THE MEWAT ANALYSIS FOR AGRICULTURAL AND GROUNDWATER FEASIBILITY IN THE STATE OF HARYANA

Vinod Kumar*

Assistant Professor, Department of Geography, Government College for Girls, Mandkola, Palwal, Haryana, India

Email ID: choudharyvinod02@gmail.com

Accepted: 10.05.2024 **Published**: 01.06.2024

Keywords: Groundwater, Natural Resources, Social and Economic Development.

Abstract

All human activity depends on groundwater, one of the planet's most precious natural resources. It is essential for a region's social and economic development in addition to human existence. Additionally, over half of India's population makes their living from agriculture and related industries. To accomplish sustainable resource development and management, sustainable agriculture will need to provide long-term benefits. Evaluating an area's groundwater and agricultural potential is essential for effective groundwater and agricultural management. By boosting the likelihood of drawing water from productive structures, this research may help to optimize the location of future drilling and meet the region's growing water demand, particularly for agricultural purposes. The goal of the current study is to evaluate the areas in Haryana's southern Mewat district that have promise for agricultural and groundwater. The research region's land use and land cover, geology, geomorphology, lineament density, slope, drainage density, soil, and other thematic layers are prepared for the mapping of groundwater potential zones in order to meet the objectives. Potential theme layers for agriculture were created, including the Soil Moisture Index (SMI), Land Surface Temperature (LST), Slope, Rainfall, Normalized Difference Vegetation Index (NDVI), and Digital Elevation Model (DEM). An analytical hierarchy process (AHP) evaluation approach is used to integrate all theme layers. Each topic, along with the categories that go with it, receives a knowledge base weighting between 1 and 5 based on its potential for agriculture and ability to retain groundwater. Using the weighted overlay technique, all of the theme maps are combined to create a composite map showing the research region's groundwater potential and agricultural potential. Four categories, ranging from very low to outstanding potential zones, were further separated into the maps of groundwater potential and agricultural potential. It has been determined that 20% and 22% of the region have outstanding and agriculture potential, respectively, and that 69% and 60% of the land have moderate to good groundwater potential. Finding suitable locations for water extraction and effective farming techniques will be made easier with the use of this groundwater and agricultural potential information.

Paper Identification

**Corresponding Author*

Introduction

One of the most important freshwater resources that humans may ethically explore and use for our daily needs is groundwater. It is kept in reserve in the top part of the shifting underlying geological formations that make up the earth's crust. Groundwater reserves can be utilized globally for many objectives related to household, industrial, agricultural, and other development. We are delving more into these subterranean freshwater deposits as a result of the growing worldwide need for freshwater. The two main determinants of groundwater flow are permeability and porosity. The groundwater aquifers are replenished by rainfall and water flow, and outflows include water flowing into lakes and streams, springs, evaporation, and pumping. One kind of water that permeates every void in a subsurface geological layer is called groundwater. Groundwater, which is created when some rainwater seeps into the earth and turns into groundwater, is the most vital component of the water cycle. The presence and distribution of this kind of freshwater resource are influenced by a wide range of natural factors, such as land use, rainfall, lineament patterns, soil, geomorphology, and drainage patterns and density. Based on these variables, there are various ways to calculate the groundwater availability for human use. Managing water resources sustainably will increase agricultural output. Therefore, it is essential to carry out a trustworthy assessment of water use for the restricted water supply and to prepare wisely. With 15–20% of the country's GDP coming from agriculture, the sector is the foundation of the Indian economy and has already played a significant role in the advancement of the economy and the fight against poverty. Groundwater projects should be installed in regions where rainfall unpredictability and shortage are essential environmental factors for increasing agricultural productivity. Because groundwater is becoming more and more important for irrigation, groundwater mapping using geospatial techniques has become a significant tool in the fields of agriculture and water management. The analytical hierarchy process (AHP) is utilized to determine the relative relevance of thematic characteristics. In order to determine the best multipurpose river projects and maximize irrigation potential for improved site selection and water supply scheme design, Akhtar et al. used geospatial techniques. Hu et al. evaluated crop evapotranspiration and groundwater availability in order to investigate the possibilities of irrigated agriculture. Worqlul et al. used pairwise comparison approaches and ranking techniques to evaluate the irrigation potential.

India is significantly dependent on groundwater for a number of industries, the most significant of which being agriculture. In rural areas, 80–90% of the water used for domestic use comes from groundwater. Additionally, 50% of the water used by cities and industries comes from groundwater. Additionally, it provides water to almost 50% of the irrigated land. Roughly 90% of extracted groundwater is used in irrigation, or 60–65% of irrigation for agricultural purposes. Given the impending water problem, safe drinking water is becoming increasingly important in India. Rising urbanization, modernization, and population increase in India are having an impact on water quality and quantity in both rural and urban areas. The issue of contamination and pollution in water It is common knowledge that India is on the brink of a freshwater crisis as a result of mishandled water resources and environmental degradation, leaving millions of people without access to clean drinking water. Over the past 20 years, as extraction has risen, water levels have severely decreased in numerous sections of the country. People in the Mewat district of Haryana are forced to purchase water to meet their needs due to problems with both the quantity and quality of groundwater. The study's primary goal is to define, locate, and map Mewat district, Haryana's groundwater resources and agricultural potential as a model for sustainable water resource development and planning in the region.

STUDY AREA

Since the government's supply of fresh water is inconsistent and poses a significant threat to the Mewat district of Haryana, appropriate groundwater sources must be identified, particularly for the district's agricultural demands. With a total area of 1507 square kilometers, the district is the 16th largest in the state and the 544th largest in the nation. Its coordinates are 199 meters above sea level, 28 °12′ N latitude, and 77 °3′ E longitude. In 2019, the land area covered by forests made up 7.38 percent of the total area. Its borders are as follows: the districts of Gurgaon to the north, Rewari to the west, and Faridabad and Palwal to the east. The district's soil is light and sandy. It is located in the subtropical region. The district is bisected by National Highway 1. The district's climate is similar to that of other northern Indian locations. The district's climate is extremely hot in the summers (40 °C) and moderately cold in the winters (10 °C). The monsoon season is when it rains the most. In the 2018–19 calendar year, the district received 525.8 mm of rain. The average annual rainfall in Mewat is about 595 mm. The district is divided into four sub-districts, eight towns, and 439 villages. The Mewat region is primarily underlined by Quaternary alluvium, which serves as a primary groundwater reservoir. A small amount of groundwater can also be found in the district's strike ridges' cracks, rock joints, and crevices of hard rocks. The top zone's groundwater is reported to exist down to a depth of 70 m and may retain water in phreatic circumstances. Deeper-level aquifers are either completely or partially enclosed. In the Mewat area, the Central Ground Water Board has conducted exploratory drilling at depths between 39 and 291 m. The results of the exploratory boreholes show that the alluvial deposit in the deeper zones contains different amounts of sand, clay, and kankar. These sediments lay on the Delhi System's basement of rocks. The area's alluvium thickness ranges from nearly nonexistent near hill ranges to over 291 m.

MATERIAL AND METHOD

Thematic layer preparation

The groundwater and agricultural potential zones were drawn in this work using a combination of RS and GIS techniques. These methods are among the most advanced and cost-effective since they produce data that is excellently suited for this type of evaluation. The groundwater potential zonation was created using seven thematic layers: Geomorphology, Soil, Slope, Drainage Density, Land Use/Land Cover, Lineament Density, and Geology. The agricultural potential zonation was created using six thematic layers: Digital Elevation Model (DEM), Slope, Normalized Difference Vegetation Index (NDVI), Land Surface Temperature (LST), Soil Moisture Index (SMI), and Rainfall. These factors influence the potentiality for agriculture. Groundwater and Agriculture Potential Zones were extracted by overlaying all of the layers with a weighted overlay tool from the spatial analyst toolbox in

ArcGIS 10.8.2.Using a weighted overlay technique, all of the spatial layers were integrated to identify the prospective zones for agricultural and groundwater. Prior to the overlaying process, every spatial layer was categorized using a consistent ranking system with 1 denoting low potential and 5 denoting great potential. Since geomorphology is the most significant factor influencing the presence of groundwater in a weight, it was given the highest weight; in contrast, LULC and Drainage Density were given low weights when it came to groundwater potential. The agriculture potential map was created using a similar method, giving NDVI and DEM a low rank, Slope and Rainfall a moderate rank, and LST and SMI a high rank because they significantly impact a region's capacity for plant development. The final integrated maps were made using ArcGIS's weighted overlay tool. This methodology provides a way to connect many thematic maps by giving each raster a standard measuring scale of values, weighting each based on its significance, and putting all of them together to create an integrated map. The weighted overlay procedure in the current study was carried out by assigning weights to the various thematic categories and ranking the relevant criteria.

SOIL

The amount of water that can seep into subterranean formations and thereby impact groundwater recharge is highly dependent on the type of soil. The two main factors considered in determining the rate of infiltration are the soil's hydraulic characteristics and texture. The Mewat area's soils are loamy sand with a medium texture and a low to medium organic content of 0.25 to 0.75 percent.

Lineament Density

Lineaments are curved or linear features that are controlled structurally. The satellite images show generally straight alignments, which makes them simple to identify. Lineaments are places where secondary porosity and increased permeability have resulted from faulting and fracture. The lineament density rankings are based on how near the lineaments are to one another.

Geomorphology

The topography and landform of a region are described by geomorphology, one of the essential components that is commonly used to define groundwater potential zones. Details about the distribution and locations of various landform characteristics within the region are provided. While the structural and denudational hills are assigned lower weights, the younger and older coastal/fluvial plains, water bodies, and valley fill are assigned higher weights.

Geology

The geology of the study region controls groundwater occurrence, flow, and storage. The Mewat district's geological map displays three separate sections. Undifferentiated aeolian/fluvial sediments, with a high potential for groundwater, cover much of the region. The rocks of the Ajabgarh subgroup of the Delhi supergroup are found in the elevated areas of Mewat. They have a moderate potentiality for groundwater occurrence since they are primarily made of carbonaceous shales and arenites. The district's northwest contains a few minor outcrops of the Alwar group of rocks, which have relatively little potential for groundwater occurrence because they are formed primarily of granite.

Land Surface Temperature

To put it simply, land surface temperature (LST) is the amount of heat that an area's surface would feel like to the touch. For effective farming, land surface temperature is a crucial controlling factor. Higher land surface temperatures are typically associated with areas that are not ideal for agriculture, such as heavily inhabited areas, asphalt surfaces, mining industries, etc. Very low (5–10 °C), low (10–20 °C), medium (20–30 °C), high (30–40 °C), and very high (40–49 °C) were the new classifications assigned to the LST map.

Agriculture Potential

After the six maps were integrated, the final map was separated into four agriculture potential zones: extremely poor, poor to moderate, moderate to very good, and exceptional. The highest rating went to the feature with the most potential for agriculture, while the lowest rank went to the feature with the lowest potential. After giving each theme a certain amount of weight and ranking each feature, the themed layers are converted into a raster format. Lastly, the weighted overlay tool in ArcGIS was used to build an integrated agriculture potential zone map.

Due to the region's virtually level terrain, low land surface temperature, high soil moisture index, and heavier rainfall, the majority of the southeast portion of Mewat has a good potential for agriculture, as the agriculture potential map plainly illustrates. The produced map of agricultural potential shows that the majority of the Mewat region is classified as having moderate to very good potential, while other sections are classified as having poor to moderate potential. Higher slopes, lower NDVI, lower SMI, and higher LST are classified as being in the zone of very poor agricultural potential. Regarding the hydro-chemical analysis of the Mewat district's groundwater. Because it identifies and illustrates possible development areas and shows how the methodology can be applied to regions with comparable topographical and geomorphological features both domestically and abroad, this study will be extremely helpful to policymakers, agriculturists, and planners of water resources. The groundwater potential zone map was validated by plotting the positions of the several wells, from which the water level data was obtained.

Conclusion

Based on the integration of many theme maps, remote sensing and geographic information systems (GIS) have shown to be crucial tools in identifying promising zones for agriculture and groundwater. The geomorphology and slope of the land are intimately correlated with the presence of groundwater. In hard rock regions, the presence of lineaments affects the possibility of groundwater occurrence. The study region is dominated by very flat slopes and unconsolidated sediment layers. The groundwater potential of residual hills, structural hills, and steeply sloping linear ridges is affected by the presence of lineaments and can be classified as very poor or poor to moderate. The groundwater potential map shows that the alluvial plain, which is made up of sand, silt, and clay, has good potentiality due to its nearly flat slope. Due to its smaller capacity to hold water, the pediment plain with a gentle slope has modest potential, whereas the aeolian plain with coarse to fine aeolian sand has moderate to very good potential. Furthermore, the agricultural potential map indicates that most of the southeast Mewat region has excellent potential (319 km2) for agriculture due to the region's nearly flat terrain, low land surface temperature, high soil moisture index, and higher rainfall totals. The generated agriculture potential map indicates that the majority of the Mewat area is situated in the moderate to very good (865 km2) agriculture potential zone, with some areas falling into the poor to moderate (264 km2) category.

Further research can be initiated using the groundwater potential map and the agriculture potential map that are generated as a result. The sustainable use of groundwater is necessary to ensure long-term agricultural sustainability as well as socioeconomic development in any location, as this study has shown. Groundwater and agriculture potential zones may be found utilizing RS and GIS approaches. The mapping of groundwater potential has increased recently in response to the growing demand for water resources. Geographic information systems (GIS) and RS have shown to be a powerful tool and an affordable method of determining a region's potential for agriculture and groundwater. For research, efficient planning, and long-term. Accurate groundwater delineation is necessary for groundwater exploration, efficient planning, sustainable use, and management of groundwater resources. It also serves to offer recommendations for future research and guidance for groundwater prospection. Groundwater zones provide the comprehensive hydrogeology and geophysical studies needed for well installation and proper well operation, especially in agricultural applications. The study claims that by combining the six thematic maps for agriculture potential (LST, SMI, NDVI, Slope, DEM, and Rainfall) with the seven thematic maps for groundwater potential (geology, drainage density, geomorphology, soil, lineament density, slope, and land use/land cover), local officials, planners, and farmers will have first-hand knowledge of the best locations for groundwater exploration and productive crop plantations.

Reference

1. Arulbalaji P, Padmalal D, Sreelash K. GIS and AHP techniques based delineation of groundwater potential zones: a case study from Southern Western Ghats, India. Sci Rep. 2019;9(1):2082.
2. Greenbaum D. Review of remote sensing applications to groundwater exploration in basement and Regolith. Nicker Hill: British Geological Survey; 1985.
3. Al-Adamat RA, Foster ID, Baban SM. Groundwater vulnerability and risk mapping for the Basaltic aquifer of the Azraq basin of Jordan using GIS, remote sensing and DRASTIC. Appl Geogr. 2003;23(4):303–24.
4. Solomon S, Quiel F. Groundwater study using remote sensing and geographic information systems (GIS) in central highlands of Eritrea. Hydrogeol J. 2006;14(5):729–41.
5. Kenda K, Čerin M, Bogataj M, Senožetnik M, Klemen K, Pergar P, Laspidou C, Mladenić D. Groundwater modeling with machine learning techniques: Ljubljana polje aquifer. Proceedings. 2018;2(11):697.
6. Lee S, Hyun Y, Lee S, Lee M-J. Groundwater potential mapping using remote sensing and GIS-based machine learning techniques. Remote Sens. 2020;12(7):1200.
7. Waikar ML, Nilawar AP. identification of groundwater potential zone using remote sensing and GIS technique. Int J Innov Res Sci Eng Technol. 2014;3(5):12163–74.
8. Sivakumar V, Vinay L, Reddy K. Identification of groundwater potential zones using GIS and remote sensing. Int J Pure Appl Math. 2019;119(17):3195–209.
9. Suganthi S, Elango L, Subramanian SK. Groundwater potential zonation by remote sensing and GIS techniques and its relation to the groundwater level in the coastal part of the Arani and Koratalai River Basin, Southern India. Earth Sci Res J. 2013;17(2):87–95.
10. Sitender M, Rajeshwari D. Delineation of groundwater potential zones in Mewat District. Int J Geomat Geosci. 2011;2(1):270–81.
11. Saha A, Patil M, Goyal VC, Rathore DS. Assessment and impact of soil moisture index in agricultural drought estimation using remote sensing and GIS techniques. Proceedings. 2019;7(1):2.