International Water Management Institute

CGIAR

Inventorying human-made wetlands

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National wetland inventories support mechanism to Contracting Parties

Innovative water solutions for sustainable development

Food · Climate · Growth

Introduction: human-made wetlands

Ramsar definition

Man-made wetlands are created or significantly altered by human activities and can serve various functions, including agriculture, water storage, and aquaculture.

"Man-made" wetlands

1. Aquaculture (e.g. fish/shrimp) ponds.
2. Ponds; includes farm ponds, stock ponds, small tanks; (generally below 8 ha).
3. Irrigated land; includes irrigation channels and rice fields.
4. Seasonally flooded agricultural land.**
5. Salt exploitation sites; salt pans, salines, etc.
6. Water storage areas; reservoirs/barrages/dams/impoundments; (generally over 8 ha).
7. Excavations; gravel/brick/clay pits; borrow pits, mining pools.
8. Wastewater treatment areas; sewage farms, settling ponds, oxidation basins, etc.
9. Canals and drainage channels, ditches.

Large dams and reservoirs

ICOLD definition: a large dam is a structure over 15 meters in height from the foundation or between 5 and 15 meters high with a reservoir volume exceeding 3 Mm^3.

>60,000 large dams worldwide, with the vast majority built in the last century (23,000 in China) have inundated an area of **400,000 - 500,000 km^2** (0.3 % of terrestrial area)

Large dams are seen by many as a **cornerstone of economic development** - providing water storage, flood control, irrigation, hydropower generation, and drinking water supply to millions of people globally.

Past failure to pay sufficient attention to **environmental impacts** and the needs of those adversely affected by construction, has resulted in the **degradation and loss of biodiversity and ecosystem services** (including from wetlands) and contributed additional **development barriers for hundreds of millions** of people worldwide.

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Small ponds and tanks

Typically constructed to collect and store rainwater and runoff which can be used for irrigation, livestock watering, aquaculture, and domestic purposes.

Globally estimated to be **300 million** small ponds (i.e. < 5 m depth and cover < 5ha). Most of these have been constructed. (c.f. lakes 1.4 million lakes globally).

Cover an area of ca. **77,000 km²** (0.1 – 6% of farm land)

Major source of GHG emissions - may account **for > 15% of total freshwater CO2 emissions** and ca. **50% of freshwater CH4 emissions.**

By serving as reliable water sources, small ponds help stabilize and increase farm production, enhance food security, and support the livelihoods of smallholder farmers.

Collecting water from a pond, Myanmar

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Aquaculture ponds

Inland aquaculture provides a substantial portion of the world's fish supply, contributing significantly to the **protein intake** and **micronutrient** requirements of millions of people, especially in developing countries.

Inland aquaculture contributes over **40% of global aquaculture production**, with freshwater fish (carp, tilapia, and catfish) being particularly important in Asia and Africa

Estimated area of aquaculture ponds in **27,000 km^2** (90% in Asia).

Aquaculture pond, Lao PDR

Rice fields/paddies

Rice fields (covering an area of **1.63 million km^2**) are essential for millions of people worldwide, serving as a critical source of food, livelihood, and cultural heritage.

Rice is staple food for more than half of the global population, providing up to 20% of the world's caloric intake.

Cultivation of rice supports the livelihoods of over a billion people, including smallholder farmers and rural communities.

Traditional rice paddies support immense biodiversity – habitat for fish, frogs, crabs, birds and insects. In Southeast Asia much is harvested by farmers as supplementary sources of protein and income.

Rice fields are also major emitters of methane (CH4)- 10-12% of total methane emissions from human activities, making it a notable contributor to agricultural greenhouse gas emissions.

Rice paddies, Myanmar

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Salt pans (salterns)

Globally human-made salt pans are estimated to cover around **20,000 to 30,000 km²**.

Constructed primarily in coastal regions or near saline water bodies to facilitate salt production through the evaporation of seawater or brine.

Salterns have been utilized for **thousands of years**, with traditional salt-making methods still practiced in some regions. These practices are culturally significant.

Unique biodiversity. In some places critical habitats for a variety of species, particularly migratory birds (e.g. flamingos, avocets).

Salterns – Putalam, Sri Lanka

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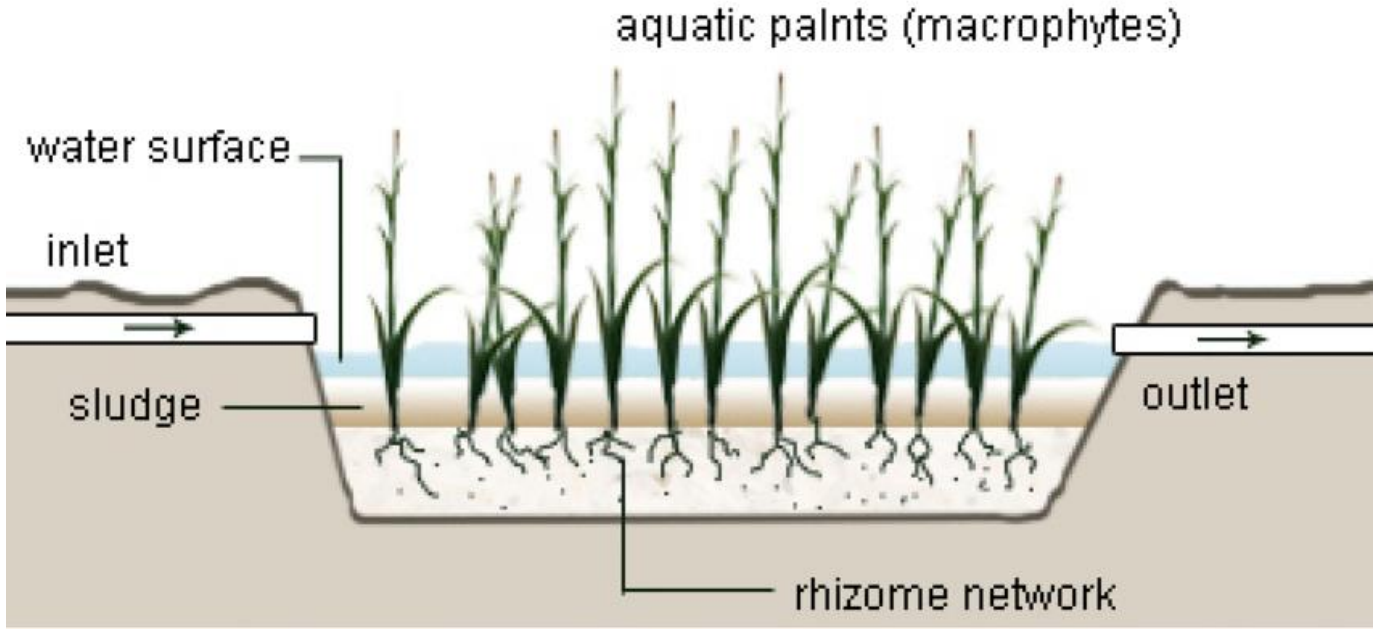
Wastewater Treatment wetlands

Constructed wetlands, which are engineered systems designed to treat wastewater using natural processes.

Estimated to be 5000 in the USA alone.

Estimates suggest that constructed wetlands cover **2,000-3,500 km²** globally but exact area is unknown.



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Areal Extent of Human-Made wetland

Wetland Type	Global extent (km2)
Large dams/reservoirs	400,000-500,000
Small pond and tanks	77,000
Aquaculture ponds	27,000
Rice paddies	1,630,000
Saltpans	20,000 -30,000
Wastewater Treatment	2,000 – 3,500

cf. HydroLAKES is a widely used global database that inventories around **1.4 million lakes larger than 10 hectares**, covering a surface area of approximately **1.47 million km^2**

Hydrological Classification of Human-Made wetlands

Permanent
- large reservoirs
- wastewater treatment
- some ponds

Seasonal/Temporary
- most rice paddies
- aquaculture (depending on management regime)
- some ponds

Intermittent
- some rice paddies (depending on management regime -AWD)
- salterns
- stormwater retention ponds

Can provide:

- Insights on ecological function- habitat provision, carbon sequestration etc
- Integration within NWI, supporting better monitoring, policy-making and conservation efforts

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Environmental Flows

EFs are those that should be left in a river downstream of human-made water infrastructure to maintain downstream biodiversity, river health, and benefits to people (e.g. fisheries).

EFs are crucial for maintaining the ecological integrity of rivers, lakes, wetlands (including flood plains), and estuaries, supporting biodiversity, and ensuring the resilience of aquatic ecosystems downstream of human infrastructure.

EFs mimic the natural variability of water systems, because rivers and wetlands need low flows and seasonal floods to maintain ecological health. Variability underpins a wide range of ecosystem functions - nutrient cycling, sediment transport, habitat creation, and the breeding and migration of aquatic species.

Determining and implementing EFs is a complex challenge

Inventorying surface water bodies

Global efforts:

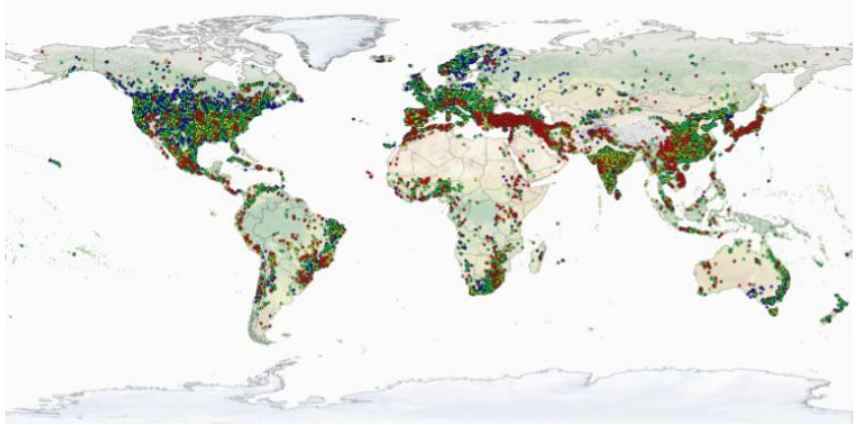
Global Surface Water Explorer uses over three million Landsat images to track changes in surface water, including **reservoirs**, from 1984. Provides statistics on extent and change.

Global Lakes and Wetlands Database (GLWD),provides offers comprehensive data on global lakes, **reservoirs**, and wetlands (WWF and Centre for Environmental Systems Research (**CESR**)

World Register of Dams developed since 1958 now contains data on 62,000 dams in 166 countries worldwide, including dam height and reservoir volume. Two-thirds are currently georeferenced (**ICOLD**)

Global Reservoir and Dam (GRanD) Database, provides detailed information on over 7,000 large reservoirs, including their locations, storage capacity, and primary purposes (International Institute for Applied Systems Analysis (IIASA))

The **Global Reservoir and Dam Monitoring (G-REALM)** monitors water level variations in large reservoirs worldwide using satellite altimetry data (NASA)



ICOLD, world register of dams

Surface Water and Ocean Topography (SWOT) aims to provide high-resolution data on reservoir water levels and storage capacity (NASA and CNES (French space agency)

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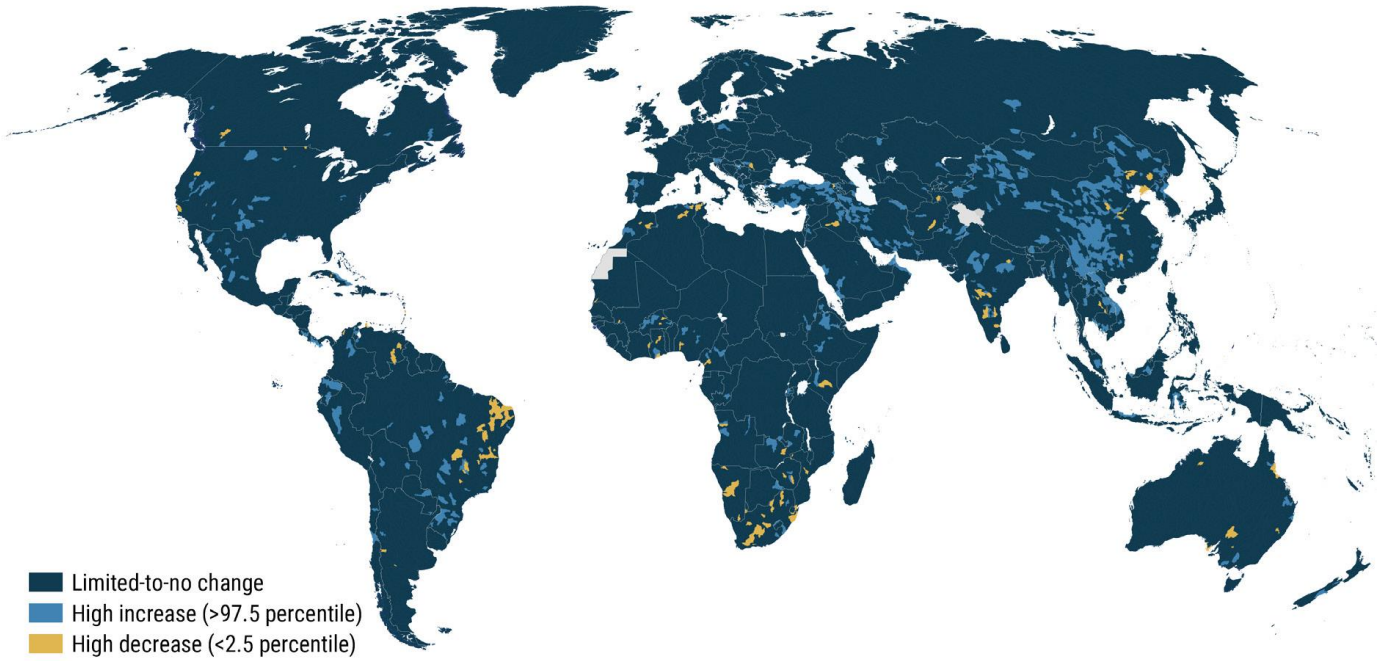
Global Surface Water Explorer



Basins with a high increase or decrease in reservoir water during 2015–2019 compared with 2000–2019

Provides accurate, up-to-date, high-resolution geospatial data depicting the extent freshwater ecosystems change over time.

Intended to support monitoring of SDG 6.6.1 – *Change in the extent of water related ecosystems over time*

Distinguishes reservoirs from other surface water bodies

National data of reservoir surface-water changes per country are available for download from the indicator 6.6.1 report website. The table provides country information on changes in reservoir surface-water area observed in 2015 and 2020, which are compared against a 20-year reference period.

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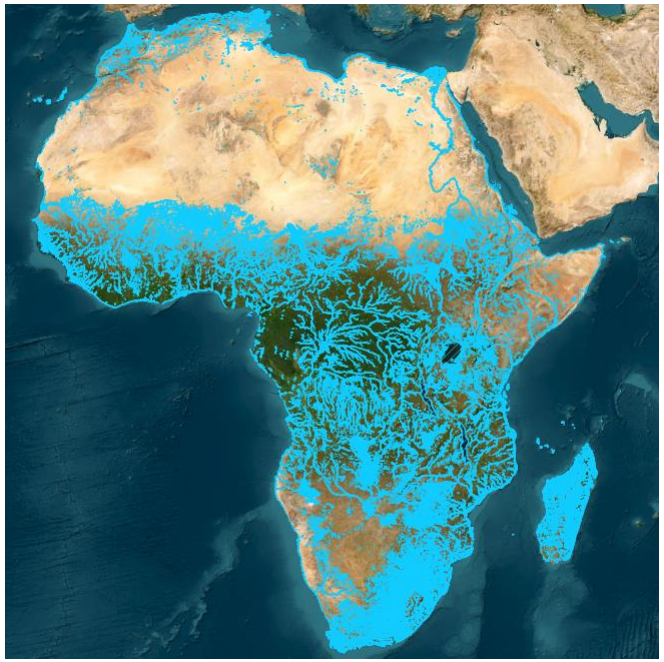
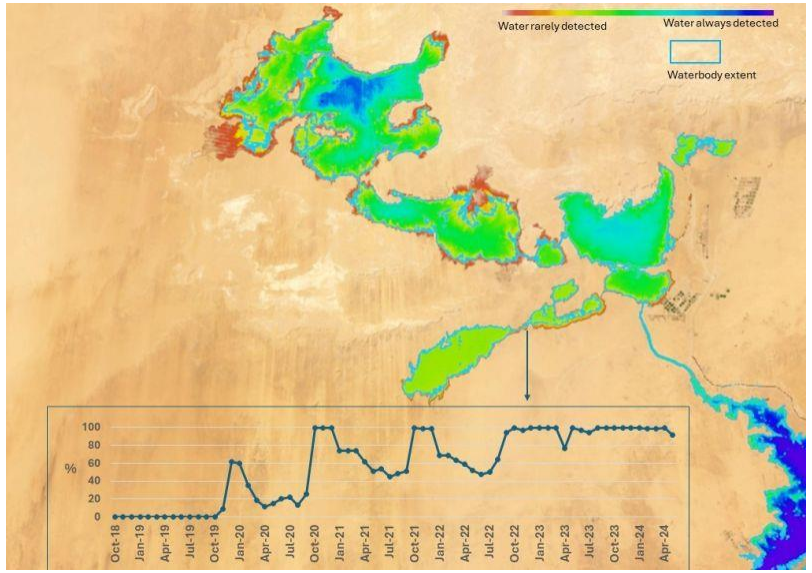
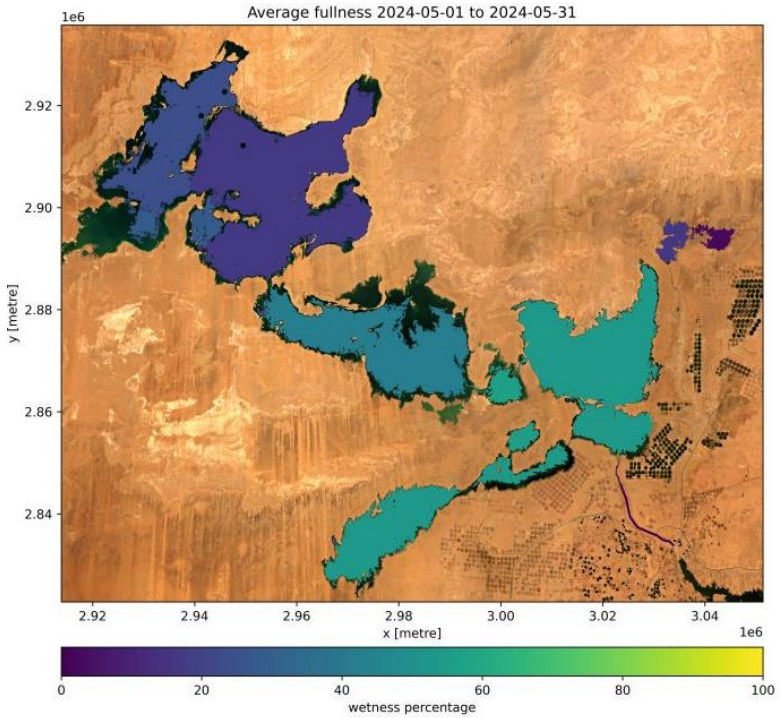
Digital Earth Africa: Water Bodies Mapping Service



Toshka Lakes in Egypt
Time series of fullness



Current Status



Continental Scale - Provides the actual surface extent, along with the wet surface area, as a **time series for each individual waterbody**

Does not yet distinguish between Natural and Human-made water bodies but this is an "attribute" that will be added in the future

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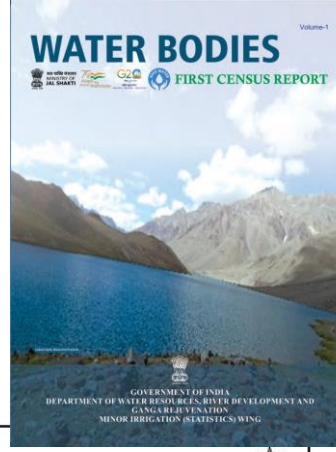
India Water Body Census (2023)



National Efforts

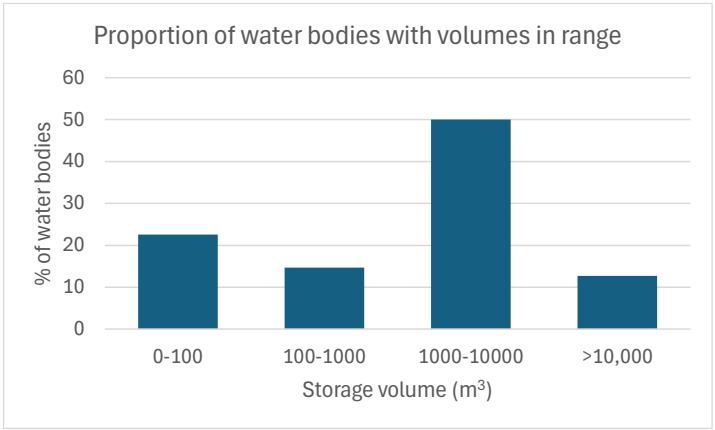
India Water Bodies Census (2023):

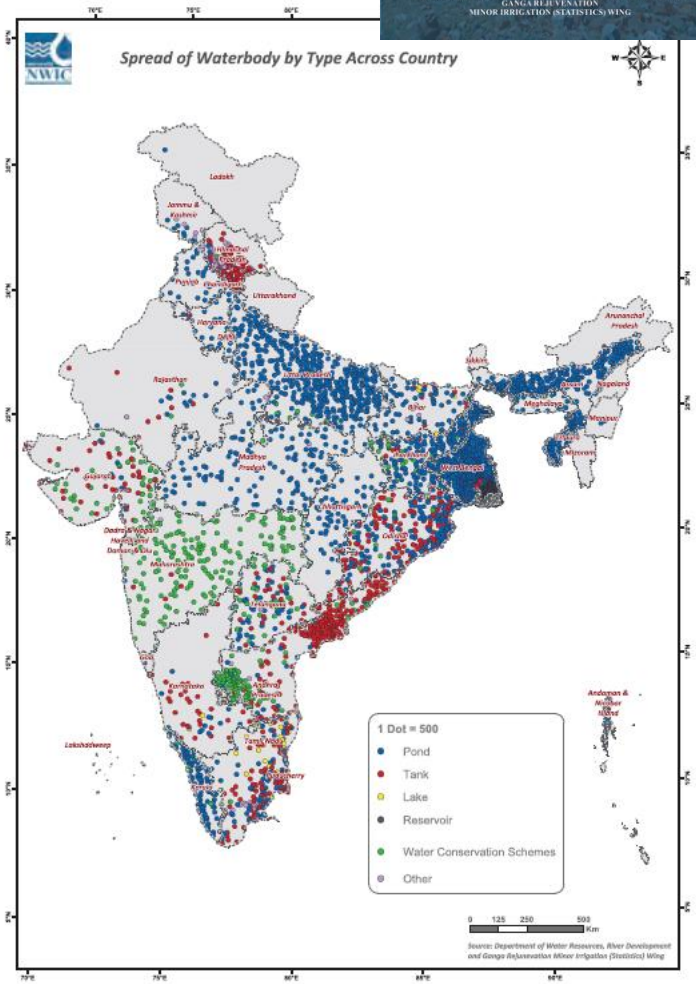
Identified: 2,424,540 water bodies

- Ponds: 1,442,993
- Tanks: 381,805
- Reservoirs: 292,280
- Water conservation schemes/percolation tanks 226,217
- Lakes: 22,361
- Others: 58,884

78% (1,890,463) of water bodies are man-made,
22% (534,077) are natural water bodies.

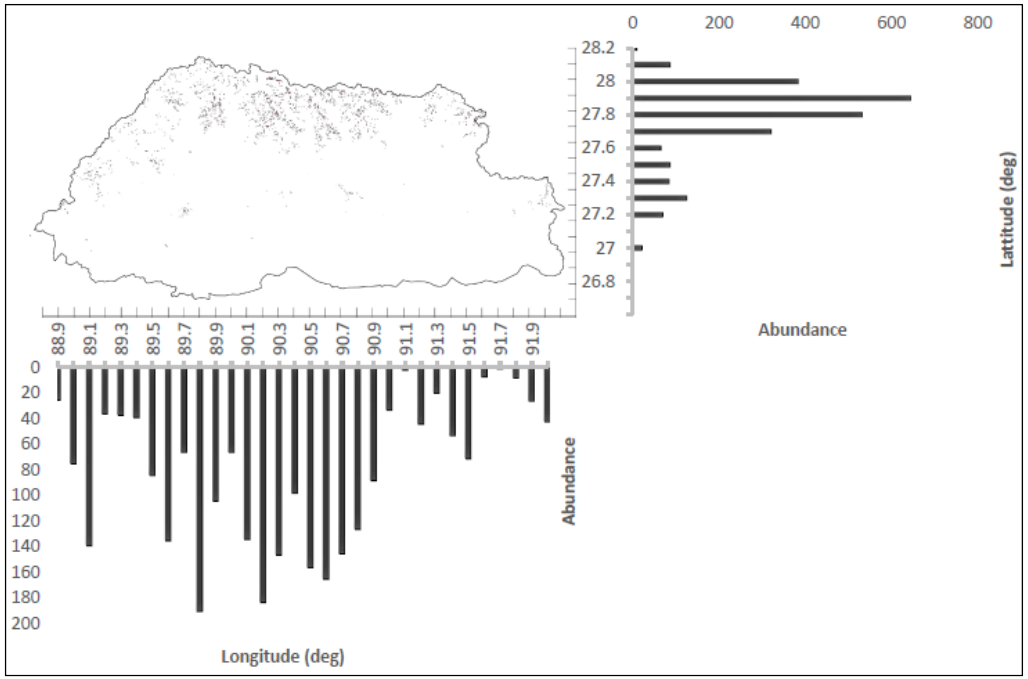
Government of India. Ministry of Jal Shakti, Department of Water Resources (2023)





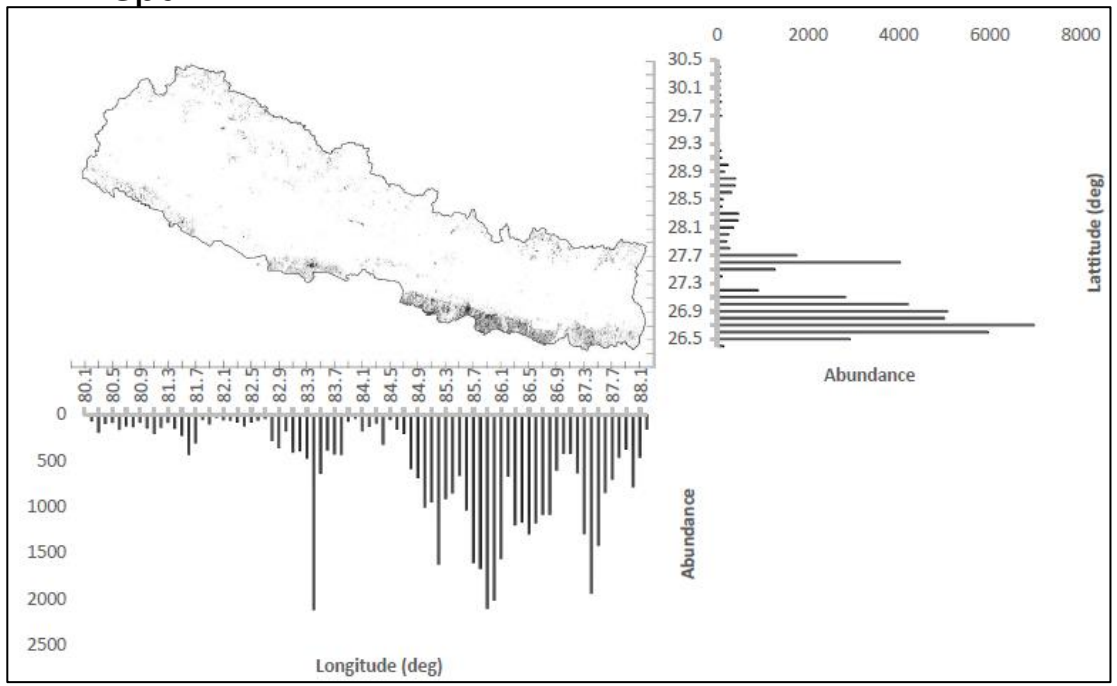
Surface water body mapping

Bhutan



Glacial lakes are the major surface water storages
80% of water features are located in between 27.7 and 28.2 N.

Nepal



Majority located in terei region (lower part) of the country)
Consists of aquacultures and man-made ponds

International Water Management Institute (2024)

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NWI – data requirements

- Location
- Type of human-made wetland
- Water storage capacity (m3)
- Hydrology (seasonal variation)
- Use:

  aquaculture, irrigation, electricity generation, flood attenuation, domestic/drinking, industrial, recreation, navigation, groundwater recharge, other
- Number of beneficiaries

Groundwater recharge ponds, Ethiopia

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Summary

The many types of human-made wetlands are critical for socio-economic development, providing vital stores of water.

Many human-made wetlands also support biodiversity by providing habitat for various species, including birds, fish, amphibians, and insects. However, their creation (especially large dams) can also undermine biodiversity and ecosystem services.

Including human-made wetlands in NWIs:

- acknowledges their significant environmental, social, and economic contributions
- helps identify and quantify the full range of wetland resources available in a country ensuring they are considered in policy-making, conservation planning, and land-use management
- supports compliance with the Ramsar Convention, which encourages the conservation and wise use of all wetlands, regardless of their origin

Reservoir, Thailand

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Thank you

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Useful websites/publications

Digital Earth Africa. Water Body Monitoring Service: DE Africa Waterbodies: A Waterbodies Monitoring Service — Digital Earth Africa 2021 documentation

Freshwater Ecosystems Explorer: SDG 6.6.1 (sdg661.app)

Government of India, Ministry of Jal Shakti, Department of Water Resources, River Development and Ganga Rejuvenation, Minor Irrigation (Statistics) Wing (2023) Water Bodies: 1st Census Report. https://jalshakti-dowr.gov.in/document/all-india-report-of-first-census-of-water-bodies-volume-1/

McCartney, M.P. Rex, W.; Yu, W.; Uhlenbrook, S. & von Gnechten, R. (2022) Change in global freshwater storage. Colombo, Sri Lanka: International Water Management Institute (IWMI). 25p. (IWMI Working Paper 202). doi: https://doi.org/10.5337/2022.204

Muduli, M., Choudharya, M. & Ray, S. (2023) A review on constructed wetlands for environmental and emerging contaminants removal from wastewater: traditional and recent developments. *Environ Dev Sustain* https://doi.org/10.1007/s10668-023-04190-0

Richardson, D. C., Holgerson, M. A., Farragher, M. J., Hoffman, K. K., King, K. B. S., Alfonso, M. B., Andersen, M. R., Cheruveil, K. S., Coleman, K. A., Farruggia, M. J., Fernandez, R. L., Hondula, K. L., López Moreira Mazacotte, G. A., Paul, K., Peierls, B. L., Rabaey, J. S., Sadro, S., Sánchez, M. L., Smyth, R. L., & Sweetman, J. N. (2022). A functional definition to distinguish ponds from lakes and wetlands. *Scientific Reports*, *12*(1), 10472. https://doi.org/10.1038/s41598-022-14569-0