

Improving Hydropower Outcomes through Strategic Portfolio Planning

A new frontier for sediment management in the Mekong

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Background

Improving Hydropower Outcomes through Strategic Portfolio Planning

Finding **good trade-offs** between dam **economic benefits** and impacts on **sediment connectivity** through **optimal dam siting and portfolio planning**

Energy and water resources

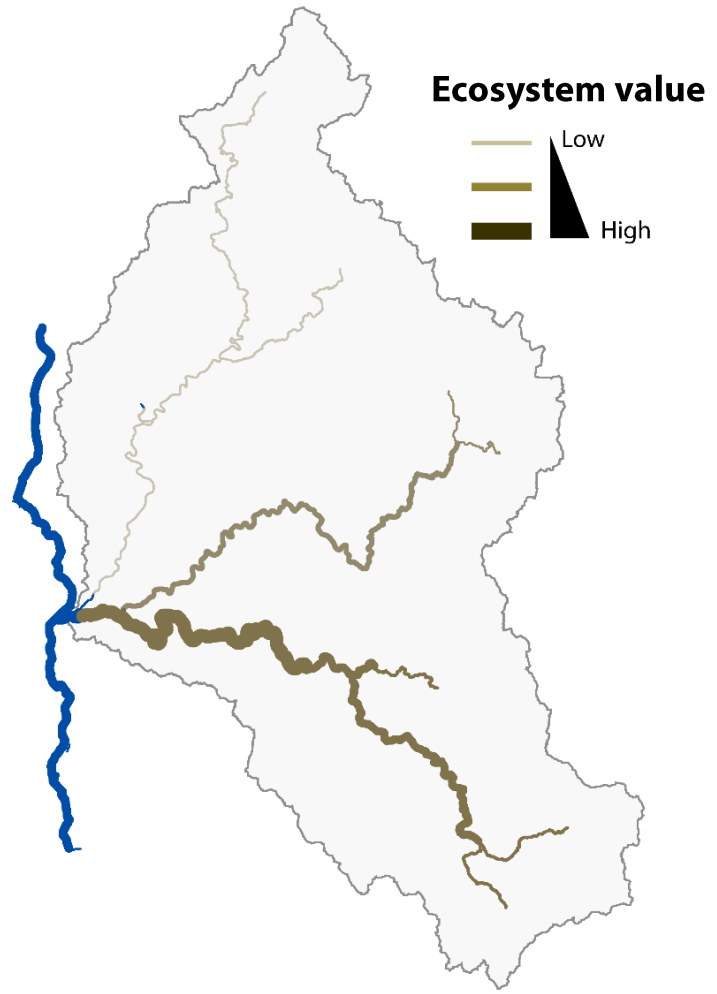
Ecosystem values

Livelihoods

Concepts

Controls behind dam impacts on sediment connectivity

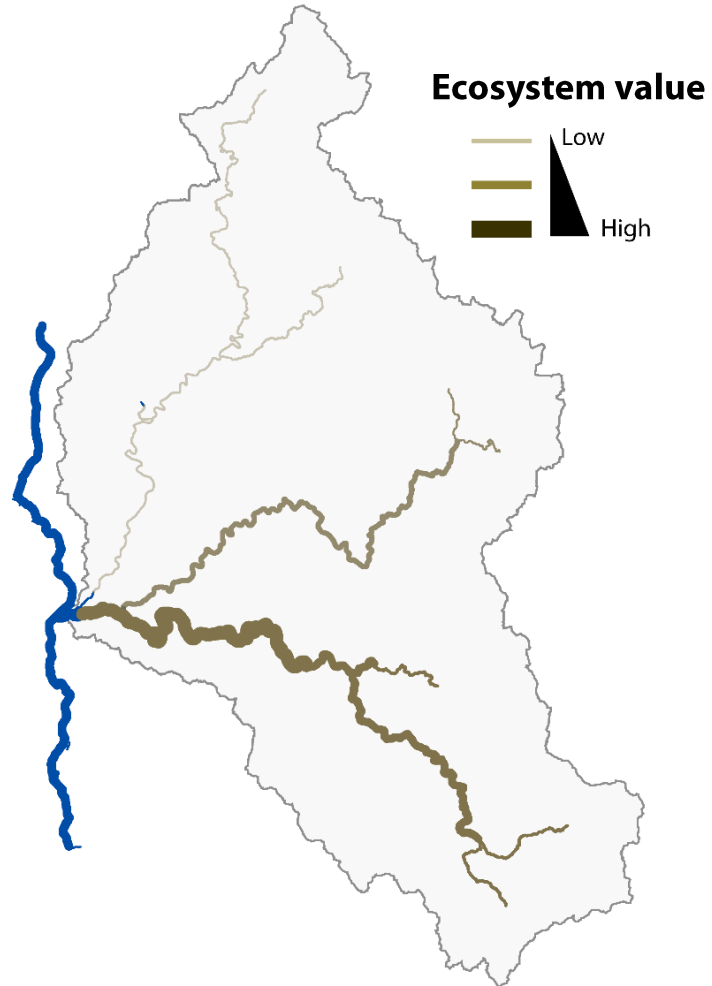
(1) Heterogeneous distribution of ecosystem value



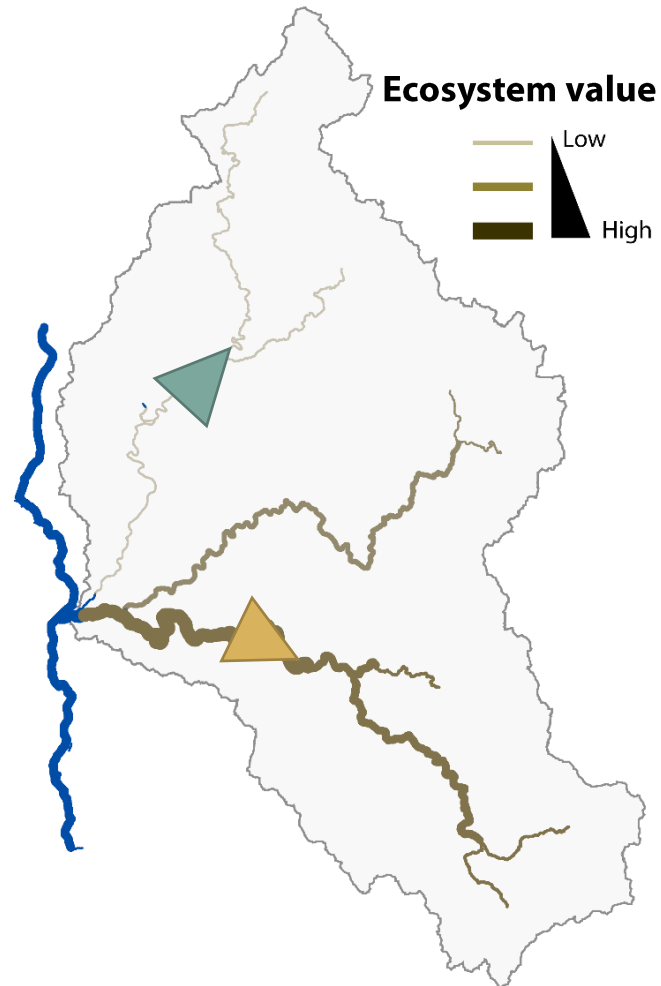
Concepts

Controls behind dam impacts on sediment connectivity

(1) Heterogeneous distribution of ecosystem value



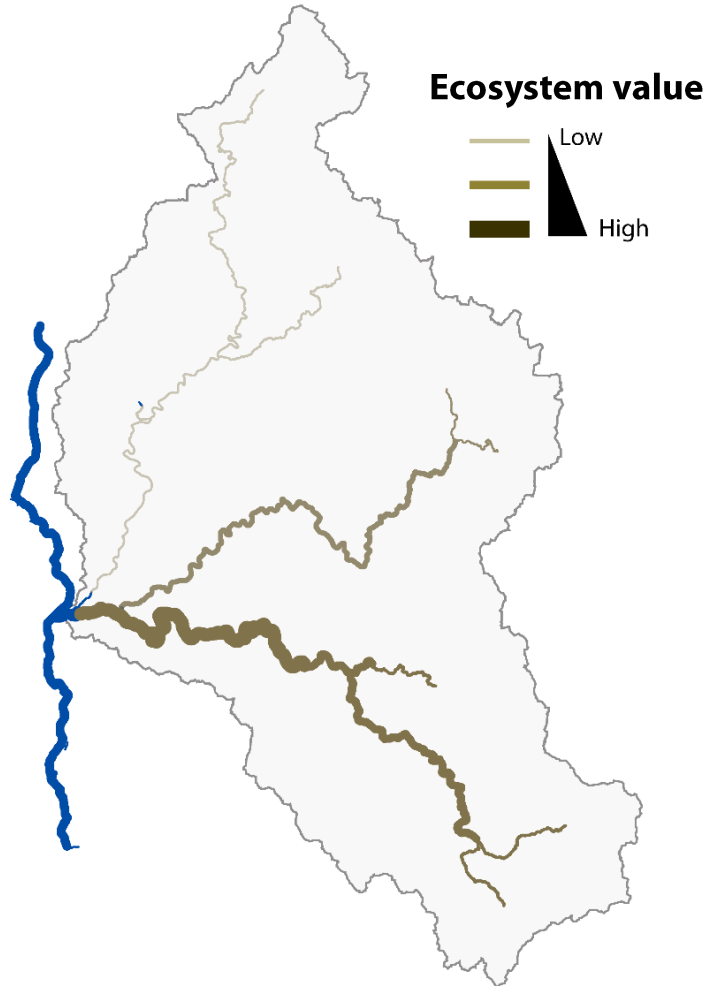
(2) **Site-specific** impacts and benefits of dams



Concepts

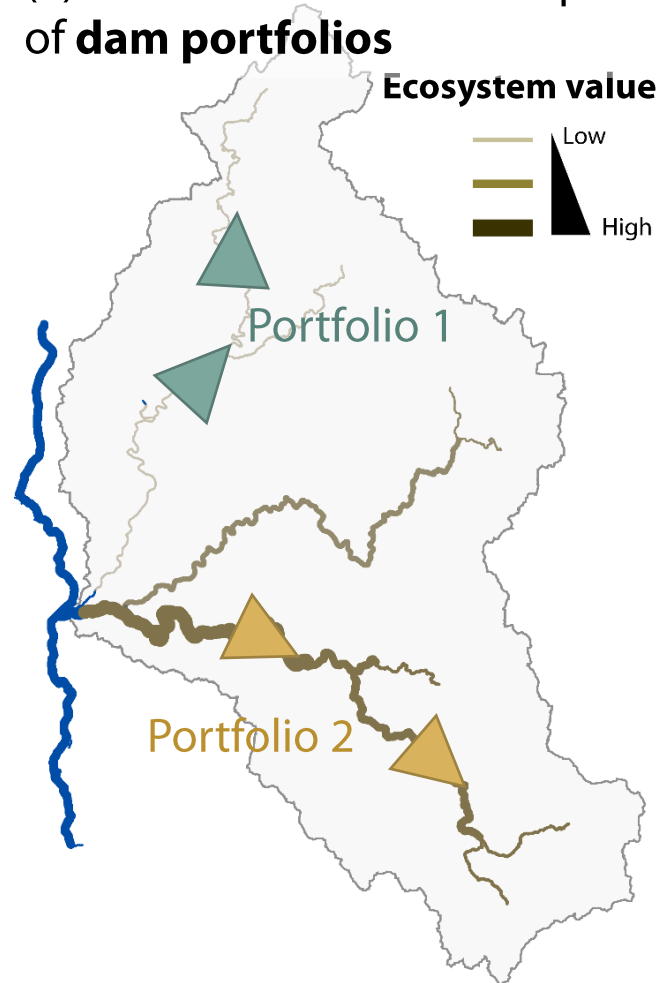
Controls behind dam impacts on sediment connectivity

(1) Heterogeneous distribution of ecosystem value

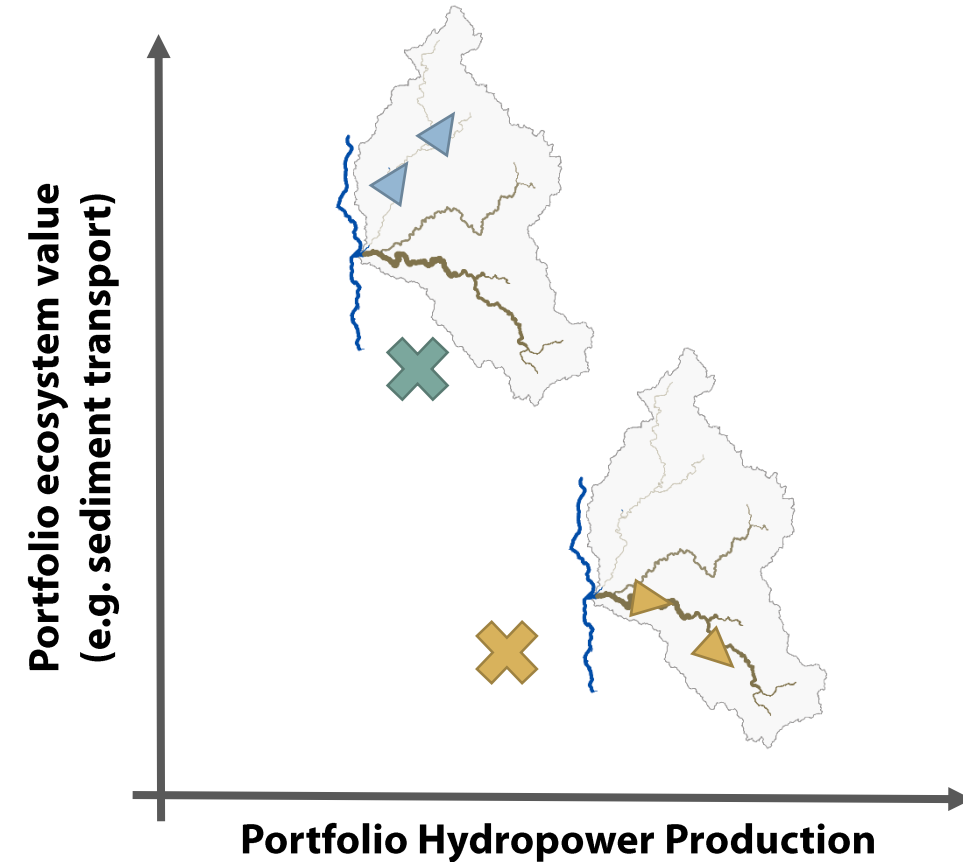


(2) **Site-specific** impacts and benefits of dams

(3) Different cumulative impact of **dam portfolios**



(3) The **full dam portfolio controls trade-offs between cumulative impacts & benefits**

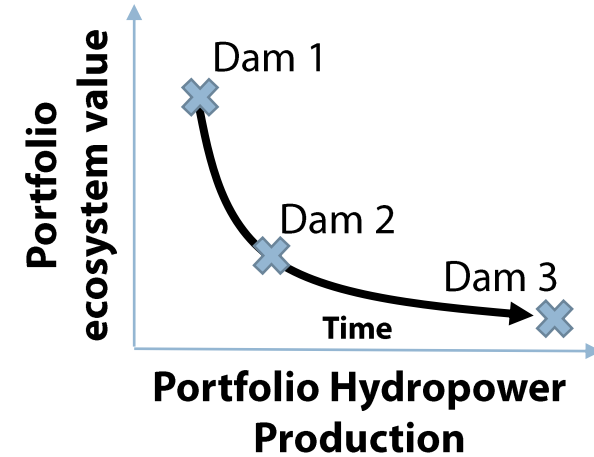
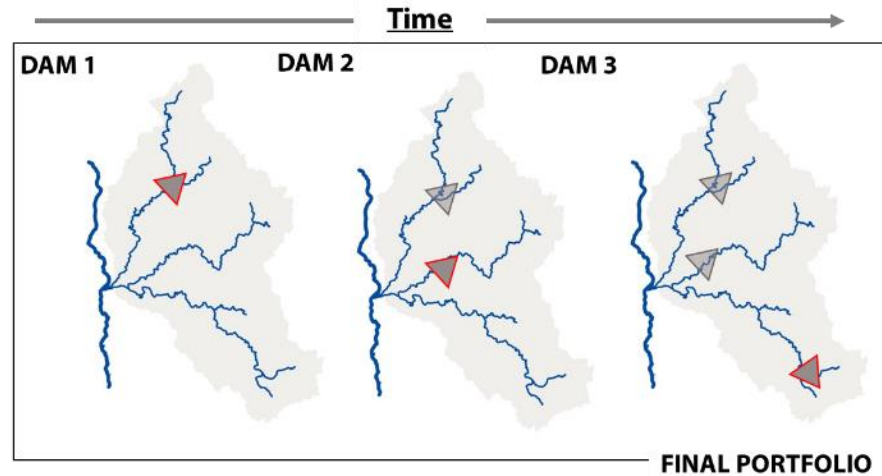


Planning approaches in hydropower

Project-by-project planning

Current planning

- Plan and develop dams **project-by-project**
- **No strategic vision** on final cumulative impacts and benefits

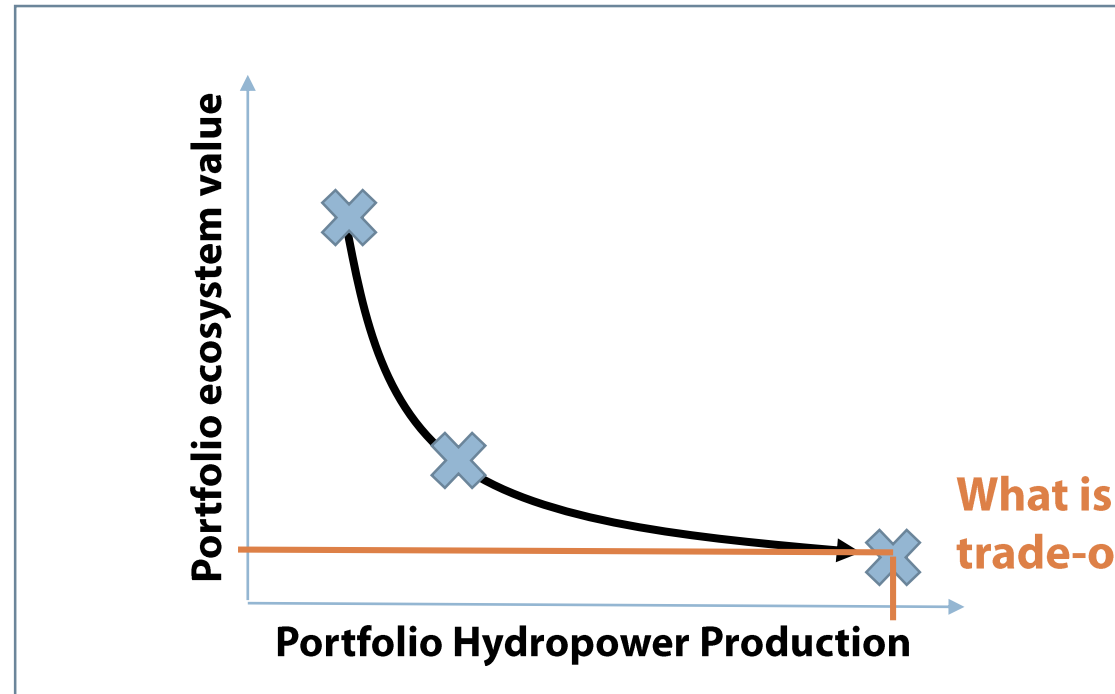
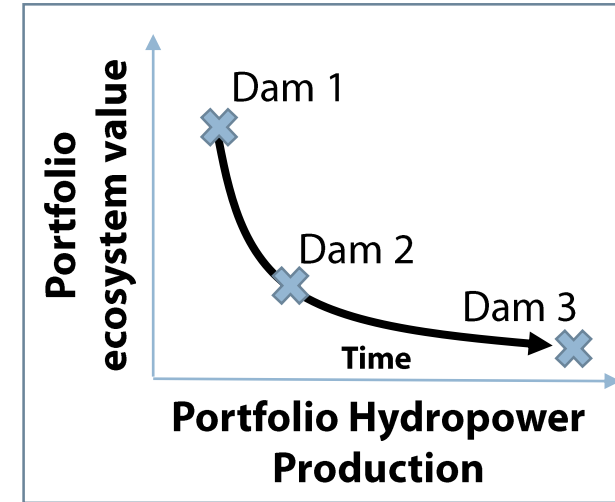
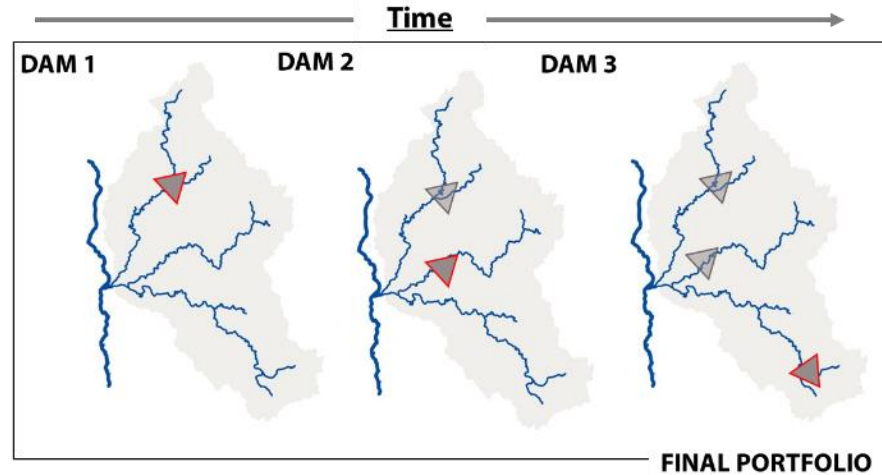


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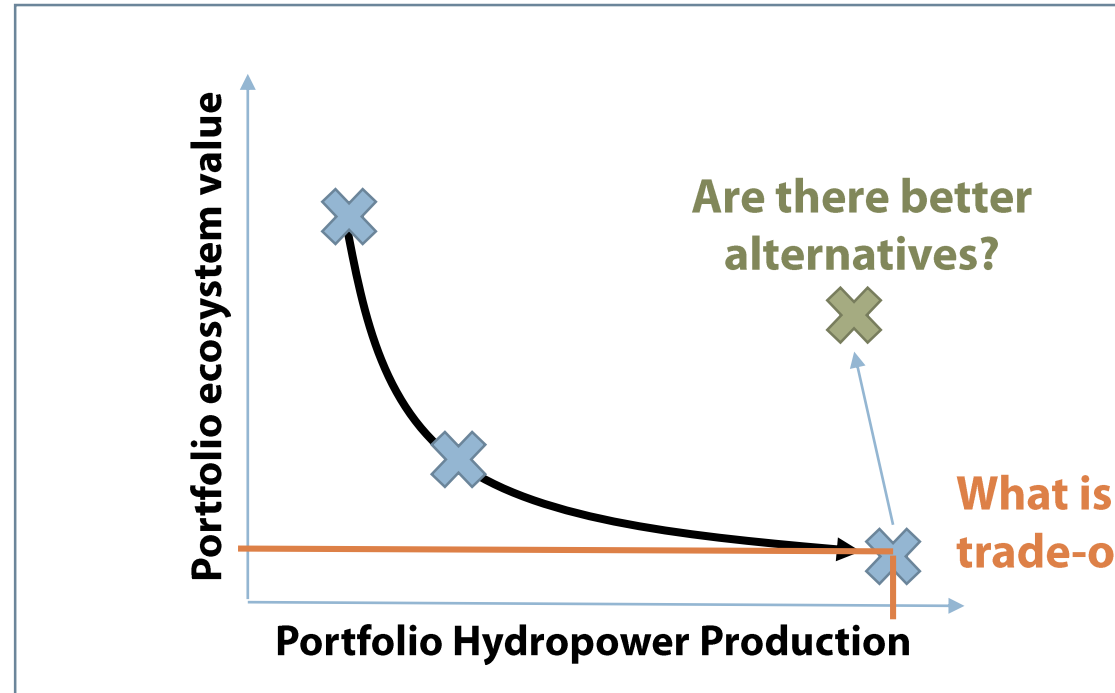
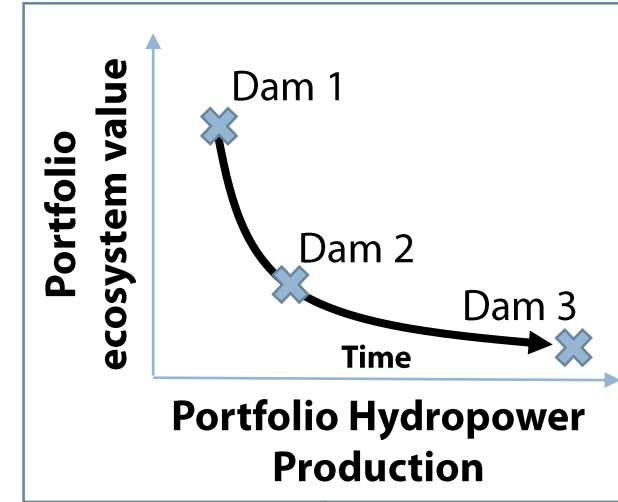
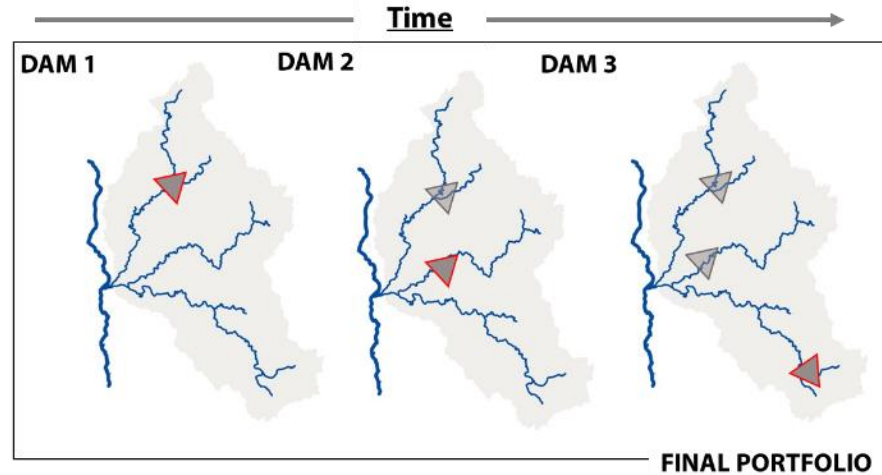


Planning approaches in hydropower

Project-by-project planning

Current planning

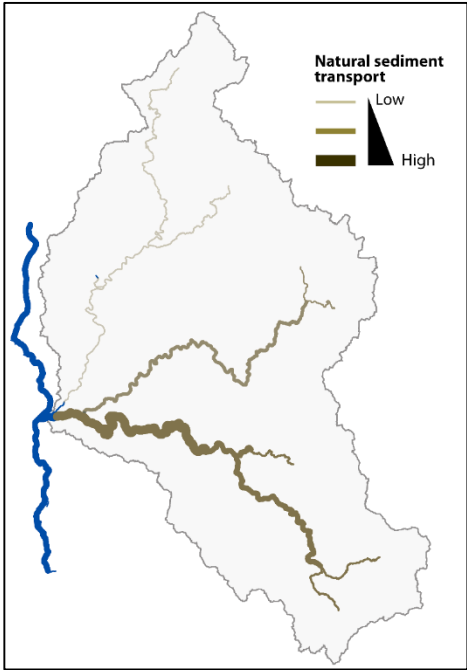
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Planning approaches in hydropower

Strategic planning

System Characterization

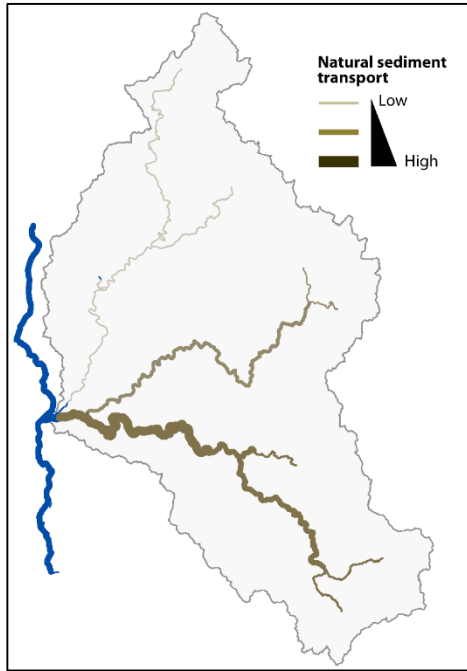


Characterize natural processes

Planning approaches in hydropower

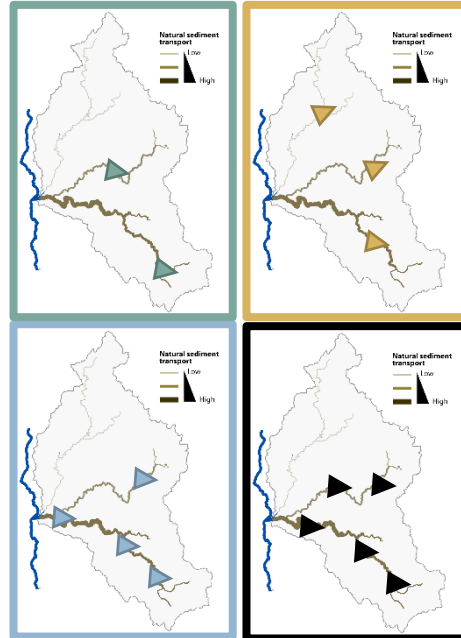
Strategic planning

System Characterization



Characterize natural processes

Portfolio identification

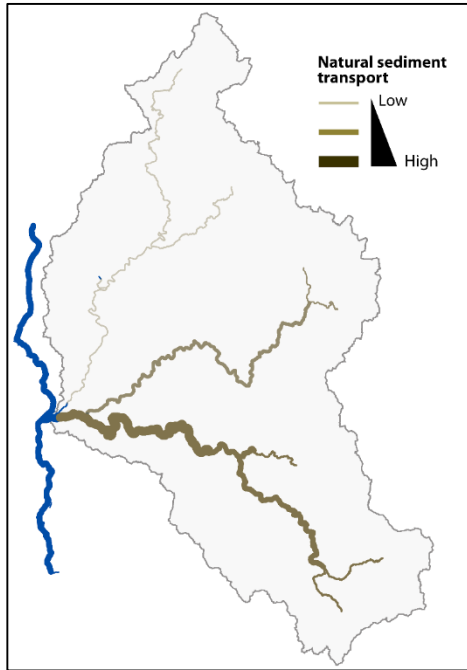


Identify planning alternatives

Planning approaches in hydropower

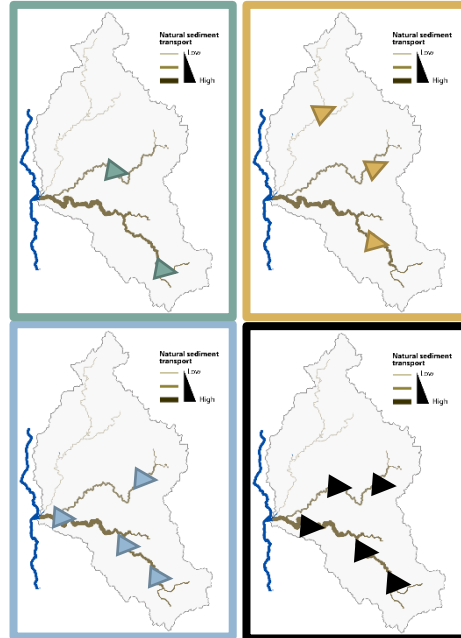
Strategic planning

System Characterization



Characterize natural processes

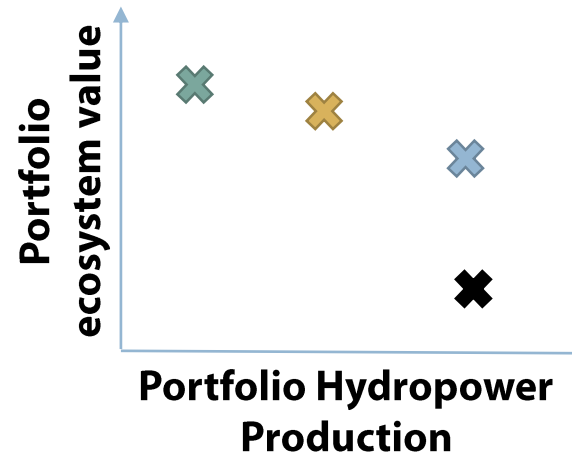
Portfolio identification



Identify planning alternatives



Predictive modeling

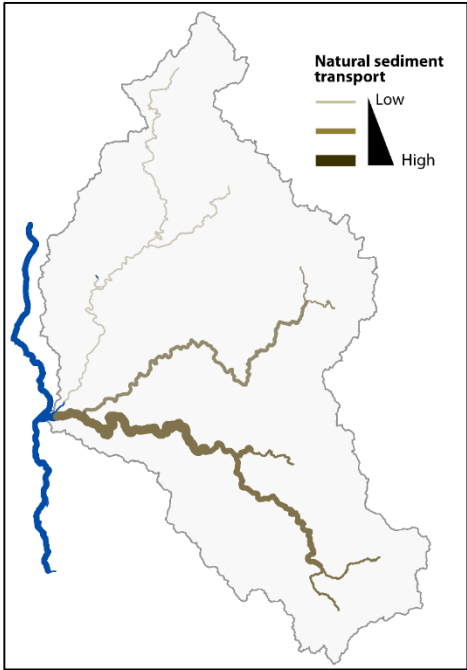


Quantify portfolio performance

Planning approaches in hydropower

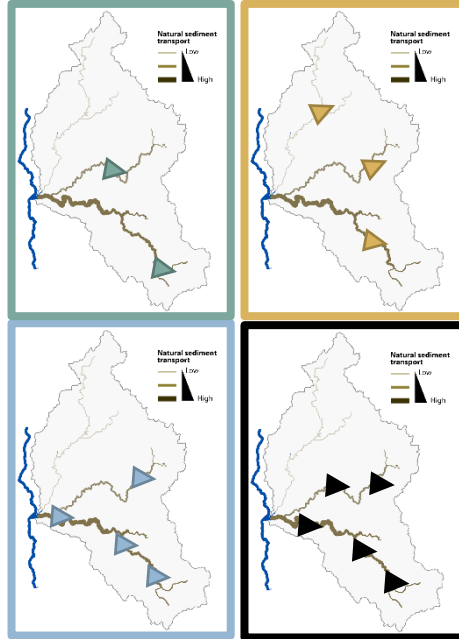
Strategic planning

System Characterization



Characterize natural processes

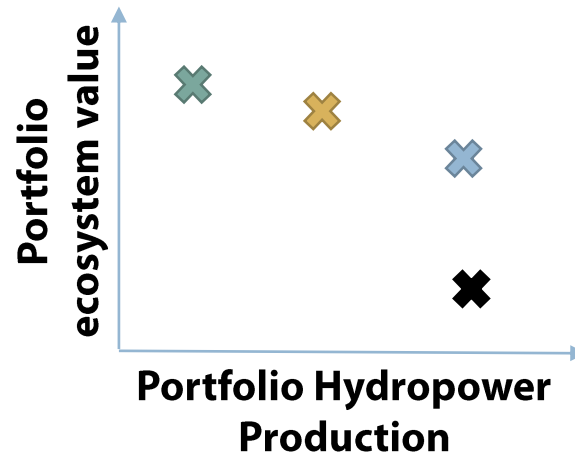
Portfolio identification



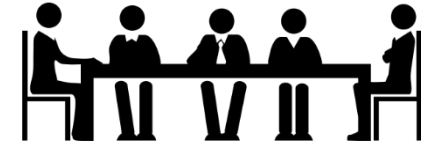
Identify planning alternatives



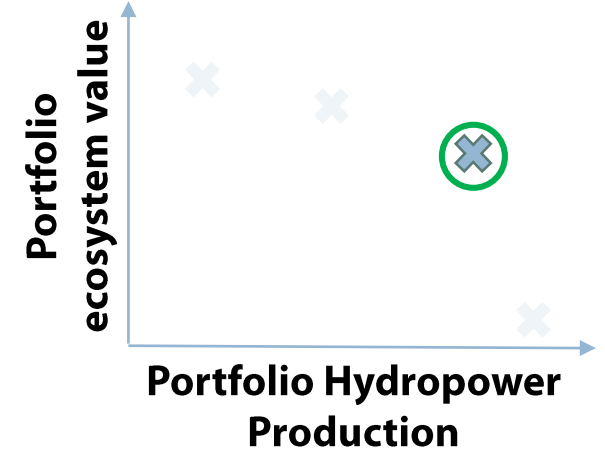
Predictive modeling



Quantify portfolio performance



Strategic decision making

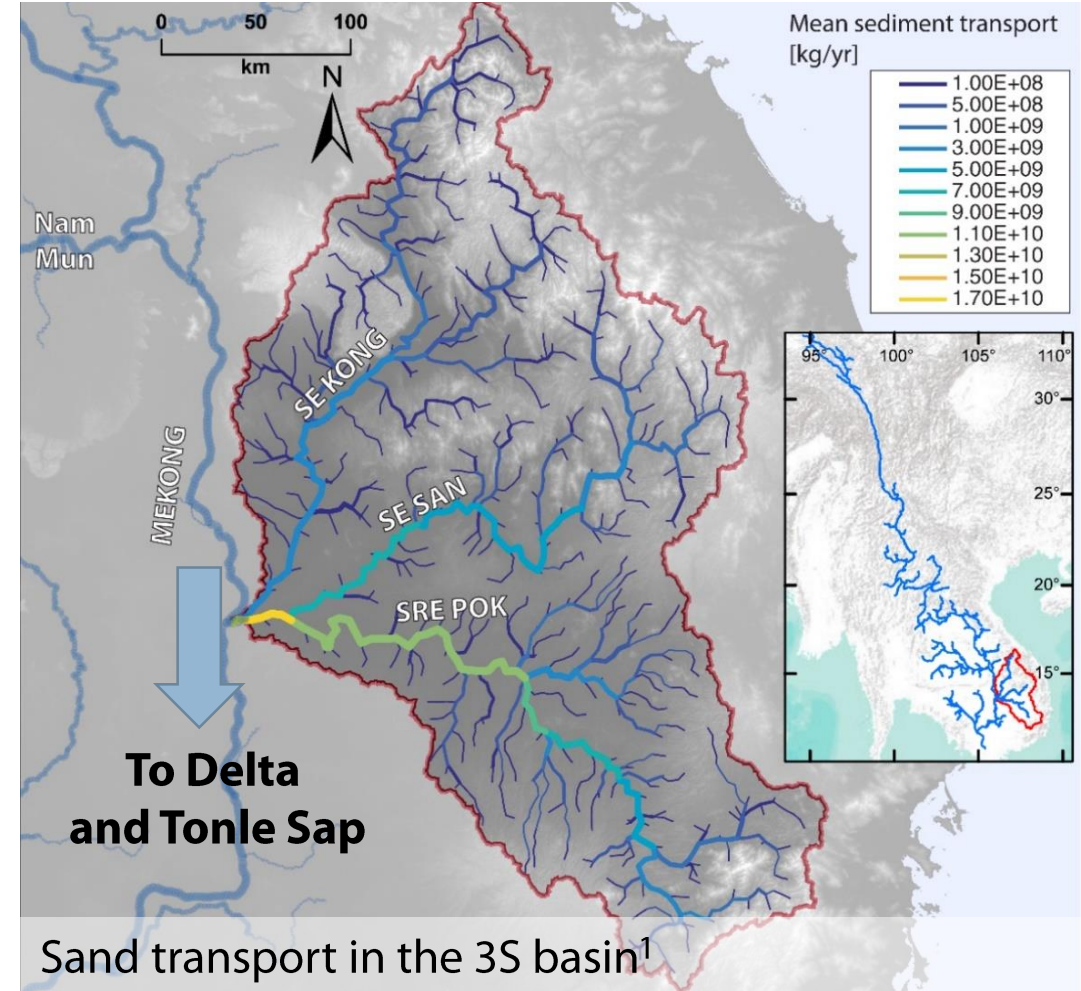


Select between optimal trade-offs

Benefits of strategic planning

Trading of sand connectivity and hydropower in the 3S basin

Se Kong, Se San, Sre Pok tributaries - great importance for the basins sediment budget



¹Schmitt et al., *JGR Earth Surface*, in Review

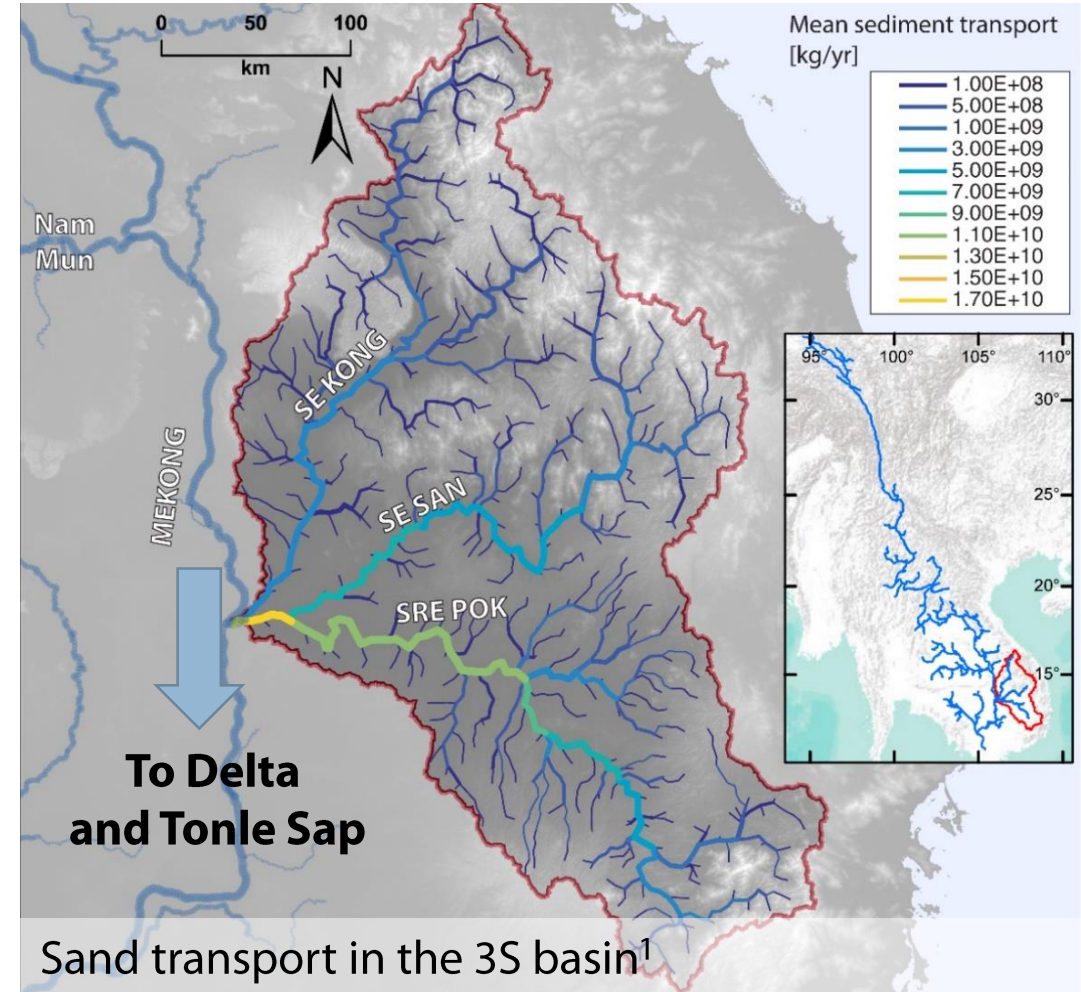
Benefits of strategic planning

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CASCADE²

CATCHMENT **S**EDIMENT **C**ONNECTIVITY **A**ND **D**ELIVERY
- screening model for system characterization and predictive modeling



²Schmitt et al., *WRR*, 2016

¹Schmitt et al., *JGR Earth Surface*, in Review

Benefits of strategic planning

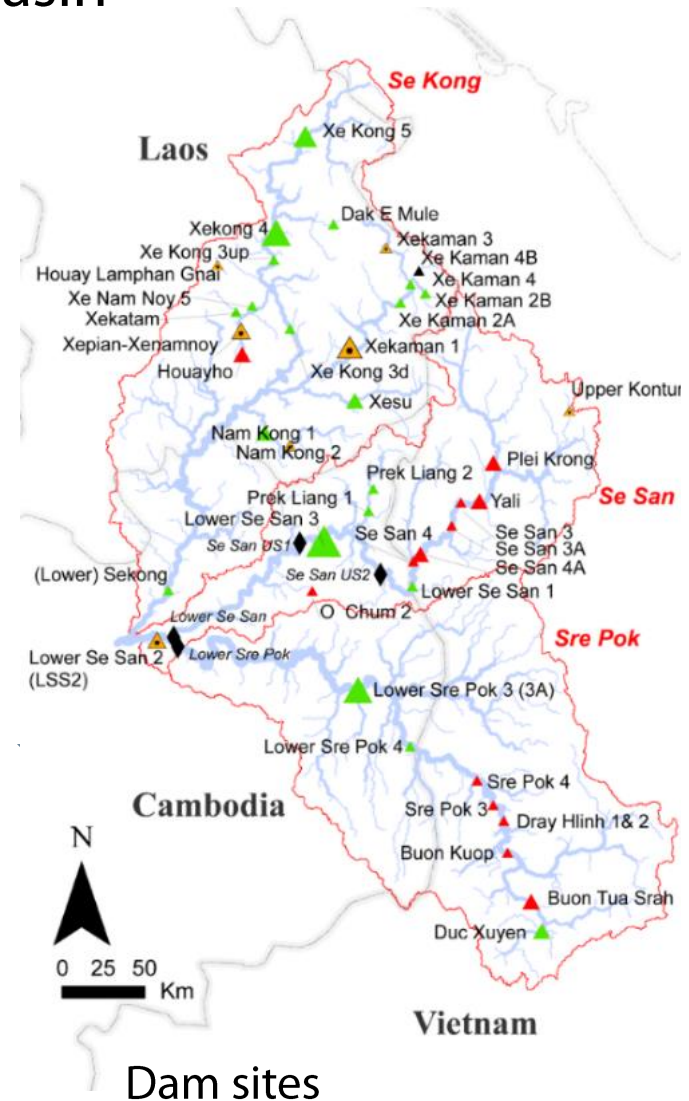
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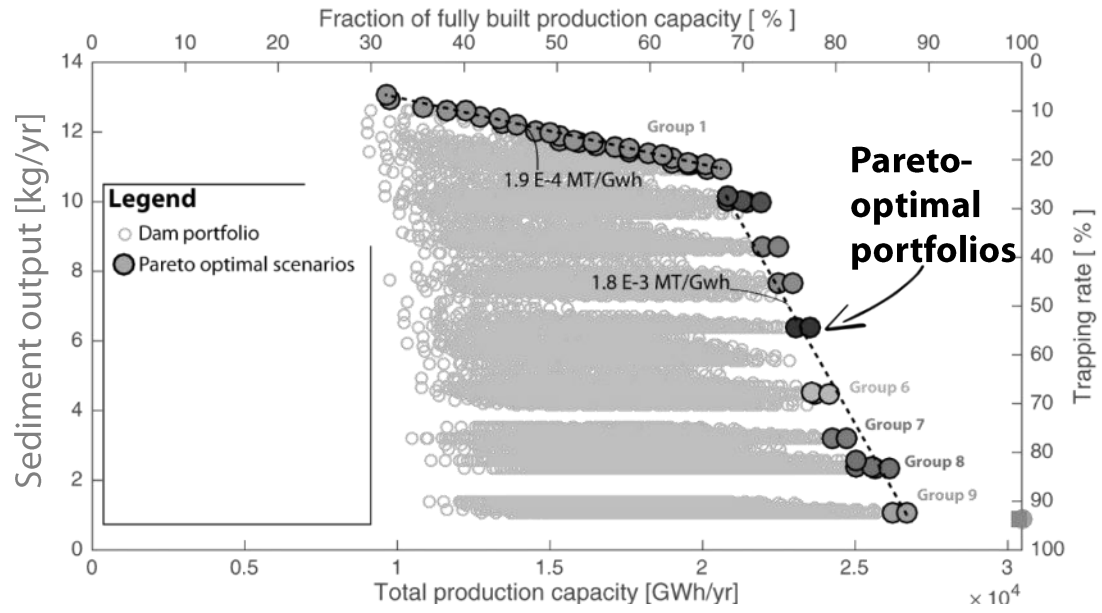
CATCHMENT **S**EDIMENT **C**ONNECTIVITY **A**ND **D**ELIVERY
- screening model for system characterization and predictive modeling

Quantify sediment trapping for planned dam sequence and 17,000 alternative portfolios



Benefits of strategic planning

Results
Pareto-optimal portfolios identify optimal trade-offs and limits for sustainable hydro¹



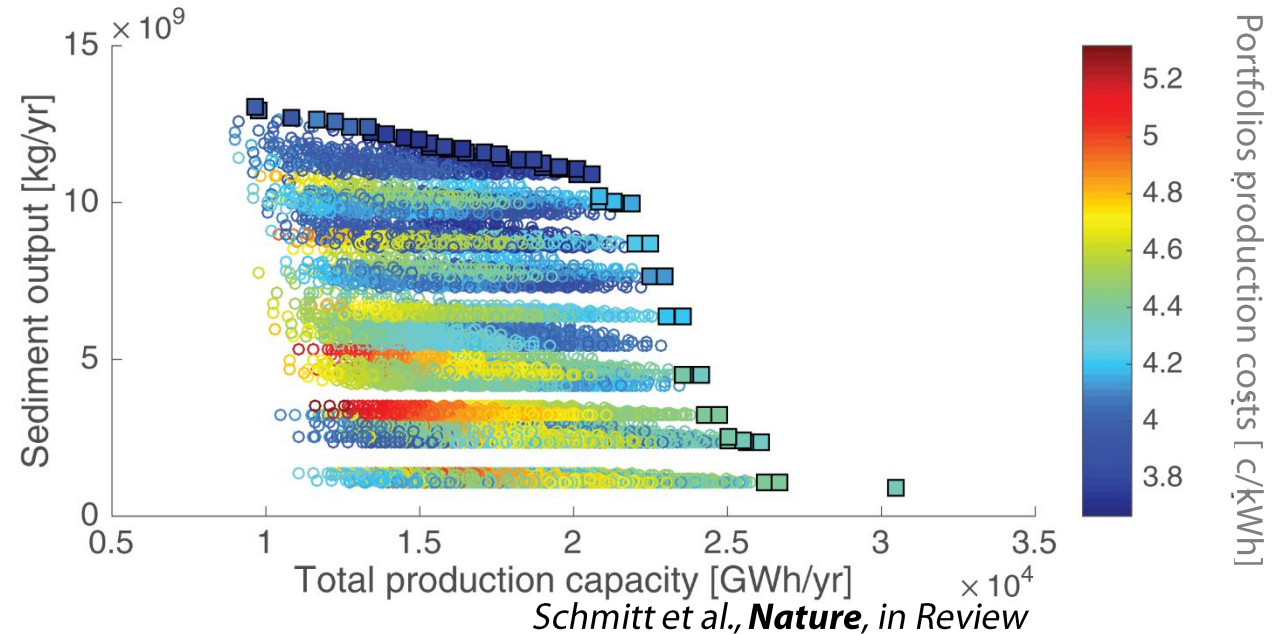
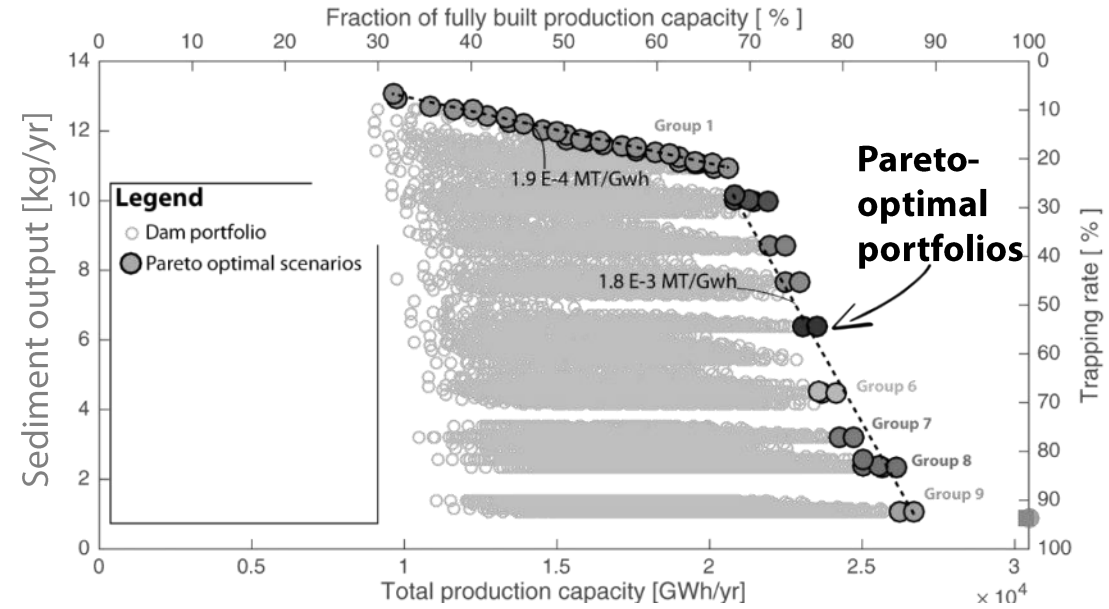
¹Schmitt et al., *Nature*, in Review

Benefits of strategic planning

Results

Pareto-optimal portfolios identify optimal trade-offs and limits for sustainable hydro

Synergy between low production costs and optimal trade-offs



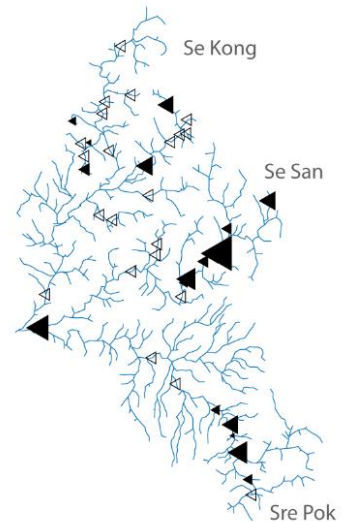
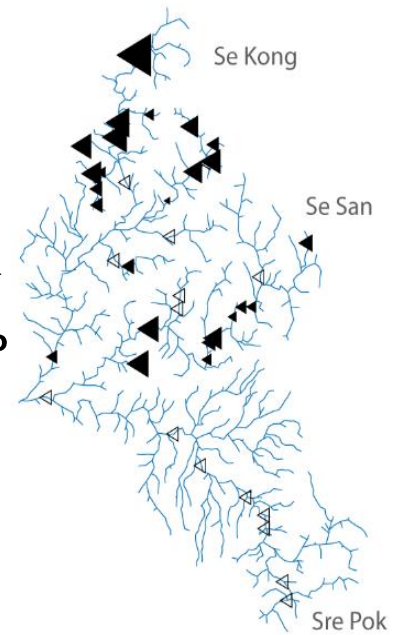
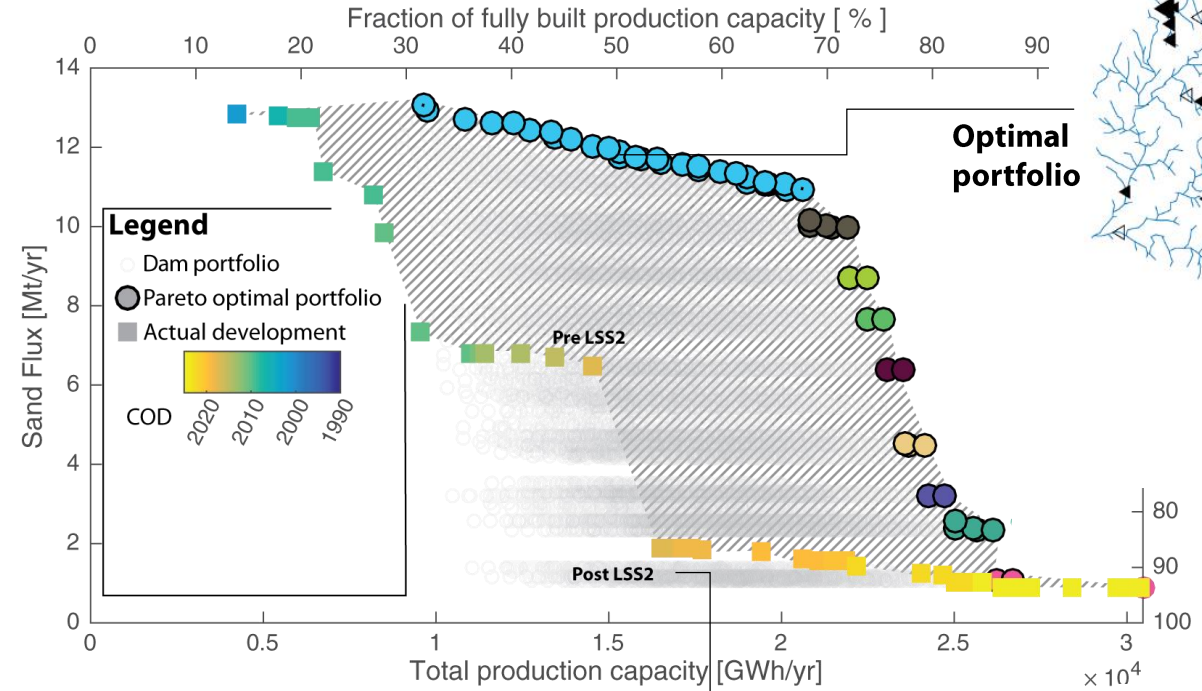
Benefits of strategic planning

Results

Pareto-optimal portfolios identify optimal trade-offs and limits for sustainable hydro

Synergy between low production costs and optimal trade-offs

Current project-by-project approach creates over-proportional impacts

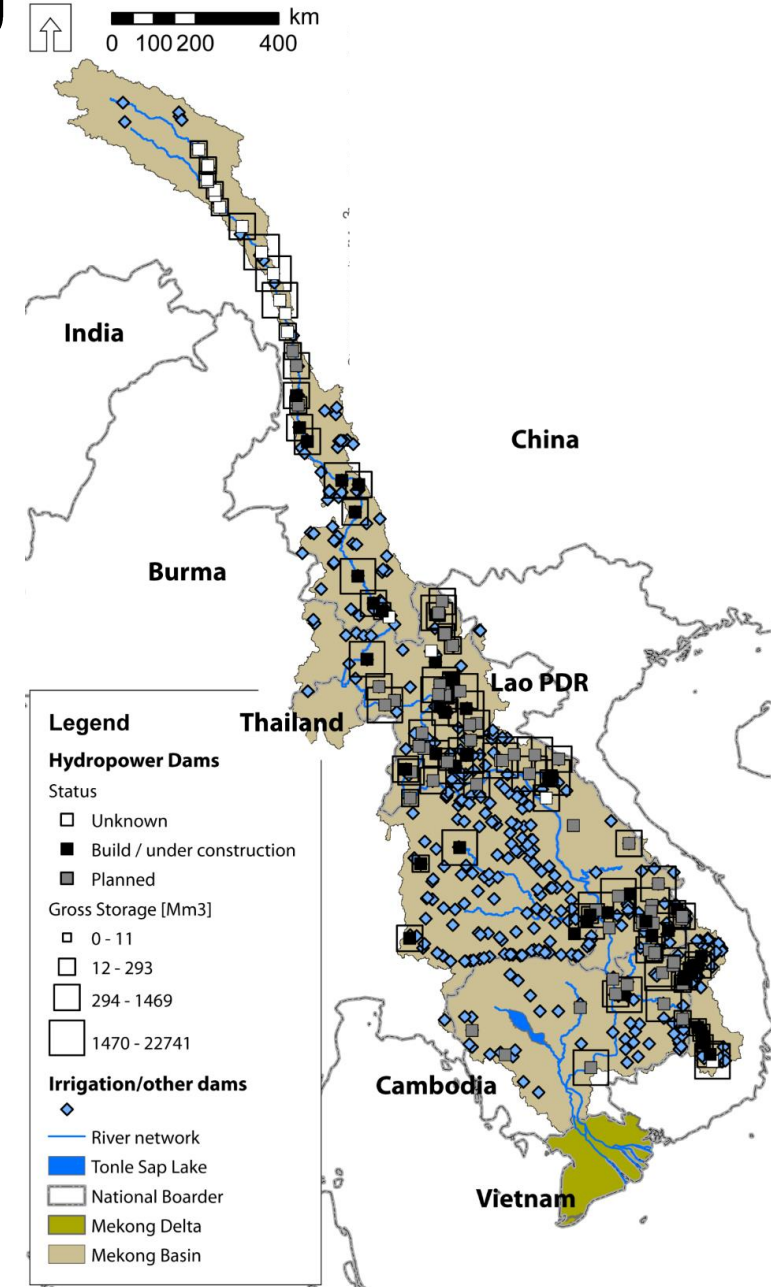
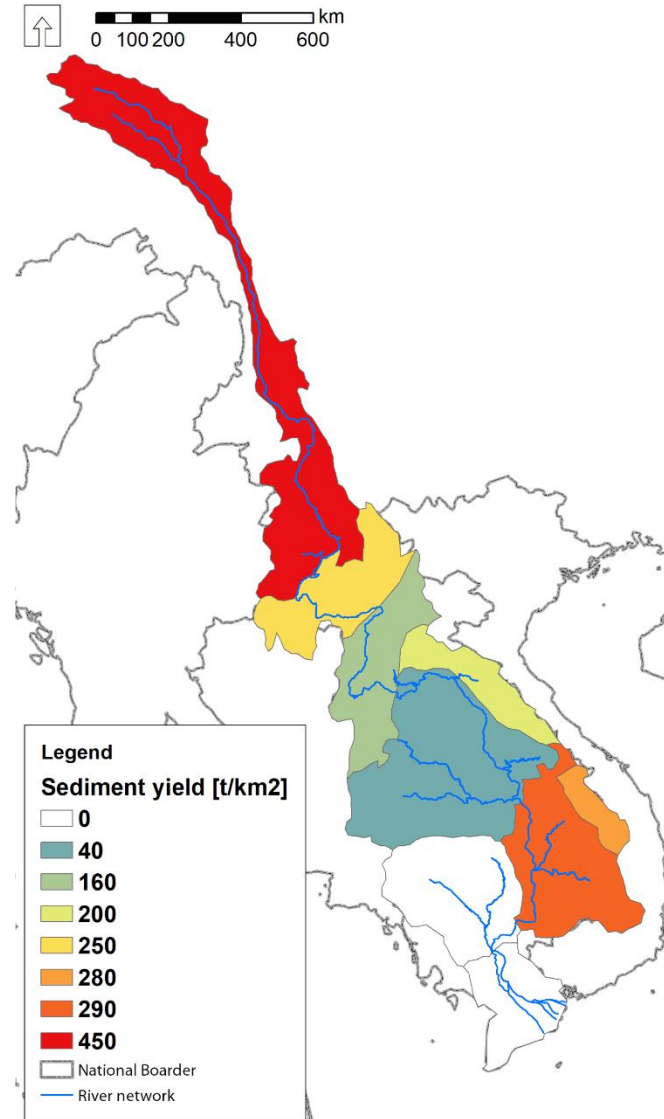


Prioritizing dam development in the Mekong

Couple CASCADE with empiric estimates of sediment yield

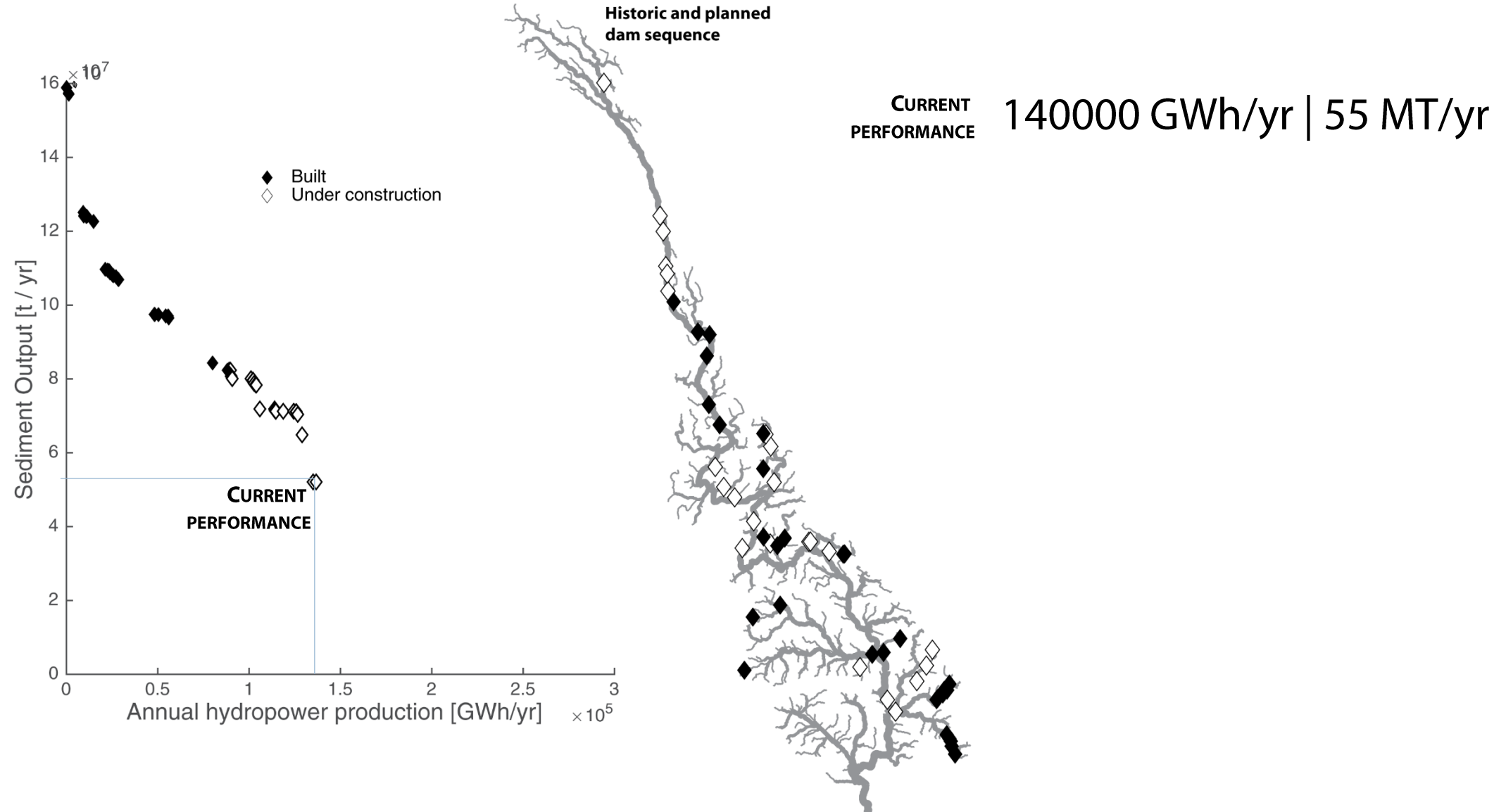
Use a genetic algorithm to identify optimal portfolios

Identify optimal planning alternatives for future dams



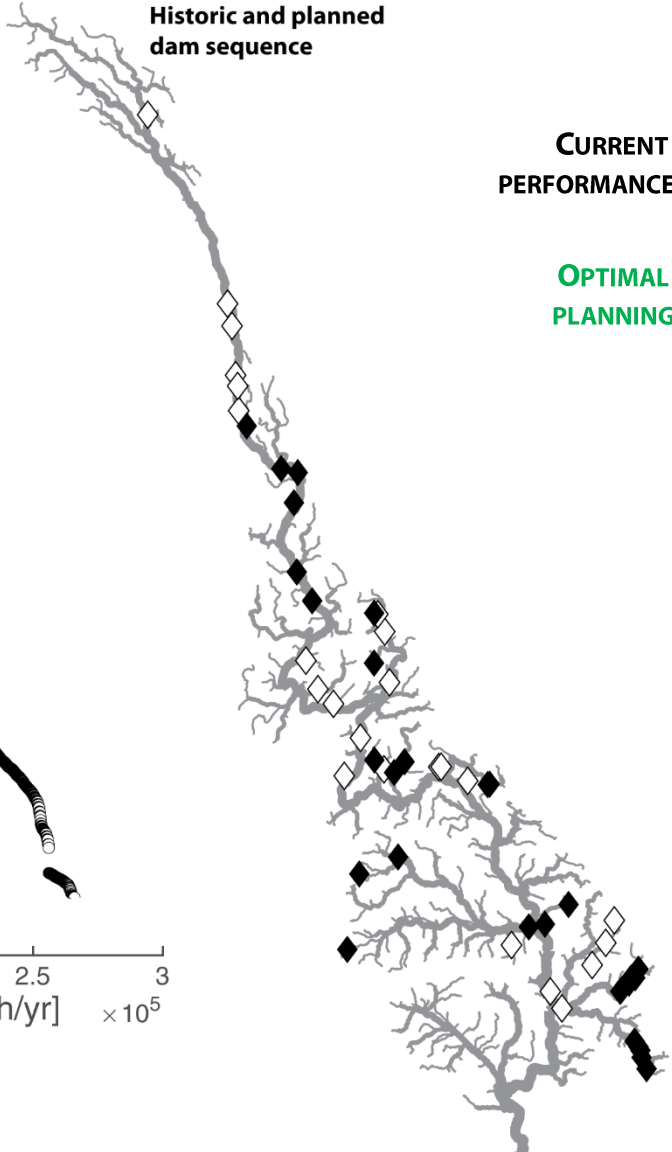
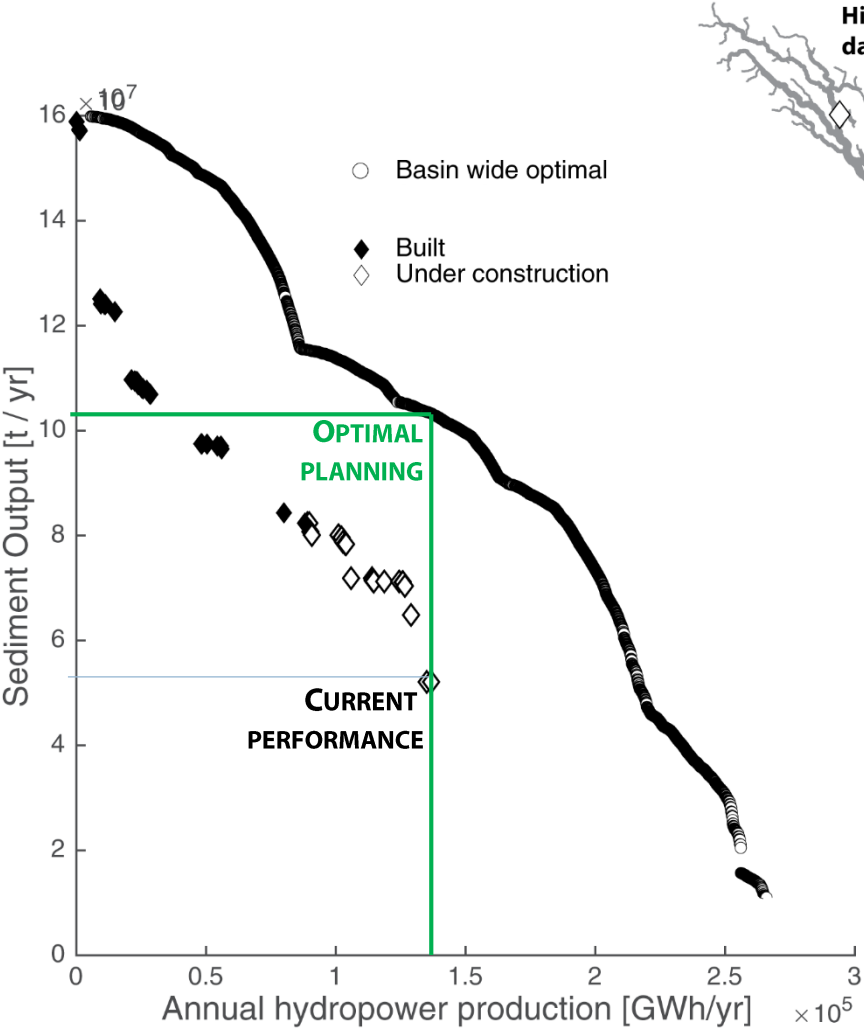
Strategic Portfolio Planning in transboundary river basins

Impacts of the current dam portfolio



Strategic Portfolio Planning in transboundary river basins

Lost opportunities for better planning

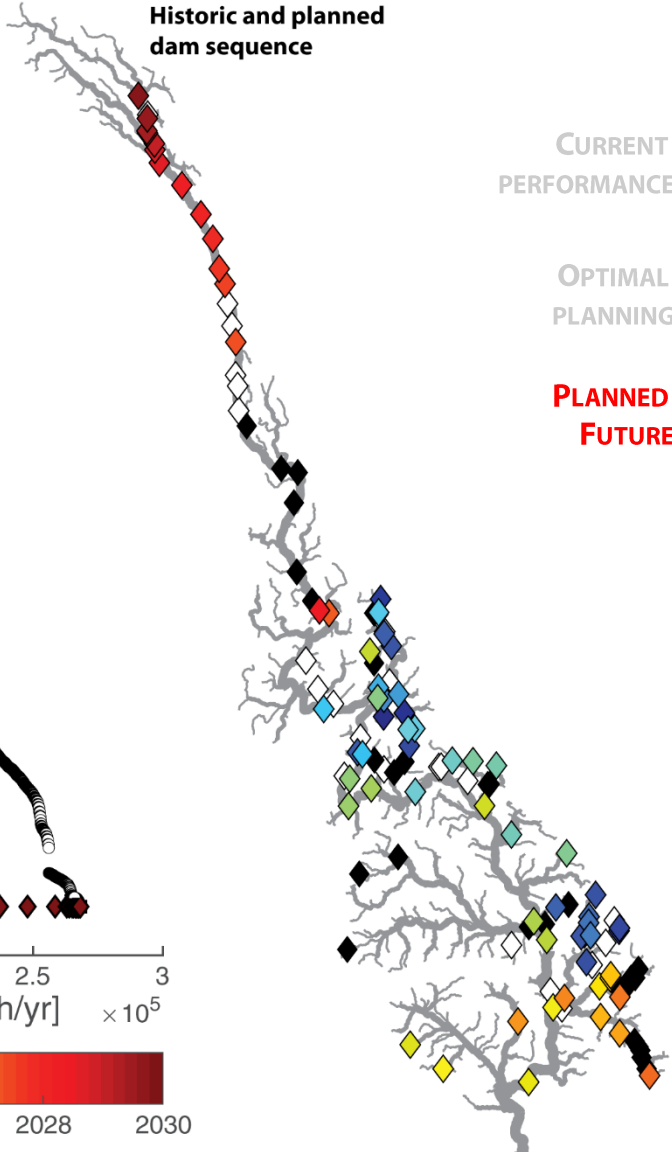
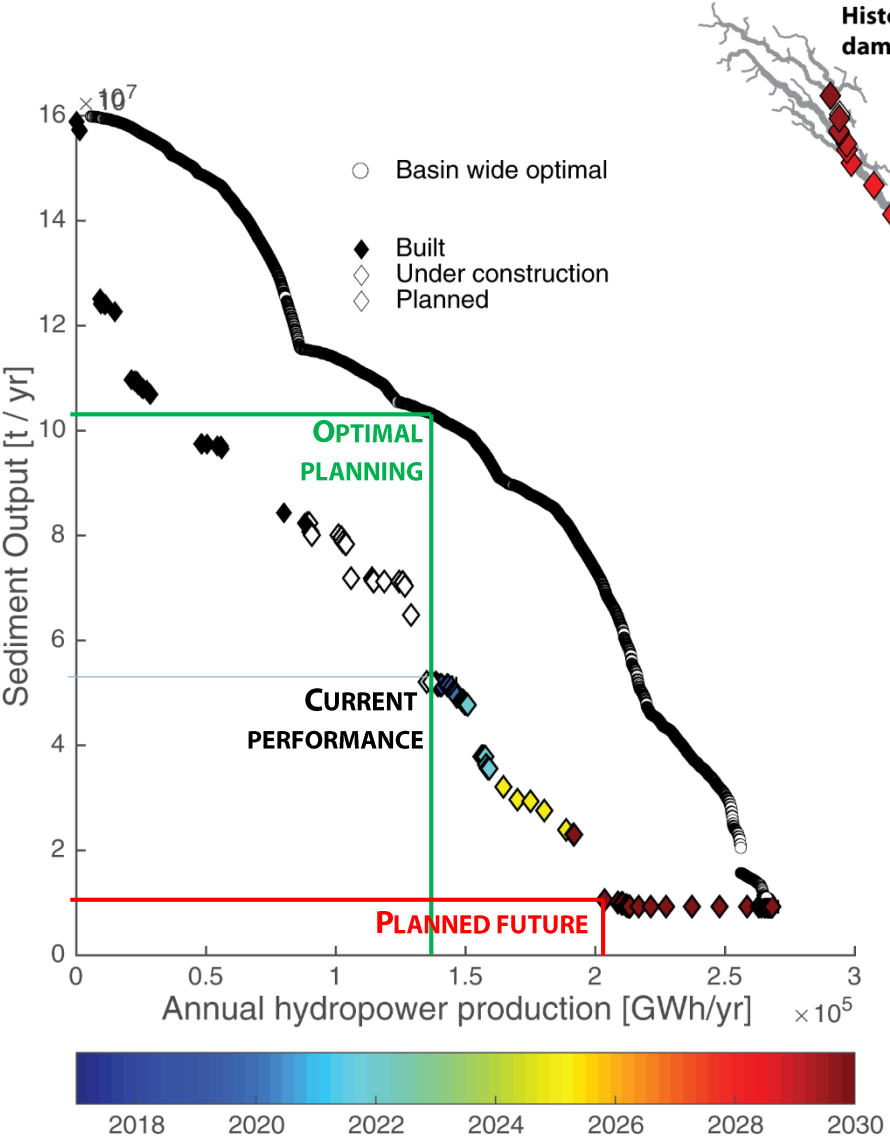


CURRENT PERFORMANCE 140000 GWh/yr | 55 MT/yr

OPTIMAL PLANNING 140000 GWh/yr | 105 MT/yr

Strategic Portfolio Planning in transboundary river basins

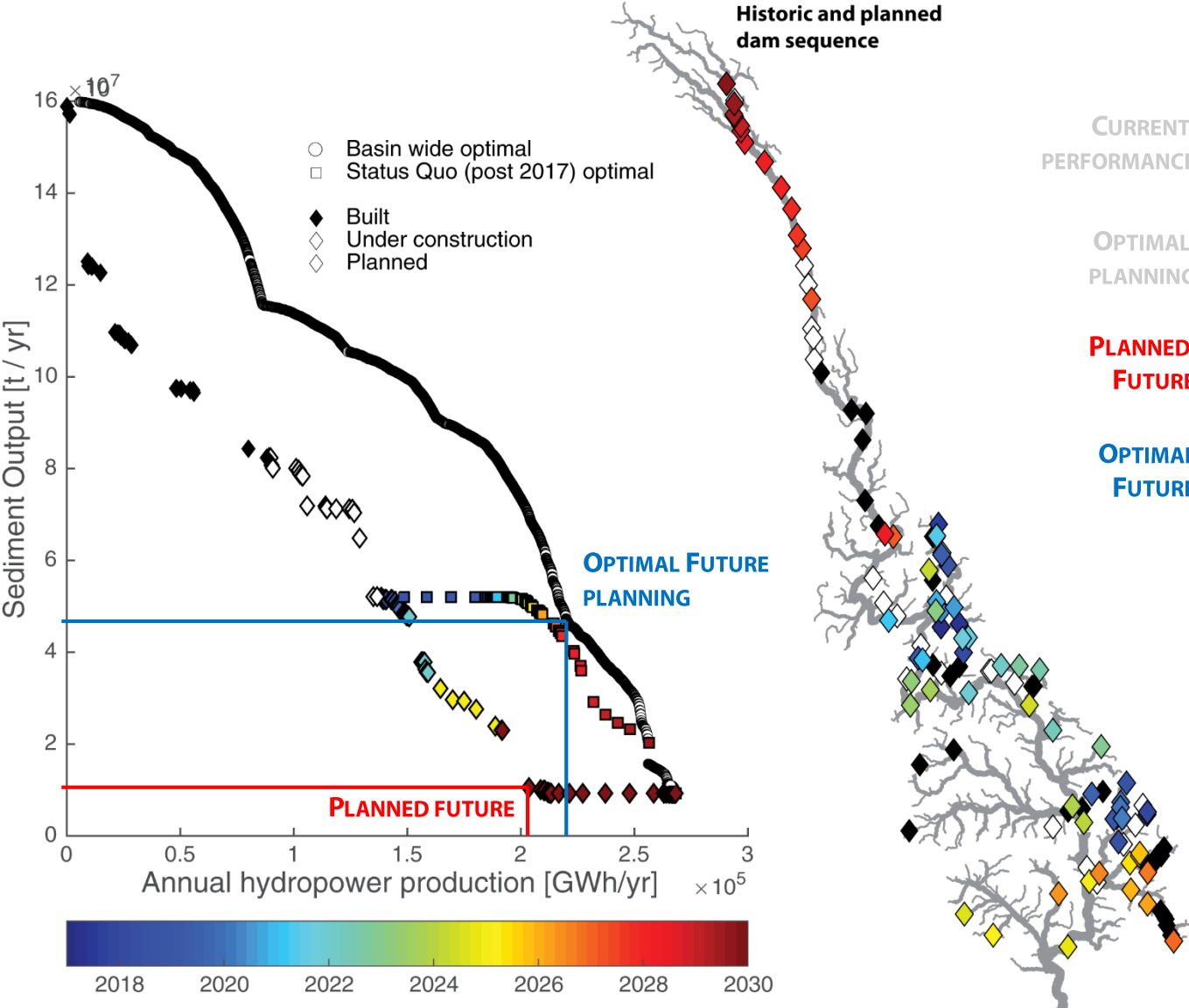
Impacts of near-future dam developments



CURRENT PERFORMANCE	140000 GWh/yr 55 MT/yr
OPTIMAL PLANNING	140000 GWh/yr 105 MT/yr
PLANNED FUTURE	200000 GWh/yr 10 MT/yr

Strategic Portfolio Planning in transboundary river basins

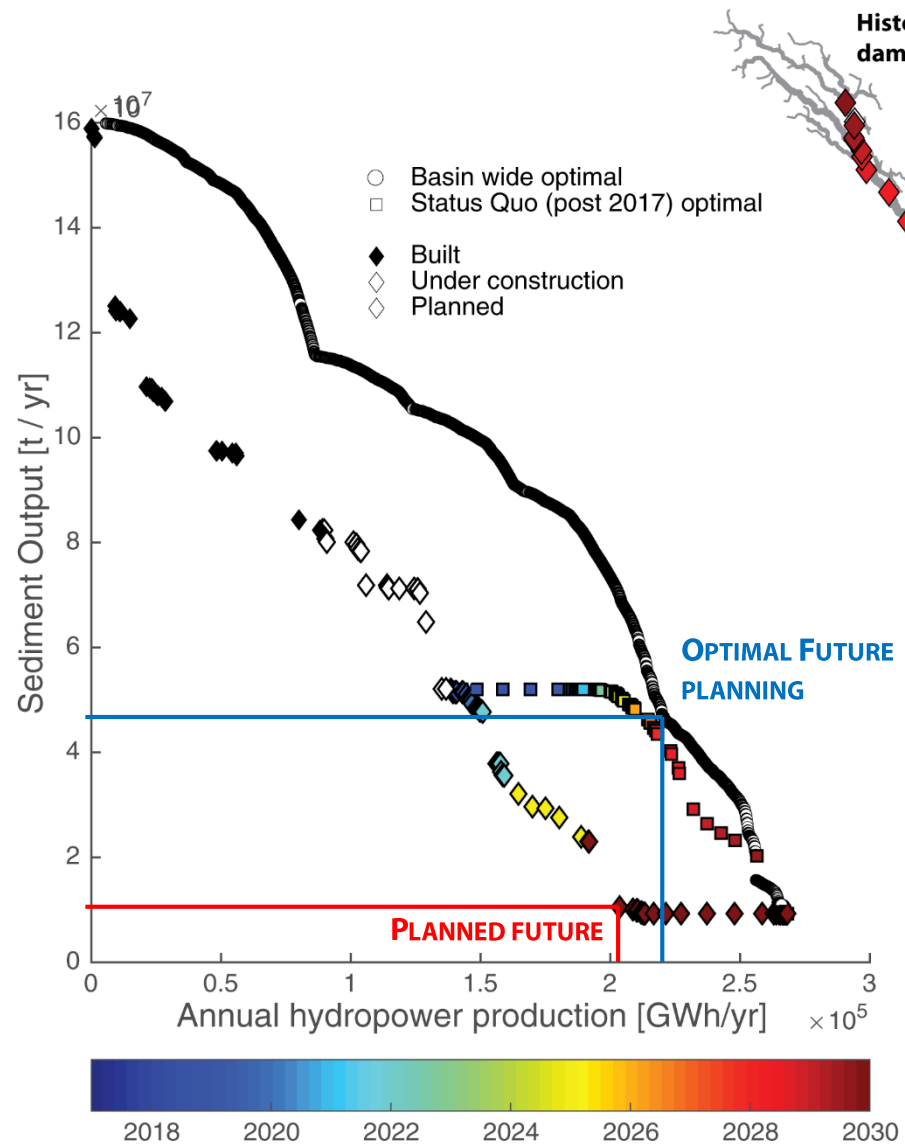
Opportunities for better hydropower outcomes



CURRENT PERFORMANCE	140000 GWh/yr 55 MT/yr
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PLANNED FUTURE	200000 GWh/yr 10 MT/yr
OPTIMAL FUTURE	220000 GWh/yr 45 MT/yr

Strategic Portfolio Planning in transboundary river basins

Opportunities for better hydropower outcomes



CURRENT PERFORMANCE

140000 GWh/yr | 55 MT/yr

OPTIMAL PLANNING

140000 GWh/yr | 105 MT/yr

PLANNED FUTURE

200000 GWh/yr | 10 MT/yr

OPTIMAL FUTURE

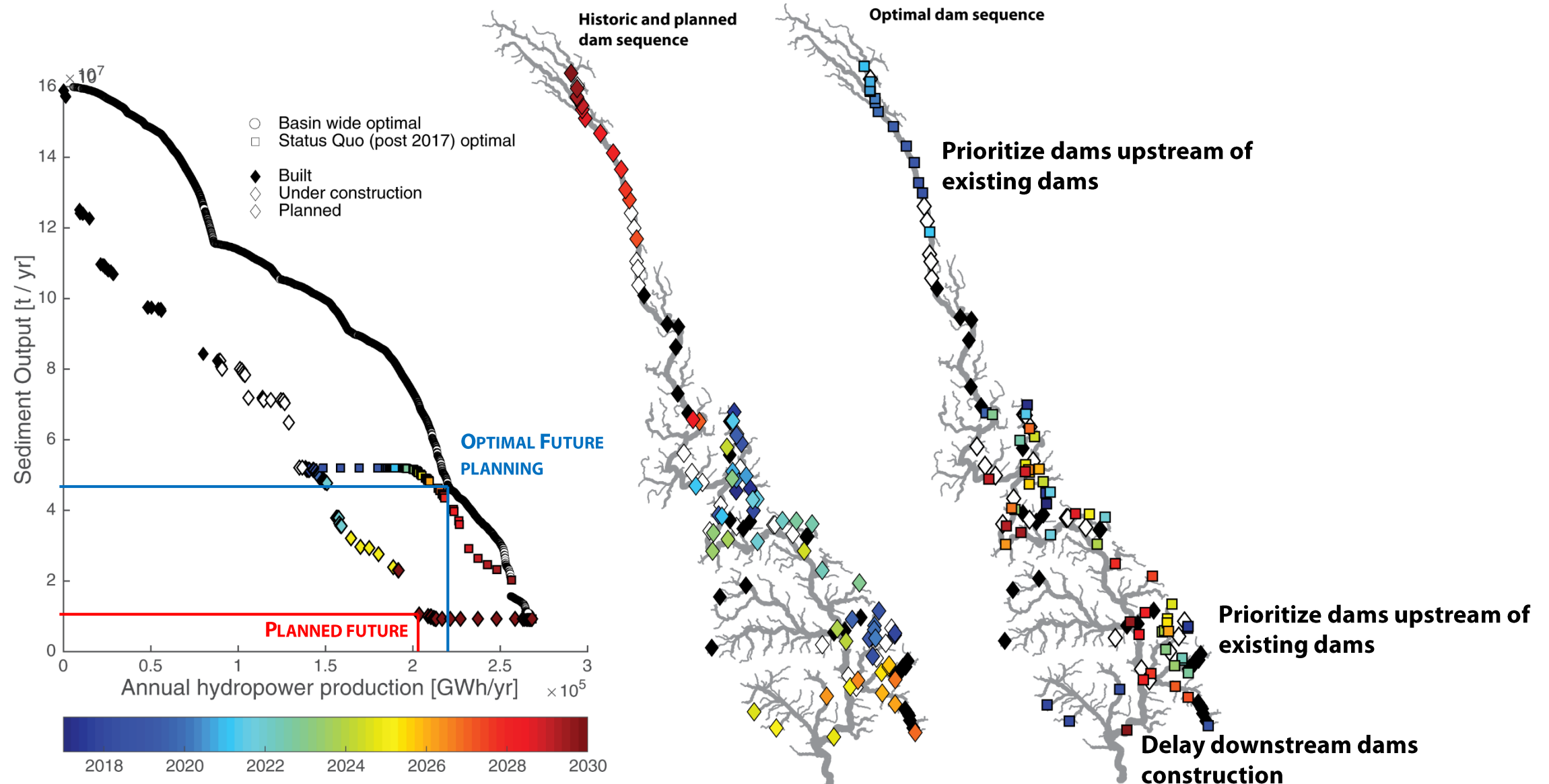
220000 GWh/yr | 45 MT/yr

There are still opportunities to improve hydropower outcomes in the Mekong

Optimal planning should begin as soon as possible

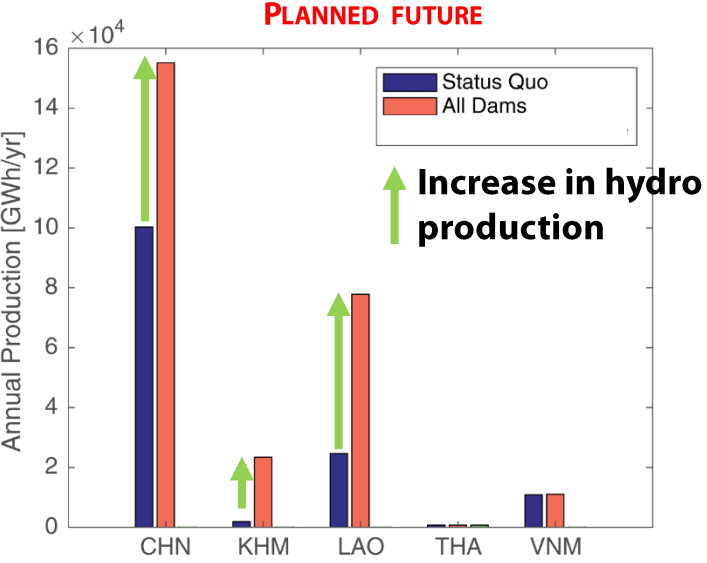
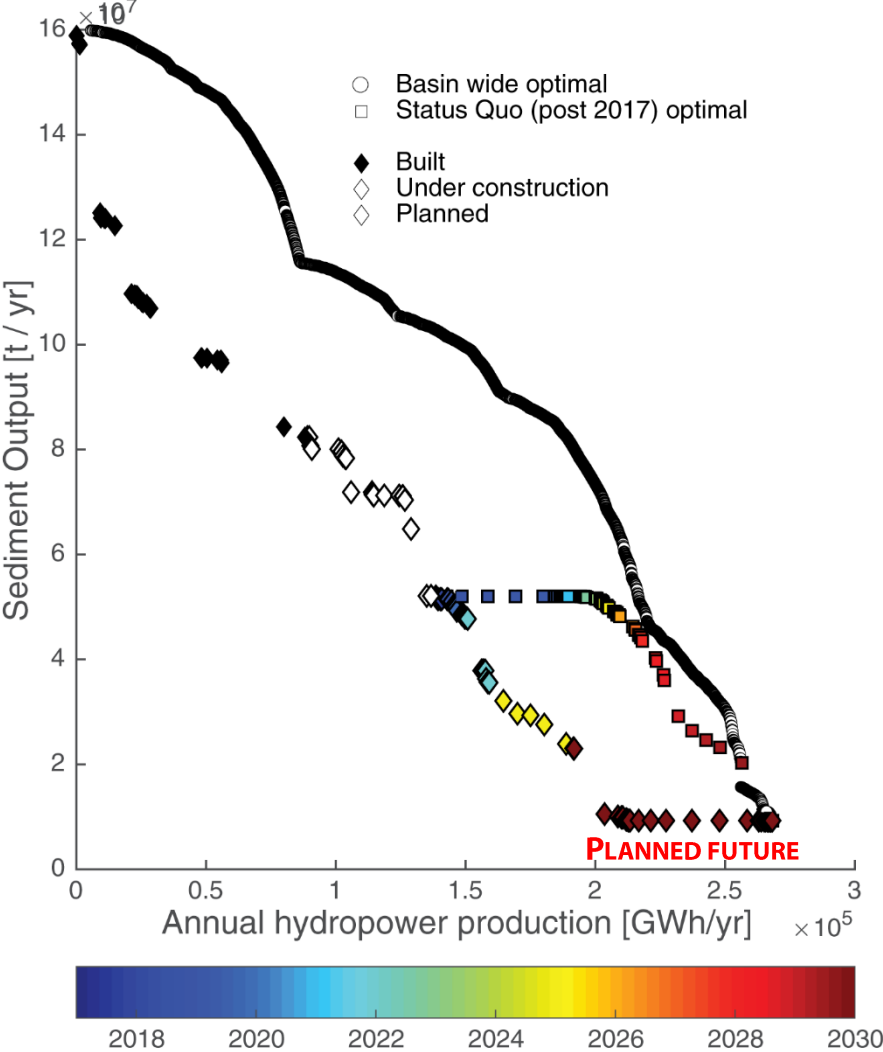
Strategic Portfolio Planning in transboundary river basins

Opportunities for better hydropower outcomes



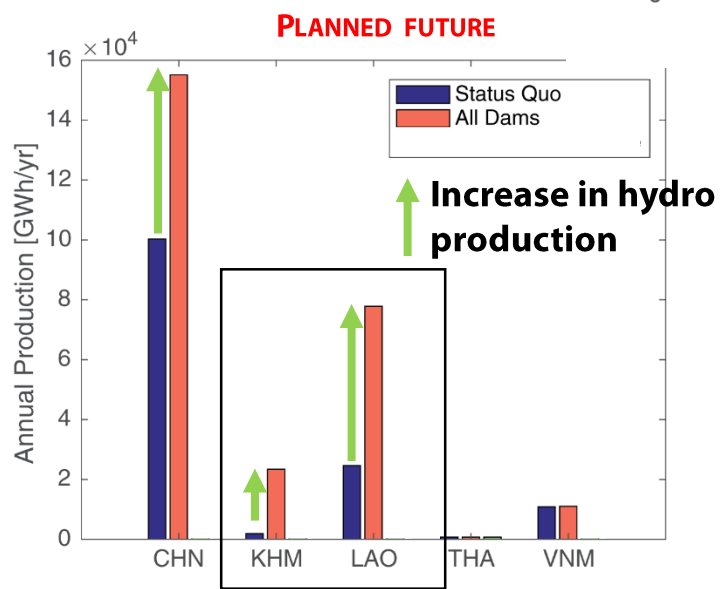
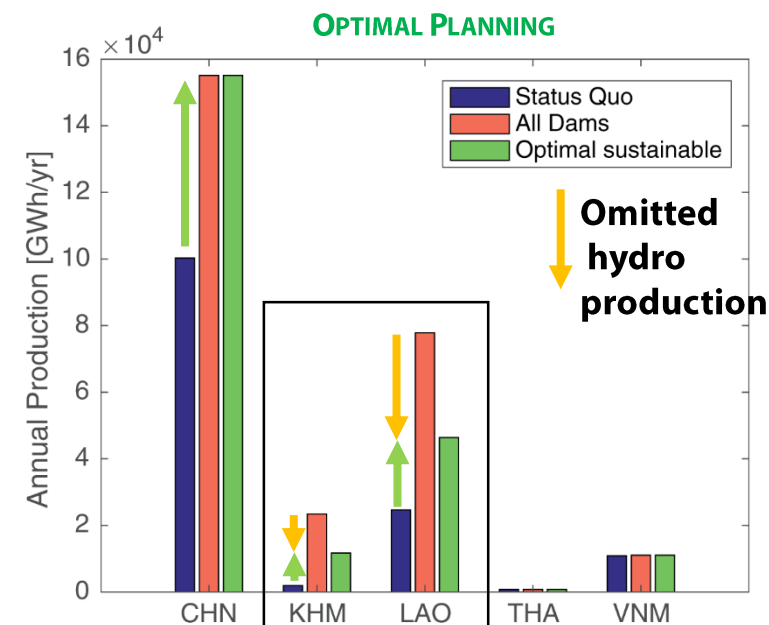
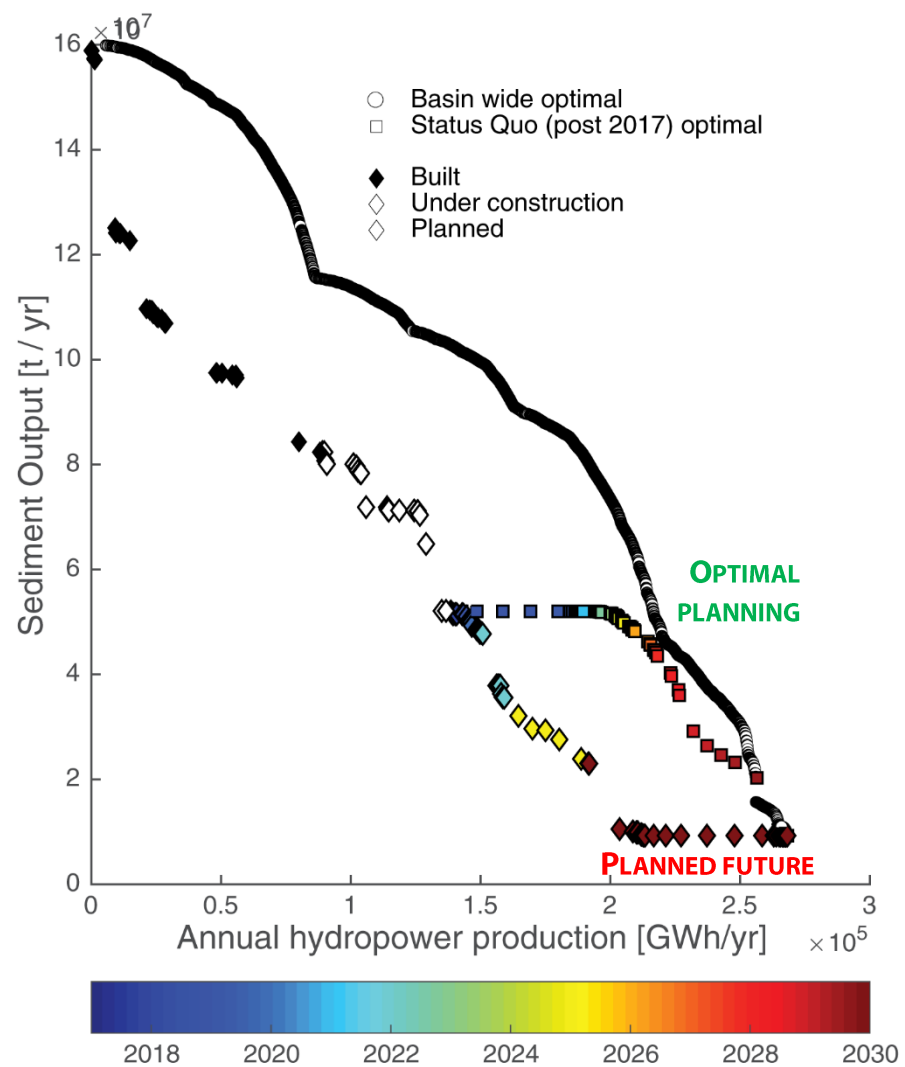
Strategic Portfolio Planning in transboundary river basins

Opportunities for better hydropower outcomes



Strategic Portfolio Planning in transboundary river basins

Opportunities for better hydropower outcomes



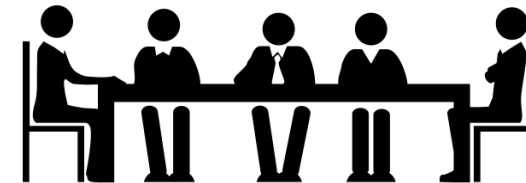
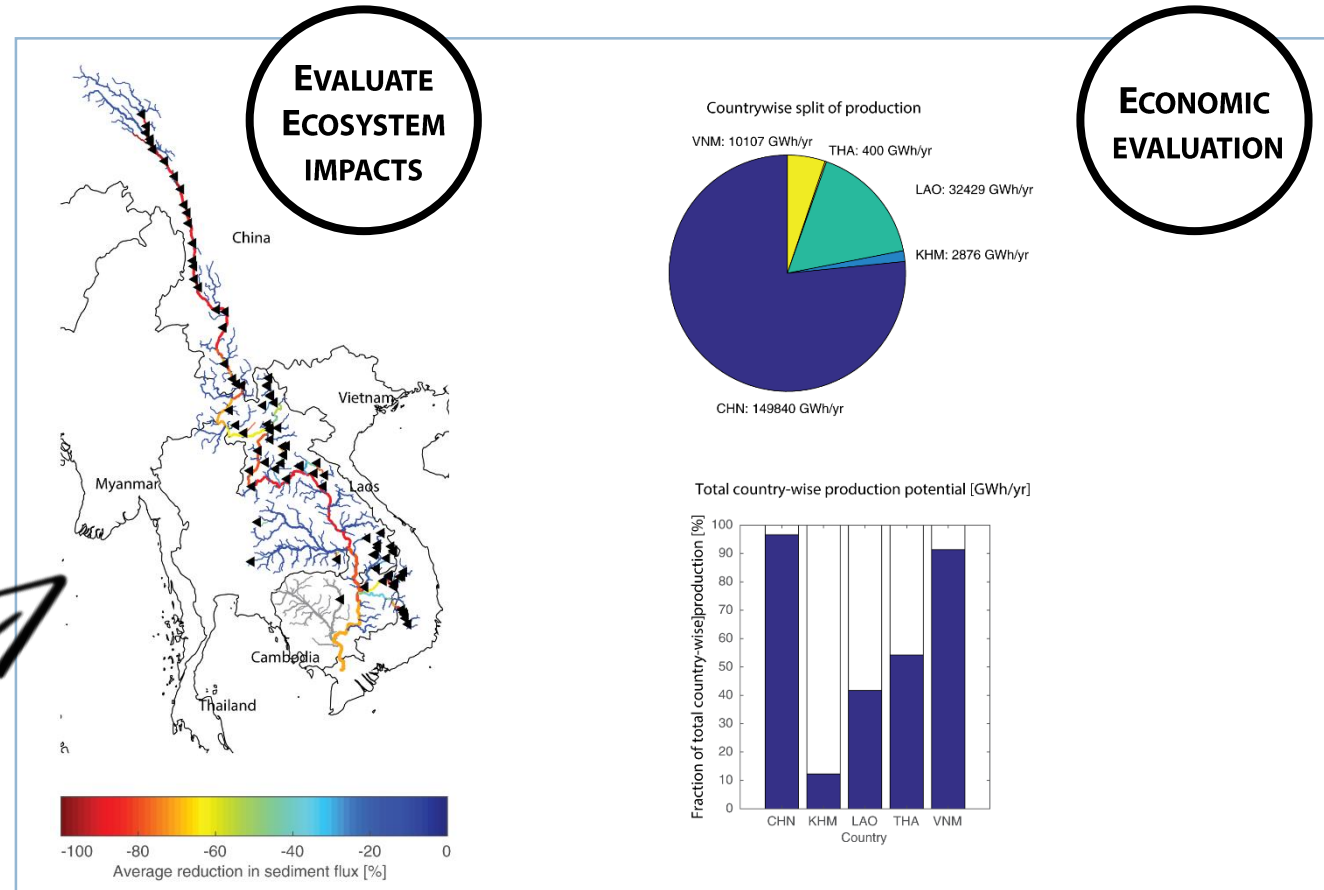
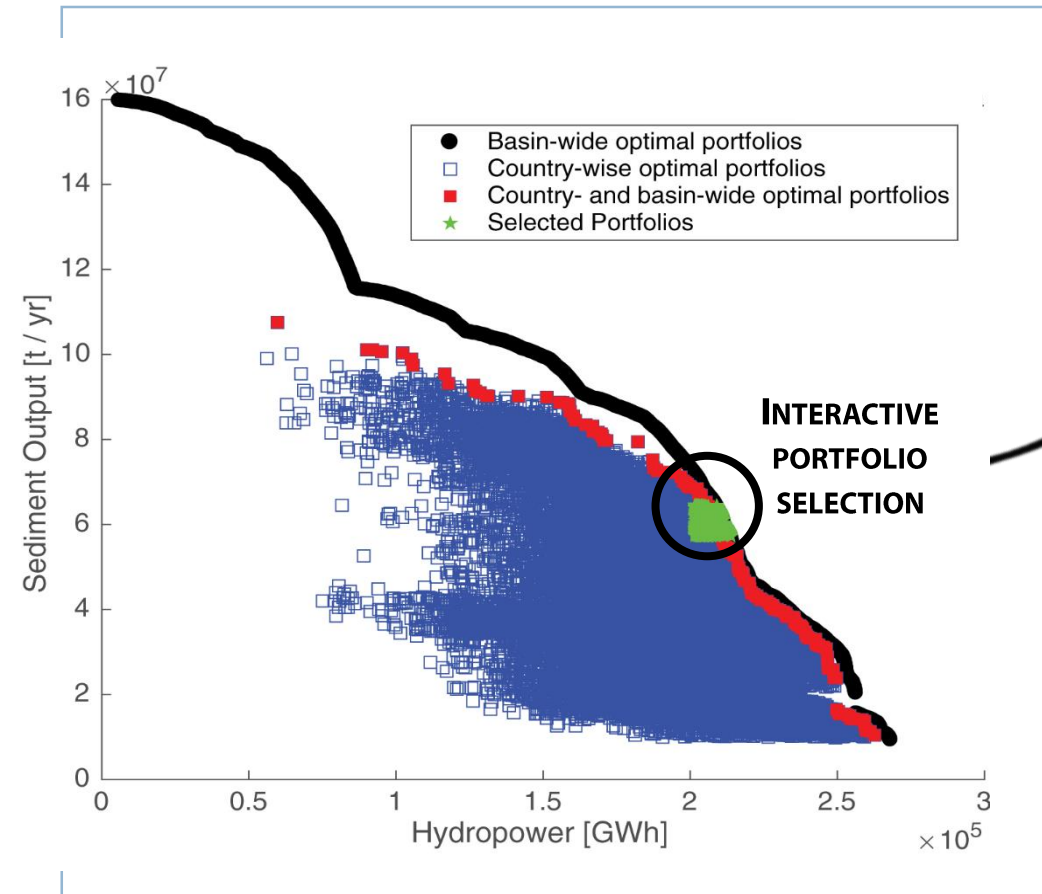
Downstream countries would need to omit part of their hydro – potential to reach optimal trade-offs

Strategic Portfolio Planning in transboundary river basins

Building sustainable hydro – a question of transboundary equity

Solutions

Model and optimization supported negotiations

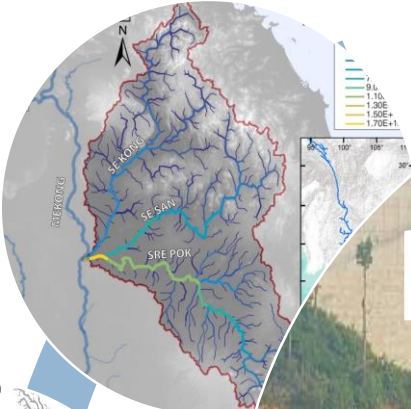


NEGOTIATE PORTFOLIOS AND POTENTIAL COMPENSATION

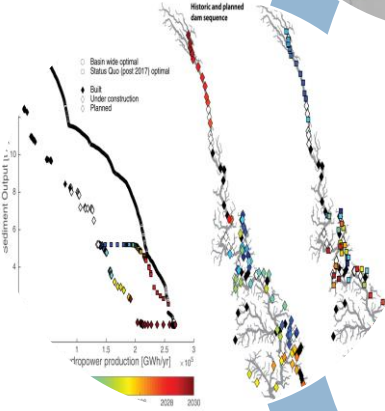
Conclusions

Strategic Portfolio Planning - The New Frontier in Hydropower ?

New models for river system functioning



Identifying better development pathways



Informing negotiations and decision making

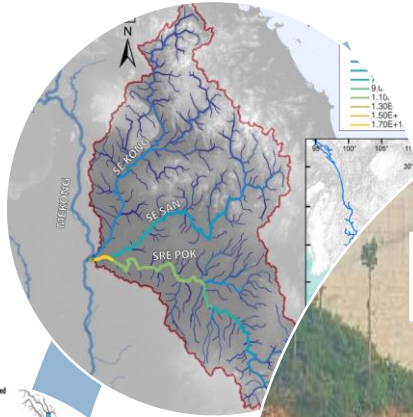


Conclusions

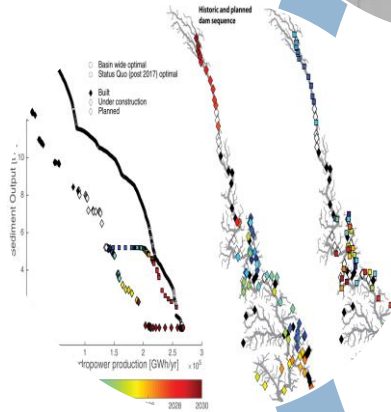
Strategic Portfolio Planning - The New Frontier in Hydropower ?

PORTFOLIO PLANNING Pathway to sustainable hydropower

New models for river system functioning



Identifying better development pathways



Informing negotiations and decision making



DATA, DATA, DATA

The understanding of natural processes determines quality of results



IT'S NOT ONLY SEDIMENT

Considering additional indicators and ecosystem values



IT'S NOT ONLY HYDROPOWER

System scale optimization Including other renewables and transmission strategies



Thank you!

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