The new hydrographic HydroSHEDS database derived from the TanDEM-X DEM

Carolin Keller [1], Leena Warmedinger [1], Martin Huber [1], Mira Anand [2], Bernhard Lehner [2, 3], Larissa Gorzawski [4], Michele Thieme [5], Birgit Wessel [1], Achim Roth [1]

[1] German Aerospace Center DLR
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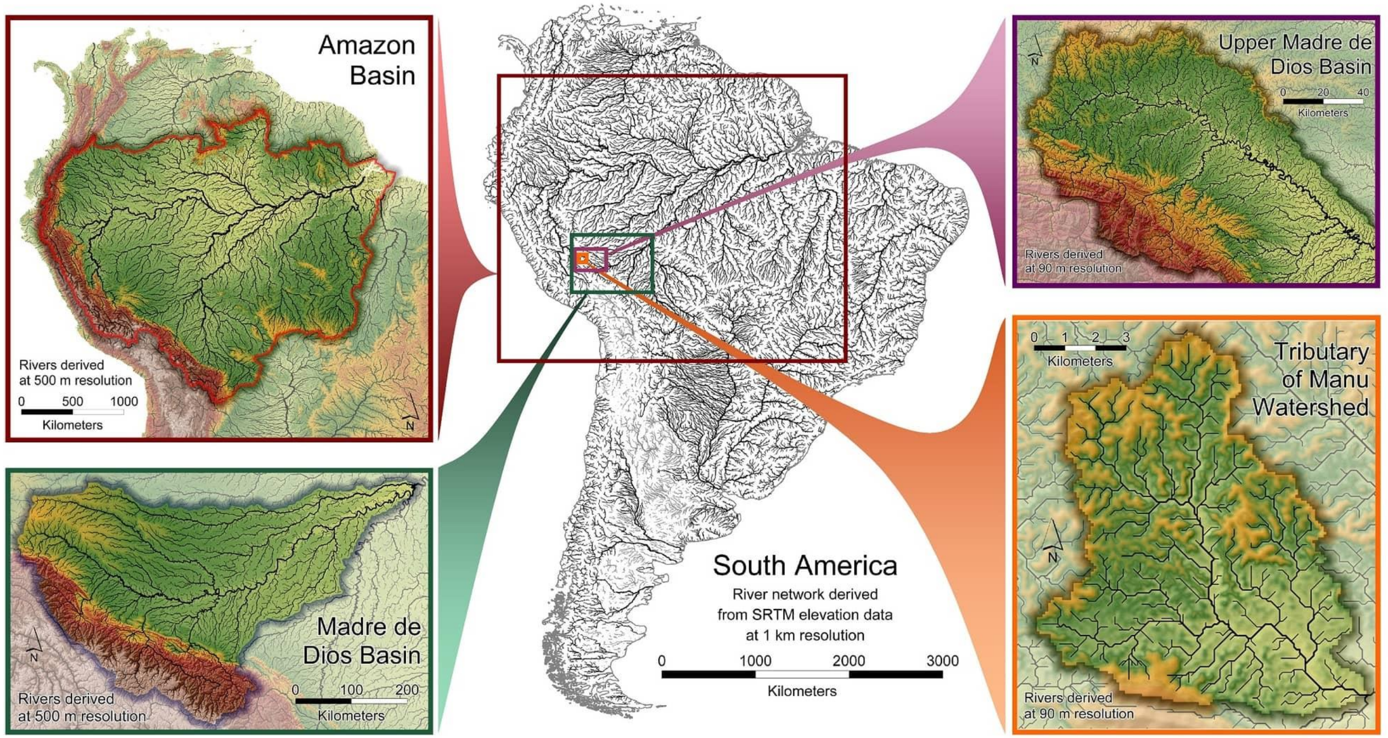
What is HydroSHEDS?

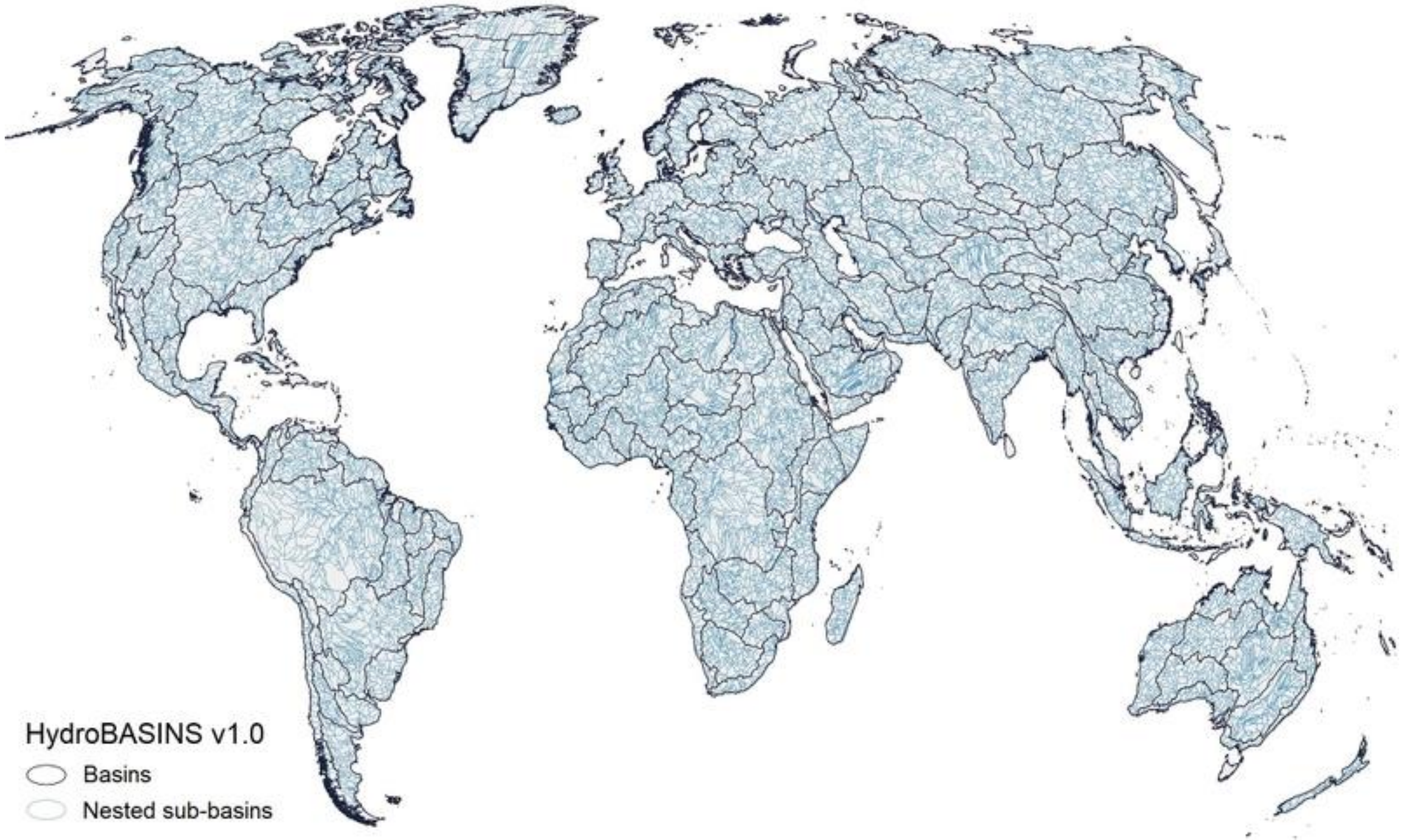
- Suite of global seamless hydrologic data
- Based on drainage directions derived from 90m SRTM data
- Regional- to global-scale
- Multiple resolutions
- Introduced 2008



HydroSHEDS product categories

HydroSHEDS core products → Secondary products → Associated products

HydroATLAS



Linke, Lehner, et al. (2019, *Nature Scientific Data*)

How is HydroSHEDS used?

- Well-established database for hydrological assessments supporting many applications: hydrological, environmental, conservation, socioeconomic, human health and more!

- HydroSHEDS provides a common framework and shared spatial units
- Interoperable results from diverse researchers, institutions, and organizations

Limitations of HydroSHEDS v1

Lower resolution

- Developed over a decade ago from 90m SRTM data
- HYDRO1k DEM used north of 60˚N
- Underlying DEM has more gaps & voids

Opportunities created from recent data products

- TanDEM-X DEM and recent high-resolution data products allow for major improvements to the HydroSHEDS database

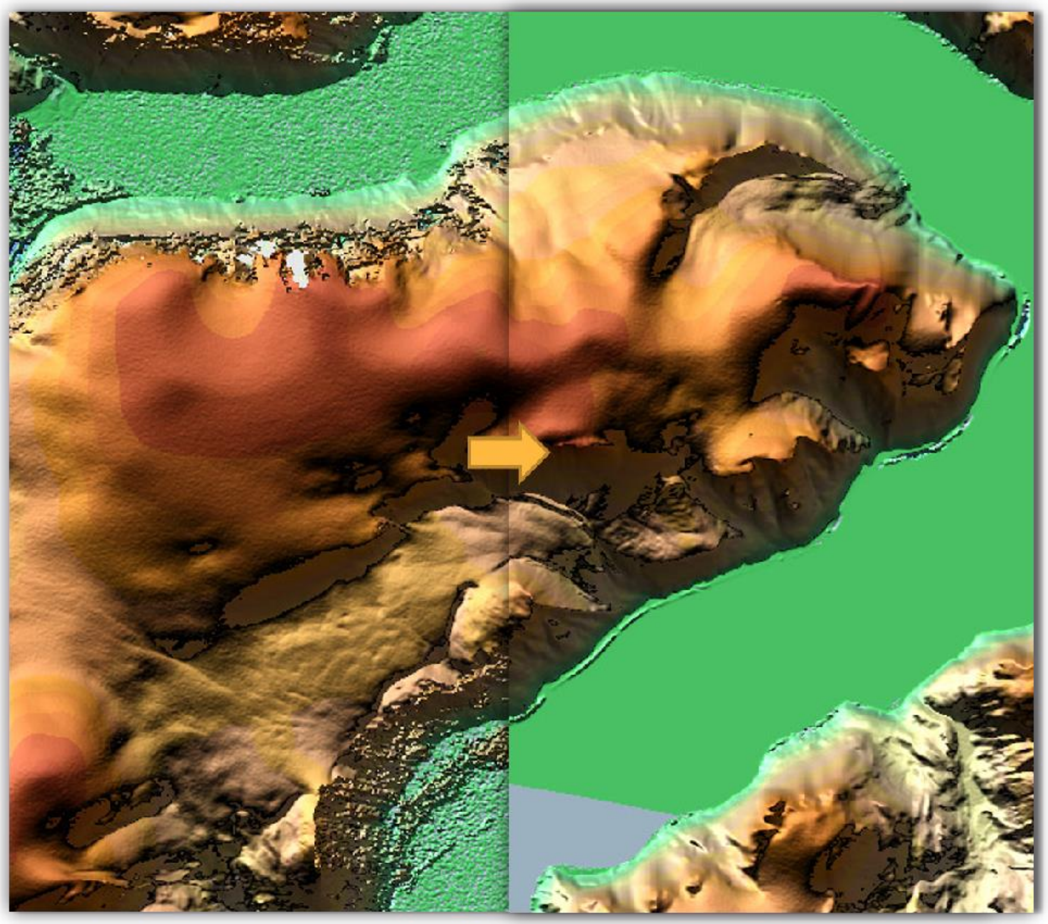
What is new in HydroSHEDS v2?

Derived from high-resolution TanDEM-X data

- 0.4“ TanDEM-X resolution
- Seamless and globally consistent 1 arc-second resolution for all land areas, including north of 60˚N

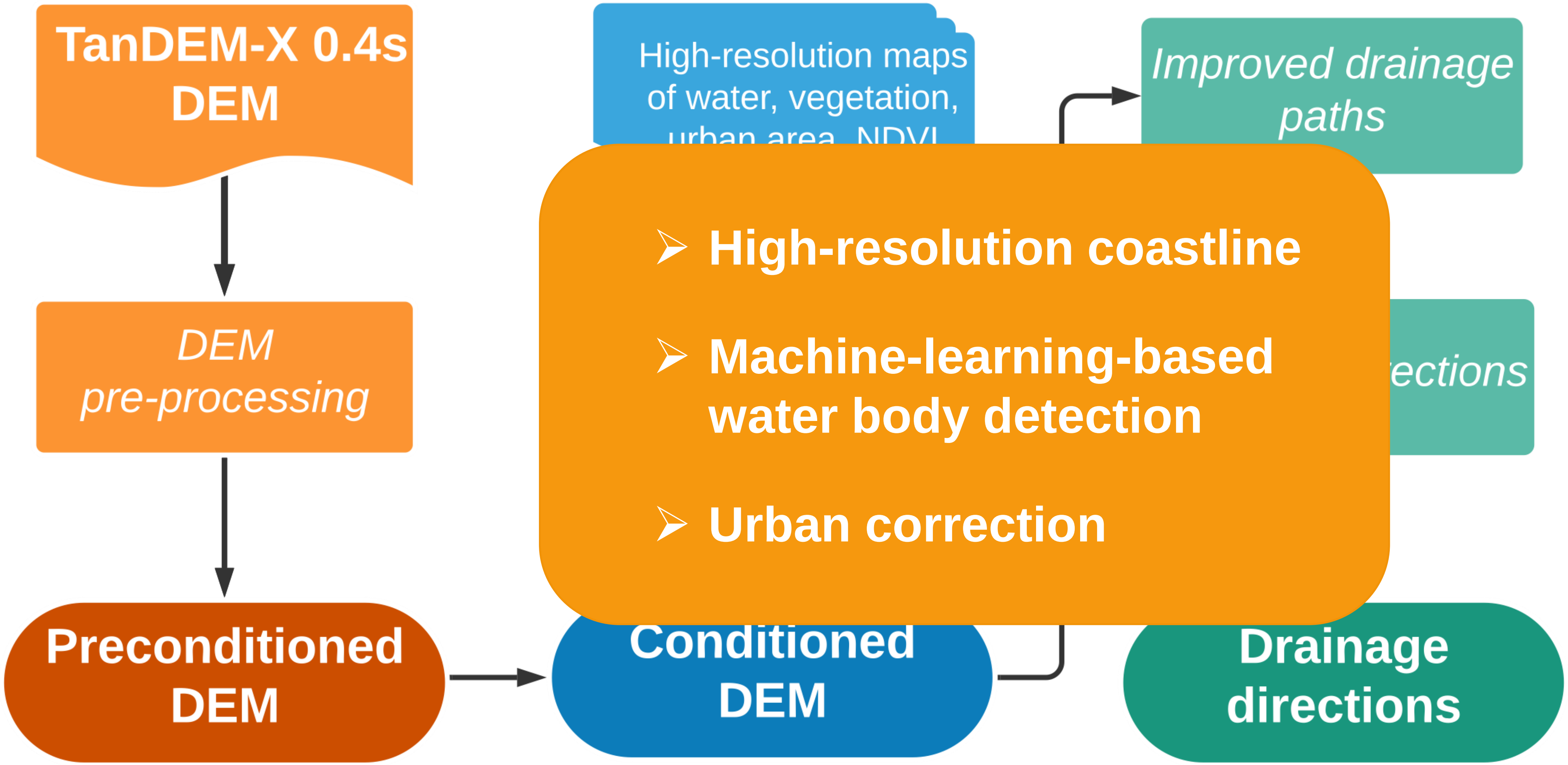
Further improvements

- Enhanced river tracing algorithms
- improved ‘stream-burning’ incorporating recent auxiliary data products
- Correction of urban areas and vegetation



DEM Infill for Baffin Island

HydroSHEDS workflow



- High-resolution coastline
- Machine-learning-based water body detection
- Urban correction

Coastline

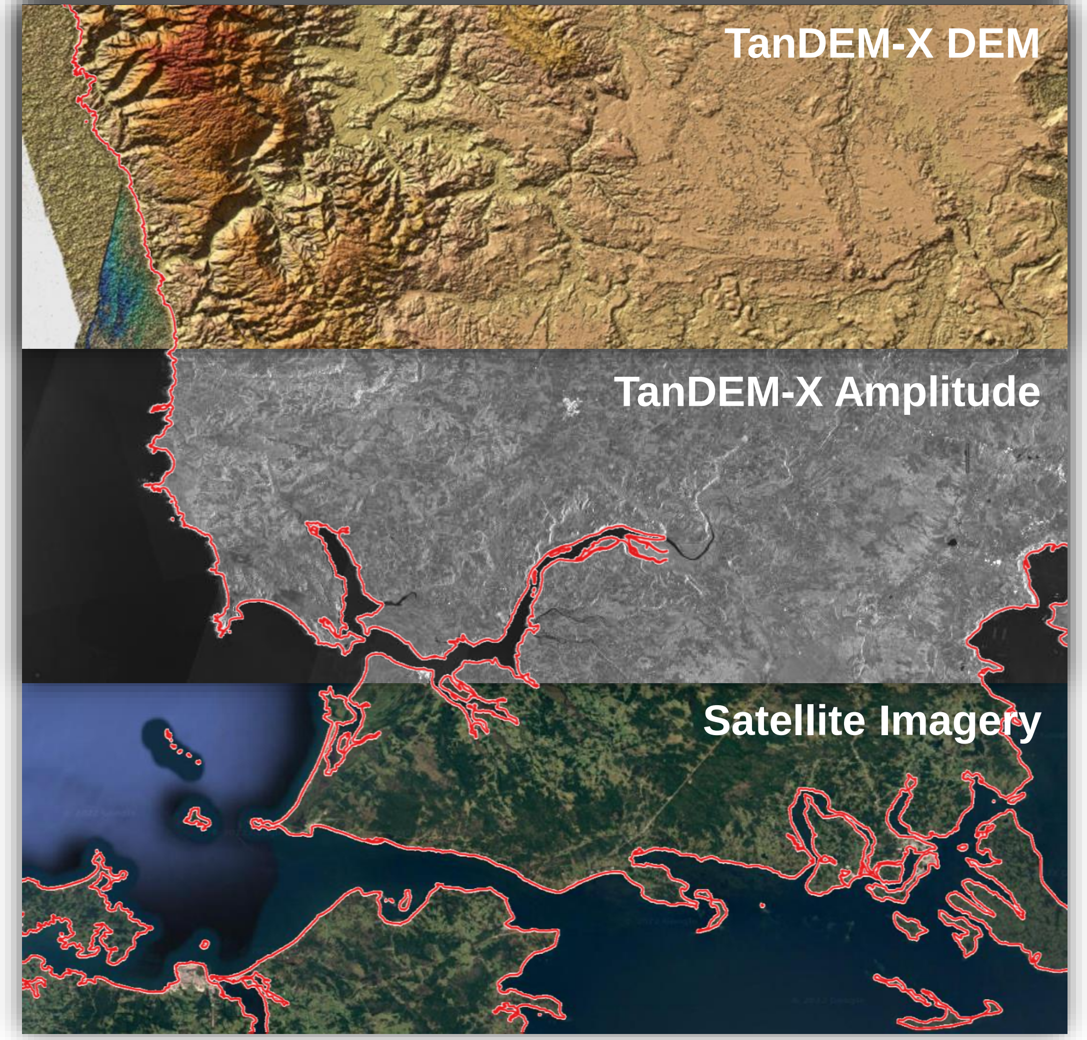
Procedure

- Automatic delineation
- Manual corrections

Challenges

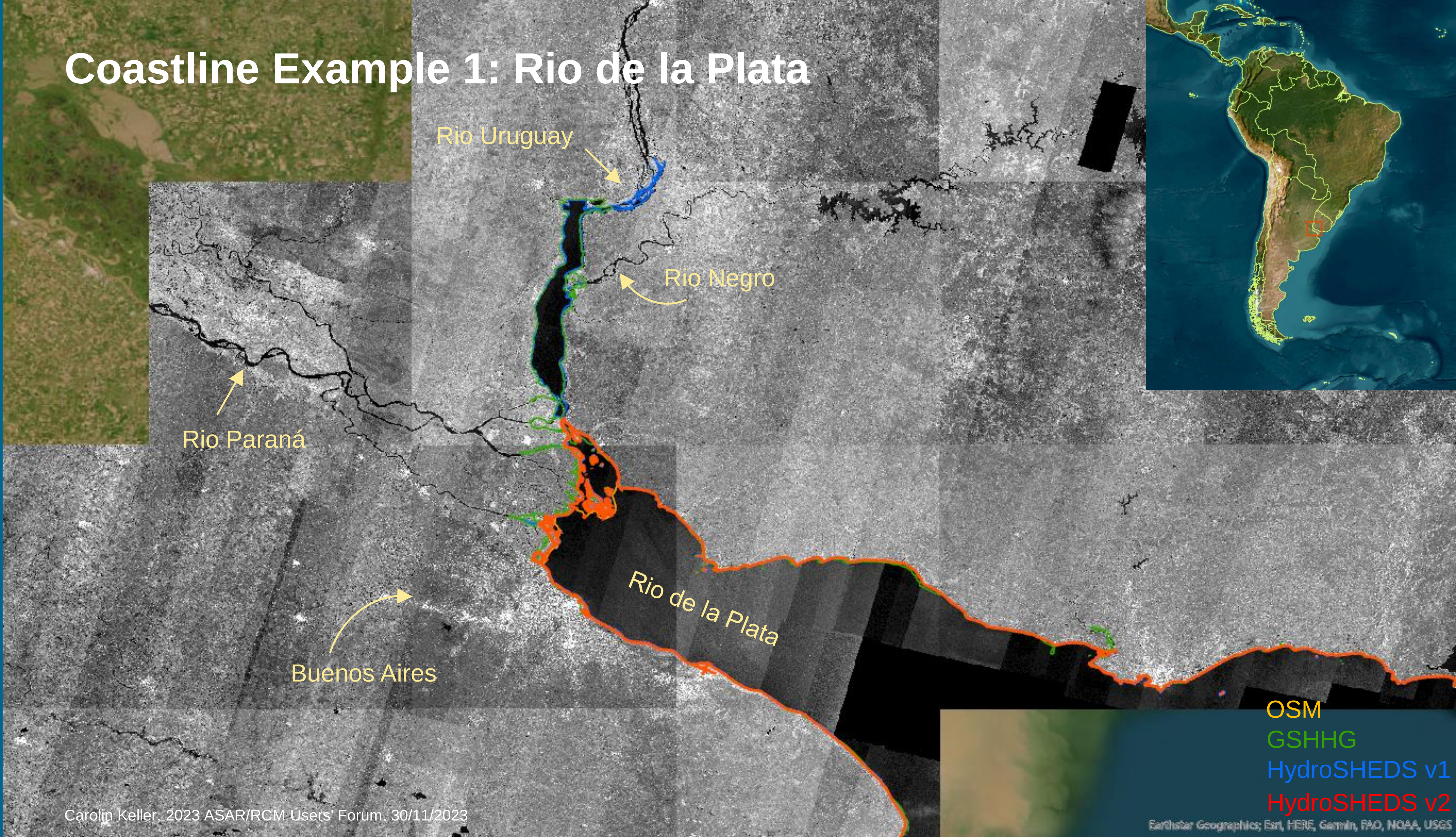
- Rather a transition zone than a sharp line
- Shifting in space and time

→ Homogeneity with regard to hydrological framework

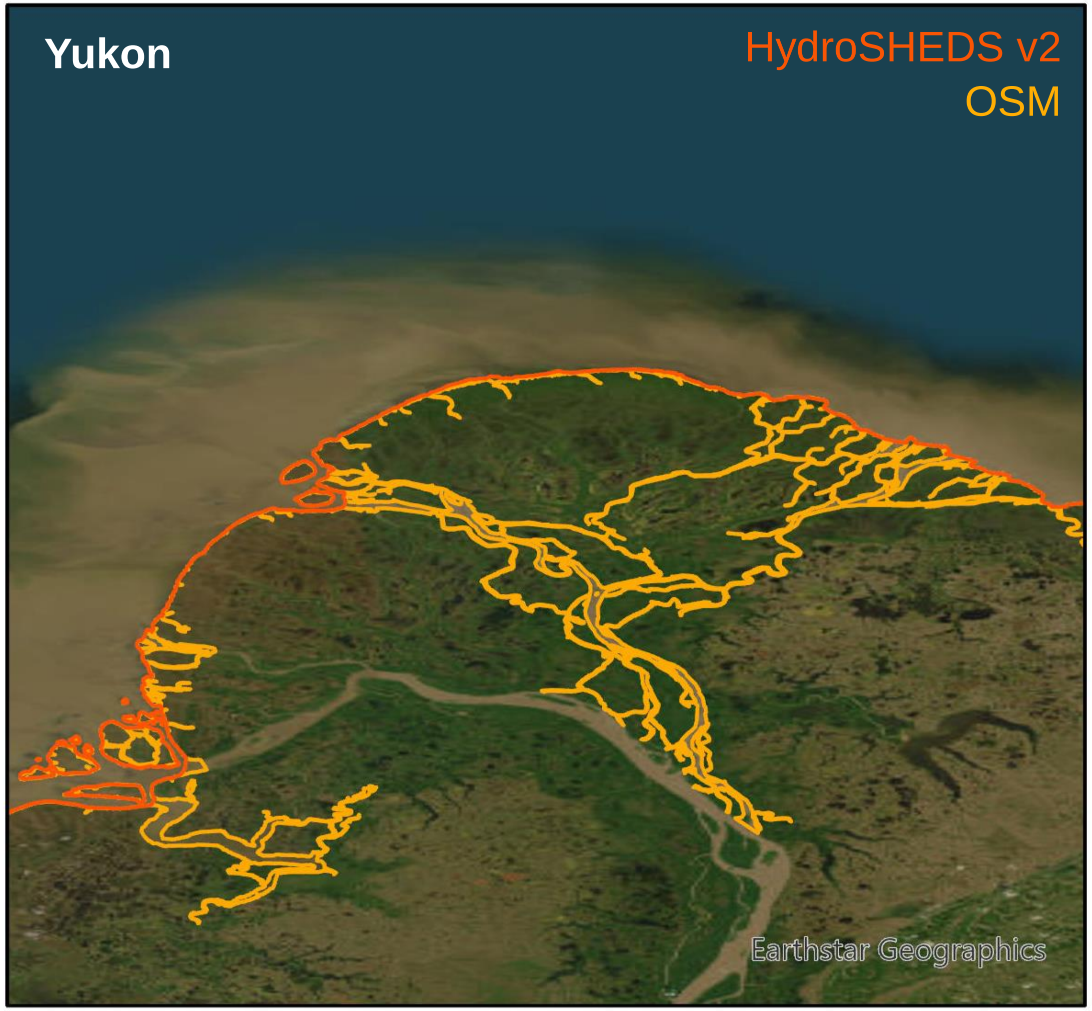


Coastline derived from the TanDEM-X dataset visualized on top of the DEM (top), amplitude (center) and satellite imagery (bottom) for Los Lagos Region, Chile

Coastline Example 1: Rio de la Plata



Coastline Example 2: River deltas



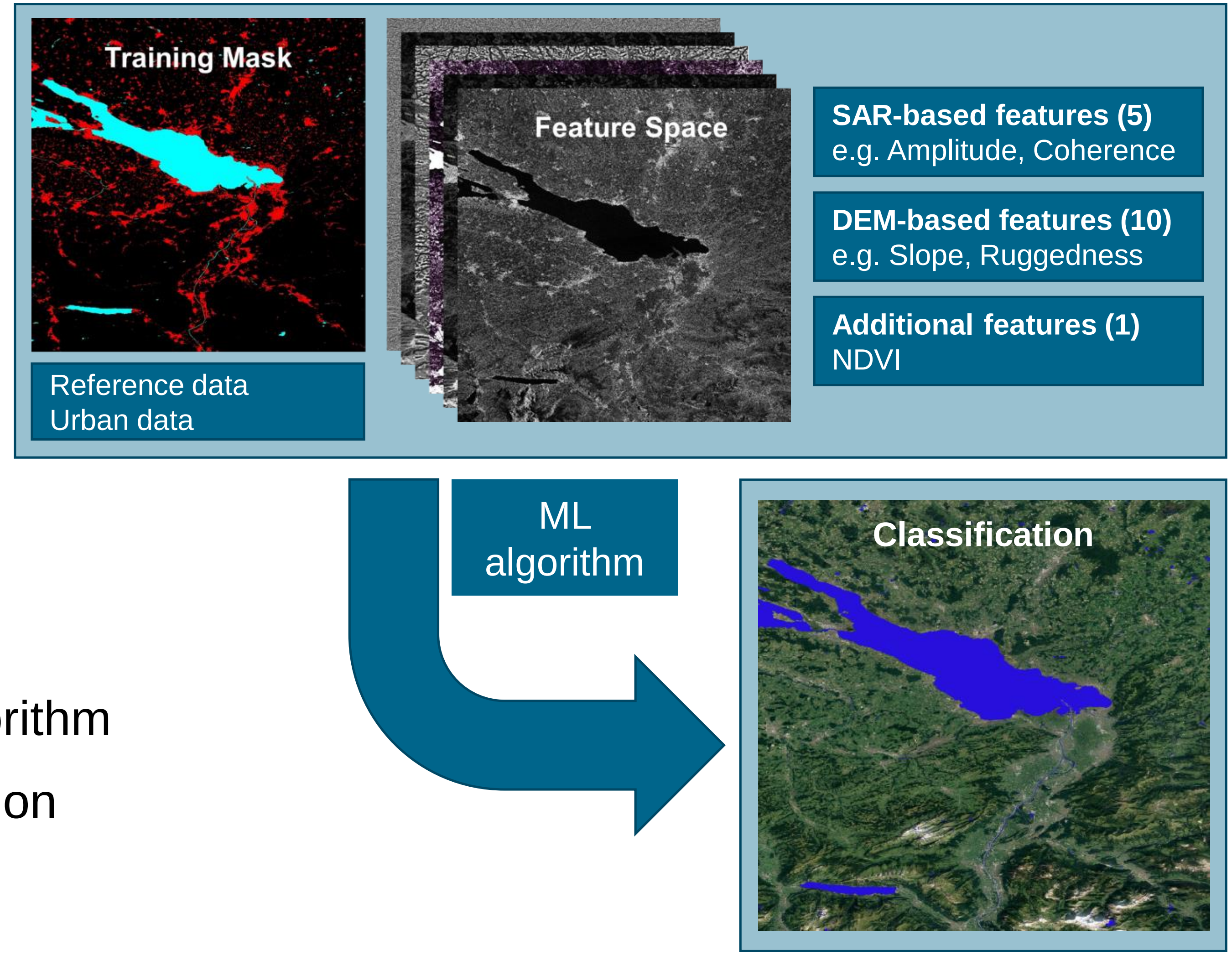
Water Body Mask

Support of hydrological usage

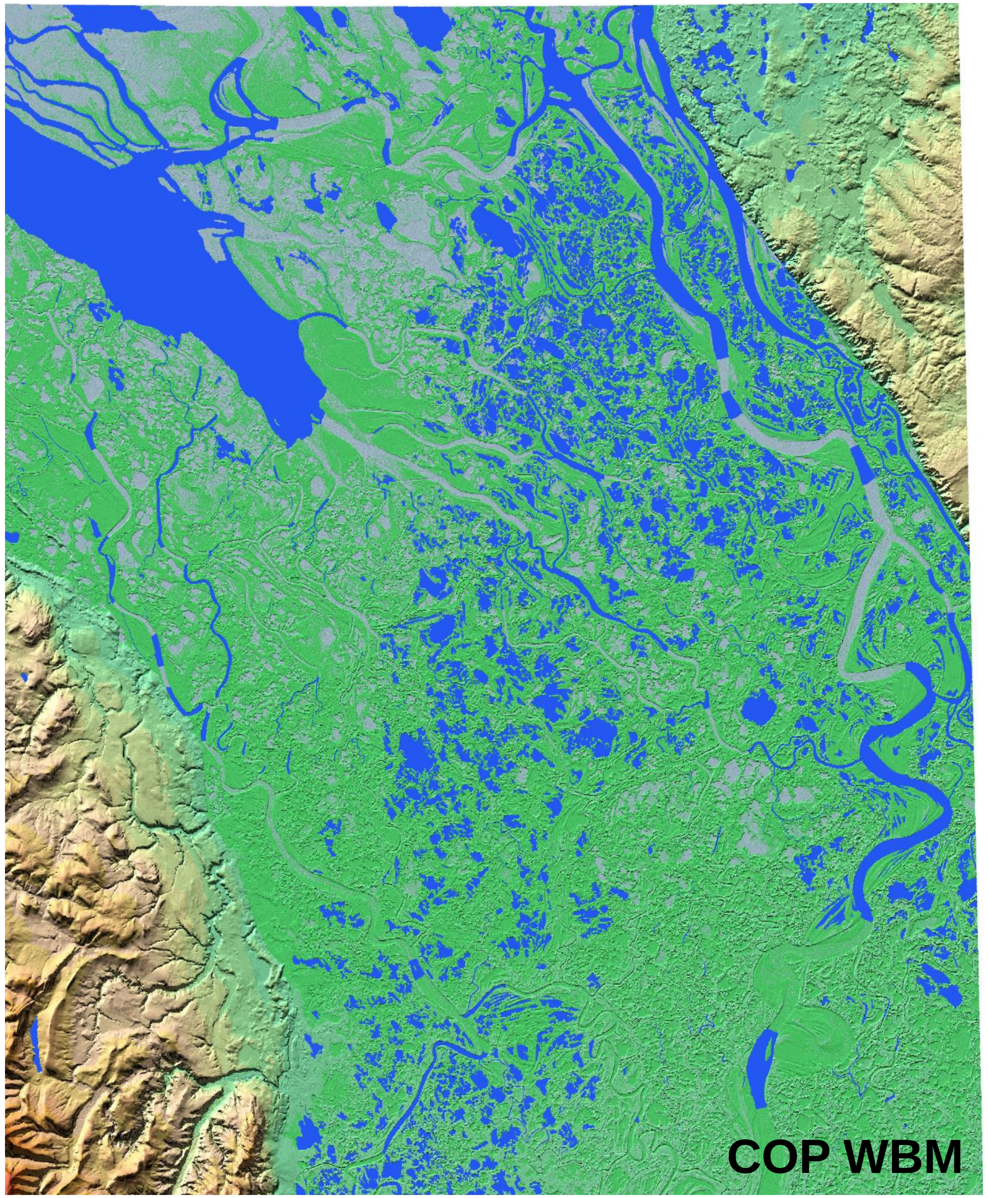
- Artefacts due to radar-related decorrelation effects
- Generation of consistent global water body mask (WBM)

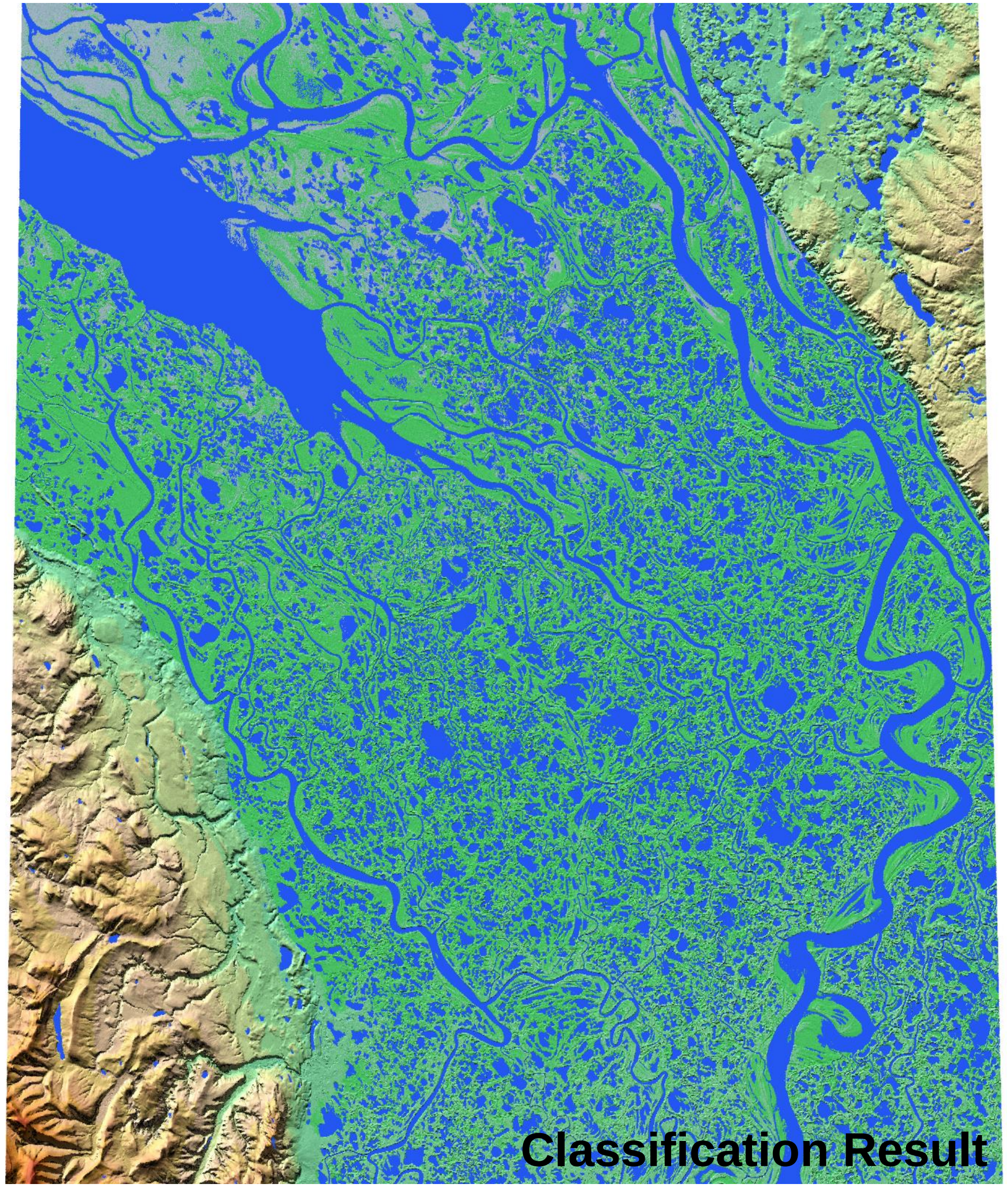
Machine Learning (ML) algorithm

- Automatic, time-efficient, robust
- Gradient Boosted Decision Tree algorithm
- Bayesian Hyperparameter Optimization



Mackenzie Delta: Water Body Classification

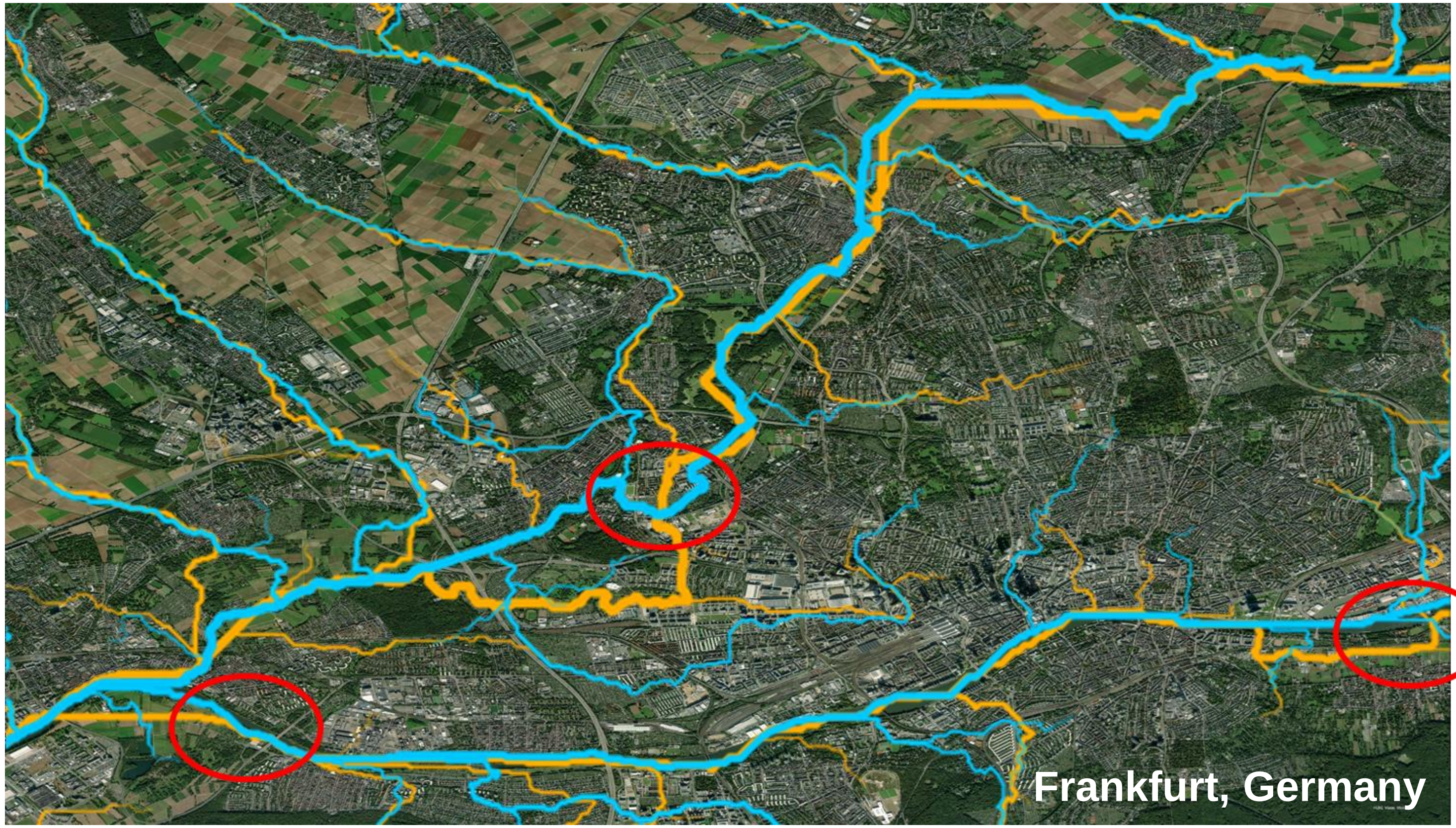




Urban Correction

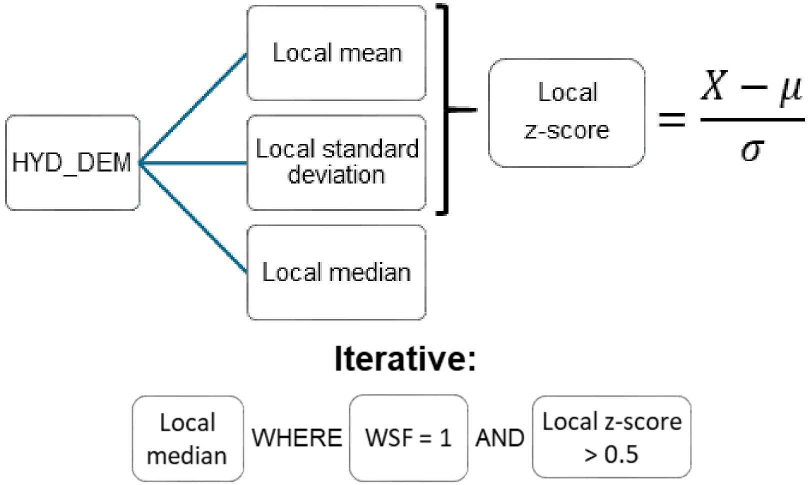
Procedure

- Creation of an urban-corrected DEM using World Settlement Footprint (WSF)



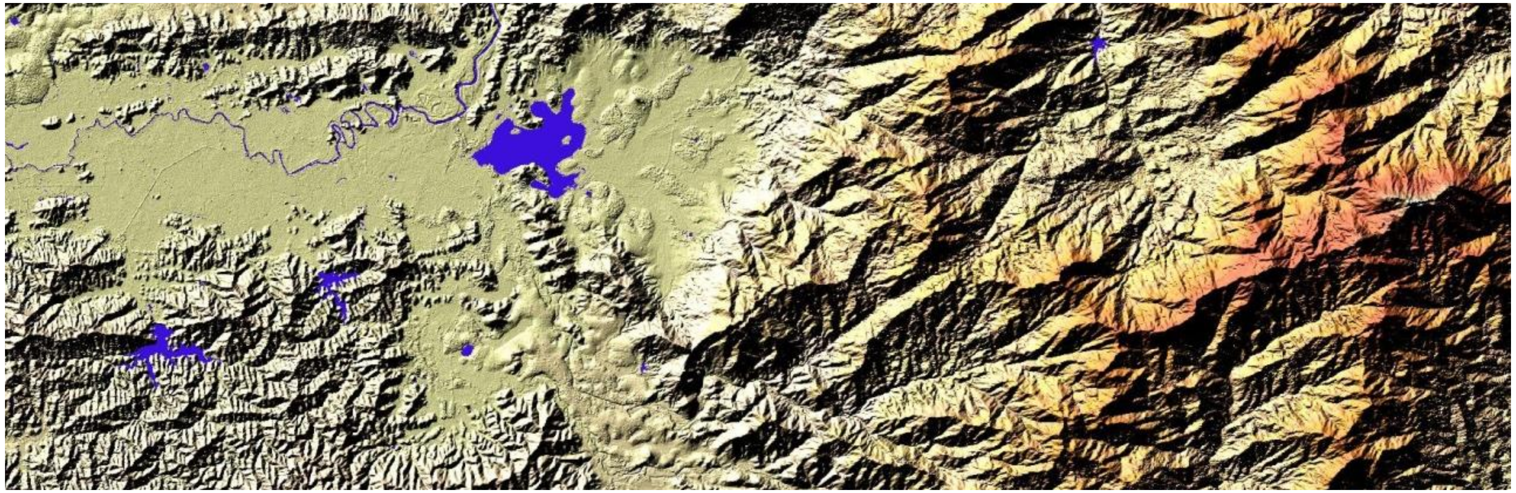
River network derived from uncorrected DEM

River network derived from DEM with urban correction

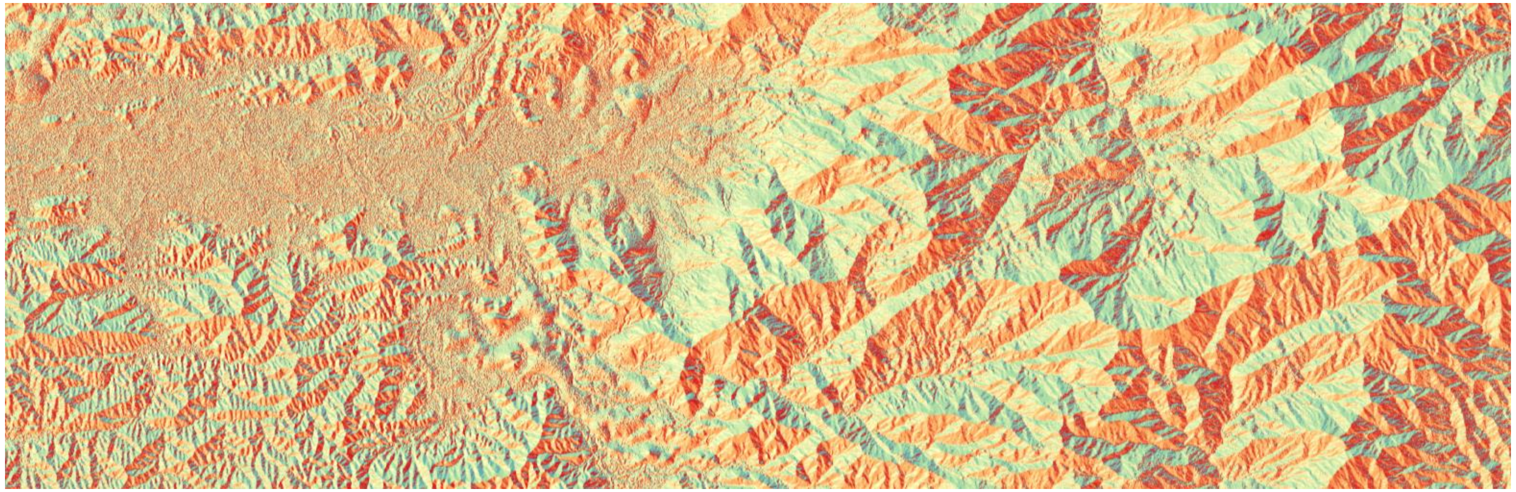


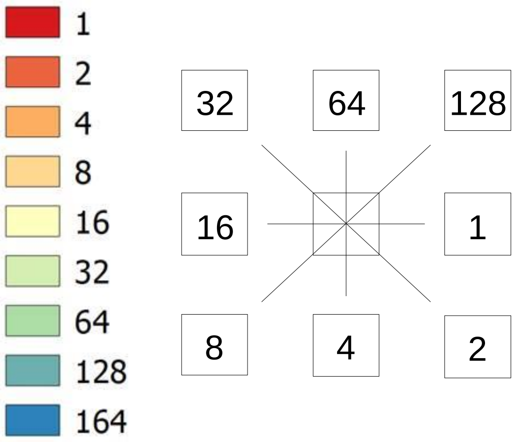
Flow direction map

Hydrologically conditioned TanDEM-X DEM

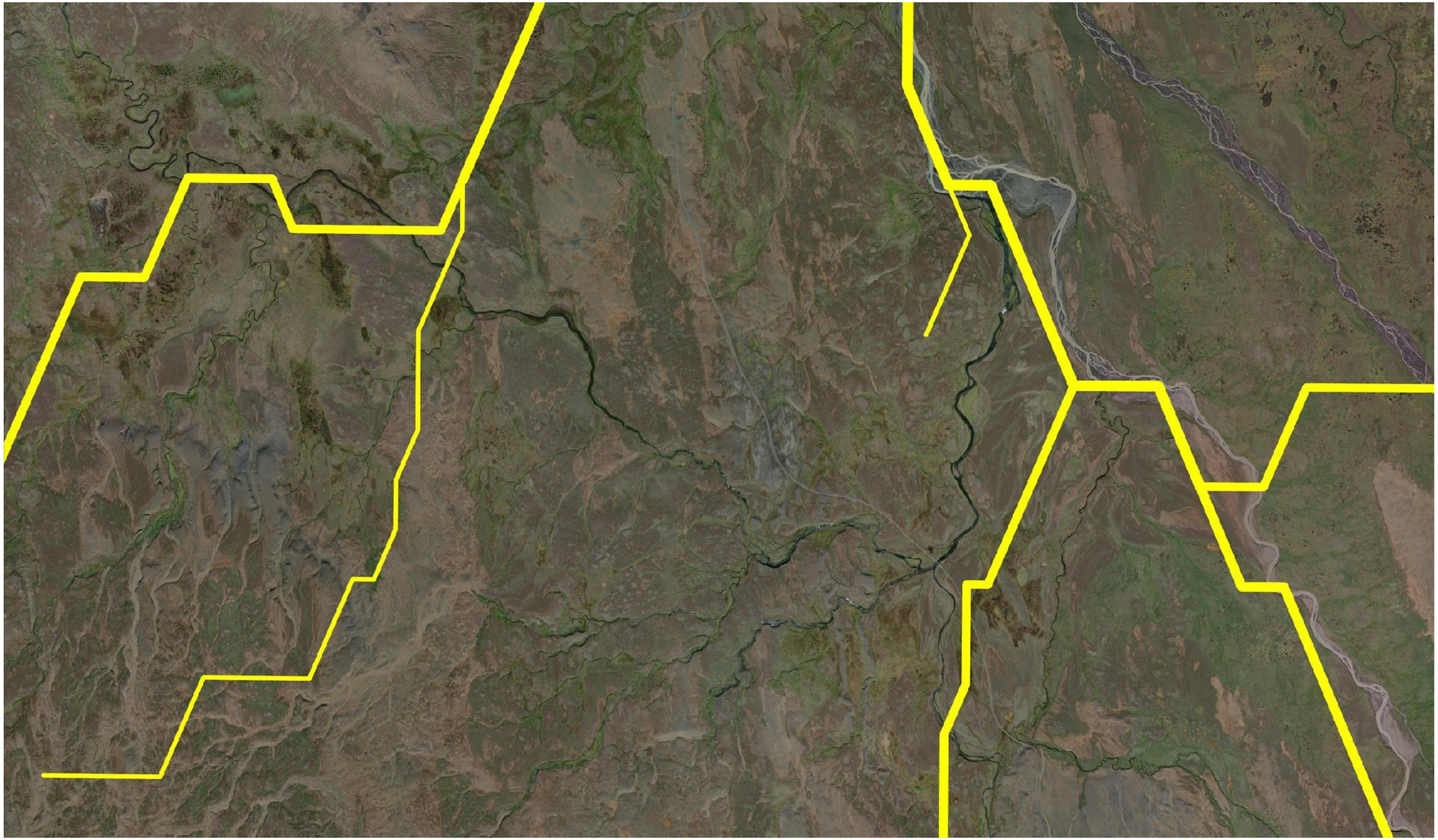


Flow direction grid



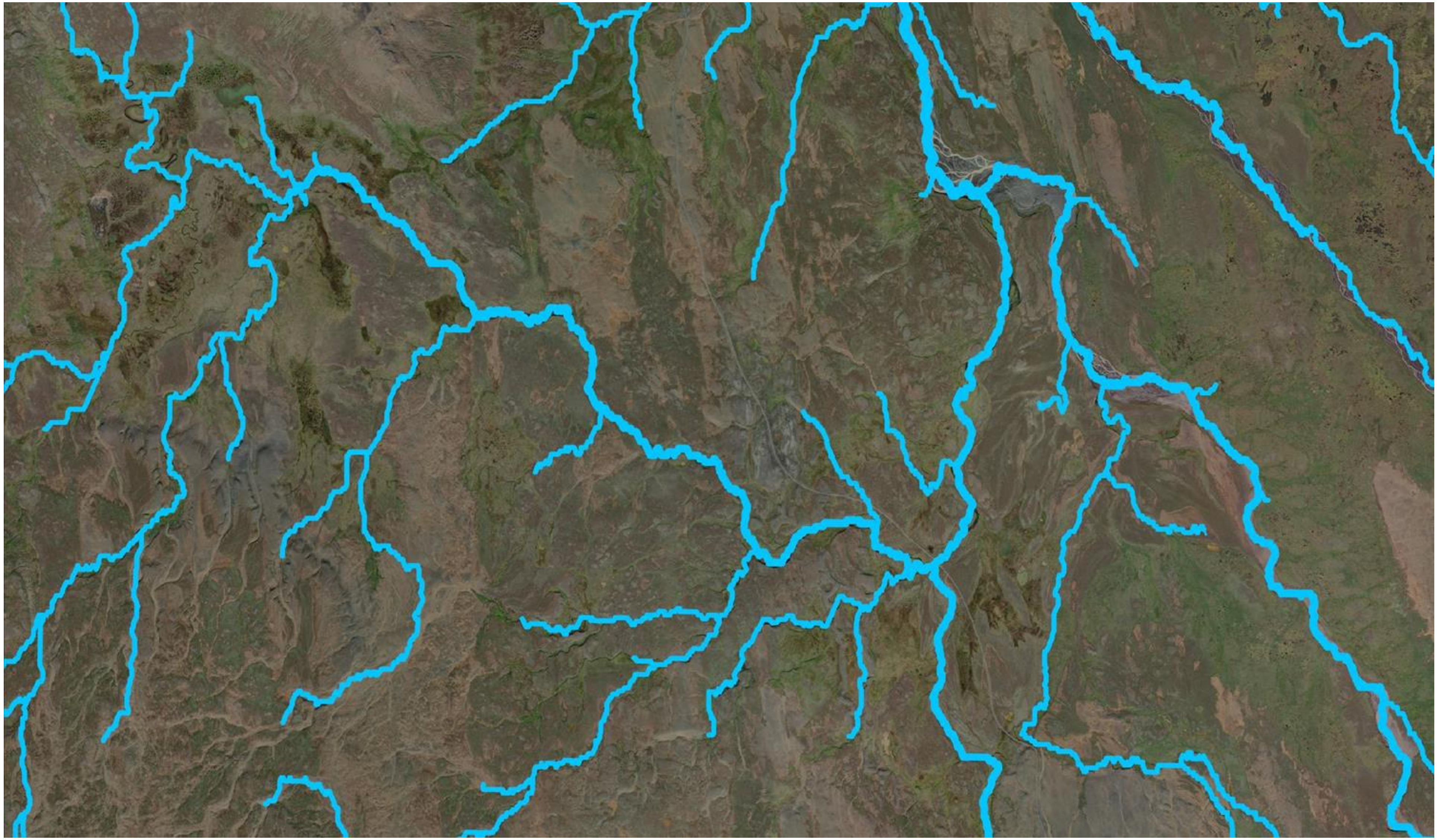


HydroSHEDS 1 river network



HYDRO1k DEM (1km) in Iceland

HydroSHEDS 2 preconditioned river network



Preconditioned TanDEM-X DEM (30m) in Iceland

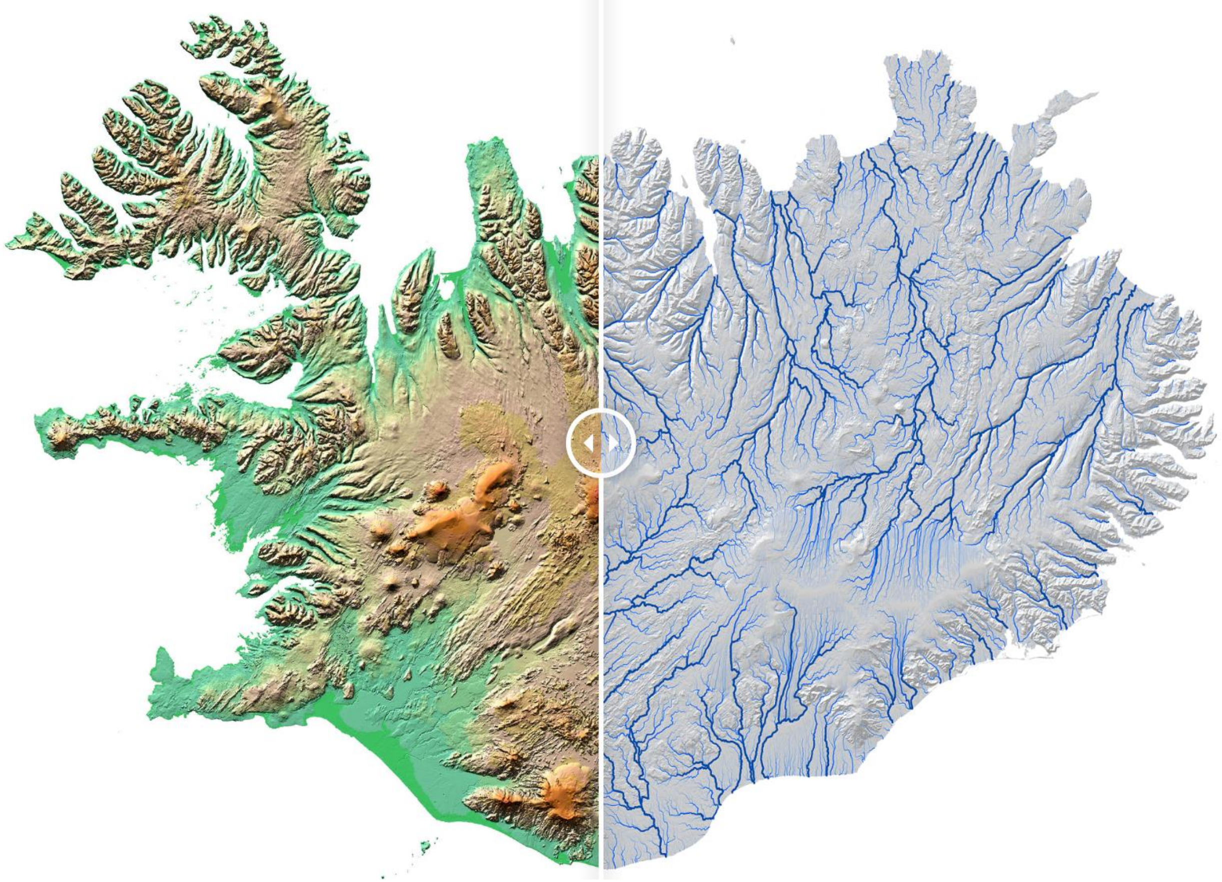
Summary

Current work

- Global processing of 1 arc second data
- HydroSHEDS v2 drainage directions will be used to update products

Outlook

- HydroSHEDS v2 combines
  - very high quality pre-conditioned DEM,
  - customized conditioning procedures,
  - unique drainage algorithms, and
  - iterative manual quality control



Preconditioned TanDEM-X DEM | HydroSHEDS v2 preliminary river network for Iceland

THANK YOU!

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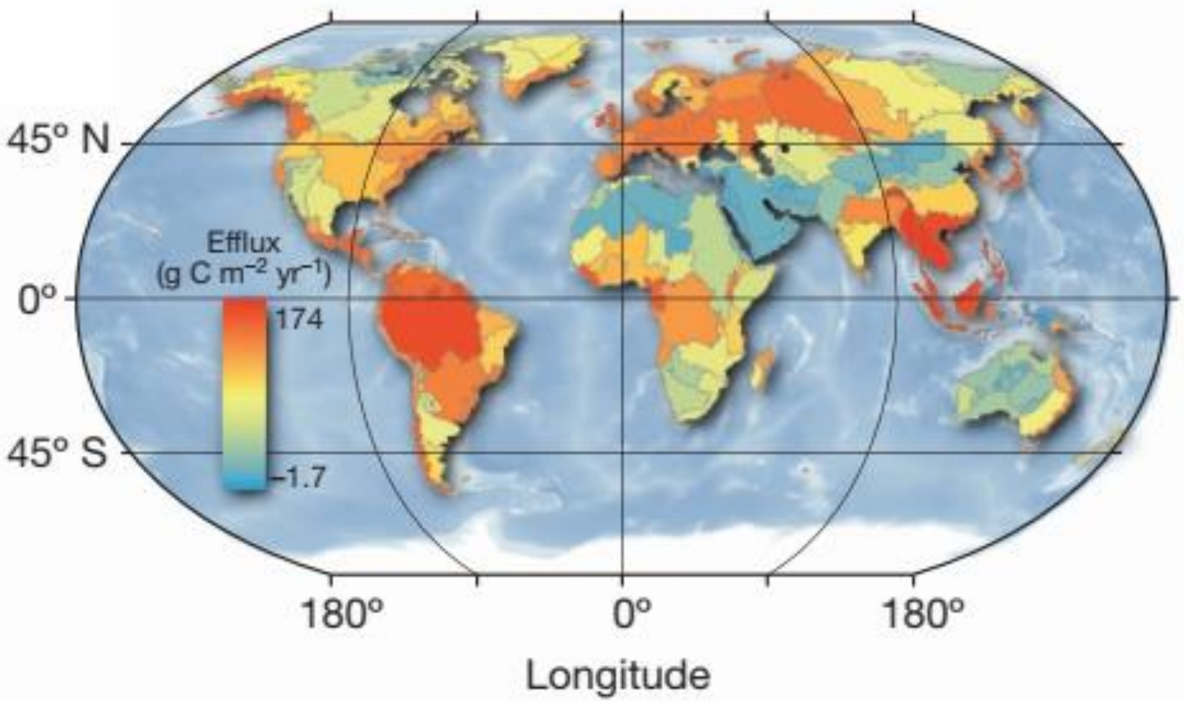
HydroATLAS applications

Carbon dioxide emission from inland waters

Source: Raymond, P. et.al., 2013, Nature

Evasion rate for rivers and streams

1.8 Pg Carbon/year



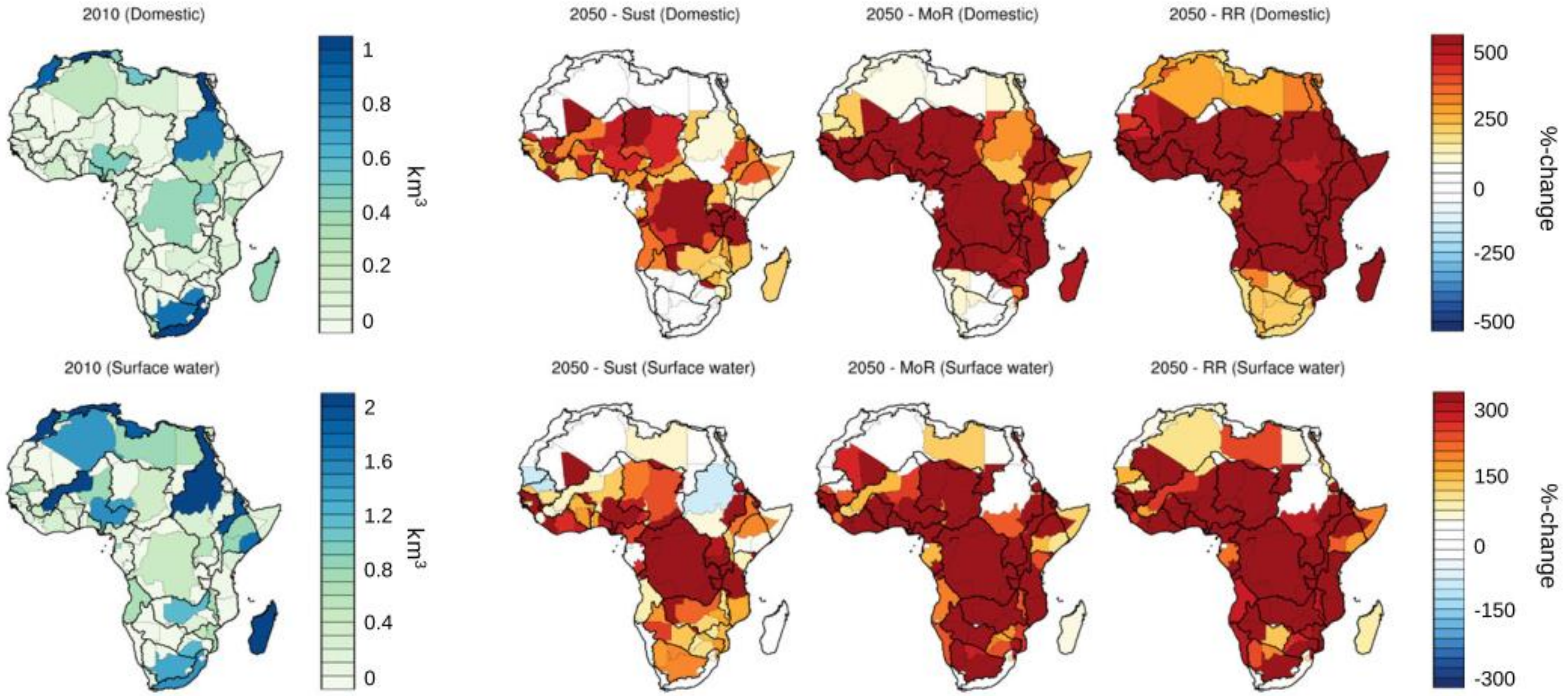
HydroATLAS applications

Hydroeconomic modelling in the context of Water-Energy-Land Nexus

Source: Kahil, T. et.al., 2018, AGU Research Article

Water withdrawal by sector for domestic use

Water withdrawal by source surface water

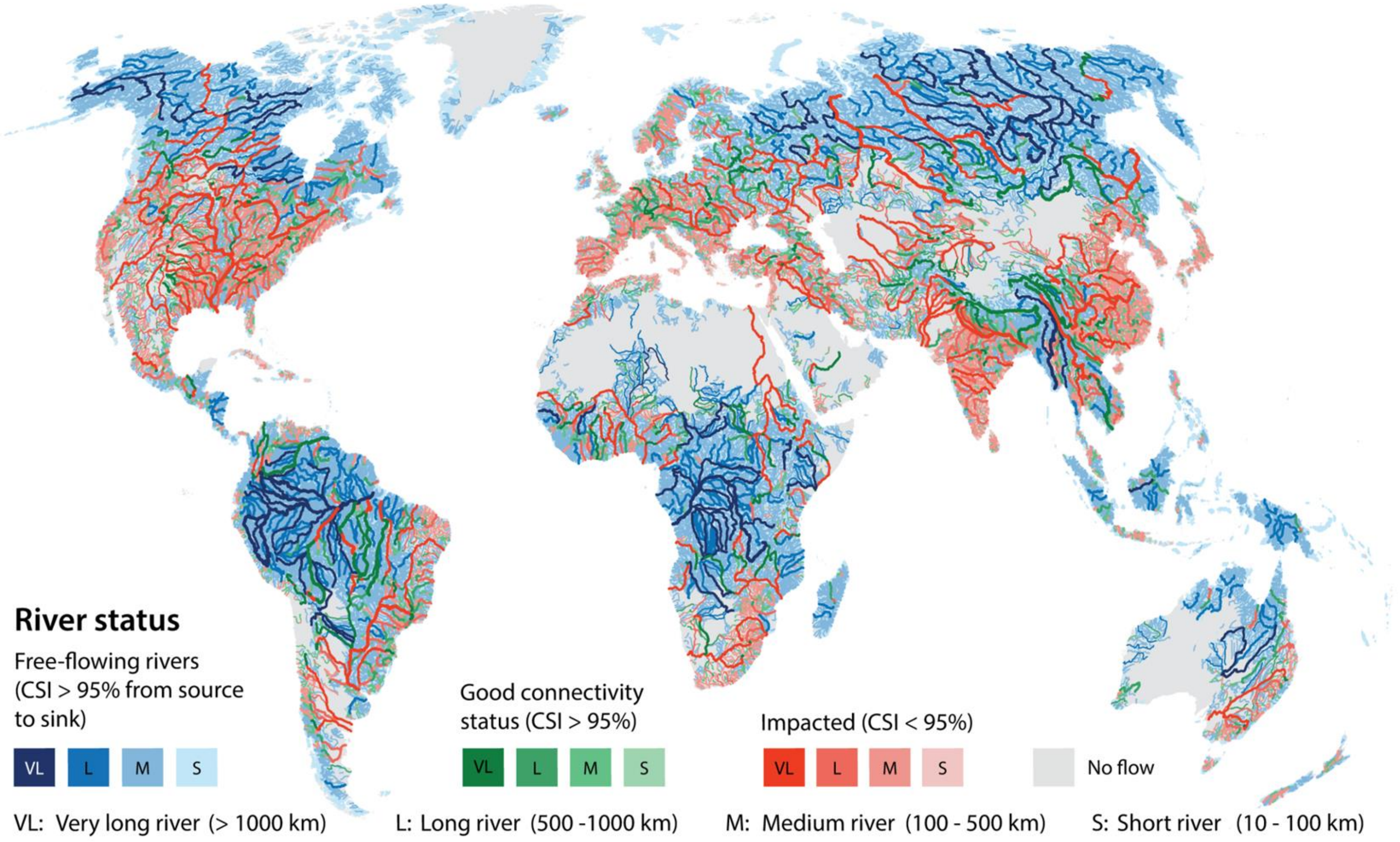


Free-flowing rivers

Grill, Lehner, et al. (2019, *Nature*)

Mapping free-flowing rivers by assessing fluvial connectivity

- ecosystem functions and services are largely unaffected by changes to the fluvial connectivity
- allowing unobstructed movement and exchange of water, energy, material and species
- aid in strategic conservation planning

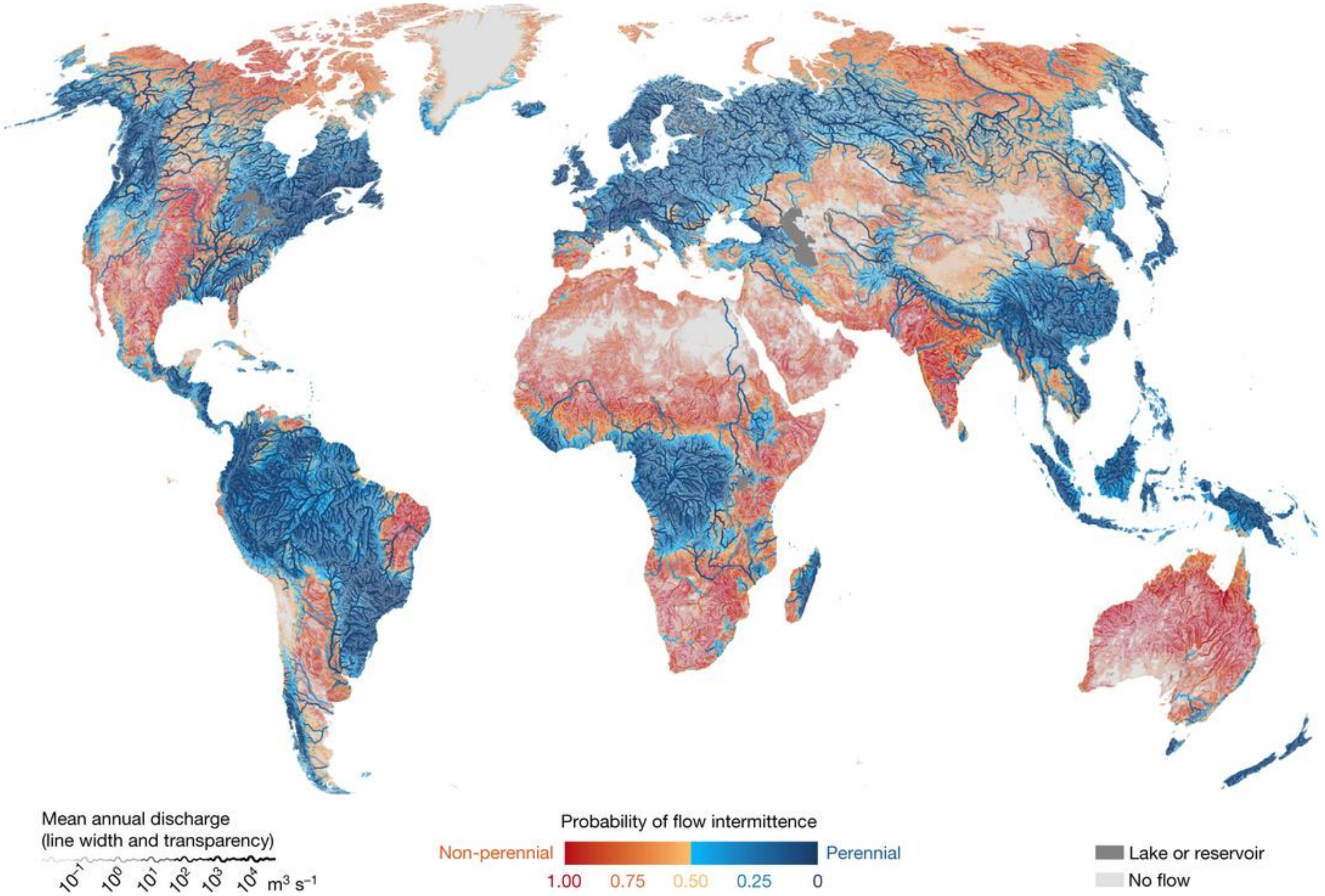


Intermittent rivers

Messager, Lehner, et al. (2021, *Nature*)

Global distribution of intermittent rivers and ephemeral streams

- affect water availability and water quality
- Contribution to the degradation of the main source of water
- not recognized in most river management policies
- need for more-detailed maps of perennial and non-perennial flows at regional and local scales



Hydropower scenarios

System-scale planning of sustainable hydropower development

- assess configuration scenarios for future hydropower development
- ‘system-scale planning’ (SSP) approach provides a large-scale perspective
- regional and downstream effects
- decision support tool