Groundwater quality mapping of Katepurna watershed in Akola district of Maharashtra India

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Abstract :In sustainable groundwater study, it is necessary to assess the quality of groundwater in terms of drinking and irrigation purposes.The quality is directly subjected to the degree of weathering, movement of groundwater, individual ion-contents and ion-exchange, climate and to time variation in the process of recharge and discharge. In present study 58 ground water sample were analyzed to delineate the variation in average chemical composition of ground water from unconfined aquifers. Particular attention was given to short term variation in water quality for the use of water for drinking, agricultural and industrial purposes. The chemical and physical characteristics of water samples of the dug wells have demonstrated the quality of groundwater. The physical properties such as pH reveals a range from 6.20 to 7.60, specific conductivity ranges from 240 to 2480mhos/cm at 25°C and chemical properties include the determination of calcium (210 to 610mgl), potassium (0.12 to 3.24mgl), sodium (1.00 to 10.48mgl), magnesium (2.06 to 6.44mgl), C03" (0.08 to 0.58mgl), HC03" (1.03 to 8.59mgl), Sulphate (1.00 to 4.88mgl), and Chloride (1.02 to 19.88mgl). The ground water quality information maps of the entire study area have been prepared using GIS technique for all the above parameters. The results obtained in this study and the spatial database established in GIS will be helpful for monitoring and managing ground water pollution in the study area.
The result demonstrate the role of chemical weathering causing water chemistry to remain unchanged in trappean area whereas the alluvial zone shows definite change in chemistry due to salinity problem .The variation of PH and TDS is controlled by lithology and climate. Chemical weathering plays major role in controlling water chemistry in the downstream temperate area. It has been observed that the presence of poor water quality in the Northern saline tract of the alluvial zone which is not suitable for drinking and irrigation purposes .Whereas, the trappean region shows fair to excellent quality for groundwater. In the study area the highly fractured, weathered and jointed horizons of Deccan trap have maximum yielded amount of water. The area of investigation is characterized by the presence of multiple aquifer system showing productive and unproductive zones due to the presence of alternating massive and vesicular units with lateral variation. The depth to water level studies will indicate distinct zones and influence by irrigation methods showing recharge of groundwater table. The groundwater level fluctuation mainly depends on the difference in water levels of pre-monsoon periods, which can be directly linked, to recharge and discharge of groundwater. Geochemical studies lead to a logical conclusion that theses process are influenced by regional environmental set up in general and particular geology of the area. In this study an attempt has been made to understand the groundwater quality mapping of the study area by preparing various water quality maps using remote sensing and GIS techniques.

Key Words: *Groundwater, Surfer 10.1, Water quality, GPS and GIS.*

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I. INTRODUCTION

In groundwater development, the chemical quality of groundwater bears equal importance with its quantity. As word population growth continue and modern industrial and agricultural processes introduced an increasingly a complex suite of chemical constituent into the environment, scientist have begun to take a serious look at their effect on surface and groundwater quality. The groundwater quality is influenced both by surface physical environment and by the environment where recharge takes place. The chemical quality of groundwater depends most on composition of the host rock and also depends on the location of sources and state of environment protection in high content of total soils like fluorides, iron, and manganese are the special characteristics of some ground water acquired through geo contamination and sea water intrusion. The quality is directly subjected to the degree of weathering, movement of groundwater, individual ion-contents and ion-exchange, climate and to time variation in the process of recharge and discharge. In arid and semi-arid areas, groundwater is considered as the major source of usable water, so that quality of water is the main key factor in management of groundwater in a sustainable manner. In the past few decades, reports of ground water contamination have increased public concern about ground water quality. Subsurface leaching of contaminants from land-fills as well as seepage from canals, rivers and drains cause severe degradation of the ground water quality. Adsorption and dispersion processes in the soil zone, degrees of evaporation, recharge and lateral inter-mixing of ground water determine the level of contaminations in ground water. Exploitation of vital ground water source leads to lowering of the ground water table and water quality deterioration. The groundwater pollution in different countries was mainly due to lack of proper waste management. Groundwater quality assessment through various graphical methods and interpreted different indices were attempted by many workers in the recent past (Elango, (2003), Singh. (2008); Raju J.(2007). Geochemical processes are responsible for the seasonal and spatial variations in groundwater quality integrated groundwater geochemistry and cartography using GIS techniques. GIS is a powerful tool to assess the groundwater quality, determining the availability of water, pre-venting flooding, understanding the natural environment and man-aging water resources on a local as well as regional scale studied the effects of land use on temporal changes in well water quality.

II. STUDY AREA

The study area, Katepurna River basin is located within the Akola district of Maharashtra covered under the Survey of India toposheet nos.55H/2, H/3, H/5 and H/6 and bounded by latitude 20° 25" - 20°47" 50' and longitude 77° - 77° 25". The Akola district falls in the western part of Vidarbha region and it is bounded byAmravati in the East, Washim in the South and Buldhana in the West (Fig. 1

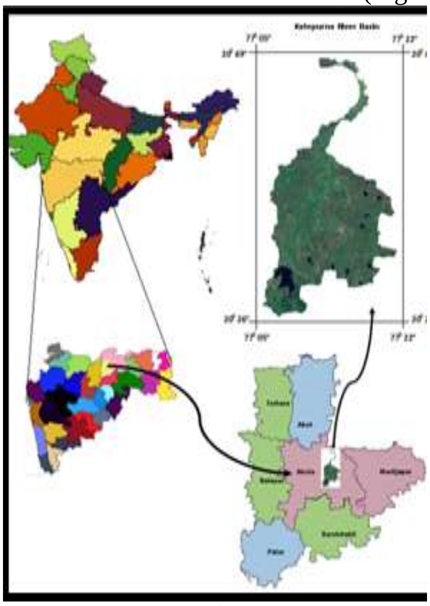

Figure1. Location map of the study area

Figure 2. Water sample location map of study area

Table I. Chemical analysis of ground water sample of the study area for the year 2010 (Pre-monsoon)

Sr No	Village	Tur.	pH	E.C. uS/cm	TDS (mg/l)	T.H.	Ca(mg/l)
1	Bhatori	1	7.1	3980	2620	651	50
2	Datala	1	6.8	1329	864	1996	50
3	Jambhakh.	3	7.2	1540	1010	720	122
4	Atkali	1	6.7	960	630	600	72
5	Akhatwada	1	7.3	403	274	420	15.2
6	Gazipurtakli	2	6.8	998	599	140	18
7	Khadka	1	7.1	1344	874	232	19
8	Pailpada	2	7.2	615	399	328	15.2
9	kurankhed	1	7.1	388	252	184	16
10	Dhaga	2	7.1	975	585	372	22
11	Nipana	1	6.9	388	252	184	16
12	Kothari	2	7.3	2100	1365	240	13
13	Tamshi	1	7.1	1044	626	428	16
14	Dodki	3	7.2	697	418	364	26
15	Sukli	2	7.1	693	415	364	16
16	Sonala	1	6.9	1207	785	500	36
17	Yelwan	1	7.1	2100	1365	240	13
18	Paranda	1	7.1	369	237	324	33.6
19	Kanshivani	1	7.2	717	466	260	36
20	pardi	2	7.1	779	467	404	45
21	Borgaonkh.	3	7.3	419	251	300	28
22	Kahala	1	7.2	504	302	164	18
23	PaturNandpur	1	7.2	347	208	228	19
24	Sonkhas	3	7.5	720	480	248	47.6
25	MozariKh.	1	7.1	372	223	260	20
26	Ghota	2	7.3	810	510	380	19
27	Parabhavani	2	7.2	779	467	404	45
28	Kasarkhed	2	7.3	568	341	300	27
29	Donad	2	7.4	681	408	384	27
30	Warkhed	2	7.7	3760	2256	932	94
31	Kajaleshwar	2	6.9	425	255	344	22
32	Ujaleshwar	3	7.3	665	399	320	22
33	Valpi	2	7.4	1203	781	420	40
34	BhendiMahal	1	7.1	640	416	224	50
35	BhendiKazi	1	6.8	480	312	180	16
36	Kherdabk	1	7.2	810	486	472	34
37	Nimbi Bk.	2	7.2	779	467	404	45
38	Vadgaon	2	7.6	419	251	300	28
39	Pinjar	1	7.1	648	388	430	46
40	Umbardari	1	7.1	810	486	472	34
41	Januna	2	7.2	504	302	164	18
42	Jankeshivni	3	7.2	347	208	228	19
43	Mahan	2	7.3	720	480	248	47.6
44	Zodga	2	7.1	372	223	260	20
45	Sarkinhi	1	7.4	810	510	380	19
46	Khopdi	1	7.2	779	467	404	45
47	Vastapur	2	7.3	1203	781	420	40
48	Wagha bk.	1	7.1	1136	751	340	19
49	Kinkhed	1	7.1	1028	675	420	19
50	Hatola	1	7.2	681	408	384	27
51	Pimpalgaon	2	7.3	1045	686	260	20
52	Tembhi	1	7.2	920	607	252	29
53	Anjanikh.	1	7.1	810	538	236	36
54	Nasirabad	1	7.1	720	480	248	47.6
55	MozariKh.	2	7.2	504	302	164	18
56	Devdari	1	7.2	3070	1842	2000	26
57	Rahit	2	6.9	3070	1842	2000	26
58	Lakhmapur	3	7.5	779	467	404	45

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III. PARAMETER FOR ANALYSIS OF GROUND WATER

A. *Turbidity*

The suspended matter in water interfering with passage of light is called as turbidity. Turbidity may be caused by a wide variety of suspended matter which ranges in size from colloidal to course dispersion, depending upon the degree of turbulence. Turbidity natural water is caused by clay, silt, organic matter and partially hydrolyzed metals. Phytoplankton and other microscopic origination Jackson and Nephelo metric turbid meter are generally used to measure turbidity of water.

B. *Total dissolved solids (TDS)*

Total dissolved solids are obtained by weighing the residue after a sample of water has evaporated. It is the concentration of non-volatile substances present in the water in colloidal and molecular dispersed state, as a result of movement of water on or below the ground surface. This is an important parameter for the analysis of coastal, marine, lake, saline water, if TDS value is high than the PPT instead of PPM.Basically, it is depends on the concentration of NaCl, which in turn determine the conductivity which has bearing on TDS. The observation of the TDS in study area ranges between 208 to 2620 for Pre-monsoon 2010 in Fig.3.

C. *pH*

All liquid of which water is constitute contained free positively charged hydrogen (H^+) ion and negatively hydroxyl ion (OH^-) in varying and related proportion. Scholeller, H. (1967)suggested a method of expressing the concentration of ionized hydrogen which is called as the pH value. The hydrogen ion concentration (pH) is important quality parameter of natural water the pH of natural water usually lies in range of 6.0 to 8.5. The pH value of value of natural water changes due to biological activity, temperature and disposal of industrial wastes, acid mine drainage wastes. The observation of the pH value in study area ranges between 6.90 to 8.40 for Pre-monsoon pH distribution map (Fig. 4) indicates the high pH distribution towards the central and lower value observed towards western part of the study area. The stacked pH plots of water samples range in the study area for the year 2010 (Pre Monsoon).

D. *Electrical conductivity (E.C.)*

The electrical conductivity is a total parameter for dissolved ad dissociated substances. It value depends on the concentration and degree of dissociation of the ion as well as the temperature and migration velocity of the ion in electrified. The electrical conductivity indicates the concentration of dissolved electrolytes present. In water, but does not give an idea about the types of ion being present. Another important point is that only ions can carry current. EC are as in Fig.5(Wilcox 1955).

Table II. EC Distribution Value.

EC x 10^6 us/emat 25°C	**Water quality**
< 250	Excellent
250 – 750	Good
750 – 2000	Permissible
2000 – 3000	Doubtful
> 3000	Unsuitable

IV. Chemical parameters:

A. *Calcium (Ca)*

It is one of the alkaline earth metals and widely distributed in earth crust and all way abundant present as a cation in ground water. In the presence of CO_2, Calcium bicarbonates can normally be dissolved up to 20 ppm at atmospheric pressure and up to 100 ppm at higher pressure; the concentration may higher in water coming from limestone zone. The values of calcium in water sample of study area are equalized by chemical analysis. The observation of the Ca value in study area ranges between 12.80 to 122.40, for Pre-monsoon 2010 Ca distribution map (Fig.6) indicates the high Ca distribution towards the eastern and lower value observed towards western part of the study area.

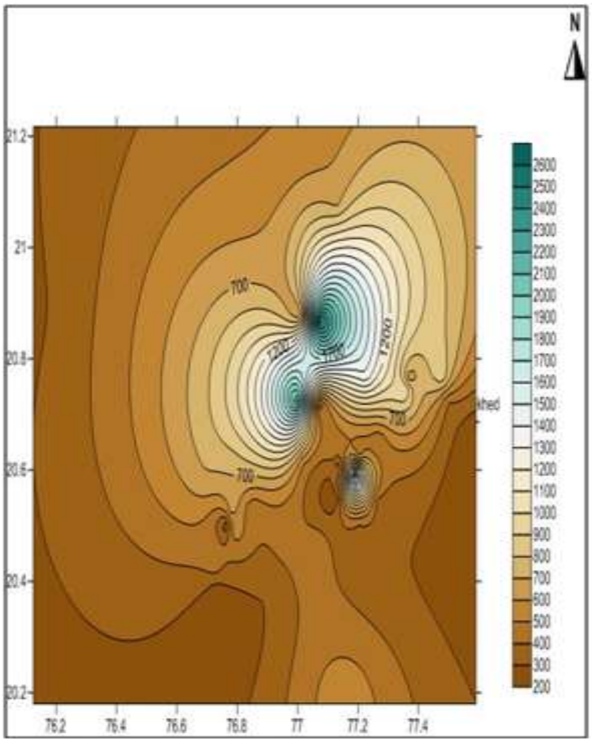

Figure 3. Total dissolved solid distribution map of the study area for the year Pre monsoon 2010.

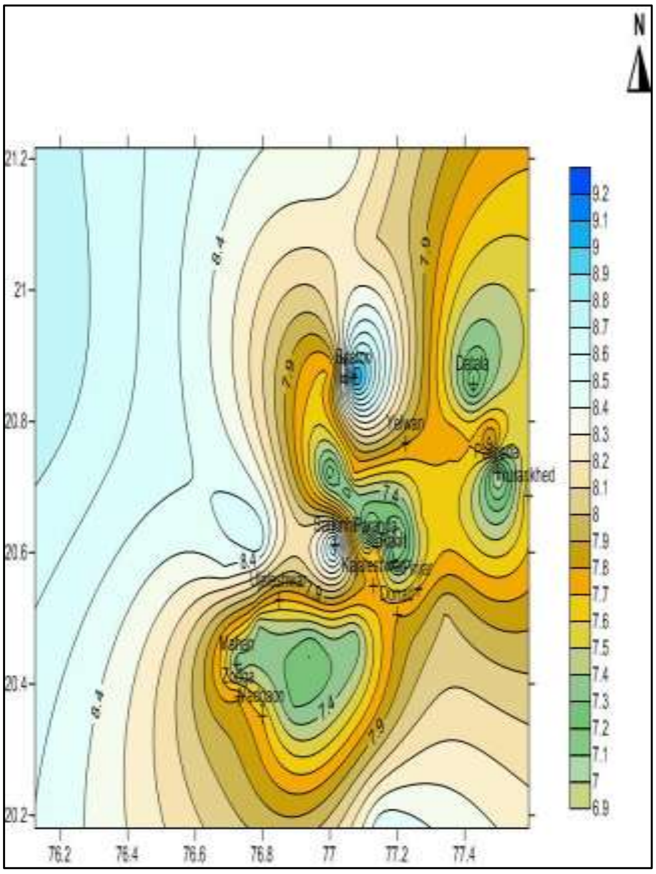

Figure4. pH distribution map of the study area for the year Pre monsoon 2010.

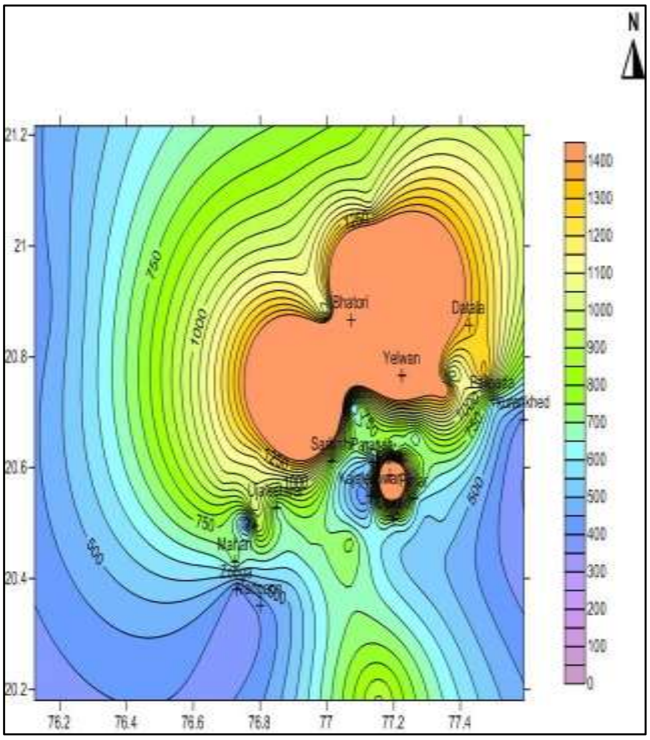

Figure 5. Electric conductivity (EC)Distribution map of thestudy area for the year Pre monsoon 2010.

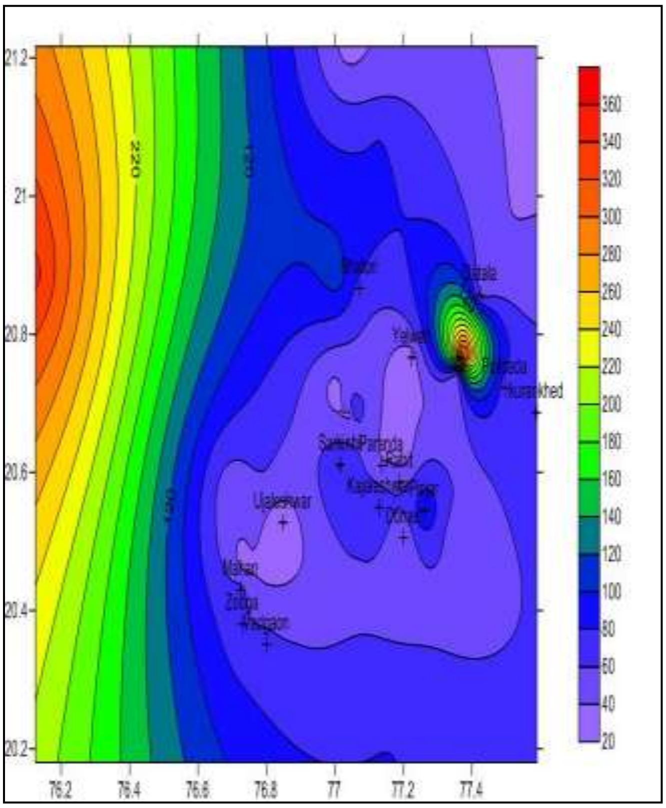

Figure 6. Calcium (Ca) Distribution map of thestudy area for the year Pre monsoon 2010.

V. Hydro-geochemical characteristics of groundwater

The piper diagram (Piper 1944) is an effective tool toevaluate the hydro-geochemical parameters of groundwaterby plotting the concentration of major ions in the piperdiagram. The diagram has two triangular fields and a diamond-shaped field. Different types of groundwater can beidentified by their position in the diamond field. The cationsexpressed as percentage of total cations in meq/l as asingle point on the left triangle, while anions are plotted onthe right triangle. Distinct groundwater qualities can be quickly distinguished by their plotting in certain areas of the diamond field. The analytical value obtained from the groundwater is plotted on piper diagram to understand the hydro-geochemical regime of the study area. The diagram can evaluate the hydrochemistry of groundwater with the help of Aqua chem. 4.0 software. According to Appelo and Postma (1996), dominant water types like Na–Cl and Ca– Cl indicate the seawater intrusion process. Groundwater contamination in an urban environment is a major issue especially in coastal urban areas (Ballukraya and Ravi (1998),Venugopal(2009),Arunprakash(2013), Various statistical analyses including multivariate analysis and principal component analysis are used to interpret the hydro-geological and suitability of groundwater (Vasanthavigar,(2010); Krishna Kumar(2011),Magesh,(2012).

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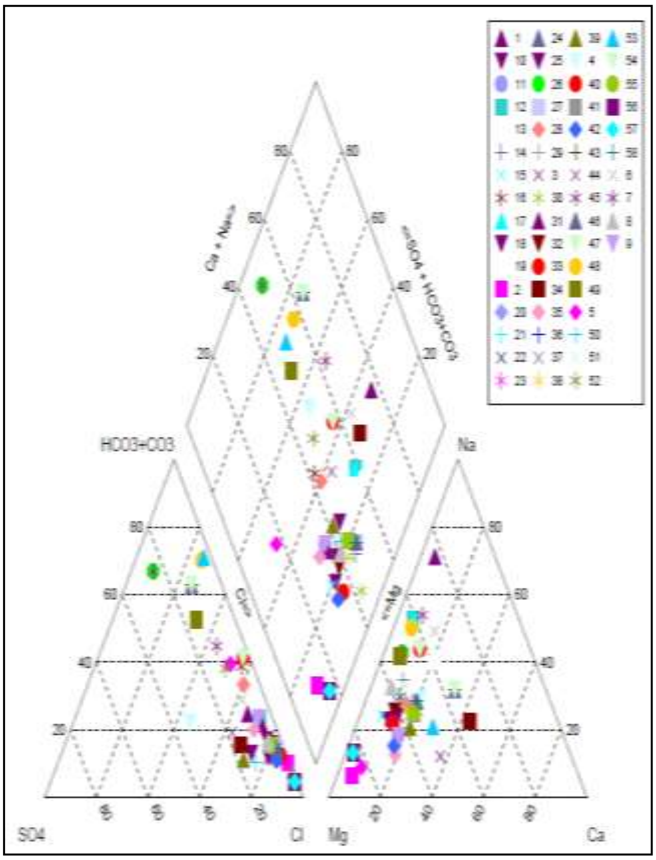

Figure 7. Piper Trilinear diagram of water samples in the study area for the year 2010 (Pre Monsoon)

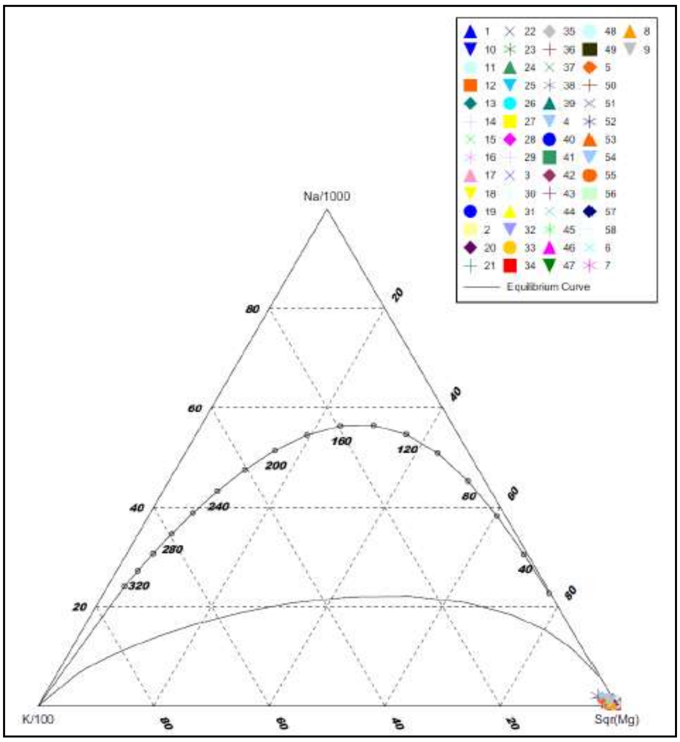

Figure 8. Giggenbach Triangle diagram of water samples in the study area for the year 2010 (Pre Monsoon)

VI. CONCLUSION

The present study will certainly help not only to improve the groundwater resource assessment management but also useful to achieve social, economic and environmental benefits to support governance and policy. The results have shown that the sub-basin area has undergone significant amount of quality deterioration which requires immediate attention on sustainable groundwater management. The spatial distribution maps generated for various physicochemical parameters using interpolation techniques could be useful for planners and decision makers for initiating groundwater quality development in the area.A procedure that integrates the traditional groundwater sampling analysis methods and GIS capabilities combined with conditional overlaying techniques was adapted in order to locate the suitable areas at the lower part of basin groundwater aquifer for drinking purposes. All analytical results compared with WHO, BIS standards and classified as desirable and undesirable groundwater in both seasons.The results demonstrate that the alluvial zone showing doubtful quality of groundwater, which is not suitable for drinking purpose in the northern most part of the study area with the gradual reduction of EC values towards south. It is interesting to note that none of the samples analysed shows EC values > 3000 which indicates that the rate of salinity is not very high in this region. This proves that the salinity of the alluvial zone of the Katepurna river basin is in the lower range which can be removed by employing suitable recharge methods and also by pumping the saline water into the Purna River during rainy season when most of the water goes as runoff.

In the present study the GIS technique has successfullydemonstrated its capability in groundwater quality mapping. The integrated GIS study resulted in the development of an efficient and effective methodology of spatial data management and manipulation. The integration and analysis of various thematic maps and image data proved useful for the groundwater quality zones suitable for domestic purposes. The final output has given the pictorial representation of groundwater quality suitable or unsuitable for drinking and irrigation purposes in the watershed.This study can offer the requisite information for the authority to pursue the sustainable approaches on groundwater management and also to propose remedial measures for the removal of contamination along with prevention.

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