Transboundary water Environmental Impacts Assessment of River Basin Transboundary Projects in Arid and Semiarid Regions: a Case Study between Projects of Brazil and Argentina

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ABSTRACT

The projects of river basin transboundary has been increasingly used because of the demand for water supply and multiple uses. This research aims to evaluate the environmental impacts of river basin transboudary projects in arid and semiarid regions, taking into account the strategic importance of the Integration Project of the São Francisco River Basin in Brazil and the Trasnfer from Río Grande to Rio Atuel in Argentina, for the development. The Integration Project of the São Francisco River Basin is a project to development the water infrastructure in order to guarantee the water supply of about 12 million people that live in the semiarid region of Brazilian Northeast. The study of environmental impacts identified 44 impacts, including 23 considered most relevant. The project of the river basin water transfer from Río Grande to Río Atuel means the incorporation of a discharge, in a first step, of 24 m^3/s, increasingly in two times natural water supply. Some environmental impacts can be indentify inside the Rio Grande basin and there will be other impacts over the target basin (Río Atuel). These impacts can be minimized by the adoption of integrated management strategies that enable the mitigation of the problems inherent to the water degradation and satisfy the expectations of the users within the context of sustainability. It is expected that the results achieved with this research subsidize the improvement of the management of reservoirs, contributing to the maintenance of water quality in accordance with the environmental legislation and the people's life quality.

KEY WORDS: *Environmental impacts, water management, semiarid regions, south america.*

INTRODUCTION

The humanity faces, since its origin, the effects of inadequate water management in semiarid region and its economic and social consequences. The projects of river basin transboundary has been increasingly used due to the demand for water supply and multiple uses. These projects are already being performed for a long time in various places in the world as a way to get water where there is scarcity of this resource. They have several environmental programs that cover various areas of study and give the support needed to monitor and minimize the potential impacts.

This extreme inequality in the geographic availability of water, leading to shortages, with special emphasis on the semiarid, where the climate has a well-defined by a dry season with high temperatures and a large interannual variability of rainfall (Rosado & Morais, 2010b). The physical and climatic conditions of the semiarid region (geomorphology, soil formation, irregular distribution of rainfall and consequent water scarcity), lead to the formation of a river network, that consisting mainly to intermittent rivers. This characteristic influences the quality and availability of water in the region.

The construction of dams to create water reservoirs, continues to be the most recurring option as a way to get water where it is needed (Morais et. al., 2009). These projects have emerged in response to the growing need for water despite the impacts observed at the level landscape, hydrological, ecological and social (UN-WATER, 2006).

In the semiarid region, the inefficient use of water from the reservoirs for multiple uses, the lack of appropriate agricultural practices, the growing practice of fish farming, the inefficient treatment of domestic sewage and agricultural, have led to increase the pollution and degradation of these ecosystems.

The pragmatic notion of semi-arid region has been the focus where it has prolonged droughts. The idea of dry comes from the lack of rainfall, deficiency of soil moisture of the agriculture, break-up of the agricultural production, even the negative social and economic impacts in general, in other words, identifying areas of drought, due to causes and effects, with different levels of coverage (Vieira; Gondim Filho, 2006).

The reservoirs provide not only important ecological characteristics, but also reveal important informations about human activities conducted in the watersheds which are inserted. According to Tundisi and Tundisi (2008) the impacts of multiple uses on water quality

of these ecosystems are crucial in its operation and its physical, chemical and biological characteristics.

According to Tundisi & Tundisi (2008) the multiple use of water in reservoirs, contributes to the degradation of its quality with consequences on ecosystem functioning, particularly in the physical, chemical and biological characteristics. The sustainable use of water with the protection of aquatic ecosystems in semi-arid regions, is a topic that requires an intense and open discussion, fundamental aspect and extremely important for planning and managing of a watershed, which includes its quality control.

The interaction between the reservoirs and their watersheds becomes a matter of extreme importance, especially when taking into account their multiple uses. The activities performed in the watershed can be effectively measured in the reservoirs, which receive the interference caused by the impacts of these activities. Within this context, the typology of a reservoir as well as its characterization, are important references for planning and management operations, especially regarding artificial aquatic ecosystems located in the semiarid region of Brazil, since the low rainfall, the intensive rates of high evapotranspiration and high soil degradation, influence the quality of its waters. To Tundisi (2008), the management of reservoirs is a complex work, which requires interdisciplinary teams with expertise to minimize the impacts, promote the optimization of multiple uses and effectively manage the artificial ecosystem.

According to Simpson (1995), a number of factors that influence the success or failure of the implementation of the transboundary projects, has been identified, including: legal and institutional basis (laws, regulations and approval processes); management; user participation; economic, financial and administrative sustainability, environmental impact on watersheds (source and destination), compensatory measures and project costs.

This research aims to evaluate the environmental impacts of river basin transboudary projects in arid and semiarid regions, taking into account the strategic importance of the Integration Project of the São Francisco River Basin in Brazil and the Trasnfer from Río Grande to Rio Atuel in Argentina, for the development.

and marine socio-ecological systems poses, however, additional scientific and managerial challenges.

METHODS

The Integration Project of the São Francisco River Basin (Figure 1) is a project to development the water infrastructure in order to guarantee the water supply of about 12 million people that live in the semiarid region of Brazilian Northeast. The idea is to transfer water of the São Francisco river through two distribution channels, axis east and north. The project will consist of canals, pumping stations, reservoirs and small hydroelectric plants to self-supply, these systems will attend the needs of water supply for the municipalities of the Brazilian semiarid region.

This project provides a continuous pumping of only 26 m³/s of water, only 1,4% of the river flows that goes to the sea. This volume will be dedicated for human consumption and benefit an estimated population of about 12 million people. The water basins that will receive water from the São Francisco River are: Brígida, Terra Nova, Pajeú, Moxotó in Pernambuco State (PE), Jaguaribe in Ceará State (CE), Apodi and Piranhas-Assu in Rio Grande do Norte State (RN), Paraíba and Piranhas in Paraíba State (PB).

With the Integration Project of the San Francisco River Basin, large dams (Castanhão - CE, Armando Ribeiro Gonçalves - RN, Epitássio Pessoa - PB, Poço da Cruz - PE and others) will provide greater assurance to supply water for various uses. In states benefit from the project, various distribution water systems are operating, under construction or being studied with the goal of bringing water from these strategic reservoirs to supply cities and irrigation perimeters.

The possibility of flows transfer for the Rio Grande to Rio Atuel was present in various studies and assessments by the Province of Mendoza, practically since the beginning of this century. The river basin of the Rio Grande, from its source to the Bardas Blancas zone, covers an area of 5,450 km^2 and is the most important water resource in the Province of Mendoza.

The project of the river basin water transfer from Río Grande to Río Atuel (Figure 2) means the incorporation of a discharge, in a first step, of 24 m^3/s, increasingly in two times natural water supply. Some environmental impacts can be indentify inside the Rio Grande basin and there will be other impacts over the target basin (Río Atuel). The construction of the transboundary basin will cause some negative environmental impacts during the construction phase of the works that can be mitigated (dam, power plant, tunnels and canals).

The flow available for transfer through the integral use of the Rio Grande is very important to the Province of Mendoza, from the moment that could almost double the average flow of the Atuel river, enabling increased the agricultural development in the cities of San Rafael, General Alvear and Malargüe, through an increase in irrigated areas, as a consequence of the increased of water supply.

Moreover, the higher availability of water, from the river basin transfer, will increase the hydropower production in the hydropowers of Nihuil I, Nihuil II, Nihuil III, Nihuil IV, and will create conditions for the establishment of any new projects of hydropower on the rivers Grande and Salado.

In the study of the complete utilization of the Rio Grande has been specially considered the environmental conservation, in order to identify the potential impacts generated during construction and operation, and designing appropriate mitigation measures.

The methodology used for the preliminary analysis of the environmental impacts that occur when starting the transfer, is based on the identification of environmental impacts through a Preliminary Identification Matrix Significant Environmental Impacts. The matrix permitted to identify, in a preliminarily way, the potential impacts of the project. This matrix was organized in large titles that correspond to the major environmental factors potentially receivers of the impacts, and the main activities of the project that can disturb the factors considered.

This organization of identifying the impacts at this stage is preferred (rather than developing an extensive matrix of impacts that is reserved for large development in a second stage) because they satisfy the requirements for identifying for the identification of the major impacts on inventory stage.

Figure 1: Components of the Integration Project of the São Francisco River Basin

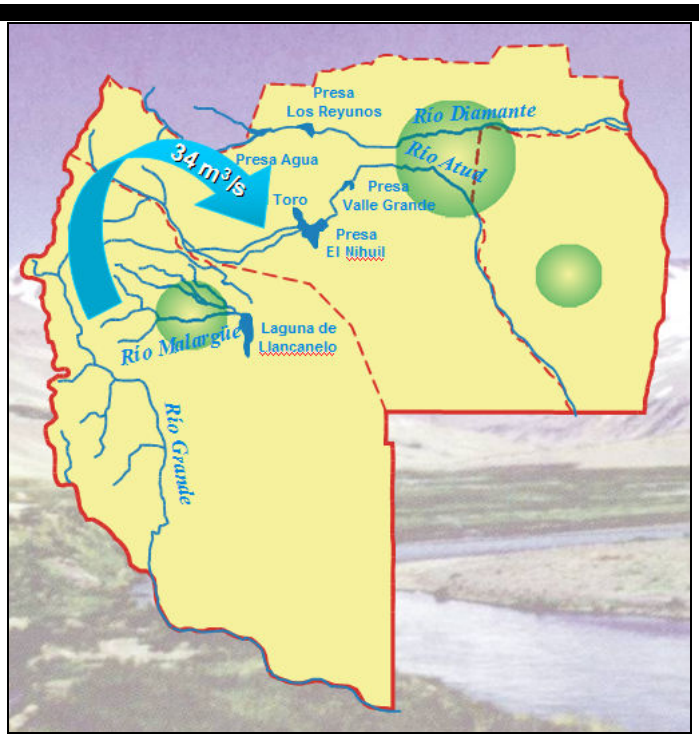

Figure 2: Components of the the river basin water transfer from Río Grande to Río Atuel

Detected interactions between environmental factors and actions arising from the project were discussed by the interdisciplinary team to rank the most relevant.

RESULTS

The study of environmental impacts Integration Project of the San Francisco River Basin, identified 44 impacts, including 23 considered most relevant, 11 are positive and 12 negative. The most significant positive impacts were the increased water supply and guarantee, job creation, promotion of the regional economy, improved of the water quality, and decrease the rural exodus. Among the negative impacts, the most important were expropriations of properties, changes in the composition of the aquatic biological community, possible interference in indigenous populations, loss and fragmentation of native vegetation and fauna habitats.

The assessment of environmental impacts arising from the installation and operation of the Integration Project of the San Francisco River Basin led to the development of 24 Environmental Programs. When they were executed, they will enable the prevention, mitigation and fix the impacts; others are important to monitor the changes that will occur in the environment of the region and others must be implemented to the benefits of the project be achieved and promoted improvements in the environmental quality of the region and the people that live in dry areas where the canal will pass.

The environmental impacts here considered to the project of the river basin water transfer from Río Grande to Río Atuel, correspond to the impacts identified in a preliminary study for the project. The actions of the basin transfer don't create new significant adverse impacts on the current situation. The new positive impacts that will produce the project will produce greater importance because it allows the optimization of the intended uses for the water transferred. The new positive impacts that will produce the project, mainly the socioeconomic (irrigation, energy, tourism), will far outweigh the expected negative impacts. Some negative impacts are detected unimportant or minor. In all cases mitigation measures are relatively simple.

Also, environmental impacts have been identified during the operation phase, during its operation, caused by the trasfer of the 25% of the medium flow of the Rio Grande. These problems will have to be solved working with Basin Authority, especially with the downstream provinces. Thanks to the creation of a large reservoir, hydraulic benefits have been evaluated in order to mitigate the effects of water extraction from the Rio Grande. The profits of the transfer necessarily mean improving existing irrigation system, the creation of new industries and services and, when the transfer takes place, the addition of 50,000 new hectares to agricultural production.

CONCLUSION

These impacts can be minimized by the adoption of integrated management strategies that enable the mitigation of the problems inherent to the water degradation and satisfy the expectations of the users within the context of sustainability. It is expected that the results achieved with this research subsidize the improvement of the management of reservoirs of multiple uses, contributing to the maintenance of water quality in accordance with the environmental legislation and the people's life quality.

Environmental management properly implemented, coupled with knowledge of the quality of water, will provide a better management of these interconnected ecosystems. It is expected that the results achieved with this research subsidize the improvement of the management of reservoirs of multiple uses, contributing to the maintenance of water quality in accordance with the environmental legislation and the people's life quality.

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