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Editorial
Economics at a River Basin Scale

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Water is vital for human life. It is an irreplaceable input for producing energy, food and virtually any good and service, and it is essential for all ecosystems which depend on the sustained provision of water to maintain life, the economy and human wellbeing (WWAP, 2015). All this makes water a special economic resource that must be managed accordingly (Hanemann, 2006).

Managing water as an economic resource requires collective action, institutions, and processes capable of managing all water related ecosystems "in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems" (GWP, 2000). This is precisely the ambition of Integrated Water Resources Management (IWRM).

Potential and actual conflicts or trade-offs are connatural to managing water. Therefore, keeping to the promise of IWRM requires institutions able to deal with many complex trade-offs. This is the case, for instance, of choosing among alternative uses of water across all the different locations where it might provide valuable services. Allocating water implies putting quantity and quality in balance. All water decisions must consider that covering current demands should not be in contradiction with securing future supplies, and overall should not expose society to unacceptable levels of droughts, floods, land-slides, water-borne diseases, and other water related risks.

Informing complex water management choices requires decision support systems able to integrate scientific knowledge at an appropriate management scale. In fact, most water governance failures can be traced back to a wrong decision in the choice of management scale. For instance, managing water on a use-by-use or sector-by-sector basis may lead to uncoordinated demands in excess of the overall capacity of the water supply system in place. Similarly, responses designed at the level of an aquifer, a lake or a river can only be considered as some of the many pieces to be adapted and put together into an integrated management plan. But, on the demand side, a lack of coordination may preclude water users from opportunities to reap the welfare gains of a better integrated water resources management. Breaking institutional silos might help to avoid failure, enhance cooperation among water users, promote mutual insurance, and identity win-win solutions across water policy sectors. This is the basis for an abundant literature on the water, energy, food and climate change nexus (Setegn and Donoso, 2015).

However, no unit seems to be ideal for managing water comprehensively. This is true for hydrology as well for economics. Rainfall and runoff processes can be fully accounted for within the limits of a catchment area, but often the catchment is not a closed system. Infiltration to groundwater bodies across water catchments and evaporation to the atmosphere connects the catchment to wider hydrological processes affected by pollution, climate regulation, etc. Water markets are similarly closely connected, and the direct impact of water interventions lead to spillovers across activities and borders. Additionally, all water services that humans enjoy from natural capital—compounded with physical, human, and social capital—are not just the product of either a water system or catchment manager, but the complex outcome of virtually all the ecosystems that intervene in the regulation of the water cycle at a planetary level. If anything, the ideal appropriate scale for managing scarce water resources is that of the whole planet.

Typically, the river basin is accepted as the most convenient scale for managing water. This is certainly an appropriate scale at which water policy decisions can be agreed upon, and thus one at which knowledge must be integrated to support management choices. Therefore, the river basin scale is ideal for applications of economics, hydrology, ecology and other water related disciplines, which comprise suitable common ground to convey the best of data and scientific knowledge to the policy arena.

With regard to the economics discipline specifically, it is not the broader research objectives or its methods that define the economics of a river basin scale; rather it is economic instruments that can be put to good effect. These instruments can be defined through a systematic effort of screening the relevant pieces of economics with better potential to inform policy decisions, and by the adaptation of these instruments by policy makers to support them in the challenge of providing a more comprehensive and better integrated response to societal water challenges.

The papers of this special issue illustrate the sort of contributions economics can make to the management of water at a river basin scale, and the kind of adaptations that need to be introduced to enhance the effectiveness of the contribution of economics to the science-policy dialogue.

Making economics count for improved water management requires identifying the clear distinction between the instrumental means and the end objectives of water policy. The end objectives are not just a matter of science, but of a social agreement. In the real policy arena, water policy objectives are the outcome of collective decision processes. This is because water is a very special economic resource with services defined by pervasive externalities (involving quantity and quality), which are linked to a wide range of public goods (such as food, health, personal and water security). Any water management decision implies complex trade-offs (e.g. between downstream and upstream, economic activities, present use and future availability, etc.), and thus important opportunity costs. All these particularities make competition and unregulated markets unsuitable for allocating water. In this context, prices and other market-based instruments cannot be seen as means to reap the benefits of competition and well-functioning markets, but as part of the toolbox to govern water and serve the agreed objectives of water management (Lago et al. 2015*)*.

One way or the other, water management refers to the preservation of the capacity of water systems—including ecosystems, infrastructure, institutions, and human capital—to provide an agreed set of water services. This implies a clear set of environmental objectives expressed, for instance, as the desired status of any water body in the river basin (EC, 2000). These objectives reflect a social agreement which balances different alternative criteria and includes efficiency, fairness, implementability within the existing institutional set-up, social acceptability, etc. (Burnett et al. 2015). Economics is a powerful tool to highlight the welfare consequences of current practice, and to inform about the welfare advantages of alternative courses of action to get the desired set of outcomes—as well as the potential gains of redefining current water policy objectives. The primary reason that economics is included in the science-policy link is not because it can inform what the objectives of water management should be, but rather because it can help choose appropriate means to reach socially-accepted objectives.

The five papers of this Special Issue represent a relevant sample of the kind of economic models and theories that can be used to inform policy making and integrated water resources management.

Gómez et al. presents what can be considered the foremost measures that economics might offer to improve water governance: incentives and economic policy instruments. The main hypothesis is that, in the context of river basin management, economic instruments can be better defined as a means to address water governance failures. Ultimately, the status of water ecosystems is the result of decisions made by individual water users based on what anyone considers his/her best interest under a given set of circumstances. Incentives and economic instruments, when properly designed and applied, intend to align these individual decisions with the collectively-agreed objectives of water policy.

Once framed in the context of water governance the analysis of economic instruments shifts from setting the necessary conditions to the right price or the best functioning market which should identify incentives with the best potential to reconcile individual actions towards collective ambitions of sustainability, fairness, and efficiency. According to Gomez et al., making economic instruments work for integrated river basin management involves wide institutional change, collective action at different levels, and then the need to factor in the analysis of transaction costs in their design and implementation. This perspective offers a new and promising framework to make, prices, charges, water trading and cooperative agreements work for managing water scarcity at a river basin scale.

Integrated management must be based on integrated knowledge. Regarding water quality, Bourgeois' paper offers and illustrative example of how abstract and applied models can integrate hydrology, biology, and economics to support decision making in the case of groundwater nitrate concentrations in the Seine river basin. The paper offers a combination of abstract economic and environmental models, on one side, with quantitative applied agroeconomic and hydrological models on the other. The first set of models allow an understanding of the rationale behind economic decisions; in this case intended to maximize profits from use of fertilizers minus the resulting damage to groundwater, and any impact on the dynamics of groundwater pollution concentrations. The second kind of model allows the empirical implementation of theoretical models. In his paper, Bourgeois targets concentrations as the optimal decision of the policy maker, and this critical assumption allows matching abstract theory with empirical observations. In this way, the optimal theoretical model can be calibrated with the data of the study area to make the abstract decision theory work for the analysis of optimal and alternative pathways to reach the given policy target (the quality objective of groundwater bodies).

Besides model integration, the reverse optimization methodology presented by Bourgeois illustrates how economics can offer much more than comparing alternatives using straightforward cost-effectiveness analysis. For instance, in line with the paper by Gomez et al., the methodology developed by Bourgeois allows deducing the optimal tax path leading to the desired target, and then assessing welfare losses resulting from alternative pathways. Going one step further, Bourgeois' method allows evaluation of the marginal social value of the damage; and thus the opportunity costs of setting more stringent pollution concentration targets.

Economics at a river basin scale is driven by water management challenges. Coping with most of these challenges implies putting in the balance the value of water for producing market goods in the economy, and for producing natural services in ecosystems. As a contribution to cope with these policy tradeoffs, the paper from Qureshi et al., provides a comprehensive methodology to understand the economic value of irrigation water in the Murray-Darling river basin. The value of water obtained by using standard residual value methods develops an innovative methodology, that combines Monte Carlo simulations and probability theory to estimate the combined impacts of biophysical and economic shocks on the value of irrigated water; and to thus obtain relevant information to compare alternative policy responses to both water scarcity and droughts. Such information can assist policy decisions aimed at taking advantage of the potential welfare gains of water reallocation for recovering environmental flows, curbing water scarcity trends, and mitigating drought exposure.

Qureshi et al.'s paper can also be taken as an illustrative example of how traditional methods must be adapted to better support policy making. Rather than average values, the potential of a well-established residual value approach to measure the productivity of irrigation water to guide policy decisions crucially depends on its' capacity to explain differences across crops, locations and, most importantly, among dry and wet periods. The stochastic approach developed in this paper overcomes these limitations and allows development of the kind of risk analysis required to assess measures to enhance adaptive capacities in the face of climate variability.

Economics at a river basin scale in the age of climate change requires methodologies able to assess pathways to enhance the capacity to adapt to uncertain water supplies. Livia Rasche et al.'s paper can be taken as a contribution toward understanding and assessing the welfare gains of coordinating investments and infrastructure within long-term water planning. These gains can be significant, even in countries such as Colombia with relatively-abundant water resources, but short on infrastructure to mitigate the impacts of climate change over future water supplies.

Rasche et al., apply their model to the Magdalena-Cauca river basin in Colombia and use it to compare the outcome of coordinated and uncoordinated actions across three different climate change (and rainfall and runoff) scenarios. Integrated river management includes allocations of water use rights through licenses and prices on one side, and investments in infrastructure across political jurisdictions on the other. The results show that gains from centralized planning may be higher than the costs of building climate change adaptation infrastructure. Yet, coordinated responses require a central planner with immediate and unrestricted access to information, while uncoordinated responses require continuous updates of information and adaptive changes in investment decisions. The institutional changes required to enhance coordination are out of the scope of their paper, but integrated models such as the one offered by Rasche et al. illustrate the significant welfare gains that may result from improving policy cooperation and better integration of water management instruments in the face of climate change.

Rainfall and runoff takes place within the limits of the river basin, but the associated economic interactions occur at smaller and wider scales. A proper understanding of economic impacts of water conservation and degradation processes requires coupling models that inform about different market scales. Dionisio Pérez-Blanco et al. offer a good example of model integration at micro and macroeconomic levels, to assess the impacts of more stringent water use allowances for irrigation. Their methodology, applied to the Po River Basin in Italy, brings together micro models to inform farmers' adaptive behavior and assess direct impacts in situ, and macroeconomic models, to assess wider indirect impacts at a regional and national levels. The integration of models allows understanding how the negative direct impact at farm or irrigation district levels is amplified at a river basin level by negative spillovers to industries that use agricultural products or supply inputs in the agricultural sector. These negative effects are somehow compensated by positive feedbacks nationwide, propelled by supply deficits originated in the river basin.

The analysis of the asymmetric economic impacts or water restrictions on Po river basin agriculture provides Pérez-Blanco at al. with a reason to review the wide array of micro and macroeconomic models used to inform water resources management, and to propose practical ways to connect them and understand how the impacts of water restrictions spill over within and among sectors and regions.

Summing up, the papers in this Special Issue are all examples on how economic analysis can be adapted to better inform policy making. All of the papers can be seen as problem-driven approaches to convey the potential of economic analysis in a way that can be taken by stakeholders and policy makers to integrate knowledge and deal with the complex tradeoffs that are connatural to managing water at a river basin scale. They cover a review of the critical role of economic instruments in managing water worldwide (Gómez et al.), the management of water quality in France (Bourgeois), responses to water scarcity and droughts in Australia (Qureshi et al.), policy coordination in Colombia (Rausher et al.), and evaluation of economic impacts of water restrictions at different market scales in Italy (Pérez et al.). They provide a good sample of the virtually infinite opportunities of applied economic analysis at a river basin scale.

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