

# Global Assessment of Free-Flowing Rivers



Free-flowing rivers are the freshwater equivalent of wilderness areas.

They are amongst the most ecologically important freshwater habitats, and many are critical to both people and nature. But they are disappearing.



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THE UNIVERSITY  
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IHE  
DELFT

The Nature  
Conservancy 



CONSERVATION  
INTERNATIONAL



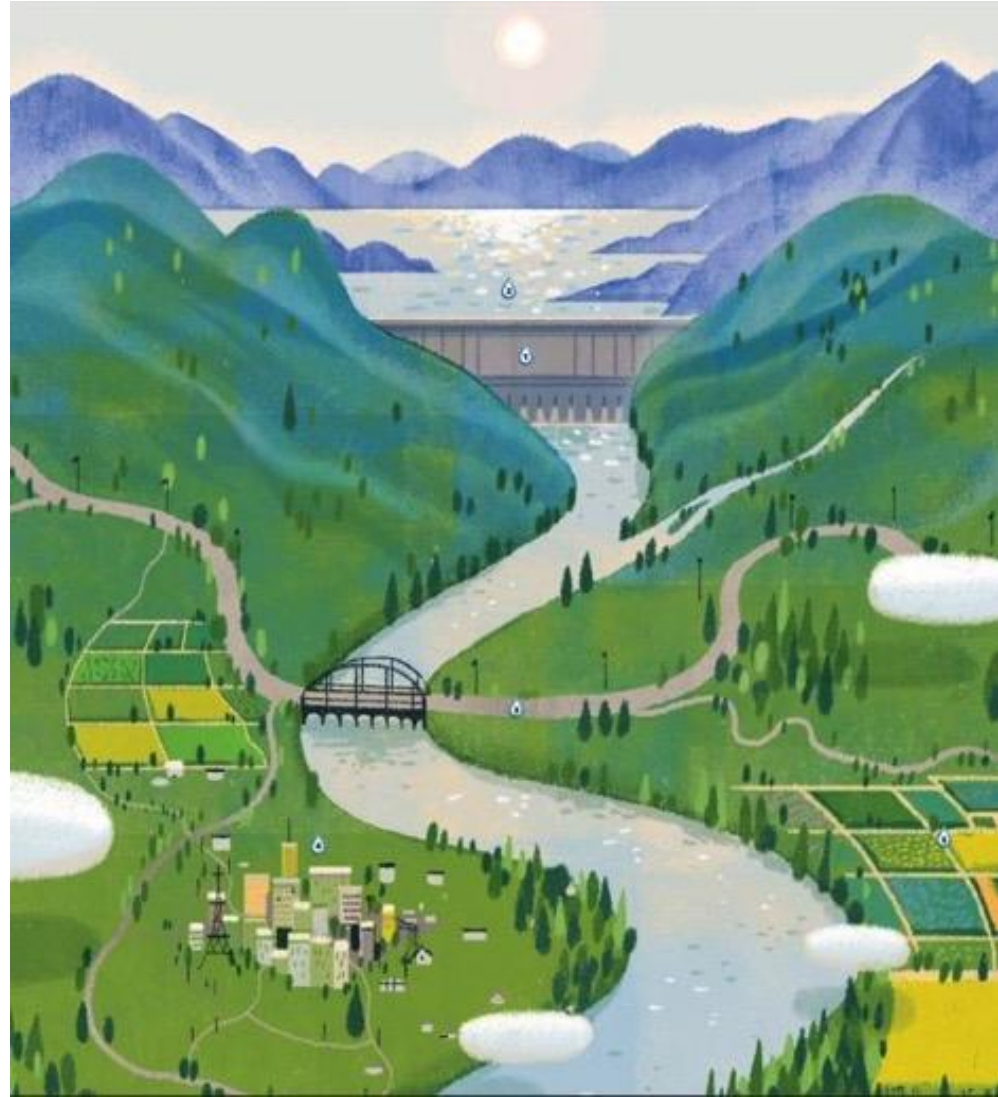
Leibniz-Institute of  
Freshwater Ecology  
and Inland Fisheries



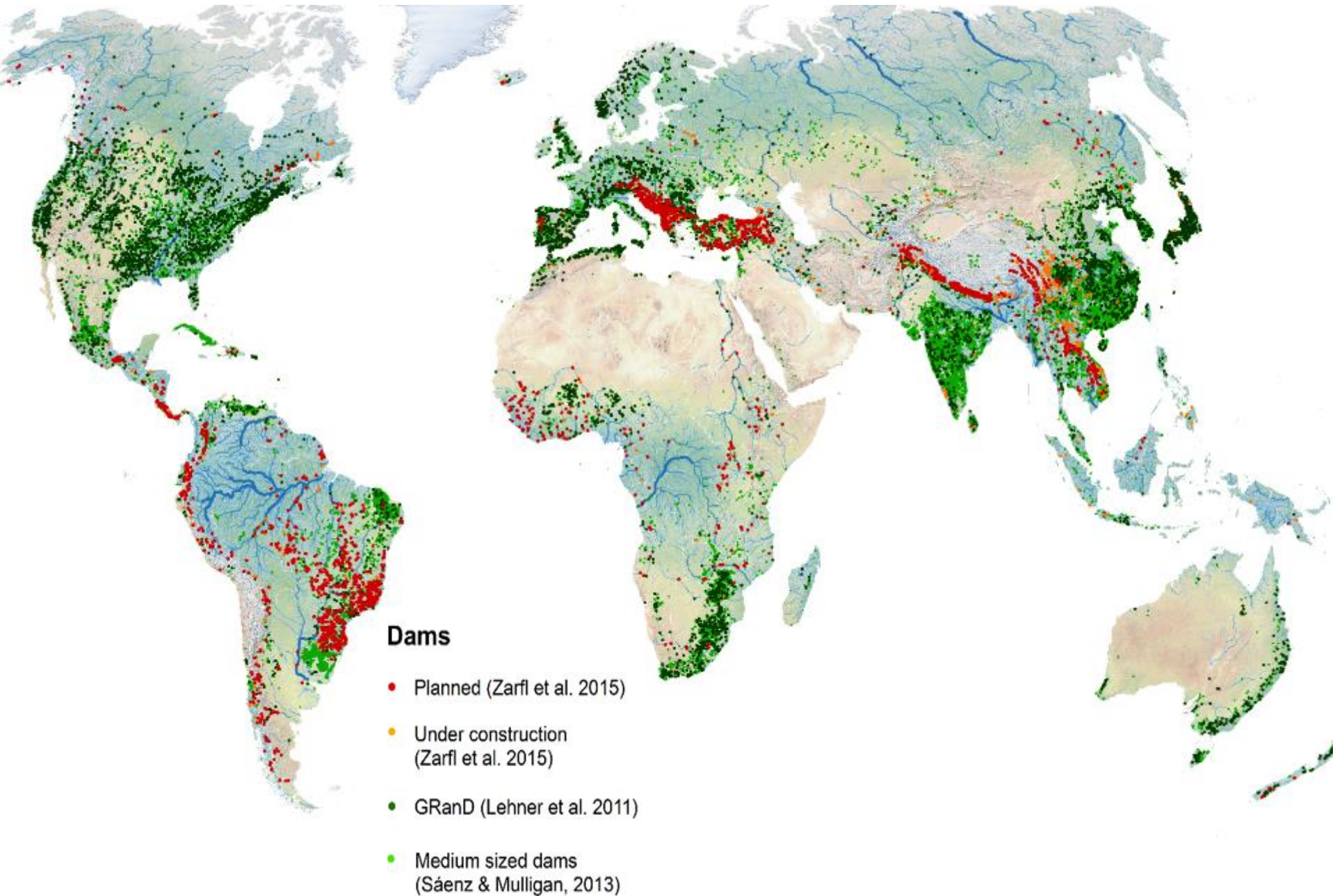
# What is a Free-Flowing River?

*A free-flowing river occurs where natural aquatic ecosystem functions and services are largely unaffected by anthropogenic changes to fluvial connectivity allowing an unobstructed exchange of material, species and energy within the river system and beyond.*

***Fluvial connectivity** encompasses longitudinal (river channel), lateral (floodplains), vertical (groundwater and atmosphere) and temporal (intermittency) components.*



# Increased pressure, e.g. global boom in hydropower

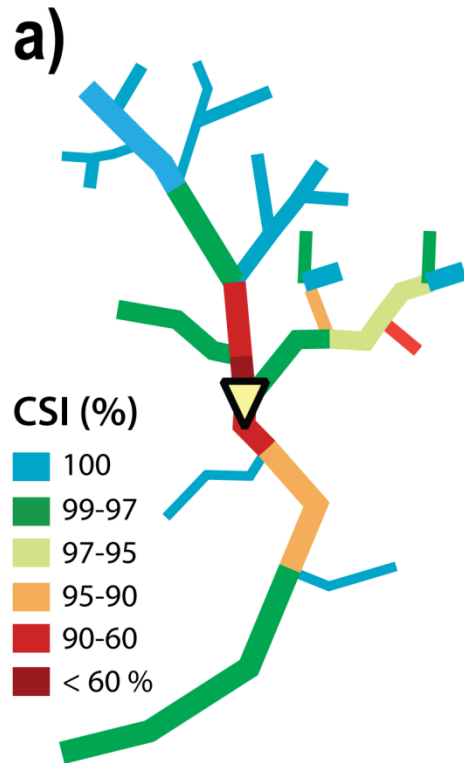




# Global Assessment & Results

## Step 1:

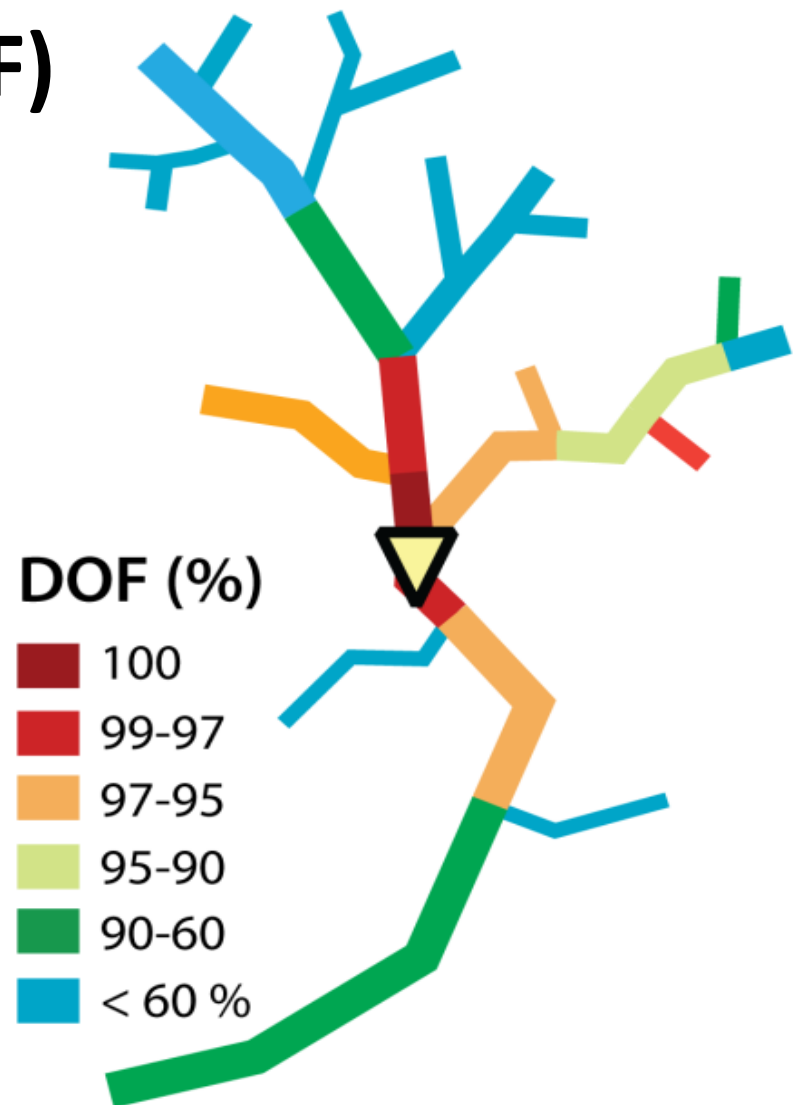
Calculate a “Connectivity Status Index” (CSI) for every river reach globally



We do this by assessing six pressure indicators...

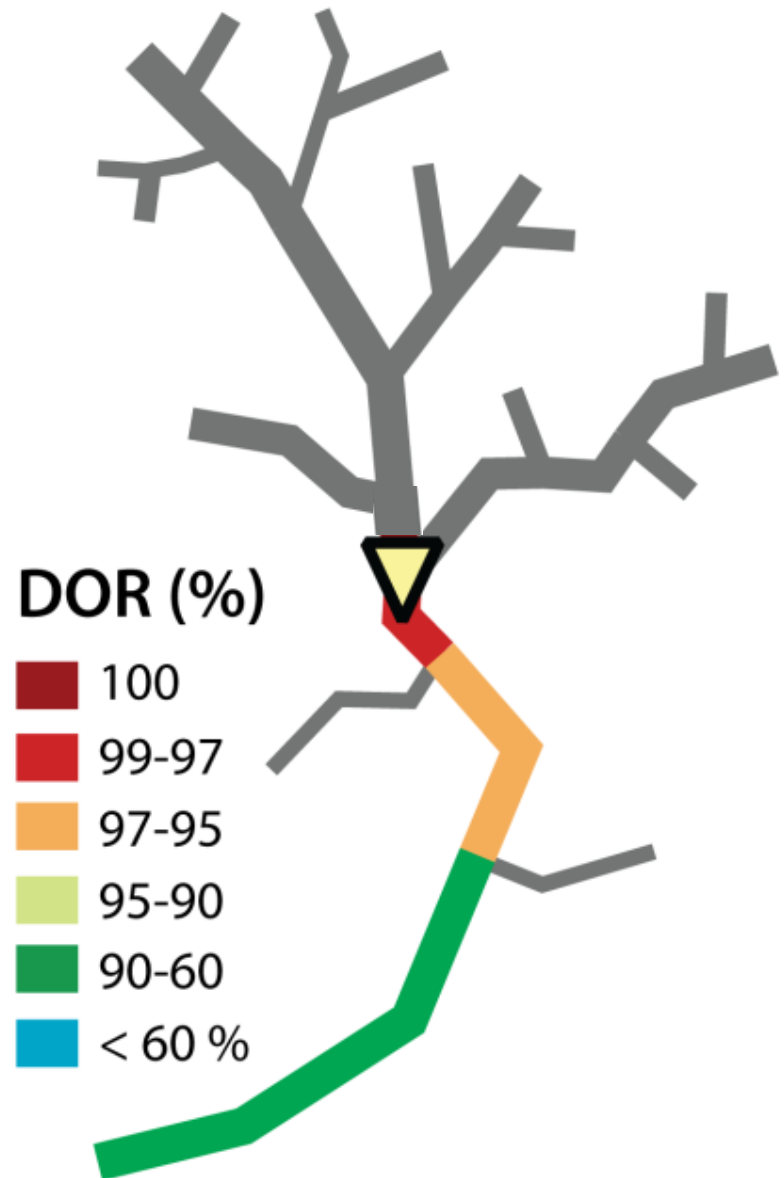
# Pressure indicator 1: River fragmentation (DOF)

- Dams fragment rivers and impede longitudinal connectivity
- Fragmentation affects river connectivity both downstream and upstream!
- > 20,000 dams were assessed
- Approx. 2,500 waterfalls were included to represent natural fragmentation



# Pressure indicator 2: Flow regulation (DOR)

- Dams alter natural flow characteristics due to water storage and managed release
- This affects longitudinal and lateral connectivity (on floodplains)
- Larger reservoirs store more water and can cause larger regulation effects





# Pressure indicator 3: Urbanization

- We use urbanization as a proxy for general infrastructure development, such as levees, canals, buildings in floodplains, etc.
- Combining urban areas with nightlight intensity
- Similar to population density “weighted” by GDP



(NOAA; Doll, 2008)

# Pressure indicator 4: Road development

- Road development near rivers may affect lateral connectivity as well as longitudinal connectivity (culverts)
- We assessed road density within a 1 km buffer around all rivers



# Pressure indicator 5:

## Water consumption

- Water consumption from irrigation, industry or domestic use can lead to altered connectivity or even temporary intermittence of flows

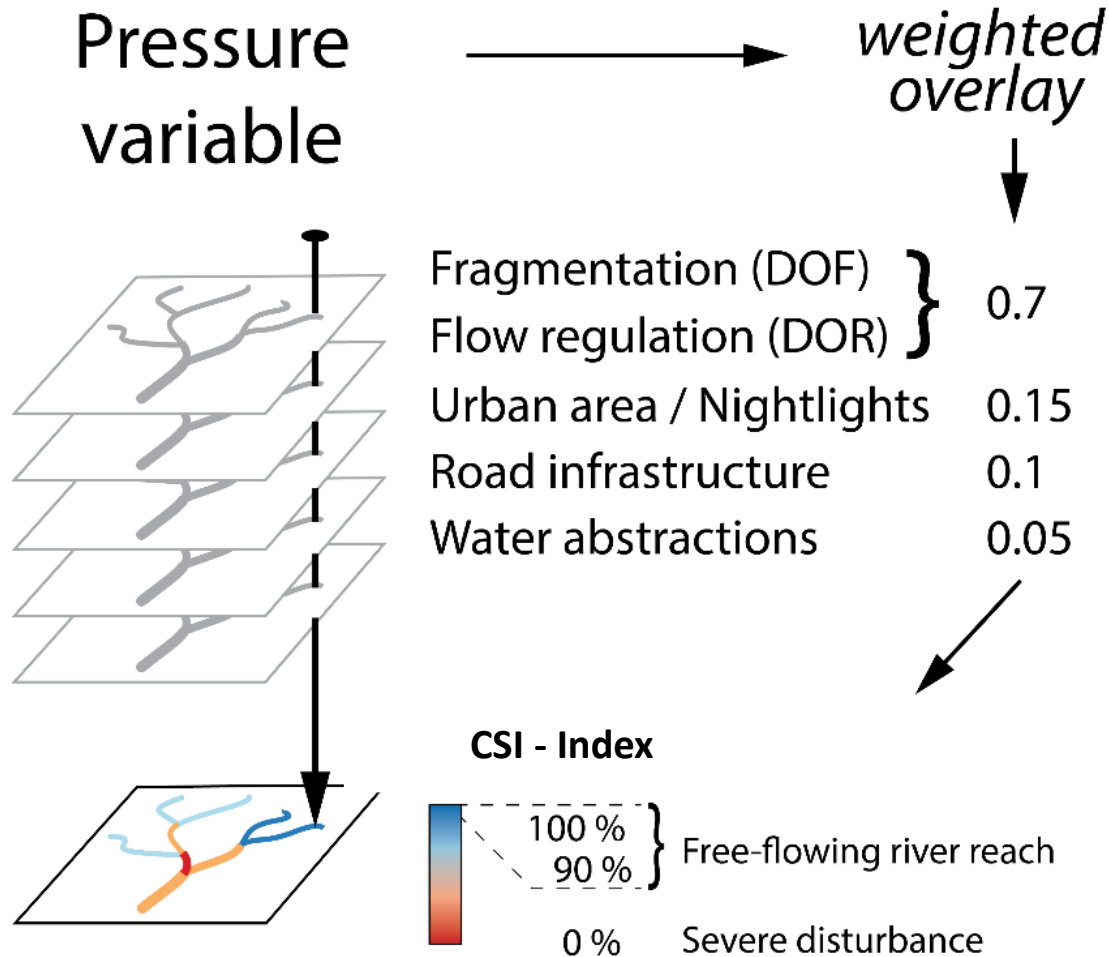


# Pressure indicator 6: Sediment trapping

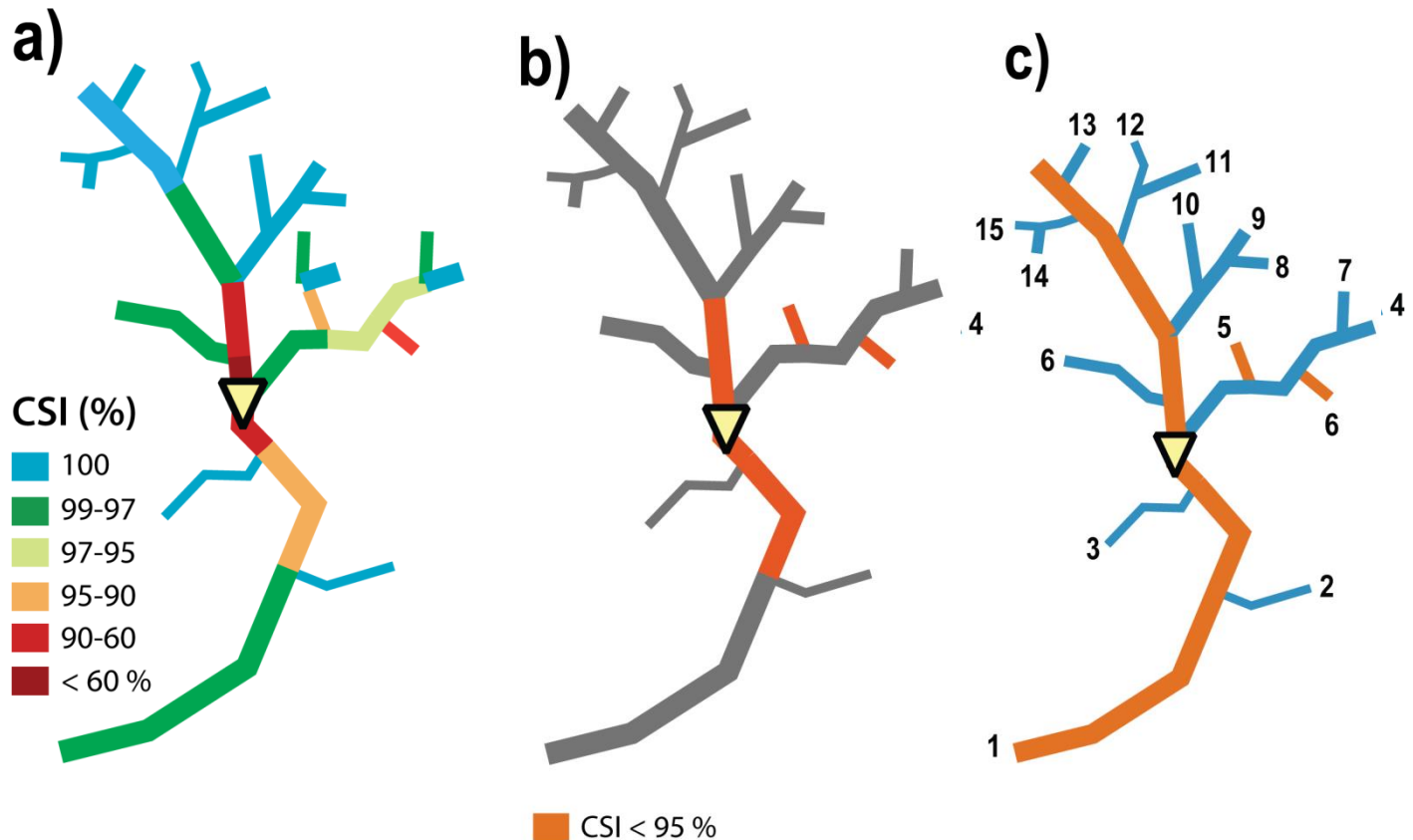
- Reservoirs can trap large amounts of sediments
- Dams on high-sediment rivers are affecting sediment connectivity more than dams on low-sediment rivers

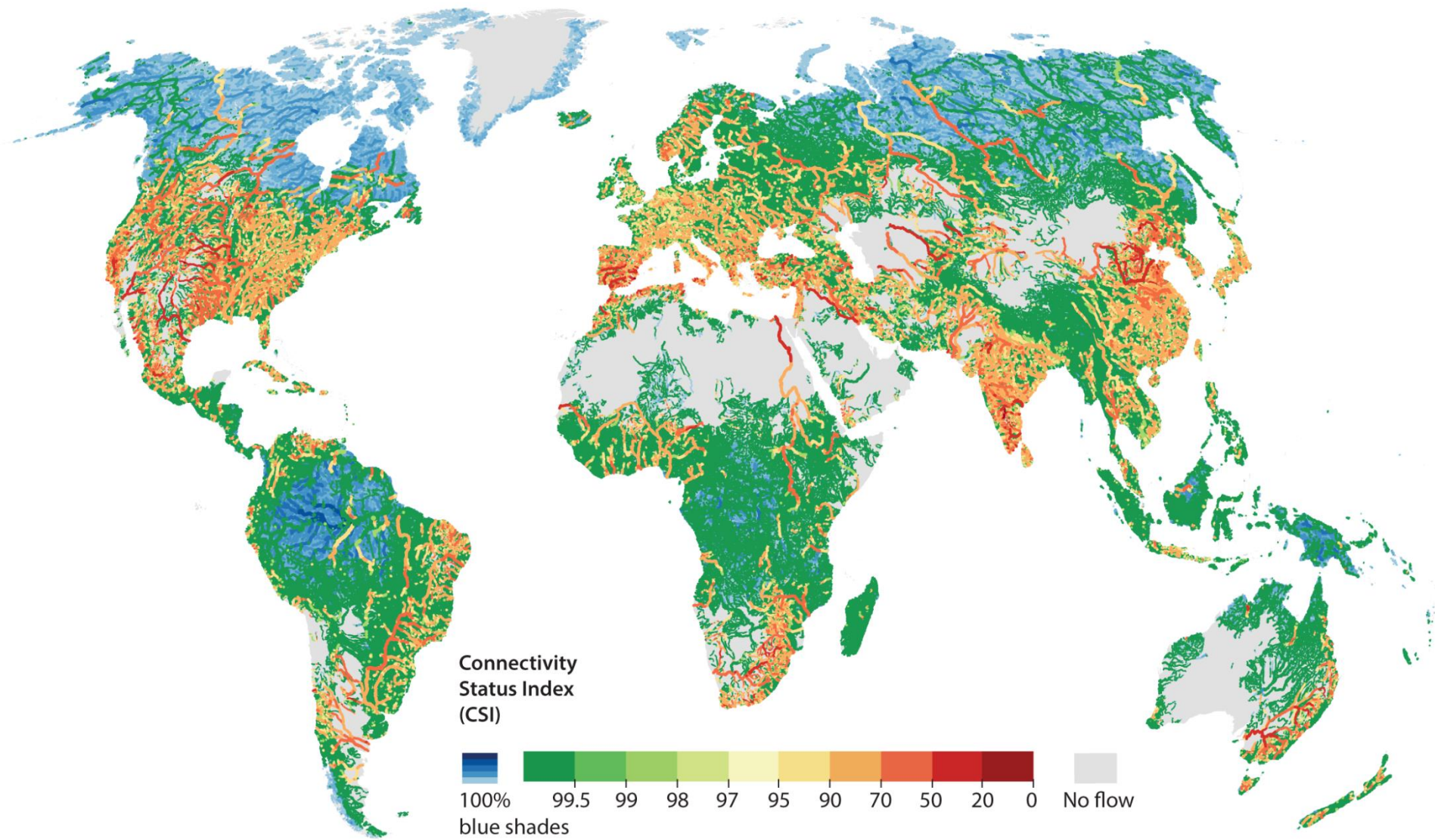


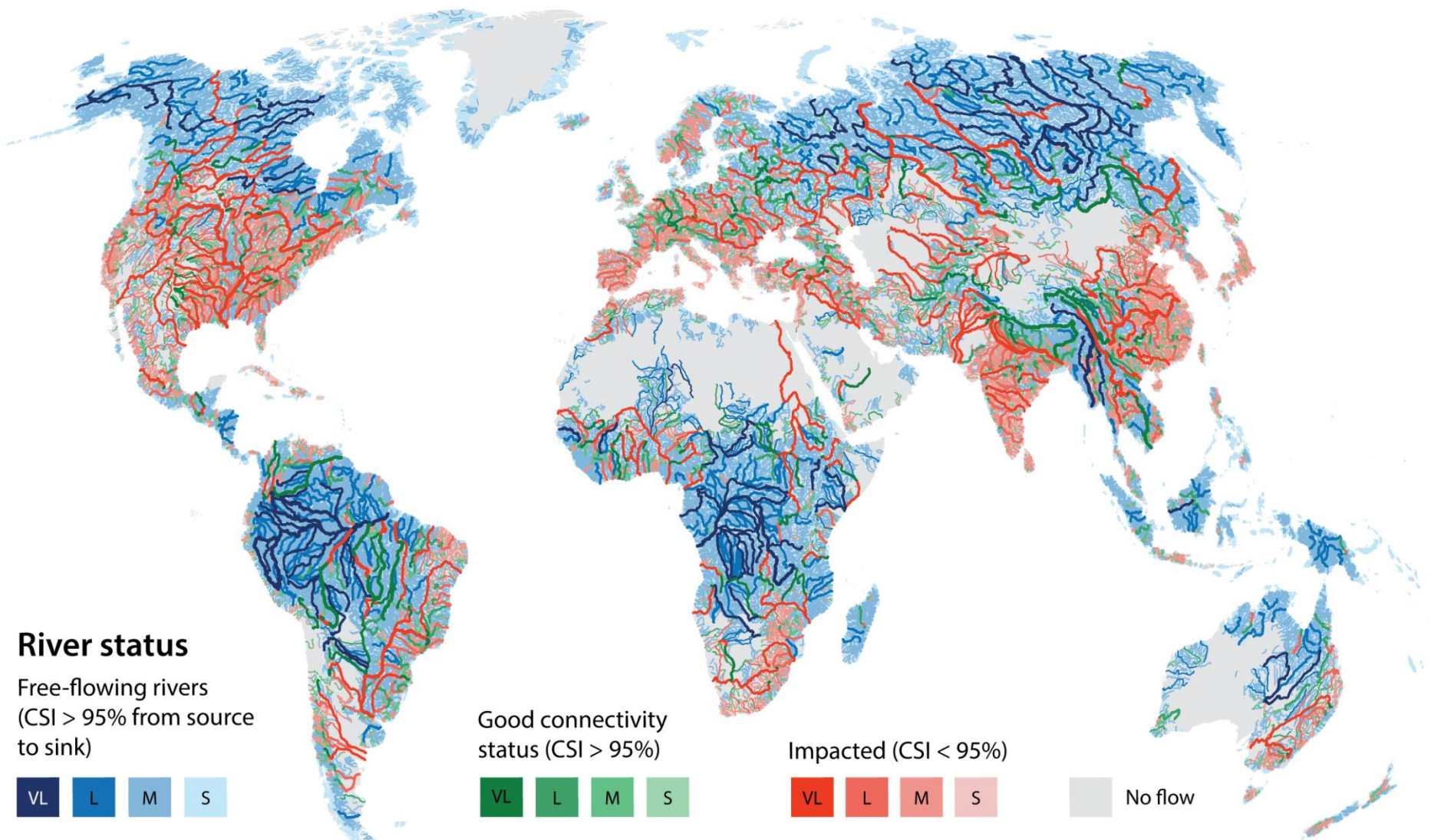
# Connectivity Status Index (CSI)



# Step 2: Apply a CSI threshold and identify contiguous rivers (from source to sink)







## River status

Free-flowing rivers  
(CSI > 95% from source to sink)



VL: Very long river (> 1000 km)

Good connectivity  
status (CSI > 95%)



L: Long river (500 - 1000 km)

Impacted (CSI < 95%)



M: Medium river (100 - 500 km)



No flow

S: Short river (10 - 100 km)

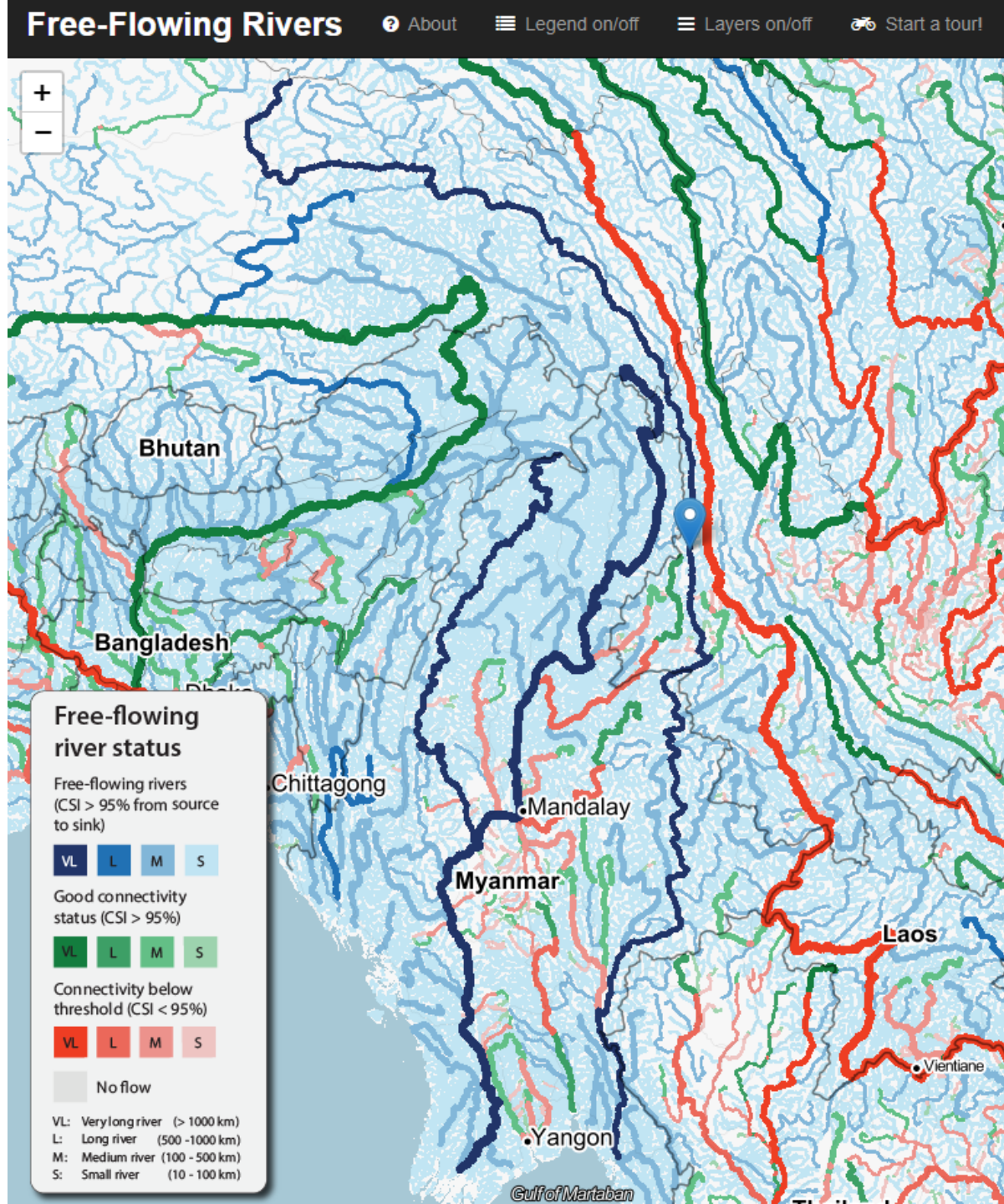


# Free-flowing rivers

## Regional results

See the results of our global analysis at:

<http://www.hydrolab.io>



# Main results of global free-flowing river assessment (focusing on very long rivers > 1000 km)

**The tropics and the Arctic are the final frontiers for free-flowing rivers.**

Free-flowing rivers are largely restricted to the remote regions of the Arctic, the Amazon and the Congo Basin.

**We are losing the world's large free-flowing rivers.**

Only 86 out of 242 very long rivers (36%) remain free-flowing.

**Only a handful of the world's rivers still run freely from their source to the sea.**

Only 23% of very long free-flowing rivers retain connection to the sea. This impacts both people and nature, especially in the face of a changing climate.

## Defining Free-Flowing Rivers In Other Words

For a river to be 'free,' it must be highly connected in four ways:



### Longitudinally,

which refers to connectivity between upstream and downstream. Dams are the most common disrupter of longitudinal connectivity.



### Laterally,

which refers to the ability of a river to swell and shrink naturally. This is disrupted when roads, buildings or other development (including agriculture when it is protected by levees or dikes) takes place on floodplains, limiting their ability to absorb the rivers' flows.



### Temporally,

or the natural ability of river flows to change intermittently. For example, when a dam is built, it consistently holds a volume of water behind the structure and releases water in a way that does not match the timing of the river's natural flows.



### Vertically,

which refers to the ability of a river to draw water from or contribute water to underground aquifers and the atmosphere. This can be interrupted by over-abstraction of groundwater and impermeable development on flood plains, among other causes.

## OUR APPROACH Pressure Indicators

To identify free-flowing rivers using global datasets, freshwater experts from around the world gathered information on 'pressure indicators,' each of which impacts at least one of the four areas of connectivity. These pressure indicators include:



## FREE FLOWING STORIES

## DOWNLOAD THE STUDY

Learn more about our process and results

[DOWNLOAD .PDF >](#)

## MAP TOOL

Explore and interact with the world's rivers

[DISCOVER >](#)

# WATER'S JOURNEY

**WWF Free Rivers App**  
Available in the iTunes App Store

Ocean water evaporates into clouds, which fall as rain. As rainwater flows



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[www.free-flowing-rivers.org](http://www.free-flowing-rivers.org)