Integrative Highlands to Oceans (H2O) Action:

Multi-level Governance & Policy Solutions for a UN Convention on Conserving River Deltas (UN CCRD)

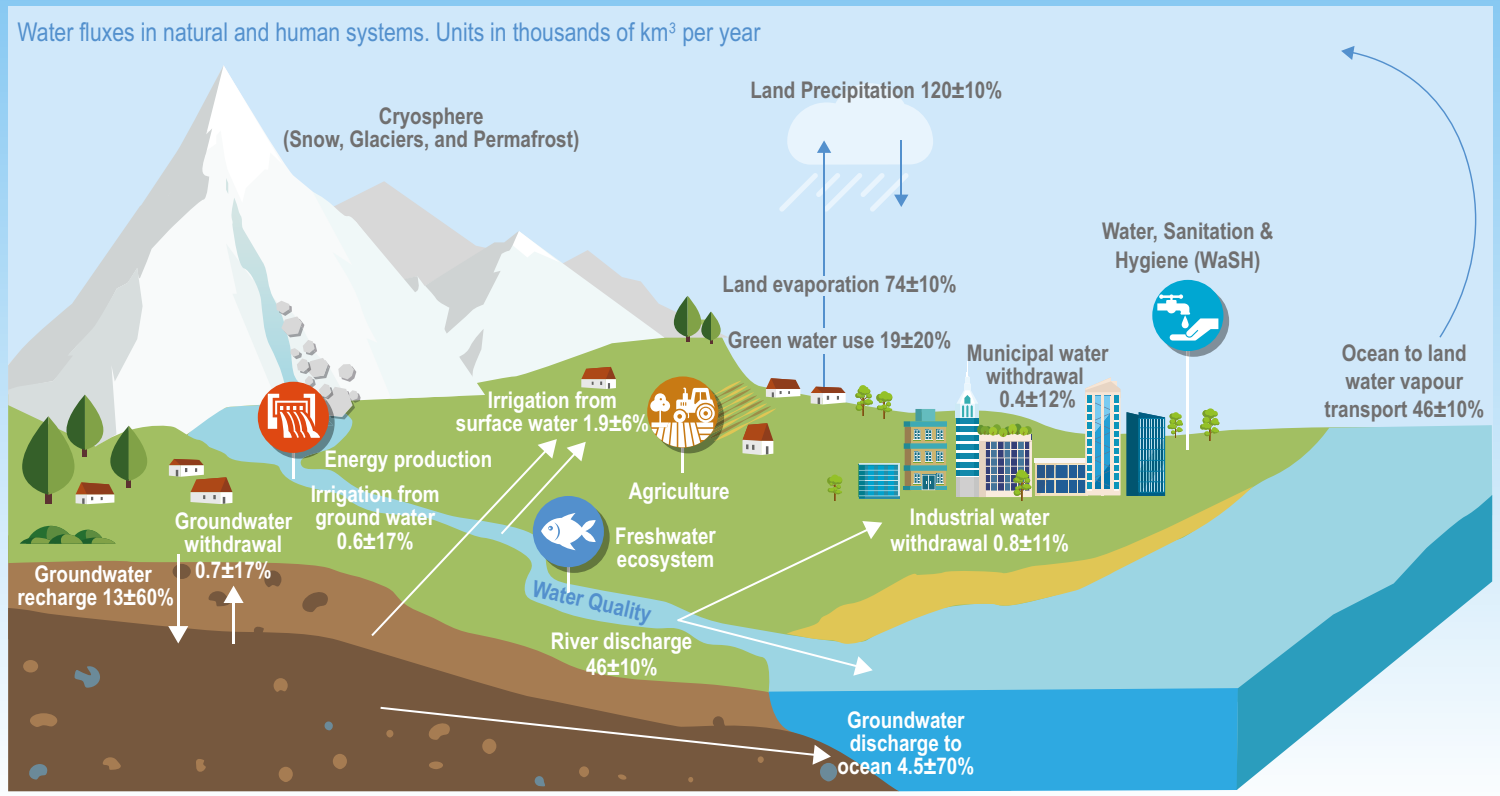
Asim Zia

Professor of Public Policy and Computer Science

Director, Institute for Environmental Diplomacy and Security

University of Vermont

The water cycle, including direct human interventions

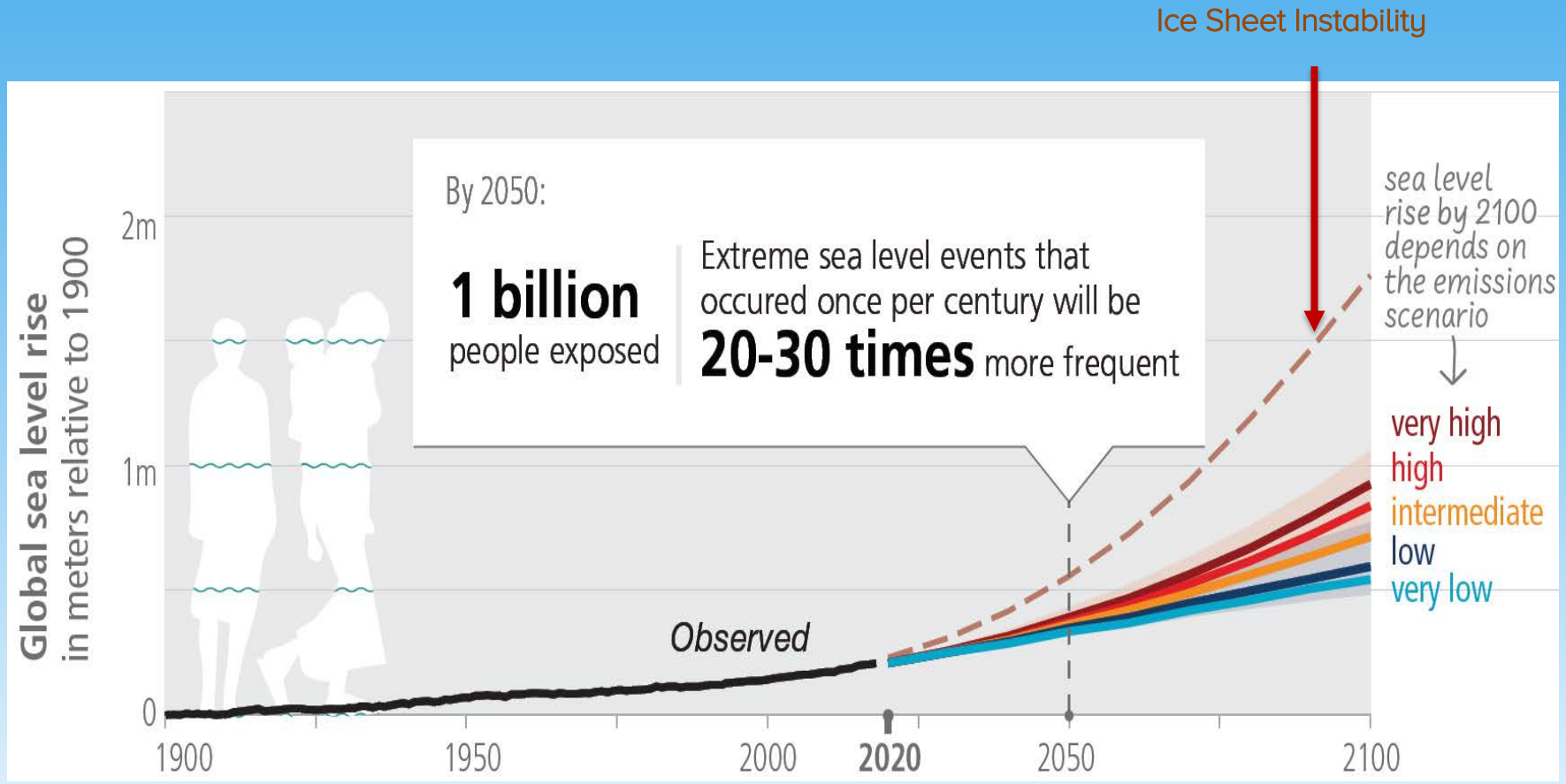


TWIN
Transboundary Water
In-Cooperation Network

IEDS

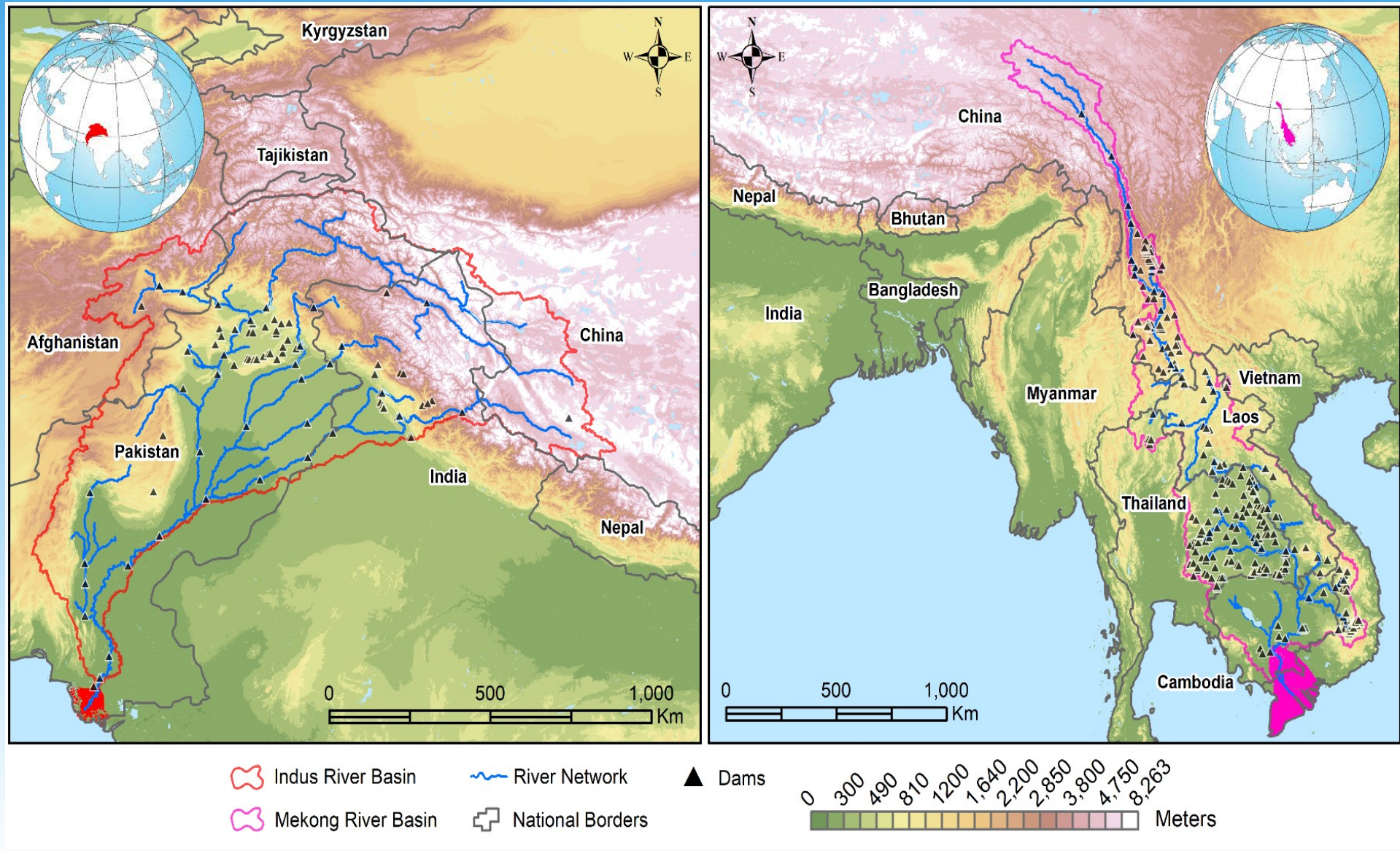
The University of Vermont

Accelerating Global Sea Level Rise will Inundate Deltas with Flooding and Saltwater Intrusion

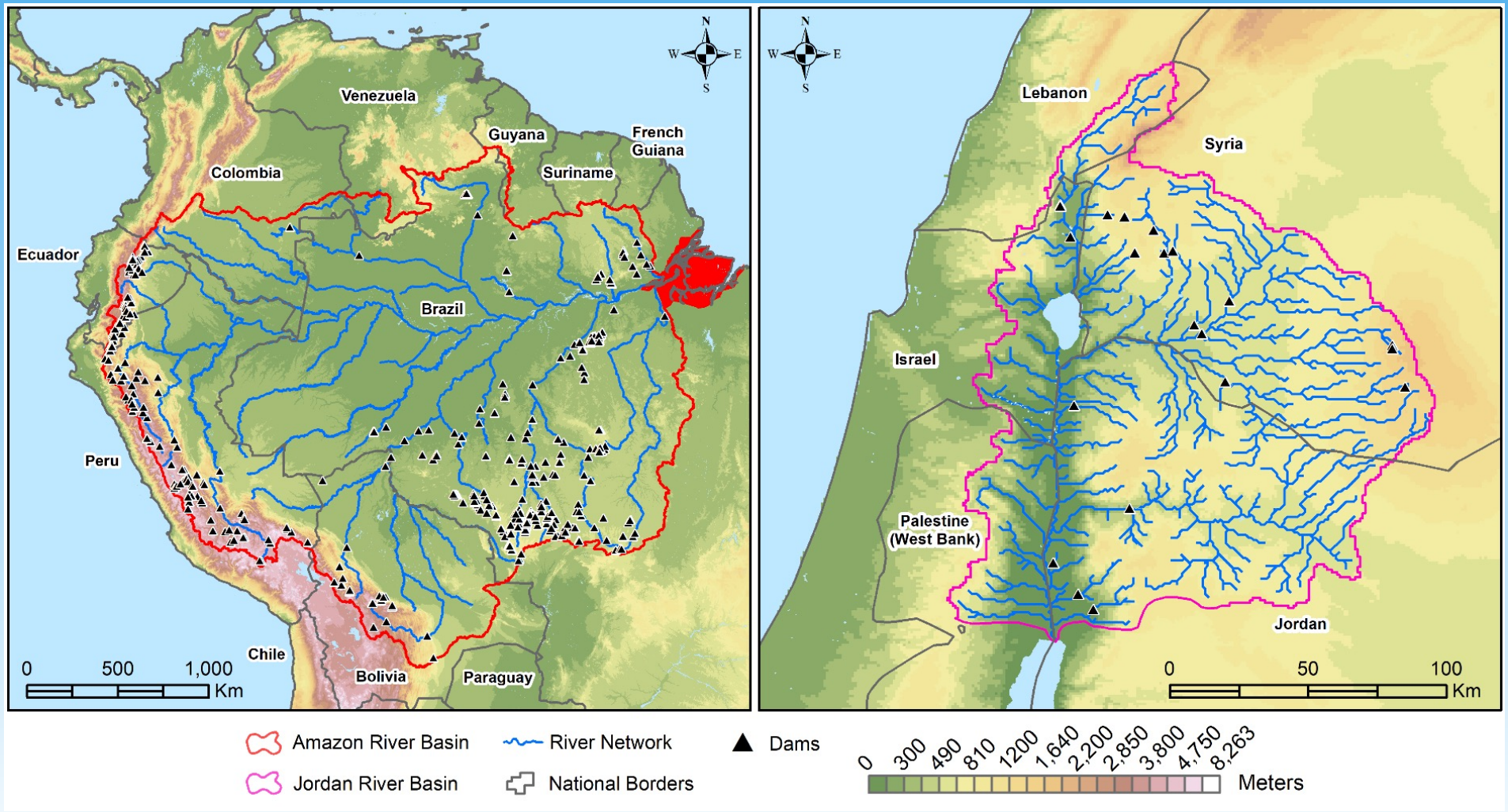


The Intergovernmental Panel on Climate Change (IPCC)'s Sixth Assessment Report, 2023.
https://report.ipcc.ch/ar6syr/pdf/IPCC_AR6_SYR_LongerReport.pdf

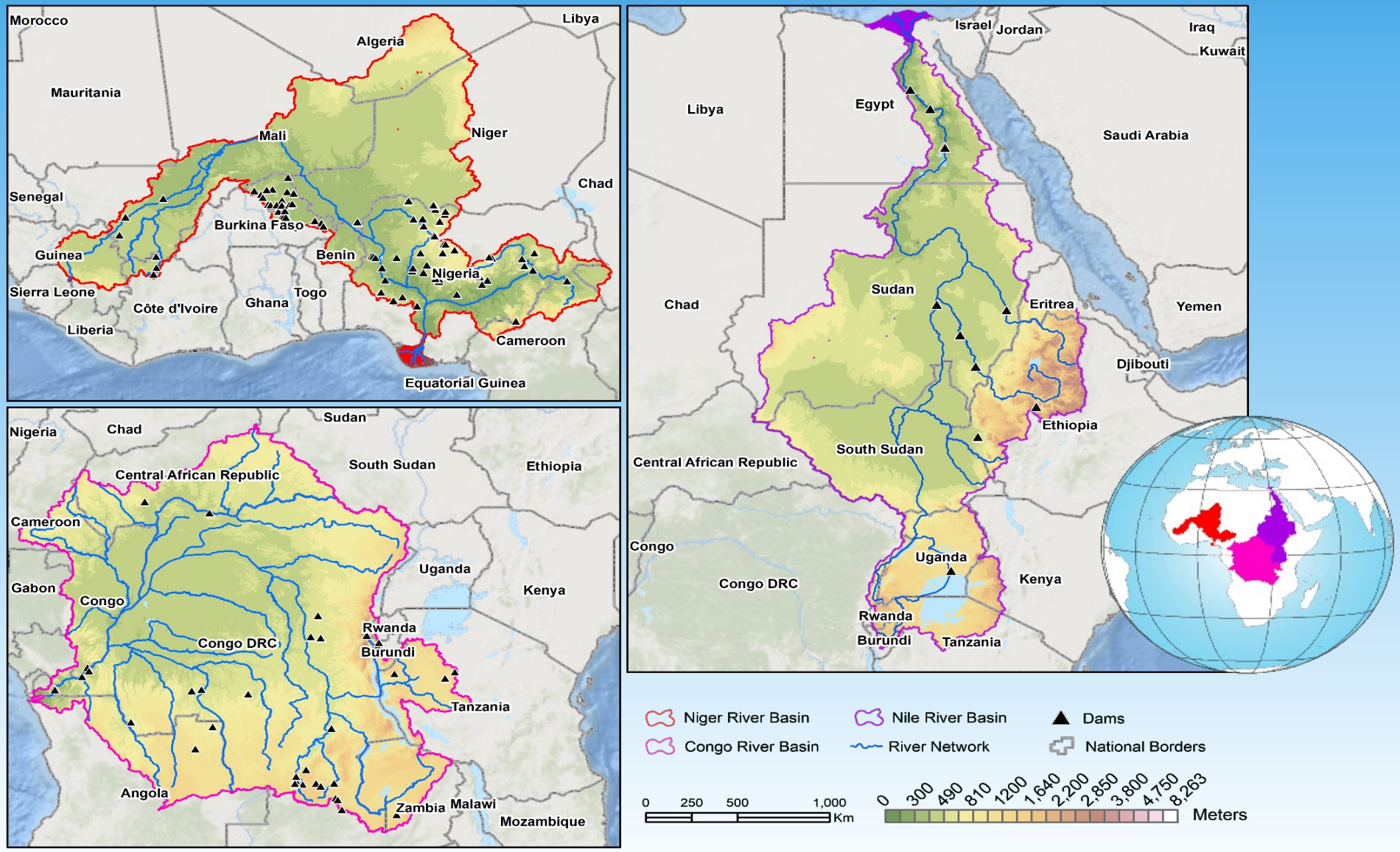
Transboundary Indus and Mekong river basins face glacial melt and rainfall variability in highlands and sea level rise and salt water intrusion in ocean-facing deltas across 9 riparian countries



Transboundary Amazon and Jordan river basins: Differences in ocean-facing vs. inland deltas



Transboundary Niger, Nile and Congo river basins are highly vulnerable to sea level rise induced migration of and from deltas



Synthesis of Social Ecological Challenges in Deltas

- **Local delta scale**
  - Saltwater intrusion, acidification and coastal erosion, agricultural and land degradation, wetland and mangrove degradation, arsenic and water pollution, coastal flooding, flash droughts, heatwaves, lack of access to clean water, poverty, loss of livelihoods, migration, loss of fisheries, dwindling critical infrastructures, land subsidence
- **Regional basin scale**
  - Increasing construction of hydropower dams and irrigation diversions reduce water flow from upstream to downstream, diminishing river flows to deltas
  - Upstream sources of pollution include manufacturing, agriculture, housing & transportation sectors
- **Global planetary scale**
  - Sea Level Rise, Glacial Melting (slow onset events)
  - Increasing intensity and frequency of extreme events such as floods, droughts, heat waves (acute events)

Policy and Governance Solutions Embedded in Draft UN-CCRD

- **Multi-level, Inclusive and Anticipatory Governance Solutions**
  - Establish intergovernmental UN-CCRD secretariat for enabling direct access to indigenous, youth and vulnerable communities
  - Enable inter-delta sharing of knowledge and resources
  - Promote transboundary cooperation from Highlands to Oceans among all riparian partners of river basins for equitable allocation of water quantity and access to clean water
  - Preserve minimum environmental flows in rivers and implement global water quality standards

- **Local to Global Policy Solutions**
  - Mainstream community centric early warning early action systems encompassing integrative Highlands to Oceans action
  - Empower and fund community science
  - Pilot basic income support programs for vulnerable populations
  - Anticipate and plan for migration of vulnerable delta communities

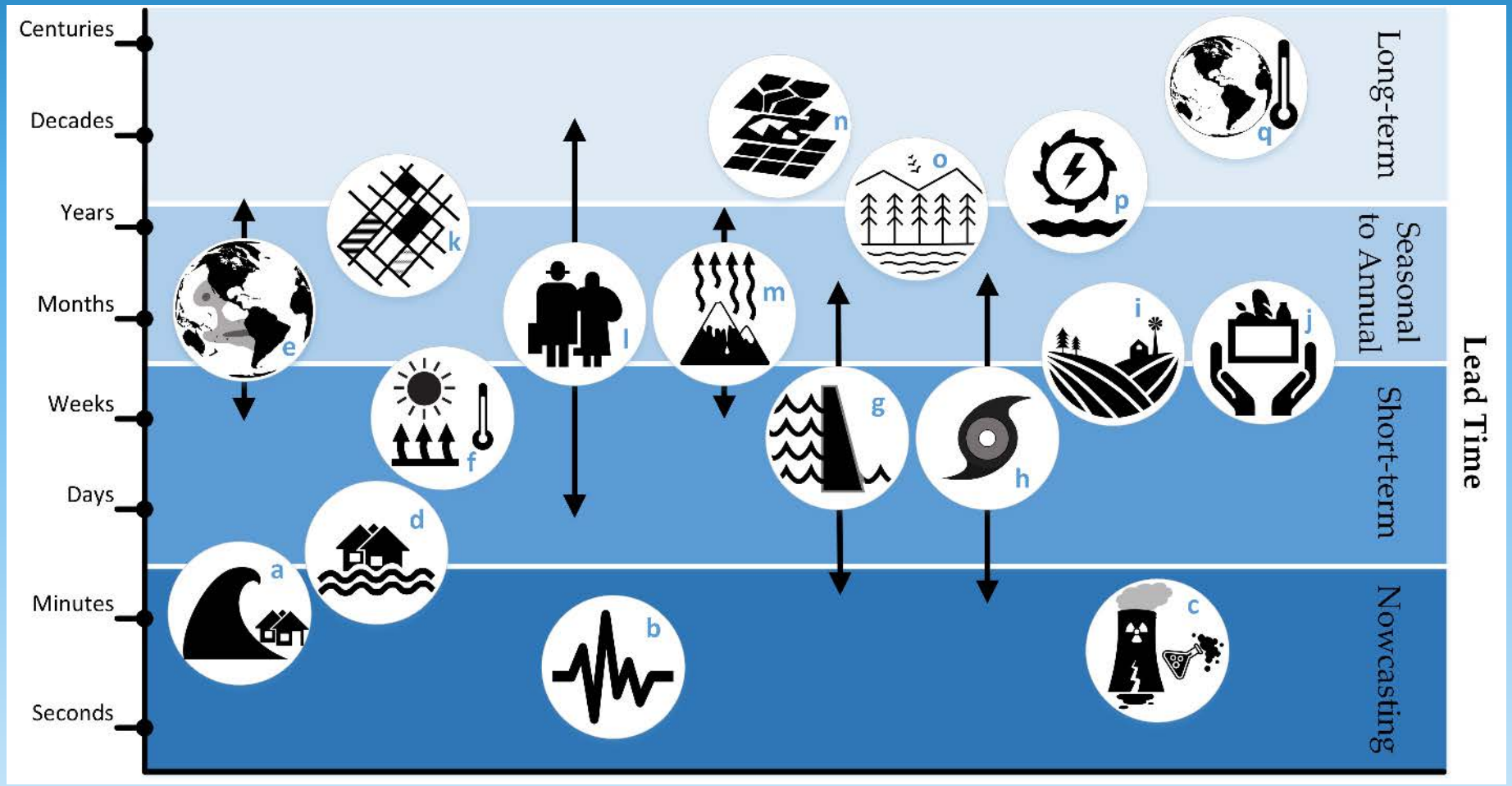


Figure 1: Illustration of Different Lead Times in Different Types of Early Warning Early Action Systems (Zia and Oikonomou 2024) where, (a) Tsunamis; (b) Earthquakes; (c) Chemical and Nuclear Accidents; (d) Floods; (e) ENSO; (f) Heat Waves and Human Health; (g) Reservoirs; (h) Weather; (i) Soils; (j) Crops, Prices, Reserves, Food Aid; (k) Urban, Industry, Infrastructure Design; (l) Conflict, Migration, People Exposed; (m) Snow Pack, (n) Land Use Planning; (o) Environmental Management & State; (p) Energy Security; (q) Climate Change.

Next generation multi-hazard early warning early action systems account for tipping points, and generate drought, flood, water quality & conflict forecasts at high resolutions

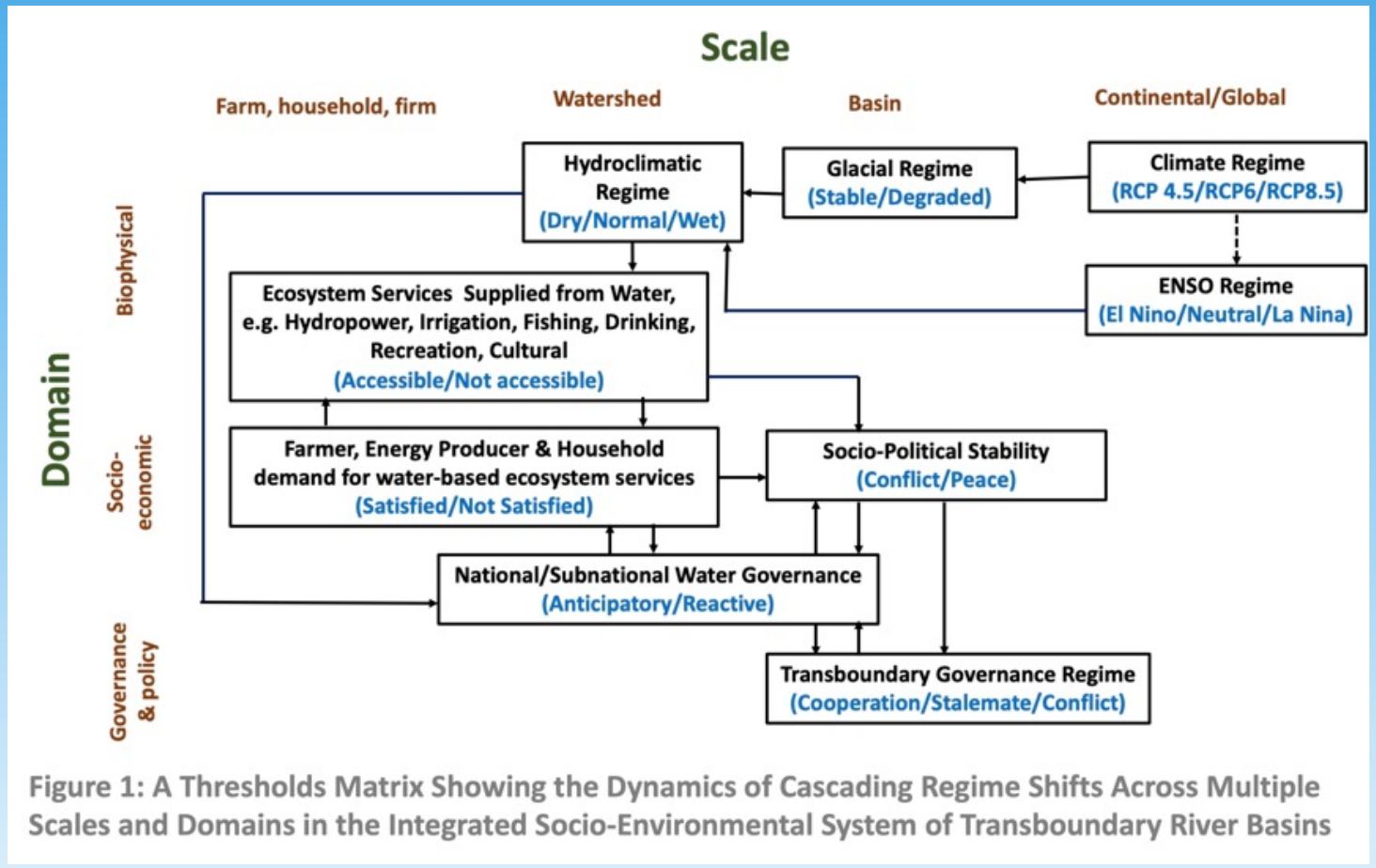


Figure 1: A Thresholds Matrix Showing the Dynamics of Cascading Regime Shifts Across Multiple Scales and Domains in the Integrated Socio-Environmental System of Transboundary River Basins

Environmental Research Letters

LETTER

Coupled impacts of climate and land use change across a river–lake continuum: insights from an integrated assessment model of Lake Champlain's Missisquoi Basin, 2000–2040

Asim Zia[1,2,3,4], Arne Bomblies[4,5,6], Andrew W Schroth[7], Christopher Koliba[1,4], Peter D F Isles[8], Yushiou Tsai[2], Ibrahim N Mohammed[4], Gabriela Bucini[4], Patrick J Clemins[2,4], Scott Turnbull[4], Morgan Rodgers[4], Ahmed Hamed[4], Brian Beckage[9], Jonathan Winter[10], Carol Adair[9], Gillian L Galford[4,8], Donna Rizzo[1,2] and Judith Van Houten[4,10]

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Modeling the sensitivity of cyanobacteria blooms to plausible changes in precipitation and air temperature variability

Jory S. Hecht [a,*], Asim Zia [a,b,c], Patrick J. Clemins [a,c], Andrew W. Schroth [a,d], Jonathan M. Winter [a,e], Panagiotis D. Oikonomou [a], Donna M. Rizzo [a,c,f]

Earth's Future

Research Article | Open Access

Climate Change-Legacy Phosphorus Synergy Hinders Lake Response to Aggressive Water Policy Targets

Asim Zia, Andrew W. Schroth, Jory S. Hecht, Peter Isles, Patrick J. Clemins, Scott Turnbull, Patrick Bitterman, Yushio Tsai, Ibrahim N. Mohammed, Gabriela Bucini, Elizbeth M. B. Doran, Christopher Koliba, Arne Bomblies, Brian Beckage, Jonathan Winter, Elizabeth C. Adair, Donna M. Rizzo, William Gibson, George Pinder

First published: 27 April 2022 | https://doi.org/10.1029/2021EF002234

Deployment of novel AI and human collaborative technologies, such as AI augmented Hydroclimatic Regime-shift Early Warning Early Action Lead Systems (AI-Hydro REWEALS), builds climate resilience and advances cooperation in transboundary river basins

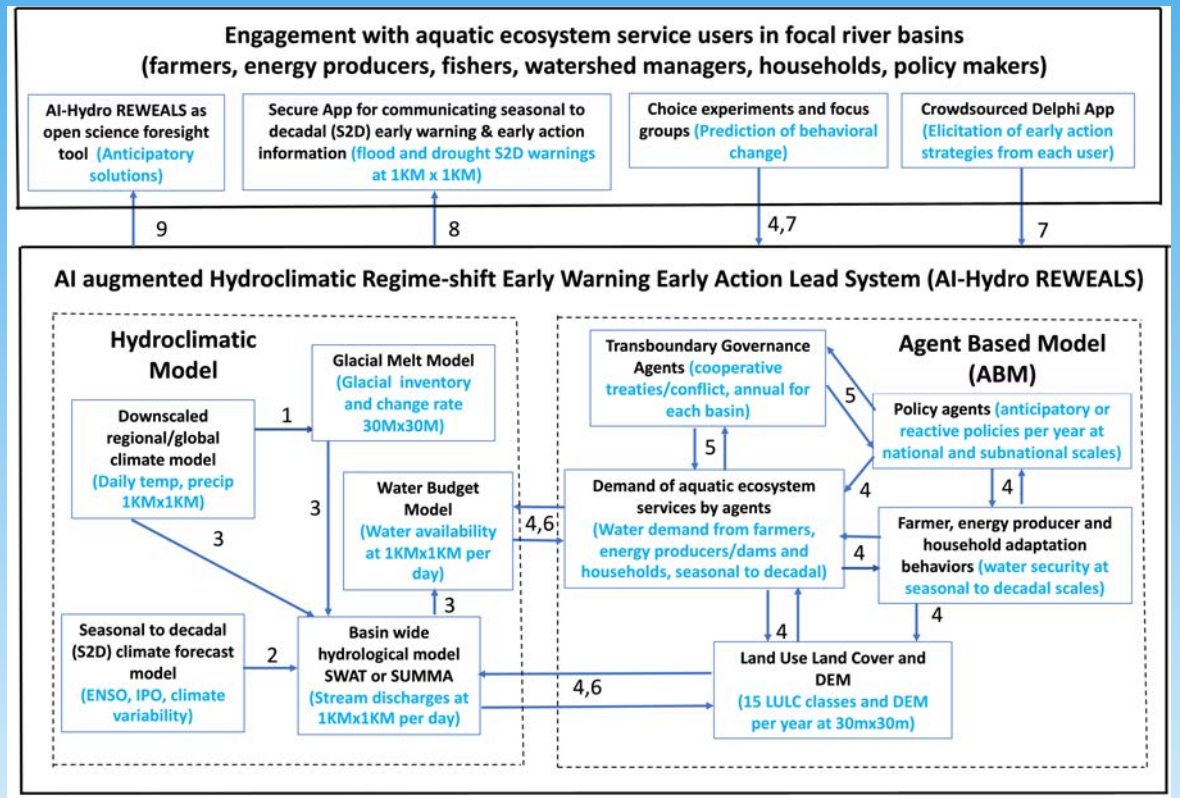
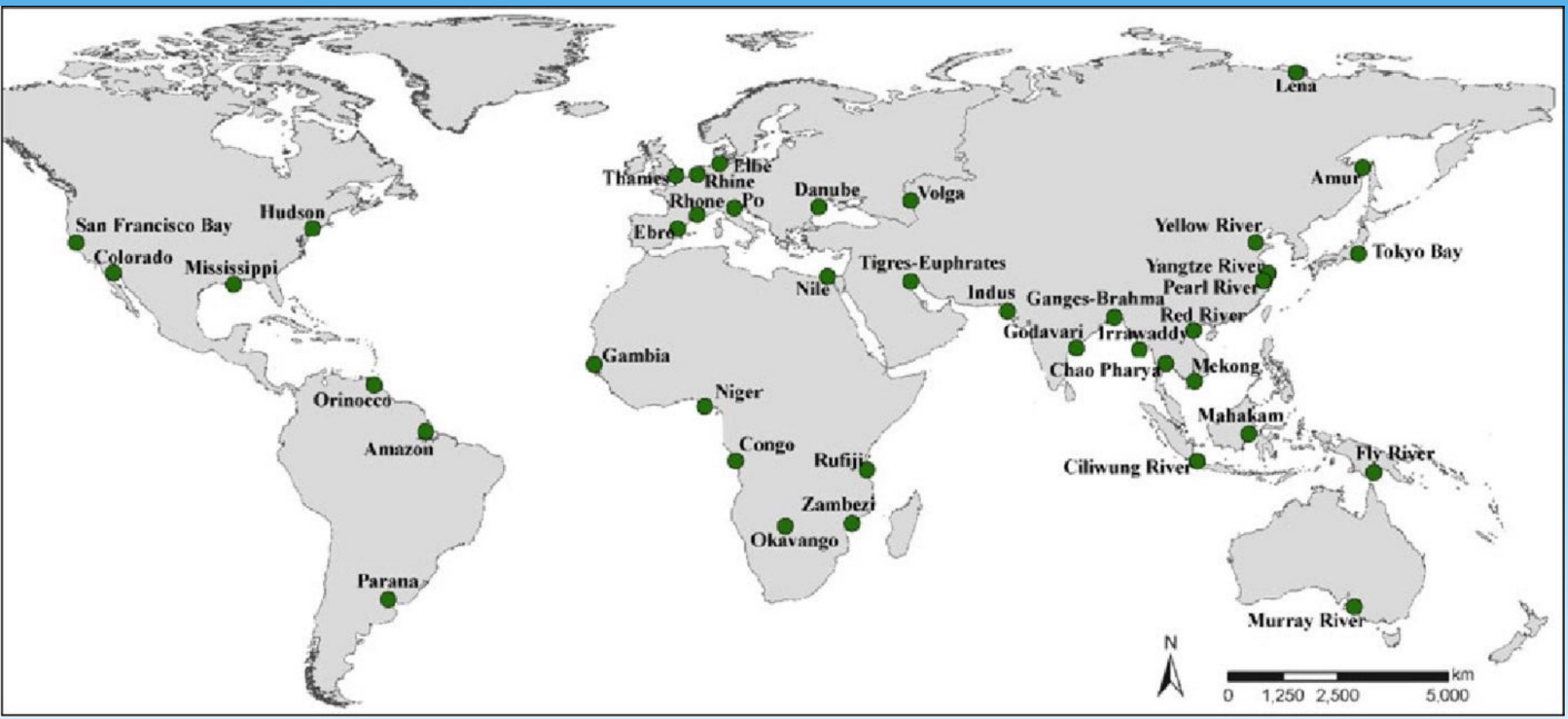


Figure 3: Computational structure of a novel AI augmented Hydroclimatic Regimeshift Early Warning Early Action Lead System (AI-Hydro REWEALS) and its co-production process with stakeholders. Arrow numbers [1,2,..9] indicate task numbers associated with simulating interactions within and among different modules of AI-Hydro REWEALS. Key dynamic variables passing from one module to another are shown in blue font. AI-Hydro REWEALS calibration and validation procedures are explained under task #6 in the project description.

Calibration, Validation, & Scenario Testing of AI-Hydro REWEALS Requires Science Cooperation and Data Sharing Among All Riparian Partners of a River Basin!

Globally distributed deltas require a UN-CCRD



Forty largest ocean facing deltas!