ASSESSMENT OF GROUND WATER QUALITY INDEX: MEHSANA DISTRICT, GUJARAT AS A CASE STUDY

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Abstract: *Water Quality Index is a useful representation of overall quality of water for public or for any required use as well as in the pollution demolition programmes and in water quality management. There are various parameters which affects the use and applicability of water for a particular purpose. This technical paper represents with the study of physio-chemical parameters such as pH, BOD, Colour, COD, TDS, Total Alkalinity in water samples collected from different wells as well as bore wells from different villages nearby the study area. The outcome of this study indicates that the groundwater of some regions in the study area needs respective degree of quality improvement by the most feasible approach like Artificial Groundwater Recharging whereas some regions have good water quality.Research paper presents the study carried out on the study of the influence of environmental parameters on the ground water quality. The development of water quality index and monitoring of ground water is done for Mehsana region, Gujarat. In this type of multifaceted study, the emphasize should be focused on relative weightage of concern parameters allied with issue rather than traditional identical weightage system. The present study is intended with similar type of multifaceted approach to determine the Groundwater Quality Index (GWQI) for the Mehsana region and nearby areas situated in Gujarat state-India. Under this study the various seasonal groundwater samples were collected for the same consecutive.* ***Keywords:****Water Quality Index,ground water,pH, BOD, Artificial Recharge.*

INTRODUCTION

Water quality refers to the chemical, physical, biological, and radiological characteristics of water. It is a measure of the condition of water relative to the requirements of one or more biotic species and or to any human need or purpose. It is most frequently used by reference to a set of standards against which compliance can be assessed. The most common standards used to assess water quality relate to health of ecosystems, safety of human contact and drinking water. Groundwater is a natural resource for drinking water. Like other natural resources, it should be assessed regularly and people should be made aware of the quality of drinking water. The present study is aimed at assessing the water quality index (WQI) for the groundwater of Mehsana city. This has been determined by collecting various groundwater samples from 6nearby areas of Mehsana and subjecting the samples to a comprehensive physicochemical analysis. For calculating the WQI, the following parameters have been considered: pH, BOD, Colour, COD, TDS, Total Alkalinity.

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About one billion people are directly dependent upon groundwater resources in Asia alone, and In India, most of the population is dependent on groundwater as the only source of drinking water supply. The groundwater is believed to be comparatively much clean and free from pollution than ground water. Water is not only essential for the lives of animals and plants, but also occupies a unique position in industries. Work in the area of water quality tends to be focused on water that is treated for human consumption, industrial use, or in the environment. Environmental scientists work to understand how these systems function, which in turn helps to identify the sources and fates of contaminants.Environmental lawyers and policymakers work to define legislation with the intention that water is maintained at an appropriate quality for its identified use.

In the setting of standards, agencies make political and technical/scientific decisions about how the water will be used.In the case of natural water bodies, they also make some reasonable estimate of pristine conditions. Different uses raise different concerns and therefore different standards are considered. Natural water bodies as well as ground water sources will vary in response to environmental conditions. Though ground water source may not contaminate much rapidly.

Present study aims to ascertain and determine the minimum Water Quality Index (WQI) which will be sufficient and acceptable by the local community of Mehsana District and Town..

LITERATURE REVIEW

The objective of the present work is to discuss the suitability of groundwater for human consumption based on computed water quality index values.To study up to which extent the physical and biological parameters have been influenced and taking place from the fresh water line to groundwater aquifer of that vicinity. This study requires the drinking water parameter of groundwater for studying water quality index. A Review of Literature has been done before the start of work.

Quality Characterization of Groundwater using Water Quality Index in Surat city, Gujarat, India was done by Mangukiya Rupal et al. (2012). The objective of the work was to discuss the suitability of groundwater for human consumption based on computed water quality index values. Salt water intrusion occurring at coastal region of Surat was also considered for the study. The study up to which extent the salt water intrusion taking place from the coastal line of Surat to groundwater aquifer of that vicinity was also carried out. Lastly the drinking water parameter of groundwater for studying salt water intrusion was done. Assessment of ground water quality can be a complex process undertaking multiple parameters capable of causing various stresses on overall water quality. The evaluation of water quality from a large number of samples, each containing concentrations for many parameters is difficult (Almeida et al. 2007).Analysis of water quality using different approaches like statistical analyses of individual parameter, multi-stressors water quality indices, etc have been considered by Venkatesharaju et al. 2010.Lakes and tanks are known to be ecological barometers of the health of a city as they regulate the micro-climate of any urban center (Benjamin et al. 1996), thereby influ- encing the life of the people adjacent to it. The quality of ground water in an inland water bodies have a profound effect on the ground water table and ground water quality of the nearby aquifers due to existence of direct interaction between ground and

ground water. Lakes have a great significance environmentally due to reasons such as (a) sources of water: ground and groundwater recharge and discharge, for drinking and irrigation, (b) supports liveli- hoods, lung space of clear and cool air, (c) food and nutrition, (d) act as flood control and stream flow mainte- nance, (e) recreation—education, boating, swimming, walking and jogging on the lake bund, (f) lakes are natural infrastructure for climate change adaptation and biogeo- logical cycles, (g) pisciculture, (h) wildlife habitat, espe- cially fishes and birds, (i) rain water harvesting and, (j) emergency water supply for firefighting.For calculating the WQI, 14 parameters namely, pH, electrical conductivity, total dis- solved solids, total hardness, alkalinity, calcium, magne- sium, sodium, potassium, chloride, sulphate, nitrate, fluorides and iron were considered.

STUDY AREA

Study area includes 6 prime locations of Mehsana city. Mehsana is situated in north Gujarat region, Unjha is situated nearly 100 kms from Ahmedabad and is a part of Mehsana Sub-district. Unjha is well known for Asia's biggest Industrial APMC. The villages considered in the study are as follows: Aithor, Laxmipura, Pratapgadh, Sinhi, Unava, Sunak, Karli and Unjha itself.

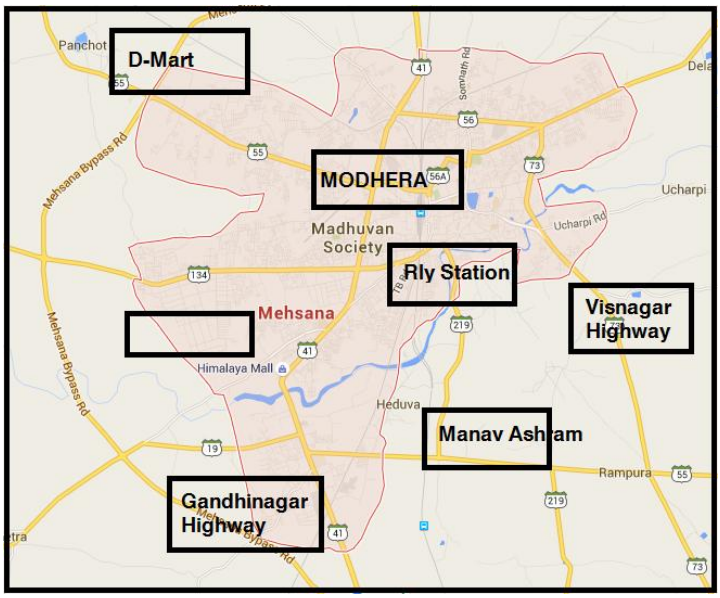

Fig.1: Mehsana and nearby villages

WATER SAMPLING AND METHODOLOGY

In an effort to compare water quality, eight locations were chosen for sampling purpose. These locations were at the eight villages considered for the study. While sampling plastic bottle, BOD bottle, Solution of MnSo4 and KI was always kept. The analysis and lab testing of parameters were done subsequently after data collection. These parameters are explained as follows:

3.1 Biochemical Oxygen Demand: B.O.D. is a measure of the amount of food for bacteria that is found in water. Bacteria utilize organic matter in their respiration and remove oxygen from the water. The BOD test provides the rough idea of biological waste present in the water. Biodegradable waste is usually composed of organic wastes, including leaves, grass clippings and manure.

3.2 Dissolved Oxygen: DO test measures the amount of life sustaining oxygen dissolved in the water. This is the oxygen that is available ti fish, invertibrates, and all other animals living in the water. Low levels of dissolved oxygen in water is a sign of possible pollution.

3.3. pH: The pH level is a measure of acid content of the water. Water with a pH of 7 is considered neutral. If pH is below 7, it is classified as acidic, while the pH greater than 7 is said to be alkaline. The pH of tap water in India lies between 6.5 to 8.5.

3.4 Total Dissolved Solids: TDS is a measure of solid materials dissolved in the water. This includes salts, some organic matter and a wide range of other things from nutrients to toxic materials. Concentrations of TDS that are high or low may limit the growth and lead to death of many aquatic life forms.

3.5 Turbidity: Turbidity is a measure of dispersion of light in a column of water due to suspended matter. The higher the turbidity, the cloudier the water appears. If water becomes too turbid, it loses the ability to support a wide variety of plants and other aquatic organisms.

3.6 Colour: Colour would help us to identify the strength of pollution load. The colour also enforces us to think about the vegetation and aquatic life.

3.7 Chemical Oxygen Demand: The discharge of organic and inorganic loads and wastes may affect the contamination of ground water. This may affect even the most purest form of water available i.e. ground water. The chemical load leads to increase the pollution of water bodies. Because of this reason only this parameter is determined.

3.8 Total Alkalinity: The household activities like cattle farming, bathing, washing etc. increase the carbonates and bi-carbonates content. This increases the inorganic load. Therefore it is necesory to determine Total Alkalinity.

WATER QUALITY INDEX DETERMINATION

The Water Quality Index uses a specific scale to rate the quality of the water. Once the Water Quality Index (WQI) score is determined, it can be compared against standard scale to determine how healthy water is available around us. The Mehsana city was divided into 6 regions which are the main and prime locations of the city too. And time to time sampling has been done succeeded by testing of the water samples. Also the data of Mehsana Municipality and tested results were also compared.

*4.1 Introduction of GWQI:*Ground Water Quality Index (GWQI) is a unit less number that describes a quality value to an aggregated set of measure chemical, physical and microbiological parameters. Basically a WQI attempts to provide a mechanism for presenting a cumulatively derived numerical expression to define a certain level of water quality. WQI is a mechanism for presenting a cumulatively derived numerical expression defining ascertains level of water quality. Water quality indices aim at giving a single value to the water quality of a source reducing a great amount of parameters into simpler expression and enabling easy interpretation of monitoring data.

Water Quality Index is a mechanism for presenting a cumulatively derived numerical expression defining a certain level of water quality. In other words, WQI summarizes large amount of water quality data into simpler terms (e.g. good, bad) for reporting to public in consistent manner. Various researches have evolved which bought the changes to the methodology depending on the usage and parameters under consideration.

Further development and calculation of WQI includes consideration of numerous parameters such as pH, BOS, COD, TDS, SS, Temperature, Chloride, Heavy metals, Sulphate etc. To analyse, determine and test all the parameters is very long and tedious process. So only few chosen parameters have been considered and these are pH, BOD, COD, Total Dissolved Solids (TDS), Total Alkalanity, Colour, DO etc.

4.2 Calculation of WQI: The Water Quality Index (WQI) has been calculated using Weighted Arithmetic Index method.

Weighing: The word weighing implies relative significance of each of the factor in the overall water quality and it depends on the permissible level of waste water discharge, as suggested by GPCB (Gujarat Pollution Control Board). Factors which have higher permissible limits are less harmful and have low weights while the factors having low permissible limits are more harmful. Therefore

$W_i = K/S_n$

Where, W_i = Unit weight of chemical factor, K = constant of proportionality and is given by,

$K = 1/ [(1/V_{s1})+(1/V_{s2})+(1/V_{s3})+….+(1/V_{sn})$

S_n = Standard value of i_{th} parameter.

Rating scale: Each chemical factor has been assigned a water quality rating to calculate WQI.

$Q_i = 100[(V_a - V_i)/(V_s – V_i)]$

Where V_a= average measured values in the water sampole for three months at a place

V_s = Standard value of i_{th} parameter (0 for all, exceptions: pH and DO)

Water Quality Index (WQI) = $[\Sigma(Q_iW_i)/\Sigma W_i]$

Where $\Sigma(Q_iW_i)$ = Summation of $(Q_i * W_i)$ of all the parameters considered.

ΣW_i = Total unit weights of all chemical factors.

Using the Water Quality Index, all the samples were categorized into the following five classes.

Table 1: Range of GWQI Scale

Excellent	0-50
Good	50-100
Poor water quality	100-200
Very poor water quality	200-300
Unsuitable water for human consumption	>300

Generally WQI are considered for a specific use of water. In this study the WQI for human consumption is considered and permissible WQI for the waste water is taken as 100. A water suppy with a poor quality rating would not normally be considered acceptable for activities involving direct contact with the water.

Table 2: Collection and sampling of data (Sample)

Sr. No.	Date/ Tested Parameter	pH	Turbidity (NTU)	Elec. Conductivity	Dissolved Oxygen (mg/l)
1	1 Aug. 2015	6.7	7	733	22
2	16 Aug. 2015	6.9	8	644	42
3	1 Sept. 2015	6.9	5	780	17
4	17 Sept. 2015	7.1	8	702	19
5	3 Oct. 2015	6.8	7	623	52

RESULTS AND DISCUSSSION

Water Quality Index (WQI) has been assessed for all the regions of Mehsana considered under study area. Table 2, Table 3, Table 4 and Table 5 summarises the WQI calculations for Mehsana city for four samples taken at different time interval. Fig. 2 shows the variation of parameters with respect to location.

Table 3: WQI calculation, sample 1: Railway Station nearby area

Parameter	Mean test Results	Unit	Standard permissible value	Relative Weight	Quality Rating	Weighted value
pH	7.91	Units	7.0	0.67	60.66	40.46
BOD	8.74	mg/l	30	0.19	29.13	5.51
COD	52	mg/l	100	0.06	52	2.95
Colour	42.7	PTU	100	0.06	42.7	2.42
TDS	320	mg/l	2100	0.002	15.23	0.04
Total Alkalinity	188	mg/l	200	0.03	94	2.67
			SUM	1		54.04
			K=5.67			
			WQI=54.02	54.02		

Table 4: WQI calculation, sample 2: Modhera Chokdi area

Parameter	Mean test Results	Unit	Standard permissible value	Relative Weight	Quality Rating	Weighted value
pH	7.78	Units	7.0	0.67	52	34.69
BOD	9.93	mg/l	30	0.19	33.1	6.26
COD	40.2	mg/l	100	0.06	40.2	2.28
Colour	36	PTU	100	0.06	36	2.04
TDS	432	mg/l	2100	0.002	20.57	0.06
Total Alkalinity	200	mg/l	200	0.03	100	2.83
			SUM	1		48.15
			K=5.67			
			WQI=48.15	48.15		

Table 5: WQI calculation, sample 3: D-Mart area

Parameter	Mean test Results	Unit	Standard permissible value	Relative Weight	Quality Rating	Weighted value
pH	7.96	Units	7.0	0.67	64	42.69
BOD	5.77	mg/l	30	0.19	19.23	3.64
COD	32	mg/l	100	0.06	32	1.81
Colour	48.3	PTU	100	0.06	48.3	2.73
TDS	508	mg/l	2100	0.002	24.19	0.066
Total Alkalinity	160	mg/l	200	0.03	80	2.27
			SUM	1		53.21
			K=5.67			
			WQI=53.21	53.21		

Table 6: WQI calculation, sample 4: Manav Ashram Chokdi area

Parameter	Mean test Results	Unit	Standard permissible value	Relative Weight	Quality Rating	Weighted value
pH	8.04	Units	7.0	0.67	71.33	47.58
BOD	8.88	mg/l	30	0.19	29.6	5.59
COD	48	mg/l	100	0.06	48	2.72
Colour	43.8	PTU	100	0.06	8.9	0.50
TDS	480	mg/l	2100	0.002	22.86	0.06
Total Alkalinity	120	mg/l	200	0.03	60	1.701
			SUM	1		48.16
			K=5.67			
			WQI=48.16	48.16		

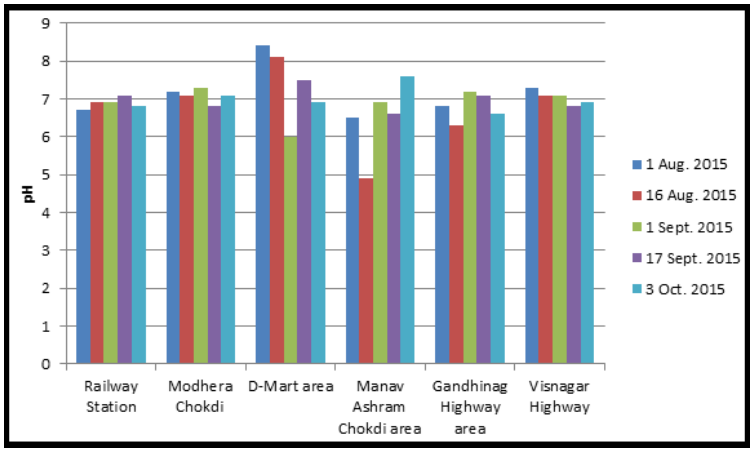

Fig. 2: pH representation region (area) wise

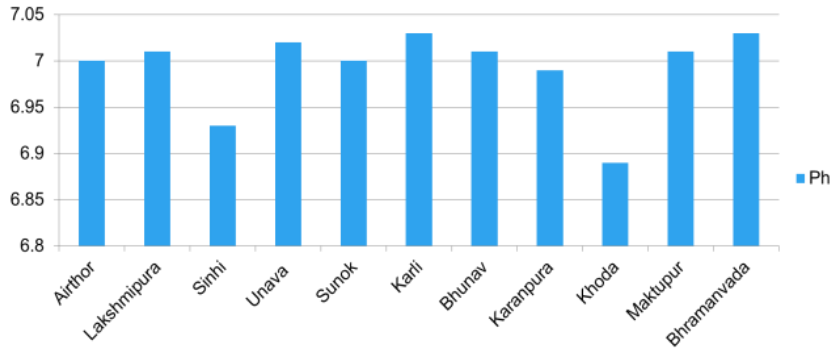

Fig.2: Region wise Variation of Average pH

Similar procedure was adopted for other regions such as Modhera Chokdi area, D-Mart area, Manav Ashram Chokdi area, Gandhinagar highway area and Visnagar Highway area to obtain WQI values. Table 6 shows the WQI parameters and the WQI status of the regions. This summarises the results of obtained WQI study.

Table 7: Average WQI: Region wise

Sr. No.	Name of the Sampled Area	Average WQI	Predominant Parameters	Status of Water
1	Railway Station Area	48.14	pH	Good
2	Modhera Chokdi Area	47.65	pH	Good
3	D-Mart Area	42.31	BOD	Good
4	Manav Ashram Chokdi Area	47.18	TDS	Good
5	Gandhinagar Highway Area	43.78	TDS	Good
6	Visnagar Highway Area	47.44	Total Alkalinity	Good

CONCLUSIONS

The analysis of different chemical and physical parameters reveals that the water is fit for drinking as per calculated Water Quality Index Scale. These values are compared with the given values by Gujarat Pollurion Control Board (GPCB) and World Health Organisation (WHO) limits. The predominace of certain parameter has been found and actions may be taken to mitigate the problem. Research paper summarises the study done for assessing the Water Quality of ground water as well as available ground water.

The obtained GWQI from representative samples of study area shows the groundwater quality lies in the range of poor to tolerable good but the temporally analysis indicates that such quality fluctuates in its own and even in some of the area it has been found within the range of very poor water . This needs the attention towards the improvement of groundwater quality before further degradation. Literature indicates that artificial recharging of groundwater by recharge well is one of best method confirmed across the world for the improvement of groundwater quality in urban region. Therefore, as a future scope of this study the recharge phenomena can be explored to study area and on the base of available data of rainfall, land use pattern ,topography- (1) Runoff in the study area can be worked out and with the consideration of individual recharge well's recharge rate capacity numbers of well can be computed and proposed . (2) Effect of recharging on groundwater quality can be predicted and the effect of recharging can be correlated with GWQI.

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