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A Review Study on "Quality Assessment of Groundwater Resource"

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Abstract: Groundwater quality assessment is necessary for observing the suitability of water for various purposes. Groundwater is a standout amongst the most valuable natural resources as it is the wellspring of drinking water for most of the populace. Groundwater aquifer is viewed as the principle and just water supply hotspot for all sort of human use. This source has been confronted a crumbling in both quality and amount for some reasons, e.g., low precipitation, expanded in the urban regions which prompted an abatement in the revive amount of the aquifer, likewise expanding the populace is draining the groundwater aquifer. This groundwater cannot be used for general purposes without assessing the quality of water. Physical, chemical and biological characteristics of water should be within the permissible limits. So, in this exploration there is an attempt to perceive the generally knowledge and full picture of ground water quality. The aim of this review paper is to study about the previous research conduct an assessment of the quality of groundwater resource.

IndexTerms *– Groundwater, Geographic Information System, Water Quality Assessment*

I. INTRODUCTION

Earth is also called as 'blue planet' because 70 per cent area of it has been covered by water resource. The total water amount on the earth is about 1.35 billion cubic kilometers. About 97.1 per cent has been locked into oceans as saltwater. Ice sheets and glaciers have arrested 2.1 per cent. Only 0.2 per cent is the fresh water present on the earth, which can be used by human for variety of purposes. Remaining 0.6 per cent is in underground form. But unfortunately, it has been getting polluted day by day due to different anthropogenic activities. The effects of water pollution are not only devastating to people but also to animals, fish, and birds. Polluted water is unsuitable for drinking, recreation, agriculture and industrial purposes. Water quality analysis is one of the most important aspects in groundwater studies. The hydro chemical study reveals quality of water that is suitable for drinking, agriculture and industrial purposes. Further, it is possible to understand the change in quality due to rock-water interaction or any type of anthropogenic influence. Groundwater often consists of several major chemical elements like Calcium, Magnesium, Chloride, Bicarbonate, Sodium, Potassium and Sulphate. The chemical parameters of groundwater play a significant role in classifying and assessing water quality. It was observed that the criteria used in the classification of waters for a particular purpose considering the individual concentration may not find its suitability for other purposes and better results can be obtained only by considering the combined chemistry of all the ions rather than individual or paired ionic characters Chemical classification also throws light on the concentration of various predominant cations, anions and their interrelationships. A number of techniques and methods have been developed to interpret the chemical data. Presentation of chemical analysis in graphical form makes understanding of complex groundwater system simpler and quicker.

II. Water quality

Humans have wrestled with water quality for thousands of years, as far back as the 4th and 5th centuries BC when Hippocrates, the father of modern medicine, linked impure water to disease and invented one of the earliest water filters. Today, the challenge is sizeable, creating existential threats to biodiversity and multiple human communities, as well as threatening economic progress and sustainability of human lives. As India grows and urbanizes, its water bodies are getting toxic. It's estimated that around 70% of surface water in India is unfit for consumption. Every day, almost 40 million litres of wastewater enter rivers and other water bodies with only a tiny fraction adequately treated. A recent World Bank report suggests that such a release of pollution upstream lowers economic growth in downstream areas, reducing GDP growth in these regions by up to a third. To make it worse, in middle-income countries like India where water pollution is a bigger problem, the impact increases to a loss of almost half of GDP growth. Another study estimates that being downstream of polluted stretches in India is associated with a 9% reduction in agricultural revenues and a 16% drop in downstream agricultural yields. To set up effective interventions to clean rivers, decision-makers must be provided with reliable, representative and comprehensive data collected at high frequency in a disaggregated manner. The traditional approach to water quality monitoring is slow, tedious, expensive and prone to human error; it only allows for the testing of a limited number of samples owing to a lack of infrastructure and resources. Data is often only available in tabular formats with little or no metadata to support it. As such, data quality and integrity are low. Ground water in shallow aquifers is generally suitable for use for different purposes and is mainly of Calcium bicarbonate and mixed type. However, other types of water are also

available including Sodium-Chloride water. The quality in deeper aquifers also varies from place to place is generally found suitable for common uses. Only in some cases, ground water has been found unsuitable for specific use due to various contaminations mainly because of geogenic reasons. The main ground water quality problems in India are as follows.

2.1 Inland Salinity

Inland salinity in ground water is prevalent mainly in the arid and semi-arid regions of Rajasthan, Haryana, Punjab and Gujarat and to a lesser extent in Uttar Pradesh, Delhi, Madhya Pradesh Maharashtra, Karnataka, Bihar and Tamil Nadu. About 2 lakhs sq.km area has been estimated to be affected by saline water of Electrical Conductivity in excess of 4000 µS/cm. There are several places in Rajasthan and southern Haryana where EC values of ground water is greater than 10000 µS /cm making water nonportable. Inland salinity is also caused due to practice of surface water irrigation without consideration of ground water status. The gradual rise of ground water levels with time has resulted in water logging and heavy evaporation in semi-arid regions lead to salinity problem in command areas. As per recent assessment about 2.46 m ha of the area under surface water irrigation projects is water logged or threatened by water logging.

2.2 Coastal Salinity

Coastal areas represent zones where land and sea meet and comprises variety of complex environments including deltas, estuaries, bays, marshes, dunes and beaches. Coastal aquifers have boundaries in contact with seawater and are always under dynamic equilibrium with it. Withdrawal of fresh ground water from these aquifers may result in in equilibrium resulting in intrusion of saline water in coastal aquifers.

2.3 Fluoride

Fluorine is the lightest member of the halogen group of elements. Fluorite (CaF_2) is a common fluoride mineral. This mineral has a rather low solubility and occurs in both igneous and sedimentary rocks. Apatite (Ca5 (Cl, F, OH) $(PO_4)_3$,) commonly contains fluoride. Most fluorides are sparingly soluble and are present in natural water in small amounts. High concentration of fluoride in ground water beyond the permissible limit of 1.5 mg/L is a major health problem in India. Nearly 90% of rural population of the country uses ground water for drinking and domestic purposes and due to excess Fluoride in ground water, a huge rural population is threatened with health hazards of Fluorosis.

III. Review of Literature

3.1 Mohd Saleem *et al* (2016) The objectives of this study are to analyze the underground water quality of Greater Noida region by water quality index. Nine physio-chemical parameters such as Calcium, Magnesium, Chloride, Sulphate, Total Hardness, Fluoride, Nitrate, Total Dissolved Solids, Alkalinity collected from 10 different locations since a period of 2015. In this study 90% water samples were found good quality and only 10% water samples fall under moderately poor category. The water quality index ranges from 16.49 to 64.65. Therefore, there is a need of some treatment before usage and also required to protect that area from contamination. The rain water harvesting structures should be installed to restore the ground water aquifers for improvement of ground water resources in order to maintain the quality and quantity of ground water reservoir and thus diluting the higher concentration of chemical constituents and dissolved salts. Public awareness program should be begun to enhance the knowledge and awareness to save water pollution on human being around their dweller.

3.2 Awadh O. Al Suhaimi *et al* (2016) The study was conducted to assess groundwater quality in the Odqus area, Saudi Arabia, for domestic and irrigation uses. Water samples were collected from 51 wells in July and August of 2013, and analysed for pH, levels of total dissolved solids (TDS), total hardness (TH), and the content of major anions and cations. The results indicated that the pH, NO_3, NO_2, Br and F in all samples were below the local drinking water guideline as per SASO values. Correspondingly, only a slight percentage of the samples failed the tests for K, Na, Cl, and SO4 ions however, 58.82% of the samples were classified as moderately hard, 33.33% classified as hard and with a minute fraction of samples classified as very hard i.e., around 7.84%. Sodium adsorption ratio (SAR) and Wilcox classifications also indicate that the majority of samples are adequate for irrigation proposes. They also recommend that groundwater quality in the Odqus area should be regularly monitored for physicochemical quality parameters, biological toxins, organic contaminants, and trace metals so that any contamination can be identified early and dealt with in a cost-effective manner.

3.3 C. Sadashivaiah *et al* (2008) The study is conducted in Tumkur Taluk which is located in the south-eastern corner of Karnataka state, India where people are frequently facing water scarcity as well as quality problems. Water samples are collected from 269 stations during pre-monsoon and 279 locations during post-monsoon of the year 2006, and were subjected to analysis for chemical characteristics. Based on hydro-chemical facies, the type of water that predominates in the study area is Ca-Mg-HCO3 type during both pre- and post-monsoon seasons of the year 2006. Besides, suitability of water for irrigation is evaluated based on sodium adsorption ratio, residual sodium carbonate, sodium percent, salinity hazard and USSL diagram. About 98% of the samples are grouped within C2S1 and C3S1 classes in both pre- and post-monsoon season. Most of the samples in Tumkur, Taluk fall in the suitable range for irrigation purpose from USSL diagram.

3.4 H. Annapoorna and M.R. Janardhana (2015) The study is carried out to determine the suitability of groundwater quality of 22 wells located in the rural areas surrounding Ingaldhal defunct copper mine in Chithradurga district of Karnataka state was assessed for drinking purpose based on the various water quality parameters. In Ingaldhal region of the Chirthradurga district, Karnataka State there is no public water supply system and the population in these villages depends on groundwater for their needs. Most of the samples analysed were above the Guidelines set by both national (BIS) and international (WHO, 2011) bodies for drinking water. Geographical Information System (GIS) capabilities are used to classify zones with acceptable groundwater quality for drinking purpose. The Gibbs diagrams show that the groundwater samples fall both in the rock and evaporation dominance fields as well as about 18% samples fall outside the defined fields indicating integrated mechanisms for hydrochemistry such as high weathering and low rates of evaporation in addition to input from the anthropogenic activities. Assessment of the quality of the groundwater from 22 bore wells indicate that the groundwater belongs to hard to very hard category and groundwater from majority of the bore wells of the study region is unfit for drinking purposes. The groundwater is laden with objectionable concentration of cations and anions which may possibly have been derived through combined sources viz., mineralization, chemical weathering of rock, mine tailings, sewage contamination and intense agricultural activities. Spatial distribution map of certain parameters prepared from the hydro-chemical data in GIS environment is useful in assessing the best groundwater quality zone in the study area.

3.5 Christian K. Avi *et al* (2014) The study focuses on hydro-chemical analysis of groundwater samples in some communities in the Ayensu river basin of the central Region of Ghana. The methodology consisted of physicochemical sampling and laboratory analysis of groundwater resources in the Basin and basic statistical analysis of the laboratory results. The groundwater in the area is undersaturated with respect to carbonate phases, the dominant water types in the study area are Na- Cl, Ca- Mg - Cl and Ca - Mg - SO_4. The groundwater is to a large extent potable. However, approximately 13% of the groundwater samples had chloride concentrations slightly exceeding the respective WHO maximum acceptable limits for drinking water. The study also concluded that the groundwater in the area is undersaturated with respect to carbonate species namely calcite, dolomite and ankerite. In most of water samples (>75%) Na^+ shows a clear dominance but in few cases either Ca^{2+} or Mg^{2+} appear to be the dominant cation. groundwater chemistry is controlled by rock weathering and to a less extent by evaporation. Thus, chemical breakdown of minerals in the various aquifers is the main process influencing the hydrochemistry of groundwater in the communities sampled in the Ayensu river basin.

3.6 G. K. Anornu *et al* (2012) This paper evaluated the potential of groundwater pollution in the Densu River Basin of Ghana. Groundwater is an important resource in this basin currently supporting domestic, agricultural and industrial activities. The significance of water resources and the potential for groundwater quality to deteriorate due various anthropogenic activities within the Densu River Basin has necessitated this study using a combination of GIS and DRATIC methods. This method typically uses the watershed topographic and geological characteristics to determine the natural susceptible vulnerability of the groundwater resource. This research is applicable for studying larger basins such as the Volta River Basin of West Africa and many other small and larger basins in Africa. The study reveals that about 47% of the basin is exposed to high-risk, 43% exposed to medium-risk and 10% exposed to low-risk. It is recommended that the fast-growing urban settlements in these high-risk prone areas need more careful urban planning of settlements, siting of irrigation schemes and sanitation facilities. The results in this research are replicable in other basins in Ghana and the sub-region. This would help in minimizing the dangers of polluting groundwater resources and saving populations depending on this resource against public health related diseases.

3.7 H. Salehi and H. Zeinivand (2016) This study focuses on Preservation of water quality, particularly in areas with inadequate water resources is considered as one of the principles of planning in integrated water management. The aim of this study was to determine the suitability and mapping of springs and groundwater for irrigation and drinking purposes based on the water quality indices. ANOVA test was used to compare the treatments of different stations quality parameters and LSD test was used to assess the statistical differences between the regions, for spatial distribution and mapping, geo-statistical interpolation techniques of Kriging method were applied. The types of water that dominates in the study area are CO3-HCO3 and mixed facies between Ca–Mg and Ca–SO_4. Gibbs diagrams suggested that the main mechanism that controls water chemistry in this area is water–rock interaction. The results of physico-chemical analyses and the calculated water quality parameters showed that most of the water samples in this area were recognized to be medium and suitable for drinking and irrigation purposes. Moreover, this study evaluated the groundwater parameters variations in Kuhdasht region using spatial geo-statistics in GIS.

3.8 Jong Yeon Hwang *et al* (2017) Understanding of the aquifer hydraulic properties and hydrochemical characteristics of water is crucial for management plan and study skims in the target area, and flow motions and chemical species of groundwater are regarded as precious information on the geological history of the aquifers and the suitability of various usages. Cations and anions of groundwater are used to estimate the characteristics and origin of groundwater. In this study, they tried to evaluate the quality of groundwater based on the comparison of the physiochemical characteristics and distribution of cations and anions in groundwater from rural areas. Major objectives of this study were grouped as following three categories 1) quality assessment of groundwater as a special usage (agricultural, industrial); 2) determination of groundwater types; 3) tracing of ion sources of groundwater. The quality of agricultural water was evaluated using SAR, sodium (%), RSC, PI, SSP, MH, PS, and Kelly's ratio. Evaluation based on the Wilcox diagram was classified as "excellent to good" or "good to permissible". And the groundwater samples were also classified groundwater using the Piper diagram and estimated the origin of ions using the Gibbs and Chadah diagram, and the classifications based on the Piper diagram showed that the types of the groundwater are Ca - Cl− -NO− type and Ca -HCO− type. And in source-rock deduction and the comparison of Gibbs and Chadah diagram, the chemical components in the groundwater are induced from the water-rock deduction such as followings: dolomite type weathering, gypsum type weathering, alkaline and alkaline type weathering.

3.9 L. Elango and G. Jagadeshan (2018) The objective of the study is to know how fluoride get released from the host rock and spot out suitable location for installing a dug well recharge system to decrease the fluoride concentration in groundwater. Several methodologies exist for in situ or exsitu removal of fluoride from groundwater. Dissolved ions concentration in groundwater beyond the recommended limits is a major problem as they make the water unsuitable for drinking purpose. Fluorine commonly found in certain rocks is released into groundwater due to the processes of rock–water interaction. This leads to increase in the concentration of fluoride in groundwater which is a major problem in several parts of the world including India. Presence of fluoride beyond the prescribed limits causes health problems to humans due to prolonged consumption of water, which is common in many parts of India. Exsitu methods can be enforced at community level or even at household level for the reduction of fluoride before its consumption, through ion exchange, reverse osmosis, adsorption, electrodialysis, coagulation, Nalgonda technique, electrodialysis, coagulation, precipitation, etc. Even artificial recharging structures can also be built in suitable location for diluting fluorite concentration in groundwater. A pilot study was carried out by construction of a dug well recharge system in Dharmapuri district, Tamil Nadu, India. The study successfully demonstrated the applicability of dug well recharge system at a carefully selected site based on the systematic long-term hydrogeochemical studies to solve the problem of fluoride contamination affecting millions of rural people.

IV. Conclusion

Groundwater is one of the important sources of fresh water for Humans. When the waste is dumped as such without any proper Engineered lining, it leads to the contamination of the groundwater due to the leaching process. From the study of above literatures, it is evident that groundwater quality gets affected by open landfills. So, proper steps have to be taken to avoid this contamination and to make sustainable groundwater. Some of the remediation to avoid this impact over groundwater are, use 3R (Reduce, Reuse and Recycle) formula, in order to reduce the waste generation. Segregation of waste at the point of generation will be effective in reducing the waste and helps in waste management. Using Engineered landfills, will avoid the contamination of groundwater, soil and air. Proper awareness should be created regarding the waste disposal and its impact over groundwater, which is harmful to

living beings and non-living beings. Treating leachate with suitable methods like biological methods, anaerobic lagoons, activated sludge process, nanoparticles and adsorption methods can reduce the hazards.

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