

Reservoirs and human well being: new challenges for evaluating impacts and benefits in the neotropics

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Received October 7, 2008 – Accepted October 7, 2008 – Distributed November 30, 2008

(With 1 figure)

Abstract

As in many other continents, neotropical ecosystems are impacted by the construction of reservoirs. These artificial ecosystems change considerably the natural terrestrial and aquatic ecosystems and their biodiversity. The multiple uses of reservoirs promote benefits for the human beings in terms of economic development, income, jobs and employment. Services of reservoirs are important assets for the regional ecosystem. Evaluation of ecosystem services produced by artificial reservoirs, are new challenges to the understanding of the cost/benefit relationships of reservoir construction in the neotropics.

Regulating and other services promoted by reservoirs lead to new trends for “green technology” and the implementation of ecohydrological and ecotechnological developments. This approach can be utilized with better success as a substitute for the usual impact/benefit evaluation of the reservoirs. Better and diversified services can be achieved with “green technology” applied to the construction.

Keywords: neotropics, reservoir, services, evaluation, cost benefit analysis.

Reservatórios e o bem estar humano: novos desafios para avaliar os impactos e os benefícios nas regiões neotropicais

Resumo

Regiões neotropicais são impactadas pela construção de reservatórios em várias bacias hidrográficas. Estes sistemas artificiais produzem consideráveis alterações nos sistemas naturais terrestres e aquáticos e na biodiversidade.

Os múltiplos usos dos reservatórios proporcionam muitos benefícios para as comunidades humanas, como desenvolvimento econômico, emprego, e renda.

Os serviços proporcionados pelos reservatórios são inúmeros e diversificados e são importantes bases sociais e econômicas para o ecossistema regional.

A avaliação destes serviços produzidos pelos reservatórios artificiais apresenta novos desafios para a compreensão da complexa relação custo/benefício da construção de reservatórios nos neotrópicos. Serviços de regulação, e outros serviços produzidos pelos reservatórios, podem ser uma rota fundamental para o desenvolvimento de tecnologias sustentáveis e a implementação de conceitos de ecologia e ecotecnologias. Esta abordagem pode ser utilizada com sucesso na substituição da abordagem usual de balanços benefícios/impactos da construção de reservatórios e proporciona novas oportunidades para avaliação adequada dos reservatórios construídos e das novas construções.

Palavras-chave: neotrópicos, reservatório, impactos, serviços, avaliação custo/benefício.

1. Introduction

The construction of reservoirs in the neotropics over the last 50 years has produced several changes in the natural terrestrial and aquatic biodiversity of ecosystems (Agostinho et al., 2008, in press). Straskraba and Tundisi (1999) gave detailed information on the impacts of reservoirs in the neotropical region, analyzing also the benefits from their construction. Reservoirs were built with several purposes such as hydroelectricity, recreation,

navigation, irrigation and fisheries. The benefits of reservoir construction were always considered in relation to their negative impacts such as the loss of biodiversity (aquatic and terrestrial), the decline in water quality of the river water and the social and economic changes induced by the construction.

In this paper the authors propose a new step in the assessment of reservoir construction in the neotropics that

is the evaluation of their services for human well-being according to the concepts of MEA (2005).

It is possible that by evaluating the services promoted by reservoirs for regional, local or national communities, this could be an innovative way for a more accurate analysis of their relevance (or not) to the regional or local system, providing a consolidated conceptual basis for future strategic plans on reservoir construction in the neotropics. It will also give alternatives for implementing public policies that provide conditions for sustainability of the projects for longer periods.

2. Reservoir Functioning Mechanisms and Connections Among Components

Reservoirs depend strongly on the interaction with the watersheds from the beginning of their construction: first, the watershed where the reservoir is constructed is a matrix of interaction between preserved areas, degradation of soil, water quality, biodiversity, multiple water uses. The future of the reservoir functioning depends upon these initial features and the further interactions with the watershed uses. In general, reservoirs are “attractors” of economic development, stimulate migration and promote a general re-organization of the regional and local systems. This has a consequence on the water quality and the multiple uses of the reservoir. The main features of the reservoir that have consequences on the relationship watershed/reservoir are: area of the reservoir/area of watershed; volume of the reservoir; morphometric characteristics: reservoirs with complex morphometry and many compartments are more subjected to impacts; retention time: the shorter the retention time, the better the water quality of the reservoir (Straskraba and Tundisi, 1999); spatial heterogeneity of the reservoir and the type of reservoir construction are other important features to be considered; biodiversity and wetlands in the reservoir are processes to be considered, in the services provided by the reservoirs, and in the watershed/reservoirs relationships.

3. Reservoir Services, their Evaluation and Diversification

Once construction is finished, the reservoir is utilized for several purposes. Based on Carpenter et al. (2006), a conceptual framework for reservoir services is presented in this paper. A theoretical framework for linking **ecological dynamics** of reservoirs to **ecological diversity** and **reservoir services** is needed and an attempt at this is given by Tundisi et al. (2008, in press).

Figure 1 describes this conceptual framework for reservoirs and the connections among local, regional and global scales. Most services are provided at a local scale, but reservoirs have an influence on regional processes and are influenced by them. Their global role can also be considered. Reservoirs are responsible for “greenhouse” gas emissions, and therefore they have an important role in atmospheric composition influencing global changes. (Abe et al., 2008).

Linking the changes in the socio-economic local or regional processes with reservoir aging and the diversification of their services is a task for managers and decision makers as well as research workers able to understand the connections between the **reservoir services** the **ecosystem dynamics** and their **value for society**.

The diversification of reservoir services occurs as these artificial ecosystems age, provided that the water quality is maintained and the overall degradation of the reservoir is prevented (Tundisi and Matsumura-Tundisi, 2008). The demands of the regional/local societies for ecological services are also relevant for the diversification of the services. In several case studies in Brazil, Tundisi and Matsumura-Tundisi, 2008, demonstrated how the services of the reservoirs diversified from a single or a few uses (such as fish production or hydro-electricity) to multiple uses that are a complex matrix of interactions consisting in several activities that make use of the (water supply) reservoir, the biota (fish, fisheries) recreation, navigation, tourism, irrigation and industrial use of water.

Evaluation of these services and their impact and interactions is a fundamental task for research workers and decision makers.

4. Conclusions

Despite the impact produced by their construction, in the neotropics it is relevant to consider that reservoir services related to human well-being are an economic and social asset if the project and the programme designed for their construction takes into account their future and potential services and the reduction of impacts upon their implementation. Therefore the evaluation of the reservoir services is fundamental for the analysis of the benefits of reservoir construction. Services provided by reservoirs can be, in some cases, much more valuable than the services of the original ecosystem removed by reservoir implementation in the neotropics. This has to be carefully evaluated including the indicators of these services. As discussed by Carpenter et al. (2006), a useful approach for indicators is to integrate biogeophysical observations with data on economic variables such as gross product or population and health information. New coalitions among disciplines are necessary as well an interdisciplinary approach with a systemic background MEA (2005). For example, Vergara (1996) has analyzed the value of the services of the Carlos Botelho (Lobo/Broa) reservoir located in São Paulo state, Brazil (Latitude and Longitude 22° 11' 39.58" S and 47° 53' 07.56" W) and concluded that a value of US\$ 250,000,000 (two hundred fifty million US dollars) was invested in 38 years in the reservoir watershed due to good water quality maintained thanks to ecohydrological technology implemented since 1971 (Tundisi and Matsumura Tundisi, 2008). Recreation, tourism, sport fisheries, water supply, hydro-electricity make up the diversified services provided by this reservoir over the last 30 years.

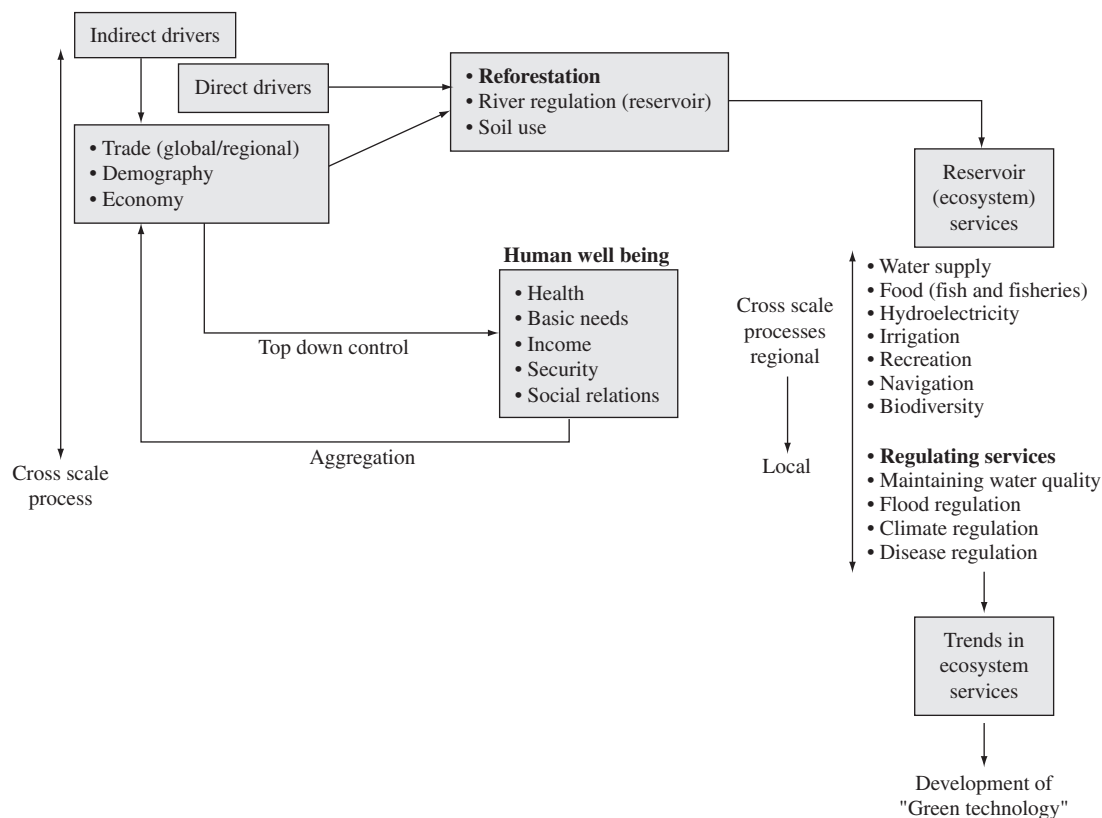


Figure 1. Conceptual framework for reservoir services and their interactions at global, regional and local scales (modified from Carpenter et al., 2006).

Making the best use of reservoir services is one of the objectives of a "green reservoir" or of "green technology" applied to reservoirs. In general the local/regional population has great expectations from reservoirs provided these artificial ecosystems promote better and sustainable (and diversified) services as compared to the natural system. This can be achieved with scientific and technological inputs promoted by previous studies during the project design. The introduction of ecohydrological and ecotechnological concepts in the design and operation of new reservoirs is thus a fundamental and strategic decision in the planning stages, enhancing the value of their services and benefits to human well-being.

Acknowledgements—The authors thank FAPESP, CNPq, FINEP for many years of support for their reservoir ecosystem work. The authors thank the Secretaria do Verde e Meio Ambiente, Prefeitura Municipal de São Paulo – Process number: 056/SVMA/2008 for the support to their work in the Guarapiranga/Billings reservoirs.

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