CHAPTER-2

LITERATURE REVIEW

2.1 General

The groundwater has allured the earth's scientists and civil engineers both to carry out some innovative studies pertaining to its budget, aquifer modeling and water level. Its quality and quantity both are equally significant for experts and people. Aquifer studies have attained a new dimension in the country as it is believed that in the coming 20 years, approximately 60 percent aquifers in the country would be assimilating a critical state. This would certainly pose an adverse impact on agriculture, our livelihood, and economics in the country. Significant works have been carried out in groundwater modeling and its sustainable development. The works encompass/involve the various scientific perspective i.e., groundwater modeling techniques, land use, land cover, sub surface and surface interaction, soil erosion, lithology and climate control on the recharge of groundwater.

2.2 A Brief review of groundwater research

Heathcote et al.,1996 has carried out an exemplary study in the area of groundwater modeling. This very work explains how the mathematical modeling of groundwater is utilized in the interpretation of hydrological data. The work helps to develop a conceptual site of hydrogeology. The study presents numerical constituents . In this paper explained about the four variety of models are described in the outline, they are cleavage flow , difficulty in geology, an issue formation, and the presence of solid solutes from more than one source. The conclusion of this research is resolving some issues, and this may be difficult to calculate the models with less active fractures check without including a greater portion.

The concepts of modeling in freshwater have been discussed by C.P. Kumar and Surjeet Singh, 2012. In the study, they explained about the issues falling under groundwater modeling. They delineated mathematical modeling as the tool used for studying the groundwater issues. The work in the total, particularly the mathematical tools used therein, is a good mentor for those who wish to pursue such a study elsewhere.

Kumar, C. P ,2018 presented the components of the groundwater balance equation , effluent and influent seepage, subsurface inflow, and outflow recharge from canal seepage recharge from the field irrigation, recharge from groundwater irrigation. His works present an overview of the hydrological studies focusing on groundwater assessment, soil moisture movement, modeling of seawater intrusion, modeling of groundwater flow and solute transport ,impact of climate change, and the application of hydrological models. The work presents the development status in the hydrological studies related to groundwater hydrology, including a review of basic concepts and associated methodologies. He discussed the modeling of flow in unsaturated and saturated zones, spring flow modeling, the interaction of the groundwater and surface water, conjunctive use of surface water and groundwater, artificial recharge, seawater intrusion, and pollution groundwater.

Kumar, C.P ,2017 presented salient details of groundwater studies. He presented a model of a coastal aquifer using FEEFLOW in Goa and also did hydrological investigation to assess causes of seepage from the reservoir of Jaswan

Sagar dam in Jodhpur Rajasthan. He discussed the impact of climate change on dynamic groundwater recharge in a drought-prone area and effects of rainwater to consign a groundwater availability in Aravali hills, coastal groundwater. Further, Managed aquifer recharge(MAR) and Aquifer storage recovery (ASR) ,flow and contaminant transport, modelling of river bank filtration (RBF) , water enabled groundwater recharge estimation model (WE-GREM) has been used to do much research on Groundwater modeling.

Doherty et al., 2019 presented models to take a correct decision related to modeling. Modeling strategy mattresses processes were utilized to analyze many model runs. All models are based on theoretical and numerical systems that are conceptual in nature and inexact in execution. This technique in the modeling strategy is utilized to optimize the decision-making procedure. Utilizing the bibliometric investigation method gives quantity bits of knowledge into the general scene of integrated water resources assessment and modeling. This research identifies the appropriation and quality of the source. This paper shows biophysical divisions identified with water ,climatic condition ,groundwater ,biology, environmental change and agribusiness .

The optimizing modeling applications is utilized to describe a solution for various optimization groundwater resources issues.In this paper the past surveys are assembled into 9 segments, to improve the modeling with conjunctive planning. Seawater interruption management, managing groundwater, accomplishing ideal editing design, supply frameworks operation, irrigation management, resource management in dry and, managing solid waste, and other utilization which comprises, to solve the issues which are caused in generation of hydropower and sugar industry is discussed by (Singh 2012).

The effect on groundwater and surface water using modeling of groundwater has been introduced by P.K.Roy et al. 2014. Short- and long-duration pumping tests were performed on the Damodar River bed at four distinct sites at Purulia District of India in order to evaluate safe yield, soil profile, and other soil properties. Pumping tests were carried out at the points where the maximum depth of porous media was reaching. The values of aquifer parameters such as specific yield (Sy), transmissivity (T), and hydraulic conductivity (K) for the aforementioned study sites were found to be in the range of 0.043–0.175, 2082–3983, and 219–603 m/day, respectively, using acceptable hydrogeological techniques. GMS software was used to create a hypothetical aquifer-stream water interaction system not only to depict hydraulic head fluctuations in the groundwater system, but also to measure flow rate due to variation in river stage, recharge due to rainfall, and establish how surface water and groundwater could interact . A lithological survey is conducted in the riverbed at intervals of 500 metres to 10.5 kilometres to determine the soil character and profile. The maximum depth of porous medium was calculated using the pumping yield test. Aquifer parameters were estimated using specified yield, hydraulic conductivity, and transmission characteristics. The GMS software is used to compute the surface groundwater influenced by pumping in a hypothetical aquifer stream interconnection system, as well as to discover the rate of flow and rainfall recharge. Finally, the aquifer characteristics were found to be in the range of 219-603 m/day.

Modeling of groundwater for huge scope is created by Refsgaard *et al.* 1999. This researcher studied about 2 case study analyses in an enormous scope recreation of aquifer pollutants because of nitrate filtering. The data accessible from quality strength databases, for example, EEA, GISCO, and EUROSTAT had utilized this premise in the modeling. This information was enhanced by chosen promptly accessible information from state sources. The display factors were totally evaluated by this information in the utilization of the different exchange capacities, and no model adjustment was done.

To handle groundwater management difficulties, McKinney and Lin ,1994 used a genetic algorithm (GA). In their first example, they calculated the maximum yield from an unconfined homogeneous isotropic aquifer. The minimal cost combination of wells to meet an exogenous demand for water from an unconfined aquifer was determined in their second scenario. The third example used air-stripping treatment technology to create a low-cost pump-and-treat remediation system to remove a polluted plume from an aquifer. They employed a response matrix strategy to solve this problem.

2.3 Aquifer Modeling and Management

The water-bearing permeability rock, rock cleavage, or unconstitutional materials of an underground surface is known as an aquifer. Modeling an aquifer is used to find the natural flow of groundwater. Groundwater models are widely used in environmental science. Models have been used to look at a wide range of hydrogeological situations. Recently, groundwater models have been used to forecast the movement of contaminants in order to assess risk. Models, in general, are conceptual descriptions or approximations that use mathematical equations to describe physical systems; they are not exact descriptions of real systems or processes. Kumar, C. P. 1992. The utility or applicability of a model is determined by how well the mathematical equations approximate the physical system being described. It is necessary to have a good grasp of the physical system and the assumptions included in the derivation of the mathematical equations in order to evaluate the applicability or effectiveness of a model. Groundwater models describe the groundwater flow and transport processes using a set of mathematical equations that are built on a set of simplifying assumptions, Anderson et al. 1992. A model must be seen as an approximation rather than an exact duplication of field conditions because of the simplifying assumptions incorporated in the mathematical equations and the many uncertainties in the values of data required by the model. Even as approximations, groundwater models are a useful exploration tool that groundwater hydrologists can employ for a variety of applications.

S.Sidda et al. 2020 highlighted seawater intrusion (SWI), which is a worldwide phenomenon that has been exacerbated and exacerbated in the coastal province due to over-exploitation of groundwater, sea-level rise, and climate change. India's wide and enormous coastline, which occupies the most valuable as well as potential aquifer system, is the keystone of its geography, economy, biodiversity, and ecology. The status, knowledge, and vulnerability of SWI within the aquifers of Gujarat's coastal region were the main focus of this review. Over-exploitation of groundwater is the main cause of SWI in this area. Several models have been created and built in order to examine and epitomise the problems that come with it. Numerical models provide several useful strategies for dealing with groundwater issues. Dilution is one of the sophisticated management solutions it offers. It also proposes certain advanced management options, such as artificial recharge to dilute salinewater, installation of physical barriers in the subsurface to limit incursion, and so on, that are applicable to Gujarat's coast.

Abd-Elaty et al. 2021 is to look at the consequences of brine water injection in the Nile coastal aquifer, which is one of the world's largest underground freshwater reservoirs, and to figure out how to reduce and manage the RO process' environmental impact. A combined seawater intrusion, numerical models for flow and salt transport in aquifers, and solution-diffusion in RO techniques were developed to evaluate the effects of brackish water extraction and brine deep-injection on the Nile coastal aquifer. The effects of several management scenarios on salt mass accumulation in the Nile coastal aquifer were assessed.

Water balance (in terms of water quantity), gaining knowledge about the quantitative aspects of the unsaturated zone, simulating water flow and chemical migration in the saturated zone, including river-groundwater relations, assessing the impact of changes in the groundwater regime on the environment, setting up/optimizing monitoring networks are some of the applications of existing groundwater models, Wang, H.F 1982. Mathematical equations were based on certain simplifying assumptions. These assumptions typically involve the direction of flow, the geometry of the aquifer, the heterogeneity or anisotropy of sediments or bedrock within the aquifer, the contaminant transport mechanisms, and chemical reactions. Because of the simplifying assumptions embedded in the mathematical equations and the many uncertainties in the values of data required by the model, a model must be viewed as an approximation and not an exact duplication of field conditions.

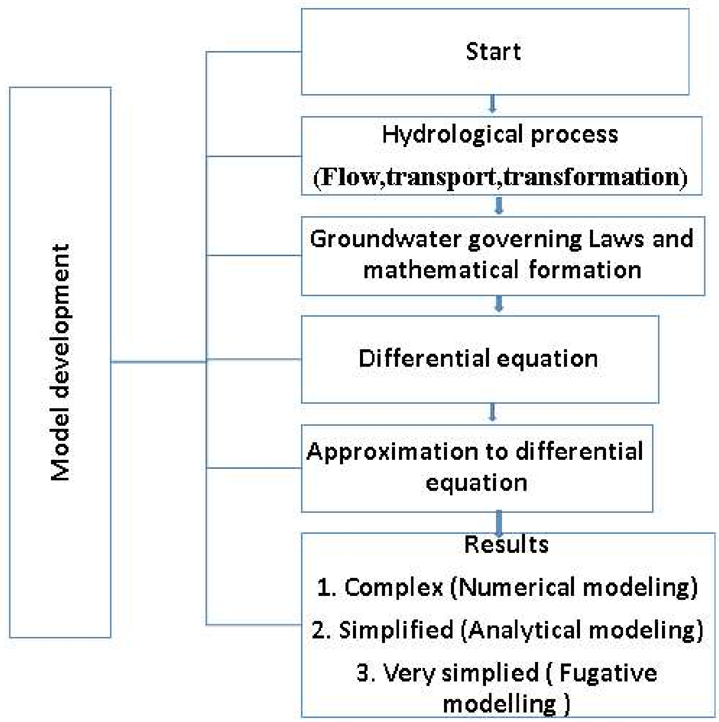

Figure: 2.1 Development of model for groundwater modeling

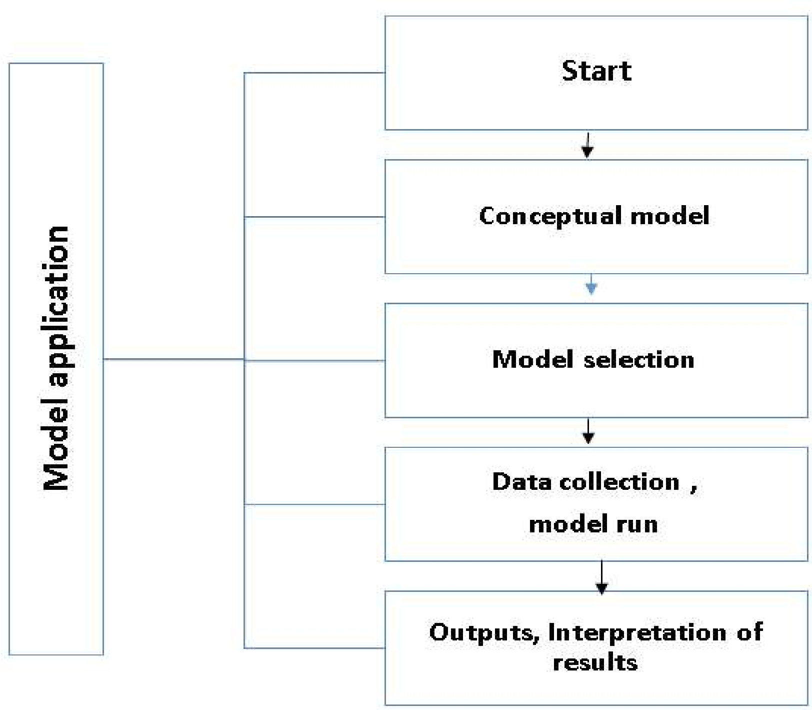

Figure: 2.2 Application of model for groundwater modeling

Figure: 2.1 and 2.2 exhibit the development and application of model in the groundwater studies. Also, forecasting of water level can be done in scarcity of data. Various studies have been done on these modeling techniques. Hydrological Process consists of flow, transport and transformation for a groundwater. Further groundwater deals with mathematical formation which is solved by differential equation which further results in complex (numerical modeling), simplified (Analytical modeling) and very simplified (fugitive modeling) for the development of a model.

2.4 Review based on modeling techniques

Artificial Neural Network (ANN) is an advantageous approach as it is best suited for modeling of non-linear systems (Uddameri, 2007; Balkhair, 2002; Gaur et al., 2021). ANN and fuzzy comparative models could provide an outstanding tool for water level fluctuation (Adiat, et al., 2020; Maiti et al., 2012). Initially, ANN model was used by Aziz and Wong (1992) to establish the aquifer parameters. Later on, in 2006, an improved neural network approach was adopted by Lin and Chen. In the absence of a hydrological relationship, an Artificial Neural Network (ANN) model significantly converts the input to output and provides a better result (Nayak et al., 2004; Chitsazan et al., 2013). This paper as cited herewith, groundwater level fluctuations of concise records with the help of ANN architecture and algorithm in Tirupati, India (Sujatha et al., 2010). Forecasting groundwater level with the help of ANN model giving the best performance by training a Feed Forward Neural Network (FFNN) with Levenberg-Marquardt (LM) algorithm at Maheshwaram watershed, Hyderabad, India (Sreekanth et al., 2011). ANN can establish a relationship between output and input without including the role of physical connection (Malik and Bhagwat, 2021).

The Ganga –Mahawa sub-basin aquifer modeling was introduced by Alaeldin et al. 2000. In this paper, the author explained about the Ganga-Mahawa sub-basin, the area of this basin being 1280km^2. To find the degree of Ganga river and interactivity of aquifer the modeling is carried out. To stimulate oblique influx and out flux the circumference to the east north and east-south are set. In the eastern circumference, there is no-flux condition. The discharge in Mahawa and Badmar are considered. Using plumping and morphometric analysis the distribution of permeability is inferred. In this paper, the output at different cells are assigned for all shallow and deep tube wells. The stimulation was funded out for steady-state flow and it may have calibrated with water level 1986 June. May 1995, the transient condition was calibrated. At finally, the groundwater computed balance is compared with field investigations estimated. The groundwater balance in the Mahawa-Ganga basin was analyzed, and the databases were generated. Morphometric analysis in infiltration zones was assessed using remote sensing data. The permeability has been reduced by 5%using sensitivity analysis.

The Analytic Element Method (AEM) and the Finite Difference Method (FDM) were used to model the part of the Ganga river basin that includes the Varanasi district in this work (Omar et al., 2019). Further results were compared to understand the limitations and benefits of both AEM and FDM in terms of model building, data requirements, and performance. The groundwater model for the transient state condition was created using data from 2004 to 2017. Model development in the AEM is reported to be less complicated than in the FDM. In some circumstances, This research can assist groundwater professionals in determining the optimal strategy for their study region and avoiding the model's complexity. According to the findings, AEM-based flow modeling is more accurate than FDM-based flow modeling.

Gaur, S et al. 2021 analyzed about Artificial Neural Network optimization technique and Wavelet Support Vector Machine (WA-SVR) model for predicting the groundwater level in the given terrain. Groundwater forecasting is significantly needed for groundwater management. The most important purpose of applying the neural network was to extract the probability of various algorithms. An ANN model is much faster than a physically-based model, which it approximates. Prediction of accurate groundwater head helps in the practical and best possible usage of the water resources. The Correlation Coefficient (R) and the Nash–Sutcliffe Efficiency Index were used to assess the models' Effectiveness (Ef). Various network designs and training strategies have been used to increase model accuracy. Following the improvement of model accuracy, it was discovered that the best results might be obtained using a conventional feedforward neural network (FFNN) trained with the Levenberg–Marquardt (LM) algorithm obtained for groundwater level simulation. The results revealed that the ANN model technique was appropriate for predicting the groundwater heads. The study conclusively confirms the ability of ANNs to give the precise estimation of the head value with fair accuracy. According to the findings, the ANNs were able to simulate and predict the water heads in the river with acceptable residuals. However, the WA-SVR model's results were more accurate. In comparison to the ANN model, the wavelet decomposition-based SVR is determined to be superior.

It is proved that an artificial neural network (ANN) can be trained to effectively anticipate transient water levels in a complicated multi-layered groundwater system under varying state, pumping, and climate variables. An ANN was created for a public supply wellfield and groundwater monitoring network near Tampa Bay, Florida, using real-world data. In response to changing pumping and climate conditions, the

ANN was trained to forecast transient water levels at 12 monitoring well locations screened in distinct aquifers. The results were tested against both measured and numerically simulated groundwater levels after the trained ANN was validated with ten consecutive seven-day intervals. The absolute mean error between projected and measured water levels for the ANN is 0.16 m, compared to 0.85 m for the calibrated numerical model at the same locations over the same time period. The ANN also recreated the fluctuating water level more accurately (Coppola et al. 2005).

(Banadkooki et al. 2020) used several temporal delays to try to predict groundwater levels (GWL) based on precipitation and temperature data. To forecast GWL, researchers employed the radial basis function (RBF) neural network–whale algorithm (WA) model, the multilayer perception (MLP–WA) model, and genetic programming (GP). The goals were to: (1) create resilient hybrid ANN models; (2) investigate the integration of ANN models with optimization methods; and (3) investigate uncertainty related to the models' input parameters, with three scenarios with varied inputs taken into account. The results showed that in the first scenario, where the input data was simply the average of the region temperature and three temporal delays of 3, 6, and 9 months were considered, the models based on the three simultaneous temperature inputs with the mentioned delays outperformed the models based on the single temperature input. The MLP–WA model was the most effective.

(Multiple linear regression (MLR) and artificial neural network (ANN) methodologies were compared in terms of their ability to predict transient water levels across a groundwater basin,(Sahoo et al., 2013). Rainfall, ambient temperature, river stage, 11 seasonal dummy variables, and influential lags of rainfall, ambient temperature, river stage, and groundwater level were all considered in MLR and ANN modeling at 17 locations across Japan. Using multi-layer feedforward neural networks and Levenberg Marquardt backpropagation algorithms, seventeen site-specific ANN models were created. Statistical and graphical metrics were used to assess the models' performance. When the MLR models' goodness-of-fit statistics were compared to those of the ANN models, it was found that the ANN-predicted groundwater levels and the observed groundwater levels had a better agreement at all of the locations than the MLR models. The graphical indications and residual analysis both corroborated this conclusion. As a result, the ANN approach has been determined to be superior.

Groundwater flow schemes are executed, and the typical alignment is carried out in the steady-state. To guarantee a strong base for the maintainable controlling of the aquifers, Ghouili et al. 2020 proposed a satisfactory extensive hydrogeological examination. The sampling effort of stable isotopes is to recognize groundwater recharge and related procedures. To measure water-rock interactions and to estimate the Spatio-temporal progression in the shallow aquifer of Sidi El Hani positioned in central-eastern Tunisia, (Soumaia M Nassri *et al.* 2019) utilized the statistical code in Kinetic Reaction and Mass Transport (KIRMAT). Here, the investigation tends to the evaluation and forecast of the chemical fluctuations of dissolved things in the groundwater, besides the main methods in geochemical, which developed in the aquifer through a flow path.

(Kushwaha et al. 2009) predicted groundwater flow using MODFLOW finite difference model. To elaborate properly depict real-world conditions, the conceptual model is developed utilising Geographic Information System (GIS) components such as points, arcs, and polygons. They describe the results of a mathematical groundwater model constructed by using a conceptual groundwater modeling approach for the northern section of the Mendha sub-basin in the semi-arid region of north-eastern Rajasthan. Groundwater Modelling Software (GMS), which supports the MODFLOW-2000 code, was utilised for the study. Recharge Coverage, Extraction Coverage, Return Flow Coverage, and Soil Coverage were all taken into account when modeling the Source/Sink Coverage. The groundwater storage system is expected to fall from 349.50 to 222.90 MCM, while groundwater abstraction is expected to increase from 258.69 to 358.74 MCM per year, according to water budget projections. Water table contour maps for the years 2007, 2015, and 2020 have been created as well.

(Eryigit 2021) proposed a groundwater flow model. In addition, the model requires fewer observation numbers for parameter estimation than other studies. The hydraulic conductivity, transmissivity, storage coefficient, and leakance of groundwater flow were all estimated simultaneously using an optimization model based on model calibration. MODFLOW was used in conjunction with the MATLAB model to simulate the groundwater flow. The MODFLOW input files were collected using the GMS groundwater simulator. To assess the model's performance, it was applied to two separate hypothetical groundwater systems (two- and three-dimensional) under transient situations. The results demonstrated that the model could be used to estimate groundwater flow and that it could correctly determine groundwater flow parameters with fewer observations and more grid cell numbers than previous studies.

(Xiang et al. 2020) stated that the groundwater modeling tool is a crucial structural tool for resolving a wide range of groundwater-related issues. Visual-MODFLOW is an example of a tool that solves problems using the finite-difference (FD) technique. The groundwater level simulation in Purba (East) Midnapur, West Bengal in India, was analysed using Visual-MODFLOW 2000 in this study. Pumping well discharge data was obtained over two distinct time periods in 2002 and 2012. The predicted pumping well records for 2012 based on pumping well discharges recorded in 2002, and the actual records in 2012 have been scrutinized, compared, and correlation coefficients determined to indicate data validity.

(Malekzadeh et al. 2019) stated that groundwater modeling has developed as a result of the requirement to predict changes in groundwater systems and the environment. MODFLOW, Extreme Learning Machine (ELM), and Wavelet-Extreme Learning Machine are used in this research to simulate the groundwater level of the Kabodarahang aquifer in Hamadan Province, Iran (WA-ELM). To begin, MODFLOW simulates groundwater levels with good precision, resulting in a correlation coefficient (R2) and Scatter Index (SI) calculations of 0.917 and 0.0004, respectively. Following that, ten alternative models are created as separate lags for the ELM and WA-ELM models using various input combinations and stepwise selection.

El-Zehairy et al. 2018 stated that in distinction to natural lakes, artificial lakes (reservoirs) are controlled water bodies with significant stage changes and distinct interactions with groundwater. For the artificial Lake Turawa in Poland, a new modeling study describing the dynamics of these interactions is provided. The combined surface-water/groundwater MODFLOW-NWT transient model was calibrated over a 5-year period (1-year warm-up, 4-year simulation), using daily lake stages, heads, and outflows as control variables.

During the Surfactant-Enhanced Aquifer Remediation (SEAR), the separation of surfactants to Non-Aqueous Phase Liquids (NAPLs) is possibly a significant and non-negligible occurrence, which is emphatically affecting remediation competence.

Masoud Babaei *et al.* 2019 used a technique that numerically examines the influence of surfactant separating on the improved NAPL suspension and mobilization techniques and the complete NAPL elimination from the subsurface. The geospatial technique is useful to portray the artificial recharge areas. Artificial recharging of groundwater is a significant procedure for managing the surface and subsurface water resources. (Avtar Singh Jasrotia *et al.* 2019) proposed a new combined approach to define the artificial recharge structures using geospatial technology is found efficient to limit the time.

2.5 Study on Climate Change and Groundwater Resources

Changes in precipitation and evapotranspiration are foreseen to alter groundwater as a result of climate change. Increased saltwater intrusion into coastal and island aquifers may result from rising sea levels, while increased frequency and intensity of floods may have an impact on groundwater quality in alluvial aquifers. Sea-level rise causes saline water to seep into fresh groundwater in coastal aquifers, posing a threat to groundwater resources. The thickness of the freshwater lens was calculated to fall from 25 m to 10 m and from 36 m to 28 m for two tiny and flat coral islands off the coast of India, respectively, for a sea-level increase of only 0.1 m. (Mall et al., 2006). Increased precipitation in brief, heavy spells will result in low infiltration, resulting in low soil moisture availability. In addition, water management techniques in the area, such as the number of reservoirs and boreholes, would affect water availability.

Green *et al.*, 2011 addressed the difficulty of understanding and predicting many interrelated variables in location and time in their first thorough study of climate change and groundwater systems. This assessment included an examination of General

Circulation Models (GCMs) and future projections, as well as a detailed description of groundwater dynamics in the wake of the Inter-governmental panel on government change in their fourth assessment report. The study also highlighted various observational tools, such as isotopic, geochemical, geophysical, and remote sensing technologies that could be effective in tracking large-scale groundwater changes.

The representation of eight aquifer systems in the western United States was explored by Meixner et al. 2016 by examining temperature and precipitation will likely affect recharge, this major body of work-integrated conceptual understanding with projections of future recharging circumstances. The researcher presented a technique to bridge the geographical gap between the global process of climate change and more localized influence on particular aquifer systems by examining recharge mechanisms and devising a systematic strategy to present future scenarios.

The rainfall-runoff models failed to credibly account for the Surface Water-Ground Water (SW-GW) exchanges. Also, it failed to vigorously pretend runoff throughout multi-year droughts, particularly in arid & semi-arid catchments, which are moderately flat. Thus to solve this problem, (Proloy Deb *et al.* 2019) introduced a combined SW-GW modeling scheme and examined it under various climatic conditions in double heterogeneous, semi-arid catchments in the location of southeast Australia. Hence, the outcomes show that the combined SW-GW modeling scheme creates extremely increased runoff simulations using catchments, particularly in dry situations.

For studying climate and projecting climate change, a number of Global Climate Models (GCM) are available. GCMs must be downscaled to a basin scale and coupled with applicable hydrological models that account for all aspects of the hydrological cycle. The output of these coupled models, such as groundwater recharge estimates, will aid in the development of appropriate climate change adaptation measures. The expected influence of climate change on groundwater resources, a climate change scenario for groundwater in India, the status of national and international research investigations, and a technique to estimate the impact of climate change on groundwater resources are all discussed in this article (C. P. Kumar ,2016).

2.6 Land Use/Land Cover Analysis

Change in patterns of land use cover caused by Social activity by humans tend to lead changes in vegetation, which affects biodiversity, water, and radiation budgets. A change in Land use and Land cover does not necessarily indicate the degradation of the land; other processes that come together to influence the climate and biosphere cause a change in Land use and Land cover pattern. (Riebsame et al., 1994).

Natural phenomena such as flood, fire, climate variability, weather, and ecosystem dynamics might affect the land cover. Globally, LULC change fundamentally direct human use such as agriculture and animal husbandry, forestry and management, and rapid construction in urban areas and development in rural areas (Meyer, 1995).

As analysis of land use and land cover is important to study the change in pattern over the period of time, but the convention is time-consuming, and possibilities of error could be high. Keeping this in view, Olorunfemi, 1983 stated that the analysis of the LULC with the change in time is difficult and cumbersome with the traditional method of surveying. In recent years, the use of satellite images has proven to be of great option for the analysis of LULC and monitoring the changes frequently and at regular intervals. With the advancement in the field of satellite remote sensing techniques, this technique has been proved to be beneficial in the case of a remote area, since in that area use of conventional methods are not possible Perhaps ,it is the only technique by which mapping can be done in a very efficient manner.

Since different sensors are used in satellites for different purposes with different characteristics, azimuth angle, difference height, sun angle, etc., the interpretation of satellite imagery and classification depends on sensors and their resolution. Hence use of a single classification method to all types of images can give slight error in the result. In this regard, the most appreciable work was done by Anderson et al., 1976. He proposed a general-purpose classification scheme that is the most compatible with Remote Sensing images, and this scheme is also referred to as the USGS classification scheme. Later on, based on the Anderson scheme, other modified classification algorithms were developed.

Later on, more study related to remote sensing technique and land use land cover was done by many researchers. Shoshany et al., 1996 discovered the upsides of remote sensing techniques methods in association to field surveys in providing a regional description of vegetation cover. The results of his study were used to produce four vegetation cover maps.

Several studies show the negative effects of soil erosion on Land use and Land cover. Bakker et al. 2008 cited that erosion reduces productivity by an average of 4% for every 10 cm of soil loss. In association with development, the change in Land use and Land cover is subject to change. The soil of many river watersheds does convert to impermeable soil surfaces, which results in lower soil infiltration rates and consequently increases the rate of runoff.

LULC within watershed plays a crucial role in watershed development and management. In the past, numerous studies have been done on hydrological simulation models, which were applied to estimate the impact of land cover changes on water balance at the catchment scale e.g., Bultot et al., 1990; Lorup et al., 1998; Lukey et al., 2000; Wegehenkel, 2002; Ott and Uhlenbrook, 2006. Bosch and Hewlett (1982); Hornbeck et al. (1993); also stated that change in LULC can significantly affect the water balance within the watershed.

One of the vital aspects for watershed management is the management of drainage networks, and drainage pattern and their properties should be known to one for the analysis. A better way to understand conceptualization and competing demands on water resources is to consider the rain falling within the watershed, as converted into two major components- Blue Water and Green Water. According to. Falkenmark, (1997) 'Blue water' is the water that runs out of the watershed in the end and is usually affected by a physical process like runoff, through flow and streamflow. 'Green Water' is the water that is lost from the watershed through various natural phenomena such as evaporation from water bodies and transpiration by vegetation. If the land-use changes, then the ratio of blue to green water may change also.

2.7 Work on Watershed Prioritization

Understanding watershed management and its basic characteristics like current erosion status, drainage pattern and their characteristics, available natural resources, and groundwater potential of the watershed are important for the sustainable development and management plan for conserving the natural resources, i.e., soil and water in the watershed. This watershed development and management planning are beneficial if they divide watershed into small sub-watershed or, say, micro-watershed. Watershed can be delineated from the depression less Digital Elevation Model (DEM), providing an outlet point.

Flood problems in India have also been reviewed by (Mohapatra, P. K., & Singh, R. D. 2003; Regional variations of the problem, current status of ongoing management methods, their effectiveness, and future flood management needs are all discussed in this study. Some unique flood-related issues, like dam breakage and waterlogging in Tal regions, are also mentioned. The progress of various structural and non-structural flood management measures is discussed. In addition, future demands for efficient and effective flood management techniques in India are highlighted.

Martz & Garbrecht, 1992 explained that Digital Elevation Model (DEM) could be made appropriate for watershed delineation at the small scale (sub-watershed level), by using the fill depression removal technique. An automated watershed delineation algorithm creates a layer of the flow path, which provides effective and useful results in the areas where convergent flow occurs, along with well-defined valleys (Freeman, 1991).

A similar result was presented by Moore, 2000. He stated that the D8 method likely to produce the flow in parallel lines along the main direction of the stream. (Liang & Mackay, 2000) proposed a methodology for small-sized watersheds, which stated that sub-watersheds of appropriate sizes could be delineated using flow direction and flow accumulation raster map. Similarly, DEM can also be used for preparing slope maps and contour maps in raster and vector form.

Remote Sensing and GIS techniques together have been proved as a powerful tool for finding suitable sites for conservation structures at the micro-watershed level. Geoinformatics techniques are convenient, and it helps in setting the different criteria standards so for locating suitable sites for land surface and water conservations structures in the watershed at a small level (Micro-watersheds) (Ravindran et al., 1992). A similar conclusion was made by (Durbude and Venkatesh, 2004).

Khan, A. et al. 2020,discussed about Analytical Hierarchy Process (AHP) based modelling in a Geographical Information System (GIS) context, artificial recharge sites were designated in the current study employing essential elements that play a very key role in groundwater occurrence.Datasets and images from various sources such as Landsat-8 satellite were utilised to assign weightage to various factors based on their importance in artificial recharge site selection. There is a constant decrease in the groundwater levels in area of Agra district and Firozabad district.These sites are generally found in and near settlement areas that are at a higher elevation. Overall, 26 percent of the study region (i.e., the very low water level class in the study area) has poor groundwater conditions (i.e., 32–42 m bgl), necessitating prompt artificial technology treatment to supplement the water strained alluvial aquifers.

Nhamo et al., 2020 discussed about groundwater sustainability, extent and availability, and challenges that requires a quantitative assessment of its current use. This study used crop evapotranspiration and irrigated crop area calculated from the normalised difference vegetation index to measure groundwater use for irrigated agriculture in the Venda-Gazankulu area of Limpopo Province in South Africa (NDVI).

Water Productivity through Open Access of Remotely sensed Actual Evapotranspiration and Interception (WaPOR) dataset (250 m resolution) was used to calculate evapotranspiration, and irrigated areas were identified using dry season NDVI data from Landsat 8. For four years, field surveys were done to assess accuracy and remedy post-classification errors. The dry season ET (May to September) was calculated using the actual ET for irrigated areas. To determine ET for solely irrigated land parcels, the irrigated areas were superimposed on the ET map. During the dry period of 2015, groundwater use was 3627.49 billion m3, with irrigated land accounting for 26% of cultivated land. A total of 44 million m3/ha of water was used to irrigate 82 435 ha of cultivated land, compared to 186.93 million m3/ha on a rained area of 237 847 ha. In the face of water shortage, groundwater management is critical for building resilience in dry environments.

Sarkar and Garg, 2012 represented Satellite data that has provided information on the river system's channel configuration on a regular basis, revealing much-needed data on changes in river morphology, erosion/deposition patterns and their impact on the land, stable and unstable reaches of river banks, changes in the Brahmaputra River's main channel, and so on using a combined Remote Sensing and Geographic Information System (GIS) methodology.

2.8 Study on Sediment Yield and Hydrological Modeling

Some of the hydrological models such as AGNPS, MIKE SHE, and SWAT have been developed in recent years by researchers and are used to simulate hydrological processes (Young et al., 1987, Tripathi et al., 2003, Arnold et al., 2012). Modeling of soil erosion and sediment yields in a vast cultivated land of south Brazil was done using Water and Tillage Erosion Model (WATEM), and Sediment Delivery Model (SEDEM)

(Didone et al., 2017); Yesuf et al., 2015 used three methods USLE-M, RUSLE-2, and WEPP for erosion management.

WEPP is the model which can be effectively used for both runoff and sediment estimation using GIS and remote sensing techniques (Pandey et al., 2004). Unit Sediment Graph is a much better process than Modified USLE and WEPP when the Climate change factor is considered ChandraShekar et al., 2015.

Among all the studied models, SWAT is entrenched for dissecting the effects of land management practices on water, silt, and complex watersheds. SWAT is a very extensively used model for sediment yield modeling (Jeong et al., 2013). SWAT is used for watershed management to enhance water quality requirements (Mittelstet et al., 2016).

The SWAT model is a physically-based continuous model developed by the USDA Agricultural Research Service (ARS) (Arnold & Allen, 1996). Hydrological modeling, runoff and soil loss prediction, water resource management, water quality modeling, land-use change affect assessment, and climate change impact assessment are done by using this model. (Prabhanjan et al., 2014) did their study about a watershed-based model using Soil & Water Assessment Tool (SWAT) integrated with geospatial techniques like Remote Sensing & GIS to model runoff and sediment yield for Khadakohol & Harsul watersheds in Maharashtra, India.

Kumar et al., 2015 attempted to classify critical watersheds disposed to soil erosion by using a hydrological model in the data-scarce Damodar River catchment, located in the Jharkhand state of India. He concludes the methods for controlling water and soil losses, which can recover reservoir life and storage for its use in flood control purposes, irrigation and hydropower production. Such an approach is particularly required in emerging countries like India for better employment of limited resources or where data is not available in sufficient amounts.

Karcher et al. 2013 proposed a modified method of Soil & Water Assessment Tool to identify areas where substantial improvement in downstream water quality was seen by applying principal management practices. Gayley (2012) used the Arc-Map-based SWAT software to estimate hydrologic resources in the San Miguel Creek watershed, Texas, to count possible reserves. The results were applied to the same agricultural land in the Edwards Aquifer Groundwater Conservation District, Texas State Regional Water Planning Area falling in the Edwards Aquifer Groundwater Conservation District, and Texas State Regional Water Planning Area (RWPA-L). In barred river basins, across borders, or in other locations where farmed channel flooding is still prevalent, where water deficiency may be a concern, the upfront methodology can be used to estimate water severity and potential water savings.

Sardar et al. 2014 modeled the Barakar Basin's hydrology and acute erosion-prone zones were classified using the Soil & Water Assessment Tool (SWAT). This work backed the selection and implementation of effective soil management techniques to reduce soil erosion. Five years of daily meteorological data, monthly discharge, sediment production, and reservoir inflow data were used. The SWAT model was found to be a useful tool for selecting a management plan for reducing reservoir sedimentation rates.

Dile et al., 2016 created an open-source user interface for the Soil & Water Assessment Tool (SWAT) model. The interface performed similar operations to Arc

SWAT but with added capabilities like integrating small sub-basins , static and dynamic output concepts. The interface was tested in a case study in Ethiopia's Lake Tana basin's Gumera watershed, where it performed well. QSAWT has shown to be a useful tool for the SWAT scientific community, offering greater ease and functionality than other SWAT model generation options.

Pisinaras et al. 2010 applied the Soil & Water Assessment Tool (SWAT)-2005 to the Kosynthos River basin in northeastern Greece, combining it with a GIS interface. It was demonstrated that, if correctly verified, the SWAT model may be used to examine management conditions in the watershed. The model solicitation, which was aided by Geoinformatics technology, was discovered to be a useful and consistent instrument for water evaluation, particularly in the context of water management strategies.

Vigiak et al. 2015 developed a robust sediment calibration approach for wide regions. Various researchers have examined and reformed the Soil & Water Assessment Tool (SWAT) for applications in big basins. The Upper Danube Basin was used as a case study. To determine effective algorithms for calculating hillslope characteristics, the Changed Universal Soil Loss Equation (MUSLE) was modified.

Mittelstet et al., 2016 using the Soil & Water Assessment Tool (SWAT) model demonstrated how a watershed model may provide crucial information for watershed-based strategies to provide numeric water quality requirements. Estimating P-loads was used to estimate the numeric water-quality criteria for the Illinois River Watershed(IRW) and Eucha-Spavinaw watersheds (ESW). The procedures of runoff and P calibration and validation were used. The model was used to classify a set of potential management strategies in Oklahoma that might help the Illinois River, Barren Fork Creek, and Flint Creek meet the water-quality criteria ,Vilaysane et al., 2015. In the Xedone River basin, in the southern part of Laos, an attempt was made to predict the hydrological stream path using the Soil & Water Assessment Tool (SWAT) model. The SUFI-2 technique was used to calibrate and validate the model, which was used to investigate climate and land-use change influences and sediment and water quality. This can be beneficial in the management of flood disasters and the construction of dams.

Psomas et al. 2016 used the Soil & Water Assessment Tool (SWAT) and the Water Evaluation & Planning System to model catchment in the Ali Efenti watershed of the upper Pinios River basin in Greece (WEAP). Calibration and validation were both carried out. Both theories are based on two distinct techniques.

Ghoraba et al., 2015 had attempted to replicate the hydrology of the Simply Dam watershed, which is located in the Saon River basin to the north of Islamabad, Pakistan's National Capital. The simulation was completed successfully, and the dam's monthly volume inflow was calculated. It was determined that the SWAT, if properly calibrated, can be used to provide semi-arid zone water management strategies.

2.9 Summary

Literature surveys were performed concentrating on review papers related to groundwater modeling. In the modeling of an aquifer, climate effect on groundwater, Land use, Land cover, different modeling techniques (which cover all the necessary contents related to groundwater) was considered. The economic viability of such studies is obvious. This clarifies the basic relationship between man and the ecosystem. The above studies could prove a stepping stone in the path of management of groundwater resources.