GROUNDWATER QUALITY MODELLING AND ITS STATUS IN LUCKNOW CITY: A REVIEW

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Abstract: Groundwater is the water which is stored in aquifers below the surface of the Earth and is one of the world's most important natural resources. Groundwater constitutes 97 per cent of global freshwater and is an important source of drinking-water in many parts of the world. In Lucknow city, river Gomti has been the main source for drinking water, but now 70% of municipal water supplies are dependent on ground water, making it a predominant source for city's water supplies. This clearly reflects the vital position ground water has attained in urban water system, despite the fact that this resource is depleting fast within the transforming concrete environment of Lucknow. Therefore, this paper mainly sums up the groundwater status in Lucknow and the efforts made by various researchers to understand this complex system through groundwater modelling and along with that give a brief overview of groundwater conditions prevailing in Lucknow.

Index terms: Groundwater modeling, simulation, groundwater lucknow.

INTRODUCTION:

Groundwater is the largest available resource of fresh water in the areas where surface water resources are limited or scarce. Excessive withdrawal from the groundwater resources has caused major decay in the quality of the groundwater resources (Maroufpoor S. 2017). The quality of groundwater depends on a large number of hydrological, physical, chemical and biological factors. Ground water is a good source of fresh water resource which is the biggest issues in front of the policy makers for its sustainable utilization. Natural filtration through soil and sediments makes the ground water free from organic impurities (Karanth, 1989).
Generally higher proportions of dissolved constituents are found in groundwater than in surface water because of greater interaction of ground water with various materials in geologic strata. The water used for drinking purpose should be free from any toxic elements, living and nonliving organism and excessive amount of minerals that may be hazardous to health. A vast majority of groundwater quality problems are caused by contamination, over-exploitation, or combination of the two. Most groundwater quality problems are difficult to detect & hard to resolve.
Therefore, a groundwater model is a representative scale model of a groundwater situation or aquifer which can be used to predict the effects of hydrological changes like groundwater abstraction for industrial purpose or irrigation development on the behavior of the aquifer (Kujur A. 2014). In recent years, various watershed management plans are implementing modelling techniques for understanding the groundwater situations. Therefore, simulation models by way of their predictive capability usually help to find an answer of "what if" because there are various solutions that could be considered to deal with the problems of groundwater resources (Singh A. 2014).

GROUNDWATER IN LUCKNOW AND CAUSES OF POLLLUTION:

The city Lucknow which is the capital of Uttar Pradesh and particularly known for its cultural and patronage to art and literature spreads over an area of 2528 sq. km on both sides of river Gomti. It is a part of Central Ganga Plain in the state of Uttar Pradesh and lies between North latitudes 26°30' and 27°10' and East longitudes 80°30'and 81°13' (Verma A. 2013). Administratively the Lucknow district has been divided into 4 tehsils and 8 community development blocks. General elevation of the district varies between 103 and 130 metres above mean sea level showing southeasterly slope.

The drainage of the district is controlled by river Gomti, Sai its tributaries. Tributaries of Gomti river are Akhadi Nala, Jhilingi Nala, Behta Nadi, Loni Nadi & Kukrail Nala. Tributaries of Sai river are Nagwa Nala & Bankh Nala. Surface water and Ground water are the main source of irrigation in the district. Length of canal in the district is 962 kms. Gross irrigated area is 126607 hectares out of which 28149 hectares (22.23%) are irrigated through ground water (77.77%) by means of deep tubewells, shallow tubewells, private tubewells borings etc. About 90% of the net cultivated area in the district has assured irrigation facilities while the irrigation intensity is 144.25%.

The single source water and lack of sustainability plan have put Lucknow under water stress. Few pockets like Gomtinagar and Indira Nagar depend on Kathauta lake, which receive water from Sharda Canal, currently closed for maintenance. The water supply has been reduced to five hours/day from 16 hours/day. The lake has a stock of only seven days in mid November. Every year, the residents face the same problem and as an alternate they switch to groundwater and tanker supply. Alternate sustainable sources are yet to be planned for many areas in the city.

The following are the main causes of groundwater pollution in Lucknow city:

- Substances like iron, fluorides, and sulphates found in rock often end up in groundwater, and when they collect in excess, they tend to harm the quality of groundwater.
- Landfill waste also contributes to groundwater pollution. Contaminants often leach out of landfills and into groundwater aquifers or wells.
- Hazardous waste which is disposed off incorrectly often possesses a chance of leaching into the soil and groundwater. Thus contaminating the quality of groundwater.
- Diesel and gasoline are well-known indirect causes of groundwater pollution. In some instances, these fuels, when kept in underground storage, can leak significantly and seep into the ground around them, leading to groundwater contamination.
- Much like chemicals and other man-made solutions, pesticide is prone to washing into the soil after heavy rainfalls, especially when it is used frequently by farmers and other members of the agricultural industry. The chemicals involved in pesticides are very dangerous for both human and animal consumption, and when they reach groundwater, they can almost never be completely removed.

GROUNDWATER QUALITY MODELLING AND GROUNDWATER STATUS OF VARIOUS AREAS:

In a research to evaluate the groundwater quality using remote sensing and geographic information sensing (GIS) resulted that the groundwater quality shows high correlation with the land use. The drinking water is highly polluted in the residential areas compared to the sub- urban areas because of high pollution (Verma

A.et al. 2013). Therefore, the pollution of drinking water is highly correlated with the population. In the residential areas where there is high population, produces more waste that find their way in to the groundwater and ultimately contaminate it.

Similarly, the study conducted in Uttarakhand, India about the neural network model for the discharge and water-level prediction for the Ramganga river catchment of the Ganga basin. An artificial neural network model has been developed for the Ramganga river, catchment basin. It is validated and tested using daily water flow and level pertaining to 4 years (2010-2013). Through this a monsoon flow pattern can be prepared can be estimated with an accuracy of about 93.42% (Khan M. et al. 2015)**.** Therefore, artificial neural network helps in predicting the future conditions of a Ramganga river catchment of Ganga basin.

In a similar study about the spatial distribution of groundwater quality using soft computing and geo-statical methods in Iran conducted by (Maroufpoor S. et al 2017). A geo-statical based Kringing and Co- Kringing method was used and model formed by the data driven artificial neural network (ANN) and artificial neuro-fuzzy inference system (ANFIS) model were compared for predicting the groundwater electrical conductivity. The best model was built by that of ANN. Hence, artificial neural network is best for predicting the spatial distribution of groundwater. Another study conducted in Iran to simulate the behavior of groundwater resources in Ramhomooz aquifer. A groundwater model was prepared using MODFLOW. The simulated model predicts that the average groundwater levels rise and the average depth of groundwater table would be less than 1.5m from groundwater surface which results in water logging, soil salinity and contamination (Saatsaz M. 2011).

For conjunctive use of surface and groundwater resources a Fuzzy Optimization Model and Fuzzy Inference System was developed. Firstly a linear fuzzy optimization model was used to find the optimal surface and groundwater withdrawal. Then, by using the results of this model, a Fuzzy Inference System (FIS) was developed to determine the groundwater withdrawal, automatically. The groundwater of the Astaneh-Kouchesfahan Plain in north of Iran was simulated using MODFLOW code (Mila S. et al. 2018). This method thus helped in minimizing the water shortage. Furthermore, a neural network model can be used for prediction of contaminants concentration in a basin like that of nitrate concentration in the Kadava River basin, Nashik, Maharastra, India (Wagh V. et al 2017). A neural network model was built and calibrated. Such model is helpful to local public health bodies and policy makers to develop management strategies.

Therefore, a mathematical model provides a quantitative framework to synthesize data of a groundwater system and it plays an important role in understanding the water systems behavior when subjected to stress and changing conditions (Kujur A. 2014). A variety of numerical schemes have been applied to groundwater flow and transport problems using computers and a number of generalized computer codes are now available which can be used for the simulation of aquifer systems. The simulation models can be very complex in their formulation, it must be remembered that they remain highly simplified representation of the aquifer system. Hence numerical models can be a useful tool to generate not only an understanding of the underlying groundwater system but also facilitate development of basin-wide detailed impact scenarios as inputs for management and policy action (Maheswaran et al. 2016).

CONCLUSION:

Lucknow city, resting on a rich alluvial aquifer system of Central Ganga plain, is a glaring example of "Hydrogeological Stress", where pressure on ground water for drinking water supplies has increased

tremendously, resulting into its continuous heavy withdrawals. As such the aquifers from the dynamic zone have alarmingly depleted, leading to significant lowering of water table in different parts of the city. The city has shown a tremendous increase in population growth in recent years which ultimately resulted in water scarcity. As the population of the city is shifting more towards the groundwater resources to meet their demand of water. In result of that the drinking water is highly polluted in the residential areas compared to the sub-urban areas.

The groundwater modelling which is a scientific tool for determining appropriate solutions to water allocations, surface water- groundwater interaction, landscape management or the impact of new development scenarios. Groundwater investigations and modelling studies in particular, involve both a science and an art. The logical basis is important and requires a sound knowledge of geology, hydrogeology, groundwater hydraulics, hydrology, surface-groundwater interaction and engineering, as well as sufficient spatial and time series data to describe the system.

RECOMMENDATION:

The following are the ways by which we can improve the groundwater quality:

- Use of native plants in our landscape. They look great, and don't need much water or fertilizer. Also choose grass varieties for our lawn that are adapted for our region's climate, reducing the need for extensive watering or chemical applications.
- Use of fewer chemicals around our home and yard, and make sure to dispose them properly.
- Properly dispose of potentially toxic substances like unused chemicals, pharmaceuticals, paint, motor oil, and other substances.
- Check all the faucets, fixtures, toilets, and taps in your home for leaks and fix them right away, or install water conserving models.
- Water the lawn and plants during the coolest parts of the day and only when they truly need it. Make sure we, our family, and our neighbors obey watering restrictions during dry periods.
- Use all natural/nontoxic household cleaners whenever possible. Materials such as lemon juice, baking soda, and vinegar make great cleaning products, are inexpensive, and environmentally-friendly.
- Get involved in water education! Learn more about groundwater and share your knowledge with others.

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