Managing water quality in transboundary river

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Abstract

A water quality diagnosis was carried out in a transboundary river that receives contributions from municipal wastewater with or without treatment, as well as water from agricultural returns that can affect the water quality of the lower watershed of the Rio Bravo/Grande. The contribution of organic matter, measured as BOD5, ranged from 1.9 to 36 tons / day. Wastewater discharges did not comply with BOD5, COD; Fats and oils. A monitoring and surveillance program should be implemented to comply with current regulations, including US treatment plants that discharge their wastewater to the main course of the Rio Bravo/Grande.

Introduction

One of the most important elements of the contamination of national water bodies is associated with discharges of municipal and non-municipal wastewater that are discharged directly or indirectly through its tributaries.

The Rio Bravo / Rio Grande is the largest river in North America, one of the main rivers in Mexico and the United States, being a transboundary water body, has been particularly important because of the growing concern for the economic development of the border area and the pollution problems that have been identified since 1992 due to the lack of sanitation in several populations of both countries, as well as the contribution of pesticides from agricultural areas and toxic substances contributed by industries.

The Rio Bravo is the main source of water for domestic, industrial and agricultural use on the border and is a very complex hydrological system due to the diversification, storage and flow management in the main channel that has modified the natural river regime.

The study was designed to improve water quality in the Lower Rio Bravo / Rio Grande, through an initiative between both countries with the purpose of serving as a model of binational water quality management for the stretch from downstream of The International Falcon dam to the mouth of the Gulf of Mexico, covering approximately 450 kilometers. The main objective of the initiative of both countries is to restore and protect the water quality of the Lower Rio Grande by identifying

and characterizing the sources of pollution and mitigating current and potential sources of river pollution.

Study area

Hydrological Region No. 24, called the Rio Bravo basin, is the largest in the country with 472,000 km2 representing 19% of the national territory. The basin is located on the border between Mexico and the United States.

The lower Río Bravo/Río Grande watershed also includes the Álamo River and the San Juan River, has an area of 47,854 km2, of which the State of Tamaulipas corresponds to 14,505 km2, and extends from downstream of the International Falcon Dam to its mouth in the Gulf of Mexico.

Due to the characteristics and extent of the study area, three types of climate are presented according to Köppen modified by García: the climate is BSo (h') hx' (w)i, which indicates a dry climate, the driest of the BS with scarce rainfall all year, average annual temperature is 22.8 ° C, maximum of 40 ° C in July and minimum below 0°C in the months of November to March; The BS1 (h') hx' very warm and warm semi-dry climate, with an average annual temperature greater than 22°C, the temperature of the coldest month of 18°C; (A) Cx' belonging to sub-humid sub-humid types with scarce rains all year round and an annual mean temperature above 18 ° C.

The total area of approximately 455,669 km2; More than half of this area corresponds to the United States (230,427 km2) and the other part (225,242 km2) corresponds to Mexico (CONAGUA, 2010; IBWC / CILA, 2004). With its 3,034 km, the Rio Bravo / Grande is the longest in Mexico and forms the largest basin in the country; It is also the fourth longest river in the USA and fifth in North America (WET, 2001; Schwandt, 2001; CONAGUA, 2010). The Bravo / Grande river basin comprises a total of eight states; Three on the American side: Colorado, New Mexico and Texas; and five of the Mexican side: Durango, Chihuahua, Coahuila, Nuevo León and Tamaulipas.

The study area comprises the Lower Bravo / Grande River which only considers the states of Texas and Tamaulipas with a distance of approximately 442 km (275 miles) (Figure 1).

In the study area there are two Irrigation Districts: 026 (Bajo Río San Juan) with a irrigable area of 86,102 hectares for the cultivation of maize, sorghum, cotton, alfalfa, orange and pasture: 025 (Bajo Río Bravo) with a irrigable surface of 248,001 hectares for the cultivation of sorghum, maize grain, soybean, cotton, watermelon, vegetables and pastures. The main source for agricultural irrigation is

surface water. The discharge and management of the water is done through drains that discharges to the Rio Bravo (CONAGUA, 2014a) (Figure 2).

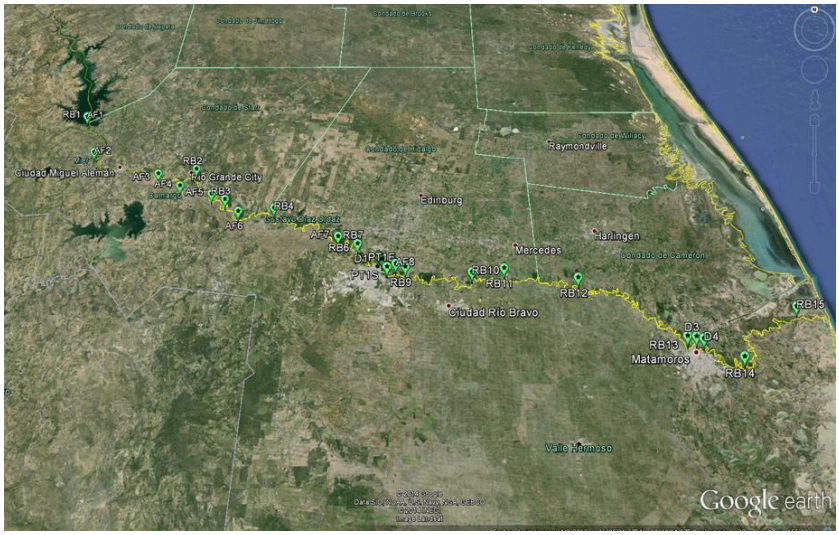

Figure 1. Rio Bravo / Río Grande location and study area

Annual average streamflows progressively diminish from below Falcón reservoir to the Gulf of Mexico, with the exception of the hydrometric station located at Camargo, Tamaulipas, Mexico, where it increases by approximately 4% because of the inflows of the Río Alamo and Río San Juan, as well as the irrigation excess of the 026 irrigation district. Of the 100 % annual streamflow gauged below Falcón, only 19 % is recorded below Brownsville, TX (Návar J, 2004).

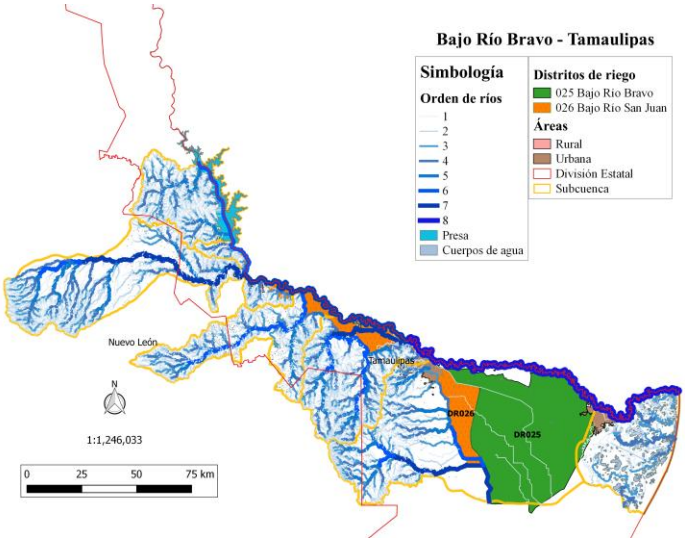

Figure 2. Irrigation Districts in the Bravo / Grande River basin.

Method

The goal was covered done in the dry season four monitoring at 15 sites in the main river channel, two tributaries (river Alamo and San Juan), eigth agricultural drains and 10 discharge of wastewater, including effluent treatment plants located in the section from the dam downstream of Falcon International to the mouth of the Rio Grande to the Gulf of Mexico. The diagram shows the location of the sampling sites (Figure 3).

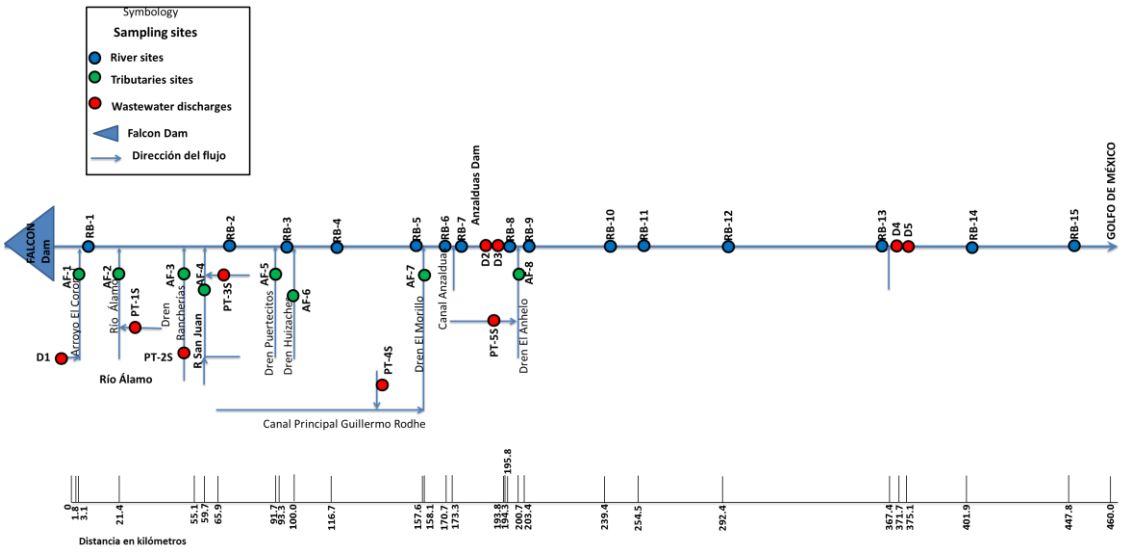

Figure 3. Diagram of sampling sites

The water sampling and field parameter measurements (in situ) and for the transfer to the laboratory (ex situ) were carried out following the protocols established by current regulations, as well as laboratory analyzes.

The concentrations obtained from the physicochemical and bacteriological parameters were compared with the guidelines for Use 1 of water supply of the Federal Law of Rights (Conagua, 2016b). While for wastewater discharges with the official Mexican standard (NOM-001-SEMARNAT-1996) it establishes maximum limits permissible to receiving body.

Results

The parameters that exceeded the guidelines for Use 1 in all the sites were: Total phosphorus, total dissolved solids, sulfides, sulfates, turbidity, and for ammoniacal nitrogen the guideline of Use 3 (protection of aquatic life). The COD at sites RB7 and RB15 were considered contaminated according to the Conagua indicator. Fecal coliforms and Escherichia coli were present in high concentrations at sites

downstream of Anzalduas dam and at sites close to population centers such as Reynosa and Matamoros.

In all tributaries, the parameters that exceeded the guidelines for Use 1 (source of supply) were: chlorides, total phosphates, total dissolved solids, sulphides, sulfates and turbidity, as well as ammoniacal nitrogen to protect aquatic life. The organic compounds that were detected at low concentrations and did not exceed the guidelines were: dibutylphthalate, Di, 2 (ethylhexyl) phthalate (DEHP), 2,4-dichlorophenol, diethyl phthalate and m and p cresol.

Di (2-ethylhexyl) phthalate (DEHP) is a substance mainly used as an additive in plastics to make them more flexible. The guideline for Use 1 (source of supply) is 32 µg / L (0.032 mg / L) and for Use 3 (aquatic life protection) of 9.4 µg / L (0.0094 mg / L); In both cases the guideline is not exceeded. DEHP levels have been reported in European rivers ranging from concentrations below the detection limit of the method to 21 µg / L in highly industrialized and urbanized areas. (European Commission, 2008).

The tributary Dren El Anhelo (AF8) is the one that contributes the highest contamination to the Rio Bravo by the discharge of compounds such as fats and oils BOD5, COD, fecal coliforms and Escherichia coli (Figure 4 and 5).

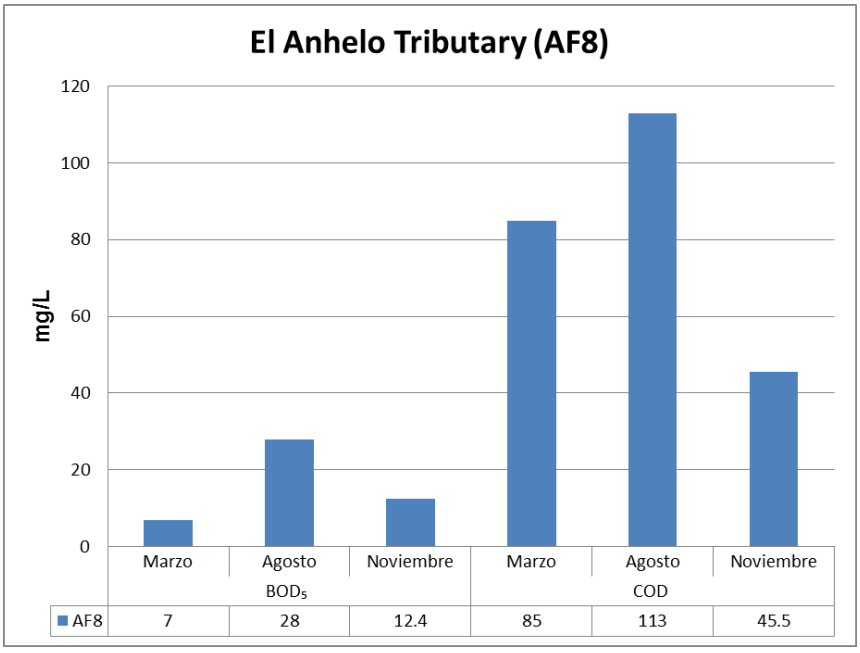

Figure 4. Concentrations of biological oxygen demand and chemical oxygen demand in the tributary

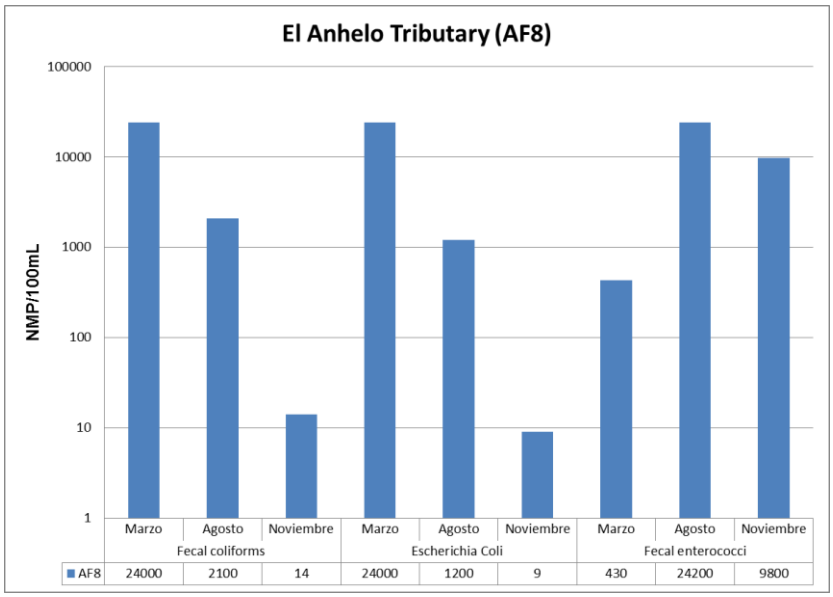

Figure 5. Concentrations of fecal bacteria in the tributary

In the wastewater discharges, the parameters that exceeded the maximum permissible limits of NOM-001-SEMARNAT-1996 were: BOD5, Fats and Oils, Total Suspended Solids, Total Nitrogen, Fecal Coliforms and COD at Treatment Plants The municipalities of Miguel Alemán, Camargo and Reynosa. Organic compounds such as Bis (2-Ethylhexyl) phthalate, Bromoform, Phenol and N-Nitrosodi-N-Propylamine were detected in effluents from treatment plants.

The organic matter load contributed to the Bravo River was 36 tons / day in March and 1.9 tons / day in August 2015.

The analysis of chlorinated and organophosphorus pesticides in the river and tributaries were detected below the limit of detection of the method.

Conclusions

The results allow zoning of the main sections of the river that receive inputs of pollutants such as El Anhelo tributary (AF8) where necessary management actions to control pollution because it receives the discharge of the WWTP Reynosa 1 and Escondida Lagoon and that through a monitoring program and surveillance actions to be implemented to improve treatment systems or failing properly operate them to always comply with the regulations. Management must include the participation of the United States, to assess their discharges because the American side have seven treatment plants that discharge to the Lower Rio Bravo/Grande.

The organic compounds detected, although presented in low concentrations, it is important to determine the source of contribution to control and prevent them from entering the river, because it is a source of drinking water for the populations.

The municipal treatment systems of the main cities (Reynosa, Camargo, Ciudad Mier, Miguel Alemán) exceeded the maximum permissible limits of NOM-001-SEMARNAT-1996 in some of the regulated parameters, in addition to detecting organic compounds.

The analysis indicated that it is necessary for the operation and maintenance of the treatment plants to be efficient and to improve the processes to be able to remove the organic compounds and not to be incorporated into the Rio Bravo.

Acknowledgements

Authors acknowledge the financial assistance of the Science and Technology Council and the National Water Commission to carry out the study.
(CONACyT-CONAGUA clave 0188747)

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