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A Review on Data Analysis to Provide Solution for Groundwater Management

Quazi Mehmoodul Hasan Izhar Ahmed[1], Dr. R. R. Keole[2], Dr. A. P. Jadhao[3]

[1]PG Scholar, Dept. of Computer Science & Engineering, Dr. Rajendra Gode Institute of Technology and Research, Amravati, India.
[2]Head of Department, Dept. of Information Technology, HVPM's Collage of Engineering & Technology, Amravati, India.
[3]Head of Department, Dept. of Computer Science & Engineering, Dr. Rajendra Gode Institute of Technology and Research, Amravati, India.

ABSTRACT:

Groundwater resources are essential for providing drinking water to India's population of 1.35 billion, with approximately 80% of the population relying on groundwater. However, the rapid growth in usage of groundwater has put significant stress on the resources, leading to potential adverse consequences such as drought and loss of plumage in agriculture and domestic water supply. Water managers need to be more cautious in managing these resources and take steps to mitigate the risks associated with them.

This review paper proposes a groundwater monitoring system based on prediction using data- driven models such as Artificial Neural Networks (ANN's) to provide a solution for predicting future groundwater levels in India. The proposed system uses a set of popular data-driven models such as ANN's to provide predictions of groundwater levels in a simplified manner. The feasibility and capability of the model are explained in detail, highlighting its potential for providing accurate predictions of groundwater levels in India.

Keywords: - Groundwater, Data Analysis, ANN, Prediction etc.

1. Introduction:

The depletion of groundwater, a critical source of drinking water in many regions, is not solely due to natural factors, but also to human activities. Excessive usage and extraction have led to a rapid decline in water levels in various parts of the country over the last two decades. In addition, India's rapidly growing population and changing lifestyles have also increased the domestic water demand, while industries require more water. The situation is alarming as the country heavily relies on groundwater, with around 80% of its population depending on it.

To address the issue of declining groundwater levels caused by human activities, it is essential to implement an effective monitoring system that can identify regions experiencing water scarcity beforehand. Such a system would play a crucial role in ensuring that proactive measures are taken to mitigate the adverse effects of groundwater depletion, which can have significant impacts on the environment and the livelihoods of people who rely on it for their daily needs.

The proposed monitoring system aims to provide reliable and accurate predictions of groundwater levels, which can help water managers take necessary actions to mitigate potential water scarcity.

In rural areas where water scarcity is a common problem, accurately predicting groundwater levels is crucial in achieving the goal of implementing an effective monitoring system. Reliable predictions can help local communities and authorities plan ahead and take proactive measures to prevent or mitigate the impacts of water scarcity. With the help of advanced technologies and data-driven approaches, it is possible to develop accurate models that can predict groundwater levels with high precision, enabling timely interventions to ensure adequate water supply in these regions.The traditional approach to predict groundwater levels involves using physical models that require a comprehensive understanding of the geology and hydrology of the region. However, these models can be expensive and time-consuming.

The proposed system utilizes the concept of machine learning to develop a monitoring system that can predict groundwater levels accurately and efficiently. Machine learning is a subfield of artificial intelligence that enables computers to learn from data and make predictions without being explicitly programmed. The data-driven model will be used to identify the process without ensuring the proper input and output. The next step will involve collecting data about groundwater, such as rainfall conditions, weather conditions, and the depth of the water level.

2. Literature Survey:

The prediction of groundwater level (GWL) is a complex task that is influenced by various factors, including over-exploitation, hydrogeological properties, and dynamic variations. In recent years, researchers have proposed different models to predict GWL, including machine learning (ML) and mathematical models. These models are designed to match the accuracy and complexities of estimating GWL under different hydrogeological and structural properties. Soft- computing techniques, such as Artificial Neural Networks (ANN), Support Vector Machines (SVM), and Adaptive Neuro-Fuzzy Interface Systems (ANFIS), have been extensively used for predicting hydrological parameters due to their low computational complexity, high precision, fast training, and performance times, among other factors.

Several studies have proposed hybrid models for predicting GWL using ANN and other techniques. For example, one study proposed a hybrid prediction model based on ANN and wavelet theorem to predict GWL fluctuations in Canada. The model considered monthly recorded temperatures as inputs. In another study, feed-forward ANN was compared with the conventional regression model for estimating GWL in one-hour time intervals. Similarly, ANN and ANFIS models were developed to predict and simulate GWL in Iran, considering three parameters as input: a flow of irrigation returned, prediction rate, and pumping rate. The ANFIS model was found to perform better than ANN.

Furthermore, a study applied ANN and SVM techniques to predict GWL based on borehole data from five stations in the Republic of Korea. The SVM model was found to be more accurate compared to the conventional ANN model. Another study used ANN and SVM to predict water table depth in the United States. The authors compared the performance of both models and found that the SVM model outperformed the ANN model in predicting the water table depth.

In conclusion, the literature survey highlights the strengths and weaknesses of existing GWL prediction models, including the use of ML and mathematical models. Soft-computing techniques, such as ANN, SVM, and ANFIS, have been widely used for predicting hydrological parameters due to their efficiency and accuracy. Hybrid models based on ANN and other techniques have been proposed, and the performance of ANN and SVM models has been compared. These studies provide a valuable reference for the proposed design of the groundwater monitoring system based on prediction in this paper.

3. Methodology:

The proposed groundwater monitoring system is based on the application of machine learning techniques, particularly Artificial Neural Networks (ANNs). ANNs are a subset of machine learning algorithms inspired by the structure and function of the human brain. They consist of interconnected layers of artificial neurons, which can learn and recognize patterns from data through a process of training.

In this study, ANNs are used to predict the groundwater level in India based on certain input parameters. The input parameters used in this study include rainfall conditions, weather conditions, depth of the water level, and other relevant hydrological factors. The number of neurons in the input layer of the network is equal to the number of independent variables, while the number of neurons in the output layer is equal to the number of dependent variables.

The ANN model used in this study consists of multiple hidden layers, which are responsible for learning the patterns in the input data and producing the desired output. The weights and biases of the network are optimized during the training phase, which involves feeding the network with a set of input and output data and adjusting the weights and biases to minimize the prediction error.

4. Conclusion:

In conclusion, the prediction of groundwater levels is a crucial task that requires constant monitoring, particularly in areas that are experiencing rapid population growth and changing lifestyles. The development of machine learning models, particularly artificial neural networks, has revolutionized groundwater level prediction and has been proven to be effective in accurately forecasting groundwater levels. However, the existing groundwater level prediction models still have some limitations due to factors such as improper extraction, dynamic variations in hydrogeological properties, and over-exploitation. Therefore, a detailed literature survey is necessary to highlight the strengths and weaknesses of the existing models.

Advancements in wireless networking infrastructure have made it possible to obtain timely data to accurately predict groundwater levels. However, to develop a complete, accurate, and practical solution to real-time groundwater monitoring, all components of the system must be developed and integrated efficiently. The proposed solution in this paper addresses the immediate needs of groundwater research and provides a test bed for future research in environmental monitoring. By implementing this solution, researchers can better understand the complex dynamics of groundwater levels, identify areas that are at risk of drought or loss of plumage, and take appropriate measures to ensure sustainable water usage for the future.

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