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Review Article

Integrating ecohydrology, water management, and watershed economy: case studies from Brazil

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ABSTRACT

In this essay the authors discuss the integration of ecohydrology, water management practice and watershed economy as fundamentals for the new water governance paradigm. The "nature's software" – ecohydrological processes and resulting ecosystem services should be coupled with 'human hardware' in the form of civil and hydrotechnical engineering, ecological engineering and ecosystem biotechnologies in a template of hydrosocial cycle adapting to the global changes. The competent and adequate water governance requires as a priority water security for the human population and for ecosystem functioning. Three case studies from Brazil are presented in order to illustrate how this integration has been realized so far, and the benefits for ecosystems and economy are presented. The case studies are: the Lobo Broa reservoir project, the sustainable management of the Pantanal wetland, and the São Francisco River Basin Management Plan. The practical results of these conceptual approaches are discussed and future research needs are identified.

1. Introduction

Water quantity, water quality and proper water governance are the fundamental assets for water security. Water security for human populations, as well as for ecosystem functioning and for food production is at the center of the sustainability process (Rogers et al., 2006; Caradonna, 2014; Young et al., 2015a,b). Because water resources are under permanent and increasing pressure from multiple uses, climate change and growth of human population, new water governance is necessary in order to face the challenges ahead. It is widely recognized today that the economy of a watershed is largely dependent upon water resources availability from surface and underground sources, and that the human induced changes in land uses, deforestation, and water contamination, to mention just few, have impaired the water availability with strong consequences on the economic development and sustainability. Water shortage due to climate change and other factors related to human activities cause impacts on the economy of watersheds as demonstrated for example for the Barcelona drought in 2007–2008 (Martin-Ortega and Markandya, 2009), or for São Paulo State, Brazil drought of 2013–2014 (Tundisi, 2015).

Therefore, the objective of this essay is to demonstrate the ways of integrating the ecohydrological knowledge with watershed management practice and its positive effect on the watershed economy, taking into account three case studies from Brazil. Details are left to the quoted references and the reader should be able to assess from these the validity of the judgements made.

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2. The relationship between water cycle and economy

Water, being essential for all life – humans, biodiversity, biogeochemical cycles – has a direct connection with economy. As pointed out by Hanemann (2006) the essentialness of water is the root of this relationship. Either as a fundamental component of food production, energy or other uses as public water supply or recreation, as well as of industrial production, water is key for the economy of continents, regions and municipalities. There are other direct relationships of water and economy when considering the degradation on water quality and the cost of technology to recover the water for re-use (Tundisi et al., 2014, 2015a). Economy of industries that depend on water for production is strongly affected when the source is contaminated. The costs of water treatment increase by a 100% when the source of water is not protected by riparian forests (Tundisi and Matsumura-Tundisi, 2010). This implies also health issues. When considering the economic impact of water borne diseases and the amount of hospital bills related to these diseases in developing countries, the impact of water on the economy of these countries is clear.

A key tool used by economists in relation to water is the production function of water (Hanemann, 2006). At a watershed level the question is: is there enough water to sustain the present and future population and to maintain the economy at the watershed with production of food, energy and water supply? What will be the cost for the public in maintaining the complex array of water functions? The economic value of water as essential commodity has been emphasized by several authors such as Walker and Williams (1982), Rosengrant et al. (2002), Ward and Michelsen (2002), and Aguirre (2006). Therefore the water governance process should include the role of water in the present and future evaluations of the economy of watersheds.

Management of water sources is a key process in watershed economy due to the role that water cycle plays in maintaining the ecosystem services.

3. Application of ecohydrology and ecosystem services to water governance: case studies from Brazil

3.1. The Hydroelectric Power Plant (UHE) Carlos Botelho (Lobo/Broa) reservoir and its watershed (S. Paulo state, Brazil)

Lobo/Broa reservoir case study was established in 1971 as a model for ecological and limnological research to be applied in other watersheds/reservoirs of Brazil. From the initial descriptive research, the project evolved as an example of sustainable water governance (Tundisi, 1987; Tundisi and Matsumura Tundisi, 2013).

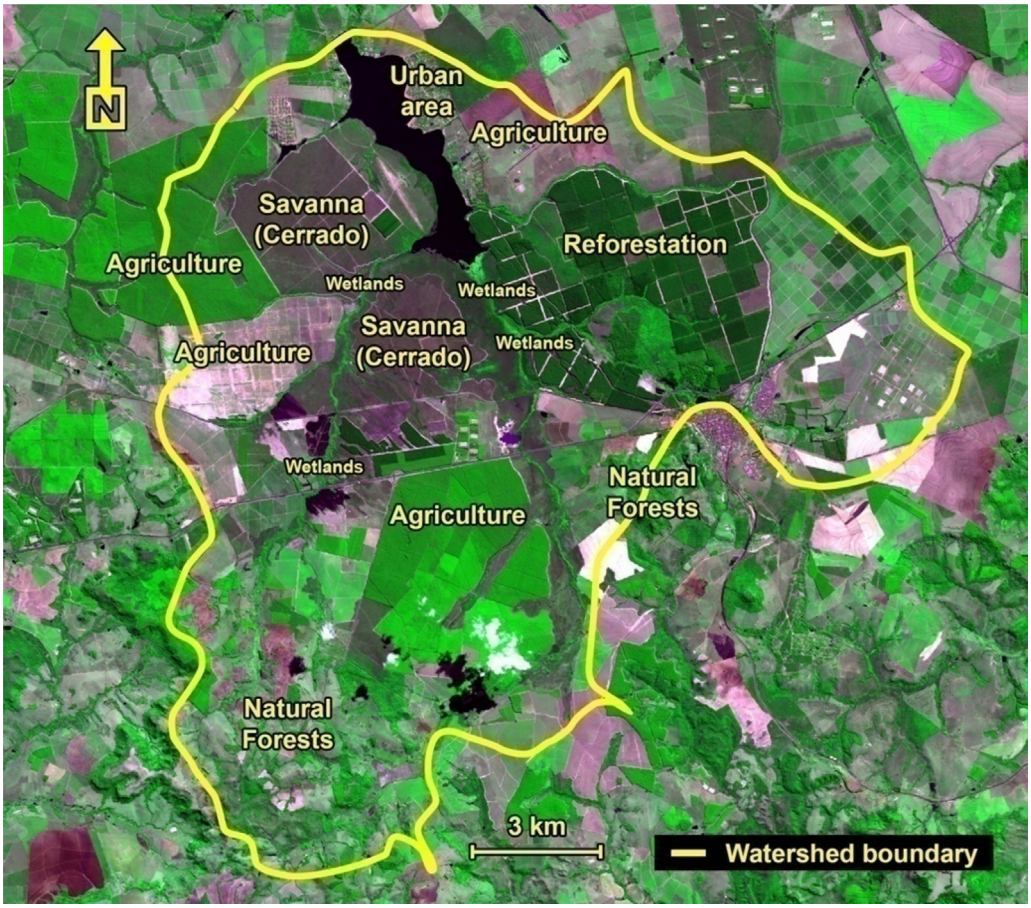

Fig. 1. A ALOS image of the Lobo-Broa watershed showing its main (Lat. 22°10′6.98 s) (Long. 47°54″10.5 s).