

Integrated planning methods to identify dam portfolios that minimize environmental and climatic impacts of new African hydropower

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Introduction

Hydro +	Hydro —
dispatchable renewable	expensive
high energy, power capacity	GHG emissions of reservoirs
	fragment rivers

>300 hydro plants >100 GW are planned for construction in continental Africa

To address hydro's drawbacks & leverage its benefits, how can we plan portfolios that maximize hydro's benefits while minimizing its drawbacks?

Methods

2 Approaches Trading Off Between Hydro's Benefits and Drawbacks

- 1 Traditional Cost Minimization**
Minimizes costs over time; ignores externalities
- 2 Strategic Environmental Planning**
Internalizes externalities; doesn't account for other constraints

Model energy system development from 2020-2050 under 3 climate scenarios using an integrated planning approach

Integrated Planning Procedure

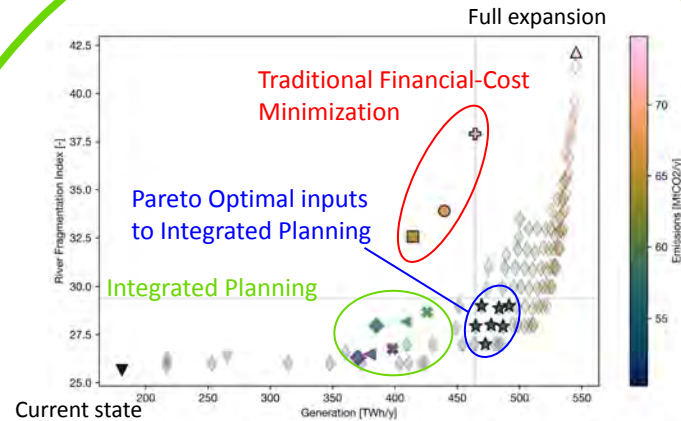
Combine Traditional Cost Minimization and Strategic Environmental Planning

Strategic Planning: Pareto-optimal dam portfolios minimize river fragmentation & GHG emissions, maximize generation

Select subset of Pareto-optimal portfolios with best tradeoff between river fragmentation, GHG emissions, generation

Traditional Cost Minimization on selected Pareto-optimal portfolios, minimize financial cost

Highlights & Impact



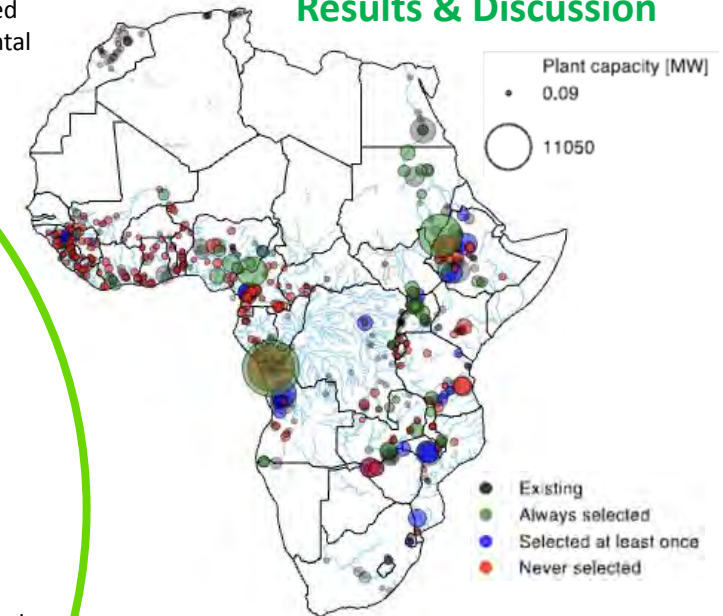
Hydro portfolios plotted by river fragmentation, annual GHG emissions, and annual generation, for different planning approaches: **Traditional Cost Minimization**, **Strategic Environmental Planning**, **Integration of both**

Compared to traditional planning, integrating traditional and strategic planning decreases river fragmentation by **5%** and GHG emissions by **10 MtCO₂/year** while increasing mean electricity prices by **<1.3%** and total discounted costs by **<0.7%**.

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Integrated Continental Portfolio

Results & Discussion



- 1 Traditional planning** minimizes financial costs over time, but doesn't take into account hydro's negative externalities
- 2 Strategic environmental planning** internalizes hydro's externalities, but doesn't account for cost of a less impactful system over time

Using an integration of traditional and strategic energy systems planning to build out hydropower, we can minimize regional ecosystem impacts, GHG emissions, and incremental cost to do so.