Original Research Paper

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Geography

"GROUND WATER POTENTIAL ZONE MAPPING OF GAYA DISTRICT, BIHAR, USING REMOTE SENSING AND GIS TECHNIQUE."

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ABSTRACT Ground water change is accelerated due to continuous development and increasing demands and need for population. The current study of Ground water aids in the preservation of water-dependent ecosystems, the management of water resources, make hydrology relevant for the study. Guarantee water security, and promote sustainable development, thorough grasp of hydrological systems and processes is essential, in the study area i.e., in Gaya district, Bihar. Remote sensing and GIS technique is applied on IRS-LISS III images for the years 1994 & 2019 for the study of hydrology in Gaya district. Because of its closeness to river systems, especially Phalgu and its tributaries, the district is having vast Ground water resources, Monsoon rainfall can overflow rivers, resulting in good Ground water potential. The mountainous regions around Gaya have low permeability resulting low ground water, which caused rough like condition nearby area. Ground water have a major effect on agriculture, livelihoods, and water supply in Gaya district. Climate change, soil erosion, groundwater depletion, and insufficient monsoons are some of the causes of these. Water shortages are common in the district as a result of erratic rainfall and growing demand for irrigation. Enhancing water management practices, enforcing new laws, and upgrading infrastructure are the main strategies used to regulate and prevent droughts and floods. Riverbank protection, flood forecasting and early warning systems, urban drainage systems, and river connection and diversion projects are some initiatives.

KEYWORDS : Hydrology, surface water, Remote sensing, GIS

INTRODUCTION

Generating valuable information of concerned area has now become easy because of the ability of imbibing diversified information within a satellite data (Hathout, 2002, Herold et al., 2003, Lambin et al., 2003, Yuan et al., 2005, Saadat et al., 2011)). From last few decades' various changes are applied for ground water mapping. Study of ground water becomes even more important on modern times because as time is passing, various effects of population on natural resources have to be seen. The best technology we have today is the remote sensing and GIS which is time-saving and at the same time it can extract multiple information. These data are real time accurate, cheap and reduce chance of error. Ground water availability and mapping factor is associated with the secondary data sources on the surface of the earth namely, land use and land cover, soil, rainfall, geomorphology, lineament, and etc. (Barnsley et al., 2001) and are often used interchangeably (Dimyati et al., 1996). Study of Ground water is very important for planning and management of the concerned area. Ground water is totally influence by the local condition, altitude, height, slope, structure, so with the study of two different time period satellite data is accurate and easy way to analyse ground water by comparing. Population growth, industrialization and urbanization have rapidly changed the ground water. Change in ground water largely effect local environment, ecological balance, degradation. Sustainable ground water is important for sustainable development and management of natural ecosystem. Changes in ground water is however responsible for rising temperature, heat wave, decrease rainfall in Gaya district. There are lots of methods to determine changes but in this study, supervise image classification is best for current study. Land use and Land cover is a result of socio-economic factors, natural factors and their utilization by human being (Amritpal Digra and Arun Kaushal et al.,2021). For the present study Landsat Thematic Mapper (TM) 4-5 C1 level-1 satellite images is used, DEM data of Cartosat-1 of 2.5 m resolution, LISS III multi spectral sensor have 23.5m spatial resolution data is used. The study area is largely depended on agriculture for their lively hood. But recent trends show decrease in agricultural land for building construction. With the help of this study, we can easily find condition of ground water in Gaya district, with suitable remedies and solution.

Study Area

Present study is conducted in Gaya which lies in between 24°30´N to 25° 06´N and 84° 24´E 85° 30´E with it headquarter at Gaya. The district is divided into 4 sub-divisions :

1. Tekari
2. Gaya Sadar
3. Neem Chak Bathani
4. Sherghati

and 24 administrative blocks namely:

1. Konch
2. Tikari
3. Belaganj
4. Khizarsarai
5. NeemChak Bathani
6. Muhra
7. Atri
8. Manpur
9. Gaya
10. Paraiya
11. Guraru
12. Gurua
13. Amas
14. Banke Bazaar
15. Imamganj
16. Dumaria
17. Sherghati
18. Dobhi
19. Bodh Gaya
20. Tan Kuppa
21. Wazirganj
22. Fatehpur
23.Mohanpur
24. Barachatti (CPCB).

Gaya district is the part of south Bihar plain. It is divided into 3 sub-micro regions, viz., Falgu Plain, Sherghati, Fatehpur Uplands and Rajgir Hills on the basis of geographical factors like relief, drainage, geology, soil and natural vegetation. The drainage network in the district is represented by four parallel streams, the Morhar, the Phalgu, the Paimar and the Dhadhar, all emanating from the southern plateau and flowing north and northeasterly (CPCB). The falgu river flows from south of Gaya to north. River Falgu is the compilation of two river, i.e., Lilajan and Mohana originated from Hazaribagh Plateau. The total length of faglu is 121.28 Kilometres, and flow as tiny rivulets meandering through wide sandy beds mainly in Gaya very little water.

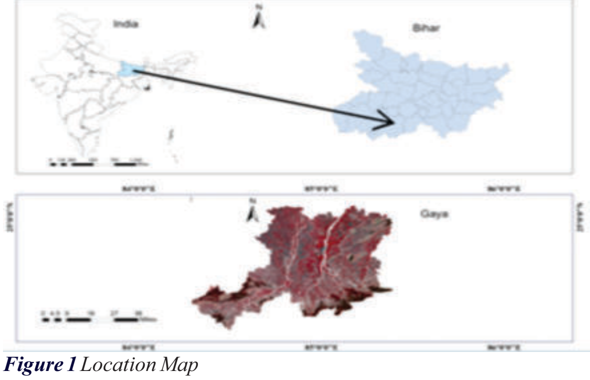

Figure 1 *Location Map*

Data

The data used in this study includes Landsat Thematic Mapper (TM) 4-5 C1 level-1 satellite images for each year such as 1994, 1995, 2018, and 2019. Topographical map collects from Survey of India website, satellite imagery of Land Sat 4-5 TM C2 L2 from USGS and Resourcesat LISS III and DEM data of Cartosat-1 of 2.5 m resolution taken from Bhuvan the official site of NRSC, Hyderabad. LISS III multi spectral sensor has 23.5m spatial resolution in visible, near infra-red and 70.5m resolution in the short wave infra-red band with a swath of 141 km (source IRS P6 data user manuals) and Land set 4-5 TM C2 L2 consist seven spectral band having 30 m resolution. The image data were freely accessed from the Landsat archive of the United States Geological Survey (USGS) website (https://glovis.usgs.gov/) (https://earthexplorer.usgs.gov/). Landsat images were spatially projected to WGS_1984_UTM_Zone 44N.

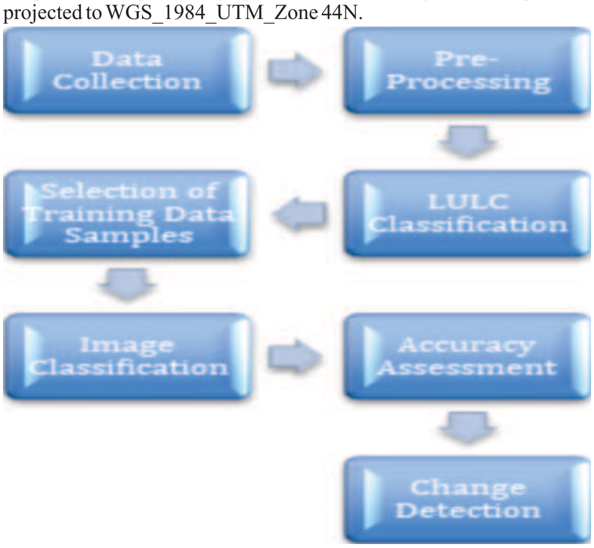

Figure 2 *Methodology Work Flow Chart*

Methodology

This study mainly focusses on interpreting the changes taken place in the land through analysing satellite imagery in GIS software. The study involves visual image interpretation method as well as digital image processing as well to extract the information. For change detection, the satellite images are georeferenced and mosaic to extract the study area. ArcGIS software is employed in the change detection method. Each satellite image is classified to find the changes by compared according to the pixel-by-pixel approach by using a change detection matrix using supervise classification in Arc GIS. All relevant thematic maps are generated also like geomorphology, and lineament map, ground water level map, Slope map, and etc. Google Earth data and secondary datasets available on official websites are also utilized for reference and better understanding of land use changes. The drainage network map and slope map are also prepared from SRTM 30 m DEM. After compiling all thematic maps the final GWPZ prospect map was prepared and categorized into five classes namely very high, high, moderate and low.

Following methodology is adopted in the present study:
Data collection included the
1) Ground reference data obtained from field surveys,
2) Relevant toposheets of the study area

Google Earth data along with Land sat 4-5 TM C2 L2 satellite imagery is downloaded from USGS which is freely available on the official site. DEM data is used to find out the slope.

Table 1 Description Of The Satellite Images Used In The Study

Satellite	Sensor	Acquisition Date	Bands used	Spatial Resolution	Processing
Landsat 5	Thematic mapper	22/03/1995	Visible (B1, B2, B3, B4, B5, B6, B7)	30 m	Level 1
DEM		17/04/2015	B1	29 m	

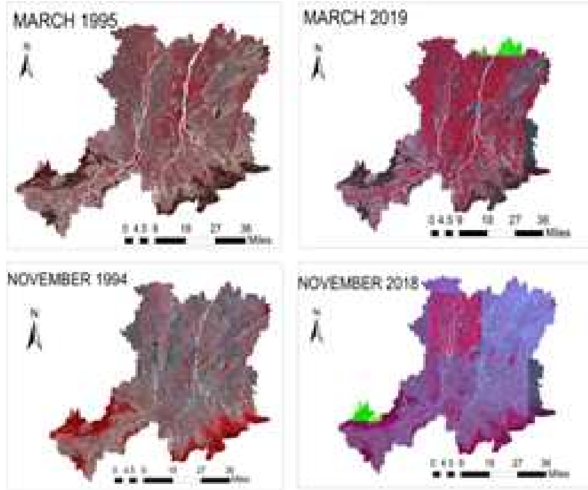

Figure 3 *FCC of satellite images for the year 1994, 1995, 2018 & 2019 respectively*

Geomorphology

Geomorphological feature has direct connection about groundwater existence. Among these geomorphological features, river and waterbodies, alluvial plains, flood plain, valley regions are assigned as a very high rank. Pediment and pediplain have good ground water potential. However, low dissected hills and dissected plateau fall under poor condition for water potential zones and highly dissected hills and barren land have assigned as very poor rank.

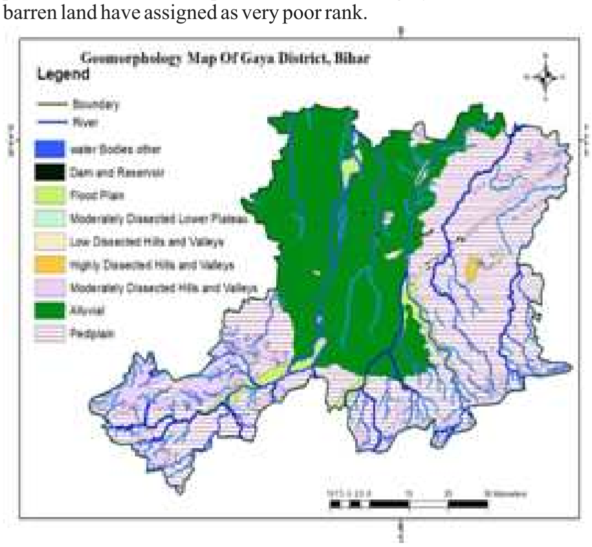

Figure 4 *Geomorphology Map*

Lineament

Lineaments represent capacity of porosity and are tectonic origin, linear feature. They are easily demarcated by their shape, tone texture through satellite imagery. Lineaments is an excellent feature to determine groundwater potential of any area. They are also correlated with faults, fractures, joints, and bedding planes.

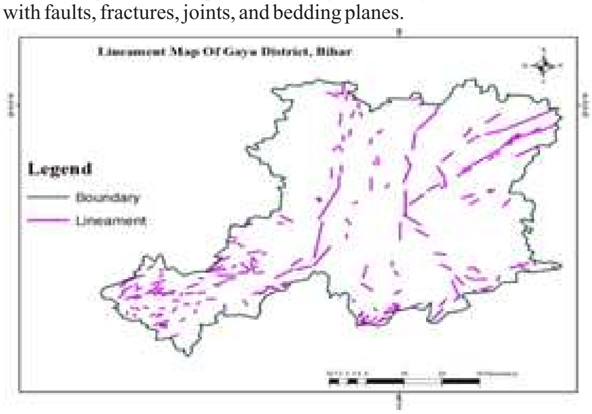

Figure 5 *Lineament Map*

Drainage Density

Majority of drainage is found in upper and Lower portion and low flow of water at middle portion due to low slope. In rainy season, all drainage has maximum of water flow. For GWPZ, natural drainage systems have play important role where the water directly on the surface because a greater number of drainages is clear sign of more possibility of water to drain out. While poor drainage network in any region will govern low possibility of good GWPZ.

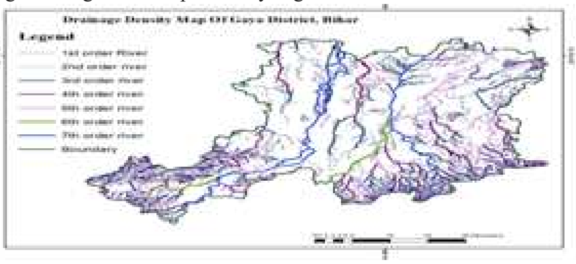

Figure 6 *Drainage Map*

Land use/land cover (LULC)

The water percolation and infiltration rate within Natural Vegetation around them is higher in Gaya district. Soils near forest are slightly suitable for percolation and infiltration process near natural vegetation, barren land have moderate capability of water percolation. Agricultural land is also more favourable for percolation and recharge process because this area is free from human construction, and loose soils which influence water to infiltrate to the subsurface. The buildup area has almost 100% of surface runoff with almost 0% of infiltration and percolation rate hence, build up area have very low ground water potential.

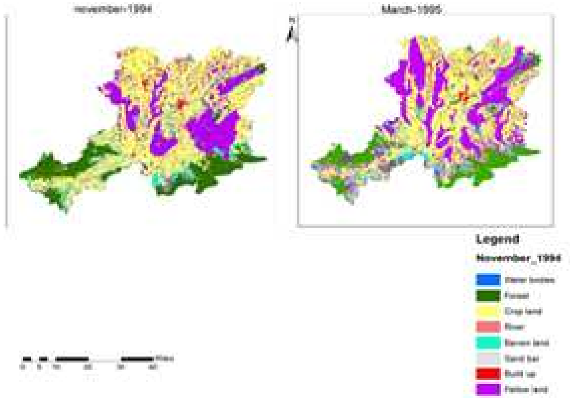

Figure 7 *LULC Map for the year 1994, 1995.*

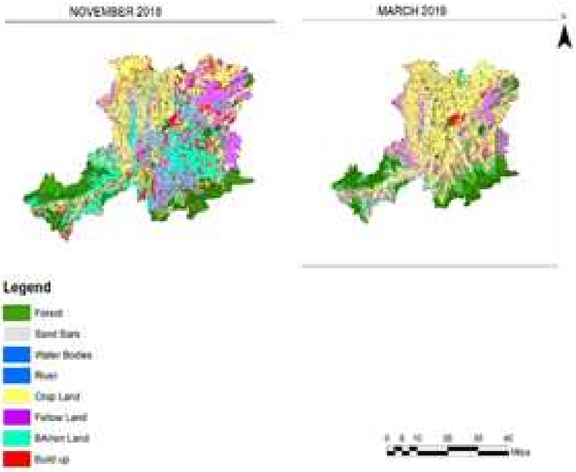

Figure 8 *LULC Map for the year 2018, 2019*

Slope Information

Slope gradient directly impacts the way of infiltration and percolation process because direction of rainwater flow is directly depended upon slop. So, slope information clearly visualise GWPZs. Higher value of slope indicates a rapid runoff and low water infiltration and percolation rate.

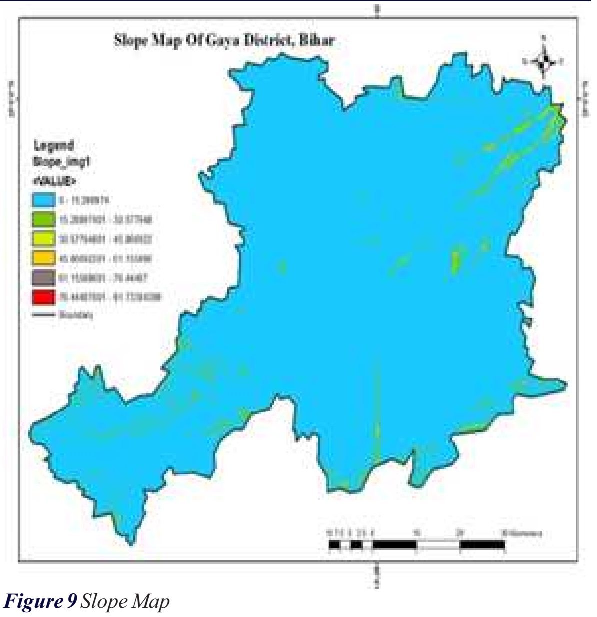

Figure 9 *Slope Map*

Ground Water Potential Zone Prospect:

Groundwater is essential for drinking, irrigation, and industry in the Gaya district of Bihar, India. Quaternary alluvial deposits and Precambrian granite gneiss make up the majority of the district's aquifers, which include both confined and unconfined aquifers. Precipitation patterns, changes in land use, and groundwater extraction methods are some of the variables influencing this increase. The distribution and capacity of groundwater resources are influenced by the district's varied geological formations. In this report Geomorphological formations and land use have a major impact on the groundwater in the Gaya district; semi-confined groundwater is found in cracks, while unconfined groundwater is found in the weathered zone. Fissures, joints, and other structural flaws regulate the flow of groundwater. In granite gneiss, fracture transmissivity and stativity range from 126 m^2/day to 168 m^2/day. Potential groundwater availability zones are recognized as NS and NE-SW trending lineaments. All things considered, the groundwater occurrence in the Gaya district is greatly influenced by these geological formations. An essential hydrogeological unit for the storage and circulation of groundwater in the Gaya district is the Quaternary alluvium, especially in the central valley and the One-Ganga plain. The alluvium is made up of a variety of materials, including clays, silts, sands, and gravels. Because of their high permeability, the medium- to coarse-grained sand and gravel strata serve as effective groundwater reservoirs. The aquifer layer, which stores groundwater, is between 15 and 20 meters thick, whereas the alluvial deposits are between 30 and 50 meters thick altogether. Near the Phalgu River, there are two different kinds of aquifers: alluvial and hard rock. Because they were developed over thousands of years, alluvial aquifers replenish more effectively through rainfall and surface water infiltration. Conversely, hard rock aquifers are vulnerable to over-extraction. Although groundwater is utilized for drinking water and agriculture, contamination from industrial pollutants, pesticides, and fertilizers is a worry. Long-term access requires sustainable management practices, such as improving recharge, conserving water, and allocating resources equitably. Fissured aquifers, also known as hard rock aquifers, and alluvial aquifers are the two primary categories identified in the Central Ground Water Board's (CGWB) assessment on the availability and capacity of important aquifers in the Gaya area. Hard rock formations with intermediate yield potential, such as granite gneisses, mica-schist, quartzites, and other Pre-Cambrian rocks, contain fissured aquifers. For local groundwater requirements, they can be efficiently accessed by observation and exploration wells. Because of their higher permeability and greater capacity to store water, alluvial aquifers—which are mostly located in the central valley (Dobhi-Gaya terrace) and the One-Ganga plain—are more productive. They have a great deal of potential to supply the local people with water, particularly for industrial, drinking, and agricultural uses. Potential groundwater zones, such as NS (North-South) and NE-SW (North-East to South-West) areas, are identified in the research based on lineament trends. Particularly in hard rock regions where groundwater is held in cracks, these places could be given priority for additional groundwater exploration and extraction. The type of aquifer, impermeable surfaces, and rainfall patterns all affect groundwater recharge in the Gaya district. Because of their enormous volume and shallow groundwater occurrence, alluvial aquifers are comparatively sustainable, whereas fissured aquifers in hard rock zones more susceptible to over-extraction because of their variable yields and low storability.

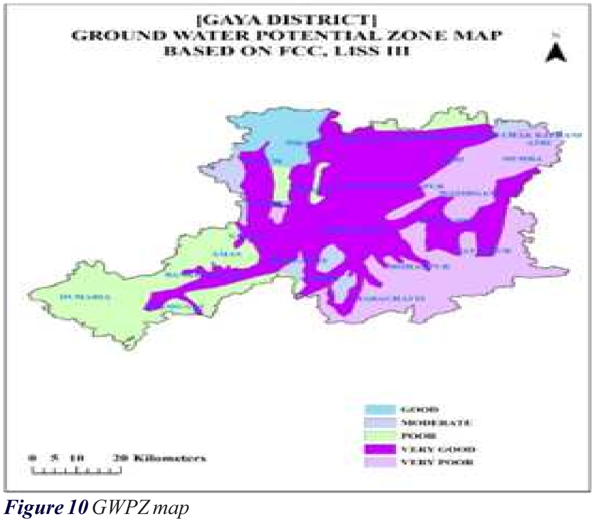

Figure 10 *GWPZ map*

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