Miles, Evan; Sharp, Martin; Wyatt, F. (analyst(s)), 2015. GLIMS Glacier Database. Boulder, CO. National Snow and Ice Data Center. http://dx.doi.org/10.7265/N5V98602

World Soil Groups

This dataset presents soil classification as endorsed by International Union of Soil Sciences. Machine learning was used to predict soil characteristics in 250m resolution from 230,000 soil profile observations.

The data represents the World Reference Base (WRB), which is the international standard for soil classification system endorsed by the International Union of Soil Sciences. It was developed by an international collaboration coordinated by the IUSS Working Group. It replaced the FAO/UNESCO Legend for the Soil Map of the World as international standard. The WRB borrows heavily from **modern soil classification concepts**, including Soil Taxonomy, the legend for the FAO Soil Map of the World 1988, the *Référentiel Pédologique* and Russian concepts. As far as possible, diagnostic criteria match those of existing systems, so that correlation with national and previous international systems is as straightforward as possible.

The distribution and sample pictures of the Reference Soil Groups are based on work carried out by FAO, ISRIC World Soils and the Universities of Leuven and Wageningen University.

More information available in FAO's Soils Portal.

Variable mapped: Most likely WRB soil group for each pixel as predicted by SoilGrids.org

Data Original Projection and Mosaic Projection: Goode's Homolosine (land) WKID 54052

Extent: World, except Antarctica

Cell Size: 250 m

Publication Date: June 14, 2021

Source: International Union of Soil Sciences; Soil Grids project.

Climate

Sea level trend (mm/yr)

This dataset, utilizing National Geospatial Data Asset (NGDA) data from the National Oceanic and Atmospheric Administration (NOAA), displays the Center for Operational Oceanographic Products and Services (CO-OPS) locations of all water level stations that have computed sea level trends at that location.

This dataset is part of the NGDA Water - Oceans & Coast Theme Community. Per the Federal Geospatial Data Committee (FGDC), Water - Oceans & Coast is defined as "features and characteristics of salt water bodies (i.e. tides, tidal waves, coastal information, reefs) and features and characteristics that represent the intersection of the land with the water surface (i.e. shorelines), the lines from which the territorial sea and other maritime zones are measured (i.e. baseline maritime) and lands covered by water at any stage of the tide (i.e.

Outer Continental Shelf), as distinguished from tidelands, which are attached to the mainland or an island and cover and uncover with the tide".

According to NOAA, "relative sea level trends provides an overview of variations in the rates of local sea level change at long-term tide stations (based on a minimum of 30 years of data in order to account for long-term sea level variations and reduce errors in computing sea level trends based on monthly mean sea level)."

Data currency: This cached Esri federal service is checked weekly for updates from its enterprise federal source (Sealevel Trend Stations) and will support mapping, analysis, data exports and OGC API – Feature access.

NGDAID: 168 (Tides and Currents Map: an interactive map of all CO-OPS stations)

For more information: Sea Level Trends; Tides & Currents Products

For other NGDA Content: Esri Federal Datasets

Source: US National Oceanic and Atmospheric Administration (NOAA)

Biomass carbon (above and below ground)

This dataset represents above- and below-ground terrestrial carbon storage (tonnes (t) of C per hectare (ha)) for circa 2010.

The dataset was constructed by combining the most reliable publicly available datasets and overlying them with the ESA CCI landcover map for the year 2010 [ESA, 2017], assigning to each grid cell the corresponding above-ground biomass value from the biomass map that was most appropriate for the grid cell’s landcover type.

Input carbon datasets were identified through a literature review of existing datasets on biomass carbon in terrestrial ecosystems published in peer-reviewed literature. To determine which datasets to combine to produce the global carbon density map, identified datasets were evaluated based on resolution, accuracy, biomass definition and reference date (see table 1 for further information on datasets selected).

Dataset	Scope	Year	Resolution	Definition

Santoro et al. 2018	Global	2010	100 m	Above-ground woody biomass for trees that are >10 cm diameter-at-breast-height, masked to Landsat-derived canopy cover for 2010; biomass is expressed as oven-dry weight of the woody parts (stem, bark, branches and twigs) of all living trees excluding stump and roots.
Xia et al. 2014	Global	1982-2006	8 km	Above-ground grassland biomass.
Bouvet et al. 2018	Africa	2010	25 m	Above-ground woodland and savannah biomass; low woody biomass areas, which therefore exclude dense forests and deserts.
Spawn et al. 2017	Global	2010	300 m	Synthetic, global above- and below-ground biomass maps that combine recently released satellite-based data of standing forest biomass with novel estimates for non-forest biomass stocks.

After aggregating each selected dataset to a nominal scale of 300 m resolution, forest categories in the CCI ESA 2010 landcover dataset were used to extract above-ground biomass from Santoro et al. 2018 for forest areas. Woodland and savanna biomass were then incorporated for Africa from Bouvet et al. 2018., and from Santoro et al. 2018 for areas outside of Africa and outside of forest. Biomass from croplands, sparse vegetation and grassland landcover classes from CCI ESA, in addition to shrubland areas outside Africa missing from Santoro et al. 2018, were extracted from were extracted from Xia et al. 2014. and Spawn et al. 2017 averaged by ecological zone for each landcover type.

Below-ground biomass was added using root-to-shoot ratios from the 2006 IPCC guidelines for National Greenhouse Gas Inventories (IPCC, 2006). No below-ground values were assigned to croplands as ratios were unavailable. Above- and below-ground biomass were then summed together and multiplied by 0.5 to convert to carbon, generating a single above-and-below-ground biomass carbon layer.

This layer supports visual analysis but, if needed, a direct download of the data can be accessed here.

Source: Soto-Navarro, C., Ravilious, C., Arnell, A. P., de Lamo, X., Harfoot, M. B. J., Hill, S. L. L., Wearn, O. R., Santoro, M., Bouvet, A., Mermoz, S., Le Toan, T., Xia, J., Liu, S., Yuan, W., Spawn, S. A., Gibbs, H. K., Ferrier, S., Harwood, T., Alkemade, R., … Kapos, V. (2020). Above and below ground biomass carbon [Dataset]. UN Environment Programme World Conservation Monitoring Centre (UNEP-WCMC). https://doi.org/10.34892/RH7V-HG80.

Forest greenhouse gas net flux

This dataset displays the net loss of forest ecosystem carbon, calculated as the difference between forest carbon emissions from stand-replacing forest disturbances and carbon removals from forest growth.

This net flux layer is part of the forest carbon flux model described in Harris et al. (2021). This paper introduces a geospatial monitoring framework for estimating global forest carbon fluxes which can assist a variety of actors and organizations with tracking greenhouse gas fluxes from forests and decreasing emissions or increasing removals by forests. Net forest carbon flux represents the net loss of forest ecosystem carbon, calculated as the between carbon emitted by forests and removed by (or sequestered by) forests during the model period. **Net carbon flux is calculated by subtracting average gross removals from annual gross emissions in each forested pixel**; negative values are where forests were net sinks of carbon and positive values are where forests were net sources of carbon between 2001 and 2022. Net fluxes are calculated following IPCC Guidelines for national greenhouse gas inventories in each pixel where forests existed in 2000 or were established between 2000 and 2020 according to Potapov et al. 2022. This layer reflects the cumulative net flux during the model period (2001-2022) and must be divided by 22 to obtain average annual net flux; net flux values cannot be assigned to individual years of the model. All input layers were resampled to a common resolution of 0.00025 x 0.00025 degrees each to match Hansen et al. (2013). With the inclusion of tree cover loss for 2022, a few other model input datasets and constants were changed, as described below:

1. The source of the ratio between belowground carbon and aboveground carbon. Previously used one global constant; now uses map from Huang et al. 2021
2. The years of tree cover gain. Previously used 2000-2012; now uses 2000-2020 from Potapov et al. 2022.
3. The source of fire data. Previously used MODIS burned area; now uses tree cover loss from fires from Tyukavina et al. 2022.
4. The source of peat maps. New tropical datasets have been included and the dataset above 40 degrees north has been changed.
5. Global warming potential (GWP) constants for CH_4 and N_2O. Previously used GWPs from IPCC Fifth Assessment Report; now uses GWPs from IPCC Sixth Assessment Report.

Net flux is available for download in two different area units over the model duration: 1) megagrams of CO_2 emissions/ha, and 2) megagrams of CO_2 emissions/pixel. The first is appropriate for visualizing (mapping) net flux because it represent the density of carbon fluxes per hectare. The second is appropriate for calculating the net flux in an area of interest (AOI) because the values of the pixels in the AOI can be summed to obtain the total carbon flux for that area. The values in the latter were calculated by adjusting the net flux per hectare by the size of each pixel, which varies by latitude. When estimating net flux occurring over a defined number of years between 2001 and 2022, divide the values by the model duration and then multiply by the number of years in the period of interest. Both datasets only include pixels within forests, as defined in the methods of Harris et al. (2021) and updated with tree cover gain through 2020.

Cautions: Data are the product of modelling and thus have an inherent degree of error and uncertainty. Users are strongly encouraged to read and fully comprehend the metadata and other available documentation prior to data use. Net flux reflects the total over the model period of 2001-2022, not an annual time series from which a trend can be derived. Thus, values must be divided by 22 to calculate average annual net flux. Uncertainty is higher in gross removals than emissions, driven largely by uncertainty in removal factors for established temperate forests outside the US and Europe. Values are applicable to forest areas (canopy cover >30 percent and >5 m height). See Harris et al. (2021) for further information on the forest definition used in the analysis. Emissions reflect stand-replacing disturbances as observed in Landsat satellite imagery and do not include emissions from unobserved forest degradation. Activity data used as the basis of the estimates contain temporal inconsistencies: 1) Removals data contain temporal inconsistencies because tree cover gain represents a cumulative total from 2000-2020, rather than annual gains as estimated through 2022; 2) Improvements in the detection of tree cover loss due to the incorporation of new satellite data and methodology changes between 2011 and 2015 may result in higher estimates of emissions in recent years compared to earlier years. Refer here for additional information. Large jumps in net flux along some boundaries are due to the use of ecozone-specific removal factors. The changes in net flux occur at ecozone boundaries, where different removal factors are applied on each side. This dataset has been updated since its original publication.

Resolution: 30 x 30m

Source: Harris, N.L., D.A. Gibbs, A. Baccini, R.A. Birdsey, S. de Bruin, M. Farina, L. Fatoyinbo, M.C. Hansen, M. Herold, R.A. Houghton, P.V. Potapov, D. Requena Suarez, R.M. Roman-Cuesta, S.S. Saatchi, C.M. Slay, S.A. Turubanova, A. Tyukavina. 2021. Global maps of twenty-first century forest carbon fluxes. Nature Climate Change. https://doi.org/10.1038/s41558-020-00976-6.

Annual Mean Temperature (2025) / Projected Annual Mean Temperature (SSP3-7.0 scenario, 2055)

Annual mean temperature for 2025, and global bioclimate projection of annual mean temperature for 2055 under the 3-7.0 Shared Socioeconomic Pathway (SSP) climate scenario. The data is derived from CMIP6 ISIMIP3b data by the Swiss Federal Institute for Forest, Snow, and Landscape Research WSL (Beta).

This layer displays global downscaled CMIP6 ISIMIP3b projections of annual mean temperature. The data is hosted by the Swiss Federal Institute for Forest, Snow, and Landscape Research WSL. WSL produced projections of 19 bioclimate predictors (defined by the USGS) as part of the CHELSA BIOCLIM+ and provides the following description in their documentation:

"The CHELSA (Climatologies at high resolution for the earth's land surface areas) data (Karger et al. 2017) consists of downscaled model output temperature and precipitation estimates at a horizontal resolution of 30 arc sec. The temperature algorithm is mainly based on statistical downscaling of atmospheric temperatures."

Phenomenon mapped: Annual mean temperature

Data projection: GCS WGS84

Cell size: 30 arc seconds (~1 km)

Units: deg C

Time extent of dataset: averages over 2011-2040, 2041-2070, and 2071-2100, **but only data for 2025 and the projection of 2055 is shown in this platform**.

Pixel type: 32 Bit Float

Data vintage: 5/30/2025

Publication date: 6/4/2025

Climate Scenarios

The CMIP6 ISIMIP3b climate experiments use Shared Socioeconomic Pathways (SSPs) to model future climate scenarios. Each SSP pairs a human/community behavior component with the traditional RCP greenhouse gas forcings. The dataset includes three SSPs: SSP1-2.6, SSP3-7.0 and SSP5-8.5, but only SSP3-7.0 is displayed in this platform, for 2055. From the IPCC AR6 Summery for Policymakers:

SSP	Scenario	Estimated warming (2041–2060)	Estimated warming (2081–2100)	Very likely range in °C (2081–2100)
SSP3-7.0	high GHG emissions: CO_2 emissions double by 2100	2.1 °C	3.6 °C	2.8 – 4.6

Processing the Climate Data

CHELSA provides 30-year averaged outputs for the various SSPs from 5 global climate models: GFDL-ESM4, IPSL-CM6A-LR, MPI-ESM1-2-HR, MRI-ESM2-0, and UKESM1-0-LL. The 5 models are average into a multi-model ensemble for each variable and time period.

Known Quality Issues

Each model is downscaled from ~100km resolution to ~1km resolution by CHELSA. This inevitably introduces some artifacts into the data.

References

Brun, P., Zimmerman, N.E., Hari, C., Pellissier, L., Karger, D.N. (2022) Global climate-related predictors at kilometre resolution for the past and future Earth System Science Data. 14, 5573-5603 https://doi.org/10.5194/essd-14-5573-2022

Brun, P., Zimmermann, N.E., Hari, C., Pellissier, L., Karger, D.N. (2022). CHELSA-BIOCLIM+ A novel set of global climate-related predictors at kilometre-resolution. EnviDat. https://doi.org/10.16904/envidat.332

Source: CHELSA BIOCLIM+

Mean Annual Precipitation (2025) / Projected Annual Precipitation (SSP3-7.0 scenario, 2055)

Mean Annual Precipitation for 2025, and global bioclimate projection of mean annual precipitation for 2055 under the 3-7.0 Shared Socioeconomic Pathway (SSP) climate scenario. The data is derived from CMIP6 ISIMIP3b data by the Swiss Federal Institute for Forest, Snow, and Landscape Research WSL (Beta).

This layer displays global downscaled CMIP6 ISIMIP3b projections of mean annual precipitation. The data is hosted by the Swiss Federal Institute for Forest, Snow, and Landscape Research WSL. WSL produced projections of 19 bioclimate predictors (defined by the USGS) as part of the CHELSA BIOCLIM+ and provides the following description in their documentation:

"The CHELSA (Climatologies at high resolution for the earth's land surface areas) data (Karger et al. 2017) consists of downscaled model output temperature and precipitation estimates at a horizontal resolution of 30 arc sec. (…) The precipitation algorithm incorporates orographic predictors including wind fields, valley exposition, and boundary layer height, with a subsequent bias correction."

Phenomenon mapped: Annual precipitation

Data projection: GCS WGS84

Cell size: 30 arc seconds (~1 km)

Units: kg m^{-2} $year^{-1}$

Time extent of dataset: averages over 2011-2040, 2041-2070, and 2071-2100, **but only data for 2025 and the projection of 2055 is shown in this platform**.

Pixel type: 32 Bit Float

Data vintage: 5/30/2025

Publication date: 6/4/2025

Climate Scenarios

The CMIP6 ISIMIP3b climate experiments use Shared Socioeconomic Pathways (SSPs) to model future climate scenarios. Each SSP pairs a human/community behavior component with the traditional RCP greenhouse gas forcings. The dataset includes three SSPs: SSP1-2.6, SSP3-7.0 and SSP5-8.5, but only SSP3-7.0 is displayed in this platform, for 2055. From the IPCC AR6 Summery for Policymakers:

SSP	Scenario	Estimated warming (2041–2060)	Estimated warming (2081–2100)	Very likely range in °C (2081–2100)
SSP3-7.0	high GHG emissions: CO_2 emissions double by 2100	2.1 °C	3.6 °C	2.8 – 4.6

Processing the Climate Data

CHELSA provides 30-year averaged outputs for the various SSPs from 5 global climate models: GFDL-ESM4, IPSL-CM6A-LR, MPI-ESM1-2-HR, MRI-ESM2-0, and UKESM1-0-LL. The 5 models are average into a multi-model ensemble for each variable and time period.

Known Quality Issues

Each model is downscaled from ~100km resolution to ~1km resolution by CHELSA. This inevitably introduces some artifacts into the data.

References

Brun, P., Zimmerman, N.E., Hari, C., Pellissier, L., Karger, D.N. (2022) Global climate-related predictors at kilometre resolution for the past and future Earth System Science Data. 14, 5573-5603 https://doi.org/10.5194/essd-14-5573-2022

Brun, P., Zimmermann, N.E., Hari, C., Pellissier, L., Karger, D.N. (2022). CHELSA-BIOCLIM+ A novel set of global climate-related predictors at kilometre-resolution. EnviDat. https://doi.org/10.16904/envidat.332

Source: CHELSA BIOCLIM+

Socioeconomic

Population density

Gridded Population of the World, Version 4 (GPWv4): Basic Demographic Characteristics, Revision 11, providing estimates of population (counts by age and sex) for the year 2010, consistent with national censuses and population registers, as raster data to facilitate data integration.

The Gridded Population of the World, Version 4 (GPWv4): Basic Demographic Characteristics, Revision 11 consists of estimates of human population by age and sex as counts (number of persons per pixel) and densities (number of persons per square kilometre), consistent with national censuses and population registers, for the year 2010. To estimate the male and female populations by age in 2010, the proportions of males and females in each 5-year age group from ages 0-4 to ages 85+ for the given census year were calculated. These proportions were then applied to the 2010 estimates of the total population to obtain 2010 estimates of male and female populations by age. In some cases, the spatial resolution of the age and sex proportions was coarser than the resolution of the total population estimates to which they were applied. The population density rasters were created by dividing the population count rasters by the land area raster. The data files were produced as global rasters at 30 arc-second (~1 km at the equator) resolution. To enable faster global processing, and in support of research communities, the 30 arc-second data were aggregated to 2.5 arc-minute, 15 arc-minute, 30 arc-minute and 1-degree resolutions.

Citation: Gridded Population of the World, Version 4 (GPWv4): Basic Demographic Characteristics, Revision 11. Center for International Earth Science Information Network - CIESIN - Columbia University. (2018). NASA Socioeconomic Data and Applications Center (SEDAC). DOI: https://doi.org/10.7927/H46M34XX

Publication References:

Taking Advantage of the Improved Availability of Census Data: A First Look at the Gridded Population of the World, Version 4. Doxsey-Whitfield, E., K. MacManus, S. B. Adamo, L. Pistolesi, J. Squires, O. Borkovska and S. R. Baptista. (2015). . DOI: https://doi.org/10.1080/23754931.2015.1014272

Gridded Population of the World, Version 4 (GPWv4): Basic Demographic Characteristics, Revision 10. Center for International Earth Science Information Network - CIESIN - Columbia University. (2017). NASA Socioeconomic Data and Applications Center (SEDAC). DOI: https://doi.org/10.7927/H45H7D7F

Gridded Population of the World, Version 4 (GPWv4): Administrative Unit Center Points with Population Estimates, Revision 11. Center for International Earth Science Information Network - CIESIN - Columbia University. (2018). NASA Socioeconomic Data and Applications Center (SEDAC). DOI: https://doi.org/10.7927/H4BC3WMT

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Gridded Population of the World, Version 4 (GPWv4): Land and Water Area, Revision 11. Center for International Earth Science Information Network - CIESIN - Columbia University. (2018). NASA Socioeconomic Data and Applications Center (SEDAC). DOI: https://doi.org/10.7927/H4Z60M4Z

Gridded Population of the World, Version 4 (GPWv4): National Identifier Grid, Revision 11. Center for International Earth Science Information Network - CIESIN - Columbia University. (2018). NASA Socioeconomic Data and Applications Center (SEDAC). DOI: https://doi.org/10.7927/H4TD9VDP

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Gridded Population of the World, Version 4 (GPWv4): Population Density, Revision 11. Center for International Earth Science Information Network - CIESIN - Columbia University. (2018). NASA Socioeconomic Data and Applications Center (SEDAC). DOI: https://doi.org/10.7927/H49C6VHW

Documentation for the Gridded Population of the World, Version 4 (GPWv4), Revision 11. Center for International Earth Science Information Network - CIESIN - Columbia University. (2018). NASA Socioeconomic Data and Applications Center (SEDAC). DOI: https://doi.org/10.7927/H45Q4T5F

Gridded Population of the World, Version 4 (GPWv4): Population Count Adjusted to Match 2015 Revision of UN WPP Country Totals, Revision 11. Center for International Earth Science Information Network - CIESIN - Columbia University. (2018). NASA Socioeconomic Data and Applications Center (SEDAC). DOI: https://doi.org/10.7927/H4PN93PB

Gridded Population of the World, Version 4 (GPWv4): Population Density Adjusted to Match 2015 Revision UN WPP Country Totals, Revision 11. Center for International Earth Science

Information Network - CIESIN - Columbia University. (2018). NASA Socioeconomic Data and Applications Center (SEDAC). DOI: https://doi.org/10.7927/H4F47M65

Source: NASA - Center for International Earth Science Information Network, Columbia University.

Land Cover Change (2017-2024)

Sentinel-2 10m land use/land cover time series of the world.

This dataset displays a global map of land use/land cover (LULC) derived from ESA Sentinel-2 imagery at 10m resolution. Each year is generated with Impact Observatory's deep learning AI land classification model, trained using billions of human-labeled image pixels from the National Geographic Society. The global maps are produced by applying this model to the Sentinel-2 Level-2A image collection on Microsoft's Planetary Computer, processing over 400,000 Earth observations per year.

The algorithm generates LULC predictions for nine classes, described in detail below. The year 2017 has a land cover class assigned for every pixel, but its class is based upon fewer images than the other years. The years 2018-2024 are based upon a more complete set of imagery. For this reason, the year 2017 may have less accurate land cover class assignments than the years 2018-2024.

NOTE: Land use focus does not provide the spatial detail of a land cover map. As such, for the built area classification, yards, parks, and groves will appear as built area rather than trees or rangeland classes.

Class definitions

Name	**Description**
Water	Areas where water was predominantly present throughout the year; may not cover areas with sporadic or ephemeral water; contains little to no sparse vegetation, no rock outcrop nor built up features like docks; examples: rivers, ponds, lakes, oceans, flooded salt plains.
Trees	Any significant clustering of tall (~15 feet or higher) dense vegetation, typically with a closed or dense canopy; examples: wooded vegetation, clusters of dense tall vegetation within savannas, plantations, swamp or mangroves (dense/tall vegetation with ephemeral water or canopy too thick to detect water underneath).
Flooded vegetation	Areas of any type of vegetation with obvious intermixing of water throughout a majority of the year; seasonally flooded area that is a mix of grass/shrub/trees/bare ground; examples: flooded mangroves,

	emergent vegetation, rice paddies and other heavily irrigated and inundated agriculture.
Crops	Human planted/plotted cereals, grasses, and crops not at tree height; examples: corn, wheat, soy, fallow plots of structured land.
Built Area	Human made structures; major road and rail networks; large homogenous impervious surfaces including parking structures, office buildings and residential housing; examples: houses, dense villages / towns / cities, paved roads, asphalt.
Bare ground	Areas of rock or soil with very sparse to no vegetation for the entire year; large areas of sand and deserts with no to little vegetation; examples: exposed rock or soil, desert and sand dunes, dry salt flats/pans, dried lake beds, mines.
Snow/Ice	Large homogenous areas of permanent snow or ice, typically only in mountain areas or highest latitudes; examples: glaciers, permanent snowpack, snow fields.
Clouds	No land cover information due to persistent cloud cover.
Rangeland	Open areas covered in homogenous grasses with little to no taller vegetation; wild cereals and grasses with no obvious human plotting (i.e., not a plotted field); examples: natural meadows and fields with sparse to no tree cover, open savanna with few to no trees, parks/golf courses/lawns, pastures. Mix of small clusters of plants or single plants dispersed on a landscape that shows exposed soil or rock; scrub-filled clearings within dense forests that are clearly not taller than trees; examples: moderate to sparse cover of bushes, shrubs and tufts of grass, savannas with very sparse grasses, trees or other plants.

Classification Process

These maps include Version 003 of the global Sentinel-2 land use/land cover data product. It is produced by a deep learning model trained using over five billion hand-labeled Sentinel-2 pixels, sampled from over 20,000 sites distributed across all major biomes of the world.

The underlying deep learning model uses 6-bands of Sentinel-2 L2A surface reflectance data: visible blue, green, red, near infrared, and two shortwave infrared bands. To create the final map, the model is run on multiple dates of imagery throughout the year, and the outputs are composited into a final representative map for each year.

The input Sentinel-2 L2A data was accessed via Microsoft's Planetary Computer and scaled using Microsoft Azure Batch.

Variable mapped: Land use/land cover in 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024
Extent: Global
Source imagery: Sentinel-2 L2A
Cell Size: 10-meters
*Citation***:** Karra, Kontgis, et al. "Global land use/land cover with Sentinel-2 and deep learning." IGARSS 2021-2021 IEEE International Geoscience and Remote Sensing Symposium. IEEE, 2021.

Source: Sentinel-2 L2A, Esri, Impact Observatory

Water stress

Measures the ratio of water withdrawals to available renewable surface and groundwater at the catchment scale.

Baseline water stress measures the ratio of total water withdrawals to available renewable surface and groundwater supplies. A higher ratio indicates more competition among users. These ratios were then converted into risk scores based on the thresholds defined in the methodology. These risk scores range from low water stress (<10%) to extremely high water stress (>80%). Water withdrawals include domestic, industrial, irrigation and livestock consumptive and non-consumptive uses. Available renewable water supplies include surface and groundwater supplies and the impact of upstream consumptive water use and large dams on downstream water availability. Water stress values are available per sub-basin (HydroBASIN level 6).

Methodology

Aqueduct, authoring entity, used the global hydrological model, PCRaster Global Water Balance (PCR-GLOBWB 2), to calculate five indicators. Baseline water stress is one of those indicators and was calculated using the gross and net total withdrawal and available water per sub-basin time series from the default model run.

The model was first used to calculate a time series of water stress per catchment per month. To calculate water stress, total withdrawals were divided by the available renewable surface and groundwater supplies. Net consumptive water use was subtracted from the total available renewable water supply before the ratio was calculated. The results were output in 12 monthly time series time series of water stress per sub-basin. Water resources in delta sub-basins were pooled.

Next, the time series were converted into baseline values using an ordinary least squares (OLS) regression. For example, the regression output for January 2014 represents the chronic, long-term condition of water stress in January's from 1960 to 2014. This was repeated for every month and then averaged into an annual value. All raw values were limited to a maximum of 100% and a minimum of 0%.

Sub-basins that were classified “Arid and low water use” were handled separately and were given a raw value for baseline water stress of -1.

Finally, raw baseline water stress values were converted to risk scores between 0 and 5, based on quantiles. These scores were placed into categories indicating how high the risk for this indicator is. The thresholds for raw baseline water stress values and the corresponding risk scores that were used in each category are defined below as Risk Category (Risk Scores): Raw Value Thresholds.

- Low (0-1): < 10%
- Low to medium (1-2): 10-20%
- Medium to high (2-3): 20-40%
- High (3-4): 40-80%
- Extremely high (4-5): >80%
- Arid and low water use (5): -1

For the full documentation, please see the source methodology.

Cautions: Although the underlying models have been validated, the results were not. Water stress remains subjective and cannot be measured directly. The lack of direct validation makes it impossible to assess some of the parameters in our calculation such as the length of the input time series, regression method and optimal moving window size. The water stress indicator presented here did not explicitly take environmental flow requirements, water quality or access to water into account. Multiple views exist regarding what to include in a water stress indicator. Views differ regarding what to include in a water stress indicator (Vanham et al. 2018). Coastal and island sub-basins were often grouped to make the area of the sub-basins more homogeneous. The assumption of shared water resources might not hold in aggregated coastal sub-basins. Water resources in PCR-GLOBWB 2 were pooled in abstraction zones. This assumption differs from the sub-basin approach in Aqueduct. This is one of the prime reasons for further processing of the PCR-GLOBWB 2 data. Results were tailored towards large scale comparison of water related risks. The indicators have limited added value on a local scale.

Suggested citation: Hofste, R., S. Kuzma, S. Walker, E.H. Sutanudjaja, et. al. 2019. “Aqueduct 3.0: Updated Decision-Relevant Global Water Risk Indicators.” Technical Note. Washington, DC: World Resources Institute. Available online at: https://www.wri.org/publication/aqueduct-30.

Sources: World Resources Institute (Aqueduct)/Utrecht University

Total yearly tourist visits (2019)

This dataset combines UN World Tourism Organization data on tourism for the year 2019 with Airbnb data, presented in a hexagon gridded population dataset.

This dataset combines UNWTO data with a gridded population dataset and information from Airbnb to address two limitations of UNWTO statistics: these focus on international trips and ignore differences between regions within individual countries. This dataset of world tourism destinations measures the number of tourism visits in 2019, before the outbreak of the COVID-19 pandemic. It also identifies hotspots of tourism and compare the level of spatial concentration of tourism. Data is not available for some areas of the globe.

Suggested citation: "Combining Conventional Statistics and Big Data to Map Global Tourism Destinations Before COVID-19". Journal of Travel Research. Volume 61, Issue 8, November 2022, Pages 1848-1871. Czesław Adamiak, Barbara Szyda. Faculty of Earth Sciences and Spatial Management, Nicolaus Copernicus University, ul. Lwowska 1, Toruń 87-100, Poland.

Link to full publication here.

Source: Czesław Adamiak, Barbara Szyda. Faculty of Earth Sciences and Spatial Management, Nicolaus Copernicus University, ul. Lwowska 1, Toruń 87-100, Poland.

Threats and pressures

Cumulative Tree Cover Loss (2001-2024)

Areas where tree cover loss was detected from 2001 to 2024.

This dataset, a collaboration between the GLAD (Global Land Analysis & Discovery) laboratory at the University of Maryland, Google, USGS, and NASA, measures areas of tree cover loss across all global land (except Antarctica and other Arctic islands) at approximately 30 × 30 meter resolution. It is to be used to identify areas of gross tree cover loss. The data were generated using multispectral satellite imagery from the Landsat 5 thematic mapper (TM), the Landsat 7 thematic mapper plus (ETM+), and the Landsat 8 Operational Land Imager (OLI) sensors. Over 1 million satellite images were processed and analyzed, including over 600,000 Landsat 7 images for the 2000-2012 interval, and more than 400,000 Landsat 5, 7, and 8 images for updates for the 2011-2024 interval. The clear land surface observations in the satellite images were assembled and a supervised learning algorithm was applied to identify per pixel tree cover loss.

In this dataset, "tree cover" is defined as all vegetation greater than 5 meters in height and may take the form of natural forests or plantations across a range of canopy densities. **Tree cover loss is defined as "stand replacement disturbance" which is considered to be clearing of at least half of tree cover within a 30-meter pixel.** The exact threshold is variable both through space and time and is biome-dependent. Tree cover loss may be the result of human activities, including forestry practices such as timber harvesting or deforestation (the conversion of natural forest to other land uses), as well as natural causes such as disease or storm damage. Fire is another widespread cause of tree cover loss and can be either natural or human-induced. **Thus, "loss" indicates the removal or mortality of tree cover and can be**

due to a variety of factors, including mechanical harvesting, fire, disease, or storm damage. As such, “loss” does not equate to deforestation.

This dataset does not take into account reforestation (either natural or human-driven).

This dataset has been updated several times since its creation, and now includes loss up to 2024. The analysis method has been modified in numerous ways, including new data for the target year, re-processed data for previous years (2011 and 2012 for the Version 1.1 update, 2012 and 2013 for the Version 1.2 update, and 2014 for the Version 1.3 update), and improved modelling and calibration. These modifications improve change detection for 2011-2024, including better detection of boreal loss due to fire, smallholder rotation agriculture in tropical forests, selective losing, and short cycle plantations.

Due to variation in research methodology and date of content, tree cover, loss, and gain datasets cannot be compared accurately against each other. Accordingly, “net” loss cannot be calculated by subtracting figures for tree cover gain from tree cover loss, and current (post-2000) tree cover cannot be determined by subtracting figures for annual tree cover loss from year 2000 tree cover.

The 2011-2024 data was produced using updated methodology. Comparisons between the original 2001-2010 data and the 2011-2024 update should be performed with caution. As methods behind this data have changed over time, be cautious comparing old and new data, especially before/after 2015. Please click here for more information.

The authors evaluated the overall prevalence of false positives (commission errors) in this data at 13%, and the prevalence of false negatives (omission errors) at 12%, though the accuracy varies by biome and thus may be higher or lower in any particular location. The model often misses disturbances in smallholder landscapes, resulting in lower accuracy of the data in sub-Saharan Africa, where this type of disturbance is more common. The authors are 75 percent confident that the loss occurred within the stated year, and 97 percent confident that it occurred within a year before or after. Users of the data can smooth out such uncertainty by examining the average over multiple years. Click here for more information on the accuracy of this data.

When zoomed out (< zoom level 13), pixels of loss are shaded according to the density of loss at the 30 x 30-meter scale. Pixels with darker shading represent areas with a higher concentration of tree cover loss, whereas pixels with lighter shading indicate a lower concentration of tree cover loss. There is no variation in pixel shading when the data is at full resolution (≥ zoom level 13).

Resolution: 30 × 30 m. Geographic coverage: Global land area (excluding Antarctica and other Arctic islands).

To download the dataset (until 2022): https://storage.googleapis.com/earthenginepartners-hansen/GFC-2022-v1.10/download.html

Suggested citations:

Use the following credit when these data are displayed:
Source: Hansen/UMD/Google/USGS/NASA

Use the following credit when these data are cited:
Hansen, M. C., P. V. Potapov, R. Moore, M. Hancher, S. A. Turubanova, A. Tyukavina, D. Thau, S. V. Stehman, S. J. Goetz, T. R. Loveland, A. Kommareddy, A. Egorov, L. Chini, C. O. Justice, and J. R. G. Townshend. 2013. "High-Resolution Global Maps of 21st-Century Forest Cover Change." *Science* 342 (15 November): 850–53. Data available online from: http://earthenginepartners.appspot.com/science-2013-global-forest.

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Source: Hansen, M. C., P. V. Potapov, R. Moore, M. Hancher, S. A. Turubanova, A. Tyukavina, D. Thau, S. V. Stehman, S. J. Goetz, T. R. Loveland, A. Kommareddy, A. Egorov, L. Chini, C. O. Justice, and J. R. G. Townshend. 2013. "High-Resolution Global Maps of 21st-Century Forest Cover Change." Science 342 (15 November): 850–53. Data available from: earthenginepartners.appspot.com/science-2013-global-forest.

Tree Cover Loss (2024)

Layer displaying areas where tree cover loss was detected only in 2024, extracted from the dataset detailed above. Source, methodology and terms of use of dataset: same as above.

Tree Cover Loss From Fires (2024)

Layer displaying areas where tree cover loss due to fires was detected in 2024.

This data is produced by the Global Land Analysis & Discovery (GLAD) lab at the University of Maryland and measures areas of tree cover loss due to fires compared to all other drivers across all global land (except Antarctica and other Arctic islands) at approximately 30 × 30-meter resolution. The data were generated using global Landsat-based annual change detection metrics for 2001-2024 as input data to a set of regionally calibrated classification tree ensemble models. The result of the mapping process can be viewed as a set of binary maps (tree cover loss due to fire vs. tree cover loss due to all other drivers).

The analysis method for the base tree cover loss map undertaken by Global Forest Watch that is used as input for this dataset has been modified in numerous ways to improve detection of boreal loss due to fires, smallholder rotation agriculture in tropical forests, selective logging, and short cycle plantations for data covering the 2011-2024 period. Due to these changes, comparing trends across the 2000-2010 and 2011-2024 periods should be performed with caution. You can read more about the updates to the modelling process here.

When zoomed out (< zoom level 13), pixels of loss are shaded according to the density of loss at the 30 x 30 meter scale. Pixels with darker shading represent areas with a higher concentration of tree cover loss, whereas pixels with lighter shading indicate a lower concentration of tree cover loss. There is no variation in pixel shading when the data is at full resolution (≥ zoom level 13).

This dataset does not include low-intensity and understory forest fires that do not result in substantial tree canopy loss at the scale of a 30 m pixel. Fires within recent forest loss due to other drivers are also excluded. Therefore, this data does not include the burning of felled logs following mechanical canopy removal, which is common in slash and burn agriculture and large-scale deforestation.

This data only maps the first stand replacing forest disturbance for each pixel between 2001 and 2024. **Areas of tree cover loss due to fires that occurred when forest regrowth followed an initial disturbance early in the study period are not detected in this data.**

This data is available for download here and also accessible through Google Earth Engine using the following image IDs (see https://glad.umd.edu/dataset/Fire_GFL/ for more information):

- *Fire certainty: users/sashatyu/2001-2021_fire_forest_loss*
- *Date of loss: users/sashatyu/2001-2021_fire_forest_loss_annual*

Source: UMD/GLAD, processed by Global Forest Watch

Use the following credit when this data is cited: Tyukavina, A., Potapov, P., Hansen, M.C., Pickens, A., Stehman, S., Turubanova, S., Parker, D., Zalles, A., Lima, A., Kommareddy, I., Song, X-P, Wang, L and Harris, N. (2022) Global trends of forest loss due to fire, 2001-2019. Frontiers in Remote Sensing. https://doi.org/10.3389/frsen.2022.825190

Energy-related pressures: power plants, mining, oil and gas (2017)

This dataset maps global human pressures on ecological systems related to energy production and occupancy (2017), extracted from Data for detailed temporal mapping of global human modification from 1990 to 2017 (Theobald et al. 2020).

Data on the extent, patterns, and trends of human land use are critically important to support global and national priorities for conservation and sustainable development. The full dataset of this layer (here only subsets are shown) includes a series of detailed global datasets for 1990, 1995, 2000, 2005, 2010, 2015, and 2017 to evaluate temporal changes and spatial patterns of land use modification of terrestrial lands (excluding Antarctica**). These data were calculated using the degree of human modification approach that combines the proportion**

of a pixel of a given stressor (i.e. footprint) times the intensity of that stressor (ranging from 0 to 1.0). These datasets are detailed (0.09 km^2 resolution), temporally consistent (for 1990-2015, every 5 years), comprehensive (11 change stressors, 14 current), robust (using an established framework and incorporating classification errors and parameter uncertainty), and strongly validated. It is also provided a dataset that represents ~2017 conditions and has 14 stressors for an even more comprehensive dataset, but the 2017 results should not be used to calculate change with the other datasets (1990-2015). The datasets for the overall of 1990 and 1995, as well as major stressors for all years, are located in **this** Google Drive.

Anthropogenic drivers of ecological stress or “stressors” (following Salafsky et al., 2008; Theobald 2013) refer to human activities that directly or indirectly alter natural systems. **Only data on specific stressors extracted from this dataset are displayed on this platform (Energy production, urban and built-up, transportation and agricultural pressures –see below).** The different datasets map the degree of human modification of terrestrial ecosystems globally for contemporary (circa 2017) conditions.

For more details on the approach and methods, please consult: Theobald, D. M., Kennedy, C., Chen, B., Oakleaf, J., Baruch-Mordo, S., and Kiesecker, J.: Earth transformed: detailed mapping of global human modification from 1990 to 2017, Earth Syst. Sci. Data., https://doi.org/10.5194/essd-2019-252, 2020.

Version 1.5 was completed in collaboration with the Center for Biodiversity and Global Change at Yale University and supported by the E.O. Wilson Biodiversity Foundation.

Source: Theobald, D. M., Kennedy, C., Chen, B., Oakleaf, J., Baruch-Mordo, S., & Kiesecker, J. (2023). Data for detailed temporal mapping of global human modification from 1990 to 2017 (v1.5). Zenodo. https://doi.org/10.5281/zenodo.7534895.

Urban and Built-up Areas Pressures (2017)

Global Human Pressures 2017 - Urban and built up

Extracted from Data for detailed temporal mapping of global human modification from 1990 to 2017 (Theobald et al. 2020).

Source and terms of use of dataset: same as above.

Transportation-related Pressures (2017)

Global Human Pressures 2017 - Transportation

Extracted from Data for detailed temporal mapping of global human modification from 1990 to 2017 (Theobald et al. 2020).

Source and terms of use of dataset: same as above.

Agriculture-related Pressures (2017)

Global Human Pressures 2017 - Transportation

Extracted from Data for detailed temporal mapping of global human modification from 1990 to 2017 (Theobald et al. 2020).

Source and terms of use of dataset: same as above.

Global Ship Density (2015-2021)

Number of automatic identification system (AIS) positions reported by all vessels combined per grid cell between January 2015 and February 2021.

This dataset shows the total number of AIS positions reported by all vessels per pixel between January 2015 and February 2021. These layers were created using International Monetary Fund's (IMF) analysis of hourly Automatic Identification System (AIS) positions received between Jan-2015 and Feb-2021 and represent the **total number of AIS positions** that have been reported by ships in each grid cell. The AIS positions may have been transmitted by both moving and stationary ships within each grid cell, therefore the density is analogous to the general intensity of the particular vessel group activity.

This data was obtained through IMF's World Seaborne Trade Monitoring System (Cerdeiro, Komaromi, Liu and Saeed, 2020). The data analysis was supported by the World Bank's ESMAP and PROBLUE programs.

More information: https://datacatalog.worldbank.org/search/dataset/0037580/Global-Shipping-Traffic-Density

Variable Mapped: total count of all vessel AIS observations

Cell Size: (~550m)

Data Time Period: data between January 2015 and February 2021 was compiled and used to generate this layer

Data Source Last Update: May 3, 2021

Data Source Accessed Date: July 1, 2024

Citation: “Data source: IMF’s World Seaborne Trade monitoring system (Cerdeiro, Komaromi, Liu and Saeed, 2020).”

Source: World Bank Group, IMF

Projected water stress by 2030

Global indicators of change in water supply, water demand, water stress, and seasonal variability, projected for 2030 under scenarios of climate and economic growth.

With the goal of producing information for decadal-scale planning and adaptation, the Aqueduct Water Stress Projections model potential changes in future demand and supply of water over the next 3 decades. Global indicators were developed for water demand (withdrawal and consumptive use), water supply, water stress (the ratio of water withdrawal to supply), and intra-annual (seasonal) variability for the periods centred on 2020, 2030, and 2040 for each of 2 climate scenarios, RCP4.5 and RCP8.5, and 2 shared socioeconomic pathways, SSP2 and SSP3. **Here only the projection for 2030 under RCP8.5 is shown.** Estimates were derived from general circulation models (GCMs) from the Coupled Model Intercomparison Project Phase 5 (CMIP5) and mixed-effects regression models based on projected socioeconomic variables from the International Institute for Applied Systems Analysis's Shared Socioeconomic Pathways (SSP) database. For access to the full data set and additional information, click here.

Full name of layer: *Aqueduct Water Stress Projections: Decadal Projections of Water Supply and Demand Using CMIP5 GCMs*

Cautions: These global indicators are best suited for comparative analyses across large geographies to identify regions or assets deserving of closer attention and are not appropriate for catchment or site-specific analyses. Large-scale climate and socioeconomic scenarios also have varying degrees of inaccuracies for different regions.

Suggested citation: Luck, M., M. Landis, F. Gassert. 2015. "Aqueduct Water Stress Projections: Decadal projections of water supply and demand using CMIP5 GCMs." Washington, DC: World Resources Institute.

Source: World Resources Institute

Riverine flood risk

This dataset measures the percentage of the population expected to be affected by riverine flooding in an average year, accounting for existing flood-protection standards.

Higher values indicate that a greater proportion of the **population** is expected to be impacted by riverine floods on average. These values were then converted into risk scores based on the thresholds defined in the methodology. These risk scores range from low (<0.1%) to extremely high (>1%).

Flood risk was assessed using hazard (inundation caused by river overflow), exposure (population in flood zone), and vulnerability. The existing level of flood protection was also incorporated into the risk calculation. **It is important to note that this indicator represents flood risk not in terms of maximum possible impact but rather as average annual impact.** The impacts from infrequent, extreme flood years were averaged with more common, less newsworthy flood years to produce the "expected annual affected population." Values are available per sub-basin (HydroBASIN level 6).

Methodology

Data on the population impacted by riverine floods were provided by Aqueduct Floods (Ward et al. forthcoming). Flood risk was simulated using a cascade of models within the Global Flood Risk with IMAGE Scenarios (GLOFRIS) modeling framework (Winsemius et al. 2013). Riverine hazard maps were derived using PCR-GLOBWB 2 inputs from 1960-1999. The riverine flood hazard is represented by inundation maps showing the flood extent and depth for floods of several return periods (2, 5, 10, 25, 50, 100, 250, 500, and 1000 years) at a horizontal resolution of 5' x 5' (regridded to 30" x 30"). Exposure is represented by gridded maps of 2010 population count per cell at a horizontal resolution of 30" x 30". Vulnerability is represented as a binary condition: people are either affected or they are not. Estimates of flood protection standards come from the FLOPROS model.

The expected annual affected population was calculated using a risk curve (Meyer et al. 2009). To create the curve, the return periods were first converted into probabilities (i.e., 1/return period) and then plotted on the x-axis against the impacted population. Next, flood protection (return year converted to probability) was added to the graph as a vertical line. All impacts that fell to the right of the flood protection line (i.e., impacted by smaller floods) were assumed to be protected against floods and were removed from the calculation. The expected annual affected population was calculated by integrating the area under the curve to the left of the flood protection line.

The expected annual affected population was divided by total population to calculate the percent of the population expected to be affected annually by riverine floods.

Finally, raw riverine flood risk values were converted to risk scores between 0 and 5, based on quantiles. These scores were placed into categories indicating how high the risk for this indicator is. The thresholds for raw riverine flood risk values and the corresponding risk scores that were used in each category are defined below as Risk Category (Risk Scores): Raw Value Thresholds.

- Low (0-1): < 0 to 1 in 1,000 people
- Low to medium (1-2): 1 in 1,000 to 2 in 1,000 people
- Medium to high (2-3): 2 in 1,000 to 6 in 1,000 people
- High (3-4): 6 in 1,000 people to 1 in 100 people
- Extremely high (4-5): > 1 in 100 people

For the full documentation, please see the source methodology.

Full name of layer: Riverine Flood Risk, Aqueduct 3.0

Cautions: Riverine and coastal flood risks must be evaluated and used separately, as the compound risks between river and storm surges were not modelled. The data also assumed that flood events are entirely independent of each other, so the impact from overlapping flood events was not considered. Finally, the data did not include any indirect impacts from flooding (e.g., disrupted transportation, loss of work, etc.). Results were tailored towards large scale comparison of water related risks. The indicators have limited added value on a local scale.

Suggested citation: Hofste, R., S. Kuzma, S. Walker, E.H. Sutanudjaja, et. al. 2019. "Aqueduct 3.0: Updated Decision-Relevant Global Water Risk Indicators." Technical Note. Washington, DC: World Resources Institute. Available online at: https://www.wri.org/publication/aqueduct-30.

Source: World Resources Institute/Deltares/IVM/PBL/Utrecht University

Drought risk

Measures where droughts are likely to occur, the population and assets exposed, and the vulnerability of the population and assets to adverse effects.

The drought risk indicator is based on Carrão et al. (2016) and was used with minimal alterations. Drought risk was assessed for the period 2000–2014 and is a combination of drought hazard, drought exposure, and drought vulnerability. Higher values indicate higher risk of drought. These values were then converted into risk scores based on the thresholds defined in the methodology. These risk scores range from low (<0.2) to extremely high (>0.8). Values are available per sub-basin (HydroBASIN level 6).

Methodology

The methodology for calculating the drought risk indicator was based on Carrão et al. (2016). Drought hazard was derived from a non-parametric analysis of historical precipitation deficits at the 0.5 degree resolution. Drought exposure was based on a non-parametric aggregation of gridded indicators of population and livestock densities, crop cover and water stress. Drought vulnerability was computed as the arithmetic composite of high level factors of social, economic and infrastructural indicators, collected at both the national and sub-national levels.

The hazard, exposure, vulnerability, risk, and no-data mask data available at 5 × 5 arc minute resolution were averaged for each hydrological sub-basin.

Finally, raw drought risk values were converted to risk scores between 0 and 5, based on quantiles. These scores were placed into categories indicating how high the risk for this indicator is. The thresholds for raw drought risk values and the corresponding risk scores that were used in each category are defined below as Risk Category (Risk Scores): Raw Value Thresholds.

- Low (0-1): 0.0 - 0.2

- Low to medium (1-2): 0.2 - 0.4
- Medium (2-3): 0.4 - 0.6
- Medium to high (3-4): 0.6 - 0.8
- High (4-5): 0.8 - 1.0

For the full documentation, please see the source methodology.

Full name of layer: Drought Risk, Aqueduct 3.0

Cautions: The drought risk indicator does not consider hydrological drought and excludes associated risks such as unnavigable rivers. The drought risk indicator has not been validated at the catchment scale and is therefore presented at a low–high scale instead of low–extremely high (different from the other Aqueduct risk indicators). Results were tailored towards large scale comparison of water related risks. The indicators have limited added value on a local scale.

Suggested citation: Hofste, R., S. Kuzma, S. Walker, E.H. Sutanudjaja, et. al. 2019. “Aqueduct 3.0: Updated Decision-Relevant Global Water Risk Indicators.” Technical Note. Washington, DC: World Resources Institute.

Source: World Resources Institute/Joint Research Institute

Coastal flood risk

Measures the percentage of the population expected to be affected by coastal flooding in an average year.

Coastal flood risk measures the percentage of the **population** expected to be affected by coastal flooding in an average year, accounting for existing flood-protection standards. Higher values indicate that a greater proportion of the population is expected to be impacted by coastal floods on average. These values were then converted into risk scores based on the thresholds defined in the methodology. These risk scores range from low (<0.0009%) to extremely high (>0.2%).

Flood risk was assessed using hazard (inundation caused by storm surge), exposure (population in flood zone), and vulnerability. The existing level of flood protection was also incorporated into the risk calculation. **It is important to note that this indicator represents flood risk not in terms of maximum possible impact but rather as average annual impact.** The impacts from infrequent, extreme flood years were averaged with more common, less newsworthy flood years to produce the “expected annual affected population.” Values are available per sub-basin (HydroBASIN level 6).

Methodology

Data on the population impacted by coastal floods were provided by Aqueduct Floods (Ward et al. forthcoming). Flood risk was simulated using a cascade of models within the Global Flood Risk with IMAGE Scenarios (GLOFRIS) modelling framework (Winsemius et al. 2013). Coastal hazard maps were derived using Global Tide and Surge Reanalysis (GTSR) (Muis et al., 2016) datasets from 1974-2014.The coastal flood hazard is represented by inundation maps showing the flood extent and depth for floods of several return periods (2, 5, 10, 25, 50, 100, 250, 500, and 1000 years) at a horizontal resolution of 5'x5' (regridded to 30"x30"). Exposure is represented by gridded maps of 2010 population count per cell at a horizontal resolution of 30" x 30". Vulnerability is represented as a binary condition: people are either affected or they are not. Estimates of flood protection standards come from the FLOPROS model.

The expected annual affected population was calculated using a risk curve (Meyer et al. 2009). To create the curve, the return periods were first converted into probabilities (i.e., 1/return period) and then plotted on the x-axis against the impacted population. Next, flood protection (return year converted to probability) was added to the graph as a vertical line. All impacts that fell to the right of the flood protection line (i.e., impacted by smaller floods) were assumed to be protected against floods and were removed from the calculation. The expected annual affected population was calculated by integrating the area under the curve to the left of the flood protection line.

The expected annual affected population was divided by total population to calculate the percent of the population expected to be affected annually by riverine floods.

Finally, raw coastal flood risk values were converted to risk scores between 0 and 5, based on quantiles. These scores were placed into categories indicating how high the risk for this indicator is. The thresholds for raw coastal flood risk values and the corresponding risk scores that were used in each category are defined below as Risk Category (Risk Scores): Raw Value Thresholds.

- Low (0-1): < 0 to 9 in 1,000,000 people
- Low to medium (1-2): 9 in 1,000,000 to 7 in 100,000 people
- Medium to high (2-3): 7 in 100,000 to 3 in 10,000 people
- High (3-4): 3 in 10,000 people to 2 in 1,000 people
- Extremely high (4-5): > 2 in 1,000 people

For the full documentation, please see the source methodology.

Full name of layer: Coastal Flood Risk, Aqueduct 3.0

Cautions: Riverine and coastal flood risks must be evaluated and used separately, as the compound risks between river and storm surges were not modelled. The data also assumed that flood events are entirely independent of each other, so the impact from overlapping flood events was not considered. Finally, the data did not include any indirect impacts from flooding (e.g., disrupted transportation, loss of work, etc.). Results were tailored towards large scale comparison of water related risks. The indicators have limited added value on a local scale.

Suggested citation: Hofste, R., S. Kuzma, S. Walker, E.H. Sutanudjaja, et. al. 2019. "Aqueduct 3.0: Updated Decision-Relevant Global Water Risk Indicators." Technical Note. Washington, DC: World Resources Institute. Available online at: https://www.wri.org/publication/aqueduct-30.

Source: World Resources Institute/Deltares/IVM/PBL/Utrecht University