*THE INTERNATIONAL JOURNAL OF SCIENCE & TECHNOLEDGE*

# Monitoring & Analysis of Qualitative Characteristics of Holy Kshipra River at Ujjain City (M.P)

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***Abstract:***
*Kshipra River is a perennial river and vital source for water in Ujjain city. It is being polluted by various effluents discharged from dye industry and domestic wastes of the city. The present study was made to investigate the water quality using benthic macro invertebrates as biological indicators. For this purpose, samples were collected from three downstream sites namely Mangalnath, Sidvat and K.D. palace. The analysis was carried out for throughout the year. Physical parameters such as temperature, conductivity, TS, TSS, TDS, and chemical parameters such as pH, alkalinity, hardness, DO, COD and chloride were examined. Results of the study indicated that water in Kshipra was highly contaminated (Downstream) and not safe for drinking purpose. Urgent action was needed and proper planning for treatment of domestic waste water and dye effluent discharge.*

***Keywords****: Kshipra river, physical, chemical, water quality parameters*

## 1. Introduction

Water is the basic and primary requirement of all vital processes. Ever since the pre-historic times man has made intimately associated with water, and it has been conclusively proved by the evidences of past civilizations that all historic human settlements were around inland fresh water resources. It is the most abundant substance, covering more than 70% of the earth's surface and existing in many places and forms: mostly in the oceans and polar ice caps, but also as clouds, rain water, rivers, fresh water aquifers and sea ice.

Running water ecosystems encompass a wide spectrum of habitats spanning a continuum from small mountain springs to immense lowland rivers. However, in practice we speak of an aquatic habitat as one in which water is the principal external as well as internal medium. Streams are naturally hierarchical extremely heterogeneous ecosystems across multiple spatial scales. The hierarchy of stream habitats consists of drainage systems, pool-riffle sequences within streams and small scale microhabitats within riffles.

With the onset of industrialization, the world's oceans and other fresh water resources have been contaminated. As population increase rapidly, the growing human need for fresh water is leading to a global water crisis. The cause of degradation of river water quality due to various point & non-point sources is increasing problem of deterioration of river water quality, it is necessary to monitor the water quality to evaluate the production capacity.

## 2. Material and Methods

### *2.1. Study Area*

River Kshipra is one of the sacred Indian rivers. It is also known as "Avanti Nadi". It originates from KokriBardi hills (747 meters high) 11km south east of Indore. After traveling a distance of 70km through Indore district, it enters holy city Ujjain. It receives its tributary river Khan near Ujjain and Gambhir river near Mahidpur, before itself merging with the Chambal at the trijunction of Ratlam and Mandsur district of M.P. and Jhalawar district of Rajsthan. Most of its course lies over the broad rolling of grassy plains of Malwa between low banks and from Mahidpur to a lot it is hemmed in by high rocky banks. Its total length is about 195km out of which 93km flow through Ujjain.

### *2.2. Geographical Location*

Ujjain is located at 23°10′58″N 75°46′38″E23.182778°N 75.777222°E. It has an average elevation of 491 meters (1610 ft).

### *2.3. Climate*

Ujjain experiences a warm sub-tropical climate, typical of the interior Indian subcontinent. Summer starts in late March with temperatures rising to 45°C at its peak in May. The monsoon arrives in the middle of June and continues till early October. About 870mm (35 inches) of precipitation is received during those months, however in some years it crosses more than 40 inches.

The rest of October generally is very warm and with high humidity. Winter starts in the middle of November and is pleasant and cool with daytime temperatures typically 20°C, though temperatures can drop significantly in the night.
The particular sites of River Kshipra where the work has been done are Mangalnath, Sidvuth and K.D. Palace.

2.3.1. Site 1 Mangalnath
This site is located in the North area gets its name from a famous temple Mangalnath which is located at the bank of the river Kshipra. Mangalnath is regarded as the birth place of Mars according to SkandaPurana.

2.3.2. Site 2 Sidvuth
This site is about 1 km away from Mangalnath site. Here washing of clothes is done directly in order to remove the excess dye.

2.3.3. Site 3 K.D. Palace
Kaliadeh palace is approx. 3.6km from Bhairavgarh. The palace is renowned for its unique water management mechanism, which comprises of 52 small ponds in which water once flows clockwise and then anti-clockwise. During the rainy season splendor view of rotating water mechanism of 52 ponds can easily be observed.

*2.4. Sampling and Storage*
Water samples were collected from these sites in plastic bottles. Physico-chemical analysis of river water was carried out by standard protocol i.e. APHA (1998) and Adoni (1985). Following parameters are analyzed:

- Temperature
- Dissolved Oxygen
- Free Carbon dioxide
- pH (Hydrogen ion Concentration)
- Alkalinity
- Conductivity
- Chloride
- Total Hardness
- Calcium Hardness
- Magnesium Hardness
- Total Solids
- Total dissolved Solids (TDS)
- Total Suspended Solids
- Chemical Oxygen Demand (COD)

**3. Results and Discussion**
Observations were made at three selected sites namely site-1 (Mangalnath), site-2 (Sidvuth) and site-3 (K.D.Palace) within downstream of River Kshipra.

| S.No. | Parameters | Maximum | Minimum |
|---|---|---|---|
| 1. | Air temperature ($^0$C) | 36.2 | 30 |
| 2. | Water temperature ($^0$C) | 25 | 19 |
| 3. | pH | 8.6 | 7.7 |
| 4. | Conductivity ( μS/cm,) ,) | 450 | 218.55 |
| 5. | TDS (mg/l) | 5310 | 4000 |
| 6. | TSS (mg/l) | 190 | 90 |
| 7. | TS (mg/l) | 5500 | 4090 |
| 8. | Chloride (mg/l) | 404.99 | 221.99 |
| 9. | DO (mg/l) | 9.3 | 1.0 |
| 10. | Free $CO_2$ (mg/l) | 10.4 | 2.2 |
| 11. | Ca hardness (mg/l) | 357 | 159.5 |
| 12. | Total hardness (mg/l) | 442.97 | 195.7 |
| 13. | Mg hardness (mg/l) | 85.97 | 36.20 |
| 14. | Total alkalinity (mg/l) | 460 | 150 |
| 15. | COD (mg/l) | 305 | 155 |

*Table 1: Physico-chemical characteristics of river Kshipra*

*3.1. Air & Water Temperature*

Temperature is an important factor influencing aquatic life, concentration of dissolved gases and chemical solutes. The temperature not only affects physiological processes but also affects the density and stratifications of water. Gasim, *et al* (2007) also reported the temperature variation between 26.15°C to 28.9°C of river Pahang. Same results were also obtained by Gupta, *et al* (2011). The rise in temperature leads to speeding up of the chemical reactions in water reducing solubility of gases. (Murugesan*et al*., 2004).

*3.2. pH*

pH is the measure of the acidity or alkalinity The variation of pH is due to the change in alkalinity of water sample. Alkaline pH found in the present study may be due to presence of ions in water body. Rao *et al* (1985) reported similar ranges of pH in River Khan ranging from 7.2 to 8.4. Salih *et al* (1986) observed pH values ranging from 6.6 to 7.2 from Tigris River. Kartha and Rao (1992) showed high pH values ranging from 8.1 to 8.4 in Gandhisagar reservoir near River Chambal.

*3.3. Conductivity*

High value of conductivity is due to anthropogenic activities such as domestic waste and human settlements. Conductivity ranged from 218.55 to 450 µS/cm considerable increase towards site-3. Kartha and Rao (1992) observed medium conductivity value of the range 232 to 285 µS/cm from Gandhisagar reservoir. Saksena *et al* (2008) studied water quality and pollution status of Chambal River in National Chambal Sanctuary and observed lowest conductivity of 145.60 us/cm in March and highest conductivity of 884 µS/cm in May.

*3.4. Total Dissolved Solids (TDS)*

Rao *et al* (1986) found very high TDS concentration ranged from 400-1250 mg/L during KumbhMela at river Kshipra. Elevated TDS can be toxic to fresh water animals causing them osmotic stress and affecting the osmo-regulatory capability of organisms (Mccullochet *al*., 1993).

*3.5. Total Suspended Solids (TSS)*

Ahlawat and Kumar (2009) also reported the high values of TSS at Solan. The high values observed during the present work were due to the ritual activities like immersion of idols offering of flowers and oil and dumping of carcasses etc.

*3.6. Total Dissolved Solids (TS)*

Total solids are due to discharge of untreated effluents, municipal sewage, and domestic waste water into the river. Lokhande *et al* (2011) also reported high values of TS. The concentration of TS increases due to ritual activities observed by Patil (2003).

*3.7. Chloride*

Chlorides occur naturally in all types of waters. In natural fresh waters, however its concentration is quite low. The most important source of chloride in water is the discharge of domestic sewage. Therefore, the chloride concentration serves as an indicator of pollution by sewage. It produces a salty taste at 250- 500mg/l level. Chlorides are highly soluble with most of the naturally occurring cations and do not precipitate. In the present study chloride ranges between 221.99 to 404.99 mg/l which may be due to large amount of sewage discharge in the river.

According to WHO (1984), standard values for chloride is 250 mg/l. Gupta and Paliwal (2010) observed that the chloride content at Yamuna River was 355.0 mg/l to 372.0 mg/l which may due to large amount sewage discharge in the river. Rao *et al* also (1986) reported a high range of chloride varied from 20 to 132 mg/l representing polluted conditions in Gandhisagar reservoir. Runoff from surrounding catchment area increases the chloride content as also observed by Khan *et al*. (1978). Domestic waste and fertilizers also increases chloride content as reported by Guru Prasad (2005).

*3.8. Dissolved Oxygen*

DO in water is of great importance to all aquatic organisms and is considered to be the factor that reflects the biological activity taking place in a water body and determines the biological changes. DO was observed between 1.0 mg/l to 9.3 mg/l. The minimum DO was reported from site-1 (Mangalnath) which is due to the cumulative effects of human activities such as sewage disposal, where oxygen is used to decompose these organic wastes causes algal blooms. The more DO was reported at site-3 (K.D. Palace) because of water flow and less human interferences. Karthick and Ramchandra (2007) also recorded the DO ranged upto9.29mg/l. Kamble (2008), recorded the value for DO varied, between 7.26 to 9.44mg/l. The decrease in DO was due to cumulative effect of various ritual activities and rise in temperature as also observed by Devi and Belgali (2005).

*3.9. Free Co2*

Free carbon dioxide dissolved in water is essentially the only source of carbon that can be assimilated and incorporated into the skeletons" of the living matter of all the aquatic autotrophs .Once fixed it can be further utilized by the organisms of other categories. In the absence of free carbon dioxide, plants utilize the bicarbonates: $CO_2$ dissolved in natural waters actively participate in the carbonate system.

In the present study, minimum range of free carbon dioxide is 2.2 mg/l to a maximum range of 10.4mg/l .Maximum amount of the free carbon dioxide was due to high surface area, and decomposition of organic matter and inorganic matter present in the river. Karthick and Ramchandra (2007) observed the values between 6.16 to 52.8 mg/l while working on physico-chemical and

hydrological parameters in Venkatapura catchment. The rate of free $CO_2$ gets increased during the immersion of idols (Gupta *et al.* 2011).

*3.10. Total Alkalinity*

The alkalinity is the buffering capacity of water. During the study period, the total alkalinity was observed between 150 to 460 mg/l. The alkalinity gets increased due to the various religious activities, domestic waste and especially due to soaps and detergents as reported by Patil (2003). The alkalinity decreases due to onset of rains as reported by Ravikumar*et al.* (2006).

*3.11. Total Hardness*

Hardness is the property of waters, which prevents the lather formation with soap and increase the boiling point of waters. Principal cations imparting hardness are $Ca^{+2}$ and $Mg^{+2}$. The anions responsible for hardness are carbonates, bicarbonates, sulphates, chlorides, nitrate and silicate. Total hardness of more than 500mg/l can be tolerated by its consumers depending upon the local conditions. In the present study, the total hardness was observed in a range of 420 to 652 mg/l. The increase in hardness may be due to domestic activities like washing clothes, animals, vehicles etc. done at the site. Rao and Rao (1986) reported the total hardness value from 72-356 mg/l in Kshipra River.

*3.12. Calcium and Magnesium Hardness*

Calcium is essential for all organisms, being an important cell wall constituent, and regulates various physiological functions in animals too. It has a direct effect on pH and carbonate system. Ca hardness and Mg hardness were reported between 159.5 to 357.0 mg/l and 36.20 to 85.97 mg/l. Hardness increasesdue to mixing of domestic waste and increase in temperature as also observed by Goyal *et al* (2006). The hardness was observed lower than the alkalinity due to the presence of basic salts of sodium and potassium in addition to those of calcium and magnesium as also observed by Jhadav*et al.*, (2009). The Ca hardness was observed high during the immersion period and other religious activities as also reported by Ujjania and Multani (2011). The hardness of water is not a pollution parameter but indicates water quality (Vyas*et al.* 2006). The high quantity of Ca and Mg was due to cumulative effect of high temperature and ritual activities.

*3.13. Chemical Oxygen Demand*

COD is the significant parameter of polluted water bodies which affects the limno-biotic fauna of the river. Ansari and Prakash (2000) observed that COD is required oxygen from the organic substance of water to oxidize them by a strong chemical oxidant. During the study, the COD was reported between 155 to 305 mg/l higher than the permissible limit. These high values were due to ritual activities like idol immersion and sewage discharge. The value of COD is helpful in knowing the toxic conditions and presence of biologically resistant organic substances as also reported by Rajkumar *et al.* (2003).

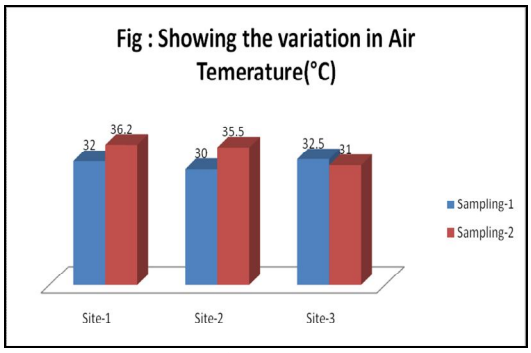



*Figure 1*

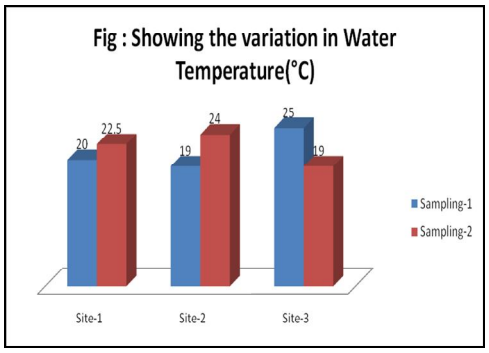



*Figure 2*

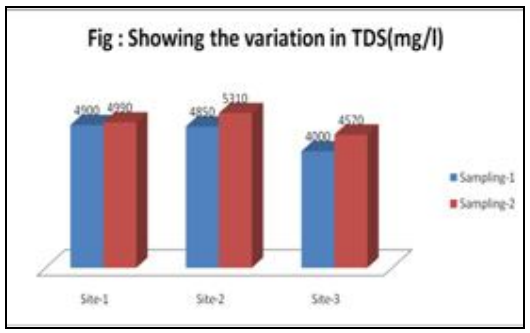
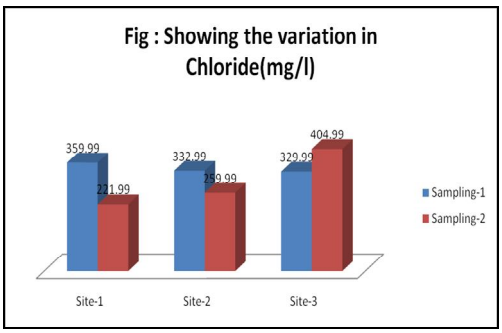



*Figure 3*

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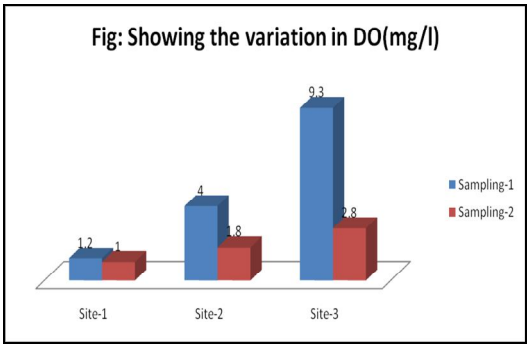


*Figure 5*

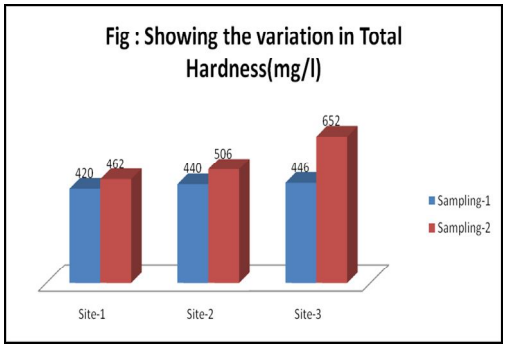


*Figure 6*

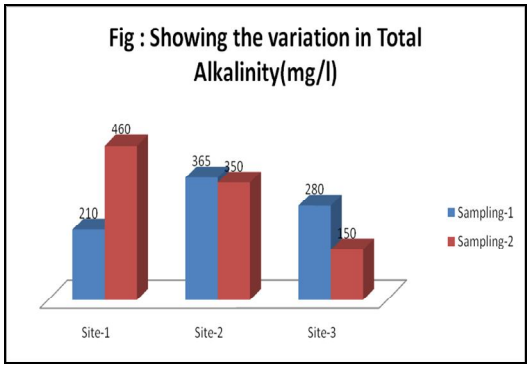


*Figure 7*

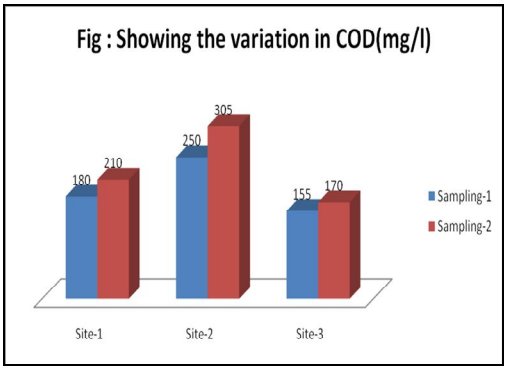


*Figure 8*

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