Inland surface water

Indicator name

Inland Seasonal and Permanent Surface Water and Change statistics

Indicator unit

Areas of inland permanent and seasonal surface water and their changes over time (1984 - 2021) are expressed in km^2 and percentages. The following statistics are computed for each protected area, each country and each terrestrial ecoregion:

- Area (km^2) of permanent surface water (2021)
- Area (km^2) of seasonal inland water (2021)

- Net change (km^2) of permanent surface water (1984 - 2021)
- Net change (km^2) of seasonal inland water (1984 - 2021)

- Net change (%) of permanent surface water (1984 - 2021)
- Net change (%) in surface area of seasonal inland water (1984 - 2021)

Area of interest

Surfaces of inland surface water and change statistics are distributed through REST services at country, ecoregion and protected area level and are available in KCBD - Global Biodiversity Data Viewer (GBDV) at country level.

Related targets

Sustainable Development Goal 15 on life on land

Policy question

How well are we protecting freshwater ecosystems and how strong are anthropogenic changes affecting surface water in a given area? Human pressures are constantly increasing and it is important to monitor the consequences of the associated changes on the environment, in particular inside and around protected areas, to ensure that natural ecosystems and their associated species and ecosystem functions (e.g. goods and services) are preserved. By comparing surface water maps over time at the country and protected area level, changes in water regimes can be identified.

Use and interpretation

Many surface waters and wetlands are unique and species-rich ecosystems upon which numerous plant and animal species depend, and can provide key ecosystem services such as nutrient cycling, primary production, water provisioning, water purification and recreation (Dudgeon *et al.* 2006; Dodds *et al.* 2013). Surface waters may be more at risk than other land habitat resources due to multiple pressures such as unsustainable consumption, wetland drainage, land use intensification, stream diversion and climate change, a situation that is particularly worrying in dry areas where water scarcity is already becoming a major limiting factor for wildlife and for humans (Vörösmarty *et al.* 2010; Carpenter *et al.*, 2011; Dodds *et al.* 2013). For these reasons, the risk of extinction for freshwater species was already found to be higher than for their terrestrial counterparts (Collen *et al.*, 2013).

Here, we quantify surface water in protected areas, countries and terrestrial ecoregions using the latest version (which extends up to 2021 the temporal series of earth observation data analysed) of the Global Surface Water product mapped by Pekel *et al.* (2016). By further assessing temporal changes using the full 37-year history of Landsat data one can distinguish between permanent and seasonal water, and assess the net change of water inside areas that are currently protected.

Hence, we provide summary statistics about permanent and seasonal surface water for two time periods, 1984 and 2021.

The Water Transitions dataset is useful to map changes in water state between the first year and the last year of observation. In particular we can map:

- New permanent water surfaces (i.e. conversion of a no water place into a permanent water place.)
- Unchanging permanent water surfaces
- Lost permanent water surfaces (i.e. conversion of a permanent water place into a no water place)
- New seasonal water surfaces (i.e. conversion of a no water place into a seasonal water place)
- Unchanging seasonal water surfaces
- Lost seasonal water surfaces (i.e. conversion of a seasonal water place into a no water place)
- Conversion of permanent water into seasonal water
- Conversion of seasonal water into permanent water
- Ephemeral permanent water (i.e. no water places replaced by permanent water that subsequently disappeared within the observation period)
- Ephemeral seasonal water (i.e. no water places replaced by seasonal water that subsequently disappeared within the observation period)

Key caveats

There are some important caveats to our study. Our analysis has treated current boundaries of protected areas as constant over the whole time period 1984 – 2021 as the World Database on Protected Areas does not provide yet means to track changes in boundaries.

A number of water bodies are not reported in the global surface water product: for example, water under forest canopy remains undetected, and the current 30-metre resolution is still too coarse for detection of small rivers, streams and ponds. For some regions, valid image acquisitions of the Landsat archive are restricted by cloud or for other reasons (see Pekel *et al.* 2016 for a full discussion) so that transitions were only detected between the first and last years of available reliable data.

The water transitions are based on two time intervals only. In areas with inter-annual variability this can lead to spurious or not relevant (perhaps misleading) change information, if the initial year considered was simply a dry year in general and the last one a wet one (this can very well happen in Mediterranean areas or in places of South and Central America affected by El Nino).

Finally, it is worth noting that a number of the countries of the world are islands or have highly-dynamic coastlines. This fact, combined with currently-

designated protected areas in coastal areas, can mean that 'loss' and 'gain' actually captures coastal erosion and deposition – i.e., actual habitat change - over the 37 years of the water history.

Uncertainties in the boundaries of the protected areas can also exist and lead to false descriptions.

Indicator status The methodology for data processing and computation of raw statistics is described in Juffe Bignoli *et al.* (2024). The methods and first results for the assessment of changes in surface water have been published in Bastin *et al.*, 2019.

Available data and resources

Data available The surface water statistics are distributed through REST services for each terrestrial and coastal protected area at least as large as 1 km^2, for countries and for terrestrial ecoregions, and from the KCBD Global Biodiversity Data Viewer at country level

Data updates Planned annually.

Codes The procedure for the computation of the indicator, which currently involves the use of a wide range of software to handle the different steps, is documented in Juffe Bignoli *et al.* (2024)

Methodology

Methodology The global surface water was mapped at 30 m resolution using the full 37-year history of Landsat data between 1984 and 2021 (Pekel *et al.* 2016). The long temporal extent of the product allowed to distinguish between permanent and seasonal water, and to assess the net change of water inside and outside areas that are currently protected. Note however that water under vegetation cover, such as swamp forests, is not detectable from optical remote sensing and hence is not included in this assessment.

We used the World Database on Protected Areas (WDPA) (IUCN & UNEP-WCMC 2025) to compute the surface water statistics. As recommended by UNEP-WCMC, the data was filtered to remove all features with a status of "not reported" or "proposed", and all features designated as UNESCO Man and the Biosphere (MAB) Reserves.

We summarized the water transitions over a 37 years period (1984-2021) based on the procedure described in Pekel *et al.* (2016). Permanent water surface and its uncertainty were computed for each year, from which the trend was derived for each country. This allowed seasonal, permanent and ephemeral water to be distinguished, and transitions between the classes to be mapped. Years for which unobserved data exceeded 5% were excluded from the trend analysis. Note that transitions are detected based on the first and last available and reliable year of data, and that for some regions of the world, the available data history is shorter than 37 years. For a full description, see Pekel *et al.* (2016).

Net gain or loss includes changes between water body categories: for example, areas which transitioned from permanent to seasonal water are counted in the net loss of permanent water and in the net gain of seasonal water.

Input datasets

The inland surface water statistics were obtained using the following input datasets:

Protected Areas

- WDPA of January 2025 (UNEP-WCMC & IUCN, 2025).
    - Latest version available from: www.protectedplanet.net

Country boundaries

Country boundaries are built from a combination of GISCO administrative units and EEZ exclusive economic zones (see Lazaro et al., 2025).

- GISCO Administrative Units, (1:1.000.000, 2020).
    - Latest version available online: https://ec.europa.eu/eurostat/web/gisco/geodata/administrative-units/countries
- Exclusive Economic Zones (EEZ) v10 (2020)
    - Latest version available from: http://www.marineregions.org/downloads.php

Terrestrial Ecoregions of the World

- TEOW (Dinerstein *et al.*, 2017)
    - Latest version available from: https://ecoregions.appspot.com/

Freshwater Ecoregions of the World

- FEOW (Freshwater Ecoregions of the World)
    - Latest version available from: https://www.feow.org/

Inland Surface Water

- Global Surface Water and long-term change maps accessed directly from the Global Surface Water Explorer (Pekel, J.F. et al., 2016). Quantitative assessments of changes in protected areas done in Google Earth Engine with support from J.-F Pekel, L De Felice & N. Gorelick.
    - Latest version available from: https://global-surface-water.appspot.com/

References

Bastin, L., *et al.* (2019) Inland surface waters in protected areas globally: Current coverage and 30-year trends. *PLoS ONE,* 14(1): e0210496. https://doi.org/10.1371/journal.pone.0210496

Carpenter, S. R., Stanley, E. & Vander Zanden, M. J. (2011) State of the world's freshwater ecosystems: physical, chemical, and biological changes. *Annual*

Review of Environment and Resources, 36: 75–99. https://doi.org/10.1146/annurev-environ-021810-094524

Collen, B., *et al.* (2013). Global patterns of freshwater species diversity, threat and endemism. *Global Ecology and Biogeography,* 23: 40-51. https://dx.doi.org/10.1111/geb.12096

Dinerstein et al. (2017), An Ecoregion-Based Approach to Protecting Half the Terrestrial Realm, *BioScience*, Volume 67, Issue 6, June 2017, Pages 534–545, https://doi.org/10.1093/biosci/bix014

Dixon, M. J. R., *et al.* (2016). Tracking global change in ecosystem area: The Wetland Extent Trends index. *Biological Conservation*, 193: 27-35. https://doi.org/10.1016/j.biocon.2015.10.023

Dodds, W. K., Perkin, J. S. & Gerken, J.E. (2013). Human impact on freshwater ecosystem services: a global perspective. *Environmental Science & Technology*, 47: 9061-9068. https://dx.doi.org/10.1021/es4021052

Dudgeon, D., *et al.* (2006). Freshwater biodiversity: importance, threats, status and conservation challenges. *Biological Reviews*, 81, 2: 163-182. https://dx.doi.org/10.1017/S1464793105006950

Juffe-Bignoli et al. (2024) Delivering Systematic and Repeatable Area-Based Conservation Assessments: From Global to Local Scales. Land 2024, 13, 1506. https://doi.org/10.3390/land13091506

Lázaro, C., Mandrici, A., Delli, G., Caudullo, G., Bourgoin, C. et al., *Challenges in integrating global environmental data with GISCO administrative layers – A GIS perspective*, Publications Office of the European Union, 2025. https://dx.doi.org/10.2760/8183010

Pekel, J. -F., Cottam, A., Gorelick, N. & Belward, A. S. (2016). High-resolution mapping of global surface water and its long-term changes. *Nature*, 540: 418-422. https://dx.doi.org/10.1038/nature20584

UNEP-WCMC & IUCN (2025). Protected Planet: The World Database on Protected Areas (WDPA) [On-line], [January /2025], Cambridge, UK: UNEP-WCMC and IUCN. www.protectedplanet.net

Vörösmarty, C. J., *et al.* (2010). Global threats to human water security and river biodiversity. *Nature,* 467: 555 561. https://dx.doi.org/10.1038/nature09440

Weatherall, P., *et al.* (2014). A new digital bathymetric model of the world's oceans. *Earth and Space Science*, 2, https://doi.org/10.1002/2015EA000107

Contact Please contact us at: EC-biodiversity-KC@ec.europa.eu

Factsheet last updated August 21, 2025