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Assessment of water quality index of different water bodies of Pusa, Bihar

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Abstract
Water quality of river (Budhi Dandak), ponds, hand pump and deep tube wells of Pusa village were evaluated by Water Quality Index (WQI) technique. Water quality is directly related to the physical, chemical and biological property of water. These properties of water were affected by the human activities such as disposal of pollutant in the water bodies that changes the standard quantity parameters of water. The objective of an index is to turn complex water quality data into information that is understandable and useable by the public. Seven most important parameters such as pH, total dissolved solids (TDS), sodium (Na), Chloride (Cl^-), calcium (Ca), magnesium (Mg), and electrical conductivity (EC) were taken for the calculation of WQI. WQI obtained from different water sources such as river, pond, hand pump & deep tube well were found to be 30.60, 33.19, 44.41 and 41.05 respectively. The different values of various parameters were analyzed and found that pH was in the range of 7.2-7, Cl^- ions concentration ranged from 42.55-99.29 (mg/l), TDS concentration 186-494 (mg/L), and Ca + Mg concentration 130-257 (mg/l), Na 56-118 (mg/l) and EC concentration 387-882 (µS/cm) respectively. We concluded that pH, Cl^-, TDS and Ca + Mg were found in permissible limit but EC and Na^+ were excess from permissible limit. Water quality index level shows that the water of water bodies in Pusa were not fit for direct use or drinking purpose, but good for domestic, irrigation, and industrial purposes.

Keywords: Water quality, water quality index, total dissolves solid, electrical conductivity and pH

Introduction
Water is one of the precious natural resources present on the earth and it is very important for survival of flora and fauna. Quality of water is equally important to the quantity available. While considering of total percentage of water present on earth as 97% in ocean and 3% as a fresh water with considering glacier. Out of which 2% as fresh water in the form of surface and subsurface water bodies and it usable for the human consumption. So when we consume water its quality measurements are necessary and management should be done in systematic path. Water quality is directly related to the physical, chemical and biological property of water. These properties of water are affected because of the pollution of water due to various human activities. Depend on the activities; disposal of pollutant in the water bodies are done that changes the standard quantity of parameters in water. There are various parameters which can be assess for measurement of quality of water but when consideration of all parameters may be generates complexity towards quality. So, development of Water Quality Index (WQI) is the quite popular method in water quality assessment.
Ramakrishnaiah *et al.* (2009) [3] assessed the water quality index (WQI) for the groundwater of Tumkur taluk. This has been determined by collecting groundwater samples and subjecting the samples to a comprehensive physicochemical analysis. For calculating the WQI, the following 12 parameters have been considered: pH, total hardness, calcium, magnesium, bicarbonate, chloride, nitrate, sulphate, total dissolved solids, iron, manganese and fluorides. The WQI for these samples ranges from 89.21 to 660.56.
Akoteyon *et al.* (2011) [1] studied the water quality characteristics of Owo river for municipal water supply in Lagos-Nigeria in order to harmonize human development and sustenance of surface water resources quality within Owo river basin. The result showed that the physical parameters (Electrical Conductivity) in surface have the highest mean while pH recorded the least value. The coefficient of variation revealed that all the examined physical parameters with the exception of pH are heterogeneous.

While the major parameters of surface water quality showed that, Total Hardness recorded the highest mean with HCO3 been the lowest. Similarly, coefficient of variation showed that all the major surface water variables with the exception of Chloride and Sodium are heterogeneous. Further, all the examined surface water samples were within the maximum permissible limit of WHO standard for drinking water quality. Similarly, the result of the calculated WQI also showed that the water is suitable for human uses.

According to Nasly *et al.* (2013) [5] Tunggak River is the impact of rapid industrialization at Gebeng, Malaysia. The aim of the study was to evaluate the water quality of the river using the application of WQI. To achieve the objectives 180 water samples were collected and comprehensive physicochemical analysis was done using APHA & HACH standard methods of analysis. The WQI was calculated using DOE-WQI based on the concentration of DO, BOD, COD, SS, pH and NH3-N. Results showed the sequence of monitoring stations 7<5<3<2<6<4<8<10<1<9 based on WQI value; where the first 7 (mid-stream) stations were categorized as class IV (highly polluted) and the last 3 were classified as class III (polluted).

Odiba *et al.* (2014) [6] Water samples collected from boreholes and hand dug wells located in two wards in Wukari town were assessed for some physico-chemical parameters on collection and after one week of storage using standard analytical methods. Furthermore the quality indices were determined for the water samples on collection and after one week of storage. The parameters determined include temperature, turbidity, suspended solids, total dissolved solids, conductivity, pH, nitrate –nitrogen, phosphates, chlorides, alkalinity, COD and DO. The result showed that some parameters like turbidity, conductivity and suspended solids exhibited a marked drop in value following their storage for one week in both borehole and hand dug well water samples.

Allahbakh *et al.* (2014) [2] evaluated water quality from Mojen River by Water Quality Index based on National Science Foundation (NSFWQI). For this purpose, samples were collected from stations at up, middle and downstream of Mojen River in Semnan province (the biggest river in region) in a 2 years interval of 2013-2014 years. Nine parameters namely Turbidity, Biochemical Oxygen Demand, Dissolved Oxygen, Fecal Coliform, nitrate, pH, temperature, total solids and total phosphate were considered to compute the index.

Gopal *et al.* (2016) [4] Water quality index (WQI) of groundwater based on the data of 27 samples collected from Rajkot district, Gujarat was assessed using seven parameters *viz*. pH, Total Dissolved Solids, Total Hardness, Fluoride, Chloride, Sulphate and Nitrate. The WQI value 98 is maximum and the value 27 is minimum in the study area. The computed WQI shows that 51.8% of water sample fall in the 'good' to 'excellent' water category. On the other hand, 48.2% of water samples fall in the 'fair' to 'poor' category indicating that the water is not suitable for direct consumption and require treatment. After treatment, the water can be used for drinking purpose and requires treatment.

Experimentation

The present study was under taken with a view for Determination of Water Quality Index and Suitability of Water Bodies in Pusa. The experiments were conducted near D.R.P.C.A.U. Pusa. The materials and methodology adopted for conducting the experiment is presented in the subsequent sections.

Water Quality Assessment

Water quality assessment of water bodies available in Pusa. The water sample were collected from the water bodies such as River, Ponds, Hand pump and deep tube wells as shown in picture below.

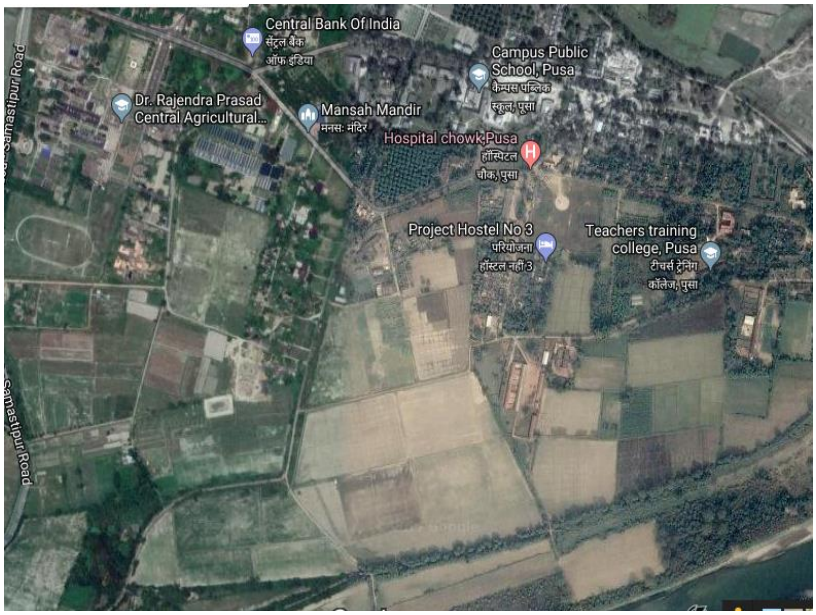

Fig 1: Location map of study area

Measurement of pH

The pH was determined by taking about 50 ml of the water sample in a 100 ml clean beaker and immersing the electrodes of the pH meter. A pH meter is actually a direct current amplifier that measuring the e.m.f. which appears across the electrodes upon being immersed in a solution, soil suspension or irrigation water. The glass and calomel electrodes are immersed in the test solution and the e.m.f. determined by an electron tube voltmeter. The meter is graduated to read directly in pH units along with the e.m.f. (milli-volts) scale. A standard buffer solution (of known pH) is used to calibrate the instrument before determining the pH of test solutions.

Measurement of EC
The cell of the conductivity meter was filled with 40ml water sample and the electrical conductivity was measured with water and expressed as mmho/cm at c (sometimes the unit of expression is micromho/cm that is 1/1000th of mmho/cm, when the EC is rather low).

Sodium (Na^+)
Small amount of sodium are generally present even the best quality irrigation water. The concentration of sodium may be quite high in saline water with EC greater than 1mmho/cm and containing relatively less amount of Ca and Mg. interest when the water sample tests saline.

Chloride (Cl^-)
The usual method for the determination of Cl^- by titration.
Volume of standard $AgNO_3$ solution required for 100ml of the water after subtracting blank reading = z ml
Amount of Cl^- ions in 1000 litre of water = (z)*(1000*1000)/(100*1000)
=10z parts per 1000litres or ppm

Calcium and magnesium
The usual method for determination of ca^{2+}+mg^{2+} is by versanate (EDTA) titration.

$$Ca + Mg\ (\frac{m.e.}{l}) = (\frac{Vv*N}{Vs}) * 1000$$

Total dissolved solid
The cell of the conductivity meter is filled with 40 ml water sample and the dissolved solid is measured in water and expressed as ppm at 25 ºC.

Determination water quality index
The quantitative assessment of water quality index was calculated using the weighted arithmetic index method as described by Cude (2001). For assessing the quality of water in this study, first, the quality rating scale (Q_i) for each parameter was calculated by using the following equation.

$$Q_i = \{[(V_{observed} - V_{ideal})/(V_{standard} - V_{ideal})]\} * 100$$

Where,
Q_i = quality rating of; parameter for a total of n water quality Parameters,
$V_{observed}$ = Observed value of the water quality parameter at given the Sampling station,
V_{ideal} = ideal value of that water quality parameter can be obtained form the Standard tables (for zero for all parameters except the parameters of pH and dissolved oxygen 7.0 and14.6 mg/, respectively),
$V_{standard}$ = Recommended standard of the water quality (BIS)
Unit weight (W_i) was calculated by a value inversely proportional to the recommended standard (S_i) for the corresponding parameter.

$$W_i = I/Si$$

Where
W_i = unit weight for parameter
S_i = Standard permissible value for nth parameter
I = Proportionality constant

$$WQI = \sum Q_i W_i \sum W_i$$

Where
Q_i= Quality rating
W_i = Relative (unit) weight

Results and Discussions
This section deals with the finding of water parameters which was collected sample near Dr. R P C A U, Pusa "Determination of Water Quality Index and Suitability of Water Bodies in Pusa." The analysis is based on different physico-chemical parameters of water.

Table 1: Determination of Water quality index of Bhudi Gandak River

Parameters	ideal value (v_i)	Observed value (v1)	Observed value (v2)	Observed value (v3)	Observed value (v avg)	Standard value (v_s)	quality rating (q_i)	unit weight (w_i)	w_iq_i	WQI
pH	7	7.30	7.10	7.20	7.20	8.50	13.33	0.1176	1.57	
EC (µS/cm)	0	390.00	391.00	381.00	387.33	300.00	129.11	0.0030	0.39	
TDS (mg/L)	0	202.00	196.00	204.00	200.67	500.00	40.13	0.0020	0.08	
Na+ (mg/L)	0	56.60	58.20	57.80	57.53	50.00	115.07	0.0200	2.30	
Cl^- (mg/L)	0	42.55	70.92	56.74	56.74	200.00	28.37	0.0050	0.14	
Ca^{++}+M^{g++} (mg/L)	0	132.80	128.80	128.80	130.13	300.00	43.38	0.0030	0.13	
								0.1506	4.61	30.60

Water quality index is composite assessment of seven parameters which determines whether the water can be used for domestic, drinking and agriculture purpose. The laboratory analysis of physical and chemical parameters of collected water samples disclosed the fact of of physical and chemical parameters of collected water samples and the fact of significant contamination in water bodies of Pusa as shown in the table 1.

Table 2: Average values of water quality parameters at different water Bodies at Pusa.

Samples station	pH	EC (µS/cm)	TDS (mg/L)	Na^+ (mg/L)	Cl^- (mg/L)	Ca^{++}+Mg^{++} (mg/L)
River	7.20	387.33	200.60	57.53	56.74	130.13
Pond	7.31	371.00	190.67	45.40	61.464	124.5067
Hand pump	7.16	986.67	482.00	94.73	85.10	253.104
Deep tube wells	7.00	882.00	436.67	117.7667	52.67467	257.6

Table 3: Stations Falling under the Water Quality Index

Water quality index level	Water quality status	Sample Stations	Usage
0–25	Excellent		Drinking, Irrigation and Industrial
25–50	Good	River, pond, hand pump & deep tube well	Domestic, Irrigation and Industrial
50-75	Poor		Irrigation and Industrial
75-100	Very Poor		Irrigation
>100	Unsuitable		Restricted use for Irrigation

The average value of various physio-chemical parameters for calculation of WQI are given in table-2 station wise WQI calculation presented in table 3 shows the WQI obtained from different water sources. WQI results of River, pond, hand pump & deep tube well were found to be 30.60, 33.19, 44.41 and 41.05 respectively.

These Water bodies water are unfit for drinking but can be useful for Domestic, Irrigation and Industrial purposes. This study reveals that the EC, Na^+ where found to more than there prescribed standard limit at stations except pond, its sodium limit is permissible, the physio-chemical characterisation of water is observed as briefed for all water bodies at Pusa. pH of all collected sample were found with in limit. The different values of various parameters were analysed and found that Cl^- ions concentration where in the range of 42.55-99.29, TDS concentration 186-494, and Ca^{++} + Mg^{++} concentration 122.36-257.6all are in mg/L.

Among all the physio-chemical parameters selected for water quality index calculation, pH is an important parameter which determines the suitability of water for various purposes. In this study, pH of all locations are well within the permissible limits of salinity. Concentration of Ca^{++}+ Mg^{++} ions make major contribution to the hardness of water. Cl^- ions is one of the most important parameter for assessment of water quality. Cl^- ions in excess imparts the salty taste to water. Sodium ion also represents the salinity

Conclusions

The average value of various physio-chemical parameters for calculation of WQI. WQI obtained from different water sources are River, pond, hand pump & deep tube well were found to be 30.60, 33.19, 44.41 and 41.05 respectively. the range of 25 – 50 of WQI. PH, TDS, Ca^{++} + Mg^{++} limit are fond in permissible limit in Pusa. EC and Na^+ are excess from permissible limit. Water quality index level show that the water of water bodies in Pusa is not fit to directly use for drinking, but it is good for domestic, irrigation, and industrial purposes. With the help of WQI people can effectively monitor their water quality and they serve as a convenient tool to highlight specific environmental conditions, and to help the decision makers in evaluating the effectiveness of regulatory program. It is suggested to the people that they must purify the ground water before consumption.

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