Setting the scene: how can hydro-economic models help policy making?

Hydro-economic modelling for transboundary river basin management

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Conflicts related to use of water:
- Agriculture
- Industries and mines
- Energy generation
- Domestic water use
- Environmental concerns and pollution

Non-coordinated planning of agriculture and hydropower developments

Political motivation driving the management of water resources

Competition, present or future, for the available water resources
# HYDRO-ECONOMIC MODELS

<table>
<thead>
<tr>
<th>WHAT?</th>
<th>KEY ASPECTS</th>
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<tr>
<td>• Address the interconnectedness between water supply and economic use of the resource at river basin scale</td>
<td>• Network representation of the physical basin</td>
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<td>• Tools to guide policymakers based on clear understanding of trade-offs arising from conflicting stakeholders’ objectives</td>
<td>• Consistent accounting of flows, water storages, diversions etc.</td>
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<td>• Representation of requirements for water and economic benefits from its use, considering both in-stream and off-stream uses</td>
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<td>• Incorporation of institutional rules and policies</td>
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<td>• Can be optimization or simulation based</td>
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## Model Design, Light and Shadow

<table>
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<tr>
<th>Design</th>
<th>Pros</th>
<th>Cons</th>
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<tr>
<td>Simulation</td>
<td>Conceptually simple; existing simulation models can be used, reproduces complexity and rules of real systems</td>
<td>Model only investigates simulated scenarios, requires trial and error to search for the best solution over wide feasibility region</td>
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<tr>
<td>Optimization</td>
<td>Optimal solutions can recommend system improvements; reveals what areas of decision space promising for detailed simulation</td>
<td>Economic objectives require economic valuation of water uses; ideal solutions often assume perfect knowledge, central planning or complete institutional flexibility</td>
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### Time

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<th>Pros</th>
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<tr>
<td>Deterministic</td>
<td>Conceptually simple: easy to compare with time series of historical data or simulated results</td>
<td>Inputs may not represent future conditions; limited representation of hydrologic uncertainty (just for a single sequence of events)</td>
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<td>Stochastic</td>
<td>Accounts for stochasticity inherent in real systems</td>
<td>Probability distributions must be estimated, synthetic time series generated; presentation of results more difficult; difficulties reproducing persistence and non-stationarity of time series</td>
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<tr>
<td>Dynamic</td>
<td>Considers time varying aspect of value; helps address sustainability issues</td>
<td>Requires optimal control or dynamic programming</td>
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### Sub-model integration

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<th>Pros</th>
<th>Cons</th>
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<tbody>
<tr>
<td>Off line</td>
<td>Easier to develop, calibrate and solve individual models</td>
<td>Each model must be updated and run separately; difficult to connect models with different scales</td>
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<tr>
<td>In line</td>
<td>Easier to represent causal relationships and interdependencies and scenario analyses</td>
<td>Must solve all models at once; increased complexity of holistic model requires simpler model components</td>
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A LITTLE QUIZ: WHICH ONE DO YOU WANT?

$1

$1
The standard objective of maximizing net benefits implies that each user:

\[
\operatorname{Max} \sum_{i=1}^{n} p_i x_i
\]

“For every user!”

“Whereas maximizing net benefits is compelling for the decision of individual agents, extending it to social decision making constitutes a moral leap of faith”

Griffin, 2006
NB maximization of one user might decrease the NB of other users.

Given the tradeoffs between multiple conflicting objectives, there exist multiple Pareto optimal solutions, i.e., solutions for which it is not possible to improve on the attainment of one objective without making at least one of the others worse.

Pareto efficiency is derived by maximizing the net benefits received by one agent subject to available water and to a required level for the benefits of other users.
Reach the Pareto Frontier and choose a socially and politically agreed solution.
WHY POLICYMAKERS SHOULD USE HEMs?

Make a complex system easy to grasp: HEMs show the impact of possible natural, technical, institutional changes on the whole water system

Comprehensive: HEM can include the interests of multiple stakeholders and show trade-offs

Include uncertainties: HEM can show the likelihood of the occurrence of certain outcomes

Policy-driven: If developed with stakeholders, HEM can answer critical policy questions and show the impact of policy changes

But how can models have the desired policy impact? How can policy and science be more integrated?
POLICY CYCLE – WHERE RESEARCH FITS

Issues and related policy goals can be of a general nature, or they can be social, economic and environmental (with the latter being more relevant for UNEP).

Policy evaluation makes use of the indicators identified in the first two steps, to evaluate the effectiveness of the intervention and the emergence of unexpected impacts and trends.

Policy formulation analysis focuses on issues and opportunities and on the broader advantages and disadvantages of policy implementation.

Decision-making is based on the results of the policy formulation stage, and should account for the forecasted impacts of policy implementation on the environment, the economy and overall well-being of the population.

IT IS NOT THAT EASY…

“But this *is* the simplified version for the general public”
BARRIERS TO SCIENCE – POLICY COMMUNICATION

- **Timeframes**: policy cycles and research agendas may not match
- Different **vocabularies**, meanings and understandings of terms
- Policy makers may not have the **expertise or the time** to consult with experts or access information from academic research
- Science includes **complexity and uncertainty** while policy makers are required to make specific policy legislation
- Different **decision making criteria**: building coalitions and balancing VS problem setting and narrower frame of choices
- **Confusion** among different disciplines and options
BEST PRACTICES

• Engage since the start, work on assumptions and scenarios together, communicate frequently

• Overall principle: transparency
  • Provide information on data sources
  • Include quality assessment of data sources
  • Show how data was collected

• Clarity in presenting:
  • Why the model fits the purpose
  • The model assumptions and structure
  • Results graphically and in an immediate manner
  • Uncertainties around results

It is a marathon, not a sprint

Hydro-economic models representing the physics, constraints and objectives of water systems to help water managers **assess and formulate** policies

Integrating science and policy is complex and is a process that should start from **issues identification**, to policy formulation and its evaluation

Beyond best practices, we will **share** practical examples of how HEM can effectively inform policies

We count on you: today it is time to **learn** and share experiences
THANK YOU

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