PREFACE

The Groundwater is a significant natural resource for several uses, such as domestic industrial, and irrigation purposes. It might be stated that its use offers a number of advantages as compared to the surface water. Groundwater reservoirs do not suffer seepage losses like surface reservoirs. Besides, evapotranspiration losses in the groundwater reservoir are minimum. It could be developed quickly and near the place of use.

However, there is plenty of water on the earth surface, the supply of fresh water is limited. That is why it is essential to have a ground water reservoir. Keeping in view of this, management of groundwater is required much as the needs for the water resources are increasing day by day. Its management calls for proper and systematic monitoring of level; which fluctuates with time and space. No doubt, groundwater is an important source of water for several purposes in the country at present. Groundwater caters for about 40% of the gross irrigated area in our country. The role of groundwater is all the more important in Ganga basin, which has a vast reservoir of groundwater, replenished every year at a very high rate. The Indo-Gangetic aquifer is one of the world's most valuable transboundary water resources, as well as the world's most frequently used aquifer. About 45% of the total countries resource is located in the Ganga basin alone. Within the basin, the gross annual groundwater recharge has been estimated to be to 212.8 million cubic metres and the exploitable resource comes 149 billion cubic metres per annum. In some areas of the alluvial region, especially in the upper and middle gangetic plain, groundwater is being too heavenly drawn upon, causing grave concern.

Varanasi, a millennia old city and an important city lying in the middle Ganga plain has been chosen for aquifer modelling in order to acquaint with state-of -the-art of groundwater level, its budget and yield capacity. Because of diminishing recharge and expanded interest in groundwater, it is very important to analyse the groundwater level. Estimation of groundwater recharge rate is a fundamental requirement for the proficient management of the groundwater resources and is specifically vital in the area and semi-arid sites where those assets are frequently the way to the financial growth. Excessive removal of groundwater to cater the need of ever growing population in the area chosen has resulted in the land subsidence in past causing a decline of water head. Permanent decline in the water table has been observed due to excessive groundwater withdrawal in the city of Varanasi, the lowering of groundwater has been 7 feet (213 cm) approximately in the preceding years.

In the present study daily meteorological data from the year 1996 to 2020, Digital elevation model (DEM), Soil lithology and Landsat 8 satellite data, Arc-GIS, SWAT-CUP and MATLAB were employed. Besides, the flow of groundwater in the study area covering 293 km^2, has been discussed with the help of GMS-MODFLOW (a widely use Groundwater modelling Tool). The study focused on the groundwater level head fluctuation, identifying the water status in entire study area. Primarily, the locations of wells in the area have been identified with the use of differential global positioning system (DGPS).The investigation of the watershed has been performed in the modelling process. Data from IMD has been taken as input and validation. Arc-GIS SWAT software was used to perform the hydrological analysis. After, the SWAT analysis of the area, MODFLOW software has been used for assessing the water budget scenario. Further, the groundwater levels of the Varanasi wells were measured during

the years from 1996 to 2019 that could be employed for training and testing. Hence, the novel GIC (Generalised intelligence control) with HAC-ABO (Hybrid Ant colony-African Buffalo Optimization) termed as GHAT was developed for forecasting the groundwater level in wells during Post and Pre-monsoon season. The GIC model is used for training the dataset to the MATLAB and the parameters of HAC-ABO model is combined with the GIC classification layer for forecasting the groundwater level and enhancing the performance. A prediction for the groundwater status for next 30 years has been drawn from the present study. So, the proposed approach predicts the groundwater level for next 30 years. Also, it attained high prediction accuracy and lower error rate than other models. The MODFLOW framework and artificial recharge system is broadly explained in fifth and seventh chapters.

In addition to above, an inventory of ponds and water bodies, an important source of groundwater reservoir has been made with utmost interest and passion .The ponds and its ecosystem have come under great pressure in the recent year due to unbridled organisation and encroachment of its surrounding lands. Out of the 118 ponds and tanks in the city the records of 39 are missing in the documents of the Nagar Nigam. As the city is suffering a severe water crisis, Ponds need to be developed. On the basis of these findings, suggestions for sustaining and augmenting the groundwater level in the city have been made, which could prove a milestone in the overall development process as envisaged by the government and also in the path of shaping this millennia old city as a 'Smart City'.