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CLASSIFICATION OF HYDROLOGICAL CHANGES RESULTING FROM DAMS IN ITAPICURU AND PARAGUAÇU RIVERS

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Abstract

This study aims to classify changes in hydrological regimes of Itapicuru and Paraguaçu rivers and their tributaries resulting from the implementation of dams, elaborating methodological procedure for such purpose as well. This effort is expected to collaborate with river basin management in Bahia state, including actions for conservation and recovery of rivers. The methodology used to perform the classification of changes in hydrological regime of rivers impacted by dams consists on obtaining series of altered flows, application of the Indicators of Hydrologic Alteration and classification of changes using the Dundee Hydrological Regime Alteration Method. The research is under development, having performed simulations of "naturalized" and altered streamflows by dams. Statistics of hydrological events is still going to be calculated in order to adapt the classification methodology to local characteristics, and further evaluation of the degree of hydrological changes will be performed.

Keywords: Hydrological variability, patterns of variation, changes classification hydrological

Introduction, scope and main objectives

In terms of environmental effects, regulation of the flow is considered one of the major consequences of the implementation of dams and reservoirs, with serious adverse ecological results (Poff et al., 1997). Altering the natural flows of water can interfere with or disrupt biogeochemical cycles and ecological processes. In order to mitigate the negative effects of reservoir operation, researchers and planners of water resources are increasingly interested in adapting these operations to the deployment of ecological flow (Lehner et. al., 2011). Such initiatives should be part of the actions necessary for a river restoration program.

River restoration involves many dimensions including the scope of the entire river basin, which must be holistically understood and integrally considered. The environmental, physical, social and economic dimensions cannot be treated separately. Therefore, it is important to evaluate hydrological, ecological and socio-economic data all together due to the need for synthesis of elements of these areas of expertise, enabling the understanding of the spatial and time multiplicity of the interactive impacts by dams (Nilsson et al., 2005). Nevertheless, authors such as Pringle et al. (2000) explain the difficulty of predicting the impacts of dams on biota and the organisms' response due to the lack of ecosystems data.

Changes in water systems caused by the implementation of dams, as well as their magnitude and involved dimensions, and the tools to quantify such impacts have been the focus of many works (Richter et al, 1996; Burke et al, 2009). Methodologies for classification of these changes have also been proposed (Richter et al 1998; Black et al, 2005). Such methodologies are expected to help in interpreting impact assessments and as guidance for efficient ecological monitoring, prevention and correction of damages to river systems. This way, the investigation of the resulting changes from these waterworks gains considerable importance, since results of such research are essential to support policy, environmental licensing processes, technical dam projects, planning and managing the use of water resources and river recovery programs.

These studies become more relevant in large river basins in which the monitoring, prevention and correction of impacts are hampered due to their extension. Paraguaçu and Itapicuru rivers are examples of the context of large river basins altered by human intervention. These basins are considered of great importance for the Bahia State due to its size and to the human activities that depend on their ecosystem services. However, even constituting important river systems, they lack good hydrological data, what difficult efficient management of its resources.

Facing this context, this study aims to classify changes resulting from the implementation of dams in the hydrological regime of Itapicuru and Paraguaçu rivers and its tributaries, discussing and elaborating methodological procedure for such in order to collaborate with the management of river basins of Bahia State and actions for conservation or recovery of rivers.

Methodology/approach

The methodology used to perform the classification of changes in hydrological regime of Itapicuru and Paraguaçu rivers due to dams comprises: obtaining "naturalized" and altered streamflow series, application of the Indicators of Hydrologic Alteration (IHA, Richter et al. 1996) to obtain statistics of hydrological events, and the classification of changes using the original Dundee Hydrological Regime Alteration Method (DHRAM, Black et al., 2000) and its version adjusted to local characteristics.

WEAP21 was used to generate the data sets that represent the changed conditions. This model has optimization and simulation modules, and operates with the basic principle of water balance accounting and it is applicable to sub-basins or complex river systems. The model was calibrated based on historical data for periods prior to the dams: the period 1963-1991 for Itapicuru river and 1963-1990 for the Paraguaçu river. The "naturalized" input streamflow series were obtained by simulation of the MGB model under the Project LARGE DAMS HYDROLOGICAL IMPACT ASSESSMENT IN THE STATE OF BAHIA – GRANBAR, for the Itapicuru river (Fontes et al., 2013), and under the project CLIMATE CHANGE AND WATER RESOURCES IN BAHIA (Genz et al., 2011) for the Paraguaçu river.

Eleven river cross-sections were considered, each one corresponding to the identified dams: Ponto Novo, Pindobaçu, Aipim e Pedras Altas in Itapicuru river, and Apertado, Bandeira de Melo, Baraúnas, Casa Branca, Pedra do Cavalo, França and São José do Jacuípe in Paraguaçu river.

The time series were computed by the IHA software to analyze changes in the regimes, carrying out comparison statistics of central tendency and dispersion of each aspect that characterizes the flow regime with outstanding relevance for river ecosystems (POFF et al., 1997). The IHA generates 33 statistical parameters taking non-parametric analysis, which are summarized for characterizing the resulting variability after implantation of the dams.

Based on the results from IHA, the classification of changes in the hydrological regime of Itapicuru and Paraguaçu rivers was performed by using DHRAM. The classification method of hydrological changes DHRAM, proposed by Black et al. (2005), assesses the degree of changes in river flow regime under human intervention in relation to reference conditions. It uses the percentage change of measure of central tendency and dispersion of each IHA group of parameters to assign points of impact accordingly to lower, intermediate or higher thresholds. The points of impact are added up and a classification is made: Class 1 (non-impacted condition), Class 2 (low risk of impact), Class 3 (moderate risk of impact), Class 4 (high risk of impact) and Class 5 (severely impacted condition). Finally, the thresholds used for assigning points of impact will be reassembled in order to represent more closely the characteristics of the studied hydrographic regions, permitting comparison between results obtained from original and adapted versions of DHRAM.

Conclusion: expected results

A measure of "natural" hydrologic variability of the streamflow regimes will be presented, which is explained for usual variabilities in climate, soil and vegetation states, among other random aspects.

The classification of the impacts caused by the eleven dams by both methods, the original and the adapted, shall permit an evaluation of the similarity, or not, of them.

As the main result of the explained analysis, it is expected to obtain a new version of the impact classification method – DHRAM, more properly suited to applications in similar regions as the Paraguaçu e Itapicuru basins.

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