Measuring wetland area

Why measure wetland area?

Over 1 billion people rely entirely on the services provided by wetland ecosystems such as swamps, bogs, fens, peatlands, marshes and paddies. Healthy and functional natural wetlands are intrinsically linked with human livelihoods, well-being and sustainable development. However, wetlands are facing major threats, caused by conversion for commercial development and agriculture, overfishing, tourism, pollution and climate change. There is an urgent need to strengthen, and reinforce, national policies and legal frameworks to help countries to protect and restore critical wetland ecosystems. Past efforts, however, have been hampered by the lack of data on the locations, types and sizes of wetland resources. This kind of data and information is crucial to measure the effectiveness of policy, legal and regulatory mechanisms and essential for tracking progress towards the SDGs. Despite the importance of wetlands, and unlike other critical ecosystems (e.g. forests, mangroves and inland water bodies), the extent and dynamics of wetland ecosystems has, until now, been ill defined, characterized and modelled.

Description of the method used to globally map wetlands

Inland vegetated wetlands are mapped according to the following definition: “Inland vegetated wetlands include areas of marshes, peatlands, swamps, bogs and fens, the vegetated parts of flood plains as well as rice paddies and flood recession agriculture”. This sub-indicator only measures inland vegetated wetlands and not coastal mangroves (see section 3.5 of this methodology on mangroves). This SDG indicator methodology is used for official reporting of SDG indicator 6.6.1 statistics[1].

Figure 3. Wetland extent map for the territory of Uganda

A high-resolution global geo-spatial mapping of inland vegetated wetlands has been produced detailing the spatial extent of wetlands per country. The data on wetlands has been produced to support countries with monitoring their wetland ecosystems and bridge an existing global data gap. The data production method uses a consistent wetland monitoring mechanism based on satellite Earth Observation data and the global map includes the entire land surface of Earth except for Antarctica and a few small islands.

As wetlands tend to be susceptible to high annual variations, multi-annual data was collected to even out potential annual biases and create a robust estimate of wetland extent. Data was gathered from 2016, 2017 and 2018 and combined to produce a wetlands area baseline measurement (in km^2). Future annual updates will enable wetlands change statistics to be produced and these once available these will be displayed on the SDG 6.6.1 data portal. Predicting wetland extent using Earth Observation data relies on four components: stratification, training data, machine learning, and post-processing. The approach uses all available data from the satellites Sentinel-1,

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[1] It does not apply the very broad definition of wetlands used by the Ramsar Convention on Wetlands, which may be interpreted to mean all water within a country including the marine environment. The SDG indicator 6.6.1 definition refers to only a specific group of inland vegetated wetlands typologies. Countries may benefit from using the SDG wetlands extent data within reports to the Ramsar Convention on Wetlands.

Sentinel-2, and Landsat 8 to predict wetland probability. A Digital Elevation Model is used to qualify wetland predictions and a post-processing routine converts the wetland probability map into a map of wetland extent.

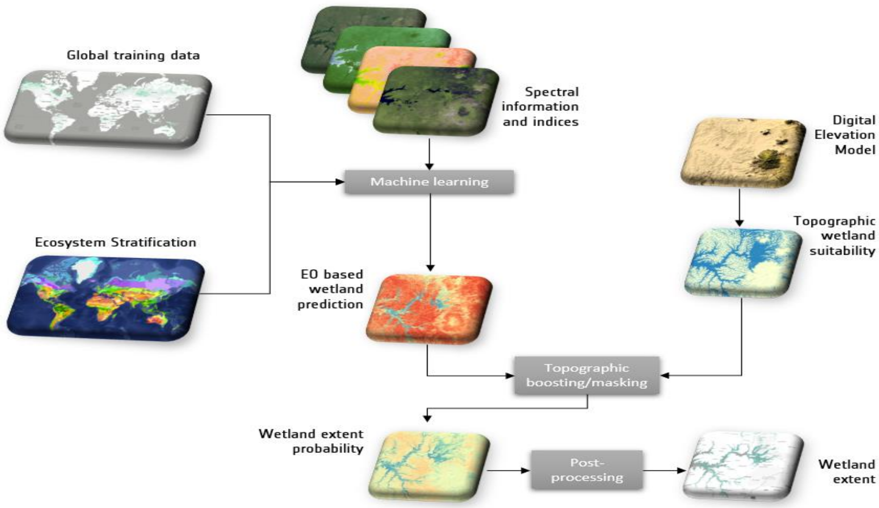

Figure 4. Workflow for mapping global wetland extent

In addition, topographic information from satellite-derived Digital Elevation Models (DEMs) are used. Close to 4 million satellite images amounting to 2.8 petabyte of data were analysed and classified as wetland or non-wetland using an automated machine learning model.

Users of the global wetland map should be aware that the map represents a first line rapid assessment of the global distribution of vegetated wetlands. The methodology applied identifies vegetated inland wetlands. This may generate underestimations compared to national statistics which may integrate metrics on surface water and coastal/marine wetlands. Data accuracy for the available wetlands data is approximately 70% and wetland data with 100% accuracy is not feasible at this current time. While it is based on a scientifically sound and robust mapping approach, there will inevitably be inaccuracies in the wetland predictions both in terms of commission and omission errors. Notable commission errors are for instance high-intensive irrigated agriculture parcels being classified as wetlands because they resemble many of the inherent spectral characteristics of wetlands (i.e. high moisture and vegetation presence even in dry season). Omission errors will mainly be attributed to the large diversity of wetlands. Despite best effort to train the model across the widest range of wetlands possible, there will be types of wetlands and instances of wetland behaviour that will not be adequately captured in a global model. For instance, some ephemeral wetlands are rarely flooded or wet and therefore often missed by satellite datasets. In other cases, the wet part of a wetland may occur under a dense vegetation canopy, which is difficult to assess using Earth Observation data, where the presence of water/moist conditions is not easily detected. Other limitations of the data are:

- Only regional stratification is applied including strata spanning several countries. Using a finer level of stratification will help improve local/national wetland predictions;
- The accuracy of the wetlands map will improve further once cross referenced with more national wetland inventories and ground truthing;
- Terrain information from satellite derived DEMs is key input for mapping wetlands globally. The current reference datasets are the 30-meter SRTM DEM which covers the globe from 60ºNorth to 56ºSouth, while the region north of 60 degrees north relied on a lower resolution 90-meter DEM model was used. Options for 30-meter DEMs north of 60ºN exists and should be considered in future updates;
- Small islands and potentially even entire small island states fall outside the acquisition plan of the Sentinel satellites. As a result, no wetland prediction has been performed for these areas. It will be possible to develop separate models for these missing islands using alternative input satellite data (e.g. using Landsat alone).

Future updates and iterations of the wetlands map will address the above limitations, including a potential shift into a deep learning model to more explicitly reflect temporal and spatial aspects of wetland predictions. Despite limitations with the methodology the production of high-resolution wetland mapping for the entire globe is at the forefront of currently available technology and computing power. It represents a huge step forward towards reporting accurate, statistically robust wetland data.

Calculating the change in surface area of wetlands per country

No change in surface area has yet been calculated. However, a baseline surface area has been calculated per country. This methodology uses a 2017 baseline (based on input imagery data from 2016 to 2018 to even out potential annual biases). Going forward, updates to this wetland area datasets will be produced annually. Once the update is produced it will be possible to calculate change of wetland area from the baseline reference period. Using this baseline period, percentage change of spatial extent is calculated using the following formula:

Percentage change in wetland extent $((\beta-\gamma))/\beta\times 100$
Where β is the spatial wetland extent for the baseline reference period
Where γ is the spatial extent for the reporting period.