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Prediction of Groundwater Quality from The Solid Waste Dumping Areas of the Perungudi-Kodungayur in Chennai

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ABSTRACT
The potentially used for various purpose of groundwater quality prediction and monitor is more important [1]. Moreover, the ground water quality is predicted using the hydro-chemical parameter of salinity. The quality of sub-surface geochemical process, recharged water, inland surface water and atmospheric precipitation is based on groundwater quality. Furthermore, the water pollution never only affects the quality of water although it causes the social prosperity, economic development and health [2]. The people are widely utilized round water for irrigation, industrial purpose and drinking due to inadequate fresh water resource. Because of hidden existence and natural, the groundwater is regarded as reliable and safe source of drinking water.

I. INTRODUCTION

One of the valuable natural resource for human life and the most common substance on the ground is water. There is deforestation in rural areas due to the reduction in infiltration rate and exploitation of groundwater. The potentially used for various purpose of groundwater quality prediction and monitor is more important [1]. Moreover, the ground water quality is predicted using the hydro-chemical parameter of salinity. The quality of sub-surface geochemical process, recharged water, inland surface water and atmospheric precipitation is based on groundwater quality. Furthermore, the water pollution never only affects the quality of water although it causes the social prosperity, economic development and health [2]. The people are widely utilized round water for irrigation, industrial purpose and drinking due to inadequate fresh water resource. Because of hidden existence and natural, the groundwater is regarded as reliable and safe source of drinking water [10].

Globally, the enlarger amount of population leads to enormous amount of waste. The municipal disposal of waste across the world is increased day by day so the ground water quality gets degraded. The areas nearer to the landfills have greater probability in the contamination of groundwater because of waste disposal in the solid. Recently, most of the states in India will suffer from heavy shortages of water [6, 8]. Therefore, the groundwater management is very much important and the necessary actions are required in future. The average water withdrawals are increased by 50% for the developing countries and 18% for the developed countries in the year of 2015 [3]. The presentation and choice of the accumulation function is to create the Water Quality Index (WQI). ANN is one of the most commonly used methods for ground water quality prediction that evaluate the groundwater contaminants. The main factor among this is the non-correlation between several variables. More researches have been carried out on the quality prediction of groundwater using ANN, but the computation of space and time is not extensively done [1-67]. In this paper, we proposed Multiple Layer Perceptron in neural network to predict the ground water quality from the solid waste dumping areas.

II. LITERATURE REVIEW

Recently, the researchers have been proposed lot of methods to predict the groundwater quality and few of the methods are discussed in the following section.

Jasrotia et al. [4] introduced geospatial technique to predict the groundwater quality. The case study is analyzed from Jammu Himalaya in India. The remote sensing data such as aquifer parameters, SRTM-DEM and IRS-P6 is to prepare various thematic layers. The artificial recharge zone map is prepared from the weighted overlay method in the GIS environment. The proposed model is implemented in Visual Modflow Flex software. The artificial recharge zone is validated by the comparison of both groundwater modeling zones and GIS based artificial recharge zone map. Bansal et al. [5] proposed artificial neural network to predict the water quality index, which can easily estimate the water pollution. The water quality index is a tedious task to select the weight value of water quality parameters. The missing value weights are calculated with the help of mathematical functions and traditional methods

were used to increase the accuracy. The contamination status alert is delivered to the authorities based on mobile app and web interface. Rahim Barzegar et al. [6] introduced radial basis function and multiple layer perceptron to detect the salinity of groundwater quality. East Azabaijan regional water company provided the groundwater samples. They used chlorides Cl^-, nitrates NO_3^-, sulphates SO_4^{2-} and magnesium Mg^{2+} are the input parameters. The training and testing results are evaluated by using mean absolute error, root mean square error and determination coefficient.

Batur et al. [7] proposed PCA data fusion and mining method that easily predict the groundwater quality and salinity. They used TDS, pH, Secchi disk depth, Chlorophyll and Chlorophyll-a as the input parameters for water quality determination. The proposed model is executed in MATLAB R2015a. As a result, the surface water quality prediction accuracy is low. Moghaddam et al. [8] introduced a ground water quality prediction method of BN and ANN method. The author were used input parameters for ground water quality prediction are namely average temperature, total monthly evaporation, aquifer recharge and discharge. The experimental works are evaluated using MODFLOW and Hugin Lite 8.3 software. Sengorur et al. [9] established SOM-ANN approach that detected the pollution source and water quality evaluation. The proposed SOM-ANN model is evaluated in MATLAB with Intel i4 processor. As result, the water quality prediction method required more time and cost. The water quality detection method of PLS-ANN is proposed by Song et al. [10]. The ground water quality without contamination is easily detected but the root mean square error (RMSE) rate is high.

1. Problem Formulation

- The extremely sensitive and crucial issue is ground water quality management because of solid waste and pesticides.
- The increasing amount of population leads to enlarger amount of waste also the landfills employed as the endpoint for the municipal disposal of waste across the world.
- The infiltration of groundwater is caused by the waste that is present in the landfills. The disposal of waste in the landfills can affect the areas closer to the landfills that have greater probability in the contamination of groundwater.
- Particularly, one of the major features of water management is drinking water management. Most of the states in India are widely suffered from heavy shortages of water.
- The necessary actions about ground water management are more important. So, sufficient availability and water supply quality direct to the huge growth for the countries. The solid waste dumping areas cause the quality of ground water so the ground water quality prediction in the early stage is more difficult and very important.

2. Methodology:

In this work, we analyze the ground water quality from the solid waste dumping areas such as Perungudi and Kodungayur in Chennai. This area receives the maximum rainfall from the June and September (southwest monsoonal wind) and 750mm of average annual precipitation is received. During summer and winter season, the annual temperature ranges from 39 to10^{o}C. During pre-monsoon (May 2018) and post-monsoon (November 2018), 39 dug well samples were collected and analyzed. We proposed Multiple Layer Perceptron (MLP) of neural network is to predict the groundwater quality. Here, the chlorides Cl^-, nitrates NO_3^-, sulphates SO_4^{2-}, its *pH* range, total dissolved solids *(TDS)* and the total hardness *(TH)* of the water are given to the input parameters of each neuron for ground water quality prediction.

One of the most common utilized approaches of Artificial Neural Network (ANN) is Multiple Layer Perceptron (MLP). The structure of MLP consists of one input layer, one output layer and one or more than one hidden layer section. The multiple layers Perceptron for ground water quality prediction is shown in Fig 1. Usually, the available data through the use of trial and error procedure is to optimize the number of neurons in the hidden layer. The connections among all the element via synaptic weights is to perform the hidden and layers calculation in neural network.

The representation of w is the weight applied to the neurons. The output value of three layered MLP with its explicit expression is shown in equation (1).

$$Y_n = F_o\left[\sum_{l=1}^{I_J} w_{nm} \cdot F_g\left(\sum_{l=1}^{J_J} w_{ml} X_l + w_{m0}\right) + w_{n0}\right] \quad (1)$$

From the above equation, the l^{th} neurons in the input layer and m^{th} neurons in the hidden layer connected to the hidden layer weight is denoted

as w_{ml}. For m^{th} hidden neurons, the bias function and the activation function is denoted as w_{m0} and F_g. The m^{th} neurons in the hidden layer and n^{th} neurons in the output layer is connected to the output weight is expressed as w_{nm}. The n^{th} output neurons with its bias and activation function are expressed by w_{n0} and F_0. The input variable is X_l and the output variable is computed using Y_m. The number of neurons in the input layer and hidden layer is denoted as I_J and J_J. During training process, the input and output layers have different weight and it become changed in nature. Using different weight is to connect each layer neurons with adjacent layer. The previous layer weight is to provide the signal to each neuron except in the input layer. By passing the summed signal via activation function is to produce an output signal. The output minimizes the error value rate thereby delivering the optimal water quality.

3. Possible Outcome

This paper proposed Multiple Layer Perceptron of neural network for the prediction of groundwater quality. The dataset details are collected from solid waste dumping areas such as Perungudi and Kodungaiyur in Chennai. We fed eight neurons to the hidden layers. The training and testing parameters of proposed method is evaluated using state-of-art approaches namely linear regression, fuzzy approach, AFSO, and asymmetric neuro-fuzzy. The experimental results demonstrate that the proposed MLP delivers low RMSE value and high water quality prediction performance.

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