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Editorial

Social sciences and hydrology: An introduction

Water resources management is increasingly uncertain. This is not only due to increasing competition for access but also because of increased uncertainty about the resource because of climate change. Both these issues are underlined by increasing populations, changes in settlement patterns, evolving environmental values, demands for justice in allocation and the changing nature of the world economy. Over the past twenty years there has been the development of the concept of basic human rights in terms of access to adequate quantities and quality of water resources for all. Water supply, sanitation and hygiene programs have emerged in the light of unacceptable health outcomes from current water management. At the same time large scale development of water resources has continued with projects such as the Three Gorges Dam and threats to groundwater in terms of quantity and quality have occurred through mining and overexploitation, sometimes due to ignorance about the resource and lack of governance.

All of these developments have implications for the questions to be asked by hydrologists and the means by which they are addressed. Uncertainties within hydrology provide major challenges such as those from data limitations and climate change that need to be addressed quickly within the increasingly rapid need for advice for decision makers and politicians. More and more hydrologists are being drawn into providing the background for "evidence based" policies in terms of water planning and allocation. While providing this evidence however it is increasingly the case that the conflicts associated with water sharing and water quality vulnerability have an effect on the professional practice of hydrologists. If decision making processes or institutional frameworks are perceived to be inadequate by the affected stakeholders the "hydrological evidence" is disputed and the issue of lack of trust in science becomes an important one. Climate scientists in many countries can attest to that.

If hydrology is to continue to have a beneficial impact on the water resource and the community it needs to seek to place itself in partnership with social scientists. The obligation is mutual, social scientists can only provide benefit for water problems if they have access to sound hydrological knowledge. This is not to say that there is a need to develop a new sub-discipline of socio-hydrology. Good solutions for the wicked problems posed by sustainable water management will require wider interdisciplinary approaches.

In this volume we present a wide variety of social science applications to water based problems. The insights include studies involving economics (yes it is a social science!), perceptual and behavioural studies, decision making, decision science, social values, social psychology and politics. The purpose of the volume is not to turn hydrologists into social scientists but more to use disparate examples to encourage hydrologists to seek partnerships with social scientists when they are in an area of obvious social or planning import. In the future this will be almost universally the case. If the discipline of hydrology is to grow and increase its benefits to the public it will increasingly require these partnerships.

We have chosen to order the papers according to their relationship to the water cycle. Some of the papers show how more formal statistical or modelling techniques can assist in integrated analysis while others deal with more qualitative approaches to values and conflict. Social scientists can help hydrologists in choosing the most appropriate directions in this regard. The need and growing demand for such an integration is very well reflected in kind of response we have received for the social sciences special issue call for papers. The response was overwhelming considering the reputation of the Journal of Hydrology as a purely scientific one. More than 40 papers were received on various socioeconomic aspects of hydrology. The normal peer review process of the journal has been followed to screen the papers. The reviewers recommended 15 papers for final publication in the special issue. These papers are grouped under four important aspects viz., policy modelling, surface water, sub-surface or groundwater and environment/climate change and water.

1. Policy modelling

The role of policy making is to achieve socioeconomic and/or environmental objectives of water resources management. Designing a good public policy is a complex process when governments translate political vision into programmes and actions to deliver desirable change. This is one of the main reasons for the failure of public policies in delivering and gaining public support. Identifying the main stages of such process and constraints is critical for designing effective policies. The Murray–Darling Basin Plan (MDBP) experience is used to highlight key stages in formulating effective natural resource policy and identify key problems or difficulties that need to be managed to maximise social acceptance. It is argued that the need for public policy primarily arises from a lack of perfect knowledge, which causes individuals and agencies to behave in ways that are not in the best public interest. Effective public policy formulation needs strong evidence, expert analysis to verify that evidence, and an understanding of knowledge gaps such that critical interventions can be agreed upon. Agreement also has to be reached in terms of how the interventions will be managed and resourced. The MDBP experience suggests that complexity can be managed when highly variable resources flow across political boundaries. This is despite the relationships between users being mis-represented or misunderstood, and/or the analysis of hydrological scale and scope being incomplete and complicated

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by future uncertainties about climate variability. It is highlighted that there are opportunities and challenges for hydrologists, economists and other social scientists to develop synergies in assisting the policy process. This facilitates in minimising the burden of information constraints in making effective natural resource policy (Loch et al., 2014).

Given the quintessential nature of water across space and utilities, political economy factors come into the fore while provisioning new water services at the regional and local levels. Integrating these aspects with the hydrological features is a necessary condition for effective policy making. Moving away from the natural resource centric approach often adopted by modellers and incorporating socio-political order can provide alternative solutions. On the backdrop of an example from a French water course the social contingency of the construction of water indicators has been highlighted. Incorporating political premises and geographical biases it is shown that several alternate model framings are possible. Using such models different scenarios are built reflecting different social orders in the context of specific biophysical aspects. Such an approach is desirable as opposed to the dominant approach that does not pay any attention to the social construction of the problem (Fernandez et al., 2014). Similarly, policy, institutional and governance arrangements to deal with water management are important even in the context of water markets with climate change uncertainties (scarcity) (Wheeler et al., 2014) and also in the management of domestic water (Panagopoulos, 2014).

A very important socioeconomic and political aspect that influences hydrological processes are changes in land use. Land use and land cover changes take place due to socioeconomic reasons such as cropping pattern changes; changes in agrarian structure; public interventions related to land and water conservation (watershed treatment) and so on. Often hydrological studies or models do not include these aspects or influences on hydrology, though they are highly relevant in understanding changes in hydrological responses. This is very well captured in the case of the Lake Naivasha basin. The recent changes in the land use and land cover in the basin exacerbated by socio-economic drivers have been studied using simplified cascade models. It is observed that the upstream land use changes have increased the runoff substantially. The influence of upstream land use and hydrological processes explain the downstream lake storage and sediment variations. It is observed that where socio-economic developments are substantial, coupling socio-economic factors to hydrological processes can greatly improve our understanding of the eco-hydrological processes of a catchment (Odongo et al., 2014).

2. Surface water

Glacier fed watersheds are facing increased uncertainty in surface hydrology in terms of quantity and consistency. These hydrological changes could generate problems for agriculture, irrigation, hydropower, subsistence farming, livelihoods, and tourism economies. In order to identify, understand, model and adapt to these climate-glacier-water changes, it is vital to integrate the analysis of both water availability (the domain of hydrologists) and water use (the focus for social scientists). This integration of social science and hydrology helps illuminate how glacier runoff is actually utilised in downstream communities – as well as which factors influence that water use and how human water use influences downstream hydrology. Drawn from a case study of the Santa River watershed below Peru's heavily glaciated Cordillera Blanca mountain range, a holistic hydro-social framework was used to identify socioeconomic and political variables that must be considered for hydrological modelling. These include: (i) political agendas and economic development; (ii) governance: laws and institutions; (iii) technology and engineering; (iv) land and resource use; and (v) societal responses.

Water usage is not necessarily linked to its availability. It is observed that notable shifts in Santa River water use (expansions in hydroelectricity generation, large-scale irrigation projects, etc.) did not necessarily stem from changing glacier runoff or hydrologic shifts, but from changing human demands (socioeconomic variables). Glacier runoff conforms to certain expected trends predicted by models of progressively reduced glacier storage. However, societal forces establish the legal, economic, political, cultural, and social drivers that actually shape water usage patterns via human modification of watershed dynamics. The hydro-social framework provided here has widespread implications for hydrological modelling in glaciated watersheds across the world, as well as for the policy makers developing climate change adaptation plans (Carey et al., 2014).

Awareness is critical for minimising unexpected and unknown impacts of hydrological events. Community awareness of flooding plays a major role in decision making in urban flood plains. The community level awareness appears to have stronger linkage with creating policy and initiating protection works. Modelling the interplay of community awareness, flooding damage and economic growth can provide optimum solutions. The model incorporates the feedbacks between the hydrological and social system components. In the model, the community can address flood risk either by moving away from the river or by building flood protections. The model results indicate that maintenance of awareness strongly affects the long term prosperity of the community. The model provides an optimum level of community awareness, which maximises the economic growth of the community. This model underlines the fundamental role of awareness building in Integrated Flood Risk Management (Viglione et al., 2014).

3. Sub-surface/groundwater

Sustainable groundwater use and management is the most challenging of the water resources. Groundwater is not only the single largest source of use (irrigation, drinking and industry), but vulnerability is also due to lack of information among users. Knowledge about groundwater has been the domain of hydrologists and often shared with stakeholders and communities in scientific terms. Besides, the scale at which the information is generated in most countries is not appropriate for the end users, often small farmers, due to the wide variations in aquifer structure. Groundwater resources play a valuable part in agricultural production in regions where surface water resources are limited or dwindling. Two contrasting stories of Australia and India provide insights on how farmers adopt when information on groundwater is available or not, especially when coping with severe drought situations. In both the regions farmers are the biggest users of groundwater and hence the main stakeholders in the quest for sustainable management of this resource. How well they understand the nature of the resource, where their farms occur in the aquifer system, how diversion limits are calculated, where the water comes from and how the aquifer behaves are of vital importance to them. After all, they invest hundreds of thousands of dollars in their bores, pumps, power supplies and irrigation equipment.

In the two regions of Australia (Victoria) where groundwater resource management plans are available, groundwater users are quite familiar with their resource due largely to their exposure to groundwater resource management plans that started in the late 1990s. The stakeholders recognise the need to have management plans and the majority of them believe that the plans have been effective. The social licence to implement these groundwater management plans arose in part through some good consultation processes run by the responsible authority, but also because sufficient

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