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Assessment of Impact of Urban Development on Local Waterbodies in Sultanpur City Uttar Pradesh

ORIGINAL ARTICLE

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Abstract

Wetland is water body which develops local ecological atmosphere in their surroundings.The Sultanpur city's wetland ecology is severely degrading due to numerous biological and anthropogenic influences, as indicated by numerous studies. Thus, conflict between development and ecology and its recurrent impact on the larger society is becoming evident here every day. The water quality related data has been produced by collecting sample from Dadupur wetland site. The sampled water has been tested and its values have been collected as data for assessment of pollution level and water quality. The collected data have been analysed using a variety of statistical analysis and representation software programs, including SPSS and Xlstat 2010. We used multivariate statistics to provide an overview of Sultanpur city wetlands' current immunological state. Dadupur wetland is both perennial and rainwater fed, with a water regime depth of 7 feet during the non-monsoon season and 21 feet during the 2023 monsoon. People who live nearby use this marsh for agriculture, fishing, waste water disposal and as a dump yard. The most significant pollutants observed in the present study are Total Alkalinity, Chloride, Fluorides, Nitrates, Total Dissolved Solids and Electrical Conductivity. Dadupur wetland are experiencing a water area crisis due to wetland shrinkage as a result of water scarcity, non-dredging, and public ignorance of wetlands.

Key Words

Sultanpur City, Dadupur Wetland, Water Quality, Encroachment, Shrinkage.

Introduction

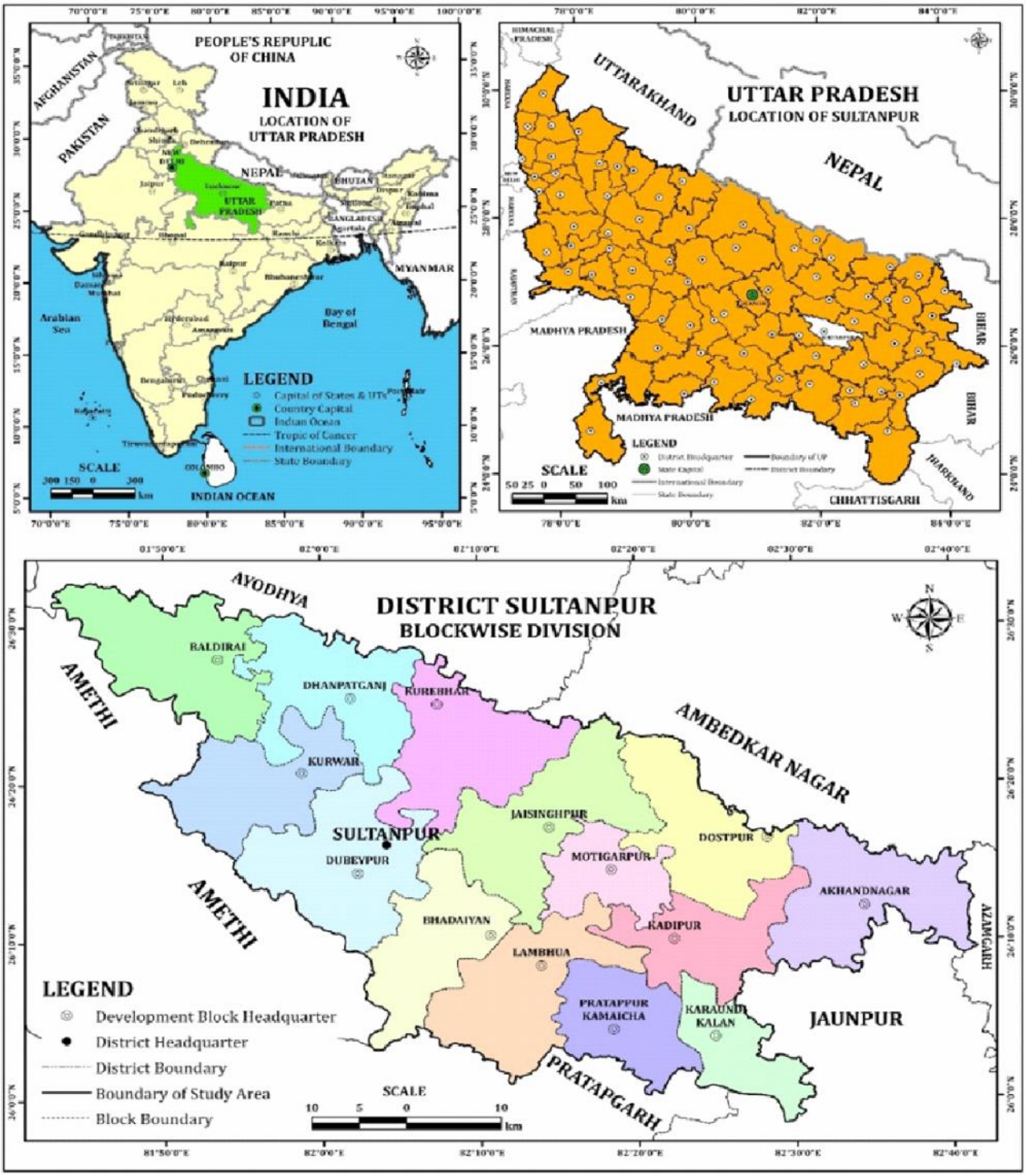
Wetlands are areas where the water table is typically at or near the surface or when the land is covered with shallow water. They are the areas where terrestrial and aquatic systems meet. Wetlands have great importance for local ecology. During the last two decades, wetlands had received greater attention, from the viewpoint of their ecology as well as conservation practices (Halder &Ghosh, 2014). Socio-ecological sustainability and management of wetlands are also being increasingly acknowledged in the world of water discourse. In spite of these priorities and action frameworks worldwide, many natural wetlands, and their biodiversity are increasingly threatened or degraded through a variety of human actions, both direct and

indirect (Dugan, 1994; Finlayson and Van der Valk, 1995). Wetland ecosystems in Sultanpur are both permanent and temporary geomorphic unit associated with rainfall that constantly change their status (Das & Pal 2017). As wetlands are the integral part of the present hydrologic cycle and support development of a civilization, they also undergo continual pressure from various anthropogenic activities. Thus, conflict between development and ecology and its recurrent impact on the larger society is becoming evident here every day (Datta and Ghosh, 2015).With rapid change in land use due to developmental activities during last 30 years many wetlands were irreversibly lost, while performing specific ecological functions in purifying air and water, conserving soil and controlling climate change (Burton et al., 1999). Shallow wetlands, thus also facilitate dense growth of rooted aquatic macrophytes, which compete for nutrients and space with phytoplankton and are not part of the autotrophic food chain (Rejmankova, 2011). The Sultanpur city's wetland ecology is severely degrading due to numerous biological and anthropogenic influences, as indicated by numerous studies (Gopalan, et al., 2022; Thomson and Estades, 2024; Dipson and Nair, 2012). Pollutants from the muck layer can be absorbed by shrubs, and tiny algae can raise dissolved oxygen levels. By breaking down organic wastes, bacteria can raise the BOD (Roy and Roy, 2012).Wetland destruction in Sultanpur city can be attributed to various factors such as deforestation and tree-cutting, soil erosion, anthropogenic pressures leading to habitat destruction and biodiversity loss, uncontrolled dredging, hydrological intervention causing aquifer loss, rapid depletion of ground water, large-scale water use for domestic, industrial, and agricultural purposes, and cultural siltation, among others. Pollution from significant tourism development and hotel construction is another factor endangering wetlands. Ecotourism has begun to disturb ecosystems that were thought to support a higher density of endemic species. Human populations' heavy reliance on these ecosystems is reflected in the stress that wetlands face from natural variables and anthropogenic activity. These aquatic bodies are under additional pressure due to diminishing water supplies. Previously Sultanpur was the home to extensive tracts of wetland habitats for water birds and other animals, many of today's agricultural landscapes are being invaded by crops and are under increasing pressure from agriculture. Since some of the most fertile soils are found close to wetlands and these places make ideal supplies of water for irrigation of nearby croplands, agriculture has emerged as the primary cause of the decline of wetlands. Water resources in India are under extreme pressure due to the fact that the great majority of the city's population is employed as farmers, who are primarily located in the areas that border wetlands. In Uttar Pradesh, food production has been steadily rising due to increasing agricultural intensification and improved irrigation systems, mostly for the production of rice, wheat, pulses, and maize, in order to fulfil the demands of the growing population. The paper is focused on impact of urban development and its impact on wetland in the city.Wetland ecosystems in Sultanpur city are both permanent and temporary geomorphic unit associated with rainfall that constantly change their status (Das & Pal 2017). As wetlands are the integral part of the present hydrologic cycle and support development of a civilization, they also undergo continual pressure from various anthropogenic activities. Thus,conflict between development and ecology and its recurrent impact on the larger society is becoming evident here every day (Datta and Ghosh, 2015). Historically such developmental activities have severely damaged physical and ecological characteristics of these wetlands. The reasons are availability of water, fertile land for agriculture and other allied activities

Study Area

Sultanpur city is one of the important parts of India's historical and cultural pre-eminence. Sultanpur city is located in Dubeypur block in Sultanpur city in Uttar Pradesh.The city of Sultanpur, lies on both sides of river Gomati between Latitude 26°16'33" N and Long. 82° 04' 48" E. It is border by different blocks such as Kurwar, Kurebhar, Jaisinghpur, Bhadaiyan. City is located on Gomati River bank.

Figure 1: Location of the Study area



(Source: Census of India, 2011)

Sultanpur city has a tropical wet and dry climate with average temperatures ranging between 20 to 28 °C (68 to 82 °F). Sultanpur experiences three distinct seasons: summer, monsoon and a mild autumn. Typical summer months are from March to May, with maximum temperatures ranging from 30 to 38 °C (86 to 100 °F).

Research Methodology

Research methodology comprises the collection of data and processing of data for productive output regarding the study. There is Dadupur wetland site from Sultanpur city has selected for the detail analysis of problems faced by wetlands.

Data Sources: There are 50 respondent's response have been collected with related to causes behind the wetland degradation. The random sampling method used for the collection of data with the help of questionnaire-based survey.The water quality related data has been produced by collecting sample from Dadupur wetland site. The sampled water has been tested and its values have been collected as data for assessment of pollution level and water quality.

Data Analysis: The collected data have been analysed using a variety of statistical analysis and representation software programs, including SPSS and XLSTAT 2010. We used multivariate statistics to provide an overview of Sultanpur city wetlands' current immunological state. To forecast the average water quality in these wetlands, we employed correlation analysis.If the data lie exactly along a straight line with positive slope, then r = 1. If X and Y are two variables, then the correlation 'r' between the variable X and Y is given by

Eq. 1. $$r = \frac{n(\Sigma xy) - (\Sigma x)(\Sigma y)}{\sqrt{[n\Sigma x^2 - (\Sigma x)^2]\,[n\Sigma y^2 - (\Sigma y)^2]}}$$

Where, *x* and *y* are the sample means. If the value of correlation coefficient 'r' between two variables *X* and *Y* is fairly large, it implies that these two variables are highly correlated.

Result and Discussion

Present Status of Dadupur Wetland

Dadupur Wetland is located in Sultanpur city's Dadupur area. It is largest waterbody in Sultanpur city. Historically it occupies large part of the Dadupur area but now it has been reduced into small area. This is natural and large wetland andit is perennial wetland and also receives water from rainfall and it also receive waste water from Dadupur locality. It occupies 44.52 Acre of land as a water area in 2023. It is Government owned wetland and managed by local municipality. Its average depth is 7 feet and deepest part has depth around 18 feet.It is perennial as well as rainwater fed wetland and its water regime depth range from 7 feet in non- monsoon to 21 feet during monsoon period in 2023. People living surrounding of this wetland uses it as dump yard, for fishing, disposal of waste water, and for agriculture purpose (Figure 2).

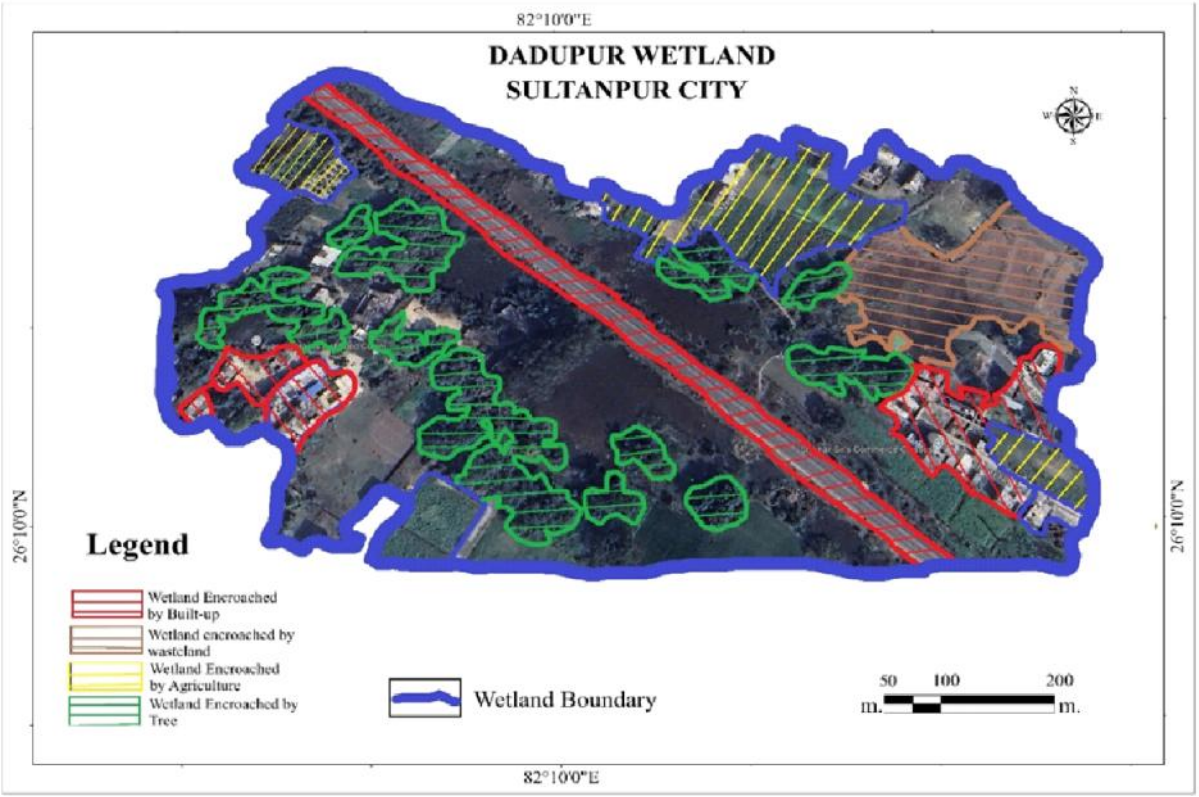
Figure 2: Dadupur wetland in Sultanpur city

(Source: Google Earth Images 2024)

Encroachment in Dadupur Wetland

Dadupur wetland is largest wetland in the city of Sultanpur. In 2023, it will be a water area covering 44.52 acres. The local municipality is in charge of overseeing this Government-owned wetland. The deepest portion is around 18 feet deep, with an average depth of 7 feet (Figure 3).

Figure 3: Wetland Occupied by Different Land Categories



(Source: Google Earth Images 2024)

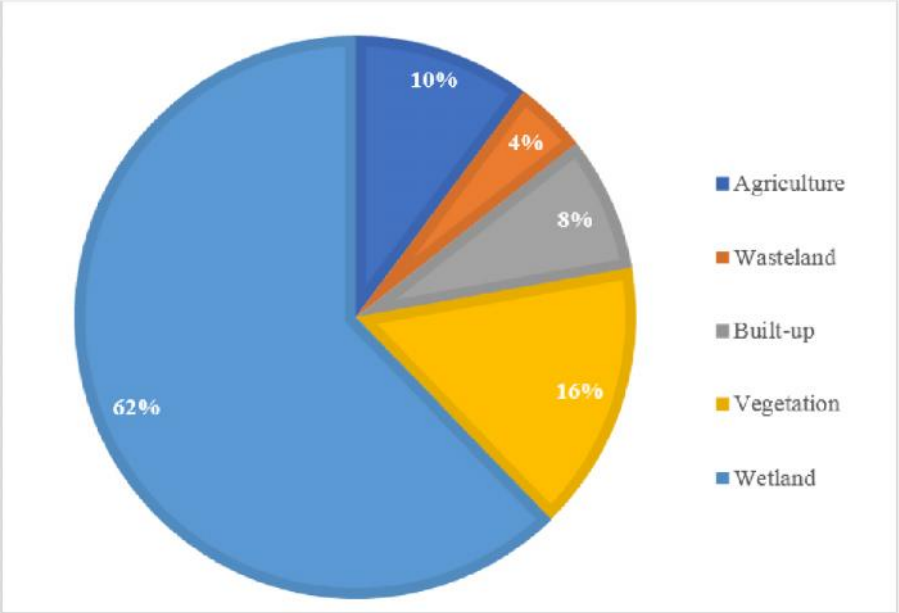
It is a wetland that is both perennial and rainwater fed, with a water regime depth of 7 feet during the non-monsoon season and 21 feet during the 2023 monsoon. People who live nearby use this marsh for agriculture, fishing, waste water disposal and as a dump yard. The persistent problem in this wetland is siltation. There is a lot of vegetation along the wetland's edges. Locals are constantly encroaching on this property by expanding their agricultural fields. The wetland's changes between 2010 and 2023 demonstrate that it is getting smaller and that an increasing amount of agricultural activity is occurring around it (Table 1). A total of 16.81 acres of wetland area have been lost, as the accompanying table further demonstrates. Agriculture has only taken up 4.54 acres of the encroached area, while 1.87 acres of the 16.81 acres are waste land. With 6.93 acres, vegetation cover occupies the largest portion of the marsh (Figure 4). With 3.47 acres, the built-up area shares a significant portion of the wetland's encroached area.

Table 1: Encroachment of land from Dadupur wetlands by different land use

Encroachment Category	Area (in Acre)	Area (in Percent)
Agriculture	4.54	10.20%
Wasteland	1.87	4.20%
Built-up	3.47	7.79%
Vegetation	6.93	15.57%
Wetland	27.71	62.24%
Total area	**44.52**	**100**

(Source: Primary Data)

Figure 4



The given figure shows the total area of encroached land in different categories. The wetland has reduced to 62 percent area and 16 percent area is occupied by vegetation followed by agriculture with 10 percent area.

Water Quality Assessment of Dadupur Wetland

1. **Water Temperature level:** The water temperature is responsible for concentration of dissolved oxygen in water of wetlands. D.O. is declining in this research region because the average water temperature here is 29.4^{o}0 C, which is on the border of the acceptable limit of 30^{o}C. In monsoon season, the highest water temperature 34.7oC was observed in Dadupur wetland. temperature in monsoon season is partially high in comparison to annual average temperature in the study area. It phenomena was detected due to high carrying capacity of water to absorb the heat during the monsoon season.
2. **Seasonal Variation of Transparency:** Transparency has a role in hydrophyte photosynthesis. The vegetation and wildlife of wetlands are severely harmed by extremes of transparency. A medium transparency range is ideal for the development of some microphytes, which result in an algal bloom (light greenish water), which serves as both a food source and a producer for little fish. In monsoon season, the highest water transparency 54.5 was observed in Dadupur wetland. Seasonally, this region has high transparency during the rainy season (July to September) and low transparency during the summer (March to May).
3. **Specific Conductivity (imho/cm):** Salts that have dissolved and solutions of most inorganic compounds, including carbonate, sulphide, chloride, and alkalis, are often good conductors. In monsoon season, the water conductivity 0.28 (ìmho/cm) was observed in Dadupur wetland. The conductivity of wetlands water is consistently measured in the present research to be within the allowable limit during the pre-monsoon season and comparatively lower during the post-monsoon season.
4. **Variation of Turbidity (PPM):** Measurement of water quality heavily relies on turbidity. Light scattered by suspended particles, such as silts, clay, organic matter that has been finely divided, plankton, and other microscopic animals, is measured as turbidity. The annual water turbidity was observed 42.84 ppm in Dadupur wetland. "A turbidity range from 30-80 cm is good for fish health; 15-40 cm is good for intensive culture system, and < 12 cm and >35 cm causes stress," state Bhatnagar and Devi (2013).

5. **Variation of T.D.S:** Total dissolved solids (TDS), a measure of the number of inorganic pollutants present in wetland water, is another aspect of water quality assessment. The total of the water's positively and negatively charged anions and cations makes up its concentration. Parts per million (ppm) is another term for the total amount of ions, including metals, salts, and minerals, dissolved in a specific volume of water expressed as mg/L. The highest water T.D.S 107.76 mg/lt was observed in Dadupur wetland.
6. **Variation of pH:** The concentration of hydrogen ions in water is measured by pH, which stands for "Potential of hydrogen" or "Power of hydrogen" (Verma et al., 2023). The pH value of water indicates how strongly acidic or basic it is at a particular temperature. The pH of the surrounding water has a significant impact on all biological processes as well as the preservation of the water's physical and chemical characteristics. The pH value in this research is shown to be somewhat higher during the pre-monsoon and somewhat lower during the post-monsoon. pH in the southern area is 7.83 to 8.20 pH, while in the north-eastern part it can go as low as 6.37 pH (location 23) or as high as 8.20 (location 25). Higher pH is observed in certain areas, while much lower pH is found in the eastern part.
7. **Variation of Dissolved Oxygen:** Wetland and water body health can be evaluated using dissolved oxygen (DO), which is thought to be one of the best markers. It measures the quantity of oxygen that is accessible in a specific volume of water for metabolic action. In monsoon season, the water DO 5.78 mg/lt was observed in Dadupur wetland. The wetlands in the present study record high levels of dissolved oxygen throughout the monsoon and post-monsoon, but comparatively lower levels during the pre-monsoon period, when the water level is low.
8. **Variation of Alkalinity:** The whole concentration of alkalinity in wetland water, including carbonates, bicarbonates, hydroxides, phosphates, borates, dissolved calcium, magnesium, and other substances, is measured as alkalinity, which represents the water's resistance to pH changes. In monsoon season, the highest water alkalinity 40mg/lt was observed in Dadupur wetland. Seasonally the alkalinity is high in the summer, winter and rainy season respectively in this study area. But overall alkalinity is in the optimum level or within the desirable range.

Correlation Matrix Wetland Water Quality Components

The WQI method is more methodological and facilitates the comparative evaluation of wetland water quality of several sampling sites. It is found that the wetland water on more than 80 percent sampling stations are not good for drinking and 20 percent has been founded less amount of pollutant. In the present study for this area TDS has highly positive correlation with EC (r = .995). This shows that with increase or decrease in the value of TDS: EC also exhibit increase or decrease in their values. TDS also show highly positive correlation with TH, Cl and F. TH show highly positive correlation with Cl, NO3 and K (Table 3). This indicates that TH in water sample may be due to presence of Ca (NO3)2 and Mg (NO3)2, CaCl2, MgCl2, CaF2, and MgF2. Positive correlation observed between Cl & F, Cl &NO3, Cl & K, K & F, Na & K. Total positive correlation is obtained between 32 union and 41 union and rest of the union (23 union, 15 combination) show negative correlation. Turbidity shows negative correlation with most of parameters (Table 2). Temperature shows negative correlation with Na.

Table 2: Water Quality Correlation Matrix of Sultanpur City

		pH	TDS	EC	TH	Cl	No3	F	Na	K
pH	Correlation	1	.079	.088	.427	.318	.434	.235	.116	.602
	Sig. (2-tailed)		.827	.808	.218	.371	.210	.513	.750	.065
TDS	Correlation	.079	1	.995**	.749*	.915**	.629	.780**	.530	.353
	Sig. (2-tailed)	.827		.000	.013	.000	.051	.008	.115	.317
EC	Correlation	.088	.995**	1	.737*	.901**	.614	.746*	.515	.325
	Sig. (2-tailed)	.808	.000		.015	.000	.059	.013	.128	.359

TH	Correlation	.427	.749*	.737*	1	.906**	.957**	.640*	.217	.796**
	Sig. (2-tailed)	.218	.013	.015		.000	.000	.046	.547	.006
Cl	Correlation	.318	.915**	.901**	.906**	1	.818**	.753*	.515	.592
	Sig. (2-tailed)	.371	.000	.000	.000		.004	.012	.128	.072
No3	Correlation	.434	.629	.614	.957**	.818**	1	.501	.169	.833**
	Sig. (2-tailed)	.210	.051	.059	.000	.004		.140	.640	.003
F	Correlation	.235	.780**	.746*	.640*	.753*	.501	1	.419	.573
	Sig. (2-tailed)	.513	.008	.013	.046	.012	.140		.228	.083
Na	Correlation	.116	.530	.515	.217	.515	.169	.419	1	.009
	Sig. (2-tailed)	.750	.115	.128	.547	.128	.640	.228		.980
K	Correlation	.602	.353	.325	.796**	.592	.833**	.573	.009	1
	Sig. (2-tailed)	.065	.317	.359	.006	.072	.003	.083	.980	

**Correlation is significantatthe 0.01level(2-tailed).

* Correlation issignificantat the0.05level(2-tailed).

The most significant pollutants observed in the present study are Total Alkalinity, Chloride, Fluorides, Nitrates, Total Dissolved Solids and Electrical Conductivity. Though, some sampling sites also exhibits total hardness, calcium and magnesium as principal pollutants with other parameters whilst by analyzing the NPI values in both seasons it can also be concluded that in some samples all parameters except pH behaves like pollution causing parameters.

Impact of Wetland Degradation

Shrinkage: Dadupur wetland are experiencing a water area crisis due to wetland shrinkage as a result of water scarcity, non-dredging, and public ignorance of wetlands. Wetland shrinkage is a result of wetlands' ecosystem being hampered by the construction of schools, and buildings for residential and commercial use.

Conclusion

The Sultanpur city wetlands degradation will undoubtedly have a significant impact on the traditional resource users' way of life. The impact of wetland deterioration on the way of life for those who traditionally use wetland resources. A comprehensive analysis of the physico-chemical characteristics of wetland water, including pH, turbidity, temperature, conductivity, total hardness, dissolved oxygen, fluoride, chlorine, iron content, and total and faecal coliform bacteria, has been conducted.Many physico-chemical and biological elements influence the quality of water, which in turn affects whether it is suitable for fish and other aquatic animal production and distribution. The most significant pollutants observed in the study are present in wetland such as alkalinity, chloride, fluorides, nitrates, total dissolved solids and electrical conductivity.Maximum wetlands are experiencing a water area crisis due to wetland shrinkage as a result of water scarcity, non-dredging, and public ignorance of wetlands.Anaerobic oxidation occurs in wetlands due to the massive buildup of organic compounds caused by it. Wetlands become poisonous when organic matter breaks down and releases CO2.These wetlands are lifeline for local community and their continuous depletion are causing threat to existence for local economy.

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