INFILLING OF URBAN WETLANDS DUE TO URBAN HOUSING PROJECTS: AN ANALYSIS AND PREDICTION OF WATER QUALITY PARAMETERS OF KONNAGAR-HINDMOTOR WETLANDS, WEST BENGAL USING MULTILAYER PERCEPTRON MODEL

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Abstract

Wetlands have a unique property of undergoing changes due to natural factors as well as anthropogenic factors. They are altered for agriculture, constructing residential projects etc leading to pollution and modification of the hydrological regime. Urban wetlands and Geographical Isolated wetlands are the are undergoing transformation at an alarming rate owing to unsustainable progress in the name of development. The Konnagar-Hindmotor wetlands being an Urban Geographical Isolated Wetland is facing severe infilling owing to construction activity in the name urban housing projects. The paper aims to measure the present condition of the water quality parameters and estimate the future health of the water of the wetlands by predicting through multilayer perceptron model using artificial neural networks. Water samples were collected from the wetlands by dividing the wetlands into environmental impact units considering the extent of the human disturbances to understand the present status. The results showed that the water quality of the wetland is at huge risk and it is predicted to deteriorate further leading to complete disruption in the normal functioning of the ecosystem of the area.

Keywords: Urban Geographical Isolated Wetlands, Water Quality Parameters, Wetland Infilling, Multilayer Perceptron Model, Change Analysis

Introduction

The definition of Wetlands owing to its extremely dynamic nature has been extremely debatable since ages. Wetlands still continue to a debatable topic wherein because of its diversity in its nature and type, there has not been any universal single definition. The Convention On Wetlands (Ramsar , Iran , 1971) have come up with the criteria's for identification of wetlands mainly on the basis of criteria based on rare or unique types of wetland, as sites of biological importance Apart from the definition given by Ramsar convention, there are several types of wetlands which are not as popular as the wetlands classified under Ramsar convention. Geographically Isolated Wetlands (GIW)'s are defined as wetlands which has not apparent surface water connectivity to perennial rivers, streams, seas or ocean. They are mostly surrounded by drier pastures. Differences in regional geography, slope, hydrology, climatic conditions have led to the formation of these wetlands (Aich Chaudhury, 2022). Wetlands have a unique property of undergoing changes continuously due to natural factors. Apart from the natural factors causing changes in wetlands, anthropogenic factors are also causing deterioration in the extent of wetlands. This is mainly due to ignorance about the value of wetlands. Even though the total loss of world wetlands is difficult to determine (Mitsch, 2015) record that more than half of the world's wetlands is lost. Wetlands were converted to agricultural fields and commercial or residential spaces. They were altered for agriculture, highway construction, mining, constructing residential or commercial buildings etc leading to pollution and modification of the hydrological regime. Urban wetlands and Geographical isolated Wetlands are amongst the most efficient socio-ecological hotspots in the cities. With flood control, they also secure the food supply chain to the city in events of disrupted rural-urban connectivity during floods.

With the changing face of the wetlands owing to anthropogenic factors namely infilling of wetlands in the name of development is also leading to a drastic change in the overall parameters of water quality of the wetlands, thereby disrupting the entire ecosystem. Due to various pollution sources and other factors, humans have exploited aquatic habitats particularly wetlands over the ages to the point where extremely few of the wetlands in their original form ceases to exist (Ngoye &Machiwa,2004). A catchment plays an important role as it is responsible for the quality and quantity of runoff generated during and after an event of rain and storm. Hence, land use type within a catchment is extremely important for estimating water quality of the water resources (Richards & Host, 1994). Therefore, as human activities rise, many of the problems associated with water contamination are caused by changes in the type of land use within a catchment (Gikas et.al,2006). Among various aquatic ecosystems, wetlands are important for improving the water quality of other bodies of water, like rivers, at the catchment-scale. However, it is also impacted by change in the land use, composition of their catchments as a result of human activity (Plameri & Treppel 2002). Significant researches conducted have inferred that the there exists a negative effect on water quality owing to a relationship between impervious cover of urban areas and sources of non-point pollution which inturn results in the degradation of wetland ecosystems caused by changes in the composition of land use of their catchments (Papastergiadou et.al 2008). While impermeable coverings do

not cause pollution, they do cause hydrological changes that are the source of many physical and biological effects that degrade the quality of water bodies, including wetlands and streams (May et.al, 1997).

Urban environments are more hydrologically active due to their imperviousness, and even little rainfalls can carry accumulated pollution into bodies of water (Basnyat et.al 1999). A connection between impermeable cover and in-stream water quality degradation has been proposed by a number of authors (Helms et.al 2009), with regard to the evaluation of the water quality characteristics of streams.

Recent urbanization and suburbanization in the regions of Sreerampore, Uttarpara belt has led to construction of innumerable high rises owing to the close proximity to Kolkata. Few of them are constructed at the cost of infilling Wetlands

The study area Konnagar-Hindmotor wetland (22°40’2 0’’N to 22°42’30’N , 88°22’30’’1E to 88°17’ 30’’E) is an Urban Geographical Isolated Wetland, situated in the Hooghly district of West Bengal. The wetlands have been formed due to sluggish streams and many saucer shaped depressions in a flat alluvial plain forming massive creeks and marshes. The Konnagar-Hindmotor wetlands is a 280 acre waterbody which facing a severe threat of infilling due to massive unsustainable urbanisation surrounding the waterbody in the form construction activity for housing development. The wetland serves as an important source of livelihood for the local fisherman, fruit growers. It serves as an important function like entire stormwater passage from Chapdani, Baidyabati, Konnagar,Rishra is being fed into the wetland

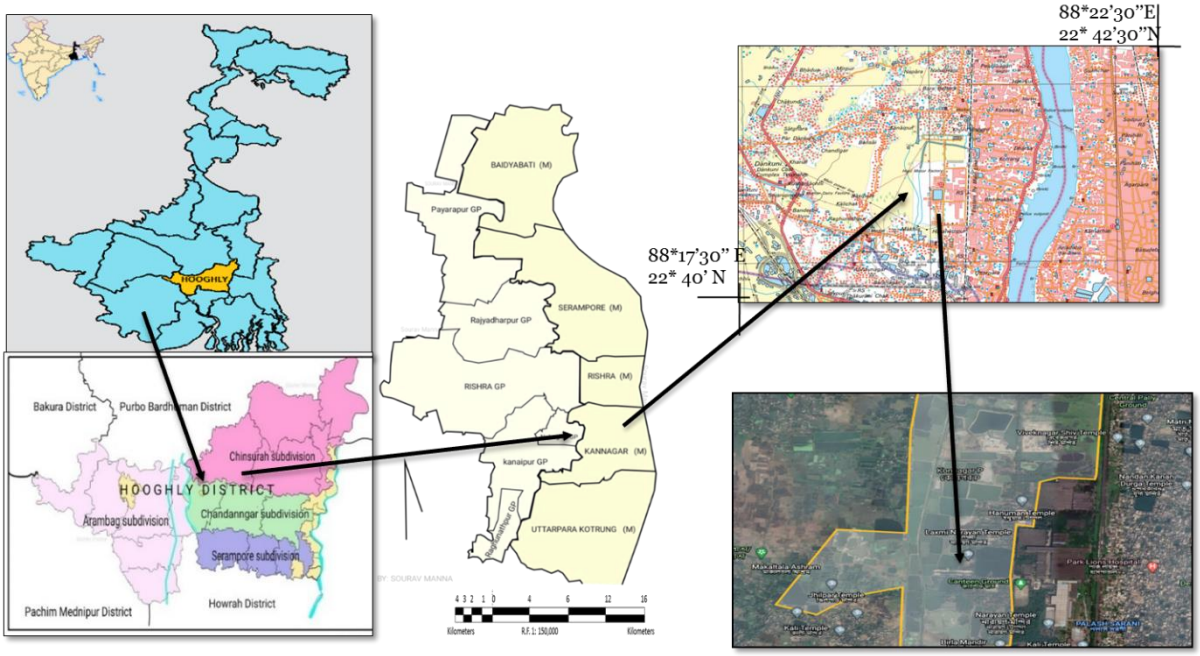


Figure 1. showing location of study area (Konnagar-Hindmotor Wetlands)
Source: Author’s own

Objectives

1. To analyse the present status of the parameters of water quality of the Konnagar-Hindmotor Wetlands

2. To predict the future health of the water of the wetlands from the present parameters of water quality.

Materials and Methodology

To analyse the status of the parameters of water quality, the study area was de-lineated on the basis of distance from the construction site. Water Samples were collected by partitioning the study area into environmental impact units' inconsideration of the extent of the human disturbances

A. Core Construction environmental impact unit site just adjacent to the construction site designated as Site A.

B. Semi-Core construction environmental impact units approximately 50 meters away from construction site designated as Site B.

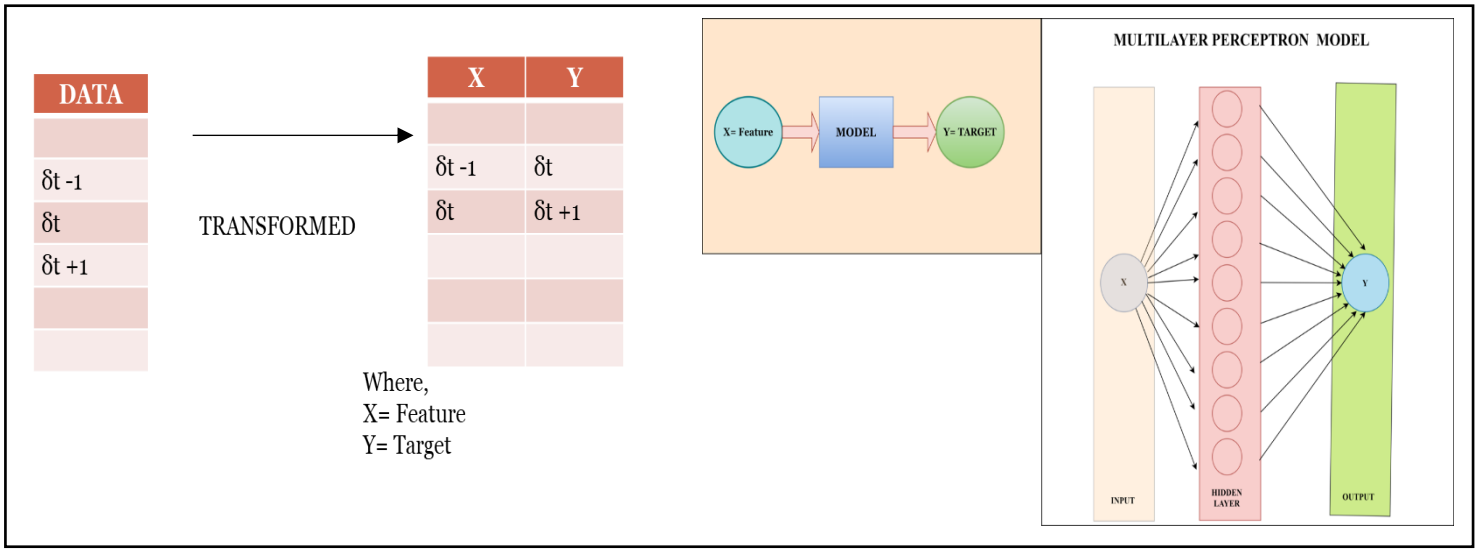
C. Partially- construction environmental impact units approximately 100 meters away from construction site designated as Site C

D. Buffer environmental impact units approximately 150 meters away from construction site designated as Site D.

For measuring the water quality and the ecological health of the wetlands, the water from the wetlands was tested by collecting water samples in the time periods namely in the month of May designated as Pre monsoon (PRM), Monsoonal months of July- September designated as MON, and post Monsoon months of February designated as POM. The water samples were tested in laboratory under specific test methods for different parameters within 12 hours from the collection of the samples. The means of the three time periods were taken to determine the present water quality were: Total Dissolved Solids (TDS), Chloride, Dissolved Oxygen (DO), Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Electrical conductivity, Ammonia, Nitrate, Fecal streptococci and Fecal Coliform Bacteria. The means of the four sites were compared with increase in distance to estimate the impact of construction activity on the water quality parameters with the increasing distance from core construction site.

Based on the results, the data was trained using machine learning, and Multilayer Perceptron Model was used using Artificial Neural Network (fig 2) to predict the future health of the water of the wetlands.

Figure 2. showing Methodology of Multiple Perceptron Model using Artificial Neural Network



Source: Author's own

Results and Discussion

The site-specific results are as follows. For Site A and Site B (table 1) i.e. in the Core Construction environmental impact unit and Semi-Core construction environmental impact units, Total dissolved Solid (TDS) content is very high and in Site B TDS is lesser to Site A. Chloride content is also very high in both the units suggesting construction activities. Ammonia content is very high which clearly indicates high fecal contamination. Nitrate content in site A and in site B is also high which is rare for public utility. It is carcinogenic in nature. The Biological Oxygen Demand is very high (moderately polluted waters have a range between 2–8 mg/l) which suggests that is not suitable for aquatic elements. The normal values of COD incase of surface water ranges from 5 to 20 mg/l. High levels of COD indicates dissolved oxygen depleting high concentrations of organic and inorganic pollutants leading to negative environmental imbalance. Dissolved oxygen concentrations above 6.5-8 mg/L is important for sustaining good aquatic life. Dissolved oxygen plays an important role in the sustenance and survival of aquatic life. Here, Dissolved Oxygen rate is also very low. There is presence of fecal coliform bacteria and fecal coliform streptococci which suggests open defecation or mixing with human fecal matter in the wetland water owing to human intervention during construction activity.

Table 1. showing water quality parameters for Site A and Site B

Site	Parameters	Mean	Test Method	Unit	Site	Parameters	Mean	Test Method	Unit
A	Total Dissolved solid (TDS)	1401	IS:3025(Part-16):1984	mg/l	B	Total Dissolved solid (TDS)	701	IS:3025(Part-16):1984	mg/l
	Chloride	358	IS:3025(Part-32):1988	mg/l		Chloride	112	IS:3025(Part-32):1988	mg/l
	Dissolved Oxygen (DO)	5.3	IS:3025(Part-38)	mg/l		Dissolved Oxygen (DO)	5	IS:3025(Part-38)	mg/l
	Biological Oxygen Demand (BOD)	65	IS:3024(Part-44):1993	mg/l		Biological Oxygen Demand (BOD)	11	IS:3024(Part-44):1993	mg/l
	Chemical Oxygen Demand (COD)	232	APHA 23rd Edition 5220B	mg/l		Chemical Oxygen Demand (COD)	38	APHA 23rd Edition 5220B	mg/l
	Conductivity as 25*c	1921	IS:3025(Part-14):1984			Conductivity as 25*c	826	IS:3025(Part-14):1984	
	Ammonia (NH3-N)	29	IS:3025(Part-34)	mg/l		Ammonia (NH3-N)	12.1	IS:3025(Part-34)	mg/l

	Nitrate as NO3	47	IS:3025(Part-34):1988	mg/l		Nitrate as NO3	51.2	IS:3025(Part-34):1988	mg/l
	Fecal Streptococci	1103		MPN/CFU per 100 ml		Fecal Streptococci	710		MPN/CFU per 100 ml
	Fecal Coliform Bacteria	2112		MPN/CFU per 100 ml		Fecal Coliform Bacteria	1112		MPN/CFU per 100 ml

Source: Laboratory experiments by Author

For site C and Site D i.e. Partially- construction environmental impact units and Buffer environmental impact units (table 2), Nitrate content is also high which is rare for public utility. It is carcinogenic in nature. The Biological Oxygen Demand is very high which suggests that is not suitable for aquatic elements. Dissolved Oxygen rate is also very low.

Table 2. showing water quality parameters for Site C and Site D

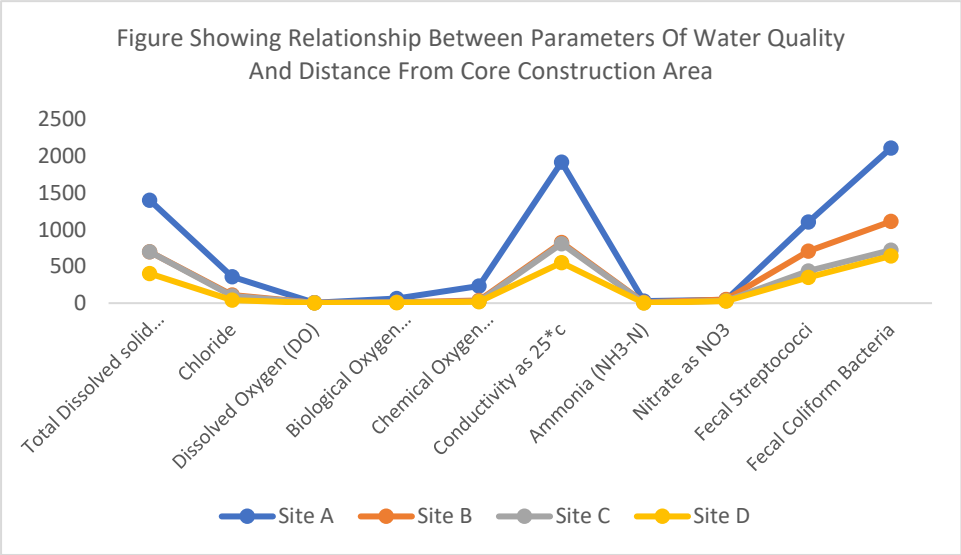
Site	**Parameters**	**Mean**	**Test Method**	**Unit**	**Site**	**Parameters**	**Mean**	**Test Method**	**Unit**
C	Total Dissolved solid (TDS)	583	IS:3025(Part-16):1984	mg/l	D	Total Dissolved solid (TDS)	401	IS:3025(Part-16):1984	mg/l
	Chloride	99	IS:3025(Part-32):1988	mg/l		Chloride	43	IS:3025(Part-32):1988	mg/l
	Dissolved Oxygen (DO)	4.2	IS:3025(Part-38)	mg/l		Dissolved Oxygen (DO)	4	IS:3025(Part-38)	mg/l

	Biological Oxygen Demand (BOD)	9.4	IS:3024(Part-44):1993	mg/l		Biological Oxygen Demand (BOD)	5.2	IS:3024(Part-44):1993	mg/l
	Chemical Oxygen Demand (COD)	25	APHA 23rd Edition 5220B	mg/l		Chemical Oxygen Demand (COD)	18.5	APHA 23rd Edition 5220B	mg/l
	Conductivity as 25*c	810	IS:3025(Part-14):1984			Conductivity as 25*c	550	IS:3025(Part-14):1984	
	Ammonia (NH3-N)	6.7	IS:3025(Part-34)	mg/l		Ammonia (NH3-N)	2.2	IS:3025(Part-34)	mg/l
	Nitrate as NO3	31.5	IS:3025(Part-34):1988	mg/l		Nitrate as NO3	28.6	IS:3025(Part-34):1988	mg/l
	Fecal Streptococci	440		MPN/CFU per 100 ml		Fecal Streptococci	351		MPN/CFU per 100 ml
	Fecal Coliform Bacteria	720		MPN/CFU per 100 ml		Fecal Coliform Bacteria	642		MPN/CFU per 100 ml

Source: Laboratory experiments by Author

However, the values of the parameters of water quality of the wetland sites improves with increase in distance from the core construction area, thereby suggesting the core construction area is the worst affected part of the wetland (Fig 3.).

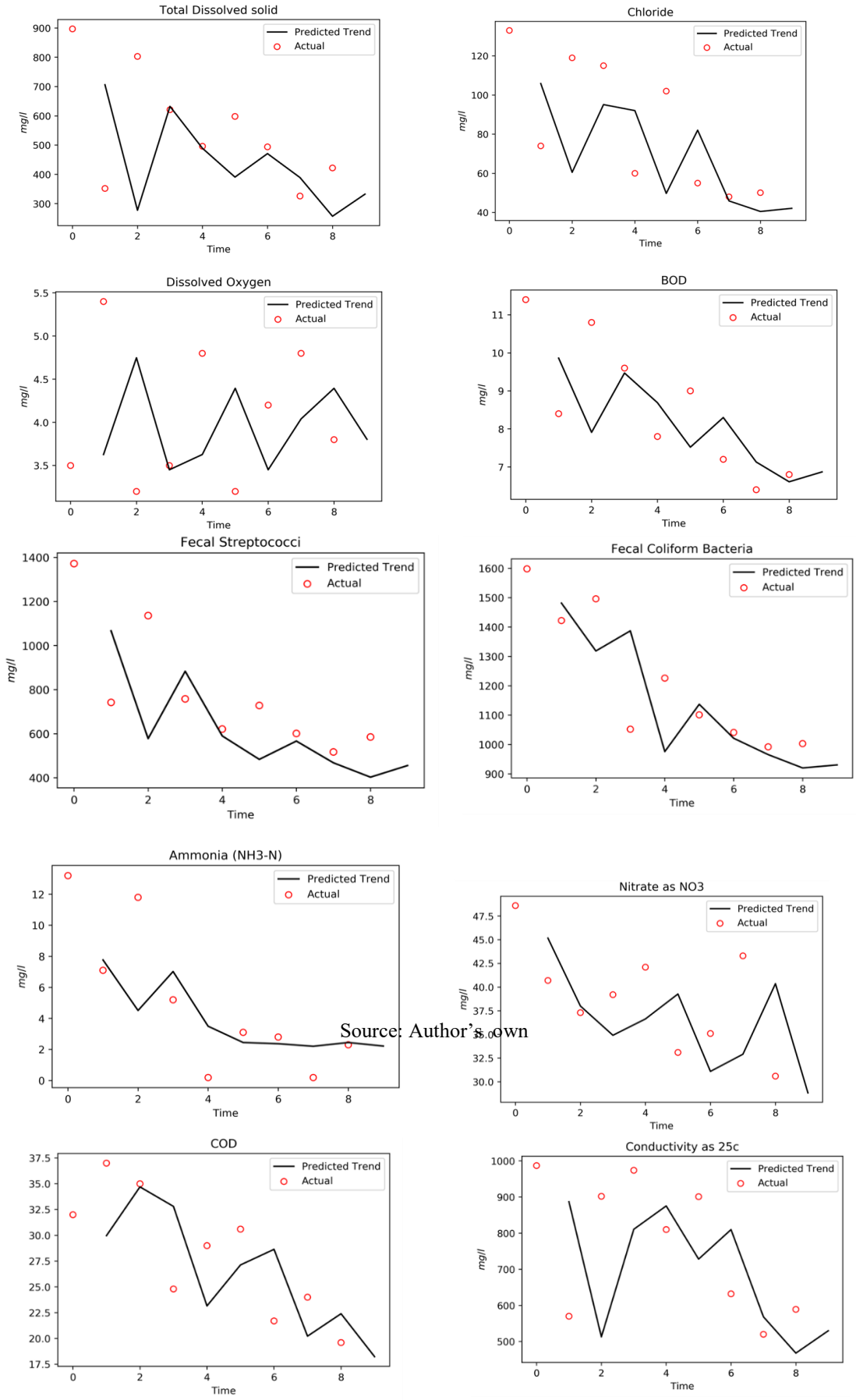
Figure 3. Showing Relationship Between Parameters of Water Quality and Distance from Core Construction Area



Source: Author's own

However, given the status of the water quality the future of the wetlands was important task to ascertain so that timely measures could be taken. The Multilayer Perceptron Model predicted a further deterioration in the parameters of measuring water quality (figure 4). It has been predicted by machine learning model that there will be further increase in the levels of TDS, chloride, BOD, Conductivity of water, fecal streptococci and fecal coliform bacteria in the water of the wetlands in the near future. At the same time, there will be decline in DO levels, COD and Ammonia and nitrate levels, thus the water health of the wetlands will be compromised.

Figure 4. Showing The Predicted Trend of Water Quality Parameters Using Multilayer Perceptron Model



Source: Author's own

Conclusion

Thus, from the study it has been absolutely clear, that the infilling of the Konnagar-Hindmotor wetlands owing to the upcoming real estate project has already wrecked a havoc in the quality of water of the wetlands. The deterioration of the water health is directly related to the health of the wetland's ecosystem. The direct and indirect stakeholders of the wetlands is getting affected and will be highly affected in the near future as the model has predicted a further deterioration in the water health, thereby leading to the complete disruption in the normal functioning of the wetland ecosystem. The need of the hour is sustainable management of the wetlands. It requires adoption of a comprehensive policy so there is a greater protection of the wetlands and the stakeholders take the entire opportunity to protect the wetlands.

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