



Editorial: Reservoirs Ecology

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Water reservoirs have been built for more than 5,000 years in many locations around the planet for a range of purposes, from reserving water for supply and irrigation to flow regulation, aquaculture, leisure, navigation and hydroelectric power generation.

In Brazil the first reservoirs were built in the northeast region in early 1900s as means of minimizing water scarcity in this semi-arid region. The Bodocongó reservoir (Campina Grande, State of Paraíba) was one of the first built in the country and is deemed to be the birthplace of Brazilian Limnology based upon the studies of Stillman Wright, at the beginning of the last century (Esteves, 2011).

Reservoirs in Brazil began to be built on an extensive scale mainly for the generation of electric power and during the sixties, seventies and nineties medium and large scale reservoirs were built in practically all regions of the country.

The construction of the Itaipú reservoir, on the Paraná River, started in 1975 and was completed in 1982. The Jupia and Ilha Solteira hydroelectric plants, also in this river, were built between the middle of 1960 and completed in the second half of 1970. In the Rio Grande (States of Minas Gerais and São Paulo) several hydroelectric reservoirs were built between 1960 and 1970, including those of Furnas, Porto Colombia, Marimondo and Água Vermelha. The Tietê River (São Paulo State) features a cascade of reservoirs, five in number, built between the 1960s and 1990s. A similar scenario is seen in the Parnaíba River (States of Minas Gerais and Goiás) and in the Paranapanema River (States of São Paulo and Paraná), which each have more than five reservoirs in their main channels. The Iguazu and Uruguay Rivers (States of Paraná, Santa Catarina and Rio Grande do Sul) also have a series of cascade reservoirs, with more than five reservoirs in each river. Only in the Paraguay River Basin (States of Mato Grosso and Mato Grosso do Sul) there are few reservoirs.

In the Brazilian central region, the Serra da Mesa Reservoir, constructed in 1998, is one of the largest in terms both of area and of volume. The Sobradinho Reservoir, in the northeast region, was built between 1970 and 1980, whilst the Xingó Reservoir was inaugurated in 1994, both situated on the São Francisco River. After eighties large reservoirs were also built in the Amazon region, northern Brazil, such as Tucuruí, Balbina and Samuel. Of all these reservoirs mentioned, it is worth noting that several have more than 500 km² of surface area.

Reservoirs are dynamic and heterogeneous environments in terms of their spatial (vertical and longitudinal) and temporal gradients, characteristics related to the type of operation and the morphometry of the sites, among other factors (Nogueira et al., 1999, 2012). The construction of these environments



has caused several changes in rivers and in their surroundings, commonly intensified by the cascade effects of a sequence of reservoirs that can critically influence an entire watershed.

In the Upper Paraná River basin in Brazil, the introduction of a large number of reservoirs changed the environment and nature of the downstream stretches. In this region, an increase in water transparency was observed due to the retention of total suspended solids by the reservoirs (Henry & Maricato, 1996; Roberto et al., 2009). In addition, noticeable local and regional limnological effects occurred due to the control and regularization of the flow (Souza-Filho, 2009).

Following the construction of a reservoir, almost all aquatic communities are affected and must adapt to the new conditions or be excluded and replaced by others. Generally, the species of lotic environment are replaced by lacustrine species, including phytoplankton (e.g. Nogueira, 2000; Silva et al., 2005), zooplankton (Serafim-Júnior et al., 2016), ichthyofauna (Agostinho et al., 2007), amongst many others. Downstream of reservoirs, modifications to the physical and chemical variables (Naliato et al., 2009) in phytoplankton communities (Matsuura et al., 2015) and consequently in zooplankton (Portinho et al., 2016) can be observed.

The implementation of medium and large reservoirs also has social effects: removal of riparian populations by the filling of the reservoirs, effects on local fisheries, increases in criminality and prostitution (Parente & Miranda, 2014). On the other hand, the construction of reservoirs can generate local benefits with the establishment of leisure areas and increases in tourism, with navigable stretches of water often created.

Due to the rapid and intense process of reservoir construction the need to evaluate these “new” ecosystems and the ecological transformations arose. An aspect that deserves attention is that during the most intense period of reservoir construction in Brazil, in 1970 decade the creation of several Graduate Programs focusing on training limnologists took place. Worth highlighting here is the foundation of the Ecologia e Recursos Naturais Graduate Program (PPGERN) of the Universidade Federal de São Carlos, the Graduate Studies in Ecology of the Universidade Federal do Rio Grande do Sul, the Universidade de Brasília (UNB), the Instituto Nacional de Pesquisas da Amazônia (INPA), the Universidade Estadual de Maringá (UEM-NUPELIA), amongst others, all focusing on studying continental aquatic ecosystems (Esteves, 2011).

As a consequence of the construction of reservoirs and the training of researchers, in 1978 a large research project entitled “Typology of Reservoirs of the State of São Paulo” began. This project was coordinated by Prof. Dr. José Galisia Tundisi, and funded by the Foundation for Research Support of the State of São Paulo (FAPESP). In this project, 52 medium and large reservoirs were studied by researchers and students from the Universidade Federal de São Carlos, Universidade de São Paulo and the Instituto de Pesca (FAPESP, 2018).

The results of the limnological studies of reservoirs were presented at several scientific events including the Congresses of the Brazilian Association of Limnology. Specific events were also held, such as the Symposia on Reservoir Ecology, three decades ago, resulting in the release of a book in two volumes entitled “Limnology and Dams Management” (Tundisi, 1988). In 1994, R. Pinto-Coelho and collaborators published some aspects of the limnology of lakes and reservoirs of Minas Gerais State as a result of a scientific event in the previous year.

The third reservoir symposium was held in Botucatu (São Paulo State) in 1998, which resulted in a book, edited by R. Henry (1999), entitled “Ecology of reservoirs: structure, function and social aspects”.

The fourth scientific meeting took place in São Pedro (São Paulo State) in 1999, an international event resulting in a book edited by José G. Tundisi and Milan Straškraba entitled “Theoretical Reservoir Ecology and its applications” (Tundisi & Straškraba, 1999).

In 2004 the fifth round of the event was held in Avaré (São Paulo State), and had as main themes: potential impacts, management actions and systems in cascades. The subjects discussed were collected in a volume edited by Marcos G. Nogueira et al. (2006). The sixth event took place in the municipality of Itá (Santa Catarina State) in 2006 for an audience of 200 people.

The seventh and last Symposium (VII Symposium on Reservoir Ecology: challenges for management in times of change) was held once again at the Institute of Biosciences of UNESP in Botucatu, on October 9th to 11th 2017. 180 people participated in this event, amongst them researchers, teachers, students and professionals in the field, discussing and presenting results on reservoir ecology topics.

The present thematic section in *Acta Limnologica Brasiliensia* assembles some of the lectures and other studies presented at the event. The papers involve biological communities and environmental and limnological variables, indexes for communities, as well as opinions about the role of academia on limnological advances and extensive and relevant reviews.

Zaniboni-Filho et al. (this section) carried out a review on opportunities and challenges for fish culture in Brazilian reservoirs, with a wide review of articles between 1977 and 2018. Bianchini-Júnior & Cunha-Santino (this section) give an opinion on how the scientific community can contribute to the management of reservoirs, by contacting the academy's great contribution potential in determining water quality, greenhouse gas inventories, quality simulation of the water using mathematical modeling and experiments upon the growth and decomposition of aquatic macrophytes.

In the case of phytoplankton Vicentin et al. (this section) studied the ecological potential of a reservoir using the phytoplankton community, pointing to the impairment of water quality through potentially toxic species in response to eutrophication of a reservoir. In relation to zooplankton, Longato et al. (this section) indicated that for these organisms the richness-area relationship is not always evident, having size limitations in natural and artificial lakes. Silva et al. (this section) obtained interesting results on the vertical migration of Cladocera in a tropical reservoir compartment, with remarkable effects of thermal and chemical stratification. About ichthyofauna, Castro et al. (this section) compared the fish diversity of two lake environments, one being an artificial lake located in São Paulo city and the other being a marginal lake of the Paranapanema River. Marques et al. (this section) address the restoration of ichthyofauna through passages to these organisms, with a case study based on beta diversity. Smith et al. (a) (this section) analyzed the change in the composition of species in the middle and lower reaches of the Tietê River with historical data, emphasizing introduced and rheophilic species. Smith et al. (b) (this section) present a study on the trophic structure of the fish community in the middle and lower reaches of the Tietê River, concluding that the trophic characteristics found vary according to each type of reservoir, introduction of exotic species and alternative sources of resources. In another paper on ichthyofauna, Petesse (this section) presents the step-by-step approach to the development of a fish-based multimetric index with case study for a Neotropical cascading system.

At the end of this section it is expected that the content gives an overview on the ecological study of reservoirs. The works contained herein serve as a basis for management measures of these environments and the planning of new ones, no less important for human development. We also wish to stimulate further studies of reservoirs and stimulate the continuity of the Symposium of Reservoir Ecology in Brazil.

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