

Utilizing Satellite Based Observations and Physical Hydrological Modeling for Freshwater Ecosystem Health in the Lower Mekong River Basin

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INTRODUCTION

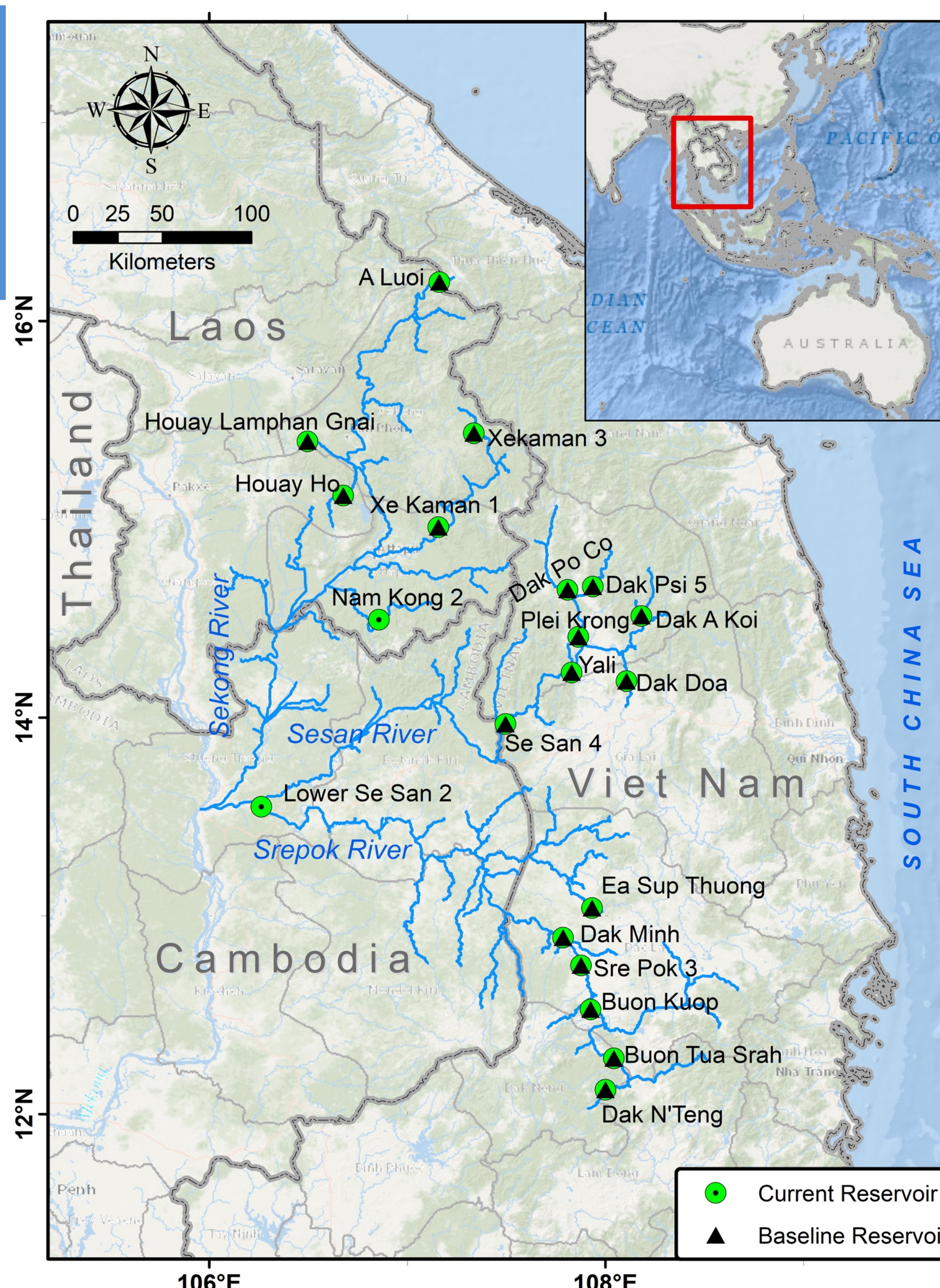
- Freshwater availability is necessary to promote economic growth through agriculture, fisheries, transport, environmental health, and social equity.
- The National Aeronautics and Space Administration (NASA) and the Conservation International (CI) are partnering to use remote sensing Earth observations to improve regional efforts that assess natural resources for conservation and sustainable management.
- Vollmer et al., (2018) have presented the social-ecological framework named the Freshwater Health Index (FHI), which takes account of the interplay between governance, stakeholders, freshwater ecosystems and the ecosystem services they provide.
- In this work, we develop decision support and making tools for natural resources conservation in the Lower Mekong by leveraging the FHI framework, multiple data products, and hydrological modeling capabilities (Mohammed et al., 2018).
- Mohammed et al., (2018) modeling capabilities enable the integration of satellite-based daily gridded precipitation, air temperature, digital elevation model, soil characteristics, and land cover and land use information to simulate water flux framework.

OBJECTIVE

The overarching goal of this work is to develop decision-making tools and practices based on satellite observations of Earth that can be applicable globally.

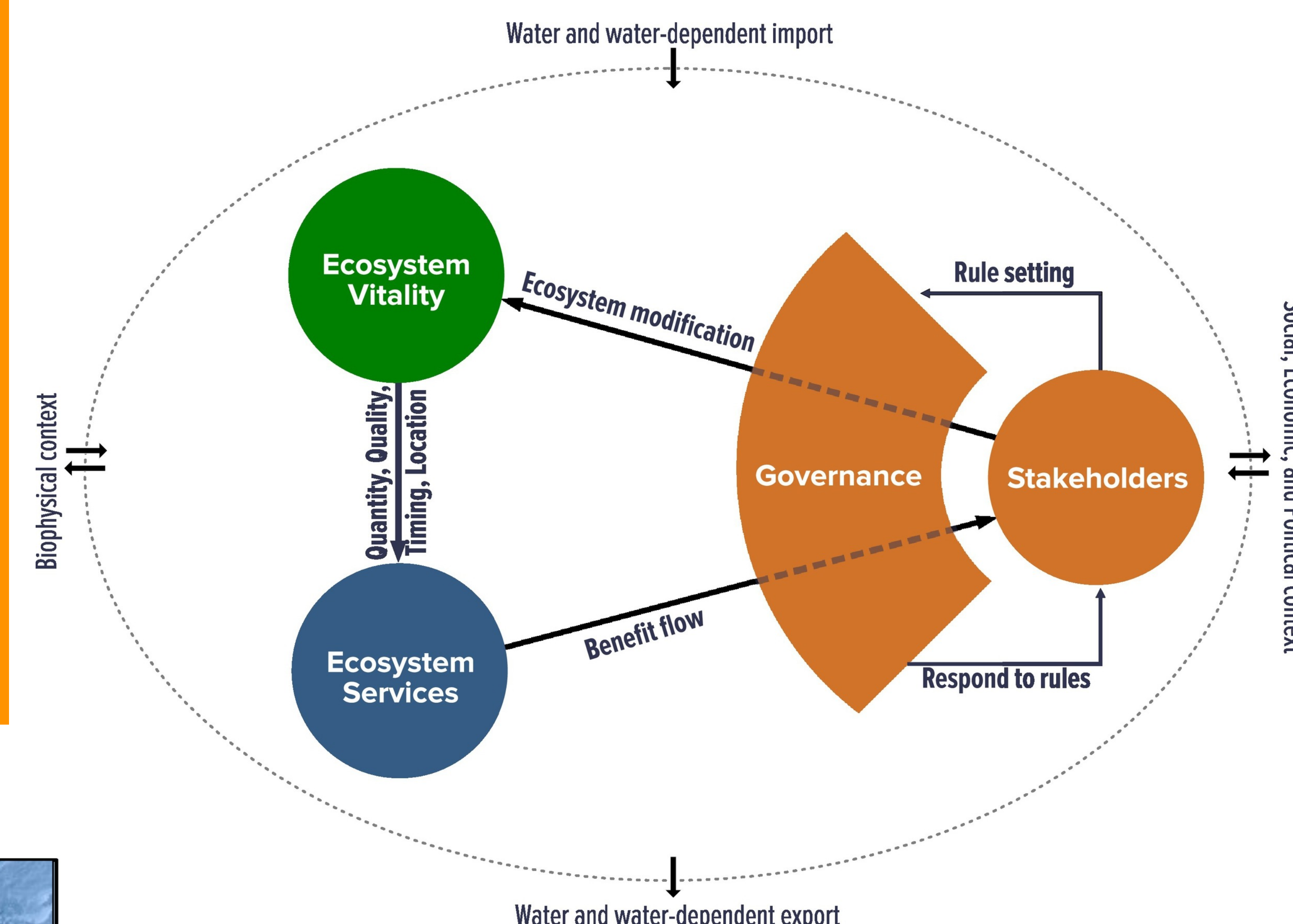
STUDY AREA

- Water resources planning efforts in the Lower Mekong River region (Laos, Vietnam, Cambodia, Thailand, and Myanmar) are complicated by uncertainty stemming from patterns of economic growth, changes in water use patterns, land use change, and climate change.
- While these processes directly increase demands, or decrease supply, research has demonstrated that there are complex processes and dynamic feedbacks among physical processes, biological, biochemical and human-mediated processes that determine change in the water system.



METHODS

The Fresh Health Index (FHI) is a conceptual framework for freshwater Social-Ecological Systems (SESs) comprised of Governance and Stakeholders, Ecosystem Vitality and Ecosystem Services.



ECOSYSTEM VITALITY

- Water Quantity**
 - Deviation from natural flow
 - Groundwater storage depletion
- Water Quality**
 - Suspended solids
 - Total nitrogen
 - Total phosphorus
 - Other quality parameters of concern
- Basin Condition**
 - Bank modification
 - Flow connectivity
 - Land cover naturalness
- Biodiversity**
 - Species of concern
 - Invasive & nuisance species

ECOSYSTEM SERVICES

- Provisioning**
 - Water supply reliability
 - Biomass for consumption
- Regulation & Support**
 - Sediment regulation
 - Water quality regulation
 - Flood regulation
 - Disease regulation
- Cultural**
 - Conservation areas
 - Recreation

GOVERNANCE & STAKEHOLDERS

- Enabling Environment**
 - Water resources management
 - Right to resource use
 - Incentives & regulations
 - Financial capacity
 - Technical capacity
- Stakeholder Engagement**
 - Information access
 - Engagement in decision-making processes
- Vision & Adaptive Governance**
 - Strategic planning & adaptive management
 - Monitoring & learning mechanisms
- Effectiveness**
 - Enforcement & compliance
 - Distribution of benefits
 - Water-related conflict

PRELIMINARY RESULTS

Ecosystem Vitality Indicator – Water quantity – Deviation from natural flow regime

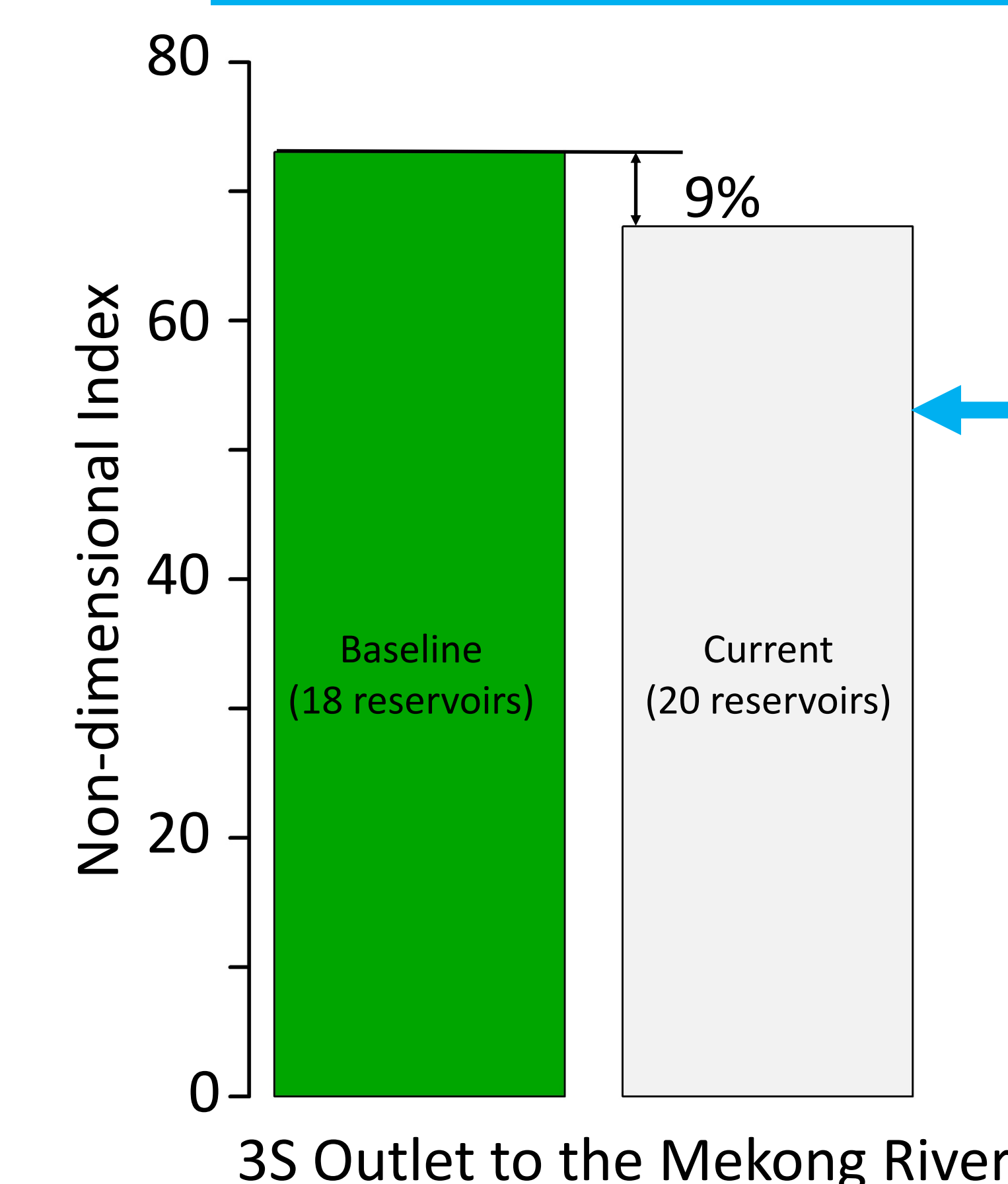
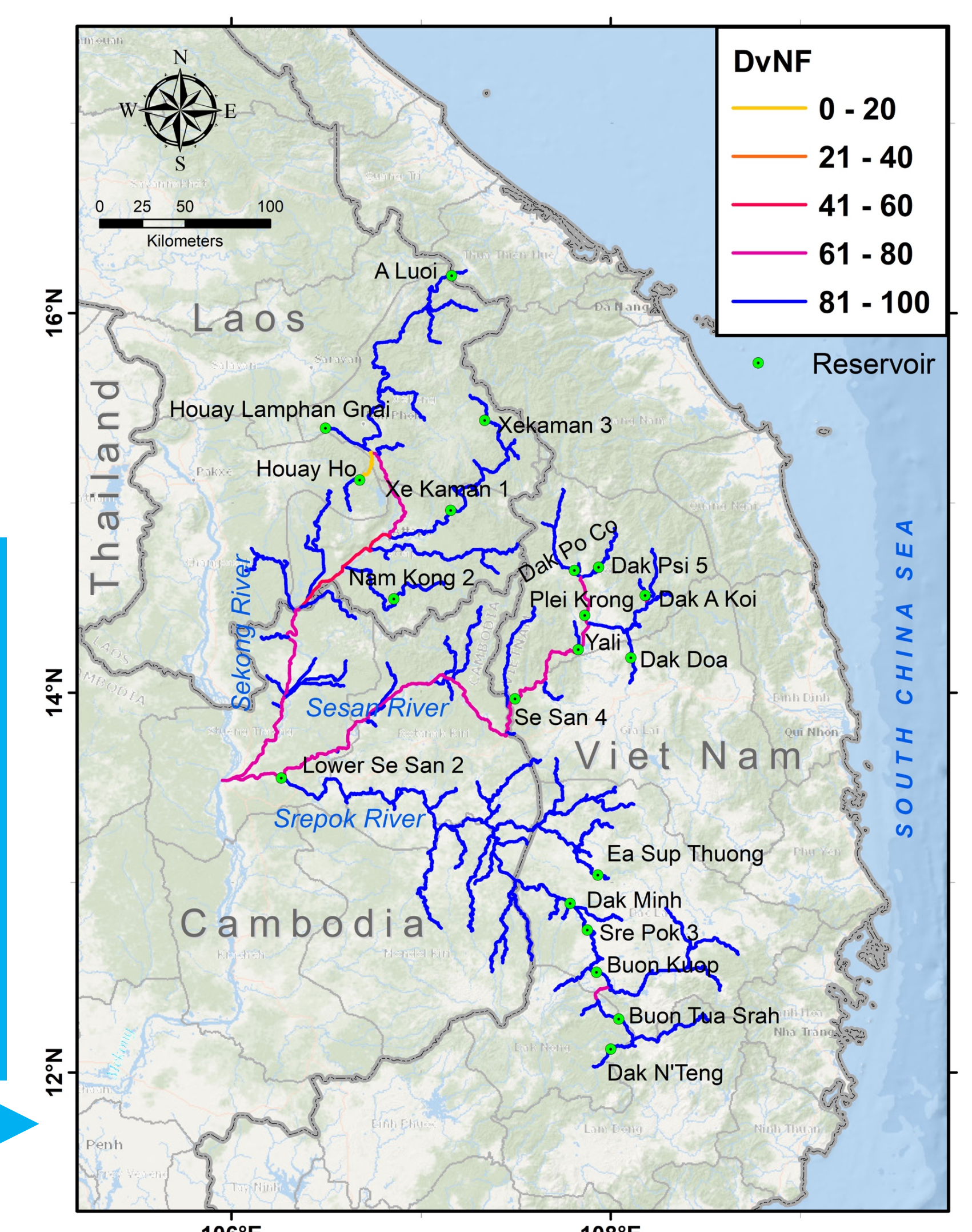


Figure gives the downstream propagation of variation for the Deviation from Natural Flow (DvNF) regime indicator under current reservoir storage. A non-dimensional scale of 0-100 where higher values denote a positive assessment regarding sustainable freshwater health is employed.

Ecosystem Vitality indicator (sub indicator for FHI) – is represented by Deviation from Natural Flow (DvNF) regime at the Sekong, Sesan, and Srepok river basins. The DvNF indicator depicts changes in the stock and flow of water through the drainage basin and water storage capacity.



HIGHLIGHTS

- The utility of satellite earth observation data has enabled us to investigate the Lower Mekong ecosystem health and develop decision awareness tools that can be applied on a global scale.
- The Ecosystem Vitality indicator score results quantify the degradation seen in the Lower Mekong 3S basin ecology. Seasonal flow patterns change is correlated with increase in water storage capacity.
- Ecosystem services and Governance & Stakeholders preliminary score results are 80 and 43, respectively. Work is underway to refine these results.
- FHI builds on Ostrom's (2009) general social-ecological systems framework by characterizing freshwater systems as dynamic social-ecological networks, with linkages and feedbacks that highlight human water uses, the effects of these uses on freshwater ecosystems and, importantly, the role that governance plays in the sustainable and equitable delivery of water-based services through the maintenance of functioning ecosystems.

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