Tracking Global Water Dynamics with Earth Observation: the Global Surface Water Explorer (JRC-GSWE)

UNGGIM: Europe Webinar

The contribution of Earth Observation to 6.6.1 Indicator

Monday 12th May 2025 – Marco Clerici (EC/JRC)

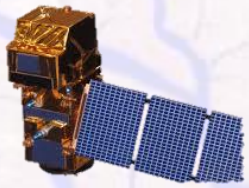
The JRC Global Surface Water Explorer, a virtual time machine to monitor Earth's surface water dynamics over 40+ years

High performance computing required, now powered by the Copernicus Data Space Ecosystem

Combining Landsat and Sentinel 2 collections to improve frequency and accuracy of the global surface water detection.

Google Earth Engine

Landsat/USGS

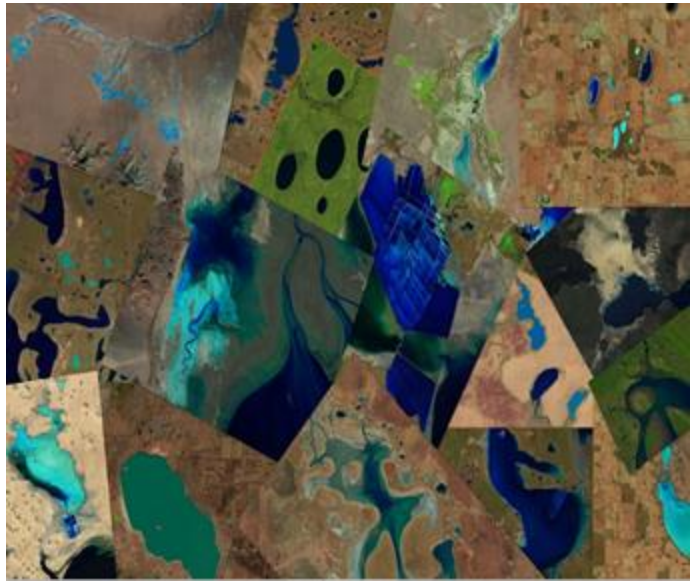


Sentinel-2

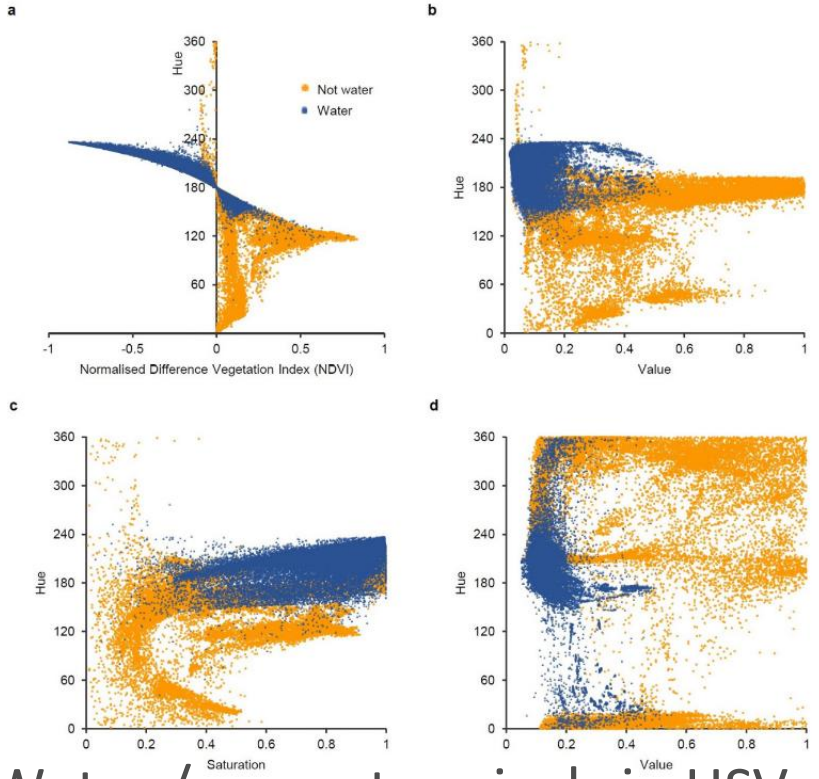
Copernicus Data Space Ecosystem

European Commission

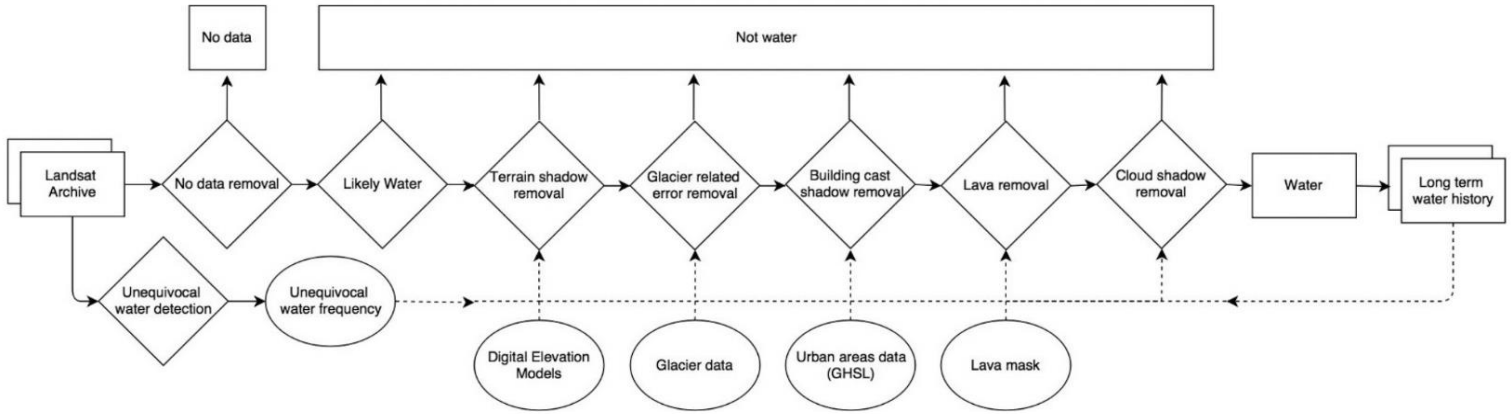
Methodology



High variability of Water spectral signature



Water / no-water pixels in HSV space



Expert System Classifier

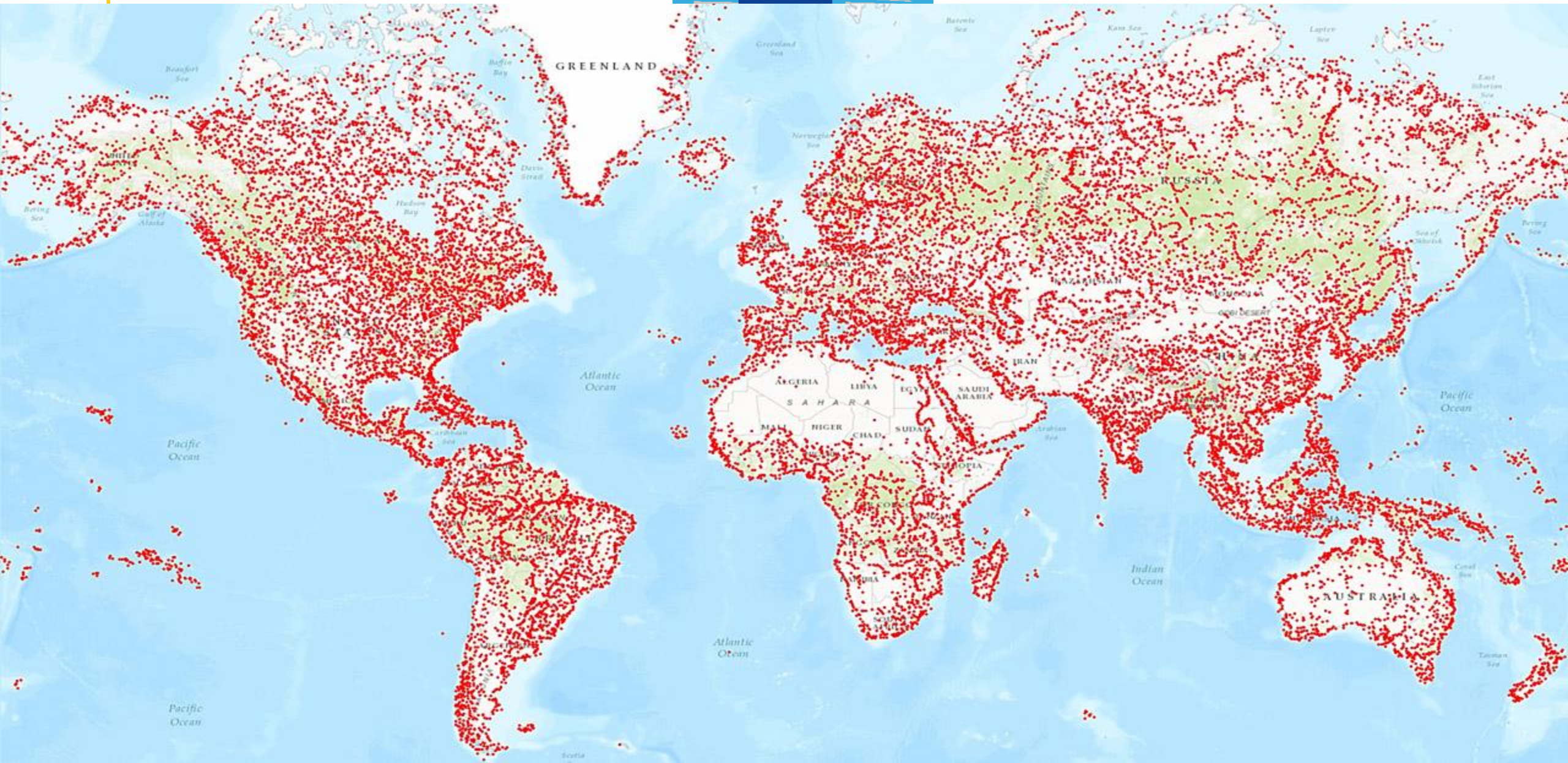
European Commission

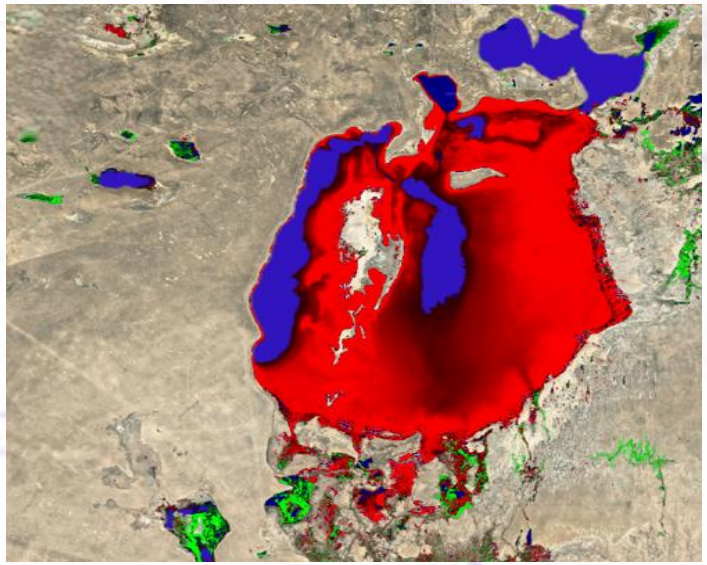
Spatio-Temporal Validation

(40.124 validation samples)

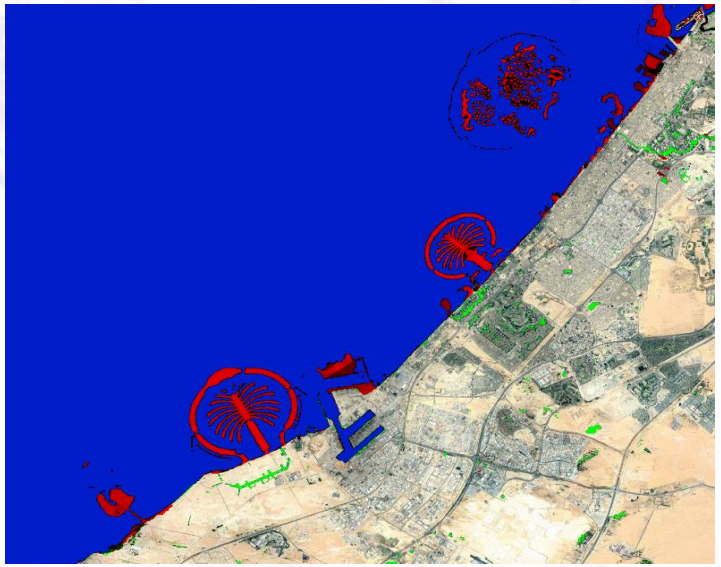
Omission < 5%

Commission < 1%

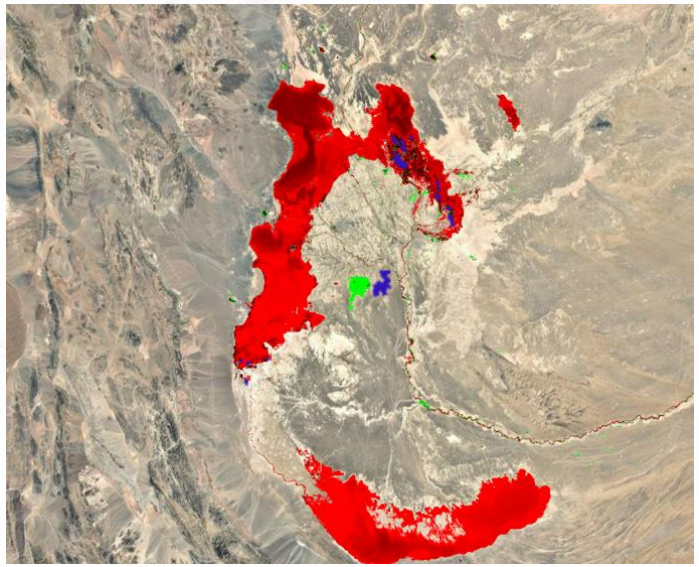




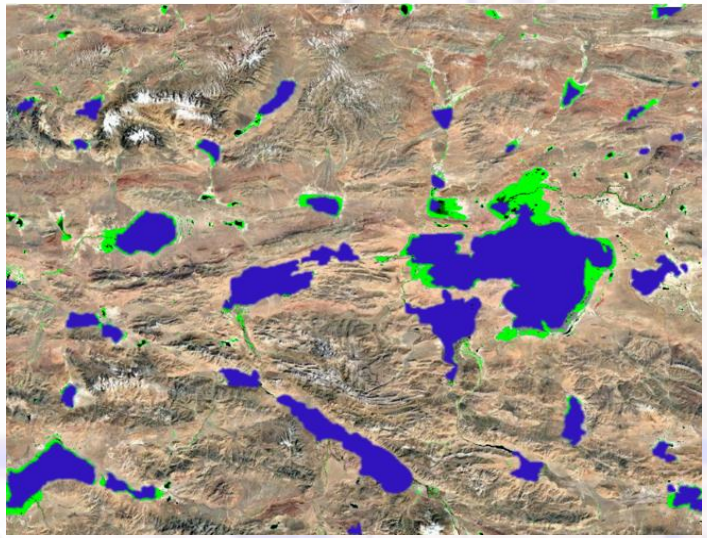
Disappearing Aral Sea



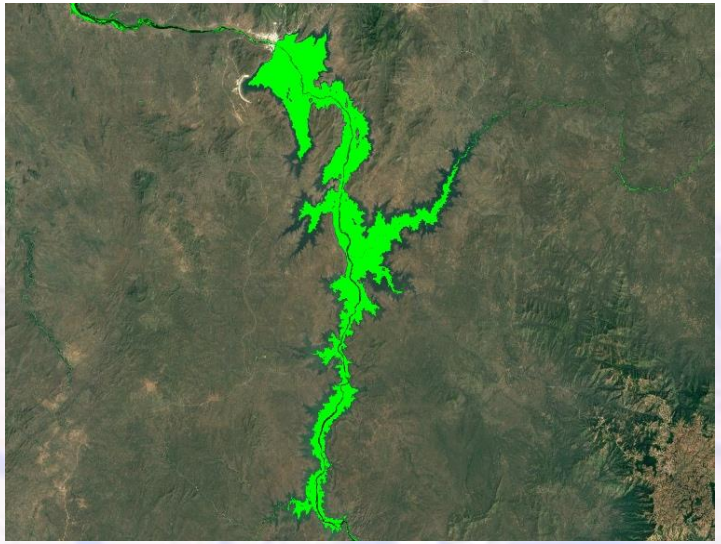
Artificial Islands in Dubai



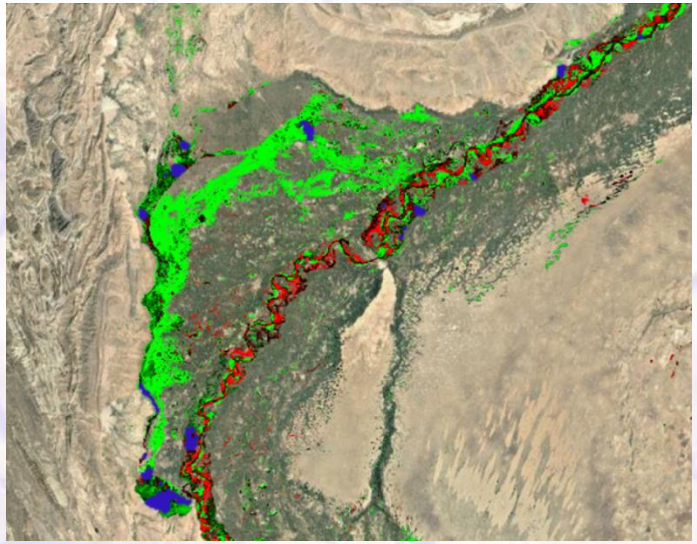
Lake Hamoun



Lakes on the Tibetan Plateau

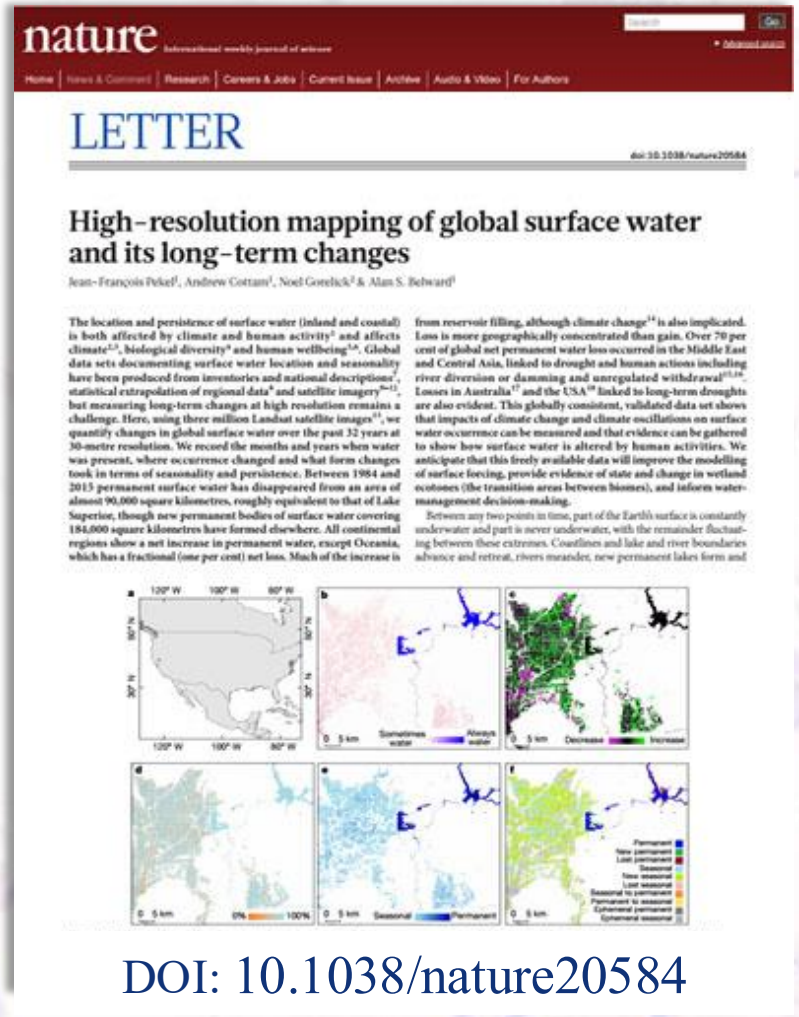


The Grand Ethiopian Renaissance Dam



More recurrent floods in Pakistan

European Commission



nature

LETTER

High-resolution mapping of global surface water and its long-term changes

Jean-François Pekel[1], Andrew Cottam[1], Noel Gorelick[2] & Alan S. Belward[1]

The location and persistence of surface water (inland and coastal) is both affected by climate and human activity[1] and affects climate[1,2], biological diversity[3] and human wellbeing[3,4]. Global data sets documenting surface water location and seasonality have been produced from inventories and national descriptions[5], statistical extrapolation of regional data[6] and satellite imagery[7–12], but measuring long-term changes at high resolution remains a challenge. Here, using three million Landsat satellite images[13], we quantify changes in global surface water over the past 32 years at 30-metre resolution. We record the months and years when water was present, where occurrence changed and what form changes took in terms of seasonality and persistence. Between 1984 and 2015 permanent surface water has disappeared from an area of almost 90,000 square kilometres, roughly equivalent to that of Lake Superior, though new permanent bodies of surface water covering 184,000 square kilometres have formed elsewhere. All continental regions show a net increase in permanent water, except Oceania, which has a fractional (one per cent) net loss. Much of the increase is from reservoir filling, although climate change[14] is also implicated. Loss is more geographically concentrated than gain. Over 70 per cent of global net permanent water loss occurred in the Middle East and Central Asia, linked to drought and human actions including river diversion or damming and unregulated withdrawal[15,16]. Losses in Australia[17] and the USA[18] linked to long-term droughts are also evident. This globally consistent, validated data set shows that impacts of climate change and climate oscillations on surface water occurrence can be measured and that evidence can be gathered to show how surface water is altered by human activities. We anticipate that this freely available data will improve the modelling of surface forcing, provide evidence of state and change in wetland ecotones (the transition areas between biomes), and inform water-management decision-making.

Between any two points in time, part of the Earth's surface is constantly underwater and part is never underwater, with the remainder fluctuating between these extremes. Coastlines and lake and river boundaries advance and retreat, rivers meander, new permanent lakes form and

DOI: 10.1038/nature20584

https://global-surface-water.appspot.com/

Joint Research Centre

Global Surface Water

Data Access

License

All data here is produced under the Copernicus Programme and is provided free of charge, without restriction of use. For the full license information see the Copernicus Regulation.

Publications, models and data products that make use of these datasets must include proper acknowledgement, including citing datasets and the journal article as in the following citat

Citation

Jean-Francois Pekel, Andrew Cottam, Noel Gorelick, Alan S. Belward, High-resolution mapping of global surface water and its long-term changes. Nature 540, 418-422 (2016). (doi:10.103

If you are using the data as a layer in a published map, please include the following attribution text: 'Source: EC JRC/Google'

Data Users Guide

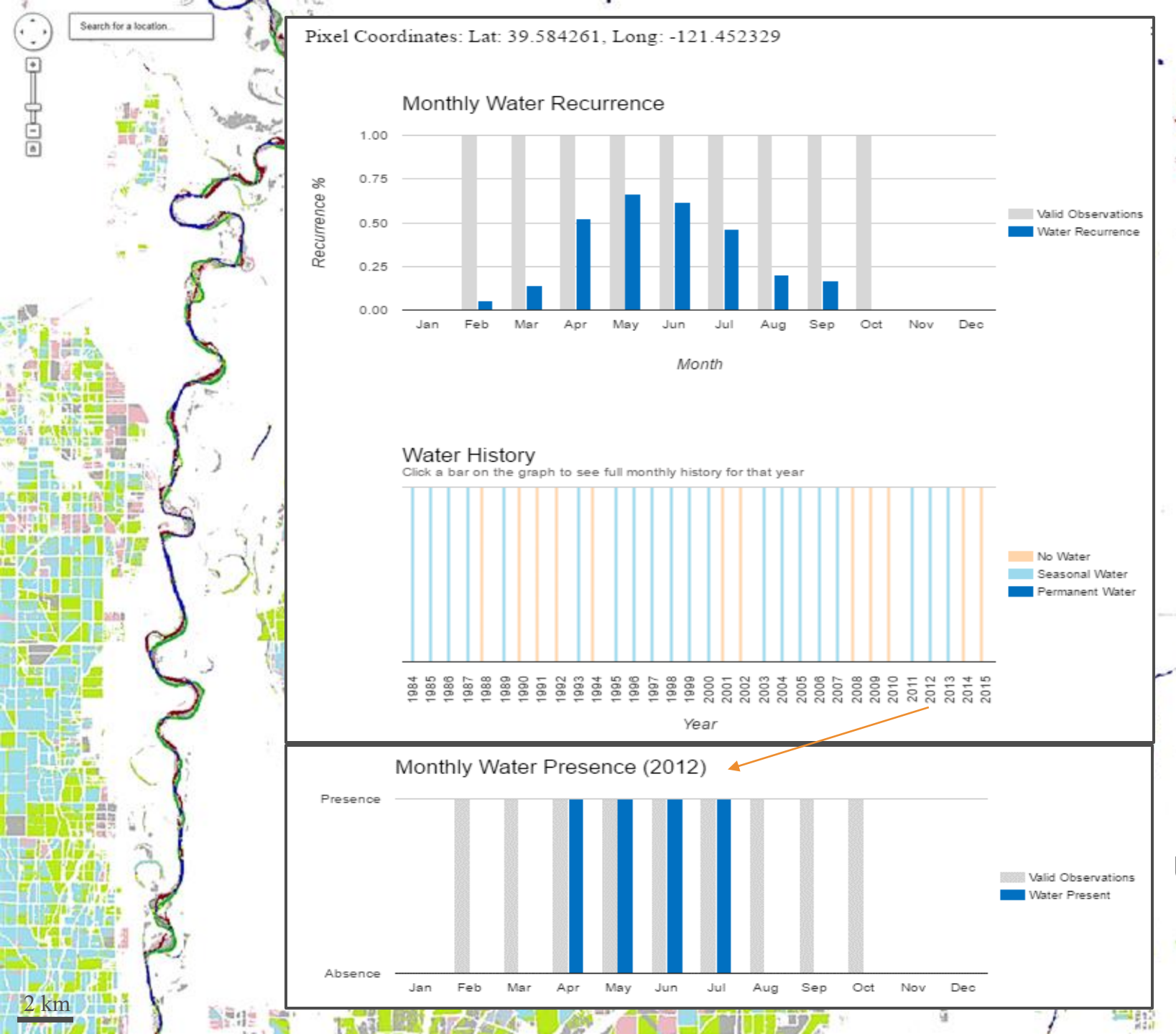
For a description of all of the datasets and details on how to use the data please see the Data Users Guide.

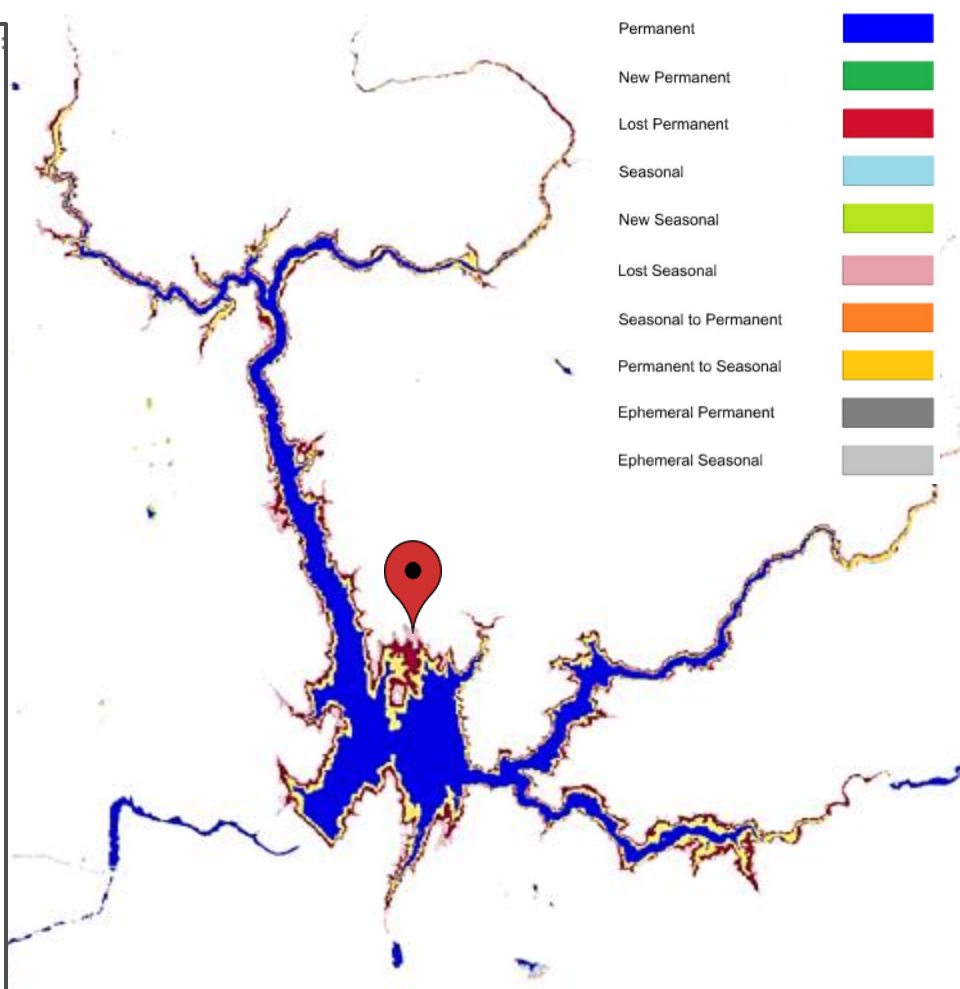
Delivery Mechanisms

All of the datasets that comprise the Global Surface Water 1984-2015 are being made freely available using the following delivery mechanisms: Global Surface Water Explorer, Data Do

Contact: Jean-Francois.PEKEL@ec.europa.eu

European Commission





What form does any change in surface water take?

Unchanging and changing water surfaces, and their corresponding seasonality

Computation resumed on CDSE (beyond 2021)

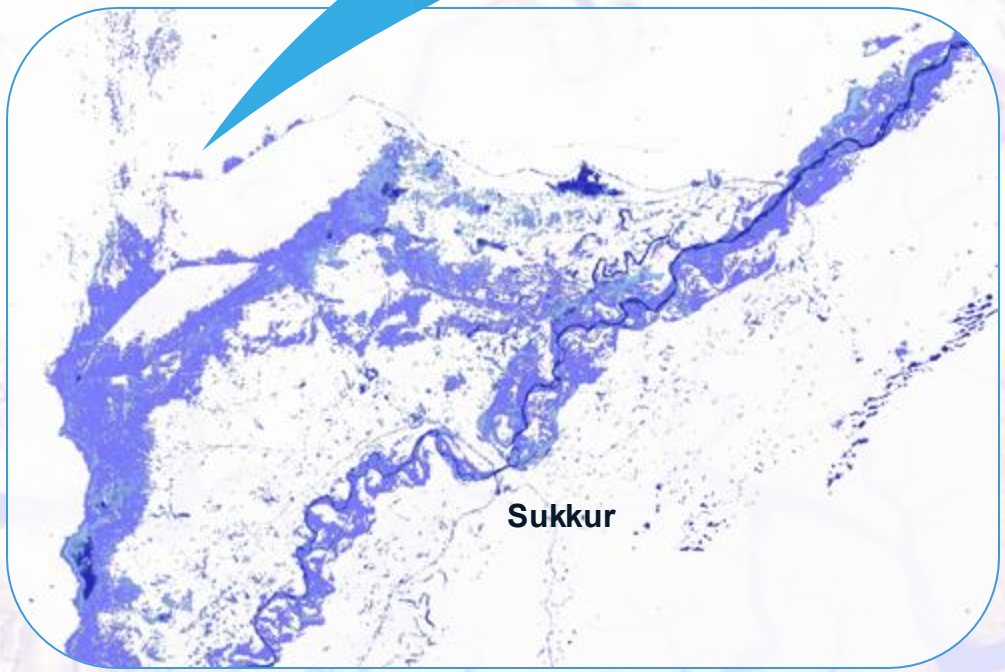
Integration of Sentinel-2 for

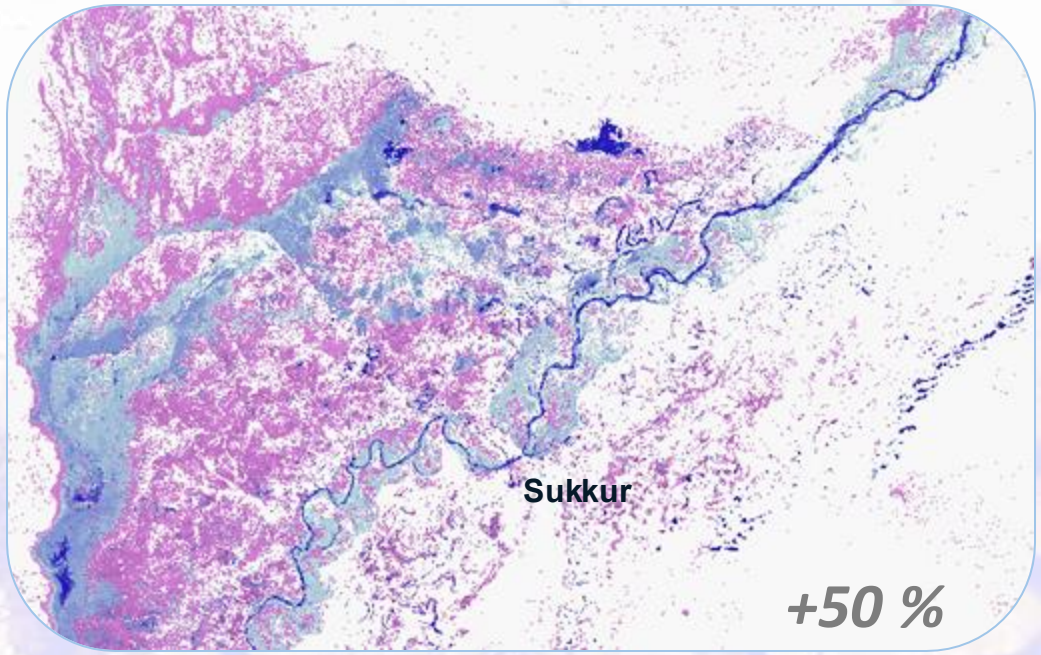
- ***better accuracy***
- ***frequency***
- ***timeliness***

1984 — Landsat (4-5-7-8-9) — 2021 — Landsat (8-9) — 2022 — 2025 — Landsat (8-9) + Sentinel-2

Google Earth Engine

Copernicus Data Space Ecosystem





Historical water
(1984-2021)

New water *in 2022*

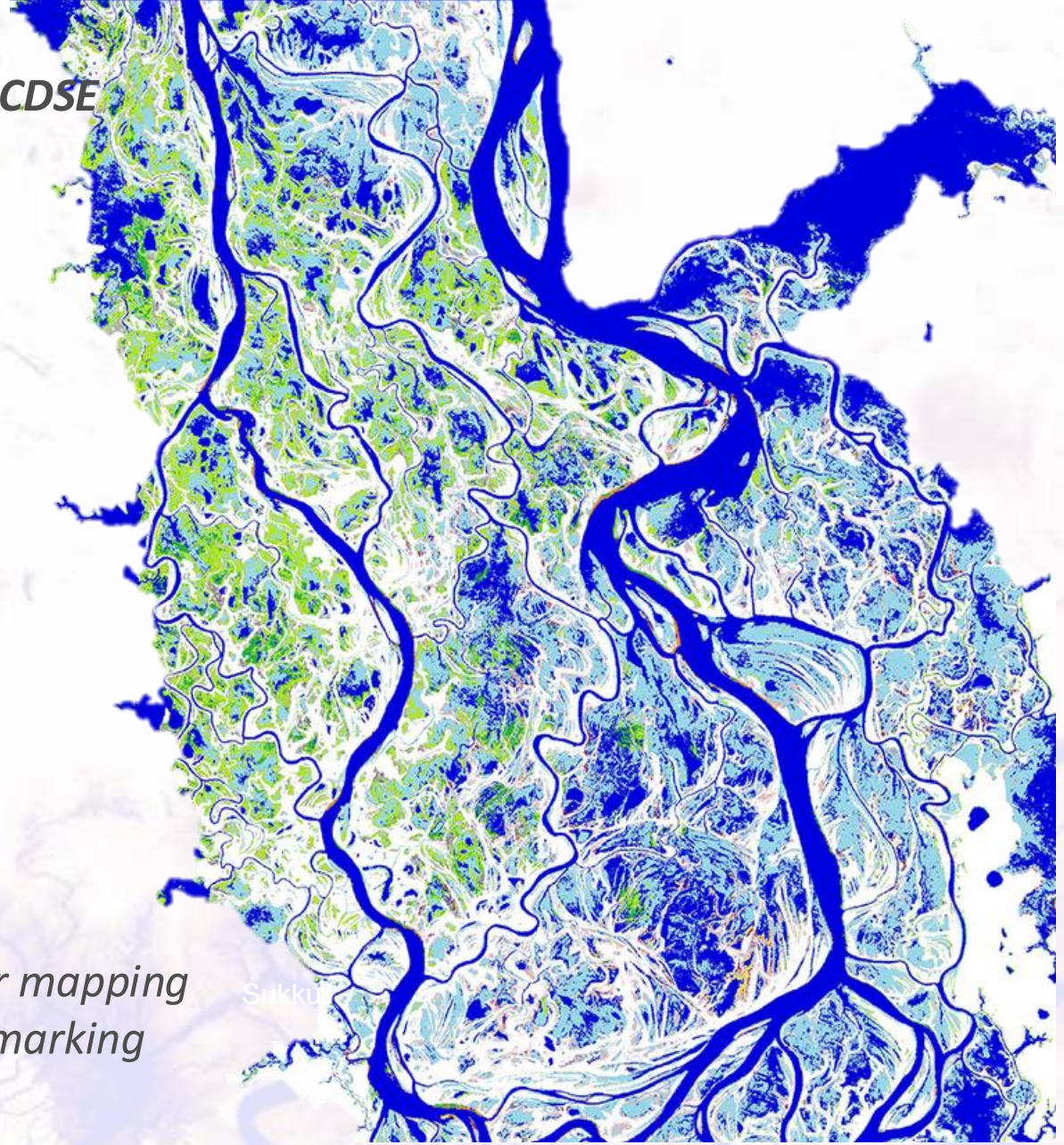
European Commission

Activities foreseen for the onboarding of GSWE on CDSE (2024/2025)

- *Fill the gap for Landsat (2022-2024 – LC2)*
- *Benchmark of algorithms for Sentinel-2*
- *Water detection from S2 on CDSE*
- *Product fusion (LC2 + S2)*
- *Products publications on a web platform*
- *Validation and quality control*

Dedicated Experts Groups established

- *WATMAP - Review and Selection of algorithms for Water mapping*
- *GRGIX – Global Reference Grid Identification and benchmarking eXercise*



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Thank you

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