Fostering Resilience through evidence-based water policies: the role of river basin authorities

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One of the goals of the Numerical Modeling – Policy Interface (NMPI) Network is to assess the value of numerical models in water management and policy domains. To this end NMPI is committed to the development of novel methodologies that blur the boundaries between the social and engineering sciences with the aim of ensuring constructive dialogue within and between the disciplines. FoResilience is a pilot case study that utilizes the unique role of river basin management authorities as brokers that use models to advice policy to evaluate adaptive management processes within selected river basins. The issue of environmental flow requirement is used as a backdrop.

Numerical Modeling – Policy Interface Network (NMPI) Secretariat

Introduction, Target Basins and Objectives

Introduction - A great deal of investment both financial and otherwise has been made into water resources research over the last couple of decades. There is no doubt immense contributions have been made to global efforts to holistically manage water resources especially considering the threat posed by climate change. Models have played a significant role in this effort especially in computer-based simulation research. Recently, the effective impact of numerical models in the development of robust climate-proofing policies to foster resilience has been questioned. There is a growing list of literature that seems to suggest a disconnect between the modeling sciences and the policy world. River Basin Authorities (RBA) present a unique opportunity as test-beds where numerical model output can be stress-tested and their effluence on policies assessed.

Target Basins

The Arkansas
The Arkansas Basin in Colorado extends from the headwaters of the Arkansas River in Leadville to the Kansas-Colorado state line. The semi-arid nature of the lower basin has meant a long history of constructing diversion and storage structures in the mountainous western reaches of the basin, and using the Arkansas River as a conduit for this water to the lower basin. The Lower Arkansas river is a highly engineered hydrologic system, with 5 major reservoirs and over 440,200 acres of irrigated agricultural dependent on the river's natural flow (CSU 2007(1)). 34 cooperative, incorporated canal companies maintain over 1,600 km of ditches, diverting over 866,000 m³ of water annually for consumptive use (Gates et al. 2006).

The Rhine
At 1320 kilometers the Rhine is the longest river in Europe. It rises in the Swiss Alps issuing from the Rheinwaldhorn Glacier 3,353 m above sea level. It flows generally north, passing through or bordering on Switzerland, Liechtenstein, Austria, Germany, France, and the Netherlands before emptying into the North Sea at Rotterdam. Its important tributaries are the Aare, Neckar, Main, Moselle, and Ruhr rivers.

The Volta
The Volta Basin is located in West Africa and lies within latitudes 5o.30 N and 14o30 N and longitudes 2o.00 E and 5o.30 W. The main channel is 1400 km and it drains 400,000km² of the semi-arid and sub-humid savanna area. The basin lies mainly in Ghana (42%) and Burkina Faso (43%) with minor parts in Togo, Cote d´Ivoire, Mali and Benin.

Ghana occupies the downstream part of the basin. A dominating feature of the basin is Lake Volta, which is the largest man-made in the world in terms of surface area (4% of total area of Ghana). The lake was created to generate hydropower at Akosombo and Kpong (1060MW), which is 100 km north of its estuary.

The Yellow River
The Yellow River is called "the cradle of Chinese civilization", as its basin is the birthplace of the northern Chinese civilizations and is the most prosperous region in early Chinese history. The mainstream of the Yellow River traverses North China from the west to the east covering nine provinces and autonomous regions: Qinghai, Sichuan, Gansu, Ningxia, Inner Mongolia, Shaanxi, Shanxi, Henan and Shandong. The nationalities living within the river basin include the Han, Hui, Zang and Mongol, with a total population of 107 000 000, accounting for 8.6% of the national population.

Research Objectives

The objective of the research is to examine the role of RBAs as agents of positive change in a bid to develop robust strategies to mitigate climate change. In the initial stages of the work, three river basin management entities will be selected in a case study format. They include the *Yellow River Basin Commission (YRBC)* in China, the *Rhine River Commission (RRC)* in Western Europe and the *Volta Basin Authority (VBA)* in West Africa. In the fourth river basin, the Arkansas in the United States, basin management is undertaken within a sectoral framework without a centralized decision-making entity. The latter provides a control for the proposed methodology. Environmental flow requirement (to foster resilience) will form the basis of the subject matter to be addressed in each river basin.

FoResilience Target Basins

- Arkansas River Basin
- Rhine River Basin
- Volta River Basin
- Yellow River Basin

Methodology and Participation

Figure 1: Strategy to assess the efficacy of applied numerical models

1st Phase Duration: 6 months
- Refine and harmonize main project concepts from multidisciplinary and basin stakeholder perspectives
- Development of logical Framework
- 1st joint-fact finding session
- Delineation of governing decision-making and bio-physical processes

Intermediate Product 1

2nd Phase Duration: 6 months
- Numerical model needs assessment / Determination of policy relevant uncertainty (implications for confidence levels)
- Basin specific policy process analysis (Figure 2)
- 2nd joint-fact finding session (definition of resilience)
- Configuration of Agent Based System for actor analysis / Configuration of LiNK Algorithm*

Intermediate Product 2

3rd Phase Duration: 6 months
- **Benchmarking**
  i. Efficacy of numerical models deployed
  ii. Response of policy process to numerical tools
- 3nd joint-fact finding session (Figure 4)
- Basin specific recommendations
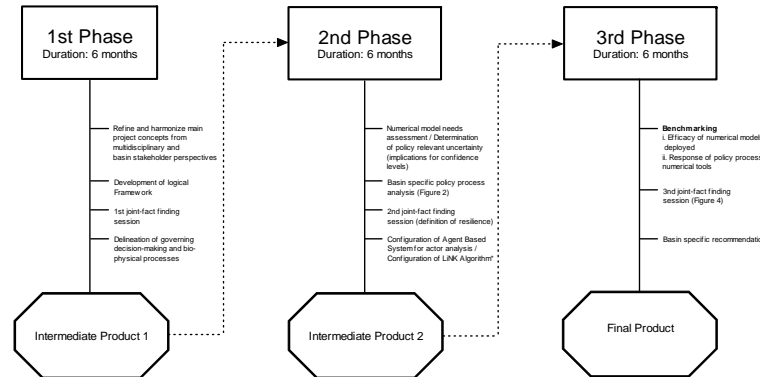
Final Product

Figure 2: Policy Analysis Approach (based on Blaikie 2001)
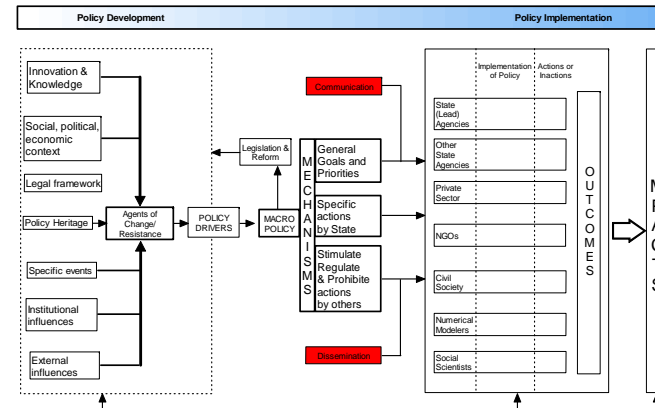

Figure 3: Overview of Basin Characteristics

Basin	Area (sq.km)	Population	Presence or absence RBA	Boundary	Precipitation Regime	Annual Flow Interruption	Perception of MFR
Arkansas River	76 000	0.85 Million	No	Trans-statal	Snow Rain	Minimum	Moderate
Rhine River	185 000	50 Million	Yes	Trans-national	Snow Rain	Minimum	High
Yellow River	752 000	107 Million	Yes	Trans-Provincial	Snow Rain	Seasonal	Moderate
Volta River	400 000	19 Million	Yes	Trans-national	Rain	Minimum	Low

Outlook & Remaining Challenges

The selected rivers basins allow the objectives of the study to be undertaken in very different socio-economic as well as biophysical conditions. The latter is expected to ensure robustness of methods and tools to be developed. The Rhine hosts a well established commission with significant levels of experience in a highly industrialized setting. The Volta and the Yellow river basins can be described as developing and transition basins respectively, both with functioning RBAs. The fact that the management entity in the Volta is in its infancy presents an opportunity for the study. The focus of the research in the Arkansas presents a particularly challenging but scientifically appetizing prospect. The complex mix of a fiercely-defended system of decentralized decision -making and entrenched water rights makes the Arkansas Basin in Colorado a fascinating study of basin governance, particularly since this is a time of change: an historical lack of adaptive capacity is potentially being addressed by a new consciousness of the value of collaborative planning. In contrast to the other basins studied, the Arkansas in Colorado has no unifying authority or regulatory structure capable of migrating funds and human resources to addressing threats to the basin's hydrologic resilience, and so resilience adaptations must be achieved through collaborative work both in achieving and implementing agreements. The study may yield insights into alternative means of governance in the face of climatic change, putting the other basin studies into context.

Some of the questions "FoResilience" is expected to answer include:
- How can modelers improve the level of trust needed by stakeholders to achieve uptake?
- How can the ability of numerical biophysical models to assimilate information provided by environmental flow data be determined?
- How can policy-relevant uncertainty be estimated – what confidence level is needed?
- How can model performance be benchmarked in light of the uncertainties in modeled and measured values? Taken a step further, how does the latter affect the confidence levels in policies or management options formulated with the assistance of model output?
- How can language barriers that currently exists amongst numerical modelers and social scientists be broken?

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Figure 4: Imbedding Expert Opinion in Numerical Modeling Processes