Water Quality Assessment of Chambal River in National Chambal Sanctuary of Madhya Pradesh

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ABSTRACT

The present study was conducted to understand the physico-chemical characteristics of Chambal River, in National Chambal sanctuary in Madhya Pradesh. The Chambal River is located in west central India and flows through three Indian states; Madhya Pradesh, Rajasthan and Uttar Pradesh. The Chambal also forms part of the Rajasthan-Madhya Pradesh boundary. The stretch of Chambal river contained in the National Chambal sanctuary (located at 25°23'-26°52'N, 76°28'-79°15'E) is extending up to 600 km downstream from Kota (Rajasthan) to the confluence of the Chambal with Yamuna river. On the basis of various parameters studied, Chambal River in this stretch can be placed under the category of Class C as per CPCB standards. The analysed water quality data of year 2003-2012 indicates that the Chambal river water in the sanctuary area is pollution free and can serve as a good habitat for many aquatic flora and fauna including endangered species.

Keywords: Water Quality, National Sanctuary, Pollution, Conservation

1. INTRODUCTION

Rivers play a vital role in integrating and organizing the landscape, and moulding the ecological setting of a basin. River Chambal is the most significant water resource of the state of Madhya Pradesh catering to the demands of a large number of cities and towns situated on its banks. Apart from the supply of potable water, the river is also ecologically very important as it harbours very rich biodiversity (Crawford, 1969, Verma et al., 1993). The Chambal River is a tributary of the Yamuna River in central India, and forms part of the greater Gangetic drainage system. It is a legendary river and finds mention in ancient scriptures. The perennial Chambal originates at Manpura, south of Mhow town, near Indore, on the south slope of the Vindhya Range in Madhya Pradesh. The Chambal and its tributaries drain the Malwa region of north western Madhya Pradesh, while its tributary, the Banas, which rises in the Aravalli Range, drains south eastern Rajasthan. It ends a confluence of five rivers, including the Chambal, Kwari, Yamuna, Sind, Pahuj, at Pachnada near Bhareh in Uttar Pradesh state, at the border of Bhind and Etawah districts. People along the river use water for many purposes. However, the surface water quality is deteriorating due to

anthropogenic activities, industrialization, farming, transportation, urbanization, animal and human excretions and domestic wastes. Pollution is caused when a change in the physical, chemical or biological condition in the environment affect quality of human life including other animals' life and plant (Lowel and Thompson, 1992; Okoye et al., 2002). Industrial and municipal wastes are been continuously added to water bodies hence affect the physiochemical quality of water making them unfit for use of livestock and other organisms (Dwivedi and Pandey, 2002). The extent of pollution is generally assessed by studying physical and chemical characteristics of the water bodies (Duran and Suicnz, 2007).

The Chambal River is considered pollution free (Hussain et al., 2011) and hosts an amazing riverine faunal assemblage including two species of crocodilians; the mugger and gharial, 8 species of freshwater turtles, smooth-coated otters, gangetic river dolphins, skimmers, black-bellied terns, sarus cranes and black-necked storks, amongst others. In this paper, an attempt has been made to assess the water quality changes during a decade based on physio-chemical to study the extent of pollution in river Chambal in National Chambal Sanctuary area.

2. MATERIAL AND METHODS

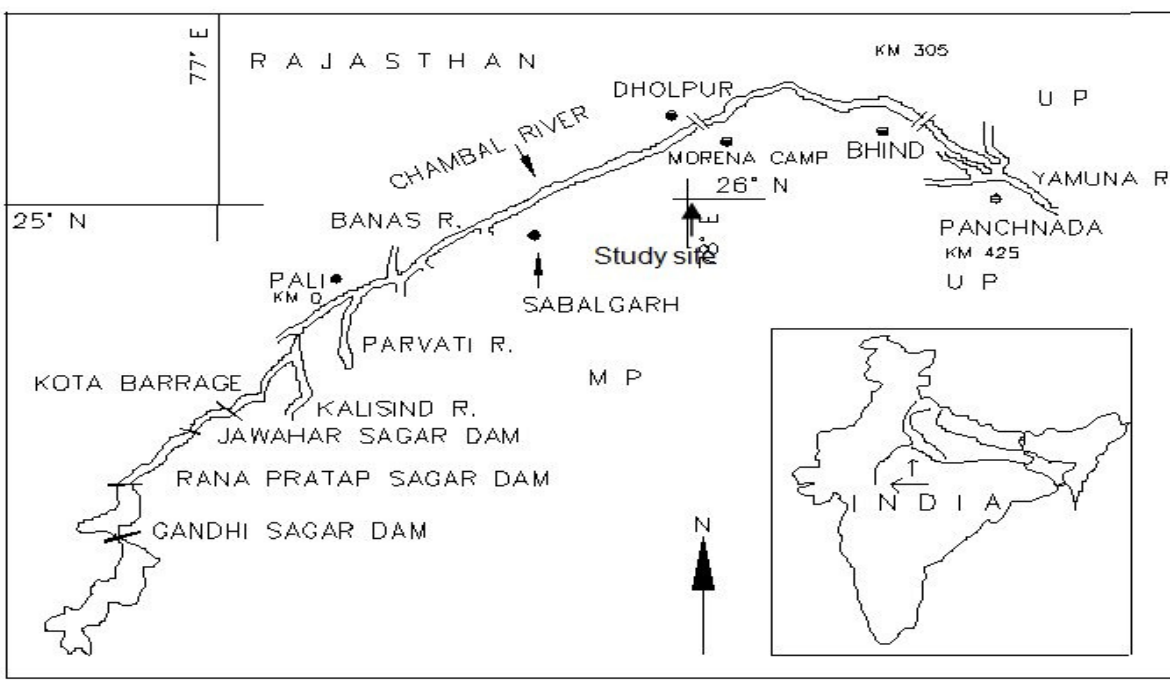


Figure 1: Showing Chambal River at Madhya Pradesh

The mighty Chambal River originates near the Janapao temple located at a distance of 24 km in south-west direction from the town called Mhow in Madhya Pradesh at an elevation of 854.35 m. The place, where from it originate, there are three Nallah which are having a length of 1.6 to 2.4 km in length around the Janapao temple. These Nallah meets the perennial Chambal River (Saksena, 2008). The Chambal is a perennial river in Madhya Pradesh. The present study has been done to assess the water quality of 10 years i.e. from 2003 to 2012 at National Chambal Sanctuary of Madhya Pradesh. The study aims at understanding the changes in water quality of the River in past 10 years so that a suitable strategy for the conservation and management of the river may be formed and implemented to conserve this very precious aquatic resource of the state near which the National Sanctuary has been established. The collection of sample and analysis was done as per the standard methods (APHA, 2005).

3. RESULT AND DISCUSSION

The physic-chemical characteristics provide a fair idea of the water quality in any fresh water body. The result obtained for various water quality parameters is discussed below and summarised in Figure 2 to 4.

3.1 Water Temperature

Temperature is one of the most important ecological features and its measurement is useful indicating the trend of biochemical and biological activity in a water body. During present investigation River water temperature remained in between 20.4 ^{O}C to 34.8 ^{O}C. Temperature was slightly high during 2008 (Figure 2).

3.2 pH

In aquatic habitats, pH has a strong effect on which fish, amphibians, invertebrates and plants can live in a community. The pH of a stream or lake depends on the water source and the kinds of rocks and soil that water contacts. Proper pH is an important life requirement for all aquatic organisms. Developing eggs and larvae also have specific, narrower pH requirements. However, even at the high and low ends of this pH tolerance level, fish become stressed. Aquatic invertebrates, with external skeletons or shells made of calcium, are extremely sensitive to pH below neutral. These organisms are important members of aquatic food chain. pH of Chambal River during the period of investigation was observed within the range of 6.9 to 8.58 (Figure 2). The river water in general remained slightly alkaline during the entire period except in 2006.

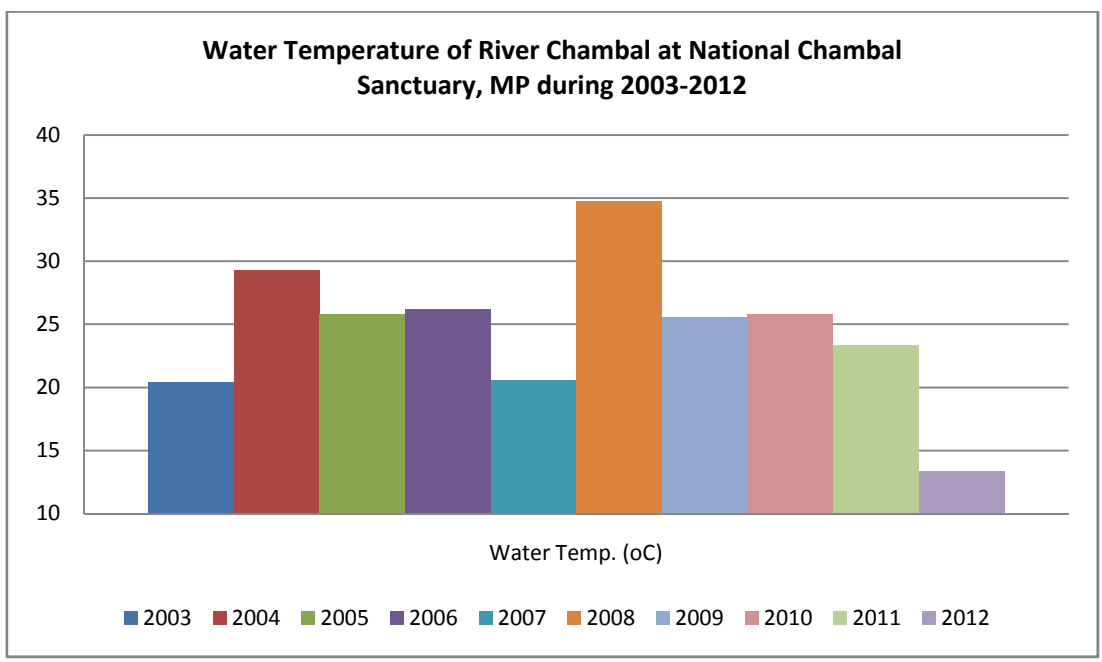
3.3 Turbidity

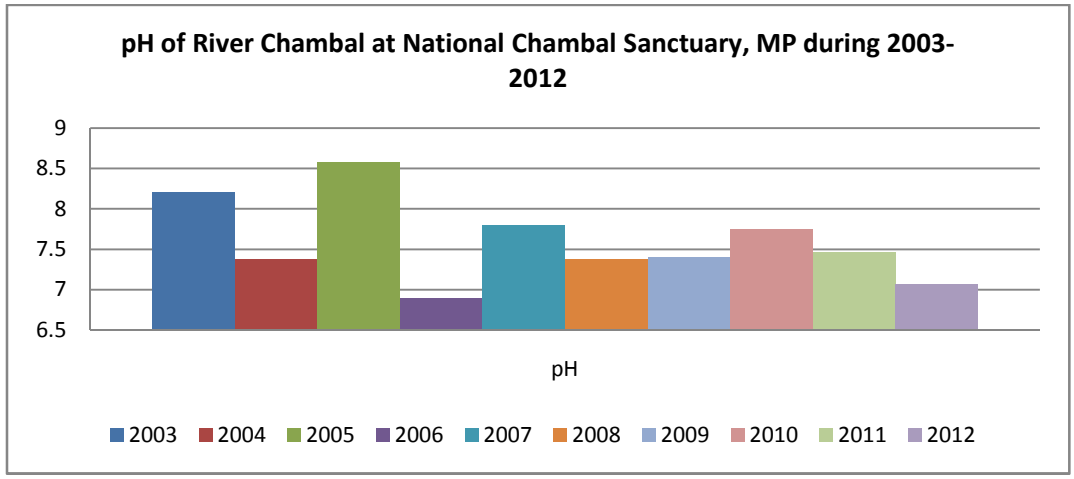
Turbidity is the measure of fine suspended matter in water, mostly caused by colloidal matter, silica of diatomaceous earth that could cause the optical effect. The suspended matter causing

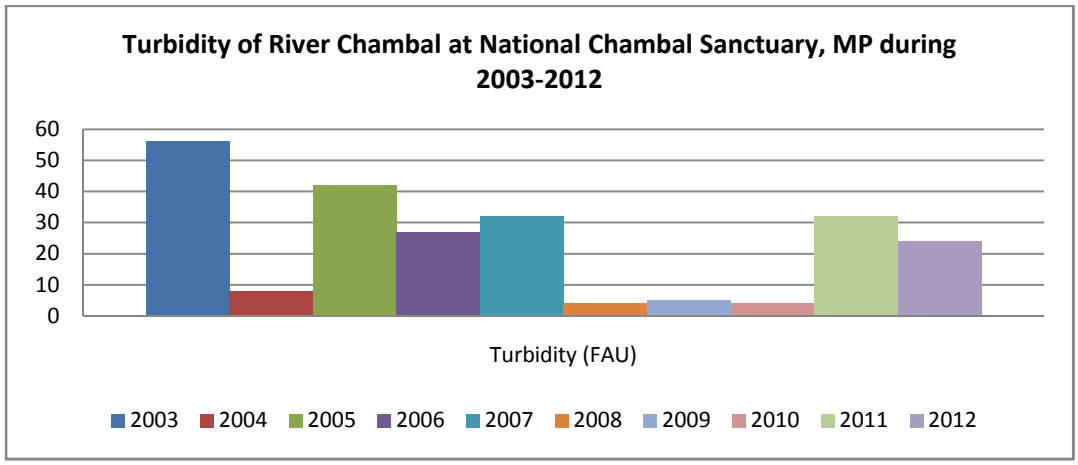
turbidity is expected to be clay, silt, non-living organic particulate, plankton, and other microscopic organisms, in addition to suspended organic or inorganic matter. Turbidity represents light scattering and absorbing properties of suspended matter in water. Turbidity values were observed in between 4 JTU to 56 JTU (Figure 2). Higher value of turbidity was observed during the year 2003.

3.4 Conductivity

Conductivity is a measurement used to determine a number of applications related to water quality like determining mineralization: this is commonly called total dissolved solids (TDS). TDS is used to determine the overall ionic effect in a water source. Certain physiological effects on plants and animals are often affected by the number of available ions in the water. Conductivity is a numerical expression of the ability of an aqueous solution to carry on electric current. This ability depends on the presence of ions, their total concentration and temperature variations. Conductivity depends on the ionic strength of the water. Inorganic salts, acids and bases show better conductance while organic compounds do not show much conductance. The value of conductivity and dissolved solids are directly proportional to each other. Conductivity of the river water ranged from 0.15 mS/cm to 1.29 mS/cm, higher value was recorded in 2006 (Figure 2).







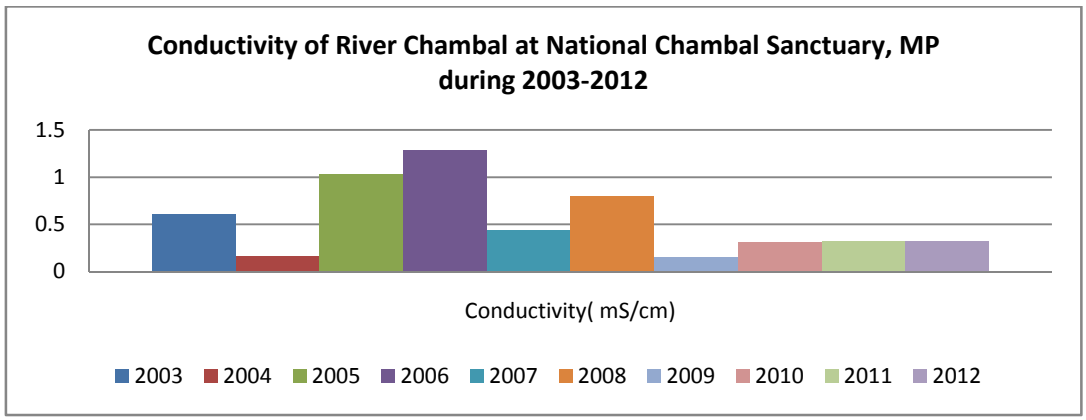


Figure 2. Graph showing Water quality (Temperature, pH, turbidity and conductivity) variation of Chambal River during a decade.

3.5 Total dissolve solid (TDS)

In natural water total dissolved solids are mainly composed of a large variety of salts and Inorganic minerals i.e., dissolved solids such as chlorides, carbonates, bicarbonates, nitrate, phosphates, calcium, magnesium, sodium potassium etc. which impart particular taste to water at higher concentration. TDS when present in excess in the water may create an imbalance for aquatic life. Total dissolved solids during this period remained in between 91.5 to 1149 mg/liter (Figure 3).

3.6 Dissolved Oxygen (DO)

Temperature, water velocity, wind, water depth and plant growth influence DO in water. Temperature has great influence on the amount of DO**.** Warmer water contains less oxygen than colder water. The number of organisms using oxygen can also influence the amount of dissolved oxygen present. If more oxygen is used (respiration) than is being put in, dissolved oxygen levels decrease. The dissolved oxygen needs for many aquatic insects and fish differ, but some ranges overlap. Fish such as black nosed dace, brook and brown trout, and certain stoneflies have similar oxygen needs. That's one of the reasons they are found together in the same community. The same holds true for smallmouth bass, certain shiners and hellgrammites. Their dissolved oxygen needs and tolerances overlap. Dissolved oxygen concentration in the river water ranged from 5.6 mg/liter to 8.8 mg/liter (Figure 3).

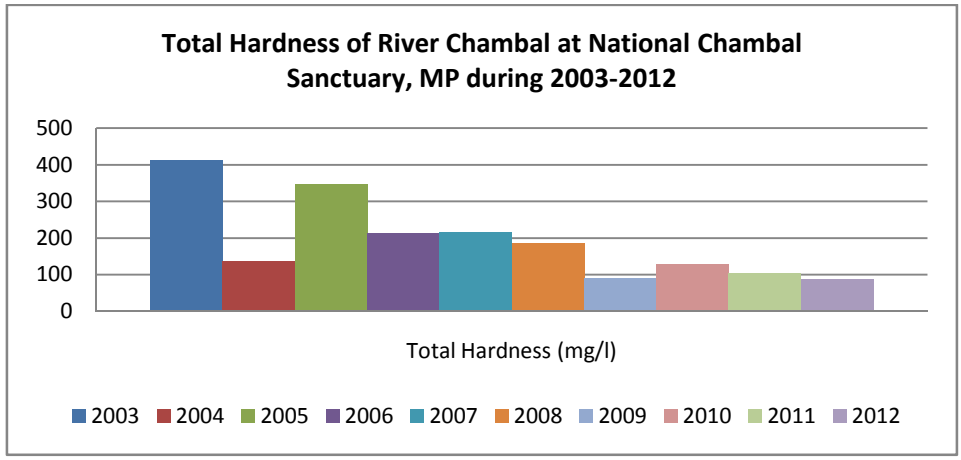
3.7 Total Hardness (TH)

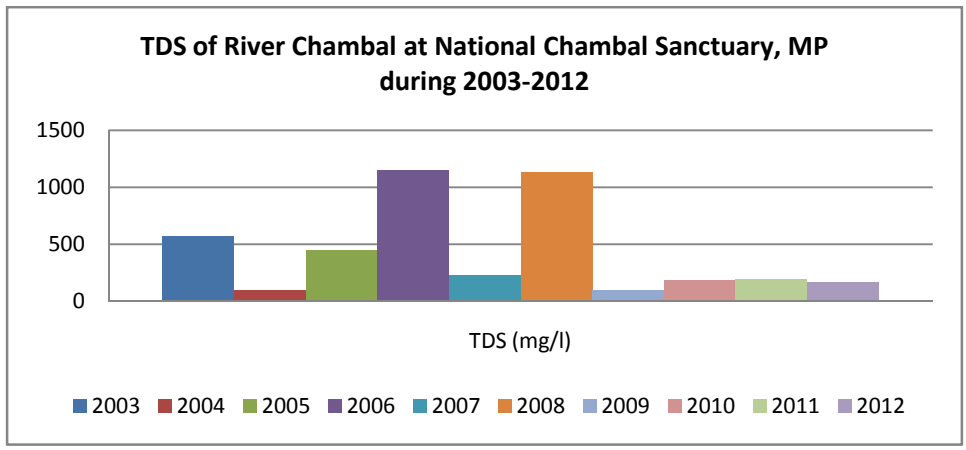
Total hardness in water is the sum of the concentrations of alkaline earth metal (e.g. Ca^{++}, Mg^{++}). In most fresh waters nearly all the hardness is imparted by the calcium and magnesium ions which are in combination with bicarbonates and carbonates (temporary hardness) apart from sulphates, chloride and nitrates. Total hardness values were observed within the range of 88 mg/liter to 414 mg/liter (Figure 3). The values were quite high during initial years.

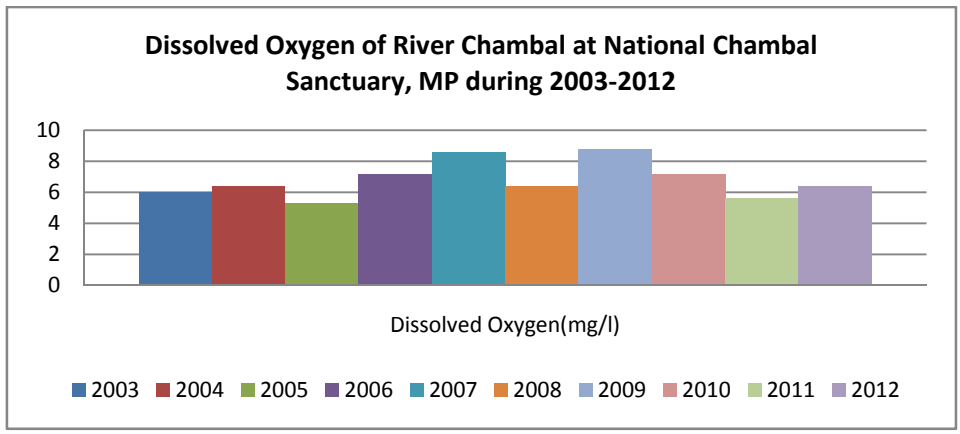
3.8 Total Alkalinity (TA)

The alkalinity of water is usually caused by carbonates, bicarbonates and hydroxyl ions and less frequently by borates, silicates and phosphates. The total alkalinity indicates the capacity of water to neutralize acids. It is the sum of all the titrable bases. As total alkalinity is the sum of carbonates and bicarbonates alkalinity and when either of the two (CO_3 or RCO_3) is absent, the value of the remaining is equal to total alkalinity. This may be used as a tool for the measurement of productivity conditions of water bodies. Alkalinity is important for fish and aquatic life because it protects or buffers against pH changes (keeps the pH fairly constant) and makes water less vulnerable to acid rain. The main sources of natural alkalinity are rocks, which contain carbonate, bicarbonate, and hydroxide compounds. Borates, silicates, and phosphates may also contribute to

alkalinity. Total alkalinity in the river water remained in between 76 mg/liter to 460 mg/liter (Figure 3).







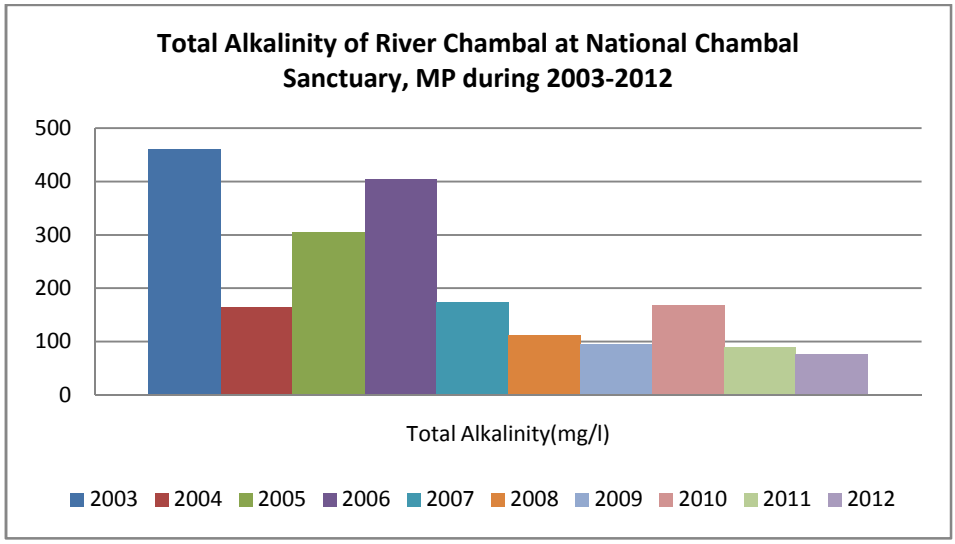


Figure 3. ***Graph showing Water quality (TH, TDS, DO and TA) variation of Chambal River during a decade.***

3.9 Chloride

Chloride occurs in all natural waters in widely varying concentration. As the mineral content increases chloride content also increases. In certain lake distinct contamination from domestic sewage can be monitored by chloride test. High chloride content indicates heavy pollution in lake. Chloride value in river water during the period of investigation remained in between 9.99 mg/liter to 246.98 mg/liter (Figure 4).

3.10 Nitrate

Nitrates stimulate the growth of plankton and water weeds that provide food for fish. This may increase the fish population. However, if algae grow too wildly, oxygen levels will be reduced and fish will die. Nitrates can be reduced to toxic nitrites in the human intestine, and many babies have been seriously poisoned by well water containing high levels of nitrate-nitrogen. The U.S. Public Health Service has established 10 mg/L of nitrate-nitrogen as the maximum contamination level allowed in public drinking water. Nitrate-nitrogen levels below 90 mg/L and nitrite levels below 0.5 mg/liter seem to have no effect on warm-water fish, but salmon and other cold-water fish are more sensitive. The recommended nitrite minimum for salmon is 0.06 mg/liter (Figure 4). Nitrate values in river water during the course of investigation varied from 0.258 mg/liter to 3.48 mg/liter.

3.11 Total phosphorus (TP)

Phosphate compounds are present in fertilizers and in many detergents. Consequently they carried into both ground and surface waters with sewage, industrial waste and agricultural runoff .High

concentration of phosphorus compounds may produce a secondary problem in water bodies where algal growth is normally limited by phosphorus. In such situation the presence of additional phosphorus compounds can stimulate algal productivity and enhance eutrophication.

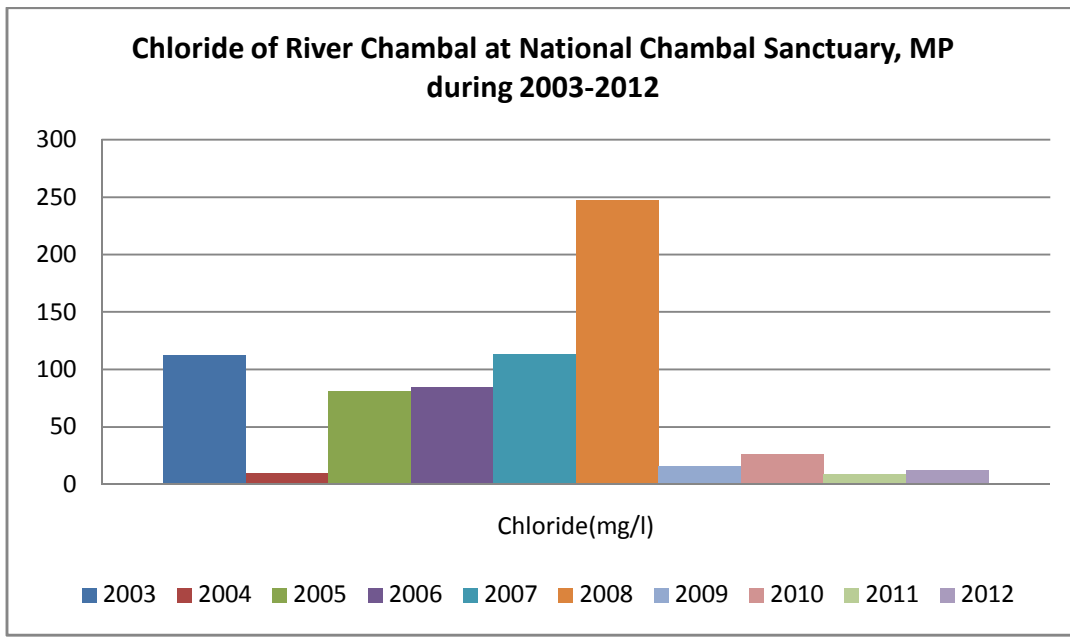
Nitrogen, Carbon and Phosphorus are the major classes of nutrients required for the growth of the aquatic plants. Excess phosphorus in the form of phosphate enter a water supply, either from agricultural runoff or from municipal waste causes eutrophication, or nutrient enrichment, of lakes and ponds. A eutrophic water body can produce massive algal blooms. The alga present in the contaminated water grows rapidly in the presence of excess nutrients. Total Phosphorus during the period of investigation remained within the range of 0.296 mg/liter to 3.22 mg/liter (Figure 4).

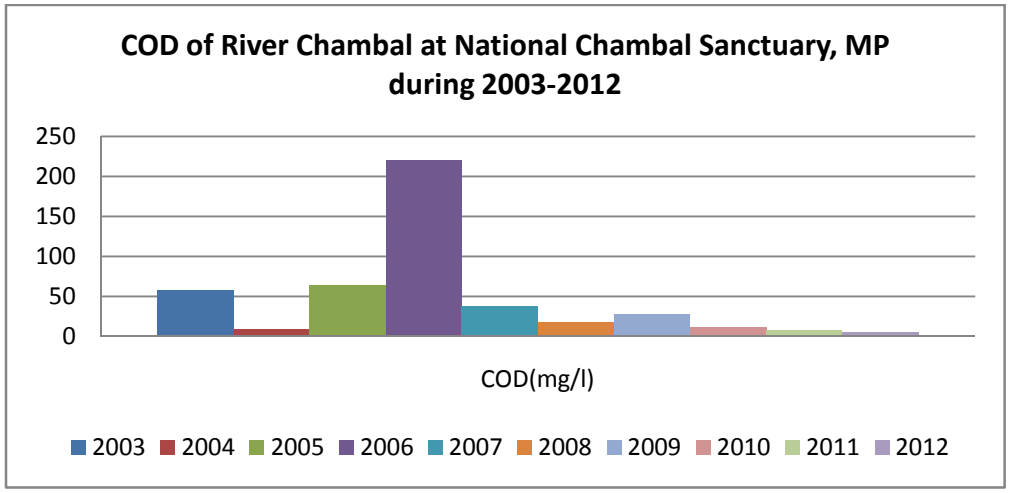
3.12 Biochemical oxygen demand (BOD)

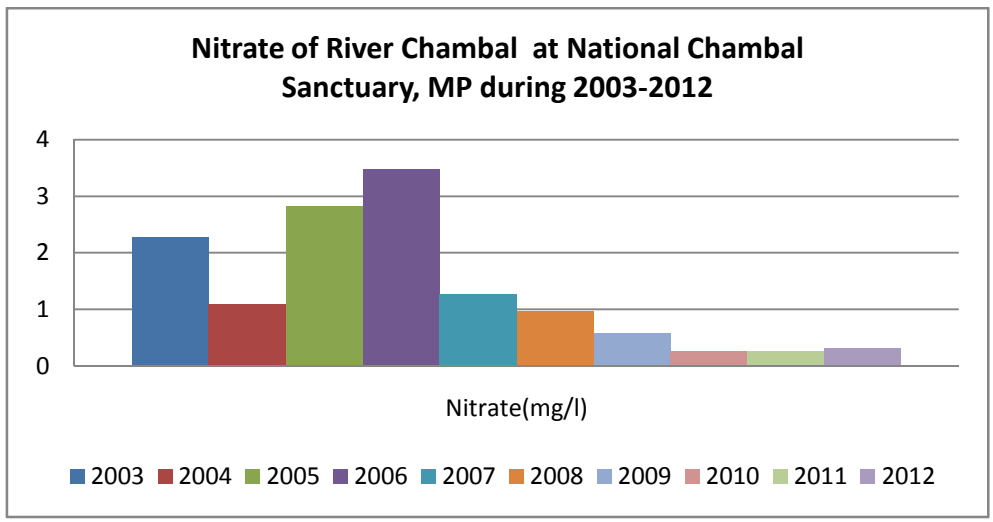
Biochemical Oxygen Demand in the river water remained within the range of 1.6 mg/liter to 62 mg/liter. BOD remained very low in most of the time except during the year 2006 when values were recorded slightly high (Figure 4).

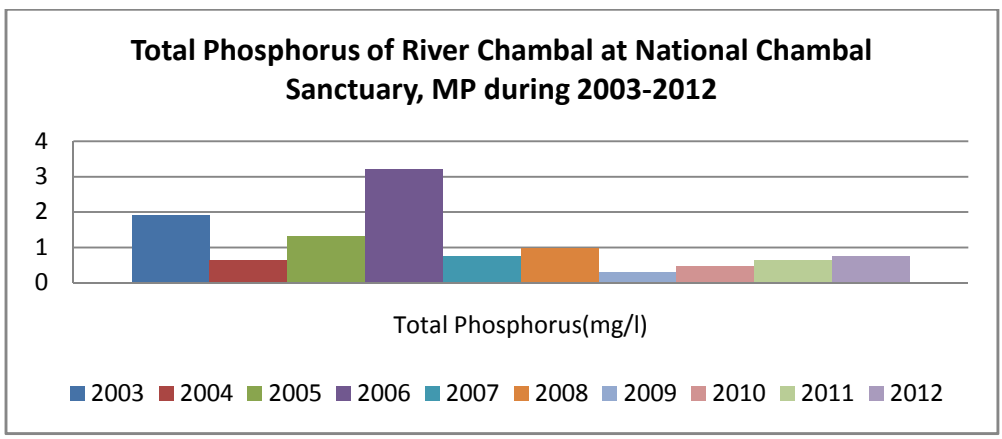
3.13 Chemical oxygen demand (COD)

Values of Chemical Oxygen Demand in river water remained within the range of 6 mg/litre to 220 mg/liter. COD values were also very high during 2006 as recorded for BOD (Figure 3).




COD of River Chambal at National Chambal Sanctuary, MP during 2003-2012
250
200
150
100
50
0
COD(mg/l)
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012


Nitrate of River Chambal at National Chambal Sanctuary, MP during 2003-2012
4
3
2
1
0
Nitrate(mg/l)
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012


Total Phosphorus of River Chambal at National Chambal Sanctuary, MP during 2003-2012
4
3
2
1
0
Total Phosphorus(mg/l)
2003 2004 2005 2006 2007 2008 2009 2010 2011 2012

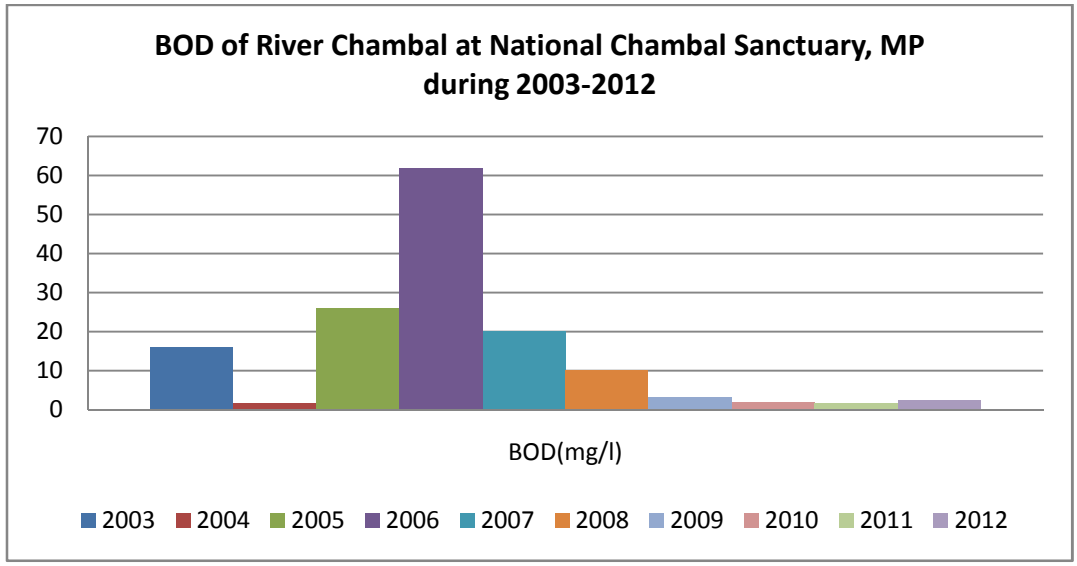


Figure 4. ***Graph showing Water quality (Chloride, COD, nitrate, TP and BOD) variation of Chambal River during a decade.***

Water is one of the critical inputs for the sustenance of mankind. It is used both in terrestrial and aquatic environment for various activities, balancing the ecological system of global environment. In central part of India, majority of the surface water resources are polluted due to one or other reasons. The increasing dependence of the burgeoning population on the water resources has led to a grave situation wherein very few water resources would have been available, the water of which could be used without a hitch. Although the importance for conservation of water resources has been realized since time immemorial but it is only recently when the gravity of the problem has been felt to such an extent. In fact the water scarcity problem has become a global scenario but in India particularly in western/eastern Madhya Pradesh the magnitude of this problem is realized much more than most other places. Even after having so much perception about the significance of water, they have been often ignored in the race of modernization and technological advances. In the past three decades, the technological evolution in Indian scenario has exerted overwhelming pressure on the water resources and as a result many of them have either lost their identity while others are in very bad shape. The unpredictable situation has cropped up in a short span of time, which invites an awaking call for realization, recognition of the problem and evolving remedial measures for recovery.

Inhabitants of freshwater ecosystems have, as a whole, suffered far more than plants and animals dependent on upland habitats such as forests and prairies. These losses are not confined to urban areas or to a specific region of the country. Aquatic systems are under stress worldwide. These

dramatic declines in freshwater animal species are due primarily to the intensive human use—and abuse—of their habitats. Rivers are affected by, and reflect, the condition of the lands through which they travel.

4. CONCLUSIONS

The analysed data for the year 2003-2012 reveals that the water quality at National Chambal Sanctuary is satisfactory during this entire period. Sometimes few parameters have recorded higher values of pollution indicating temporary sign of pollution which may be due to some localized affect. The water quality at the Sanctuary fairly satisfies the water quality criteria for Class C water body (Drinking water source after conventional treatment and disinfection) at almost all the instances. The overall health of the river during all the years has been found satisfactory. The present study recommends to continue the monitoring that is useful for the sustainable development through planning and for the implementation of remediation methods in the future, in order to mitigate the adverse effects of the deprived quality of river water on human health, as well as on plant growth.

REFERENCES

[1] A.R. Crawford (1969), India, Ceylon and Pakistan: new age data and comparisons with Australia, Nature 223: 380 – 384, in Chowdhury, S., 1981. Some Studies on the Biology and Ecology of Gavialis gangetics, the Indian gharial (Crocodilia; Gavialidae). PhD Thesis, University of Lucknow

[2] APHA, AWWA, 2005 Standard methods for analysis of water and wastewater 19th edition 2005.

[3] B.K. Dwivedi, G.C. Pandey 2002, Physico-chemical factors and algal diversity of two ponds in Faizabad, India Poll. Res. 21(3), pp.361-370.

[4] D. Mustafa and M. Suicmez (2007), Utilization of both benthic macroinvertebrates and physicochemical parameters for evaluating water quality of the stream Cekerek (Tokat, Turkey). J. Environ. Biol., 28, pp. 231-236.

[5] D.M. Verma, N. P. Balakrishnan, R. D. Dixit (1993), Flora of Madhya Pradesh, Botanical Survey of India, Calcutta, India. pp.472.

[6] D.N Saksena, R.K.Garg, R.J. Rao (2008), Water quality and pollution status of Chambal river in National Chambal Sanctuary, Madhya Pradesh. J Environ Biol., 29(5), pp.701-10.

[7] F. Lowel Thompson (1992), Biodiversity of vibrios. Microbiol. Mol. Biol. Rev., 68, pp. 403-431.

[8] P. A. C. Okoye, R.E. Enemuoh, J.C. Ogunjiofor, 2002, Traces of heavy metals in Marine crabs. J. Chem. Soc. Nigeria, 27 (1), pp.76-77

[9] S. Hussain, R.K. Sharma, N. Dasgupta, A. Raha (April 2011), Assessment of minimum water flow requirements of Chambal River in the context of Gharial (Gavialis gangeticus) and Gangetic Dolphin (Platanista gangetica) conservation, www.wii.gov.in., Wildlife Institute of India, Retrieved 11 February 2014.

[10] S. Jain, K. Pushpendra K. Agarwal, V.P. Singh (2007), Hydrology and water resources of India, Volume 57 of Water science and technology library Tributaries of Yamuna river, Springer. p. 350. ISBN 1-4020-5179-4.