# INDICES OF WATER & SOIL IN PHYSICO-CHEMICAL & BIOLOGICAL PROPERTIES AT RIVER KSHIPRA, UJJAIN INDIA

MANDERIA SUSHIL , MANDERIA KRISHNA

**Abstract**: Kshipra river is a holy perennial river of Ujjain city. According to mythological view this river is very important ritual river. Due to direct discharge of dye effluent water quality was deteriorated and soil characteristics also affected when irrigated with untreated water / effluent. Change in water & soil characteristics is not only an ecological risks but pose to socio-economic threat.

Water samples were also collected from upstream point, industrial effluent point, confluence point & down stream point and soil samples from two areas i.e. irrigated with effluent water (contaminated area) & not irrigated with effluent (uncontaminated area). Ten different locations were marked in each area. Selected parameters include pH, temperature, electric conductivity, total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), dissolved solids (DO), chemical oxygen demand (COD), total alkalinity, total hardness (TH) & chloride content in water samples and pH, conductivity, water holding capacity (WHC), bicarbonate, Ca, Mg, Na, K ions total organic carbon (TOC), total organic matter (TOM) in soil samples. These were analysed by following standard protocol of APHA.

Results depict that all parameters in water samples increases in ranges of 15 to 25%. High levels were recorded in COD (73-345mg/l), pH (7.6-9), TS (2100-6050mg/l), TDS (1990-5820mg/l), DO (0-8mg/l) TH (321-880mg/l), which exceeds the standard levels of BIS & WHO. Data of soil samples indicate its neutral to slight alkaline nature. Cation & anion concentration, organic carbon & organic matter were also shows a wide variation in contaminated soil samples as compared to uncontaminated samples. The study conclude that application of effluent appears to deteriorate soil quality in the area but crop growth was enhance due to excess nutrient present in irrigated water. This may be harmful to human beings, animals as well as environment viz biomagnifications may occurred and accumulation of heavy metals in tissues. On the basis of results a compartmentalization of nutrients can be formulated with its budgeting.Further research will be needed at molecular studies.

**Introduction:** Growing urbanization and industrialization have led to generation of large quantities of waste/effluents, which affects the natural resources like soil, water, air etc. in various ways. Water is essential for most plant and animal life and the most widely used of all solvents. With the world population growing and the increasing population of our natural resources, we are facing a water crisis and soil degradation deteriorates soil quality and productivity. Modern agriculture, particularly those practices established by our 'green revolution' resulted in the contamination of water by fertilizer & pesticide residue, due to run offs caused by large irrigation schemes.

Discharge of industrial effluents, domestic sewage and solid waste dump into the groundwater to become polluted and causes health problems (Shyamala, et.al., 2009; Raja, et.al., 2002; Mishra, e.al., 2002 and Mishra and Bhatt, 2008). Water pollutants mainly consist of heavy metals, micro organisms, fertilizers and thousands of toxic organic compounds (Arvnabh Mishra, 2010; Parihar, et.al., 2012).

Ujjain is a great centre of the textile industry with a number of textile mills in Bhairav garh, famous for Dye Industries (Bhairav Garh Prints) not only in M.P but also throughout the India. Dye industries consume a lot of water during dye processing. This untreated waste water is being discharged freely into drains that connect the industry to the main drainage network (The River Kshipra) in the town. Since the waste water is being used for crops cultivation which affects the nearby agricultural land. The most common textile processing unit consists of desizing, scouring, bleaching, mercerizing and dyeing process. The objective of this study was to assess qualitative analysis of effluents discharged into the river Kshipra by some physico-chemical parameters and to make indices of soil & water in the area.

Materials and methods:

Ujjain is located at 23°10′58″N 75°46′38″E. It has an average elevation of 491 meters (1610 ft) and is situated on the Malwa Plateau in Central India. Ujjain experiences a warm sub-tropical climate, typical of the interior Indian subcontinent. River Kshipra is one of the sacred Indian rivers.

Soil samples were collected from the nearby agricultural land where untreated industrial effluent is used for irrigation purpose. Three replicates of each sample from ten different location were collected from 0-25 cm depth. Composite sample for each replicate were prepared, air-dried, gently crushed with a wooden roller and passed through 2 mm sieve. Sieved soil samples (<2 mm) were stored in plastic bags for further analysis. The industrial effluents were also collected from outlet for physico-chemical analysis.

The water and soil samples were analysed for various parameters i.e. Temperature and pH were recorded directly in the field, other physicochemical parameters electrical conductivity (EC); Water Holding Capacity (WHC); percent organic carbon (OC); and organic matter (OM); available phosphate (P) and potash (K); available sodium (Na); bicarbonates (HCO3); calcium (Ca) and magnesium (Mg) were analyzed by standard protocol followed by APHA 1998; Adoni 1985.

Results and discussion:The results revealed that soil parameters were affected due to application of different industrial wastewater (Fig 1to10; Table 1). pH of contaminated soil was ranged between 7.76 to 8.7 while un-contaminated soil ranged between 6.90 to 7.31. According to Rai, *et al.,* (2011) crop growth neither need a high pH (above 8.4) nor a low pH (below 5.0) for maximum yield of crops. Electrical conductivity ranged between 220 to 418 μS $cm^{-1}$ in uncontaminated and contaminated soil samples respectively. In the contaminated soil, EC increased with the application of effluent as irrigation water having high concentration of salts, particularly $Na^{+}$ and $Cl^{-}$ has significantly increased the salinity as compared to the uncontaminated soil (Ishaya, *et al.,* 2011). Water Holding Capacity ranged between 53 to 65% in the uncontaminated and contaminated soil respectively

Bicarbonates of contaminated soil ranged between 440 to 540 mg/kg and in uncontaminated soil ranged between 280 to 380 mg/kg.. High pH values indicate alkalinity (bicarbonates) problem with sodium ion likely to be the dominant cation in the soil colloid (Ishaya, *et al.*, 2011). The Calcium in contaminated soil was ranged between 189 to 273 mg/kg and Magnesium 8.50 to 45.9 mg/kg. In uncontaminated soil, Calcium was ranged from 63 to 94.5 mg/kg and Magnesium 3.08 to 6.99mg/kg. The lowest SOC and SOM (0.18 & 0.31%) respectively was recorded in the non-treated/uncontaminated soil as compared to contaminated samples. Irrigation with waste water increases OM content of soil (Mojiri, *et al.,* 2011). Most of the difference in OM content and EC may be due to long term application of waste water in soil.

The application of effluent water markedly improved the available Sodium in contaminated soil as compared to the uncontaminated soil. The minimum available Sodium was recorded in the uncontaminated soil ranged between 37.8 to 46.6 ppm and maximum in contaminated soil ranged between 70.3 to 79.7 ppm. Increase in the Sodium ion concentration of soil irrigated with waste water can be attributed to minerals in the waste water (Mojiri, *et al.,* 2011). High amounts of Sodium ions can result in precipitation of calcium and magnesium ions from the soil thus affecting their effectiveness in enhancing physical internal drainage (Ishaya, *et al.,* 2011).

The data revealed that application of industrial waste/effluent markedly improved the soil available potassium in contaminated soil as compared to uncontaminated soils. The minimum available potassium was recorded in the uncontaminated soil ranged between 30.7 to 33.8 ppm. The potassium content was maximum in the contaminated soil as compared to uncontaminated soil and was ranged between 50.7 to 58.7ppm. Available potassium content of soil increased significantly by the waste water application (Baddesha *et al*., 1997).

The minimum available phosphate was recorded in the uncontaminated soil ranged between 0.67 – 0.78 mg/kg. Swaminathan and Vaidheeswaren (1991) reported that waste water produced continuously could cater for the needs of irrigated crops. Soil irrigated with waste water contains high amount of available phosphorus which play significant role in plant growth (Reddy, *et al.,* 2003). Since the waste water is being used for crops cultivation which affects the nearby agricultural lands, there may built up toxic substances in the soils of the area.

Untreated waste water was being discharged freely into drains that connect the industry to the main drainage network (The River Kshipra) in the city. The pH ranged between 8.2 to 9.0 means alkaline in nature also reported by Rana, *et al.,* 2010. The electrical conductivity which represents total ions concentration ranged between 410.38 to 500.46 µS $cm^{-1}$. This indicates that salts used in the dyeing process are leached out in outlet. Chloride concentration was maximum (669mg/lit) as compared to other parameters like Na, Mg and K i.e. 70mg/lit, 121mg/lit & 39.7mg/lit respectively (Table-1)..

Water temperature ranged between 19 to 23.5°C at all site. The dissolved oxygen (DO) recorded were 0 to 8 mg/l. The effluent waste discharge to surface water source is largely determined by oxygen balance of the system and its presence is essential in maintaining life within a system (Lokhande et.al., 2001). pH values within the permissible limit i.e. 7.6 to 8.2 and alkalinity levels ranged between 168 to 430mg/l. Maximum chemical oxygen demand (COD) observed was 250 to 345mg/l and electrical conductivity was 289 to 337.5µS/cm. The minimum chloride values were 220mg/l. and maximum 550 mg/l. Total solids (TS) was minimum 2100 to 2280 mg/l, while maximum 5800 to 6050 m/l. Ca Hardness ranged between 217 to 420mg/l and magnesium hardness ranged between 22.81 to 121mg/l (Table-2).

**Conclusion:** The data suggested that the soil irrigated with industrial water affects physicochemical characteristics of soil & plants. Also, effluents affects the water quality which lead to significant environmental & health risk to the rural communities who rely on the receiving water as their source of domestic water purpose without treatment. There is urgent need for proper- utilization practices for irrigation purpose: identification of resistant crop; waste water treatment plant prior to re-use; rotation of crops. The result shows that application of effluent becomes an environmentally sustain technology. The study needs continuous pollution monitoring programme for the river Kshipra. In addition to this provincial government and NGO's of MP should evolve measures to check and ensure that discharge effluents comply with laid down rules and regulations.

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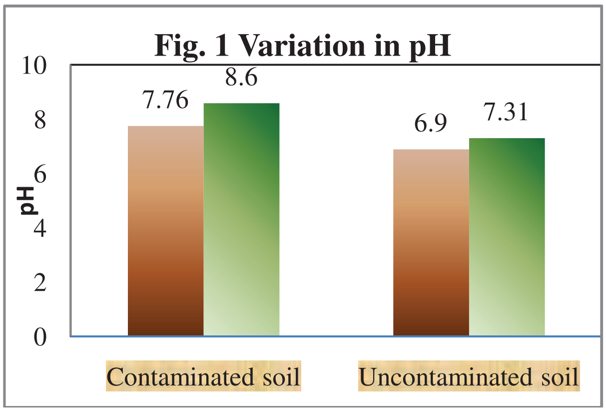
**Fig. 1- 10 : Comparison of soil characteristics when irrigated with industrial effluent water and fresh water**



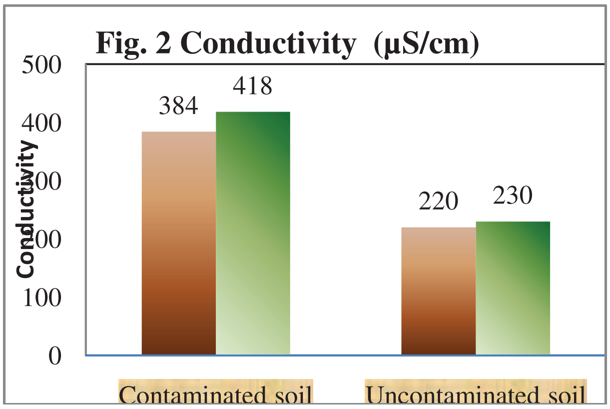



**Fig. 3 % Water Holding Capacity**

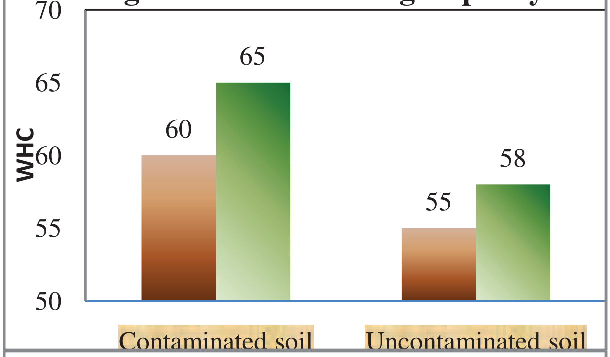



**Fig. 4 Bicarbonates (mg/kg)**

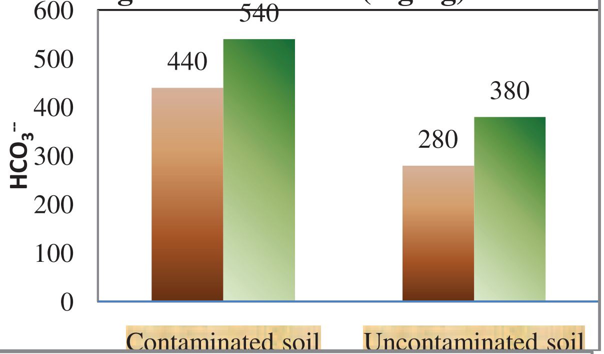



**Fig. 5 $Ca^{++}$ (mg/kg)**

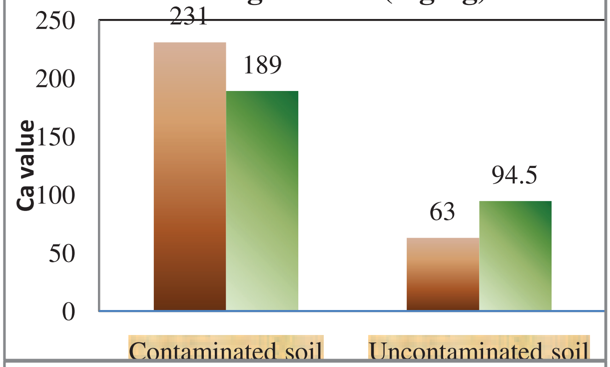



**Fig. 6 $Mg^{++}$ (mg/kg)**

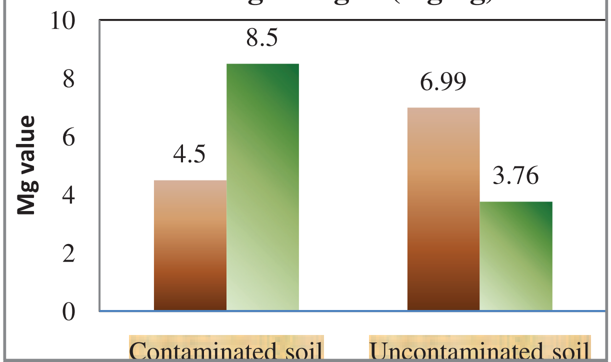



**Fig. 7 % Organic Carbon**

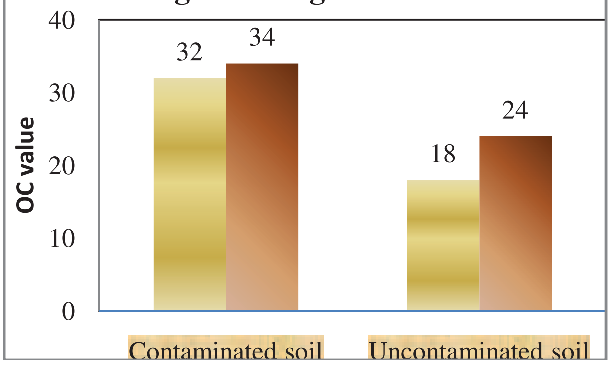



**Fig. 8 Potassium (ppm)**

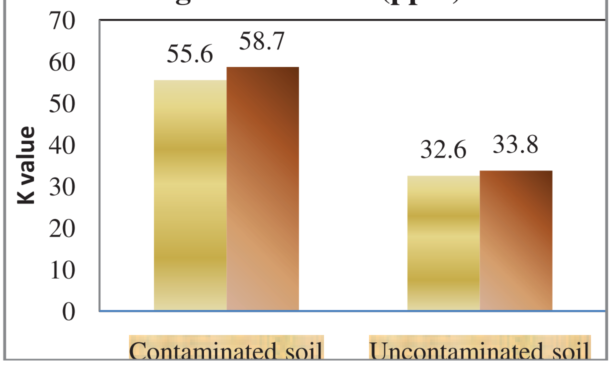



**Fig. 9 Sodium (ppm)**

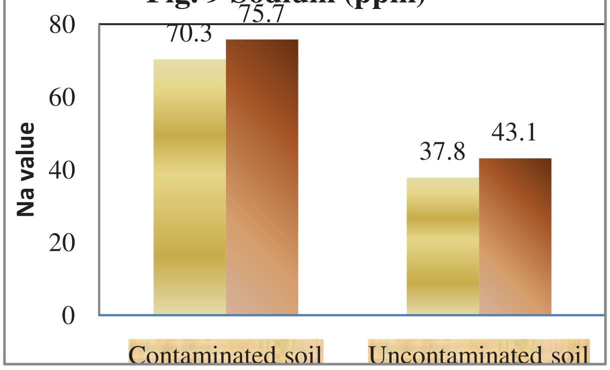



**Fig. 10 Phosphate (mg/kg)**

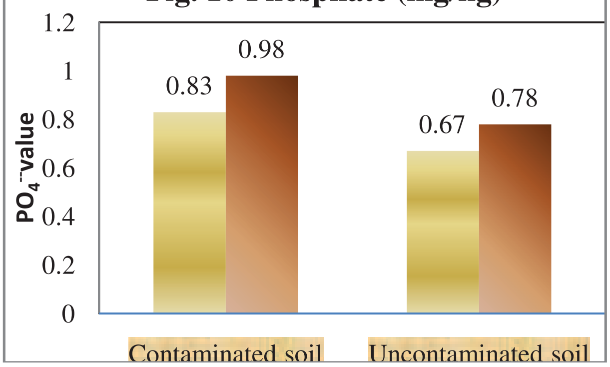


**Table 1: Analysis of physico-chemical parameters of contaminated and uncontaminated soil**

| S. No. | Parameters | Contaminated soil | | Uncontaminated soil | |
|---|---|---|---|---|---|
| | | Min | Min. | Max. | Min. |
| 1 | pH | 7.76 | 8.6 | 6.90 | 7.31 |
| 2 | Conductivity (μS/cm) | 384 | 418 | 220 | 230 |
| 3 | Water Holding Capacity (%) | 60 | 65 | 55 | 58 |
| 4 | Bicarbonates (mg/kg) | 440 | 540 | 280 | 380 |
| 5 | $Ca^{++}$ (mg/kg) | 231 | 189 | 63 | 94.5 |
| 6 | $Mg^{++}$ (mg/kg) | 4.59 | 8.50 | 6.99 | 3.76 |
| 7 | Organic Carbon (%) | 32 | 34 | 18 | 24 |
| 8 | Phosphate (mg/kg) | 0.83 | 0.98 | 0.67 | 0.78 |
| 9 | Potassium (ppm) | 55.6 | 58.7 | 32.6 | 33.8 |
| 10 | Sodium (ppm) | 70.3 | 75.7 | 37.8 | 43.1 |
| | | | | | |

Plate 1 Dye Industrial Effluents;

Plate 2. Discharge of Dye Effluent;

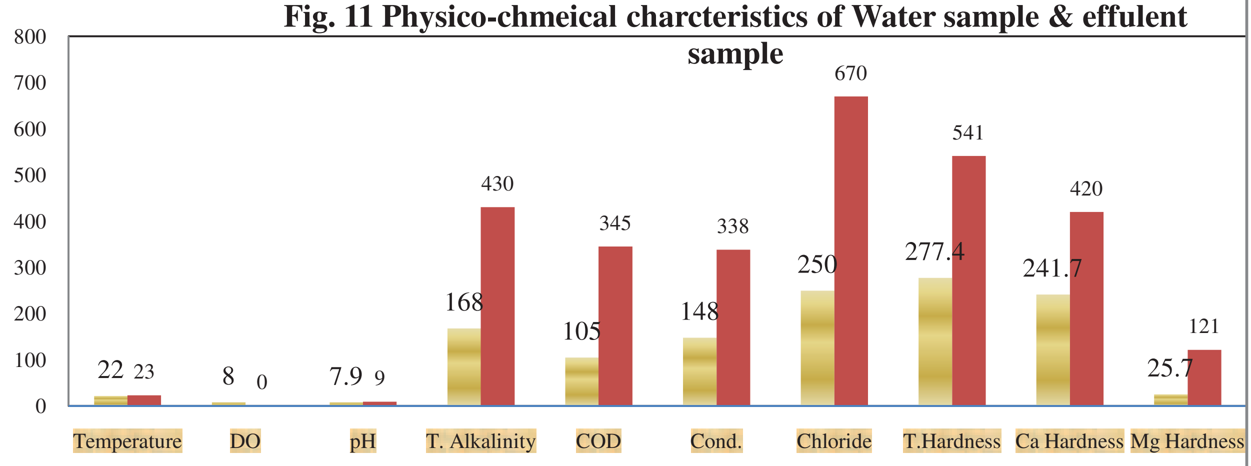
Plate 3 Washing of Clothes;

Plate 4 Effluent used for Irrigation

Table 2: Analysis of Physico-chemical characteristics of water samples and untreated effluent

| S. No. | Parameters | Water Samples | Untreated effluent |
|---|---|---|---|
| 01 | Temperature (°C) | 22 | 23 |
| 02 | DO (mg/l) | 8 | 0 |
| 03 | pH | 7.9 | 9 |
| 04 | Total Alkalinity (mg/l) | 168 | 430 |
| 05 | COD (mg/l) | 105 | 345 |
| 06 | Conductivity (µS/cm) | 148 | 337.5 |
| 07 | Chloride (mg/) | 249.9 | 669.99 |
| 08 | Total Solids (mg/l) | 2280 | 6050 |
| 09 | TDS (mg/l) | 2190 | 5820 |
| 10 | TSS (mg/l) | 120 | 230 |
| 11 | Total Hardness (mg/l) | 277.40 | 541 |
| 12 | Ca Hardness (mg/l) | 241.7 | 420 |
| 13 | Mg hardness (mg/l) | 25.7 | 121 |

**Fig. 11 Physico-chmeical charcteristics of Water sample & effulent sample**

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Manderia Sushil , Manderia Krishna,School of Studies in Botany,
Jiwaji University, Gwalior (M.P.) IndiaDepartment of Botany,
PMB Gujarati ScienceCollege Indore M.P.) India