Ground water quality testing In Bengaluru city

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Abstract: **Physical assessment of drinking water quality was carried out for the samples taken in Bangalore, India. Being one of the fatest growing cities in india, inevitably Bangalore is facing the pressure of supplying safe and healthy drinking water to such a huge population. Therefore it is of high importance quality in such place. In this present study water samples were collected from all over Bangalore peripheral regions as well as proportions from the central region as well. Test for pH and TDS were carried 20 samples. The whole city was divided in four regions for well parameter was found to fairly exceed the standard values in certain places. All the unfitness of the water may has occurred due to the poor storage and maintenance system. All the limit came high in some sector depending upon external sources. It is evident that more than 50 percent of water samples are non portable as per Indian standard.**

Keywords: pH, total dissolved solids, water analysis and Quality assessment.

1.INTRODUCTION

Our planet Earth is a live planet because of some special ingredients out of which water plays a great role. Water has been considered as the most important and vital resource for the upbringing of biological sphere as well as the human civilisation. The other agents which are responsible for the biosphere on globe are Air, Heat, Soil, Sky. All these agents are linked in between themselves to a much greater extent and any irregularities in one of them affects others as well. Along with the progress of our civilisation, these resources have begun being polluted and its quality started depleting due to various reasons like the onset of industries, domestic wastes, runoff from urban areas, urban and rural garbage.

With the onset and progress of human civilisation, it has constantly been observed that the coastal areas as well as the river banks have been the most populated spots on account of the availability of ample water resources for the maintenance of daily life along with farming and other climatic advantages. The cities and towns always have shown the rising trend of population because of the easy earning sources due to the various industries which are setup to meet the increasing demand of the growing civilisation. Because of this, day by day urban areas are being densely populated and as a result, the surrounding areas of cities are suffering from various kinds of pollutions like air, water, soil pollution and many more due to sewage, garbage, dumps and barnyard manures etc.

The majority of water for Bangalore is imported by the BWSSB from the Cauvery river, over 100 km south of the city Cauvery water was originally drawn from a reservoir near the village of Thorekadanahalli. Up to 20% of the normal water supply for Bangalore comes from the Arkavathy river, from two reservoirs built on the river, the Hesaraghatta built in 1894 and Tippagondanahalli Reservoir, which was built in 1933. BWSSB currently supplies approximately 900 million litres (238 million gallons) of water to the city per day, despite a municipal demand of 1.3 billion litres.

Universally, requirement for freshwater will continue to rise significantly over the coming decades to meet the needs of increasing populations, growing economies, changing lifestyles and evolving consumption patterns. This will greatly amplify the pressure on limited natural resources and ecosystems. Unsafe water and sanitation account for almost one tenth of the global burden of disease. According to the World Commission on water for the 21st century, more than half of the world's major rivers are depleted and contaminated to the extent that they threaten human health and poison the surrounding ecosystems (Interpress, 1999). Contaminated drinking water can cause various diseases such as typhoid fever, dysentery, cholera and other intestinal diseases.

In India, rivers are an important source of water, as many Indian cities are situated on the banks of the rivers. Untreated discharge of pollutants into a river from domestic sewers, storm water discharges, industrial wastewaters, agricultural runoff and other sources can have short-term as well as long-term effects on the water quality of a river system. Total 80% of the water in India has become polluted due to the discharge of untreated domestic sewage and partially-treated industrial effluents into the natural water source. High levels of pollutant input in river water systems cause an increase in biological oxygen demand (BOD), chemical oxygen demand(COD), total dissolved solids (TDS), total suspended solids (TSS), metals such as Cd, Cr, Ni and Pb, and fecal

coliforms (Mohd Kamil,1991; Sangodoyin, 1991; Chatterjee et al., 2000; Adekunle and Eniola, 2008).

In the study area considered, peoples are using contaminated water for various purposes and are facing different health problems. Hence, the present study aims at assessment of water quality in the area considered and suggesting mitigate measures for the problems related to water pollution. An understanding of water chemistry is the bases of the knowledge of the multidimensional aspect of aquatic environmental chemistry which involves the source, composition, reactions and transportation of water. The quality of water is of vital concern for the mankind since it is directly linked with human welfare.

1.1 OBJECTIVES OF THIS PROJECT

There are two types of objectives here: - narrative and numerical.

- Narrative objectives present general descriptions of water quality that must be attained through pollutant control measures and watershed management.
- Narrative objectives also serve as the basis for the development of detailed numerical objectives.
- numerical objectives were developed primarily to limit the adverse effect of pollutants in the water column.
- Numerical sediment objectives, that will ensure the protection of all current and potential beneficial uses.
- Numerical objectives typically describe pollutant concentrations, physical/chemical conditions of the water itself, and the toxicity of the water to aquatic organisms.
- These objectives are designed to represent the maximum amount of pollutants that can remain in the water column without causing any adverse effect on organisms using the aquatic system as habitat, on people consuming those organisms or water, and on other current or potential beneficial uses.

These water quality objectives are considered necessary to protect the present and potential beneficial uses and to protect existing high quality waters of the state. These objectives will be achieved primarily through establishing and enforcing waste discharge requirements and by implementing this water quality control plan.

2. STUDY AREA:

The chemical analysis of drinking water study was performed in Bangalore Urban District dividing the whole city into six meta divisions i.e. North, East, South-East, South, West and Central. Bangalore is the capital city of Karnataka with a geographical location of latitude 12o.58N and longitude of 77o.35E, 921 m above the sea level. Historically, Bangalore Water Supply and Sewage Board (BWSSB) used to supply the drinking water i.e. Cauvery river water, to the central region of the Bangalore as it was the main populated and core region of the city. But, the peripheral regions have recently being populated because of the rapid urbanization and industrialization. Hence, the drinking water supply has become inadequate enough to supply water throughout the city now developed. The current situation, obviously compelling the dwellers to procure drinking water from alternative sources such bore wells, tankers which is in turn is nothing but the ground water. This urbanization phenomenon in developing countries like India with still developing sanitation and safe water supply protocols is leading to consumption of contaminated water in several occasions leading to serious health concerns. Hence; it is of urgent and immense importance to scrutinize the drinking water quality in these areas and the same has been determined in this study.

2.1 Sampling: In order to keep the sample collection and analysis less complex and well organized, the whole Bangalore was divided into four meta-divisions as North East, South-East, South West North West each of these divisions containing several numbers of wards. Each house in each of these wards was assigned with a number and was then selected by generating random number generating tools. The house owners were questioned about the cleanliness measures followed to ensure the drinking water safety and with their consent 500 ml of bore water sample was collected in a sterilized polyethylene bottles and were carried to lab and were stored at 40C. Later the samples were tested for the mentioned parameters. The samples of waters were collected in month of February 2016 and later water from same areas have been collected in month of March 2016 and experiments have been done twice simultaneously in March and April 2016.

3.3 Analysis: The collected and stored samples were subjected to testing for pH according EPA method. The samples were performed for various test written below and the results of these tests are compared with **BIS105001991** and **WHO 2011** to know the quality of water.

Table 1: Analysis on test done and methods used in them

SL NO.	PARAMETER	METHODS	INSTRUMENTS
1.	PH	PAPER METHOD	_____
2.	DISSOLVED OXYGEN	TITRATION BY SODIUM THISULPHATE	_____
3.	CONDUCTIVITY	ELECTROMETRIC	CONDUCTIVITY METER
4.	TOTAL DISSOLVE SOLIDS	ELECTROMETRIC	_____
5.	CALCIUM HARDNESS	TITRATION BY EDTA	_____
6.	MAGNESIUM HARDNESS	TITRATION BY EDTA	_____
7.	TOTAL HARDNESS	TITRATION BY EDTA	_____
8.	CHLORIDES IN WATER	TITRATION BY AgNO3	
9.	IRON	DIGESTION FOLLOWED BY ATOMIC SPECTROMETRY	ATOMIC ABSORPTION SPECTROMETER
10.	SULPHATE	TURBIDIMETRIC	TURBIDITY METER
11.	NITRATE	ULTRA VIOLET SCREENING	UV-SPECTROPHOTOMETER

3. MATERIALS REQUIRED

Table 2: Name of the reagents used in the tests

A. **WATER-SAMPLE**		
B. **REAGENTS**		
SL NO	PARAMETER	REAGENTS
1	ELECTRICAL CONDUCTIVITY	(0.1N) KCL
2	PH	pH paper
3	CHLORIDES IN WATER	(0.0141N) SILVER NITRATE, POTASSIUM CHROMATE SOLUTION
4	CALCIUM HARDNESS AND MAGNESIUM HARDNESS	STANDARD EDTA(O.O1M), (1N) SODIUM HYDROXIDE, MUROXIDE INDICATOR
5	TOTAL HARDNESS	(0.01M) EDTA, AMMONIA BUFFER SOLUTION, ERICHROME BLACK T INDICATOR
6	DISSOLVED OXYGEN	MANGANESE SULPHATE, ALKALI IODIDE AZIDE, CONCENTRATED SULPHURIC ACID, STARCH INDICATOR, SODIUM THIOSULPHATE (0.025N)
7	CHLORIDE IN WATER	CHLORINE WATER, POTASSIUM IODIDE, GLACIAL ACETIC ACID, STARCH, (0.1N) SODIUM THIOSULPHATE
8	IRON TEST	HYDROCHLORIC ACID, HYDROXYLAMINE HYDROCHLORIDE SOLUTION, AMMONIUM ACETATE BUFFER SOLUTION, PHENANTROLINE SOLUTION, STOCK IRON SOLUTION, STANDARD IRON SOLUTION
9	NITRATE TEST	STANDARD SILVER SULPHATE, PHENOL DISULPHONIC ACID, AMMONIUM HYDROXIDE, STOCK NITRATE SOLUTION, STANDARD NITRATE SOLUTION
10	SULPHATE TEST	GLYCEROL, CONCENTRATED HYDROCHOLINE SOLUTION, ETHYL ALCOHOL, SODIUM CHLORIDE, BARIUM CHLORIDE CRYSTALS, STANDARD SULPHATE SOLUTION

Fig 1. Locations in Bangalore from where water samples are collected

3. 1 NAME OF LOCATION

The areas from where water was collected are divided in each zone as:

NORTH EAST REGION (zone 1)

- KR PURAM
- MAHADEVPURA
- KAMANAHALLI
- INDIRANAGAR
- WHITEFIELD

NORTH WEST REGION (zone 2)

- YESHWANTPUR
- RAJAJI NAGAR
- MALLESHWARAM
- MAJESTIC
- GOLF COURSE ROAD

SOUTH EAST REGION (zone 3)

- MARATHAHALLI
- DEV ANABISANAHALLI
- SARJAPURA ROAD
- HSR LAYOUT
- KORAMANGLA

SOUTH WEST REGION (zone 4)

- JAYANAGAR
- JP NAGAR
- BANSHANKARI
- KUMARSWAMI LAYOUT
- KENGERI

4.RESULT AND DISSCUSSIONS

Twenty groundwater samples (1 to 20) were collected from the bore-wells which included hand pumps, piped water supply schemes. The results of the chemical analysis are presented in the critical parameters along with the permissible limits for these parameters.

- **Odour** of sub surface water is agreeable but 6 surface water samples out of 20 samples are non-agreeable due to decomposition of organic matter and not fit for domestic and other purpose.
- **Taste** at all point of sample collection (100%) is non-agreeable hence objectionable.

The following values of parameters have come after performing experiments in each of them with various water sample collected

Table 3. Results on quality of water has shown during February -March 1016

NAME	PH	CONDUCTIVITY	CA HARDNESS Mg/l	MG HARDNESS Mg/l	TOTAL HARDNESS Mg/l	DISSOLVE OXYGEN Mg/l	CHLORIDE IN WATER Mg/l	IRON Mg/l	SULPHATE Mg/l	NITRATE Mg/l	TDS Mg/l
ZONE-1											
K R PURAM	7.3	1.2	350	175	525	0.1	405.87	1.5	297	101	2500
WHITEFIELD	6.9	0.9	76	250	326	0.9	89.96	1	96	31	2000
MAHADEVPURA	6.9	1	635	129	764	0.1	260.92	1.4	320	105.6	2850
INDRA NAGAR	7	0.9	75	165	240	1	79.75	0.5	8	22	1446
KAMMANAHALLI	7.1	0.8	125	189	314	1.2	117.96	0.8	10	33	1855
ZONE-2											
KANGERI	7.1	0.6	149	186	335	2.1	113.96	0.6	8	31	1807
BANASHANKARI	5.6	0.4	25	238	263	1.8	100.96	0.5	20	29	2202
JP NAGAR	5.9	0.9	20	240	250	1.6	106.96	0.6	9	28.6	1907
JAYNAGAR	7.3	0.8	195	130	325	2.3	75.97	0.5	10	25	1920
KUMARSWAMY LAYOUT	6.8	0.9	155	181	336	1.8	168.94	0.5	17	29.8	1800
ZONE-3											
YESWANTPUR	7	1.1	192	139	331	0.2	209.93	1	330.6	81	2500
RAJAJI	7.4	1	55	214	269	1	202.94	0.7	234.2	55.6	2350
MALLESHWARAM	8.1	1	166	128	294	1.2	325.1	0.8	85	35.7	2401
MAJESTIC	6.6	0.9	235	120	355	0.2	283	1.2	159	55.6	2471
GOLF COURSE	7.2	0.9	50	170	220	1.9	74.97	0.4	5	17.5	1200
ZONE-4											
HSR LAYOUT	7.3	0.7	63	185	248	1.5	95.2	0.6	6	20	1796
DEVANABISAHALLI	7.1	0.4	105	293	398	0.1	360.5	1.2	20	38.2	1850
KORAMANGLA	6.9	0.7	75	205	280	1.5	295.22	0.8	14	28	1700
SARJAPUR ROAD	7	0.5	200	120	320	1.2	297.9	1	13	33	1989
MARATHAHALLI	7.4	0.5	160	240	400	0.1	360.1	0.9	14	43.5	2201
BIS:105001991	6.5-8.5	-	75	30	300	-	250	0.3	150	45	500
WHO:2011	6.5-8.5	1.2	75	50	-	4	250	0.3	500	50	1200

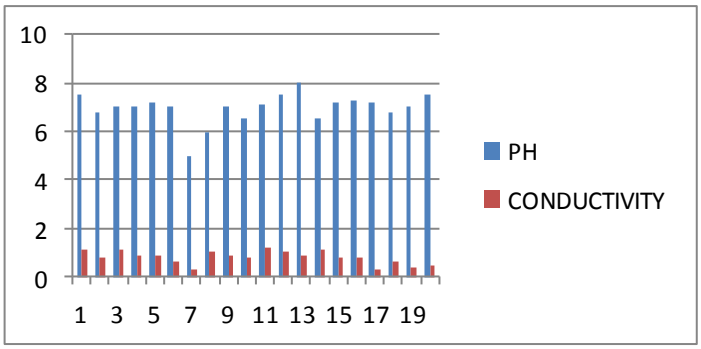

Fig-2 **Number and percentage of samples obtained in each range of PH, CONDUCTIVITY from each Meta regions**

DISCUSSION: PH of few areas have come less due to present of carbon dioxide in water samples of those areas which is due to industrial waste water in their ground water beds and conductivity have come less in few water samples due to presence of very less ions of alkali, chlorides are found in their ground water beds.

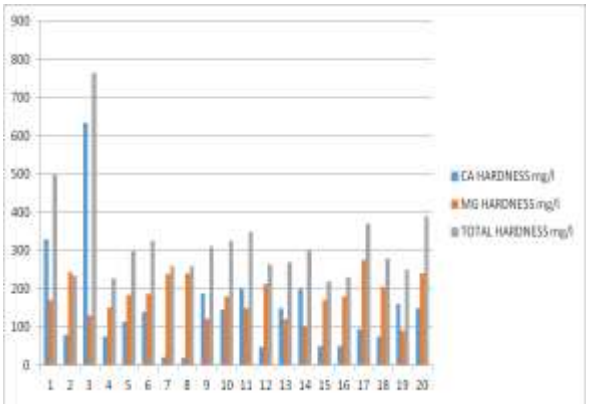

Fig-3 **Number and percentage of samples obtained in each range of CA HARDNESS, MG HARDNESS and TOTAL HARDNESS from each Meta regions**

DISCUSSION: Calcium hardness in few water samples we have seen have to increase due to more industrial waste in ground water table of those areas and due to this total hardness of those areas will also increase and Magnesium hardness of this areas though increase in very less amount.

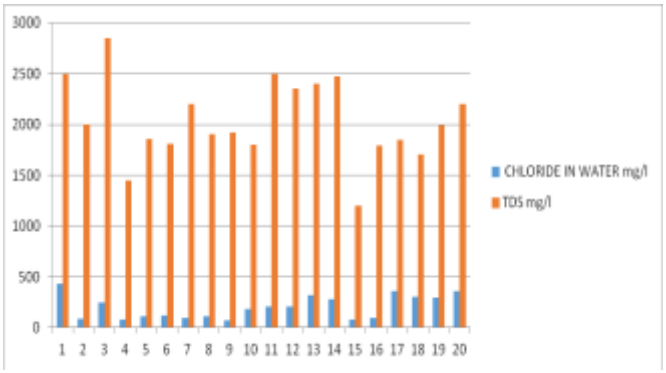

Fig-4 **Number and percentage of samples obtained in each range of CHLORIDE IN WATER, TDS from each Meta regions**

DISCUSSION: Chlorides in water increases when more salt is present in ground water table and due to industrial wastes in water found in those areas ground water table, so chlorides in few industrial areas have increased as seen and TDS is increased in few water samples have increased due to high correlation factors in those samples. Sometimes it is due to presence of inorganic compounds in their ground water beds.

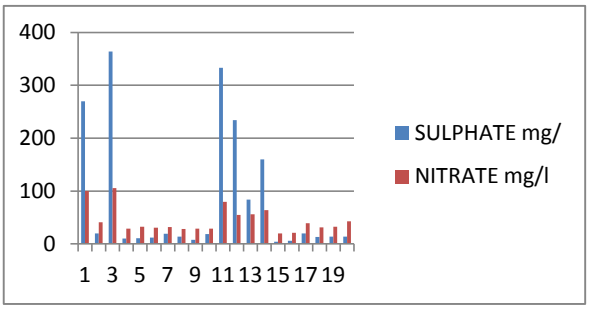

Fig-5 **Number and percentage of samples obtained in each range of SULPHATE, NITRATE from each Meta regions**

DISCUSSION: Sulphates in few water samples have increased due to present of sulphur in ground water table due to industrial wastes in ground water and similarly Nitrates have also found high in those water samples where more industrial waste water flows.

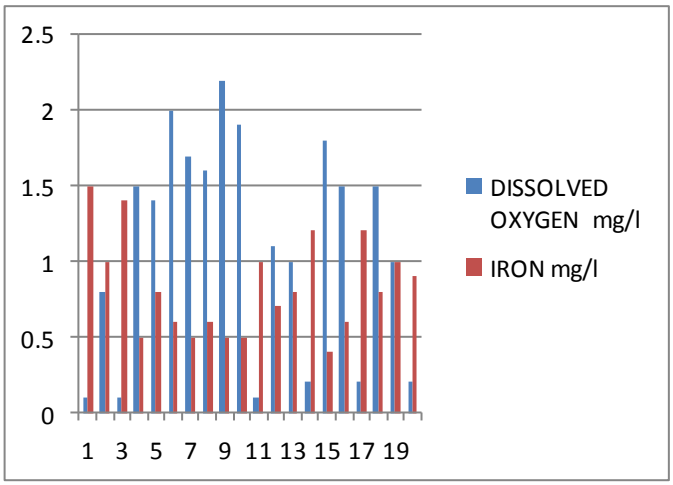

Fig-6 **Number and percentage of samples obtained in each range of DISSOLVED OXYGEN, IRON from each Meta regions**

DISCUSSION: Dissolved oxygen in few water samples have come less due to low amount of oxygen present in those waters which is because of more impurities are found in those ground water table and Iron in few water samples have increased due to presence of more iron component in those ground water table.

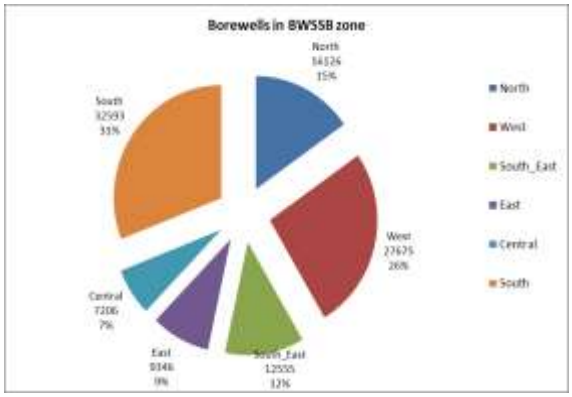

Fig 7. Total no. of bore wells in Bangalore city

5. CONCLUSIONS

- The analysis of groundwater and the surface water samples from the Bangalore area has shown that almost 30% of the samples are unfit for drinking purpose.
- The analysed data clearly indicates that the groundwater is getting polluted at an alarming rate due to rapid industrialization.
- Most of the samples were found to be potable, yet a considerable percentage in all the meta divisions especially South-east showed a significant non-potability for each of the parameters.
- pH, as one of the quality assessment parameter, contributes to the occurrences of eye and gastrointestinal irritation leading to severe health concerns.
- Onset of cardio-vascular diseases as well as renal complications is enhanced by the presence of several inorganic and organic ions comprising TDS.
- Therefore, in order to reduce the propensity of morbidity, regular scrutinization and treatment of the contaminated drinking water such as use of neutralizer filter for pH, reverse osmosis, deionization, distillation, carbon filtering etc.
- Most importantly the awareness about occurrences of such deadly diseases in the end users are of profound importance.
- In addition to it, assigning a particular water quality index for ground water, e.g. Universal Water Quality Index (UWQI) developed for surface water quality assessment, will also help in representing the complex ground water quality data in a simpler way, which will facilitate an easier analysis, interpretation and further treatment measures.
- There are existing treatments and intense research works being organized all over the world to treat all such lethal diseases, predominantly, diarrheal complications occurring due to the consumption of enteric pathogen contaminated water, but are yet to be mastered from aspects such as availability, expensiveness in an epidemic setting.
- Hence; considering prevention as a better combating measures against these morbidities, it is strongly suggested to analyse and treat the drinking water at the point of use in a regular basis. From a social point of view, a better city foundation plan including proper water supply throughout the peripheral regions and better sanitary establishments will certainly complement the cause.

- Replacing of the damaged pipelines and lining of sewer drains is necessary to prevent the leakage of sewage in pipes and seepage through unlined channels and to prevent the mixing or leaking of sewage with groundwater.
- Water treatment facility shall be designed in order to provide potable water to the residents of the area. To meet the ever increasing need of Potable groundwater and surface water, the best way is to collecting the groundwater by protecting it from pollution and augmenting it with the groundwater resources by recharging it through rainwater harvesting.
- This study is carried out during pre-monsoon season. It was observed that the main causes of deterioration in water quality were high interference of anthropogenic activities, lack of proper sanitation, and industrial and domestic wastewater inflow. A specific management plan involving all stakeholders will help

  improve and maintain the river water quality

6. RECOMMENDATIONS

From the present scenario it is quite evident that our dependency on surface/ground water is going to increase with every passing day. In the view of this growing demand and deterioration in the quality of ground water there is an urgent need to take up effective measures for conservation management and augmentation of ground/surface water resources. A comprehensive ground/surface water management plan involving ground/surface water scientists, city planners, land use exports, environmentalists and general public should be drawn.

The major list of the recommendations is presented below: -

- More observation station for water level and quality monitoring should be established.
- Setting of ground/surface water obstruction structures should be scientific.
- Proper care should be taken to keep it away from the influence of waste disposal sites.
- Artificial recharge schemes should be made popular; this can be done by popularizing roof tap rain water harvesting methods to achieving this building codes of the city may be suitably revised to make this mandatory for all new constructions.
- Disposal of municipal waste should be managed properly apart from proper treatment of sewage.
- Mass awareness programs to educate public should be arranged by different groups and through electronic media.
- Water Storage, Distillation and Recharging of Underground Aquifers.
- Water quality management needs to be taken up on priority basis.
- Rain harvesting is crucial for water and food security due to short time span of annual rainfall.
- River Basin Planning and Holistic Water Management.
- Inter-ministerial/inter-departmental co-ordination.
- Developing Core Competence in Research and Facilitating Data availability.

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