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An Investigation of Water Quality of Tajan River and Its Impact on Caspian Sea (Mazandaran Province North of I.R. Iran)

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To design and implement monitoring programs for Tajan river water, factors such as frequency of sampling, analytical methods, site selection and criteria for water use area, were defined accordingly. A monitoring station was selected upstream of the river, inside Sari City and downstream close to Caspian Sea (delta). Samples were collected in 500 mL sterilized bottles on a monthly basis for physical, chemical and microbiological analysis. Sampling and analyses were carried out in accordance with standard methods. The results of water quality at different sampling locations show a moderate range of 7.6–8.2 pH. Total dissolved solids (TDS) are in the range of 350–1100 mg/L and at Delta up to 10800 mg/L. Maximum values for BOD and COD are 18 and 53 mg/L; maximum value of nitrates is 2.6 mg/L. The results show that the river quality is in moderate range. However, the presence of faecal-coliforms is indicative of the presence of domestic waste in the river water.

Key Words: Monitoring, Caspian Sea, Environmental Engineering, Tajan River, Water Quality, Wastewater, Management, Sampling.

INTRODUCTION

The Caspian Sea is the largest (in surface area) land-locked body of water in the world. The Caspian Sea is a rich source of natural resources and raw materials hosting a unique variety of living species and a developed natural economic system. The area of the Caspian Sea is 386400 km^2. Five countries share the 7000 km coastline of the Caspian Sea. Tajan river has a Shahid Rajaee dam, which is located about 25 km south of Sari, the capital city of Mazandaran province. The minimum discharge regulated by the authorities of the Dam on Tajan river as reported is 5 m^3/sec. The effluent from Sari treatment plant after three years will be around 0.17 m^3/sec and after 20 years will be around 1.03 m^3/sec. The dilution of treated wastewater in Tajan river after 23 years will be 1 : 5. This amount of wastewater entering Tajan river will give an additional flow to the farmers to use for agricultural purposes or discharge to the Caspian Sea. Annual maximum and minimum rainfalls in Sari in the ten years from 1989 to 1999 are 1004 and 456 mm respectively. Monthly maximum and minimum rainfalls in the year 2000–2001 are 112.9 mm in September and 2.7 mm in June respectively. Monthly maximum and minimum humidity in Sari is 91 and 62% respectively;

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the record shows that the maximum and minimum temperatures in Sari are 39°C and –4°C respectively.

The Iranian Caspian coastline includes two different geomorphological provinces: one is the central coast with its high dip topography and the other is a low plain in the western and eastern ends of the shoreline. The average slope of the beaches can be classified into three types[1, 2]:

(1) High land slopes with 0.5 per cent or more,

(2) Moderate land slopes with 0.1 to 0.5 per cent,

(3) Low land beaches with gentle slopes of less than 0.1 per cent.

Most of the beaches with high and moderate slopes are sandy and mixed with coarse or medium grade sand easily dispersed by waves[3].

In the south of the Caspian Sea (Iranian side), there are habitats that are ecologically important and contain many valuable species of flora and fauna. These play a major role in marine life cycles and fishery resources. The Caspian Sea is rich in marine fish of commercial value. The sea is world famous due to the presence of a unique species of sturgeon which is of commercial value due to its black caviar. In recent years, sturgeon landing has decreased dramatically: from 30,000 tons in 1985 to only 5,672 tons in 1995. The whole Caspian coastline is a major sanctuary for the migration pattern of migratory birds from the northern hemisphere to the south. Important sensitive areas in Mazandaran province are Miankleh Peninsula: 70000 ha, 36°50′ N, and 53°45′ E 9; Lapoo-Zagmarz: 200 ha, 36°50′ N and 53°17′ E 8; Seyad Mahalleh and Zarrinkola Complex: 1600 ha, 36°44′ N and 33°00′ E 7 and man-made Abbendan (Fig. 1).

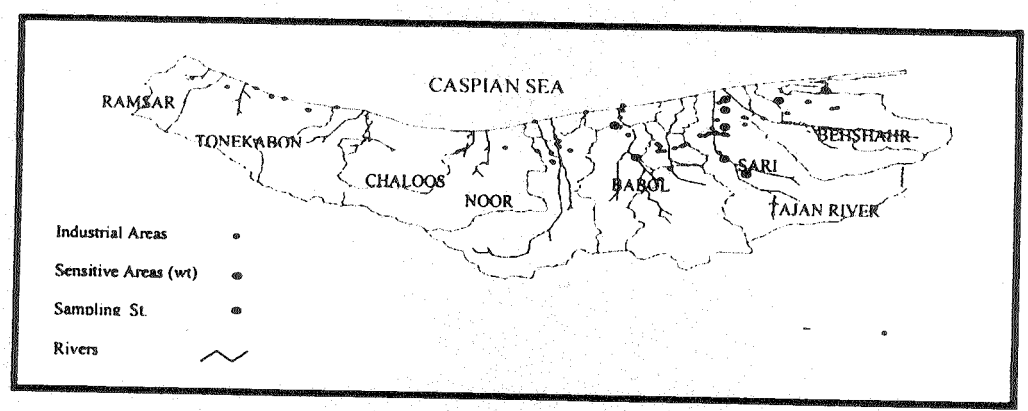

Fig. 1. Distribution of industrial sectors, rivers, sensitive areas and sampling station of Tajan river of Mazandaran province

Environmental issues of Caspian Sea

The Caspian Sea is currently undergoing increasing anthropogenic pressure. Hence there is an increase of eutrophication, water pollution by heavy metals and chemical pollution. The major environmental issues and overall decline in environmental quality are threats to biodiversity, *e.g.*, decline in human health, decline in fish stocks as wall as sturgeon, damage to coastal habitats and damage to coastal infrastructure. Table-1 shows the overall pollution load to the sea from the different sources shared by five countries[4].

TABLE-1
TOTAL POLLUTION LOAD TO THE CASPIAN SEA AT DIFFERENT SOURCES

Sources	BOD (T/Y)	N (T/Y)	P (T/Y)	*E. coli* (10–15 C/Y)	Oil (T/Y)	Hg (T/Y)	Cd (T/Y)
Rivers	641000	827000	88000	145000	75000	14	141
Municipal areas	80000	24000	6000	5000	19000	1	2
Industries	25000	2000	1000	0	28000	2	6
Atmosphere	0	39000	800	0	350	0	0
Total	746000	892000	95800	150000	122350	17	149

Tajan River

Tajan river has a Shahid Rajaee dam which is located about 25 km south of Sari, the capital city of Mazandaran province. Sari is situated about 20 km towards south of the Caspian Sea with the current population of around 400000, Sari area comprises mostly of fairly flat land with a general slope of about 0.7% (7 per 1000) from the south towards the north (Caspian Sea). The average elevation of the city above sea level is +40 m. The land around the city as well as Tajan River is used mostly for harvesting of rice orchards of orange and other trees. The Tajan river is passing through the city and flowing towards north, discharging into the Caspian Sea. The water of Tajan river is used to irrigate farms and gardens in and around the city. Tajan river is a source for many irrigation creeks (canals and Abandans which is a local system for storing water in ditches during high flow period of river Tajan and being used later on for agricultural purposes). For many years, even though the city has been developed a lot and the land use pattern has been changed from agricultural to residential, the direction of these creeks and canals has not changed as these canals are mostly earthen and often pass through the city towards agricultural land. The flows of Tajan river is being recorded for the last many years at various stations. Daily maximum flow in the last twenty-five years was between 340 to 418 m^3/sec.

Methods

To design and implement water quality monitoring programs for Tajan River, factors such as frequency of sampling, analytical methods, site selection and criteria for water quality and water use area, were defined accordingly. Monitoring station was selected and named as upstream of the river (Takam bridge), inside Sari city (Tajan bridge) and downstream, close to the Caspian Sea (delta, Khazar-Abad) (Fig. 1). River water samples were collected in 500 mL sterilized bottles on a monthly basis for physical, chemical and microbiological analyses. Sampling and analyses for water quality monitoring were carried out in accordance with the standard methods[5]. Water samples were processed for total coliforms and fecal coliforms using the standard membrane filter technique[6].

Field sanitary surveys along the Tajan River at the time of water sampling were made. The aim of the sanitary inspection was to identify sources of existing and potential microbiological hazards that could affect the safe use of Tajan river water.

RESULTS AND DISCUSSION

The result of water quality at different sampling locations along the Tajan River in Mazandaran province shows considerable variation in different stations at different seasons. Fig. 2 shows the variation of BOD and COD on monthly basis at delta station which is in the range of 16–25 and 29–55 mg/L for BOD and COD respectively; the trend shows that the maximum values of BOD and COD are at the time of summer.

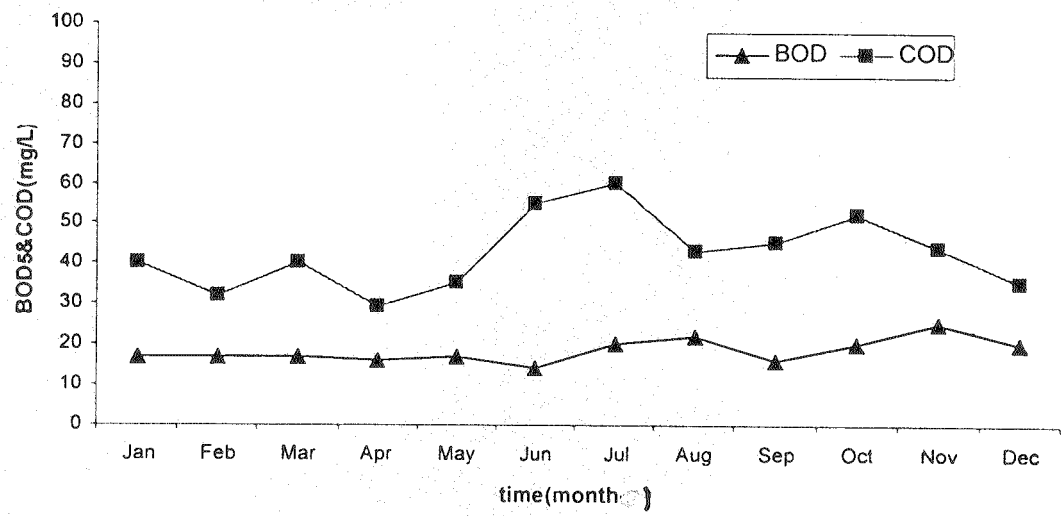

Fig. 2. Variation of BOD_5 and COD (mg/L) on monthly basis at delta station

Results are presented for three sites sampled in Tajan River as Takam Bridge Tajan Bridge and Delta (Figs. 3–8). The higher concentration of BOD, COD, NO_3, PO_4, DO and bacteria is greatly influenced by many factors such as weather conditions, rainfall, onshore winds and most importantly direct and indirect domestic and industrial effluent. Figs. 3 and 4 indicate the average concentration of BOD and COD at three stations at different seasons. Figs. 5 and 6 display potential variations of NO_3 and PO_4 taking place in different seasons. The

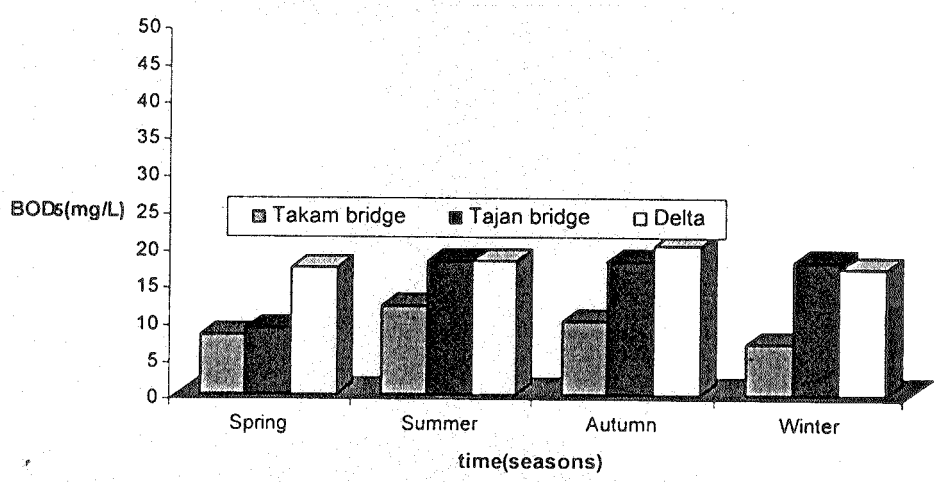

Fig. 3. Variation of BOD_5 (mg/L) on seasonal basis at different stations

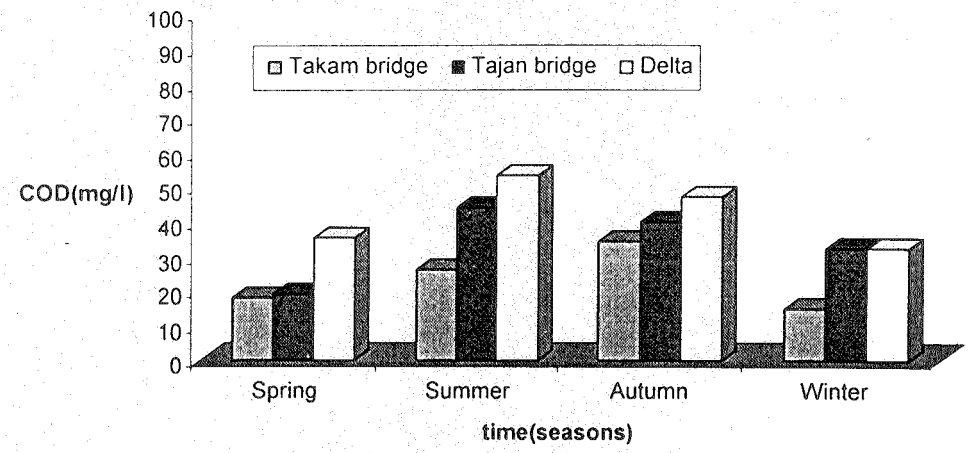

Fig. 4. Variation of COD (mg/L) on seasonal basis at different stations

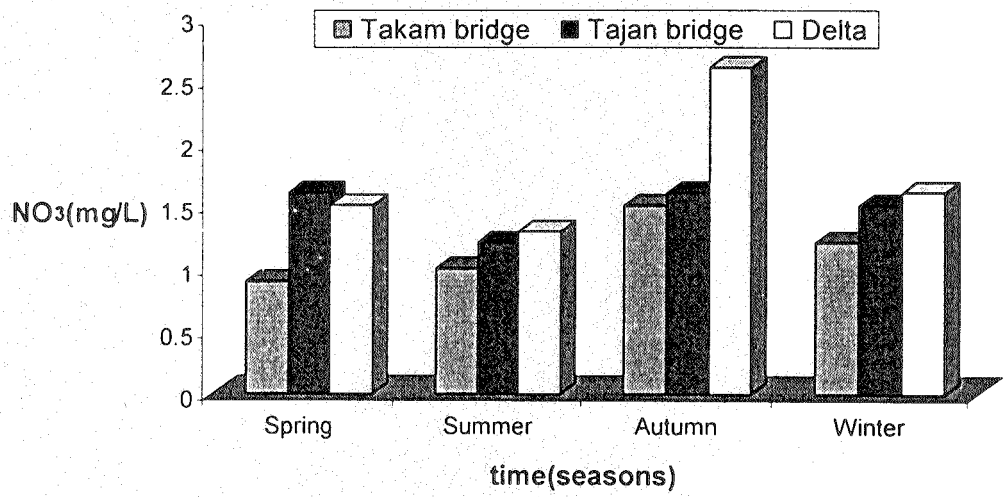

Fig. 5. Variation of NO_3 (mg/L) on seasonal basis at different station

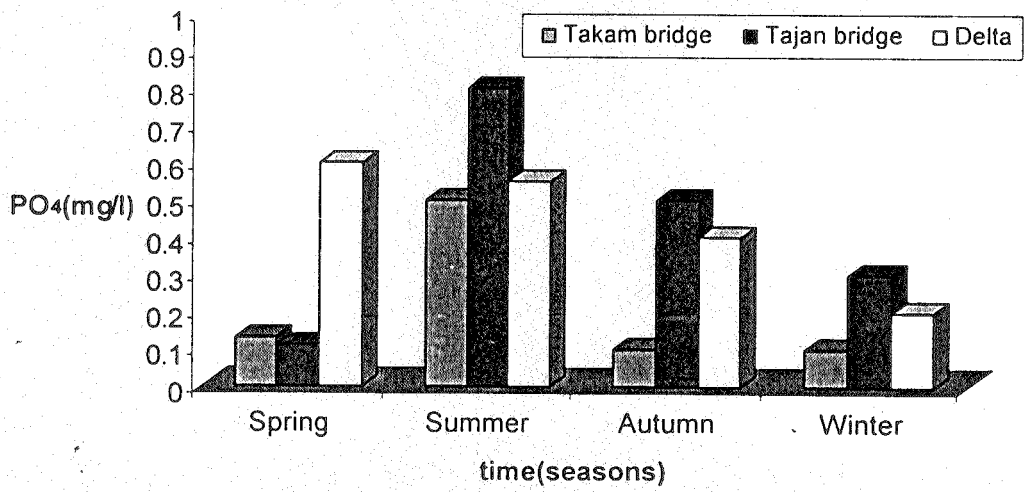

Fig. 6. Variation of PO_4 (mg/L) on seasonal basis at different stations

concentrations of NO_3 and PO_4 are more in sits of Tajan Bridge because of different industrial affluent entering into the river at upstream side.

As can be seen in Fig. 7 potential values vary depending on the flow of the river as well as the mixing, which takes place along the river.

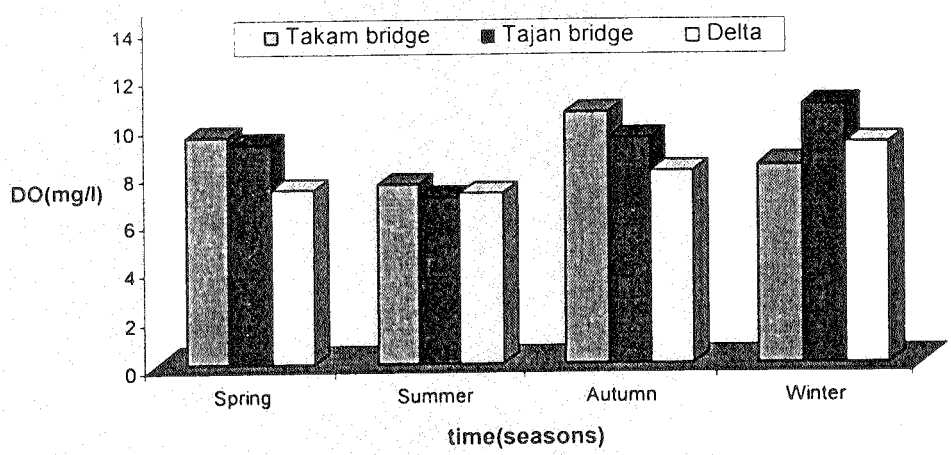

Fig. 7. Variation of DO (mg/L) on seasonal basis at different stations

Given in Fig. 8 are time-dependent variations of fecal coliforms at different sampling stations as well as at different seasons. The variations suggests that the fecal pollution pattern for different sampling stations is more or less the same, except in Tajan bridge stations as well as in summer due to minimum flow at summer seasons.

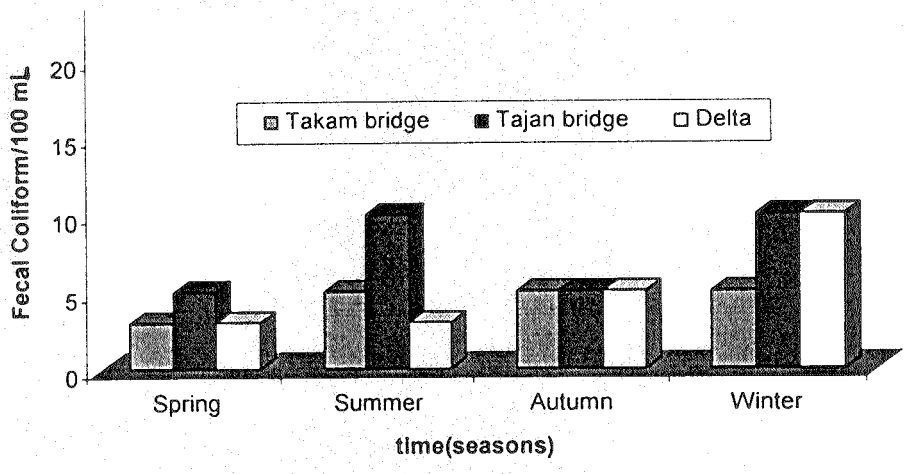

Fig. 8. Variation of fecal coliforms/100 mL on seasonal basis at different stations

Conclusions

1. It is concluded that the Caspian sea is undergoing overall decline in environmental quality, threats to biodiversity, decline in fish stocks and damage to coastal habitats. Total pollution of BOD, P from rivers to the Caspian Sea is 641000 T/Y and 88000 T/Y, respectively shared by five countries.

2. The dilution of treated wastewater in Tajan river after 23 years will be 1 : 5; this amount of wastewater entering Tajan river will give an additional flow to the farmers to use for agricultural purposes or discharge to the Caspian Sea.
3. Water quality at different sampling locations along the Tajan river like COD, BOD, TDS, TSS, EC, DO, NH_4, NO_3, NO_2, PO_4, total coliforms, fecal coliforms, turbidity shows considerable variation in different monitoring stations at different seasons due to fluctuation of flow along the river, influence of weather conditions, domestic, industrial and agricultural effluents and also surface water flow.
4. The results are indicative of a need for continued monitoring. It is also suggested to implement management measures such as wastewater management, river management and public awareness to reduce the level of contaminants.

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REFERENCES

1. N. Mehrdadi, An Investigation on Sources of Environmental Problems in the Caspian Sea. 24 International Conferences on Science and Technology, New Delhi, India (4–7 July 2001).
2. ———— , An Investigation of Water Quality Monitoring in Bating Beaches along the Caspian Sea, First International ICSC-NAISO Symposium on Information Technologies in Environmental Engineering, University of Gdansk, Poland (24–27 June 2003).
3. UNDP and Department of Environment of Iran, Initial National Communication to United Nations Framework Convention on Climate Change (UNFCCC) (March 2003).
4. Caspian Environment Program (CEP) Report, General Information and Activities, CRTC for Pollution Control Office, Baku, Azerbaijan (2001).
5. APHA/AWWA/WPCF, Standard Methods for the Examination of Water and Waste Water, 19th Edn., American Public Health Association, Washington, DC. (1995).
6. J. Bartram and G. Rees, Monitoring Bathing Waters: A Practical Guide to the Design and Implementation of Assessments and Monitoring Programs, WHO (2000). WHO. (1998); Guidelines for Safe Recreational Water Environments, Vol. 1, Coastal and Freshwaters, Draft for Consolation, WHO, Geneva (October 1998).

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