

Three dimensional heat transport modeling in Vossoroca reservoir

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Freshwater reservoirs are used for many purposes as hydropower generation, water supply and irrigation. In Brazil, according to the National Energy Balance of 2013, hydropower energy corresponds to 70.1% of the Brazilian demand. Superficial waters (which include rivers, lakes and reservoirs) are the most used source for drinking water supply – 56% of the municipalities use superficial waters as a source of water. The last two years have shown that the Brazilian water and electricity supply is highly vulnerable and that improved management is urgently needed. The construction of reservoirs affects physical, chemical and biological characteristics of the water body, e.g. stratification, temperature, residence time and turbulence reduction. Some water quality issues related to reservoirs are eutrophication, greenhouse gas emission to the atmosphere and dissolved oxygen depletion in the hypolimnion. The understanding of the physical processes in the water body is fundamental to reservoir management.

Lakes and reservoirs may present a seasonal behavior and stratify due to hydrological and meteorological conditions, and especially its vertical distribution may be related to water quality. Stratification can control heat and dissolved substances transport. It has been also reported the importance of horizontal temperature gradients, e.g. inflows and its density and processes of mass transfer from shallow to deeper regions of the reservoir, that also may impact water quality. Three dimensional modeling of the heat transport in lakes and reservoirs is an important tool to the understanding and management of these systems. It is possible to estimate periods of large vertical temperature gradients, inhibiting vertical transport and horizontal gradients, which could be responsible for horizontal transport of heat and substances (e.g. differential cooling or inflows).

Vossoroca reservoir was constructed in 1949 by the impoundment of São João River and is located near to Curitiba – Brazil. It is monomictic and its function is to regulate the flow to Chaminé hydropower plant. Vossoroca is monitored since 2012. Temperature is measured with seven temperature sensors in the deepest region of the reservoir and meteorological data is measured on a station close to the reservoir. The objective of this work is the 3D modeling of heat transport in Vossoroca reservoir with Delft3D. Temperature gradients between surface and bottom of Vossoroca reservoir during summer may reach 10°C, with surface temperatures around 25°C. Vossoroca is mixed during winter, with temperatures around 15°C. Based on these results, the position of the oxycline can be reconstructed. This information may lead to an adapted reservoir management, minimizing the potential effects to the downstream ecosystem, which normally can be strongly affected by the exposure to oxygen depleted water.