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Investigation of Ground Water Quality of Upstream Water Tanks in Coimbatore Using GIS: A Review

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Abstract **- Coimbatore city, the head quarters of Coimbatore District is located on the bank of Noyyal River in Tamil Nadu state. It lies between 10 ° 13' N and 11 ° 23' N latitudes and 76 ° 39' E and 77 ° 30' E longitudes with a total geographical area of about 7469 km2.Water is the basic element of social and economic infrastructure and is essential for a healthy society and sustainable development .Coimbatore is one of the major developing citiesin India .Ground water is being the favourite alternative to water provided through taps,is facing threats due to anthropogenic activities in India, which has led to deterioration of ground water quality. In addition to the source contamination,urbanization and improper disposal of solid wastes lead to contamination of groundwater and surface water resources in this region. Municipal and industrial wastes of the city are presently disposed at four distinct open tanks namely Narasampathy, Krishnampathy, Selvampathyand Kumaraswamy/(muthannankulam) tanks.**

The leaches of these wastes directly contaminate the groundwater and surface water resources leading unsuitability of water for drinking at many places. Hence, a detailed study has been carried out using Geographical Information System (GIS) to understand the spatial variation of surface water and groundwater quality. About sixteen groundwater samples and sixteen surface water samples are to be collected during monsoon and post monsoon periods of the year - 2014& 2015 from the study region, and the samples have to be analyzed for various physical and chemical parameters such as pH, Electrical Conductivity, Total Dissolved Solids, Alkalinity, Hardness, Na+, K+, Ca2+, Mg2+, Cl•, HCO3•, CO32•, SO4, NO3 and F.

The concentrations of physical and chemical constituents in the water samples are going to compared with the Bureau of Indian Standard (BIS) and World Health Organization (WHO) standard to know the suitability of water for drinking.The study indicates that the water quality parameters exceed the permissible limits for drinking at many locations leading the water unsuitable for drinking. The spatial variation of groundwater quality parameters is also yet to be plotted using GIS.
Keywords: **Spatial variation,Ground water contamination,Geographical Information System**

I.INTRODUCTION

Water that exists in the pore spaces and fractures in rock and sediment beneath the Earth surface is called Ground water. Ground water is a long-term reservoir of the natural water cycle, which originates from rainfall or snow. Ground water moves through the soil and back to surface streams, lakes or oceans.

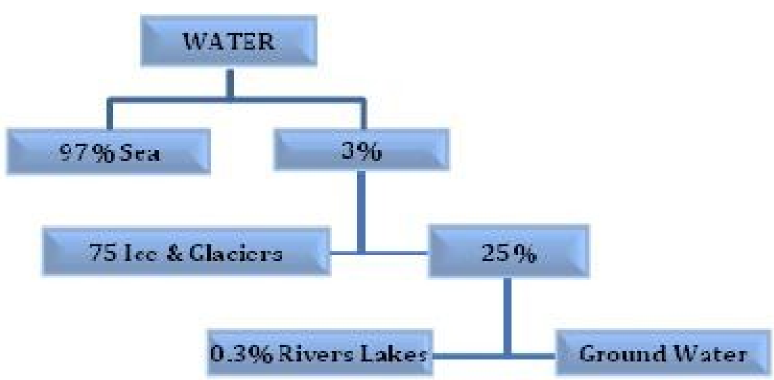

Fig.1.Ground water follow chart

Groundwater Contamination

Residents in cities and many rural homes use groundwater for drinking and other household purposes. At the same time, groundwater is contaminated by many sources.

Definition: The detrimental alteration of the naturally occurring physical, thermal, chemical, or biological quality of groundwater.

Types of Groundwater Contamination

Groundwater contamination caused by human activities usually falls into one of two categories: point-source pollution and non point-source pollution. Fertilizers and pesticides applied to crops eventually may reach underlying aquifers, particularly if the aquifer is shallow and not "protected" by an overlying layer of low permeability material, such as clay. Drinking-water wells located close to cropland sometimes are contaminated by these agricultural chemicals.

Point Sources

Transfer of pollutants from municipal, industrial liquid waste disposal sites and from municipal and household hazardous waste and refuse disposal sites. The pollution from these sources can be measured directly or otherwise quantified and one can evaluated their impact directly.

Non-point Sources or Diffuse Sources

Wash off and soil erosion from agricultural lands carrying material applied during agricultural use, mainly fertilizers, herbicides and pesticides. Run off from urban streets, commercial activities, industrial sites and storage areas. There is no single outlet of such source but consists of number of outlets. Because non point- source substances are used over large areas, they collectively can have a larger impact on the general quality of water in an aquifer than do point sources, particularly when these chemicals are used in areas that overlie aquifers that are vulnerable to pollution. If impacts from individual pollution sources such as septic system drain fields occur over large enough areas, they are often collectively treated as a non point source of contamination.

II. SOURCES OF GROUND WATER CONTAMINATION

Landfills and Hazardous Waste Facilities

Municipal solid waste (durable and non durable goods, containers, food scraps, yard waste, inorganic waste, and sludge from water and wastewater treatment facilities, septic tanks, and construction and demolition debris) Landfills contaminate groundwater when rain water leaks into aquifers below the landfill. Many early landfills did not have liners to trap rainwater that percolates through the landfill,and some newer landfills have liners that leak. The percolating water leaches toxic chemicals from batteries, broken fluorescent bulbs, electronic equipment, discarded household chemicals, and paints and solvents.

Agriculture

Extensive herbicide use in agricultural areas has resulted in widespread occurrence of herbicides in agricultural streams and shallow ground-water. The highest rates of detection for the most heavily used herbicides-atrazine, metolachlor, alachlor, and cyanazine-were found in streams and shallow ground water in agricultural areas.

Insecticides were frequently detected in some streams draining watersheds with high insecticide use but were less frequently detected in shallow ground water because most insecticides are applied at lower levels than herbicides and tend to sorb onto soil or degrade quickly after application.

Pesticides

Pesticides are any substance or mixture intended to prevent, kill, or repel any pest, including insects, weeds, mice, fungi, or bacteria.

Thus, household chemicals to disinfect surfaces or to remove mildew are legally classified as pesticides. Insecticides generally are applied more selectively and at lower rates than herbicides.

Major changes in insecticide use have occurred over the years in response to environmental concerns, which have resulted in various restrictions on the use of organochlorine insecticides, such as DDT.
Specifically, as the use of these persistent pesticides declined, the use of other, less persistent insecticides increased.

Glyphosate is by far the most commonly used herbicide, but it is of little concern because glyphosate doesn't readily leach into water systems. Instead, it latches tightly to soil particles and degrades within weeks into harmless byproducts. By contrast, herbicides such as atrazine have been widely implicated in contaminating groundwater.

Among the major findings are that pesticides are frequently present in streams and ground water, are seldom at concentrations likely to affect humans, but occur in many streams at concentrations that may have effects on aquatic life or fish-eating wildlife. Human-health benchmarks were seldom exceeded in ground water.

III. COMMON EFFECTS OF CONTAMINATED GROUND WATER ON HUMAN

Contaminant with their potential health and other effects

1. ARSENICcauses acute and chronic toxicity,liver and kidney damage,decreases blood hemoglobin,possible carcinogen.
2. CHLORIDEDeteriorates plumbing , water heaters and municipals water work equipments at high levels.
3. CHROMIUMIt causes liver and kidney damage, hemorrhaging,respiratory damage dermatitis and ulcers.

4. COPPERCauses liver and kidney damage,stomach and intestinal distress and toxic to plants.
5. CYANIDEPoisoning is the result of damage to spleen,liver and kidney.
6. DISSOLVED SOLIDSMay have influence on the acceptability of water in general.High concentration of DS may interrupts the life of water heaters.
7. FLOURIDEDecreases incidents of tooth decay,causes crippling bone disorders at high levels.
8. HARDNESSDecreases the lather formation of soap and increases the scale formation in hot water heaters and low boilers at high level.
9. IRONImparts a bitter astringent to the taste of water.
10. LEADAffects red blood cell chemistry,physical and normal development in babies and young children.
11. MERCURYcan cause acute and chronic toxicity and may makes the nervous system to damage.
12. NICKELDamages the heart and liver of laboratory animals exposed to large amounts over their life span.
13. ZINCUse in the healing of wounds.Causes no health affects.Toxic to plants at high level.
14. SULPHATECan change the taste of water and may enhances the laxative effects at higher doses.
15. VOCCan cause anemia, skin irritation,weightloss,damage to the nervous system and gives the respiratory tract irritation.
16. PESTICIDES Cause poisoning, dizziness, numbness, cancer, weakness.Damages nervous system,thyroid and reproductive system.

IV. STUDY AREA

(Nagarajapuram,Seeranaikanpalayam,kumarasw amy lake,Thondamuthur)

Fig.2. Coimbatore pond map

Groundwater is a precious and most widely distributed resource of earth and unlike any other mineral source; it gets replenished from meteoric precipitation. Considering the fact that land is a finite resource and the burgeoning population, which requires more and more of it, an integrated landscape assessment is essential. In India, groundwater is the most precious natural resource to provide for the population at large during draught period. Considering the fact that population is increasing dramatically, an integrated landscape assessment is essential to compensate the rising needs due to Urbanization. Now• a• days quality of groundwater is more important than its quantity . Studies on groundwater quality have not received attention that it deserves.

Coimbatore city, the head quarters of Coimbatore District Tamil Nadu, is located in the southern part of Indian subcontinent. The boundary of the study area is upstream tanks(ponds)inCoimbatore city. The annual average rainfall in the studyareais 900mm. In the study area, the MW and IW are discharged in fourpoints, of which the larger pond is located at Nagarajapuram, around 4 km from Coimbatore city. Another disposal pond is located at Seeranaikanpalayam. The third pond is located at the west of kumaraswamy lake .Then another one is at Thondamuthur road.Wherein the wastes are dumped in literally illegal which results in the contamination of surface and sub• surface water inregion considered for study.

The soil found in the study area is mostly black cotton soil, some regions have coarse sand and some regions are found to have laterite soil. The entire study area is found to comprise gneissic complex type of geology.

V. PURPOSE AND SCOPE OF THE STUDY BACKGROUND

Coimbatore city has 8 major water tanks to meet their water demand. Because of the anthropogenic activities, Surface water quality of the tanks has been depleted. At present, Siruvani and athikadavu are the two major sources which serve for drinking purpose. But in future because of the excessive water demand, a situation of using groundwater for drinking may occur. Our objective is to determine the ground water quality parameters, to assess whether the ground water can be used for domestic and drinking purposes if there is a demand.

VI. NEED FOR THE STUDY

1. To assess whether the groundwater quality is within the tolerance limit.
2. To determine whether the groundwater can be used as an alternate source for drinking in case there is a water scarcity.
3. To assess the impact of groundwater quality on human health.

VII. OBJECTIVE OF THE STUDY

1. To determine the physical, chemical, biological characters of the tank water and groundwater.
2. To prepare the map for groundwater quality using GIS.
3. To assess the health impacts of groundwater quality using PRA Tools.
4. To assess the impact of anthropogenic activities on ground water quality and its social consequences

VIII. MATERIALS AND METHODS

The Survey of Indiatoposheets (SOI) of 1:50000 scale are planned to use for the preparation of base map, ground elevation contour map and drainage map. GIS technology proved to be very useful for enhancing the accuracy. We would obtain the location of the wells and ponds by using the GPS and Arc GIS software. Software which isgoing to be used is ARC GIS 10.1.The IDW is to be applied for finding out the spatial distribution of groundwaterquality.Steps were followed;

In ARC MAP → Arc Tool box →
Spatial Analysis Tools → Interpolation
→ IDW → input point feature→Z value field →
Output raster → OK

The MODD software also would be very useful for producing thematic maps such as water quality index, concentration spreads, geomorphology, lineament and land use by visual interpretation techniques.

Geological Survey of India map can be used to get information about the geological formations.The major sources of MSW are shown in Table I. In order to know the ground water to be selected and the water samples would be collected to analyze its quality. Fifteen borewells ,one open well and sixteen surface water samples are going to be collected from the study area and those have to analyse for its physical and chemical characteristics as per standard procedure. Detailed well inventory survey wasalso carried out and the details such as well depth, well cross sections, subsurface lithology and groundwater level fluctuations were collected. Collection of Groundwater samples is being done byusing water sampler during monsoon and post monsoon periods of 2014-2015 for chemical analysis.

Electrical Conductivity (EC) and pH will be measured electromagnetically in the field using digital meters immediately after sampling.

Clean polythene bottles of one litre capacity soaked with 1:1 HNO_3 and washed using detergent is being used for groundwater sampling. These bottles are initially rinsed with double distilled water before taking to the field. Then the sample bottles will be rinsed two to three times in the field using the representative groundwater samples. Water level recorder is to be used formeasuring the water level in ponds.

Groundwater and surface water samples collecting in the field are to be transported to the laboratory on the same day. They will be filtered using 0.45 mm Millipore filter paper and acidified with nitric acid (Ultra pure, Merck) for cations.Half• litre of each sample is to be stored below 4^{o}
C for major anion studies.

Then these samples will be analysed for determining the concentrations of various chemical constituents such as sodium, potassium, calcium, magnesium, chloride, bicarbonate, carbonate, sulphate, nitrate, fluoride and total dissolved solids (TDS) in the laboratory using the standad methods (Table 1) as suggested by the American Public Health Association. Ca^{2+}, Mg^{2+} , HCO_{3-}, CO_3 , Cl^- and TDS are to be analysed by volumetric titrations. Concentrations of Ca^{2+} and Mg^{2+} have to be estimated titrimetrically using 0.05• N EDTA. SO_4^{2-}, NO_3^- and F^- are to be determined by spectrophotometric techniques.

Moreover this study has to reveals the effectiveness and efficient of the GIS tool in handling the problems related to various quality parameters in their spatial extent.

Finally, spatial distribution maps generated through this investigation for various quality parameters will be helpful for planners and policy makers in suggesting remedial measures in a holistic way for sustainable water management in the study area.

TABLE I TYPE AND SOURCES OF SOLID WASTES

TYPES OFWASTE	SOURCES
.Domestic waste	Glass bottles, rags, vegetable parts, residues etc,.
Commercial waste	Polyethylene bags, egg shells, cans, bottles, etc,.
Agricultural waste	Vegetable parts and residues
Construction waste	Rubbles, wood, concrete, etc,.

TABLE II METHODS USED FOR CHEMICAL ANALYSIS

Chemical parameters	**Methods**
Ca^{2+} and Mg^{2+}	Titration using 0.05 • EDTA
Na^{+} and K^{+}	Flame Photometer
$HCO_3^{\bullet}$ and $CO^{2\bullet}$	Titration using 0.01 • H_2SO_4
$Cl^{\bullet}$	Titration using 0.05 • $AgNO_3$
$NO_3^{\bullet}$	Spectrophotometer
$SO_4^{2\bullet}$	Spectrophotometer
SiO_2	Spectrophotometer
$F^{\bullet}$	Spectrophotometer
B	Atomic Absorption Spectrophotometer

The results yet to be obtained in this case study and the spatial database to be establishing in GIS, will have to shows the same approach can be used for determining, monitoring and managing ground water quality and its pollution for wide areas. The database creation can be very useful for future research and reference.

IX. RESULTS AND DISCUSSION

Understanding the quality of groundwater is as important as that of its quantity as it is the main factor determining its suitability for drinking, domestic, agricultural and industrial purposes. The analyzing Sixteen groundwater samples during monsoon and postmonsoon periods would have been used for classifying the groundwater into various types based on its suitability for drinking and agricultural uses. Further, the data is to be used for understanding the spatial distribution of geochemical constituents over the Coimbatore city.

X. CONCLUSION

1. The groundwater quality maps have to be prepared for selected parameters.
2. In the present study , ground water quality maps are to be analyzed and then integrated water quality maps of study area is prepared by considering the groundwater quality data using GIS
3. This integrated groundwater quality maps helps us to know the existing ground water condition of study area.
4. From the study, public acceptability of groundwater seems to be more for domestic use as similar to the canal water supply.
5. The resulting study has to say as there is no health based concerns would be perceived in g round water use for drinking and other domestic purposes.
6. For irrigation,also the ground water should be in high permissible to good quality.
7. Strict regulations are needed to be implemented to reduce the risk of groundwater contamination

 TARCE Vol.4 No.1 Jan - June 2015

by several anthropogenic activities.

REFERENCES

[1] "Indian Standard specification for drinking water": IS: 10500-1992 2."APHA Standard methodsfor examination of water and waste water", 19th Edition. Washington, DC: American Public Health Association, 1995.

[2] Arvindkumar (2004). "Assessment of ground water quality in residential colonies of 'Vishakhapatnam".

[3] Goyal SK, Sethi GK, Chaudhary BS (2006) :(Integrated groundwater studies in Kaithal district of Haryana, using remote sensing and GIS''.Proceedings of National Conference on Environmental Conservation. Sept 1–3, Pilani, India, pp 745-751

[4] Asadi .SS.,Vuppala .P., Reddy .MA., (2007): "Remote sensing and GIS techniques for evaluation of groundwater quality in municipal corporation of Hyderabad (Zone-V)") india. Int J Environ Res Public Health,pp.4(1):45–