DATASETS METADATA / INTERPRETATION

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Operational Monitoring (near-real time / forecasts)

Sentinel-2 Views (Latest Acquisition)

This layer provides access to recent multispectral satellite imagery from the European Space Agency Sentinel-2 mission, delivered as a dynamically updated image service. It is designed for visual interpretation of current surface conditions across UNESCO-designated sites worldwide.

This layer displays the most recent available Sentinel-2 image for each location, prioritizing scenes with low cloud cover. Imagery is sourced from the Sentinel-2 archive hosted on AWS and is updated daily, with a global revisit frequency of approximately 5 days. Only the latest acquisition is visualized in the platform to ensure a consistent and up-to-date representation of ground conditions.

Data characteristics

- **Satellite mission:** Sentinel-2 (A & B)
- **Provider:** European Space Agency / European Commission
- **Processing level:** Level-1C (Top of Atmosphere reflectance)
- **Spatial resolution:** 10 m, 20 m, and 60 m depending on band
- **Temporal coverage:** Rolling archive (~14 months), filtered to latest scene only
- **Update frequency:** Daily

Visualisation and rendering

The layer is displayed using Natural Color (RGB: Bands 4-3-2) by default, allowing intuitive interpretation similar to human vision.

How to interpret this layer

This layer supports visual situational awareness of site conditions, including:

- Vegetation condition and changes (i.e. greenness, stress, disturbance)
- Burned areas and fire impacts
- Water presence and surface moisture
- Urban expansion or land-use changes
- Sediment plumes, coastal dynamics, and landscape patterns

Because the imagery represents *Top of Atmosphere reflectance*, atmospheric effects (i.e. haze, aerosols) may influence appearance, especially in humid or high-altitude regions.

Notes and limitations

- The layer shows only the most recent cloud-minimized image, not a time series
- Image availability depends on satellite overpass and cloud conditions

- This is not analysis-ready surface reflectance (Level-2A), but suitable for visualization
- Scene selection is automated and may occasionally include residual cloud cover
- Radiometric differences between dates may affect visual comparison

Geographic Coverage

- Global
- Continental land masses from 65.4° South to 72.1° North, with these special guidelines:
    - All coastal waters up to 20 km from the shore
    - All islands greater than 100 km2
    - All EU islands
    - All closed seas (e.g. Caspian Sea)
    - The Mediterranean Sea

Multispectral Bands

Band	Description	Wavelength (µm)	Resolution (m)
1	Coastal aerosol	0.433 - 0.453	60
2	Blue	0.458 - 0.523	10
3	Green	0.543 - 0.578	10
4	Red	0.650 - 0.680	10
5	Vegetation Red Edge	0.698 - 0.713	20
6	Vegetation Red Edge	0.733 - 0.748	20
7	Vegetation Red Edge	0.773 - 0.793	20
8	NIR	0.785 - 0.900	10
8A	Narrow NIR	0.855 - 0.875	20
9	Water vapour	0.935 - 0.955	60
10	SWIR – Cirrus	1.365 - 1.385	60
11	SWIR-1	1.565 - 1.655	20
12	SWIR-2	2.100 - 2.280	20

Use within the platform

This layer is intended as a contextual visual reference, complementing other datasets. It supports rapid interpretation of current conditions on the ground but should not be used alone for quantitative analysis without further preprocessing.

Source: Sentinel-2 imagery is the result of close collaboration between the (European Space Agency) ESA, the European Commission and USGS. Data is hosted by the Amazon Web Services as part of their Registry of Open Data. Users can access the imagery from Sentinel-2 on AWS, or alternatively access EarthExplorer or the Copernicus Data Space Ecosystem to download the scenes. For information on Sentinel-2 imagery, see Sentinel-2.

Daily Satellite Imagery (MODIS)

This layer shows imagery from MODIS and is updated on a daily basis. It uses the True Color band composition (Bands 1 4 3 | Red, Green, Blue).

This series of products from MODIS brings daily global composites and is suitable for use at global and regional levels. This True Color band composition (Bands 1 4 3 | Red, Green, Blue) most accurately shows how we see the earth's surface with our own eyes. It is a natural looking image that is useful for land surface, oceanic and atmospheric analysis. This map shows the 250-meter corrected reflectance product from both satellites that carry a MODIS, Aqua and Terra. Although the resolution is coarser than other satellites, this allows for obtaining imagery on a daily basis, which is made available in near real-time (Landsat needs 16 days to collect a global composite). Besides the maximum resolution difference, the surface and corrected reflectance products also differ in the algorithm used for atmospheric correction.

NASA Global Imagery Browse Services (GIBS)

This layer provides access to a subset of the NASA Global Imagery Browse Services (GIBS), which are a set of standard services to deliver global, full-resolution satellite imagery. The GIBS goal is to enable interactive exploration of NASA's Earth imagery for a broad range of users. The source data used by this image layer is a finished image; it is not recommended for quantitative analysis.

Several full resolution, global imagery products are built and served by GIBS in near real-time (usually within 3.5 hours of observation). These products are built from NASA Earth Observing System satellites data via LANCE data providers and other sources. The MODIS instrument aboard Terra and Aqua satellites, the AIRS instrument aboard Aqua, and the OMI instrument aboard Aura are used as sources.

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 nominal and high confidence detections with a fire radiative power higher than 30 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

Active fires (MODIS)

Global thermal activity detected by the MODIS sensors on the NASA Aqua and Terra satellites during the last 48 hours.

This layer presents detectable thermal activity from MODIS satellites for the last 48 hours. MODIS Global Fires is a product of NASA's Earth Observing System Data and Information System (EOSDIS), part of NASA's Earth Science Data.

The MODIS 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.

MODIS stands for MODerate resolution Imaging Spectroradiometer. The MODIS instrument is on board NASA's Earth Observing System (EOS) Terra (EOS AM) and Aqua (EOS PM) satellites. The orbit of the Terra satellite goes from north to south across the equator in the morning and Aqua passes south to north over the equator in the afternoon resulting in global coverage every 1 to 2 days. The EOS satellites have a ±55 degree scanning pattern and orbit at 705 km with a 2,330 km swath width.

It takes approximately 2 – 4 hours after satellite overpass for MODIS Rapid Response to process the data, and for the Fire Information for Resource Management System (FIRMS) to update the dataset. Occasionally, hardware errors can result in processing delays beyond the 2-4 hour range. Additional information on the MODIS system status can be found at MODIS Rapid Response.

The centre point location of the 1km (approx.) pixel is flagged as containing one or more fires/hotspots (fire size is not 1km, but variable). For more information on this, see What does a hotspot/fire detection mean on the ground?.

Scale/Resolution: 1km

Update Frequency: 1/2 Hour (every 30 minutes) using the Aggregated Live Feed Methodology

Source: NASA FIRMS - Active Fire Data - for World

Recent earthquakes (48h)

This dataset presents recent earthquake information (magnitude, location, etc.) from the USGS Prompt Assessment of Global Earthquakes for Response (PAGER) program for events in the last 48 hours.

Events are updated as frequently as every 5 minutes. 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.
- **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

Fishing Activity (last 7 days)

This AIS Apparent Fishing Effort layer displays one week of data (with a 72-hour lag), showing the estimated number of hours of apparent fishing activity per square kilometer per day, based on AIS data. It is derived from vessels equipped with AIS transponders and analyzed using a machine learning algorithm that identifies patterns consistent with fishing behavior.

The AIS Apparent Fishing Effort is part of the 4Wings API (aka Map Visualization). The API provides access to three core datasets that enable comprehensive analysis of maritime activity. To determine "apparent fishing effort," Global Fishing Watch analyzes automatic identification system (AIS) data collected from vessels that our research has identified as known or possible commercial fishing vessels and applies a fishing detection algorithm based on changes in vessel speed and direction. The algorithm classifies each AIS broadcast data point for these vessels as either apparently fishing or not fishing and shows the activity on the Global Fishing Watch apparent fishing effort heat map. To learn more, read the Global Fishing Watch AIS-based fishing activity methodology paper.

Global Fishing Watch uses data about a vessel's identity, type, location, speed, direction and more that is broadcast using the Automatic Identification System (AIS) and collected via satellites and terrestrial receivers. AIS was developed for safety/collision-avoidance. AIS data as broadcast may vary in completeness, accuracy and quality. Also, data collection by satellite or terrestrial receivers may introduce errors through missing or inaccurate data. Global Fishing Watch's fishing presence algorithm is a best effort to mathematically identify "apparent fishing activity." As a result, some fishing activity may not be identified as such by Global Fishing Watch; conversely, Global Fishing Watch may show apparent fishing activity where fishing is not actually taking place. For these reasons, Global Fishing Watch qualifies designations of vessel fishing activity, including synonyms of the term "fishing activity," such as "fishing" or "fishing effort," as "apparent," rather than certain. Any/all Global Fishing Watch information about "apparent fishing activity" should be considered an estimate and must be relied upon solely at your own risk.

For more information, please see the Data Caveats and Terms of Use in the Global Fishing Watch API documentation for details on Global Fishing Watch data.

Source: Global Fishing Watch

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.

Cloud and storm map (10-minutes)

Real-time IR-colorised satellite imagery of clouds and storms around the world, updated every 10 minutes.

This global colorised infrared ("cloud-top temperature") composite is derived from the GOES-R Series Advanced Baseline Imager (ABI) Level 1b radiances, merged via a processing workflow (including the McIDAS-V/Cooperative Institute for Meteorological Satellite Studies technique) and rendered with transparent lower-level to facilitate visualization.

It combines data from NOAA's GOES East and West satellites and Japan's Himawari satellite to reveal cloud cover and storm intensity, day and night. The colours represent cloud-top temperatures: colder colours represent higher, colder cloud tops, which are usually linked to stronger storms or intense convection. Warmer temperatures (shown as yellow, orange, or red tones) indicate lower clouds or the Earth's surface, meaning weaker or no storm activity. This rendering is intended to provide a real-time meteorological backdrop and help users quickly understand current weather conditions affecting different regions.

This layer can also help visualize smoke from large wildfires by showing how plumes spread in the atmosphere. Although it primarily detects cloud-top temperatures, smoke often appears as thin, hazy streaks extending from fire areas, especially during clear daytime conditions. When viewed alongside fire alert data, it helps users confirm active burning and understand how wind is transporting smoke toward or away from nearby areas.

Spatial coverage: west coast of Africa to east coast of India, via the GOES-East, GOES-West and Himawari geostationary satellites**.**

Spatial resolution: ~1.5 km per pixel (composite tile service)

Temporal resolution: Updated every ~10 minutes

Spectral band: Infrared "window" band near ~10.3 µm (and potentially other emissive bands) of the ABI instrument.

Processing: Radiances from the ABI Level 1b product (channels 7-16: emissive IR bands) are mapped to brightness temperatures, then colour-mapped to enhance cloud-top coldness/convective intensity; lower-level values are rendered transparent to facilitate overlay. Colour mapping and merging use McIDAS techniques by SSEC.

Dataset product description: GOES ABI Level 1b Radiances – METplus documentation.

Limitations / Usage Notes:

- The colourisation is designed for visual interpretation of cloud-top temperature and intensity, not for quantitative radiometric analysis.
- Geostationary satellite radiances are subject to limb-viewing distortion and increasing spatial sampling error toward the edge of the disc.

- While the layer updates every 10 minutes, there is still latency, and the merged composite may involve slight delays.
- This layer is contextual (situational awareness) and is not itself an alert layer; it should be used in conjunction with other hazard-specific datasets (i.e. flood forecasts).

Sources:

- NOAA/NCEI. NOAA GOES-R Series Advanced Baseline Imager (ABI) Level 1b Radiances. DOI: 10.7289/V5BV7DSR.
- Schmit, T. J., Griffith, P., Gunshor, M. M., Daniels, J. M., Goodman, S. J. (2017). "A closer look at the ABI on the GOES-R Series", Bulletin of the American Meteorological Society, 98(4), 681-698. DOI: https://doi.org/10.1175/BAMS-D-15-00230.1
- McIDAS-V User's Guide, SSEC University of Wisconsin-Madison.

Observed flood extent

This layer shows areas where flooding has been effectively detected via Earth Observation data. The dataset is part of the Global Flood Monitoring (GFM) product developed by the European Centre for Medium-Range Weather Forecasts (ECMWF) under the Copernicus Emergency Management Service (CEMS). It provides near real-time observations of inundated areas to support flood monitoring and situational awareness.

This layer displays flood extent derived primarily from Sentinel-1 Synthetic Aperture Radar (SAR) data, processed automatically to map water bodies and identify floodwaters. New observations are typically available within hours to a few days after satellite acquisition. The product is global, near real-time, and continuously updated as new imagery is acquired. The extent represents detected surface water during the observation period, not forecasted conditions.

Update frequency

The product is updated continuously based on new Sentinel-1 acquisitions. Typical refresh frequency is **1–3 days globally**, depending on satellite overpasses, with a maximum of about **6 days** in areas with less coverage.

Interpretation keys

- Shaded areas represent locations where surface water has been detected as floodwater.
- Flood extent is based on satellite observations at the time of image acquisition.
- Water depth, duration, or flood severity are not provided.
- Cloud cover does not affect Sentinel-1 SAR observations, but very small floods or urban flooding may not be detected.
- In regions with permanent water bodies, classification errors may occasionally occur.

Limitations and disclaimers

- Observed data depend on satellite revisit frequency and acquisition geometry; not all areas are observed every day.
- Flood extent may be underestimated in areas with dense vegetation, steep terrain, or small/localized flooding.
- **This product does not replace official flood reports from national or local authorities.** To be used for awareness and monitoring purposes only.

Dataset name: Copernicus Global Flood Monitoring (Observed Flood Extent)
Source: Copernicus Emergency Management Service / ECMWF

Streamflow forecast (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

Flood forecast extent (15-day)

The Flood forecast extent layer shows areas where the Global Flood Awareness System (GloFAS) projects a high probability of flooding within the next 15 days. The dataset is produced through hydrological modelling of forecasted river discharge and rainfall. It provides indicative flood extents to support preparedness and situational awareness.

This layer displays forecasted flood extent for the next 15 days, derived from the Global Flood Awareness System (GloFAS) Rapid Flood Mapping product developed by the European Centre for Medium-range Weather Forecasting (ECMWF) under the Copernicus Emergency Management Service (CEMS). The GloFAS Rapid Flood Mapping (RFM) product uses hydrological modelling and meteorological forecasts from the ECMWF Integrated Forecasting System to estimate potential inundation areas associated with river flooding. Forecasts are updated daily and provide a rolling 15-day outlook. The layer represents areas where river discharge is expected to exceed thresholds that may lead to floodplain inundation. The output is probabilistic and best interpreted as indicative flood-prone zones rather than precise flood boundaries.

This layer is part of the CEMS Flood Rapid Risk Assessment framework, which integrates multiple data streams to provide situational awareness and early warning for flood hazards. While the flood extent layer itself shows the medium-range forecast up to 15 days, the broader Rapid Risk Assessment incorporates longer-range hydrological forecasts extending up to 30 days, combined with exposure information such as population, critical infrastructure, and administrative boundaries. This integration allows the system to estimate potential impacts beyond the 15-day forecast window, including areas that may become affected later, cumulative exposure of communities, and potential severity of flood events. More information here.

Interpretation keys

- **Shaded areas** represent locations where river flooding is forecasted, based on the Rapid Flood Mapping model.
- The extent is **probabilistic** and does not indicate precise water depth or flood duration.
- **Lead time**: up to **15 days ahead**.
- Forecast uncertainty **increases with lead time** (closer dates are more reliable).

Limitations and disclaimers

- Model-based forecast, not direct observation.
- Small-scale or flash floods (from local rainfall, urban runoff, coastal storm surge) may not be captured.
- Updates are daily, but conditions can change rapidly.

- Spatial resolution may not capture **local topography** or **small rivers**.
- **Not to be used as an official hazard warning**; always refer to authoritative national or regional agencies for emergency information.

Dataset name: GloFAS Rapid Flood Mapping

Source: Copernicus Emergency Management Service / ECMWF

Air quality (PM2.5, hourly update)

This layer shows the latest values for global air quality from ground-based monitoring stations compiled by OpenAQ, focusing on PM2.5 particles, and updated hourly.

The OpenAQ Recent Conditions in Air Quality layer displays the latest mass concentrations and particulate count for small particles of 10, 2.5, 1 micrometers (PM10, PM2.5, PM1) of the stations in the OpenAQ data set with at least one value reported in the past 30 days. **In this platform, only data for PM2.5 is shown.**

The source information is the OpenAQ community which reports measured concentrations (µg/m³) and particle matter count (particles/cm³) on a global scale by aggregating station data from national networks of air quality. The dataset it updated every hour using the Aggregated Live Feed (ALF) methodology.

For more information on the dataset, please consult here.

Source: OpenAQ

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)

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

IOC Sea Level Stations (IOC Sea Level Station Monitoring Facility)

Global network of real-time sea level monitoring stations (IOC-UNESCO), with operational status updated via real-time transmission metadata.

This layer displays the locations and operational status of global sea level monitoring stations managed under the UNESCO-IOC Sea Level Station Monitoring Facility (SLSMF), **as well as relative sea level at station, when data is available**. Hosted by the Flanders Marine Institute (VLIZ) on behalf of UNESCO/IOC, the service aggregates real-time station data from networks including the GLOSS Core Network and regional tsunami early-warning systems. It supports rapid assessment of station connectivity and incoming data streams to assist disaster preparedness and ocean monitoring.

Update frequency

The KML is dynamically generated to reflect current station states. Many stations transmit sea level data at **high frequency**, commonly every **1 to 5 minutes**, depending on the instrumentation, while longer-term averages (hourly, daily, monthly) are available via data centres such as PSMSL, BODC, and UHSLC.

Interpretation keys

- **Locations on the map** show station status:
    - Green: Station is online
    - Red: Station is offline, or data is outdated
    - Blue: Station is not available at this site
- Stations flagged as **"online"** are actively reporting data; those **"offline"** have had no updates within three times their expected transmission interval (see here).
- Clicking on a station brings up relative sea level and metadata such as station name, provider, latitude/longitude, and communication protocol.
- The quality of the transmitted data is not checked.
- Stations are part of real-time networks including tsunami warning systems (IOTWS, NEAMTWS, PTWS, CARIBE-EWS) and the GLOSS Core Network.

Limitations and disclaimers

- This tool is intended for quick inspection and situational awareness; operational use during emergencies may be affected by connectivity or service disruptions.
- Coverage and update delays depend on each station's configuration and communication method.

Dataset name: IOC Sea Level Station Monitoring Facility (Stations KML)
Source: UNESCO/IOC – Flanders Marine Institute (VLIZ)

More info about *Tsunami Warning Operations: Sea Level Monitoring – Tide Tool and IOC Sea Level Monitoring Facility* consultable here.

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 in September 2025 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

Biodiversity

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 2025 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 (2025) 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 2025 version. Available at http://keybiodiversityareas.org/kba-data/request

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

Ecosystem Integrity Index (2000-2020)

The Available as a time series, the Ecosystem Integrity Index (EII) provides values for ecosystem integrity across all terrestrial areas, globally.

The Ecosystem Integrity Index (EII) provides values for ecosystem integrity across all terrestrial areas, globally. It provides a simple and robust way of measuring, monitoring and reporting on ecosystem integrity. EII is a Component Indicator in the Kunming-Montreal Global Biodiversity Framework and listed by the Taskforce for Nature-Related Financial Disclosures (TNFD) and the Science Based Targets Network (SBTN).

The index is formed of the three components that make up ecosystem integrity: structural, compositional and functional integrity and measured against an unimpacted or 'natural' baseline on a scale of 0 to 1. Values towards 1 indicate greater levels of integrity, closer to the natural reference state, whilst towards 0, values are indicative of high levels of degradation. The data is available as a time series spanning two decades at five yearly intervals from 2000 to 2020.

The structure component takes the Human Modification Index (HMI) (Kennedy et al., 2019) inputted into the algorithm described in Beyer et al. (2019) that accounts for habitat intactness within a grid cell and the influence of habitat quality within neighbouring cells. This method ensures that the structure layer encompasses impacts of landscape fragmentation as well as local intactness. The composition component is a novel formulation of the Biodiversity Intactness Index (BII), which summarises change in the make-up of local ecological communities in response to human pressures (Newbold et al., 2016, Hill et al., 2019). The functioning component is estimated using the difference between potential natural and current net primary productivity (NPP) within each grid cell. Current NPP values are taken from remote sensed geospatial layers (Running and Zhao, 2019). Potential natural NPP values are modelled using environmental input data. These three component layers are aggregated to form the EII. The time series is presented at 1km2 spatial resolution.

For further information on EII, input data, the methodology underlying the formation of the component layers as well as aggregation to the composite index, please see the published paper in Ecological Indicators: *The ecosystem integrity index: a component indicator in the Kunming-Montreal global biodiversity framework reveals the integrity of terrestrial ecosystems globally*

Source: UNEP-WCMC; Hill, S.L.L., Harrison, M.L.K., Maney, C., Bedford, J., Harris, M., Mason, T.H.E., Ash, N., Hughes, J. and Jones, M., 2026. The ecosystem integrity index: a component indicator in the Kunming-Montreal global biodiversity framework reveals the integrity of terrestrial ecosystems globally. Ecological Indicators, 190, p.115314.

Biodiversity Intactness Trends (1970–2050)

This layer presents the Biodiversity Intactness Index (BII), developed by the United Kingdom's Natural History Museum. It provides modelled estimates of biodiversity intactness from 1970 to 2050, assessing changes in species abundance and ecological community composition in response to human pressures. BII estimates the proportion of original species abundance and ecological community composition remaining relative to modelled reference conditions. These conditions are inferred from biodiversity observations collected at minimally disturbed sites worldwide, representing the best available approximation of ecosystems under minimal human pressure. The dataset includes historical estimates and future projections under five different Shared Socioeconomic Pathways (SSPs).

This layer presents the Biodiversity Intactness Index (BII), which quantifies changes in the composition and abundance of ecological communities in response to anthropogenic pressures and climate change. BII is expressed as the estimated percentage of original species abundance remaining relative to a 1970 baseline, representing minimally disturbed conditions. Values reflect modelled estimates of current status and projected biodiversity intactness under combined human pressure and climate change scenarios for 2050.

The layer uses a divergent colour schema Blue-Green-Yellow. In blue are shown areas with little to no biodiversity loss; areas in green represent areas of biodiversity loss where most species remain viable; areas in yellow represent the most extreme areas of biodiversity loss with the potential for significant species loss.

Biodiversity Intactness Index (BII) Methodology:

Using the PREDICTS database, which compiles local biodiversity measurements from thousands of sites worldwide, it was statistically modelled responses of total organism abundance and community compositional similarity to land use and associated anthropogenic pressures. These response models were integrated with spatio-temporal projections of explanatory variables at 0.25° spatial resolution for the period 1970–2050, based on five Shared Socioeconomic Pathways (SSPs), to generate projections of the Biodiversity Intactness Index (BII). Area-weighted mean BII values were then calculated at national, subregional, inter-regional, and global scales. Uncertainty was quantified using a leave-one-biome-out cross-validation approach, producing decadal upper and lower uncertainty bounds for the period 1970–2050. To read more about the methodology visit: https://adrianadepalma.github.io/BII_tutorial/

Source: Helen Phillips; Adriana De Palma; Ricardo E Gonzalez; Sara Contu et al. (2021). The Biodiversity Intactness Index - country, region and global-level summaries for the year 1970 to 2050 under various scenarios [Data set]. Natural History Museum. https://doi.org/10.5519/he1eqmg1

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 >

Net Primary Productivity (Current and Projected)

Net Primary Productivity (NPP) measures the rate at which plants and other autotrophs convert atmospheric carbon into biomass through photosynthesis, expressed as grams of carbon per square meter per year (g C/m²/yr). It is a fundamental ecological indicator describing ecosystem functioning, landscape productivity, and the capacity of habitats to support biodiversity, agriculture, and carbon cycling.

This layer displays a global downscaled CMIP6 ISIMIP3b projection of NNP, as well as an estimation for 2025. 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:

"High-resolution information on climatic conditions is essential to many applications in environmental and ecological sciences. 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. The precipitation algorithm incorporates orographic predictors including wind fields, valley exposition, and boundary layer height, with a subsequent bias correction."

Climate Scenarios

The CMIP6 ISIMIP3b climate experiments use Shared Socioeconomic Pathways (SSPs) to model future climate scenarios. Each SSP pairs a human/community behaviour 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, both as an estimation for 2025 and projection for 2050. From the IPCC AR6 Summary for Policymakers:

SSP	Scenario	Estimated warming (2041–2060)	Estimated warming (2081–2100)	Very likely range in °C (2081–2100)
SSP1-2.6	low GHG emissions: CO2 emissions cut to net zero around 2075	1.7 °C	1.8 °C	1.3 – 2.4
SSP3-7.0	high GHG emissions: CO2 emissions double by 2100	2.1 °C	3.6 °C	2.8 – 4.6
SSP5-8.5	very high GHG emissions: CO2 emissions triple by 2075	2.4 °C	4.4 °C	3.3 – 5.7

Phenomenon mapped: Net primary productivity
Geographic extent: Global
Data projection: GCS WGS84
Cell size: 30 arc seconds (~1 km)
Units: g C m^{-2} $year^{-1}$
Pixel type: 32 Bit Float
Data vintage: 5/30/2025
Publication date: 10/16/2025

What the values represent

- Pixel values represent mean annual net primary productivity
  Unit: $g\ C\ m^{-2}\ yr^{-1}$
- Higher values = higher vegetative productivity and biomass accumulation.
- Lower values = reduced photosynthetic activity (e.g., deserts, degraded landscapes, drought-impacted areas, alpine/high-latitude zones).

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+

Forests

Global Forest Cover (2020)

This dataset provides a single harmonized, globally consistent representation of forest extent for the year 2020 at 10-meter spatial resolution.

The Global Forest Cover 2020 (GFC2020) Version 3 imagery layer provides a globally consistent representation of forest cover for the year 2020 at 10-meter spatial resolution. The dataset was produced by the European Commission Joint Research Centre (JRC) by combining global datasets on tree cover, mangrove cover, tree height, land cover, and land use into a harmonized representation of where forests existed in 2020.

The maximum potential extent of forest cover circa 2020 is first delineated by integrating global tree- and mangrove-cover datasets and historical time-series of tree cover and loss to identify areas of potentially unstocked forest resulting from natural disturbances or forest management practices. In a second step, this maximum potential forest extent is intersected with additional datasets on tree height, deforestation, cropland, agroforestry, and other land uses. A series of Boolean decision rules is then applied to exclude areas that are not considered forest according to the FAO Forest Resources Assessment (FAO-FRA) and EUDR forest definitions.

Forest is defined as land spanning more than 0.5 hectares with trees higher than 5 meters and a canopy cover greater than 10%, or trees able to reach those thresholds in situ, excluding land predominantly under agricultural or urban land use. Agricultural plantations and production systems associated with commodities such as cocoa, coffee, oil palm, rubber, soy, and livestock production are excluded from the forest definition.

Geographic Coverage: Global landmasses (excluding ocean areas)
Temporal Coverage: 2020
Spatial Resolution: 10-meter

Source: Global Forest Cover (GFC2020) Version 3 is credited to the European Commission's Joint Research Centre (JRC). For more information, including known issues, refer to the GFC2020 Open Data Catalog.

For direct access and metadata, refer to the JRC data catalogue (JRC 2024). Technical documentation describing the mapping approach and accuracy assessment is referenced in the official GFC2020 documentation.

Global Canopy Height (2020)

2020 Global vegetation height with a resolution of 10-m, produced by EcoVision Lab in the ETH Zurich Department of Civil, Environmental and Geomatic Engineering.

This dataset was produced at ETH Zurich via a method to estimate canopy height using LiDAR data from space and airborne sensors, including the Global Ecosystem Dynamics Investigation (GEDI) on board the International Space Station.

These LiDAR observations were used as ground truth data to train a deep convolutional neural network to regress canopy height from Sentinel-2 images at a 10-m spatial resolution. Units are in meters. The accuracy of the vegetation height is ± 5 m.

Source: ETH Zurich

Tree Cover Loss (2001-2025)

This dataset measures annual tree cover loss across nearly all global land areas at approximately 30 m resolution from 2001 to 2025.

This dataset is produced through a collaboration between the **Global Land Analysis & Discovery (GLAD) Lab** at the University of Maryland, Google, USGS, and NASA. The product is derived from multispectral Landsat imagery (Landsat 5 TM, Landsat 7 ETM+, and Landsat 8 OLI). More than one million satellite images were processed using supervised machine learning algorithms to identify tree cover loss at the pixel level.

Tree cover loss is defined as a **stand-replacement disturbance**, generally involving removal of at least half of the tree cover within a 30-m pixel. The threshold varies by biome and through time. Loss may result from timber harvesting, conversion to other land uses, fire, disease, storms, or other natural and human disturbances.

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 2011-2025 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).

The dataset is currently available as Version 1.13, covering 2001–2025. Methodological updates have introduced improved modelling, calibration, and change detection, including reprocessing of previous years. The 2011–2025 data better capture boreal forest loss due to fire, smallholder rotation agriculture in tropical forests, selective logging, and short-cycle plantations.

Tree cover, loss, and gain datasets use different methodologies and reference dates and are therefore not directly comparable. Tree cover gain should not be subtracted from loss to calculate net loss, nor should annual loss be subtracted from year 2000 tree cover to estimate current tree cover. Comparisons between the original 2001–2010 data and the updated 2011–2025 data should be treated with caution, particularly around the 2015 methodological change. 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).

Cautions and Interpretation

- **Tree cover** includes all vegetation taller than 5 m, including natural forests and plantations.
- **Loss** represents removal or mortality of tree cover and may result from harvesting, fire, disease, storms, or other disturbances.
- Tree cover loss **should not be interpreted as deforestation** without additional contextual information.
- Tree cover loss should not be **subtracted** with other extent and gain layers to **estimate net change**.
- The 2011–2025 series uses an updated methodology; comparisons with 2001–2010 should be made cautiously.
- Reported global accuracy in the original publication was approximately **13% commission error** and **12% omission error**, with substantial regional variation.
- Accuracy is generally lower in many smallholder agricultural landscapes in sub-Saharan Africa.
- The authors estimate about **75% confidence that loss occurred within the mapped year** and **97% confidence within ±1 year**.

More information: Accuracy blog series

Version 1.13 documentation:

- Methodology update
- Google Earth Engine dataset

Map Visualization Notes

- At zoom levels **< 13**, pixel shading represents the density of tree cover loss within larger display cells.
- Darker shading indicates a higher concentration of loss.
- At zoom levels **≥ 13**, the data are displayed at full spatial resolution with no density shading.
- Displayed canopy density can be adjusted using the map legend threshold settings.

Property	**Value**
Geographic coverage	Global land area (excluding Antarctica and some Arctic islands)
Temporal coverage	2001–2025 (annual updates; 2026 expected mid-2027)
Spatial resolution	30 m × 30 m
Product level	Annual tree cover loss detection for woody vegetation ≥ 5 m tall
Source CRS	WGS84 (EPSG:4326)
Update frequency	Annual

Suggested citations: **Hansen, M. C., et al. (2013).** *High-Resolution Global Maps of 21st-Century Forest Cover Change.* Science, 342, 850–853. doi: 10.1126/science.1244693

Data available from: GLAD Global Forest Change

Source: Hansen/UMD/Google/USGS/NASA

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

Mangrove Aboveground Biomass (Mg ha-1)

Global mangrove distribution and aboveground biomass in the 2000s estimated by NASA's Carbon Monitoring System (CMS) program through synthesizing remotely sensed and in situ field measurement data.

This layer is composed by one-time estimates of 30-meter resolution global mangrove distribution, aboveground biomass, and canopy height that represent conditions of mangrove-forested wetlands in the 2000s based on remotely sensed data and in situ field measurements and region-specific allometric models. **However, on his platform only the aboveground biomass layer is displayed.**

The original, underlying multidimensional image dataset contains three variables.

- agb (Mg ha-1): mangrove aboveground biomass measured in megagrams per hectare
- hmax (meters): maximum canopy maximum height (height of the tallest tree) measured in meters
- hba (meters): basal-area weighted height (individual tree heights weighted in proportion to their basal area).

The maximum canopy height and basal-area weighted height values were capped at the 95th percentile of the maximum value in each country to minimize the impact of canopy height error reported from a potentially small number of misclassified pixels. Data sources used include the Shuttle Radar Topography Mission (SRTM) Digital Elevation Model (DEM) data collected in February 2000, lidar heights collected from 2003 to 2009 by the ICESat/Geoscience Laser Altimeter System (GLAS) Spaceborne Lidar mission, and in situ field measurements collected from 2004 to 2014. Details about the underlying data can be found at https://doi.org/10.3334/ORNLDAAC/1665

Legend:

Variable	Units	Pixel Value	Description
Agb ***[displayed on the platform]***	Mg ha-1	High: 910.476	Mangrove aboveground biomass
		Low: 0.284	

Hmax	meters	High: 62.789 Low: 0.849	Mangrove canopy maximum height (height of the tallest tree)
hba	meters	High: 39.79 Low: 0.538	Mangrove basal-area weighted height (individual tree heights weighted in proportion to their basal area)

Contact:

For inquiries about this data, please contact support@earthdata.nasa.gov or post/view questions on the Earthdata Forum.

Source: NASA's Carbon Monitoring System (CMS) program

Suggested Citation:

- Simard, M., T. Fatoyinbo, C. Smetanka, V.H. Rivera-monroy, E. Castaneda, N. Thomas, and T. Van der stocken. 2019. Global Mangrove Distribution, Aboveground Biomass, and Canopy Height. ORNL DAAC, Oak Ridge, Tennessee, USA. https://doi.org/10.3334/ORNLDAAC/1665

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 kilometer 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, read here and 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. Adequate 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.

Dataset downloaded from Zenodo: https://zenodo.org/record/883444

Oceans

Marine Species Patterns

Gridded dataset depicting global patterns of marine species richness and average rarity, derived from habitat-suitability indices based on species distribution models (SDMs).

The dataset covers marine fishes and marine mammals, aggregated to an equal-area grid of approximately 3,025 km² per cell (≈ 55 km × 55 km in the tropics). Grid cells are clipped to the coastline (GADM 3.6) and only ocean-covered cells are retained.

Values for both species richness and species rarity are expressed as **percentile ranks** from 1 (lowest) to 100 (highest) relative to all global grid cells.

Species richness indicates the relative number of species whose modelled ranges overlap each grid cell (for fish, for mammals, and combined taxa). **Species rarity**, also termed "average range-size rarity," refers to the mean of the inverse global range sizes of the species predicted to occur in each cell.

Separate indices are provided for marine fishes, marine mammals, and combined taxa.

This dataset provides a relative global assessment of marine biodiversity patterns at a consistent spatial resolution suitable for broad-scale analyses. High percentile values indicate grid cells where modelled species richness or rarity is relatively high compared to other global cells.

Because the values are percentile ranks and not absolute counts or proportions, they serve best as **relative indices**, highlighting biodiversity "hotspots" or areas of elevated modelled richness or species-range-rarity. They are particularly useful for global or regional assessments, conservation prioritization, and spatial planning. However, they are **not designed** for detailed local ecological inference or for obtaining actual species counts within each cell.

Attribute	Description
Cell area (km²)	Area of each grid cell (~3,025 km²)
Species richness: fish	Percentile rank (1–100) of modeled richness of marine fish species
Species rarity: fish	Percentile rank (1–100) of modeled rarity of marine fish species
Species richness: mammals	Percentile rank (1–100) of modeled richness of marine mammal species

Attribute	Description
Species rarity: mammals	Percentile rank (1–100) of modeled rarity of marine mammal species
Species richness: all taxa	Percentile rank (1–100) of modeled richness combined (fish + mammals)
Species rarity: all taxa	Percentile rank (1–100) of modeled rarity combined (fish + mammals)

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Source: Map of Life, Yale University

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
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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

- Telesca L, Belluscio A, Criscoli A, Ardizzone G, Apostolaki ET, Fraschetti S, Gristina M, Knittweis L, Martin CS, Pergent G, Alagna A, Badalamenti F, Garofalo G, Gerakaris V, Pace ML, Pergent-Martini C, Salomidi M, 2015. Seagrass meadows (Posidonia oceanica) distribution and trajectories of change. Scientific Reports 5: 12505. URL: http://www.nature.com/articles/srep12505
- 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

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)

Sea Level Change Projections (AR5, 2100)

Gridded layer for global sea level change projections under different RCP scenarios based on AR5.

This dataset, provided by the Integrated Climate Data Center (ICDC) at the University of Hamburg, presents projections of global mean and regional sea level rise under different Representative Concentration Pathway (RCP) scenarios (RCP2.6, RCP4.5, RCP6.0, RCP8.5) based on the IPCC-AR5 report. The dataset includes contributions from thermal expansion, glaciers, and ice sheets, aggregated at a global level.

These are the relative sea surface height (SSH) data, which was used in the construction of figures for IPCC-AR5. The data include 10 geophysical sources that drive long-term changes in relative SSH:

- 5 ice components (Greenland dynamic ice and surface mass balance, Antarctic dynamic ice and surface mass balance, and glaciers),
- 3 ocean-related components, all of which are derived from CMIP5 models (dynamic SSH, global thermosteric SSH anomaly, and the inverse barometer effect from the atmosphere),
- land water storage (also called terrestrial water), and
- glacial isostatic adjustment (as a change in sea level relative to land).

All processing methods and data sources are defined in chapter 13 of the Supplementary Material (see References here). Some further details, including combining uncertainties from different components, are included in a readme file consultable thereat.

On this platform, projection under RCP4.5 scenario is displayed by default, but users can switch between different scenarios to compare projected sea level changes.

Metadata and identifiers:

- Temporal coverage: Historical baseline (1986–2005) and projections up to 2100
- Spatial coverage: Global
- Resolution: 1° × 1° grid (global)

Interpretation notes:

- Values are given in meters of sea level rise relative to the 1986–2005 baseline.
- RCP scenarios represent different greenhouse gas concentration trajectories: RCP2.6 (low emissions), RCP4.5 and RCP6.0 (intermediate), RCP8.5 (high emissions).
- Uncertainty ranges reflect differences among models and contributions from ice sheets, glaciers, and thermal expansion.

- Data are suitable for integration into GIS platforms, climate risk assessments, and adaptation planning but should be interpreted as projections rather than deterministic predictions.
- Symbology has been harmonized across layers for visual comparison of different projections.

Source: Integrated Climate Data Center (ICDC), University of Hamburg
For more information: ICDC AR5 Sea Level Rise Data

Offshore infrastructure (satellite-detected)

Global fixed infrastructure detected using Synthetic Aperture Radar (SAR) from Sentinel-1 Imagery data that was detected with satellite imagery and classified with deep learning. This layer receives monthly updates with all data from 2017 to 3 months ago.

Offshore fixed infrastructure is a global dataset that is accessible through the Global Fishing Watch Datasets API. It uses AI and machine learning to detect and classify structures throughout the world's oceans. This is the same API used in Global Fishing Watch's Public Map (see the Data Download Portal). In the Map and API, data labelled as noise are excluded, only structures that have been detected for at least 3 months and have a predicted noise probability of < .3 are included, and data from certain regions, such as Chile, Canada, and Norway are filtered to remove additional noisy detections.

Classification labels (oil, wind, and unknown) are provided, as well as confidence levels (high, medium, or low) reflecting certainty in the assigned label (in this platform, only high confidence detections are shown). The data is updated monthly, and new classified detections are added at the beginning of every month. Infrastructure no longer in place is also removed from the dataset.

For more information, please see the SAR (Synthetic-Aperture Radar) Data Caveats and Terms of Use in the Global Fishing Watch API documentation for details on Global Fishing Watch data, API licenses, and rate limits.

Source: Global Fishing Watch

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

Global fishing effort (total hours fished, 2020)

The amount of fishing activity (apparent fishing effort) per square kilometre for the year 2020, measured in hours, tracked via automatic identification system (AIS) positions.

This layer shows the amount of fishing activity recorded by Automatic Identification System (AIS) for the year 2020. Using cloud computing, machine learning and public vessel registry information, Global Fishing Watch (GFW) analyze tens of millions of AIS positions each day to map global apparent fishing effort. Producing such a map involves two key steps: Identification of fishing vessels in the AIS data (Hours) and Detection of fishing activity (Fishing Hours). This annual summary is produced from the daily GFW AIS-based apparent fishing effort data. The daily fishing activity made available by GFW was rasterized at 100th degree resolution then aggregated to produce an annual summary for the given year. The maps show areas where likely fishing activity occurred in the year 2020 and the estimated level of fishing intensity. This information can help understand areas where fishing activity might be considered in a marine spatial planning application.

More information: https://globalfishingwatch.org/dataset-and-code-fishing-effort/

Variable Mapped: Apparent fishing effort in hours per sq/km

Cell Size: (~1km)

Version: 2.0, released 18 March 2021

Source: Global Fishing Watch

Water

Transboundary Aquifers

This dataset displays transboundary aquifers around the world.

The 2015 Map of Transboundary Aquifers of the World illustrates the known occurrence and extent of transboundary aquifers worldwide. It identifies 592 transboundary aquifers, including 226 transboundary groundwater bodies defined under the European Union Water Framework Directive (EU WFD), underlying almost every country.

More information: www.isarm.org

Sources: Internationally Shared Aquifer Resources Management (ISARM) Programme, launched by UNESCO's International Hydrological Programme (UNESCO-IHP) in 2000.

Transboundary River Basins

This dataset displays transboundary river basins around the world.

The world's transboundary river basins span 151 countries, include more than 2.8 billion people (around 42 % of the world's population), cover 62 million km² (42 % of the total land area of the Earth), and produce around 22 000 km³ of river discharge each year (roughly 54 % of the global river discharge). From earlier known transboundary river basin delineations (214 transboundary basins identified by UNDESA (1978), 261 by Oregon State University (1999), 263 by OSU (2002), 276 by OSU (2012)), the number has risen to 286. For more information, visit: http://twap-rivers.org/.

Sources: UNDESA (1978); Oregon State University (1999, 2002, 2012); Transboundary Waters Assessment Programme (TWAP) – Rivers (http://twap-rivers.org/).

Surface Water Recurrence

This dataset measures the percentage of inter-annual variability in surface water presence from 1984-2021 at 30-meter spatial resolution.

The dataset of surface water recurrence (1984–2021) describes the inter-annual behavior of surface water and expresses how frequently water returns from year to year as a percentage at 30-m spatial resolution over the 38-year Landsat archive. Recurrence measures the degree of inter-annual variability in surface water presence for each pixel. Unlike occurrence, recurrence is not systematically computed over an entire archive because water may not have been present throughout the full observation period. Therefore, recurrence is calculated individually for each pixel within its defined water period — the period extending from the first month in the first year in which water was observed to the last month in the last year in which water was observed.

To calculate recurrence, a water season is identified for each pixel from monthly water recurrence. The water season represents the months of the year during which water occurs from time to time. A water year is defined as a year with at least one water observation during the water season, while an observation year is defined as a year with at least one valid observation during the same water season. Years containing observations only outside the water season are excluded because water presence during the water season cannot be determined. Water recurrence is calculated as the ratio between the number of water years and the number of observation years, expressed as a percentage.

High recurrence values (close to 100%) indicate persistent or regularly recurring water bodies, including permanent and seasonal water, whereas low recurrence values indicate intermittent, episodic, or highly variable surface water occurrence and flooding.

The mapping approach used to generate the Global Surface Water dataset is described in Pekel et al. (2016), while additional details on dataset processing and validation are provided in the JRC Global Surface Water Data Users Guide.

Geographic Coverage: Coastal and inland areas; ocean pixels excluded

Temporal Coverage: 1984 – 2021

Spatial Resolution: 30 meters

Sources: European Commission Joint Research Center (JRC) Global Surface Water dataset. Refer to the JRC Global Surface Water Data Catalog.

Water risk

This layer provides a global assessment of current and future water-related risks based on the Aqueduct 4.0 framework developed by the World Resources Institute (WRI). It supports the identification of UNESCO designated sites potentially exposed to increasing water stress, water scarcity, and water quality challenges under present-day conditions and future climate scenarios.

The dataset includes indicators such as water stress, water depletion, untreated connected wastewater, and unimproved or no drinking water access, grouped into two main categories: (1) physical risk – quantity, and (2) physical risk – quality.

Aqueduct 4.0 provides water risk assessments for a historical baseline period (1979–2019) and for the three future projection periods below derived from CMIP6 climate projections, which are translated into hydrological indicators using the PCR-GLOBWB 2 hydrologic model developed by Utrecht University:

- 2015–2045
- 2035–2065
- 2065–2095

Future projections are produced under three combined climate and socio-economic scenarios:

- **SSP1–RCP2.6 (Optimistic):** Low greenhouse gas emissions and relatively strong socio-economic development
- **SSP3–RCP7.0 (High challenges):** Limited mitigation, fragmented development, and increasing pressures on water resources
- **SSP5–RCP8.5 (Pessimistic):** High greenhouse gas emissions and resource-intensive development pathways

The indicators are aggregated into watersheds based on HydroBASINS level 6. For more information, visit the Aqueduct 4.0 Public Documentation website or the Aqueduct 4.0 Technical Note.

This layer is presented here to support preventive and strategic monitoring of UNESCO designated sites, rather than operational water management or emergency response. When overlaid with sites boundaries, the dataset allows users to:

- Identify sites located in watersheds with high or increasing water risk, including chronic water stress and declining water quality.
- Compare baseline conditions with future projections to assess how water-related pressures on sites may evolve under different climate pathways.

- Support prioritisation of sites for further assessment, field-based studies, or management planning related to water availability, ecosystem health, and conservation resilience.
- Provide contextual evidence for State of Conservation reporting, Periodic Reporting, and strategic dialogue with stakeholders.

Limitations

- This layer represents modeled, aggregated water risk at the watershed scale and does not reflect site-specific infrastructure, local water management, or short-term hydrological extremes.
- Results should be interpreted as screening-level indicators, not as direct measurements of impacts at individual sites.
- Future projections are based on climate model scenarios and carry inherent uncertainty; they should be used comparatively rather than deterministically.
- The layer is intended for heritage monitoring and early awareness, not for regulatory decision-making or emergency response.

Data Dictionary

- **Water Stress**: Ratio of total water withdrawals to available renewable surface and groundwater supplies. Measures competition for water resources.
- **Water Depletion**: Ratio of total water consumption to available renewable water supplies. Measures total water consumption as a share of available resources.
- **Available Blue Water**: The total amount of renewable freshwater (surface water and groundwater) available to a sub-basin with upstream consumption removed.
- **Gross Water Demand**: The total water withdrawals across all sectors within a sub-basin, including: domestic, agricultural, industrial, power generation, and livestock.
- **Interannual Variability**: The average variation in available water supply from year to year, calculated as the coefficient of variation of annual values for each month and each sub-basin.
- **Seasonal Variability**: The average variation in available water supply within a single year, calculated as the coefficient of variation across monthly averages over a multi-year period.
- **Groundwater Table Decline**: Decline in groundwater table levels measured in centimeters per year.
- **Untreated Connected Wastewater**: Domestic wastewater that is not treated before being discharged into the environment.
- **Coastal Eutrophication Potential**: Potential for algal blooms and oxygen depletion in coastal waters due to nutrient loading from inland sources.

- **Unimproved/No Drinking Water**: Risk to the population due to lack of access to improved drinking water source.
- **Unimproved/No Sanitation**: Risk to the population due to lack of access to improved sanitation facilities.

Phenomenon mapped: Water-related risk

Spatial unit: Watersheds (HydroBASINS Level 6)

Hydrological model: PCR-GLOBWB 2 (Utrecht University)

Baseline period: 1979–2019

Future climate projections: CMIP6-based scenarios for 2015–2045, 2035–2065 and 2065–2095

Risk categories included:

- Physical Risk – Quantity (i.e. water stress, water depletion)
- Physical Risk – Quality (i.e. untreated connected wastewater, drinking water access)

Update frequency: 3-5 years

Data vintage: April 2023

Publication date: November 2025

Source: WRI Aqueduct

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

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

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

Climate

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 CH4 and N2O. 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 CO2 emissions/ha, and 2) megagrams of CO2 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, 2050)

Annual mean temperature for 2025, and global bioclimate projection of annual mean temperature for 2050 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 2050 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 behaviour component with the traditional RCP greenhouse gas forcings. The dataset includes three SSPs: SSP1-2.6, SSP3-7.0 and SSP5-8.5, with SSP3-7.0 is displayed in this platform by default, for 2050. From the IPCC AR6 Summary for Policymakers:

SSP	Scenario	Estimated warming (2041–2060)	Estimated warming (2081–2100)	Very likely range in °C (2081–2100)

SSP1-2.6	low GHG emissions: CO2 emissions cut to net zero around 2075	1.7 °C	1.8 °C	1.3 – 2.4
SSP3-7.0	high GHG emissions: CO2 emissions double by 2100	2.1 °C	3.6 °C	2.8 – 4.6
SSP5-8.5	very high GHG emissions: CO2 emissions triple by 2075	2.4 °C	4.4 °C	3.3 – 5.7

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 (not all shown in this platform).

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, 2050)

Mean Annual Precipitation for 2025, and global bioclimate projection of mean annual precipitation for 2050 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, with SSP3-7.0 displayed by default in this platform, for 2050. From the IPCC AR6 Summary for Policymakers:

SSP	Scenario	Estimated warming (2041–2060)	Estimated warming (2081–2100)	Very likely range in °C (2081–2100)
SSP1-2.6	low GHG emissions: CO_2 emissions cut to net zero around 2075	1.7 °C	1.8 °C	1.3 – 2.4
SSP3-7.0	high GHG emissions: CO_2 emissions double by 2100	2.1 °C	3.6 °C	2.8 – 4.6
SSP5-8.5	very high GHG emissions: CO_2 emissions triple by 2075	2.4 °C	4.4 °C	3.3 – 5.7

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 (not all shown in this platform).

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+

Earth systems

Volcanoes

This layer represents volcanoes that have had eruptions during the Holocene period (approximately the last 12,000 years). It is derived from the Smithsonian Institution's Global Volcanism Program (GVP) database. The dataset contains 1,249 volcanoes with detailed attributes.

GVP reports volcanic activity through:

- Smithsonian / USGS Weekly Volcanic Activity Report
- Bulletin of the Global Volcanism Network

Data includes eruptive histories, morphology, tectonic settings, and materials erupted.

Click here to contact the data providers. Terms of GVP content are consultable here.

Fields

- Volcano Number
- Volcano Name
- Volcanic Region Group
- Volcanic Region
- Volcano Landform
- Primary Volcano Type
- Activity Evidence
- Last Known Eruption
- Latitude
- Longitude
- Elevation (m)
- Tectonic Setting
- Dominant Rock Type

Suggested citation:

- Global Volcanism Program, 2025. [Database] *Volcanoes of the World* (v. 5.3.1; 6 Aug 2025). Distributed by Smithsonian Institution, compiled by Venzke, E. https://doi.org/10.5479/si.GVP.VOTW5-2025.5.3

Source:

- Global Volcanism Program (GVP), Smithsonian Institution. Dataset: *Volcanoes of the World (v. 5.3.1; 6 Aug 2025),* Compiled by Venzke, E. DOI: https://doi.org/10.5479/si.GVP.VOTW5-2025.5.3. Website: https://volcano.si.edu/

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.

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

More information available in FAO's Soils Portal.

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

World soils organic carbon density

This dataset presents a prediction of organic carbon density (mass divided by volume) of world soils at a depth of 45 centimetres. Machine learning was used to predict soil characteristics at 250m resolution from 230,000 soil profile observations. This version, sourced from SoilGrids250m version 2.0 (ISRIC), was released in May 2020.

This layer contains the chemical soil variable **organic carbon density** which measures carbon mass in proportion to volume of soil (mass divided by volume). Soil carbon provides a source of nutrients through mineralisation, helps to aggregate soil particles (structure) to provide resilience to physical degradation, increases microbial activity, increases water storage and availability to plants, and protects soil from erosion.

This layer is a general, medium scale global predictive soil layer. In many places samples of soils do not exist so this map represents a prediction of what is most likely in that location. The predictions are made in six depth ranges by soilgrids.org, funded by ISRIC based in Wageningen, Netherlands. Each 250m pixel contains a value predicted for that area by soilgrids.org from best available data worldwide. The full dataset provides data for organic carbon density at six depth ranges from the surface to 2 meters below the surface. **Here data is presented for 45 centimetres depth only.**

*Phenomenon Mapped***:** Organic carbon density in kg/m³
Cell Size: 250 meters
Pixel Type: 32 bit float, converted from online data that is 16 Bit Unsigned Integer
Coordinate System: Web Mercator Auxiliary Sphere, projected via nearest neighbour from Goode's homolosine land (250m)
Extent: World land area except Antarctica
Number of Columns and Rows: 160300, 100498
Actual depth range of data: 100 – 200 cm
Mean depth: 45 cm
Publication date: May 2020
For more information, access about the data soilgrids.org (ISRIC) frequently asked questions page.

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

World soils pH

This dataset presents a prediction of pH of world soils at a depth of 45 centimetres. Machine learning was used to predict soil characteristics at 250m resolution from 230,000 soil profile observations. This version, sourced from SoilGrids250m version 2.0 (ISRIC), was released in May 2020.

This layer presents the chemical soil variable pH. Soil pH affects many chemical processes. It specifically affects plant nutrient availability by controlling the chemical forms of the different nutrients and influencing the chemical reactions they undergo. The optimum pH range for most plants is between 5.5 and 7.5; however, many plants have adapted to thrive at pH values outside this range.

This layer is a general, medium scale global predictive soil layer suitable for global mapping and decision support. In many places samples of soils do not exist so this map represents a prediction of what is most likely in that location. The predictions are made in six depth ranges by soilgrids.org, funded by ISRIC based in Wageningen, Netherlands. Each 250m pixel contains a value predicted for that area by soilgrids.org from best available data worldwide. The full dataset provides data for pH at six depth ranges from the surface to 2 meters below the surface. **Here data is presented for 45 centimetres depth only.**

Phenomenon mapped: Soil pH
Cell size: 250 meters
Pixel type: 32 bit float, converted from online data that is 16 Bit Unsigned Integer
Coordinate system: Web Mercator Auxiliary Sphere, projected via nearest neighbour from Goode's homolosine land (250m)
Extent: World land area except Antarctica
Number of columns and rows: 160300, 100498
Actual depth range of data: 100 – 200 cm
Mean depth: 45 cm
Publication date: May 2020

For more information, access about the data soilgrids.org (ISRIC) frequently asked questions page.

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

Digital Elevation Models

Global digital elevation layer for terrain visualization and analysis, based on Copernicus DEM GLO-30 elevation data sourced from the Microsoft Planetary Computer.

The Copernicus DEM GLO-30 is a Digital Surface Model (DSM) representing the Earth's surface, including buildings, infrastructure and vegetation. Derived from the edited WorldDEM™ product, it incorporates the flattening of water bodies, consistent river flow, coastline editing and corrections to selected features and implausible terrain structures. The source data originate from radar satellite acquisitions collected during the TanDEM-X mission.

The Copernicus DEM GLO-30 is a Digital Surface Model rather than a bare-earth Digital Terrain Model. Elevation values may therefore reflect buildings, infrastructure and vegetation. Its approximately 30-metre resolution is suitable for regional and landscape-scale interpretation but may not capture fine-scale terrain features around individual monuments or small sites.

For further technical details, please refer to the Copernicus DEM Product Handbook.

Key Properties

- **Geographic Coverage:** Global landmasses
- **Temporal Coverage:** 12 December 2010 – 15 January 2015 (relevant TanDEM-X acquisition period)
- **Spatial Resolution:** 1 arc-second (approximately 30 metres)
- **Product Level:** GLO-30
- **Source Data Coordinate System:** GCS WGS 84 (EPSG:4326)
- **Data Source:** Microsoft Planetary Computer Open Data Catalog
- **Available Uses:** Terrain visualization and elevation analysis

Processing Templates

The layer as presented in this platform includes two processing templates, grouped under **Digital Elevation Model**, providing different ways to visualize and interpret elevation data. The default option is intended for visual interpretation of terrain, while the alternative provides raw elevation values for analysis.

- **Tinted Hillshade (Default)** – Combines multidirectional shaded relief and color to enhance the representation of topographic features, including mountains, ridges and valleys. Intended for visualization and contextual interpretation of the landscape.
- **Raw Elevation (meters)** – Displays the original elevation values in metres without applying a derived terrain calculation. Recommended when elevation values are required for analysis or as input for further terrain processing.

Source: Copernicus DEM GLO-30 is credited to the European Space Agency (ESA) and its partners, the German Aerospace Center (DLR) and Airbus Defence and Space. The data used in this layer are sourced from the Microsoft Planetary Computer Open Data Catalog.

Socioeconomic

Land cover (2017-2025)

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-labelled 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 2018-2025.

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-labelled 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

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.

Population density (2010)

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

Gridded Population of the World, Version 4 (GPWv4): Data Quality Indicators, 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/H42Z13KG

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

Gridded Population of the World, Version 4 (GPWv4): Population Count, 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/H4JW8BX5

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.

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.

Regional Datasets

Africa

Southern African Development Community (SADC) Transfrontier Conservation Areas

This dataset was developed by Peace Parks Foundation to provide a consistent spatial representation of Transfrontier Conservation Areas (TFCAs) for use by conservation practitioners, government agencies, researchers, and regional partners. It supports ecosystem and biodiversity conservation, transboundary natural resource management, land-use planning, environmental assessments, policy development, and monitoring of cross-border conservation initiatives.

Polygon feature class depicting the boundaries of recognized Transfrontier Conservation Areas (TFCAs). The dataset provides spatial information on cross-border conservation landscapes established through international cooperation for biodiversity conservation, ecosystem management, and sustainable development. It is intended for use in geographic analysis, environmental planning, conservation management, and regional reporting.

To access the service, click here.

Source: Peace Parks Foundation

Coastlines hotspots in Africa

This is a continental dataset that includes annual shorelines and rates of coastal change along the entire African coastline.

The coastlines hotspots of Africa layer represents the changes of coastlines across the continent as a summary layer producing moving window hotspots of coastal change at three differing scales of 15 km, 5 km, and 1 km. This layer is useful for visualizing regional or continental-scale patterns of coastal change.

Geographic coverage: Continental Africa - approximately 37° North to 35° South

Temporal coverage: 2000 to Present

Spatial resolution: 30 x 30 meter

Update frequency: Annual from 2000 - Present; 6 months from end of previous year

Parent dataset: Landsat Collection 2 Surface Reflectance

Source data CRS: WGS 84 / NSIDC EASE-Grid 2.0 Global (EPSG:6933)

Service CRS: WGS 84 / NSIDC EASE-Grid 2.0 Global (EPSG:6933)

More details on this dataset can be found here.

Source: Digital Earth Africa

Rate of change of coastlines in Africa

This is dataset contains statistics on the rate of change along coastlines of Africa from 2000 to 2024.

The change of coastlines dataset is a point dataset providing robust rates of coastal change (in metres per year) for every 30 m along Africa's non-rocky (e.g. sandy and muddy) coastlines. These rates are calculated by linearly regressing annual shoreline positions against time, using the most recent shoreline as a baseline.

Negative values (red points) indicate retreat (e.g. erosion), and positive values indicate growth (e.g. progradation) over time. By default, rates of change are shown for points with a statistically significant trend over time only.

Attribute shown in symbology and popups represent annual rates of change (in metres per year) calculated by linearly regressing annual shoreline distances against time (excluding outliers). Negative values indicate retreat and positive values indicate growth.

Geographic coverage: Continental Africa - approximately 37° North to 35° South

Temporal coverage: 2000 to 2024

Spatial resolution: 30 x 30 meter

Update frequency: Annual from 200 - Present; 6 months from end of previous year

Parent dataset: Landsat Collection 2 Surface Reflectance

Source data CRS: WGS 84 / NSIDC EASE-Grid 2.0 Global (EPSG:6933)

Service CRS: WGS 84 / NSIDC EASE-Grid 2.0 Global (EPSG:6933)

More details on this dataset can be found here.

Source: Digital Earth Africa

Africa annual shorelines (2000-2024)

Continental dataset documenting two decades of coastal change across Africa. This layer represents the annual median or 'most representative' position of the shoreline at approximately mean sea level tide (0 m Above Mean Sea Level) for each year from 2000 to 2024.

This layer is a continental dataset that includes annual shorelines along the entire African coastline that has been generated for 2000 to 2024.

The product combines satellite data from the Digital Earth Africa program with tidal modelling to map the typical location of the coastline at mean sea level each year. The product enables trends of coastal erosion and growth to be examined annually at both a local and continental scale, and for patterns of coastal change to be mapped historically and updated regularly as data continues to be acquired. This allows current rates of coastal change to be compared with that observed in previous years or decades.

The ability to map shoreline positions for each year provides valuable insights into whether changes to the coastline that are the result of particular events or actions, or a process of more gradual change over time. This information can enable scientists, managers, and policy makers to assess impact from the range of drivers impacting the coastlines and potentially assist planning and forecasting for future scenarios.

Annual shoreline vectors from 2000 that represent the median or 'most representative' position of the shoreline at approximately mean sea level tide (0 m Above Mean Sea Level) for each year. Light-coloured lines (e.g. yellow) in the plot represent recent shorelines (e.g. 2024), while dark-coloured lines represent older shorelines (e.g. 2000).

Geographic coverage: Continental Africa - approximately 37° North to 35° South

Temporal coverage: 2000 to Present

Spatial resolution: 30 x 30 meter

Update frequency: Annual from 2000 - Present; 6 months from end of previous year

Parent dataset: Landsat Collection 2 Surface Reflectance

Source data CRS: WGS 84 / NSIDC EASE-Grid 2.0 Global (EPSG:6933)

Service CRS: WGS 84 / NSIDC EASE-Grid 2.0 Global (EPSG:6933)

More details on this dataset can be found here.

Source: Digital Earth Africa

Americas

River Networks and Watershed Basins

This grouped dataset provides a high-resolution representation of river networks, key river nodes, and watershed basin boundaries for North, Central and South America. The datasets were developed by Confluvio Consulting as part of HydroSHEDS 2.0, using advanced hydrological modelling based on the TanDEM-X digital elevation model (DEM), processed to a target resolution of 1 arc-second (~30 m at the equator). The June 2026 version 2.0 includes river and stream centerlines, key river network nodes, and watershed catchment boundaries.

The datasets are derived from hydrological modelling based on the TanDEM-X digital elevation model rather than from direct mapping of observed water bodies. River Streamlines therefore represent modelled drainage pathways and should not be interpreted as the exact location or width of surface water at a particular date. Similarly, River Basins represent modelled catchment boundaries, which may differ from locally delineated or officially designated watershed boundaries.

The River Streamlines layer represents the centreline paths of rivers and major streams as vector polylines, while River Nodes identify key points in the network, including sources, confluences, and outlets. River Basins delineate the corresponding watershed catchments as polygons. Together, the three layers provide a consistent representation of river networks and their drainage areas, supporting the interpretation of the hydrological context.

Interpretation key

River Streamlines show the modelled centreline of rivers and major streams and can be used to identify drainage channels and their connectivity.

River Nodes indicate key locations in the river network, such as sources, confluences, and outlets, and can help identify connections between stream segments.

River Basins represent modelled watershed catchments and can be used to understand the broader area contributing water to a particular part of the drainage network.

The layers represent modelled hydrological features and do not indicate the current extent, width, flow, or condition of surface water. Although based on a source DEM with a target resolution of approximately 30 m, the datasets are intended for regional and global-scale analysis and should not replace local or authoritative hydrological data where precise channel locations or watershed boundaries are required.

Phenomenon mapped: river and stream networks, river network nodes, and watershed basins

Spatial resolution: based on a TanDEM-X DEM processed to a target resolution of 1 arc-second (~30 m at the equator)

Geographic extent: North, Central and South America

Data vintage: June 2026, HydroSHEDS version 2.0

Publication date: June 2026

For more information, access the HydroSHEDS 2.0 resources.

Source: Confluvio Consulting / HydroSHEDS June 2026. Hydrological modelling based on the TanDEM-X digital elevation model.