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Studies on water quality and sustainable livelihood role of wetland, Maran Chaur, Darbhanga

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Abstract
Darbhanga district is reach in wetlands, which play a significant role in livelihood resources due to highly productive flora and fauna. Maran chaur is an important wetland in the Darbhanga district. This water body is not used for fisheries only, but makhana (Euryale ferox) and singhara (Trapa bispinosa) are also cultivated. The abundant water resource is used for irrigation and another purpose, thus provide the basis of livelihood for human beings. The main objective of the current study was to analyze water Physico-chemical parameters and highlight the value of wetlands and their products in sustaining livelihood in Darbhanga. The surveys were conducted on a micro-area approach for assessing wetland product-based economy and their role in sustaining livelihood. All the physico-chemical parameters were found within the permissible limit. The result of sample survey data analysis and empirical assessment becomes the basis of this study. The paper takes into account some important facets of Maran chaur, Darbhanga in relation to socio-economic sustainable regional development.

Keywords: Maran chaur, Physico-chemical, wetlands, sustainable livelihood, socio-economic

Introduction
Darbhanga district is reaching in wetlands, which play a significant role in livelihood resources due to highly productive flora and fauna. Thousands of ponds, tanks, *chaurs* (land depressions) and *moins* (ox-bow lakes) constitute the lifeline of the area by serving as the source of irrigation and pisciculture. Wetlands of Darbhanga District, such as *chaur*, *moin*, *tal*, tank, rivers etc. provide a basis to capture fishes, shellfishes, crabs, etc. it supports thousands of people in securing their food supply and sustaining their livelihood. Maran chaur is an important wetland in the Darbhanga district. This water body is not used for fisheries only, but makhana (*Euryale ferox*) and singhara (*Trapa bispinosa*) are also cultivated. The abundant water resource used for irrigation and another purpose, thus provide the basis of livelihood for human beings.

Hence, in this paper, efforts have been made to illustrate the water physico-chemical parameters of wetland, Maran chaur and highlight the value of the wetland and its products in sustaining livelihood in Darbhanga.

Materials and Methods
The water samples were collected from four different stations of wetland, Maran chaur, Darbhanga in the morning period around 9 to 11 am., in polythene bottles regularly for once in every month and samples were brought into the laboratory for the estimation of various physico-chemical parameters like water temperature, transparency, pH, were recorded at the time of collection, by using thermometer pocket digital pH meter, transparency was measured with the help of Secchi Disc while other parameters such as TDS, DO, BOD, free CO_2, chloride, carbonate, bicarbonate, nitrate, phosphate and magnesium were estimated in the laboratory by using standard methods as APHA (2000) [1], Trivedy and Goel (1986) [21], Kodarkar (1992) [7].

Results
The monthly variation of certain physico-chemical parameters of wetland, Maran chaur was observed is presented in tables as follows.

Table 1: Physical parameters of Maran chaur, Darbhanga.

Month	Water Temperature ˚C	Transparency cm	TDS gm/liter	Turbidity NTU	pH
Sept	29.5	46	0.3	2.4	7.6
Oct	30.0	45	0.4	0.6	8.0
Nov	29.0	45.2	1.8	1.3	8.1
Dec	19.0	51	0.6	1.7	8.2
Jan	20.0	43.2	0.37	1.9	8.5
Feb	21.5	46.9	0.39	11.4	8.7
Mar	27.5	45	0.4	12.1	7.6
Apr	28.0	61	0.2	8.5	7.7
May	34.4	66.5	0.6	7.5	7.1
Jun	32.0	60.5	2.2	11.5	7.1
Jul	33.1	58	1.13	1.5	7.2
Aug	33.4	45.5	0.2	2.0	7.5

Table 2: Chemical parameters of Maran Chaur, Darbhanga

Month	Carbonate	Bicarbonate	Dissolved Oxygen	Free CO_2	Nitrate	Chloride	Magnesium
Sept	0.0	177	7.0	16.57	4.7	46.41	4.10
Oct	0.001	149	7.6	12.01	5.8	33.08	11.00
Nov	2.4	150	8.0	14.50	5.9	26.25	11.08
Dec	2.9	113	8.60	5.00	6.3	30.00	12.00
Jan	3.01	112	9.0	0.01	8.1	28.10	8.30
Feb	2.3	114	8.50	0.86	11.4	33.45	8.50
Mar	0.0	109	9.8	4.00	12.5	40.10	14.00
Apr	0.001	257	6.2	5.28	27.2	43.40	16.42
May	0.001	162	6.5	9.40	36.3	36.49	12.40
Jun	0.0	394	5.3	10.41	37.8	34.00	9.20
Jul	0.001	206	10.1	18.10	17.1	28.25	10.40
Aug	0.0	195	7.7	19.10	12.2	39.00	6.70

Livelihood

Table 3: Important fishes found in wetland, Maran Chaur of Darbhanga.

Sr. No.	Local name	Zoological name
1.	Tengra	*Mystus tengla*
2.	Shinghi	*Heteropneustes fossilis*
3.	Mangur	*Clarias batrachus*
4.	Kawai	*Anabas testudineus*
5.	Bulla	*Glossogobius giurs*
6.	Kanti	*Mystus Seenghala*
7.	Marwa	*Oxygaster culpeoides*
8.	Garai	*Channa punctatus*
9.	Saur	*Channa marulius*
10.	Rohu	*Labeo rohita*
11.	Catla	*Catla catla*
12.	Naini	*Cirrhinus mrigala*
13	Gainchi	*Mastucombelus pancalus*
14.	Kawa	*Xenantodon cancila*
15.	Nekti loach	*Botia derio*
16.	Teger loach	*Botia almorhae*
17.	Banspata	*Alia coila*
18.	Galpulani	*Eresthistes triangularis*
19.	Sand loach	*Lepido cephalus*
20.	Chanari	*Chanda nama*

Fig 1: Livelihood rescores like Fresh water fishes, Bhent (*Nymphaea alba*), Makhana (*Euryale ferox*), Singhara (*Trapa bispinosa*) found in Maran Chaur, Darbhanga

Discussions

The physico-chemical analysis of the Maran chaur water has been made during different seasons of a year of observation. The detail of observation may be discussed in relation to the previous works done by the other workers.

Temperature: The water temperature of Maran chaur was recorded maximum in the month of May (summer) at 34.4 ˚C and in December (winter) at 19 ˚C while Temperature is one of the important factors that have a direct effect over the survival and existence of living organisms as well as the physico-chemical quality of water. The temperature of the Maran chaur water showed typical seasonal fluctuation as it was recorded maximum in summer and minimum in winter. The yearly mean of the temperature was observed to be higher in pond water during the summer but lower in winter. Vyas and Kumar (1968) [24] have found similar results.

Transparency: Water transparency of Maran chaur was recorded maximum in the month of May (summer) at 66.5 cm and in October (winter) at 45 cm. while in higher transparency occurs during winter and summer due to the absence of rain, runoff and flood water as well as the gradual setting of suspended particles. Higher transparency in winter was also reported by Bhatt *et al.* (1985) [2]. However, Towhead *et al.* (1988) observed maximum transparency during the winter. Minimum transparency was observed during the rains, has also been observed by several investigators, including Bhatt *et al.* (1985) [2] and Towhead *et al.* (1988).

pH: Water pH of Maran chaur was recorded at a minimum in the month of May (summer) at 7.1 and in October (winter) at 8.7. The monthly it varies between 7 and 9. In the commonest water, pH is slightly alkaline due to the presence of bicarbonates and carbonates of alkaline earth. Seulpthorpe (1976) [16] has suggested that pH and carbon dioxide are even more critical factors in the survival of aquatic plants and fishes then the oxygen supply. Alternations in pH in natural waters are usually accompanied by changes in other physico-chemical factors also. It is therefore very essential to monitor the level of pH in a given water body regularly in view of its implication. Its level fluctuated in within a narrow range in conformity with the findings of various workers (Hosmani and Bharati, 1980; Mesfin and Belay, 1989 and Surabhi, 1994) [10, 4, 19].

Turbidity: of Maran chaur water was recorded maximum in the month of March at 12.6 NTU and in October (before winter) 0.6 NTU. It is due to heavy rainfall. Similar records were observed to reported by Verma and Munshi (1987) [22] and Towheed *et al.* (1988) [20].

TDS of Maran chaur water was recorded at maximum in the month of June (rainy season) 2.2 gm/L and in April (before summer) 0.2 gm/L. It is due to heavy rainfall. Similar records were observed to reported by Verma and Munshi (1987) [22] and Towheed *et al.* (1988) [20].

DO: The amount of oxygen in water depends on the surface area exposed, temperature and salinity. Water, where organic matter is very high, has very little oxygen dissolved in it and the self-purification of the water system depends on the presence of a sufficient amount of oxygen dissolved in it. Dissolved Oxygen was found to be maximum during the winters in both ponds. This can be attributed to the prevailing lower temperature. Solubility of oxygen is dependent on temperature and it increases with a decrease in water temperature (Clarke, 1965) [3]. Higher amounts of dissolved oxygen during the winters have also been reported by Vyas and Kumar (1968) [24], Bhatt *et al.* (1985) [2] and Towheed *et al.* (1988) [20]. The minimum content of Dissolved Oxygen was observed during the rains and summers, a result also observed by Verma and Munshi (1987) [22] and Towheed *et al.* (1988) [20].

BOD: Biological Oxygen Demand is an important parameter for assessing water quality. When oxygen is used up faster than it is replaced, the water quality begins to deteriorate. Water BOD of Maran chaur was recorded maximum in the month of May (summer) 155.5 ppm and minimum in November (winter) at 20 ppm and rainy season due to runoff water. A similar result was also observed by Verma and Munshi (1987) [22] and Towheed *et al.* (1988) [20].

Carbonate & Bicarbonate: Seasonal mean was maximum in winter and minimum in summer in Maran chaur water. Carbonate alkalinity was low, whereas bicarbonate alkalinity was recorded as fairly high. The lower levels of carbonate alkalinity and a higher level of bicarbonate alkalinity can be attributed to the pH range, which favours more CO_2 to be present as an HCO_3 ion (Clarke, 1965) [3]. The high value of bicarbonate alkalinity in polluted water has been reported by Singh (1985) [17] and Sahay *et al.* (1985). Based on alkalinity values, Moyle (1946) [12] classified water into three categories: low productive with less than 20 ppm alkalinity, low to medium with 20-40 ppm alkalinity and medium to high with 40-90ppm alkalinity. Philipose (1959) [13] categories Indian water as low productive, having 40-50 alkalinity, moderately high with 50-100 ppm alkalinity and fairly high with 100-200 ppm alkalinity. On the basis of these classifications, the wetland under study appears to be of good production value. The property of water which prevents leather formation with soap is called hardness and is mainly caused by the calcium and magnesium cations. However,

other cations and anions also contribute to hardness. Hard water is not suitable for various domestic purposes. It has no adverse effect on health, but the highest desirable limit of 100 mg/l and maximum permissible limit of 500 mg/l have been set by WHO for drinking water. However, the Ministry of Works and Housing (1975) [11] considers 200 mg/l as acceptable and a concentration of 600 mg/l as the cause of rejection.

CO_2: Water with a concentration of free CO2 less than 5ppm supports good fish production, whereas its high concentration in water leads to asphyxiation and fish death. As far as a prediction of the trophic status of a water body on the basis of recording of annual mean values of free CO_2 is concerned, there are differences in opinions. Yadava *et al.* (1987) [25] and Hosmani (1988) [4] have observed decreased value of free CO_2 in eutrophic and polluted water bodies and on the other hand, Hosmani and Bharti (1980) [5], Mesfin and Belay (1989) [10], Rana and Palria (1998) [15], have ascertained lower free CO_2 content at unpolluted sites. Thus, CO_2 concentration appears to be no yardstick for predicting either the trophic level or magnitude of pollution of any water body.

Chloride: Water BOD of Maran chaur was recorded at maximum in the month of May (summer) at 46.5 ppm and minimum in November (winter) at 26 ppm. None of the values exceeded the desirable standard (200ppm) of WHO and the Ministry of Works and Housing in the water of pond and river. The high chloride content in the polluted water has been reported by Venue *et al.* (1984), Singh (1985) [17], High chloride content in the polluted water has been reported Venue *et al.* (1984) [23], Singh (1985) [17] and Rana and Palria (1988) [15].

Magnesium: is an important major nutrient needed by all organisms, since it activates many enzyme systems. It is an essential constituent of the chlorophyll and is also involved in the phosphorus transfer process. It is particularly associated with clay. It plays an important role in the synthesis of ATP and ADP and inorganic phosphates. It is also an activator for many of the enzymes involved in carbohydrate metabolism. In the present study, the yearly mean of magnesium was found to be lower in the rainy season and higher in winter. The highest desirable limit of magnesium in drinking water prescribed by WHO and the acceptable limit to the Ministry of Works and Housing is 30ppm. Thus the existing level of magnesium in the pond and river water is within the maximum desirable limit of WHO and the acceptable limit of the Ministry of Works and Housing Prasad and Singh (1982) [12] recorded higher values of magnesium of polluted stations (35.36 ppm) in comparison with the unpolluted station (17.13 ppm) of Gomati river at Lucknow. Singh *et al.* (1970), during their study of the algal flora of sewage, recorded the range of magnesium between 15.4 and 85.0ppm. Singh (1992) [18] recorded the minimum magnesium level during monsoon months and the maximum in the month of February. Therefore, it may be concluded that the both ponds water under study is not polluted as far as magnesium is concerned.

Nitrate: The value of Nitrate ranges from 4.7 to 36.3 ppm. The maximum value 36.3 ppm was observed in the month of July (rainy season) and the minimum (4.7 ppm) in the month of November (winter).

Economics: Livelihood support: Fish production

This biologically sensitive and fragile area is a repository of a variety of fresh water and ornamental fishes. This *chaurs* provide a basis to the capture fishes with a production rate of 50-60 kg/ha/year. Ornamental fishes are characterized by a wide variety of colour, shape and size pattern that are kept in aquariums to overcome pressure from day-to-day materialistic life. Due to its various colour pattern and natural beauty, these fishes are called as *living jewels*. Several types of ornamental fishes have not been popular yet. So, it is still an untouched sector for the exploitation of wild ornamental fishes. The State Fisheries Policy envisages recognizing this unique property regime for cooperative management wherein cultivation is to be integrated with fisheries (Jha *et al.*, 2014) [6].

Aquatic plant products

A survey was done in the study area to know the diversity and utilization of aquatic plants used by the people for their livelihood. About a six aquatic plants have been found to be intimately associated with livelihood practices in this wetland. Of these, Makhana (*Eurale ferox*) and Singhara(*Trapa bispinosa*) are cultivated as commercial crops and constitute subsidiary food items. Other aquatic plants like Khubani (*Scirpus articulatus*) and Bhent (*Nymphaea alba*) are collected from the wild. A number of aquatic plants like Sarhanchi, Tal Makhana etc. are also collected from the wild to be used as leafy greens (Mandal *et al.*,2010) [9].

In general, Makhana is a crop of the pond ecosystem. A field based cultivation techniques has been developed in order to enhance the productivity and facilitate the horizontal expansion of Makhana, which is being adopted by the farmers of the region. Makhana with fish and Water-chestnut integrated farming system model have been developed, which is gaining popularity among the farmers. Economics of different Makhana-based cropping systems have been worked out and net monetary returns have been recorded highest through the makhana-Rice-Wheat cropping system (Rs 1,22570/ha), followed by Makhana- Barseem (Rs 98,465/ha) and Makhana- Water chestnut(Rs 88,790/ha). Net monetary returns through Makhana-Fish-Water chestnut was estimated at Rs. 88,910/ha. (Kumar *et. al.*, 2011) [8].

Singhara (*Trapa bispinosa*): This aquatic plant are growing in shallow, stagnant water body and slow moving water. Plant bears ornately triangle shaped fruits. The fruit contains a single large starchy edible seed. These edible seeds are cultivated for supplementary nutritious food. It has much wider distribution as against Makhana.

Bhent (*Nymphaea alba*): This is an aquatic flowering plant. It grows in deepest area chour that is 30-150 cm deep. Its seeds are collected, processed and eaten by the people as subsidiary food.

Cultural value of wetlands

The relationship of people of Darbhanga district with these wetlands has strong reflection in the culture and belief systems. In Mithila region, „ponds" are treated as daughter. The people had linked their festivals and rituals with the ponds. If there was a marriage or child birth, they would go to the pond and perform their rituals. With onset of Monsoon, the ponds and river channels were cleaned to provide for much needed flood storage. This practice is known as „*joorsital*". The Sankranti of Baishakh month was a sacred duty of every person to clean all the water sources. The active

preparation before flood has a Celebrating name,, jhajhar". Some cultural acts which are associated with wetland of the region are Marriage rituals; Shradh and Tarpan; Emersion of goddess Saraswati, Durga, Kali, etc.; Bathing on Purnimas, Shankranti and Sun and Moon eclipses; Abode of Goddess Kamla (Goddess of water); Sama-Chakewa; Chat Brata etc.

Conclusion

Observed values of Maran chaur water on Temperature, pH, Turbidity, TDS, Transparency, Carbonate, Bicarbonate, Dissolved Oxygen, Free CO_2, Nitrate, Chloride and Magnesium were analyzed for a period of one year from 1st September 2020 to 31 October, 2021. All parameters were within the permissible limits.

In conclusion the wetlands are essential for human health and prosperity. They provide us fresh water, maintain ground water, ensure our food security, sustain biodiversity, protect against flooding etc. This is a major source of employment globally and also ideally placed to showcase truly sustainable livelihood. Wetlands of Darbhanga District such as *chaur*, *moin*, *tal*, tank, rivers etc. provide a basis to capture fishes, shell fishes, crabs etc. it supports thousands of people in securing their food supply and sustaining their livelihood. These wetlands are also a habitat for many aquatic plants and animals. Harvesting and processing of these aquatic plants and their fruits, seeds and grasses also provide a basis of livelihood around the wetland. Maran chaur, wetland of Darbhanga district is known for wintering ground for migratory birds. Therefore, it has the potential of being developed as a place for eco-cum-religious tourism. It could create employment opportunities and hence support local people for their livelihood.

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