JOURNAL OF
ENVIRONMENTAL HYDROLOGY
The Electronic Journal of the International Association for Environmental Hydrology
On the World Wide Web at http://www.hydroweb.com
VOLUME 8 2000

WATER QUALITY OF THE PARANÁ RIVER AT CORRIENTES, ARGENTINA: A TEN YEAR RECORD

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This paper presents results of particular interest for the assessment of the water quality of the Paraná River. By considering its physical-chemical and bacteriological composition at this point in time, it is possible to make important political decisions related to environmental legislation, which are especially relevant to the regulation of human activities. Information is presented on water quality variations of the Paraná River for pH, color, turbidity and conductivity over a period of ten years between 1982 and 1992 at a monitoring point in Corrientes, northeastern Argentina.

INTRODUCTION

Environmental management studies of the Paraná River require real data to present important information about its physical-chemical and bacteriological behavior. These can include control of contamination, sources of water fit for human use, irrigation and industrial uses, and animal consumption.

This report is the first contribution directly related to variations of the physical-chemical parameters pH, color, turbidity, and conductivity over a period of ten years.

The increasing industrial and agricultural production that is occurring throughout the world not only represents greater liquid discharges to receiving water bodies, but also the addition of new pollutants. Including the consequences of population growth, the ecosystem experiences many changes, some of which have adverse effects. Sometimes these effects and changes are not well understood, but they should be evaluated and controlled periodically.

PARANÁ RIVER

The monitoring point on the Paraná River that is reported here is in Corrientes, Argentina (Figure 1).

Figure 1. Location map.

Corrientes

The Province of Corrientes is located in northeast Argentina, at 27º 15' and 34º 40' south latitude and 55º 40' and 59º 37' west longitude. The total area of the province is 88,890 km^2 (3.2 percent of the continental area of Argentina), and the total population estimated in June 1994 was 836,700 people.

Climatic features: the climatic conditions are quite homogeneous throughout the province since there are no obstacles for the shifting of air masses. Climate is subtropical in the northern region and of cumulative transition to humid plains in the south. There are no dry seasons.

Geomorphology: the province is located in the heart of the basin of the La Plata River. It is part of the Mesopotamian plains with elevations ranging from 28 m in the southwest to 220 m in the northeast.

Paraná River

The Paraná River, with a length of 4,880 km, is South America's second longest river, draining an area of roughly 2.8 million km^2. Its width and depth are variable depending on the geological composition of its bed. Its main tributaries are the Paraguay, Tiete, Paranapanema, Iguazú, and Salado rivers. Beginning at the junction of the Paranaiba and Grande rivers in south central Brazil, it follows Paraguay's borders with Brazil and then Argentina. At Corrientes, Argentina, it turns south and eventually flows through its delta into the La Plata River. Shallow and broken at several points by falls, the Paraná is navigable by large ocean vessels as far as Rosario. The Paraná River is doubtlessly the most important element within the hydrologic system of the La Plata River.

For each type of river station, a special rating system has been defined and a global rating given to each station according to three criteria: representativeness of the drainage basin, station characteristics, and water quality monitoring. The water quality data from these stations should be representative of the pristine water quality where the stations are located. The baseline stations are generally on small forest-covered watersheds, far from any direct pollution source in contrast to the impact stations located at sites of major water uses.

The Paraná River is, in general terms, the principal collector of the copious precipitation that falls within the tropical and subtropical regions of its tributary basin. Some discharge data are shown in Table 1.

RESULTS

Table 1. Flow Variations Versus River Depth at Corrientes Port

Depth (meter)	Flow (m^3/seg)
1.00	8020
1.62	9860
2.22	11820
3.00	14040
3.57	15670
3.94	16980
4.58	18310
5.40	27600
6.29	29510
7.10	31150

This paper presents information about several water quality parameters of the Paraná River; pH, color, turbidity and conductivity.The monitoring station was located in Corrientes City, Argentina, eight meters from the river bank and at 0.60 meters depth, in the city port. Samples were taken once a week, and sometimes more frequently.

The physical-chemical parameters that have been analyzed and reported represent a fraction of the entire analysis, which includes bacteriological parameters. The variations are summarized in Tables 2, 3, and 4 as parameter values versus years, maximum, minimum, and mean values, variations and weather influences, and the interrelation between them.

Some interesting conclusions come out when considering that the increasing values generally

Table 2. pH and Turbidity: Ten-Year Variations

pH			
YEAR	**MAXIM**	**MINIM**	**MEAN**
1982	7,35	6,80	6,94
1983	7,20	6,60	7,00
1984	8,20	7,00	7,24
1985	8,00	7,00	7,24
1986	8,10	7,10	7,30
1987	7,60	6,90	7,22
1988	8,20	7,00	7,48
1989	7,60	6,80	7,11
1990	7,30	7,00	7,13
1991	7,50	7,00	7,14
1992	8,00	7,00	7,21
DECADE	8,20	6,60	7,22

TURBIDITY - NTU			
YEAR	**MAXIM**	**MINIM**	**MEAN**
1982	112	44	72
1983	136	18	48
1984	650	18	88
1985	330	10	42
1986	1200	8	108
1987	400	12	73
1988	750	13	205
1989	60	12	31
1990	280	7	49
1991	470	9	58
1992	650	14	64
DECADE	1200	7	80

Table 3. Color and Conductivity: Ten-Year Variations

COLOR			
YEAR	**MAXIM**	**MINIM**	**MEAN**
1982	36	30	34
1983	32	6	15
1984	40	10	21
1985	42	3	17
1986	20	5	11
1987	30	7	14
1988	20	2	10
1989	12	3	6
1990	8	4	5
1991	25	3	7
1992	25	3	10
DECADE	42	2	14

CONDUCTIVITYmS / m - 25 ºC			
YEAR	**MAXIM**	**MINIM**	**MEAN**
1982	-	-	-
1983	-	-	-
1984	6,70	3,50	5,71
1985	7,70	4,80	5,33
1986	-	-	-
1987	5,20	2,90	3,75
1988	7,60	3,40	4,64
1989	4,70	3,08	4,39
1990	4,80	3,00	3,59
1991	6,50	2,70	3,61
1992	7,30	2,00	2,91
DECADE	7,70	2,00	4,85

Table 4. Paraná River: Global (i.e., mean) Characteristics

MEANS Decade			
pH	**Color**	**Turbidity**	**Conductivity**
7,22	14	80	4,68

increase in the same direction, and the extreme values are associated with the unusual height of the river stage in 1984, 1986 and 1992.

Procedures

The laboratory where the determinations were carried out followed protocols according to GEMS/Water programs. U.S. EPA Standard Methods for the Examination of Water and Wastewater were used for water monitoring procedures (APHA-AWWA-WPCF, 1989).

CONCLUSIONS

The information obtained from this research program constitutes the first document describing the state of the river over a period of ten years at a monitoring station in Corrientes, Argentina. Monitoring included esthetic values (color and turbidity), pH and conductivity. The monitoring allowed the continuous changes brought about by human activity to be evaluated and their evolution traced.

The information is also a tool which can be used for future reference about the nature and behavior of the river at the monitoring point. It will enable correct decisions to be made about the activities of the many communities living in areas which influence the Paraná River. This river is the most important in the countries it flows through, and many large cities use it for numerous purposes, generally discharging their wastes back into the river.

Tables 2 to 4 show the observable fluctuations in the physical-chemical water quality features, and their relationship to the heavy regional and local rains, which show an increase in summer and fall.

In this work attention was focused on the esthetics of water in natural and man-made environments, and the extent to which the beauty of the water can be preserved or enhanced by the establishment of water quality recommendations. Although the perception of many forms of beauty are profoundly subjective and experienced differently by each individual, there is an apparent sameness in the human response to the beauties of water. Water may be pleasant to look upon, to walk or rest beside, or simply to contemplate. It may enhance the values of adjoining properties, public or private.

The management of water for esthetic purposes must be planned and executed in the context of the uses of the land, the shoreline, and the water surfaces. The recognition, identification, and protection of the esthetic qualities of water should be an objective of all water quality management programs. The retention of suitable, esthetic quality is more likely to be achieved through strict control of discharges at the source than by excessive dependence on assimilation by receiving waters. Paradoxically, the values that esthetically pleasing water provide are most urgently needed where pollution problems are most serious as in urban areas, and particularly in the central portions of cities where population and industry are likely to be heavily concentrated.

As for recommendations for esthetic purposes, surface waters will be esthetically pleasing if they are virtually free of substances attributable to discharges or waste as follows: (1) materials that will settle to form objectionable deposits; (2) floating debris, oil, scum, and other substances; (3) substances producing objectionable color, odor, taste, or turbidity; and (4) substances and conditions or combinations thereof in concentrations which produce undesirable aquatic life.

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