Future Groundwater Disaster:A Case Study Of Kolhapur District

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Abstract:
Groundwater has great value for its economic, social and environmental uses i.e. potable water, water supply system, agriculture, industry, and recreation. Water plays important role in the ecosystems at the surface and below ground levels. In dry periods groundwater maintains surface water ecosystems. Groundwater and surface water are interlinked with each other where the impact on one can lead to the change in the quality or quantity of other. Hence, protection of groundwater should be as rigorous as that of surface water. In recent years in India, there are more issues than ever before relating to groundwater contamination as a result of pollution from natural (geogenic) and human activities.

In Kolhapur district along with surface water, groundwater resource is used for drinking, irrigation as well as industrial purposes. The rapid growth in population, agriculture, urbanization, industrialization and developmental activities in the district are responsible for decline in quality, depletion of quantity and availability of the vital ground water resource. The major anthropogenic causes of groundwater pollution are attributed to domestic sewage intrusion, leaching from solid waste surface dumps, and agro-chemical runoff. Ground water pollution leads to negative effect on ground water uses and recovery of deteriorated ground water is one of the most difficult or impossible tasks to avoid the further negative impacts on ecology and life.

The likely disaster in Kolhapur district due to ground water conditions is discussed in the paper based on the present trends of pollution, local ground water conditions, demand and availability of ground water and future scenarios.

Keywords: - Ground water pollution, anthropogenic effects, quality degradation and disaster.

Introduction:

In recent decades groundwater has become the most important natural resources in most countries of the world. For water supply purpose groundwater has a number of essential advantages when compared with surface water because of its higher quality, and protection from possible contamination including infection, it is less subjected to seasonal, perennial fluctuations, and more uniformly spread over large area than surface water (UNESCO, 2004). Importance of ground water resource has been endorsed by many researchers. Groundwater is an important water resource in India for domestic, irrigation, and industrial needs (Mamatha and Rao, 2010). According to Jha and Sinha, (2009) groundwater has come out into view as the primary democratic water source and poverty reduction tool in rural areas in countries like India. As human's dependence on groundwater increases, its quality becomes an ever more important issue (Veronica and Ruth, 1983). The environmental impact of anthropogenic activity on the groundwater is considered as one of the major hazards in the modern days. Rapid urbanization and increased agricultural activities has resulted in the degradation of the water quality (Venugopal, *et al.;* 2009, Dragon, 2008).

In the recent years there is significant decline in the below ground water levels in many parts of Maharashtra. During pre monsoon of year 2009, water levels recorded in many parts in the state are mostly in the range of 5-10 mbgl [meter below ground level] except western Maharashtra where water level is generally less than 5 mbgl. However, during August 2009 water level recorded was mostly in the range of 2-5 mbgl except western Maharashtra where water level was generally less than 2 mbgl. And during post monsoon in the western parts of the country deeper water level is recorded in the range of 10-20 mbgl. In the west coast water level is generally less than 10 m than in western parts of Maharashtra. During January 2010 in western parts of the state isolated pockets of water level, less than 2 m, has also been observed. In the state ground water development was 48 % only. In Maharashtra out of 318 total numbers of assessed units 23 are semi-critical, 1 was exploited and 7 are over exploited. During years 2009 and 2010 in the 756 Wells analyzed and depths to water level (mbgl) were found to be 0.35 minimum and 55.30 maximum (May 2009), 0.01 minimum and 27.90 maximum (August 2009), 0.05 minimum and 55.40 maximum (November 2009), and 57.38 maximum during January 2010 (Central Ground Water Board, Ministry of Water Resources Government of India, Faridabad, 2010). According to the Agriculture Contingency Plan of Kolhapur District, 65% of ground water of Kolhapur District is exploited (Source:-Agriculture Contingency Plan for Kolhapur District-http://www.crida.in/cp-2012/).

According to the Central Ground Water Board, Ministry of Water Resources, Government of India agency the ground water in 7 Tahsils in the state are over exploited, 1 Tahsil is critical and 23 Tahsils are Semi- critical. Salinity affected Districts (in part) are 6, Fluoride (>1.5 mg/l) affected districts (in part) are 8, Iron (>1.0 mg/l) affected districts (in part) are 20, Nitrate (>45 mg/l) affected districts (in part) are 29 (http://cgwb.gov.in). According to Shankar, *et al.;* (2011) in Maharashtra at least one of the three most serious quality problems are related to arsenic or fluoride or salinity and nitrate pollution is becoming more prevalent in ground water. The studies carried-out by GSDA and CGWB during the period 2007-2009 revealed that 87 Tahsils in 21 districts have shown nitrate levels above desirable limits all the times. Groundwater within 30 Tahsils in 17 Districts shows total hardness exceeding the permissible limits (600mg/l) all the times. The groundwater quality showed that within 7 Tahsils in 4 districts has Fluoride levels above permissible limits of 1.5 mg/l, TDS in 6 Tahsils of 5 districts of Maharashtra show total exceedance of permissible limit and pH in 2 Tahsils of 2 districts of Maharashtra also shows total non compliance of BIS standard of 6.5-8.5 mg/l. According to the Central Ground Water Board, Ministry of Water Resources, Government of India (http://cgwb.gov.in) Kolhapur district has ground water quality problems related to contamination of ground water from Iron that is greater than 1.0 mg/l. According to the Das and Panchal, (2006) out of 12 tahsils of Kolhapur district 2 tahsils were affected by Fluoride and 2 tahsils were affected by TDS.

Kolhapur district has varied hydro geological and geomorphologic characteristics and hence the ground water potentials within district differ from place to place. Increasing urbanization and growing dependence on groundwater for irrigation and industry has called for judicious and planned exploitation of the groundwater resources. For proper planning and management of groundwater development quantification of groundwater resources is one of the most important prerequisites. This is a general statement.

Material and Methods:-

Study area:

Location of Kolhapur District is 16^{0}42" North 74^{0}15" East on the North West plateau of Maharashtra. The district is surrounded by the steep ridges of Sahyadri to the west, the Deccan plateau on the east, and boundaries of Goa on the south and Karnataka on east. The area of the district is 7746 sq. km. and it is 2-5% of the state area (Collector, Kolhapur District, 2012). The type of rock pattern in the district is weathered basalt having 10 to 34 % porosity, specific yield 2 to 6 %, Transsmissivity 100 to 140 m^2 / day, specific capacity of wells 80 to 170 LPM /m (Deolankar, 1980). Geology of the Kolhapur district two distinct trends in the hill ranges are seen in the district. One runs roughly north-south, along the main range of the Western Ghats presenting wild and picturesque hill slopes and valleys. The other one comprises the narrow broken-crested ridges and flat topped masses stretching eastwards and merging gradually into the plains in the east. The rivers Hiranyakeshi, Vedganga, Dudhganga, Bhogvati and Panchganga drain the area towards east.

Sr. No.	Geological formations	Antiquity
1.	Soil and Laterite	Recent and Sub-Recent.
2.	Deccan trap	Lower Eocene.
3.	Lower Kaladgi Series	Cuddapah.
4.	Granite-gneiss	Dharwars Archaean.

Table 1 The geological formations met with, in the descending order of their antiquity.

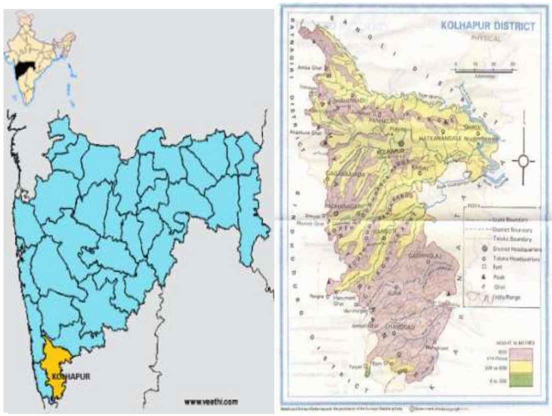
Water Supply in the Kolhapur district may be divided into three belts as regards its water supply, viz. the hilly and rugged country forming the Western Ghats towards west, the narrow broken-crested ridges stretching eastwards in the central portion, and the plains towards east. The hilly country in the west receives the maximum rain-fall of the district and the ground water is mostly tapped from percolation wells and mountain springs. In the Central portion the water supply is partly from springs and wells, the main source being the five perennial rivers (Source:- Water Supply and Sanitation Department, Government of Maharashtra, Ground water and development Agency, Pune-http://mahagsda.org/gsda/web/kolhapur.html).

Kolhapur District receives average rainfall of 1019.5 mm with 65 normal rainy days out of which the district receives normal rainfall of 809 mm during SW Monsoon (June to September) in 54 normal rainy days. The SW monsoon normally has period of onsets in 2nd week of June and normal cessation period of 2nd week of October. Also Kolhapur district receives rainfall 137.7 mm during NE Monsoon (October to December) in 8 normal rainy days. And in midsummer season (March to May) Kolhapur district receives 65.2 normal rainfalls in 3 normal rainy days. Kolhapur district has 172400 hector of Shallow laterite soils, 151500 hector of deep brownish soils and 102900 hector of Medium deep black soils.

Sr. No.	Land use pattern of the district (latest statistics)	Area ('000 ha)
1	Geographical Area	776.3
2	Cultivable area	427.0
3	Forest area	147.2
4	Land under nonagricultural use	36.4
5	Permanent pastures	41.6
6	Cultivable wasteland	36.4
7	Land under Misc. tree crops and groves	6.4
8	Barren and uncultivable land	44.1
9	Current fallows	12.6
10	Other fallows	24.6

Table 2 Land use pattern of the Kolhapur district (Source: - Agriculture Contingency Plan for District: Kolhapur)

The population of Kolhapur district has increased up to 38, 74,015 in 2011 which are 9.96 percent increase in the population above 2001, having density of 504 individuals per square km (Census, 2011). Total crop area under agriculture is Kharif – 376600, Ha Rabi - 34900 Ha (http://kolhapur.nic.in). There are 13 MIDC's in the district with 3928 industries (390 red type industries, 406 Orange type industries and 3132 green industries). In sub-region Kolhapur predominantly large number of sugar, distillery, small foundries and cloth processing industries are in existence. Among them the major industries are 21 spinning mills - co-operative and private, 21 textile mills and 15 sugar industries. Remaining 53 units are of engineering, foundry, chemical, poultry, and animal food etc. There are 2 existing industrial areas MIDC (Maharashtra Industrial Development Corporation) areas are and 4 more are proposed. Total of 1207 units are functioning in these two existing MIDC Areas and total of 7 industries estates have been approved by the Government for cooperation sector (http://kolhapur.nic.in/Htmldocs/industries.htm). In 13 MIDC, s total effluent generated is 194.71 MLD. In the district there is 1 Municipal Corporation and 9 Municipal Councils. The total effluent (m^3/d) and solid waste (MT/d) generated by Kolhapur Municipal Corporation was 85,000 and 150, Ichalkaranji 40,000 and 52, Kurundwad 750 and 2.8 respectively (MPCB, 2006).



Source-http://www.veethi.com/ Source-http://kolhapur.nic.in/

Figure 1 Location and Physical map of Kolhapur district

Methodology:

To know the present status of groundwater in the study area, secondary data related to Kolhapur district such as population, number of industries, different uses of ground water, groundwater level , ground water quality was collected from various Government departments such as Maharashtra Pollution Control Board (MPCB), Groundwater Survey and Development Agency (GSDA), Central Ground Water Board, Ministry of Water Resources Government of India, Kolhapur Collector office, Kolhapur Zilha Parishad, Kolhapur Municipal Corporation, and various research papers related to ground water in Kolhapur district. In addition personal observations were made related to ground water in the district. On the Basis of review of literature and personal observations the paper attempts to make predictions of future threats to ground water.

Results and Discussion:

Overexploitation on groundwater:

Overexploitation on groundwater i.e. excessive withdrawal beyond the normal recharge in any given area creates many harmful effects which could be identified as; continuous lowering of water levels, lowering of pump sets, causing low efficiency, higher cost of operation, reduction of yields of wells, well interference due to close spacing of wells, severe drinking water scarcity in summer months, deepening of wells and increase in cost of ground water extraction, damage to aquifers due to compaction, risk of ground subsidence due to inter-relationship between withdrawal and downward trend in water levels due to overdraft conditions, Total collapse of operation and management system of groundwater resource of the basin or watershed and disturbed planned and sustained development and regulatory system in the area (Shaji, 2011). The advent of high speed drilling rigs specially the down-the-hole hammer rigs, with their capacity to construct bore wells in shorted possible time and at relatively low cost is very common. Mushrooming of drilling contractors to complete the job instantaneously has resulted in excessive exploitation of ground water with deleterious effect on the sources. This has had tragic consequence on availability of ground water for meeting the subsistence needs of bulk of the rural population. The consequences are the most pronounced in the Kolhapur districts where these commercial crops dominate (http://publications.iwmi.org/).

Declines in groundwater levels:

Widespread and continuous depletion of groundwater tables in many areas in Maharashtra has become a cause of major concern over the past 10 years, The developmental sequence for groundwater observed since the mid-1980 decade has been; most dug wells drying-up ever earlier in the dry (rabi) season initially those at the margins of the main groundwater bodies, deepening of dug wells as dug-cum-bore wells, (Foster, *et al.*; 2007). According to the ground water survey in the major portion of Kolhapur district there were about 0-1 meter decrease in the ground water level. Kolhapur is included in list of districts in India which experience a drop in ground water level of over 4 meters for 20 year period or a drop of over 2 meters over a ten year period (Centre for Water Policy, 2005). It is revealed from a survey of open wells from Kolhapur city by Patil and Raut, (2010), that more than 200 wells were present in Kolhapur city in the recent past, but now most of them are either destroyed or not in good condition. Increase in population, urbanization and industrialization has created unhygienic conditions enhancing the problem of these water resources. The current use of wells is as waste dumping sites. Considering rapid expansion of Kolhapur city and other cities and towns in the district for the future demand of water, old wells once used for water supply will need to be rejuvenated. Changing ground water levels in the past five years at some of the identified sites in Kolhapur district are given in Table 3.

Sr.No.	Location	2007	2008	2009	2010	2011
1	Patne	6.84	7.05	6.95	6.12	6.46
2	Karve	5.38	7.75	6.71	4.7	6.13
3	Naganwadi	4.85	4.43	3.64	3.47	4.02
4	Nesari	1.4	1.67	2.12	1.8	2.33
6	Ajra	8.84	9.16	8.6	7.78	8.63
7	Halkarne	5.09	4.56	4.44	4.06	4.62
8	Nitawade	9.96	8.21	10.11	10.02	9.41
9	Gadihinglaj	1.16	1.73	1.28	1.3	0.99
10	Authur	6.2	5.95	4.03	3.66	4.07
11	Pimpalgaon	3.25	3.34	3.19	2.96	2.76
12	Murgud	0.22	4.12	0.87	0.55	1.14
13	Radhanagari	4.99	5.93	4.68	4.66	4.2
14	Surupali	2.7	2.06	2.6	2.77	2.23
15	Solankur	3.42	4.04	5.84	1.06	0.55
16	Shelewadi	6.48	3.73	5.42	3.96	1.68
17	Aslaj	5.97	6.85	5.45	5.57	5.29
18	Washi	4.94	3.66	4.34	3.61	4.26
19	Gokul shirgaon	1.05	0.59	2.05	1.01	0.65
20	Shiradwad	6.54	8.42	6.14	5.38	6.93
21	Partangale	1.32	1.96	1.71	1.5	1.32
22	Khupire	0.35	0.17	0.6	1.47	0.75
23	Shiroli	4.84	5.76	5.1	5.31	5.63
24	Korochi	1.27	2.21	2.68	0.29	4.41
25	Pimpli Tarf Thane	0.6	2.47	0.57	0.6	0.87
26	Panhala	8.86	10.08	5.65	1.35	1.13
27	Paijarwadi	5.42	6.14	5.1	1.26	2.73
28	Kini wathar	6.5	7.68	6.32	5.42	6.89
29	Amba	5.26	5.11	4.44	4.92	4.98

Table No.3 Ground water level in the Kolhapur district at selected location

From the above table No 3 it is clear that there were fluctuations in ground water level during years 2007 to 2011. There was slight increase in the values at some sites (Karve, Nesari, Murgud, Shirwad, Partangale, Shiroli, Korochi, Pimpli Tarf Thane, Kini Wathar) and other sites (Patane, Naganwadi, Ajara, Halkarne, Nitawade, Gadhingalaj, Authur, Pimpalgaon, Radhanagari, Surupali, Solankur, Shelewadi, Aslaj, Washi, Panhala, Paijarwadi, Amba) of Kolhapur district had declining trends of water level as compared to the previous year's. This shows general declining trend in ground water level in Kolhapur district. The major factors responsible for this decline are change in land use pattern, agriculture expansion, increasing population, urbanization and industrialization casing stress on these ground water resource in the Kolhapur district

Problem associated with surface water and quarries:

According to Winter, *et al.;* (1998) the flow between ground water and surface water creates a dynamic habitat for aquatic fauna near the interface determining the contributions of ground water to contamination of lakes and streams is a critical step in developing effective water-management practices. Poor quality of river water, because of the vigorous exchange, can be the source of pollutants in groundwater, and vice versa (Yoneda, *et al.;* 2001). For example, Squillace and Thurman, (1992) estimated the effects of groundwater on agricultural chemicals in a river, and Driescher and Gelbrecht, (1993) studied the effects of groundwater on the phosphorus pollution of surface water.

Water bodies in Kolhapur city are exhibiting varying degrees of environmental degradation caused by enrichments of nutrients from domestic and industrial effluents leading to eutrophication and siltation. Human settlements and public effluent sources are the chief factors for degradation of lakes (Kolhapur Municipal Corporation, 2009). The intensity of water pollution has very deteriorated in Kotitirth, Lakshatirth, and followed by Rankala (Pawar, 2012). The presence of algal bloom of *M. aeruginosa* in some reservoirs of Kolhapur (Rankala, Kotitirth, Rajaram and Shivaji University tank No. 3) indicates the eutrophication of these reservoirs and stands as a sign of declining the wealth of these reservoirs. Occurrence of *M. aeruginosa* blooms in some reservoirs of Kolhapur district is a striking feature (Gaikwad, *et al.;* 2013). Panchganga river is among the major river in the Kolhapur district. Increased developmental activities due to urbanization and industrialization are greatly responsible for water pollution in Kolhapur city (Thorvat, *et al.;* 2012). The river Panchganga is a highly contaminated downstream with untreated sewage and industrial effluents, while flowing through Kolhapur city. The high value of CO_2, BOD, COD, phosphate, nitrate, Zn, Fe, Cu and low value of DO at discharge zone indicates increase in organic pollution as we go down the river (Mulani, *et al.;* 2009). Other rivers in Kolhapur district also have threat of pollution due to various sources in their basin for example Chloride is little higher in summer of 2008 and 2009 of Tambraparni River at Kowad, indicating a lot of anthropogenic activities (Hiramani and Sunkad, 2011).

Quality deterioration:

Ground water pollution occurs widely from land use changes, such as the vegetation clearing, groundwater over abstraction or excavation below the water table, may also contribute significantly to groundwater pollution (Tredoux, *et al.;* 2004). Pollution of groundwater due to external contaminants such as industrial urban and agricultural practices is influenced by number of factors like geology, soil, weathering, growth of industries, emission of pollutants, sewage disposal, and other environmental conditions, with which it alters from point of its entry to exit (Srinivasamoorthy, *et al.;* 2011). Ground water of Kolhapur district is affected by excess of nitrates- over 45 mg/l (Centre for Water Policy, 2005).

Sr. No.	Site Name	Mg	pH	NO3	K	SO_4	EC	TDS	Ca	Na	CO_3	HCO_3	Cl	F	SAR	RSC
1	Surute	3.66	7.2	4	1	0	105	55	10	5	0	49	7	0	0	0
2	Patne	3.65	6.9	5	1	3	70	39	4	4	0	31	4	0	0	0.01
3	Karve	8.53	7.2	19	1	0.1	210	116	16	12	0	55	32	0	1	-0.6
4	Naganwadi	6.09	7.1	2	0	0.1	100	49	6	4	0	49	7	0	0	0
5	Nesari	8.53	7.5	3	7	15	320	176	20	28	0	85	53	0	1	-0.3
6	Ajra	15.8	7.1	79	31	18	490	312	30	26	0	104	60	0	1	-1.1
7	Gadinglaj	46.2	8.2	3	3	11	780	398	40	48	0	317	89	0	1	-0.6
8	Authur	36.6	8	25	7	48	1040	571	90	60	0	207	202	0	1	-4.1
9	Pimpalgaon	20.8	7.7	25	4	16	640	340	70	20	0	268	50	0	1	-0.8
10	Murgud	23.2	8	9	6	10	740	388	58	52	0	268	96	0	1	-0.4
11	Radhanagari	12.2	7.9	25	9	18	370	213	32	17	0	122	3.9	0	1	-0.6
12	Khindi Varvade	9.75	7.5	6	1	6	240	125	22	8	0	116	14	0	0	0
13	Gagan bauda	3.66	7.2	1	0	1	100	49	10	3	0	49	7	0	0	0
14	Aslaj	1.22	6.9	6	1	0	50	28	4	3	0	18	4	0	0	0
15	Washi	24.4	8.1	15	1	13	500	254	40	16	0	226	32	0	0	-0.3
16	Shiradwad	52.4	7.9	48	1	86	1180	654	100	51	0	207	213	0	1	-5.9
17	Partangale	12.2	7.7	19	15	18	400	226	30	23	0	140	39	0	1	-0.2
18	Khupire	30.5	8.2	7	4	27	620	316	50	19	0	232	64	0	1	-1.2
19	Shiroli	39	8	47	0	24	680	360	44	25	0	256	53	0	1	-1.2
20	Undri	4.89	7.5	4	2	6	175	94	20	6	0	79	11	0	0	-0.1
21	Panhala	6.09	7.3	7	5	8	160	87	12	7	0	55	14	0	0	-0.2
22	Paijarwadi	8.53	7.5	1	0	2	185	92	18	5	0	85	14	0	0	-0.2
23	Kini wathar	56	7.7	7	1	64	1070	560	78	45	0	293	163	0	1	-3.7
24	Wadicharan	41.5	8.2	11	65	36	1440	782	110	88	0	573	145	0	2	0.49
25	Amba	2.45	7.5	1	0	1	120	64	12	5	0	54	7	0	0	0.08
	Standards	30	6.5-8.5	45	-	200	300	500	75	50	75	30	250	1	26	2.5

Table 4 Ground water quality at Various Locations in the Kolhapur District

(Source: - http://gis2.nic.in/cgwb/Gemsdata.aspx)

Where, Mg-Magnesium, NO_3- Nitrate K- Potassium, SO_4- Sulphate, EC- Electrical Conductivity, TDS-Total Dissolved Solids, Ca- Calcium, Na-Sodium, CO_3- Carbonate, HCO_3- Bicarbonate, Cl- Chloride, F- Fluoride, SAR- Sodium Absorption Ration and RSC – Residual Sodium Carbonate. Units of all the parameter are in mg/l except EC (ìS cm^{-1}), pH, Sodium Absorption Ratio and Residual Sodium Carbonate (epm).

[Standard Source:-WHO, (2006), Guidelines for drinking water quality" Geneva, Report No: WHO/SDE/WSH 06.07, Bureau of Indian Standard/Specification for Drinking Water (BIS: 105001991), Surface Water Quality Standards (as per IS: 2296), for SAR-US department of Agriculture and USSL classification for RSC (Sadashivaiah, *et al.;* 2008)].

From the Table No. 4 it shows ground water quality at 25 different locations in the Kolhapur district in that Bicarbonate and Electrical conductivity at many locations was well above the prescribed limit. Also there were at some locations Magnesium, Nitrate and TDS values were above the prescribed limit showing contamination of ground water in Kolhapur District. At many locations of in the district Nitrate above the prescribed standards (45 mg/lit) was found at locations as shown in following table 5.

Sr.No.	Location	Tahsils	Nitrate (mg/l)
1.	Ajara	Ajara	54
2.	Authur		50
3.	Pimpalgaon	Bhudargad	71
4.	Gadinglaj	Gadhinglaj	69
5.	Halkarne		320
6.	Nesari		71
7.	Kini wathar	Hatkanangle	53
8.	Shiroli	Karvir	60
9.	Pimpli Tarf Thane	Panhala	47
10.	Wadicharan	Shahuwadi	65

Table 5 Nitrate (>45 mg/l) in Ground Water in different parts of Kolhapur District.

(Source:-Central Ground Water Board, Ministry of Water Resources, 2011)

The parameters like pH, chloride, nitrate and iron, except fluoride in few of the sites in six villages of Hatkanangale Taluka, Kolhapur district, surpass the WHO, (2006) standards. This shows the ground water in the study area is slightly affected by pollutants, probably due to human interventions (Loni and Raut, 2012). Out of 51 samples in Ajara Tahsil of Kolhapur District , 8 samples exceeded the permissible limit WHO for DO, 3 samples fall under very hard category, total hardness above permissible limit (WHO) i. e. 300 mg/l (Jadhav, *et al.*; 2012).

In Kolhapur city and around area i.e. Bhavani Mandap in residential area, Shiroli in MIDC industrial area were most polluted sites and due to high concentration of heavy metal as well as other parameters the ground water is not potable as compared to standards of WHO (Salvi and Chavan, 2009). All the wells sampled in the in each ward of Kolhapur city showed fecal contamination so the water cannot be used for drinking purpose (Kolhapur Municipal Corporation, 2009). The water quality index for 15 samples in Kolhapur city ranged from 59.85 to 80.46. All samples exceeded water quality index value of 50, the upper limit for drinking water. About 60.24% of water samples are poor in quality and about 39.76% of water samples are very poor in quality as per water quality index. The analysis revealed that the groundwater of the area needs treatment before consumption. Bauxite mining is common in the hilly areas in Kolhapur district in the upper catchments of rivers. Similarly there are a large number of old and new stones quarry all around the city. Their impact on the mining activity ground water level, availability and quality needs to be further ascertained (Jagtap, 2010).

Impacts of groundwater contamination and pollution:

According to Balakrishnan, *et al.;* (2011) and Sustainable Sanitation Alliance, (2009) groundwater contamination can result in poor drinking water quality, loss of water supply, high costs of clean-up, high costs for alternative water supplies, and/or potential problems of health. A wide variety of materials have been identified as contaminants found in groundwater. These include synthetic hydrocarbons, organic chemicals, inorganic cations, inorganic anions, radionuclide and pathogens.

The belief that under all circumstances, ground water is safe is not true. The unscientific disposal of animal and human wastes is found to be the main anthropogenic activity that has led to the contamination of ground water with, nitrates, potassium, microorganisms etc. Seepage overflow into drinking water sources can cause disease from the ingestion of microorganisms such as E coli, Cryptosporidium, Giardia, Hepatitis A, and helminthes (Jain and Sharma, 2011). The Groundwater microbial contamination is a serious problem that can result in large outbreaks of waterborne disease (Keswick, *et al.;* 1980). Many studies have shown that anthropogenic activities, involving nitrogenous compounds such as mineral fertilizers and products of organic compounds from agriculture, cattle manure and septic systems, are the major factor leading to the increase of nitrate pollution (Rao, 2006). Nitrate pollution of groundwater has become a widespread problem which affects all countries regardless of their level of development (Colleen, 1993; Aghzar, *et al.*; 2002). Such situations may become worse in semi-arid and arid areas where water resources are recharged slowly, irrigation returns are re-used intensively and evaporation rates are high (Tagma, *et al.;* 2009). The negative impacts of poor quality of potable water on human health are summarized in Table No 6.

Sr. No.	Quality Problems	Cause	Impact
1.	Salinity	Inherent (geogenic)/Man-made (e g, coastal saline intrusion due to over pumping)	Kidney stones due to poor hydration in such areas
2.	Fluoride	Inherent (geogenic), but aggravated also by over-exploitation; increased by malnutrition	Fluorosis
3.	Arsenic	Complex geogenic processes not yet well understood; but suspected to be related to excessive use and related water table fluctuations; increased by malnutrition	Arsenicosis; skin lesions, in extreme cases leads to cancer of lung and bladder
4.	Iron	Geogenic mainly	Iron overload; cirrhosis; suspected diarrhea linkages; cardiac linkages
5.	Biological	Related to poor sanitation and hygiene practices; increased by malnutrition	Diarrheal problems;
6.	Agro-chemicals	Related to pesticide/fertilizer use in agriculture	Multiple impacts; not understood well
7.	Industrial effluents	Due to effluents from industries	Multiple impacts; not understood well

Table 6 Impact of Drinking Water Quality Problems (Source:-Shankar *et. al*., 2011).

Groundwater quality management plans for urban and rural water services:

Foster, *et al.;* (2010) have discussed various issues related to public ground water supply sources protection form pollution sources, significance of private in-situ self-supply from groundwater in urban areas, wastewater reuse as a risk and a benefit to groundwater resources, strategies for rural water-supply development from minor aquifers, management of naturally-occurring groundwater quality problems agricultural irrigation and drainage, realistic groundwater resource accounting in areas of irrigated agriculture, promoting 'real groundwater resource savings' through irrigation water management, improved conjunctive use of groundwater resources in irrigation canal-commands. The intensive practical exposure gained through these activities, coupled with the extensive past experience provided the basis for; knowledge product elaboration and best-practice dissemination. In case of Kolhapur district this information is very important in order to build necessary data and prepare a management plan to face the existing and futuristic ground water resource scenarios.

Collaborative initiatives in groundwater management:

This overview suggests two broad avenues for future work. The first approach involves the development of a detailed research program to gather groundwater data directly from governments and other sources within country in order to develop an improved picture of groundwater conditions and use. The second a line of approach focuses on the development of adaptive responses to policy approaches and water problems that reflect and respond to change, uncertainty and the absence of real understanding of systems and their interactions. Addition to these technical assistance organizations like GSDA, CGWB, MPCB, and CPCB to assist in developing effective responses to emerging groundwater problems is important (Adopted from www.fao.org).

Conclusions:

Ground water is one of the rich fresh water resources available to Kolhapur district after surface water. In 21st century irrigation facilities are improving as compare to the past despite with one lean monsoon there has been serious drought like situation in the state this year except few districts like Kolhapur because of large number of dams providing water in three seasons. However, ground water is one of the most crucial water resources in Kolhapur. The demand of ground water is increasing day by day with increase in population, urbanization and industrialization. Overuse, abuse, unequal distribution, exploitation, and pollution of ground water is increasingly creating a problem in Kolhapur district. And if this situation is not taken seriously we may be leading to a potential disaster. Therefore we have to do optimum use of ground water resource by taking care of by taking proper care of sanitation and hygiene conditions to keep safe the ground water resources. A revised strategy must be developed by the government and implemented by the district administration to protect and conserve the ground water. Holistic approach between government bodies, local people, NGO's and experts in the concerned fields is required for efficient management of the vital resource. An integrated approach of regional development needs to be evolved, taking water resources, particularly ground water at the centre, on scientific basis keeping in mind the impact of global warming and needs of growing population. It is high time we change our careless attitudes towards ground water.

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