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Groundwater Prospect Variability Analysis with Spatio-Temporal Changes In Ranchi City, Jharkhand, India Using Geospatial Technology

AVINASH KUMAR RANJAN[1*], SATYA PRAKASH[2], AKASH ANAND[3], SANTOSH KUMAR VERMA[4], LAKHINDAR MURMU[5], PATIBANDLA B SRAVAN KUMAR[6]

[1,2,3]*Centre for Land Resource Management, Central University of Jharkhand, Brambe 835205, India*

[4]*Department of Environmental Science & Engineering, Indian Institute of Technology (ISM), Dhanbad 826004, India*

[5]*Department of Electronics and Communication Engineering, VNR Vignana Jyothi Institute of Engineering & Technology, Hyderabad 500090, India*

[6]*School of informatics and computing, Indiana University, Indiana 47408, USA*

***Email:** avinashcuj.wings07@gmail.com, avinash.ranjan@cuj.ac.in*

Abstract: *Groundwater reflects the major percentage of the world's freshwater resources, for a human being it is a dynamic natural resource to fulfill their day to day life requirements. Groundwater is essential for human being along with animals, trees, aquatic living organism etc. Due to urbanization, industrialization, mining, irrigation, domestic demands and so on, the demand of water is hugely increasing. In present stage water resources are depleting drastically on account of access exploitation, mismanagement etc. so its conservation and management are significant. Using Geospatial technology, this study has demonstrated the variability in groundwater prospects with respect to spatio-temporal changes in Ranchi city and its nearby area, Jharkhand, India, based on thematic maps of LU/LC, drainage, lineament, slope, and aspect. The groundwater potential has been categorized in four categories viz., very poor, poor, moderate and very good. The Geospatial technology is the modern, innovative and dynamic technique used for M-3 movement that is monitoring, mapping and management of various environmental issues with its specific capability. The high-resolution remote sensing data of years 1998, 2004, 2010 and 2016 have been used for various modeling and mapping along with the GIS environment to assess the groundwater prospect variability with LU/LC changes.*

***Keywords:** Groundwater prospects, LU/LC, Remote sensing, GIS environment, M-3 Movement.*

1. Introduction

Geospatial technology is basically Geo-informatics technology which is comprised of Remote Sensing (RS), Geospatial Information System (GIS) and Global Positioning System (GPS) (Ranjan et al., 2016). The various author defined this term in a different way like Prakash (2006) defined as "the group, integration, management, analysis and presentation of geospatial data, models and knowledge that support disciplinary, multidisciplinary, interdisciplinary and transdisciplinary research and education" (Bhatta, 2011). The leading four assignment of Geospatial technology are: (a) collection and processing of geodata, (b) development and management of a database of geodata, (c) analysis and modeling, (d) development and integration of logic and computer tools and software for the first three tasks. Likely, Virrantaus and Haggren (2000) states that "Geoinformatics is the combination of RS and GIS (Bhatta, 2011; Ranjan et al., 2016). For example, spatial analysis is a field in which image processing and GIS software tools are integrated and perform together. It is quite interesting to see how identical function can be achieved by using either image processing tool or traditional GIS analysis techniques within the geoinformatics technology. Hence geoinformatics is the fusion of ideas from geoscience and informatics. It is the incorporation of disciplines dealing with the structure, arrangement, and character of spatial data.

Groundwater is the leading accessible source of fresh water lying on earth surface or subsurface. One of the furthermost needed resources in our routine life is water, but now-a-days its crisis is rising faster in rural and urban areas due to immense demand in agricultural activity and domestic demands. In water resource management and planning, ground water is appealing an ever-increasing attention caused by scarcity of worth subsurface water. Groundwater is the utmost water source on earth (Villeneuve et al., 2011); it involves the foremost and desired source of drinking water in rural along with municipal areas. It supplies 80% of the total drinking water demand and 50% of the agricultural requisite in rural India (Meenakshi et al., 2006; Saraf et al., 2012). The groundwater is a vibrant and more replenishable regular source. However in hard rock landscapes, its availability is the partial extent and it is principally limited to the fractured and weathered horizons,

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which indicates towards effective management of groundwater in these regions (Saraf et al., 2012). The behavior of groundwater in the Indian sub-continent is very much complex down to the existence of varied geological foundations (Manimaran et al., 2012). It is furthermost god gifted resources, supports anthropological health, commercial growth, and environmental variety. As a result of its numerous integral abilities (e.g. reliable temperature, extensive and incessant availability, consistency etc.); it has turn into a significant and trustworthy source of water delivers in altogether climatic zones together with both municipal and rural zones of developed and developing nations (Todd and Mays, 2005). Over 90% of the rural and closely 30% of the urban population in India rely on groundwater for gathering their drinking and domestic necessities (Reddy et al., 1996). Thus, groundwater is emergent and challenging shortage saving tool in rising nations (IWMI, 2001). As talk about, groundwater investigation has come to be decisive not only for groundwater potential zonation, also for monitoring and preserving this dynamic source. On the other hand, such tactic for groundwater studies through the field observation is quite costly, time taking and needs to train manpower (Sander et al., 1996). In another hand, Geoinformatics technology offers specific capabilities in a manner of spatial, spectral and temporal data coverage in large and inaccessible areas within a short time. It has risen as a very advantageous tool for M-3 movement that is mapping, monitoring, and management of groundwater resources (Jha et al., 2007).

The hydrogeological analysis of satellite imagery has been given away to be an appreciated survey tool in ranges of the globe wherever slight geologic and cartographic data occurs, along with in unreachable condition of the globe (Engman and Gurney, 1991). Furthermore, Geoinformatics tool has developed as real-time application influential tools designed for management of spatial data and decision-making in numerous areas together with manufacturing and conservational fields (Stafford, 1991; Godchild, 1993). Earlier, a number of scholars (from India and abroad) have used Geoinformatics technology to delineate the groundwater potential zone with positive results. In these researches, they normally used thematic maps viz. lithology, geomorphology, drainage pattern, drainage density, lineament, lineament density, soil and topographic slope, aspect etc. The nature and quantity of matters used for the evaluation of groundwater resources by Geoinformatics tools noticeably differ from one study to another. In maximum studies, local information has been preferred for assigning weights to diverse thematic map and their features. In present research work, ground water prospect variability has analyzed with temporal variations in land use and land cover status.

Land use land cover is a central part to recognize worldwide land status; it displays the present as well as past status of the Earth’s surface (Ranjan et al., 2016). Land use and land cover are two distinct terms which are frequently being used vice-versa. In collective, land cover is well-defined as per the “perceived physical shield on the Earth’s surface which may consist of vegetation, man-made features, rock, basic soil, and local water surfaces, etc.” Wherever “Land use represents the approach in which land has been used or being used for anthropological deed (Olokeoguna et al., 2014; Mengistu et al., 2007; Reis et al., 2008; Forkuo et al., 2012). Land use and land cover is the basic structure which evaluates the arrangement of Earth’s surface to monitor the situation and functioning of the ecosystem. LU/LC variations affected by natural and human activity which is generally lead to deforestation, global warming, biodiversity damage and the rise of natural disaster flooding (Lubis et al., 2011; Kindu et al., 2013; Ghosh et al., 1996; Prasad and Sreenivasulu, 1996). Land use/ land cover data groups are the basic ideas for conservational modeling and observing, carbon cycle supervision, hydrology and worldwide climate revolution analysis, natural resources management, policy-making, etc. (Tsegaye et al., 2014). Hence it also crucial involvements for ground water prospect zonation. Various LU/LC features may affect the ground water, as the rapid urbanization influence, the impervious surface which will have very low infiltration of rainwater and surface water, such as riverbed, watershed area, and water body will have higher water prospect. Likely vegetation cover, agricultural land, forest cover, grassland etc. will reflect the good ground prospects.

1.1. Study area

The area selected for the proposed study is Ranchi city (and its nearby area), the capital of Jharkhand state (India). It is geographically extended in the southern part of Jharkhand state and surrounded by a further district of Jharkhand, viz., Hazaribagh, West Singhbhum, Gumla, Lohardaga, and East Singhbhum. It is also surrounded thru Purulia district of West Bengal. Ranchi district covers total geographical area of 4,912 Sq.km and it is spatially situated concerning, latitude 22°45′ to 23°45′ North to longitude 84°45′ to 84°50′ East as shown in Figure 1 (Krishna et al., 2015: Rani et al., 2011). The study area is regarded as by sub-tropical weather, temperature ranges from 20 to 37°C during summer and 3 to 22°C during winter. The precipitation form is monsoonal; cover the mid of June to mid of October with an average precipitation of almost 1530 mm/year (Rani et al., 2011). Ranchi district has diverse hydrogeological physical features; therefore the groundwater potential fluctuates with different spatial location. The three-fourth area of the district is shielded by Chhotanagpur granite gneiss of pre-Cambrian age (CGWB 2009). Two blocks of Ranchi district namely Ratu and Bero having thick lateritic is found over the granite gneiss. In Mandar block as well as a northernmost portion of Burmu blocks having the big cover of older alluvium and existents of limestone rock. The district is mostly covered with hilly terrain and forests, mostly in the northern and southern region. In overall, the height above sea level of the district varies in the different-different site from 500 m to 700 m, however, there is some hilly terrain which may have altitude more than 700 m above mean sea level. There is mainly two kinds of aquifers are studied in the Ranchi district; Weathered aquifer and fractured aquifers. The weathered aquifers having a thickness from 10 to 25 m in granite topography as well as 30 to 60 m in lateritic topography (Krishna et al., 2015). In weather-beaten aquifers groundwater comes about in unconfined condition, whereas in cracked aquifer groundwater come about in semi-restricted to confine conditions (Krishna et al., 2015). The primary dominate land use and land cover types of the investigated area are studied as cropland, settlement with and without vegetation, some area having dense and open forest, dense shrub, plantation and water bodies embracing mostly reservoir, lakes, river and its streams and several numerous ponds (Rani et al., 2011).

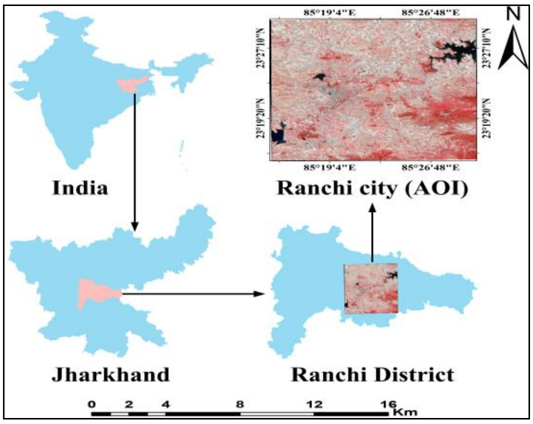

***Figure 1**: Geographic location map of study area (Ranchi city and its nearby area)*

2. Material and Techniques

2.1. Dataset Used

As per availability of remotely sensed satellite data, different multi-temporal data of the study area were collected from Global Land Cover Facility (GLCF), United State Geological Service (USGS) and BHUVAN geo-portals which provide the satellite data without any cost. Likely SRTM (2000 & 2005) and Cartosat-1 (2011 & 2015), digital Elevation Model (DEM) data were downloaded from GLCF and BHUVAN; the topographical sheet was taken from Texas library at the scale of 1: 50,000. Four satellite data of years 1998, 2004, 2010 & 2016 were used in current research work to prepare various thematic maps. Satellite data of 1998, 2004 and 2010 belongs to Landsat ETM+, wherever 2016 belongs to Landsat OLI as shown in Table 1. The attention was taken during the collection of data that all the data belong from the same interval. SRTM and Cartosat-1 data has used for the preparation of slope and aspect map whereas Landsat data has used for LU/LC, drainage, drainage density, lineament and lineament density map.

***Table1**: Data used in present investigation*

Year	Data	Spatial Resolution	Source
1998	Landsat ETM+	30 m	USGS
2004	Landsat ETM+	30 m	USGS
2010	Landsat ETM+	30 m	USGS
2016	Landsat OLI	30 m	USGS
2000 & 2005	SRTM	30 m	GLCF & USGS
2011 & 2015	Cartosat-1	2.5 m	Bhuvan

2.2. Software's used

In present study mainly two software has used namely; ArcGIS 10.4 and Erdas Imagine 14. Layer stacking of individual bands into single image and georeferencing were completed by Erdas imagine whereas AOI subset and image processing for preparation of various thematic map i.e. LU/LC map, drainage map, drainage density map, lineament map, lineament density, slope map and aspect maps were done with the help of ArcGIS 10.4.

2.3. Methodology

A base thematic map has produced from satellite images and topographical sheet at scale 1:50,000 comprising of surface drainage features, lineaments, and LU/LC. Slope and aspect map have prepared by SRTM and Cartosat-1 data. To prepare the LU/LC map, Maximum Likelihood Classification tool (supervised classification) has been used. There are two major phases of integration (1) The principle defining the sense of the analysis (2) The comparative weightage of the factors. The measure for every investigation, it dependent on the motive of works and the data sets. On the base of virtual significance, selective weights were assigned to various data and the best proper condition resulted. The methodology can be easily understood by considering the flow chart as shown in Figure 2.

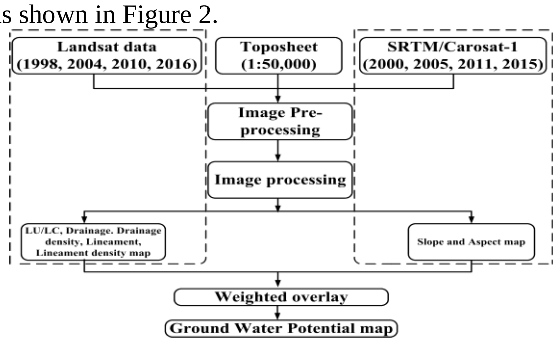

***Figure 2**: Flow chart of the methodology adopted in the present investigation*

2.3.1 Multi influencing factors of groundwater potential zones

Five influencing factors, such as LU/LC, drainage, lineament, slope, and aspects have been taken to demarcate the groundwater potential zones. Interrelationship among these features and their influence is shown in Figure 3. According to its strength, all relationship is weighted. The typical weight of a feature of the potential zone is the summation of all weights from every feature. A feature with an upper weight value indicates a larger impact and a feature with a lesser weight value indicates a less significant impact on groundwater potential zones. Incorporation of these features with their potential weights is calculated over weighted overlay analysis in ArcGIS environment.

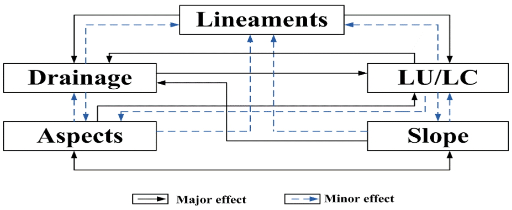

Figure 3: Interrelationship between the multi influencing factors

3. Results and discussion

The ground water potential (GWP) zonation has accomplished according to weighted overlay analysis of multi influencing factor which can influence the GWP. The weightage was taken off mainly five influencing factors that are LU/LC map, drainage density map, lineament density map, slope map and aspect map, whereas the drainage and lineament map were used to prepare drainage density and lineament density map. The weightage has decided based on the interrelationship between the multi influencing factors with major and minor effects (Fig. 3).

3.1. Land Use/Land Cover Map

The repetitive coverage of satellite data plays a vital role in this aspect by depicting the status of Land use/Land cover over the time periods (Magesh et al., 2012; Hutti and Nijagunappa, 2011). A land use land cover map shows the changes in any area over the time period. LU/LC map displays that how much area has covered by forests, agricultural land, water bodies, settlement and other features. It can demonstrate that how the land is being used for human purposes. Land use/Land cover technique plays a dynamic role in groundwater potential zonation. Because, it can have an influence on the runoff and recharge of groundwater zone (Magesh et al., 2012). In the present study, LU/LC maps of the different time period have been prepared using Maximum Likelihood Classification (MLC) technique of supervised classification. The prepared LU/LC map of four different time period has shown in Figure 4. Prominent features in the study area have observed including forest (open and dense), vegetation/agricultural land, settlement areas, waterbody, fallow land and others features.

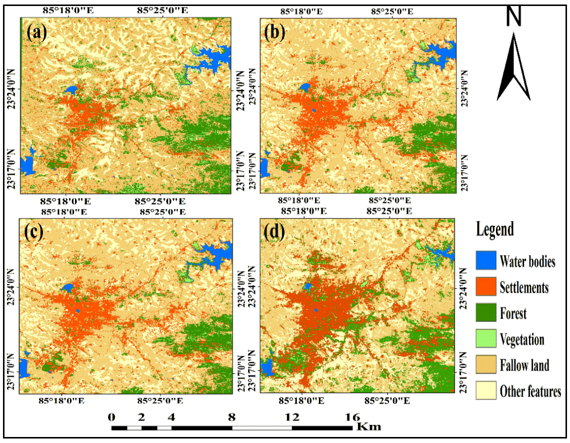

Figure 4: LU/LC map of study area over the years 1998, 2004, 2010 and 2016 respectively (a), (b), (c) and (d)

3.2. Drainage Map

Drainage system is an arrangement of water bodies, this is formed by streams, rivers, and lakes in a specific drainage basin. A drainage basin is one of the significant terms that designates any point or degree, from where the shallow groundwater outspreads from rain, melting snow and ice to a lower elevation and the water links a new water system such as a river, lake, reservoir, sea or ocean etc. The drainage map can help us to recognize the groundwater potential zones along with GIS environment. The surface and subsurface formation are well characterized by drainage pattern which can provide valuable information about the basin topography. As the drainage density will high there would be a higher runoff. The drainage map has prepared by on-screen digitization of various temporal satellite imagery as shown in Figure 5 (Yeh et al., 2009). Further, these drainage maps have been used to prepare the drainage density map.

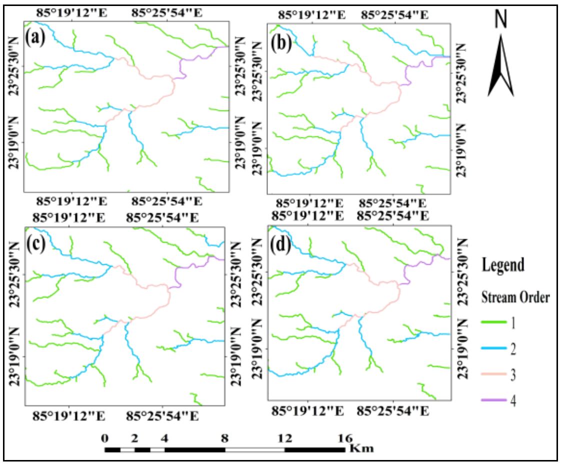

Figure 5: Drainage map of study area over the years 1998, 2004, 2010 and 2016 respectively (a), (b), (c) and (d)

3.3. Drainage density

Drainage density can be well defined as the closeness of gaps of tributary channels. It is an extent of the over-all length of the stream section of all orders per unit area. The analysis of drainage density can help to delineate the groundwater potential zones. The drainage density map has prepared using the drainage map, the drainage map has used in line density analysis tool in ArcGIS environment to assess the drainage density map as shown in Figure 6. The groundwater potential zone is indirectly interrelated to drainage density on account of its relation with surface runoff and permeability. If the drainage density is less than there is a greater probability of groundwater recharge/potential. Whenever, higher drainage density has a lower probability of ground water prospects (Hutti and Nijagunappa, 2011). If drainage density is high, then it would be a greater runoff and it also points to flood risk if drainage density is much higher. The relation of drainage density with permeability is an opposite significance (Magesh et al.., 2012).

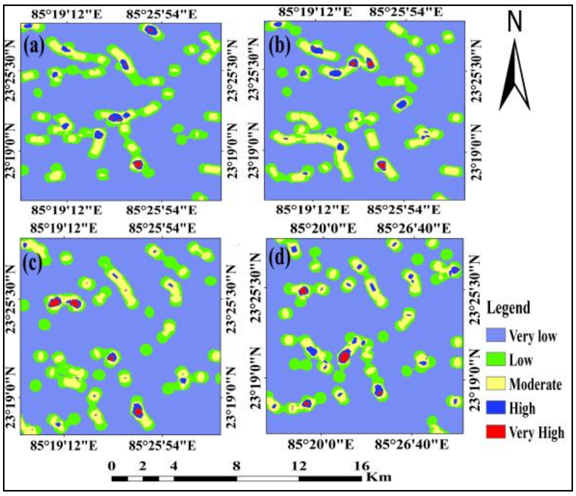

***Figure 6**: Drainage density map of study area over the years 1998, 2004, 2010 and 2016 respectively (a), (b), (c) and (d)*

3.4. Lineaments

Lineaments are the geological construction of the land surface which is centered on the linear or curvilinear constructions of the geological structure, bedrocks, and nature of soil etc. lineaments plays an important role in groundwater development and contaminant transport in the deep aquifer. The intersection of lineament can describe the good occurrence of groundwater potential zones. In this study, the lineaments map has prepared by the linear alignment of the regional morphological features of streams of water bodies (Kumar et al., 2010). The lineament has been prepared from the multi-temporal satellite images along with the drainage map and structural configuration of the basin as presented in Figure 7. Mapping of lineaments has done by the visual interpretation and on-screen digitization. These skills have been developed for comprehending the groundwater flow system. This method can define that greater density of lineament cause higher ground water potential. To delineate the lineaments, geomorphic features (residual hills, weathering deposits along foothills and floodplains) are well yields to determine the groundwater potential zone (Magesh et al., 2012). The lineament intersection locations can show the good potential zones for groundwater development.

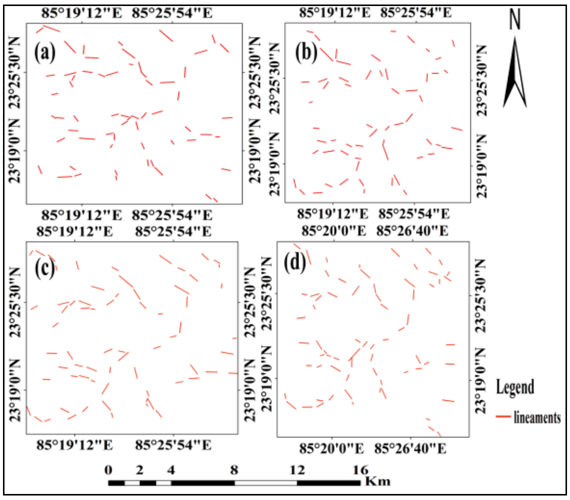

***Figure 7**: Lineament map of study area over the years 1998, 2004, 2010 and 2016 respectively (a), (b), (c) and (d)*

3.5. Lineament density

The Lineament density map can show the relationship between lineament and groundwater exploration. Lineament density mapping can be done by after digitizing the lineaments by using line density tool in ArcGIS software. Lineament density can be calculated as based on across the map area by the sum of all mapped lineaments length (Magesh et al., 2012). It can calculate for each square mile within the area or examine the sum of lineament lengths occurring within each unit grid cell. The lineament density map can show different classes on different ranges, but present study it has classified into mainly five classes i.e. very low, low, moderate, high and very high as shown in Figure 8. The higher lineament density will reflect the greater groundwater potential zone whereas lower will show the minor groundwater prospects. The very high lineament density in the year 1998 is observed in middle and North-West part of the study area and a very small portion in south direction whereas it is likely observed in 2010. But in 2004 very good lineament density observed in a very small portion in north, south and north- west region while it is reduced in 2016, it can observe a small portion in the south region as shown in Figure 8. The study area covers the lineament density in ascending order by very low, low, moderate, high and very high.

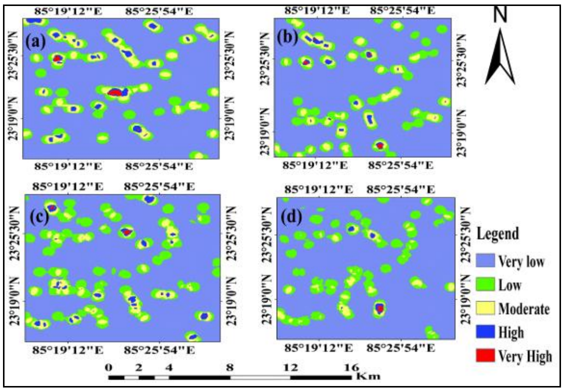

Figure 8: *Lineament density map of study area over the years 1998, 2004, 2010 and 2016 respectively (a), (b), (c) and (d)*

3.6. Slope Map

The Slope is one of the most significant features that refer to the steepness of line; it is also an important structure that affects the land stability. The slope is also being used as a significant feature to delineate the groundwater potential zones. It is also an important aspect having control over infiltration of groundwater into subsurface; therefore it can be said that it works as an indicator for the suitability of groundwater prospect (Magesh et al., 2012). The slope map can support us to recognize the surface and subsurface flow of water with the use remote sensing data. The slope map has been prepared with the use of Shuttle Radar Topography Mission (SRTM) and Cartosat 1 data based on the availability of four different years. The slope in the study area can support us to describe the several types of slope i.e. nearly level, very gently slope, gently sloping, moderate sloping, and moderately steep to steep sloping. The gentle slope of an area offers us to additional time to infiltrate the rain water to aquifer zone whereas high slopes take the minor time to infiltrate the ground water (Magesh et al., 2012). The slope map of the investigated field was completed using SRTM and Cartosat 1 data with the spatial analysis tool in ArcGIS 10.4 as presented in Figure 9.

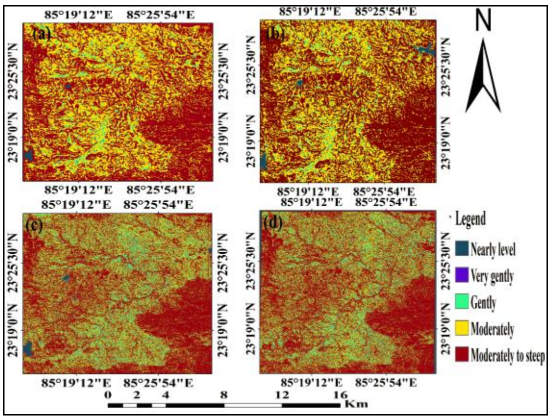

Figure 9: *Slope map of study area over the years 2000, 2005, 2011 and 2015 respectively (a), (b), (c) and (d)*

3.7. Aspect map

Aspect is the directional measure of slope faces; it can help us to define the analyzing and think about of landform physical characteristics. Slope and aspects are important parameters for measuring water potential zone. The aspect map has prepared with the help of SRTM, and Cartosat 1 data, based on the availability of data using ArcGIS software (Figure 10).

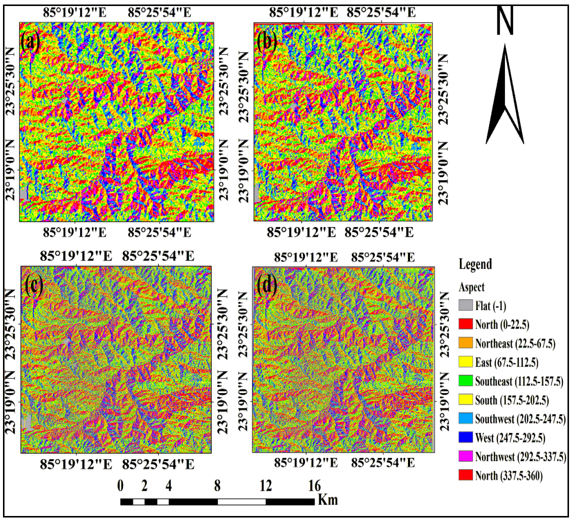

Figure 10: *Aspect map of study area over the years 2000, 2005, 2011 and 2015 respectively (a), (b), (c) and (d)*

3.8. Weightage calculation

In the present study Multi Influencing Factor (MIF) technique has been used for weightage assignment. The multi influencing features for groundwater potential zonation namely LU/LC, lineaments, drainage, slope, and aspects has surveyed and given an appropriate weightage as shown in Table 2. The influence of every influencing feature may subsidize to delineate the groundwater potential zones. Moreover, these features are mutually dependent. The influence of each and every major and minor factor is given a weightage of 1.0 and 0.5 respectively (Figure 3). The aggregate weightage for both major and minor effects are assigned to calculate the relative rates for particular features as plotted in Table 2. This proportion is promoted to calculate the total of each influencing factor. The projected total for respectively influencing factor is considered by using the given formula;

$$\left[\frac{(A+B)}{\sum (A+B)}\right] \times 100$$

Where, A is indicating towards major inter-relationship between two factors as well as B is indicating toward minor inter-relationship between two factors. The concerned weightage for every single influencing factor was allocated equally and consigned to each reclassified factor as presented in Table 3.

Table 2: *Effect of influencing factor, relative proportions and weightage*

Features	Major effect (A)	Minor effect (B)	Total Y=(A+B)	Weightage (%) (100*Y/ΣY)
LU/LC	1*1=1	3*0.5=1.5	2.5	20
Drainage density	1*1=1	2*0.5=1	2	16
Lineaments density	2*1=2	0	2	16
Slope	2*1=2	2*0.5=1	3	24
Aspects	2*1=2	2*0.5=1	3	24
Total			ΣY=12.5	100

Table 3*: Ordering of weightage for factors which are influencing the potential zones*

Features	Classes	Weightage
LU/LC	Waterbody	6
	Settlement	2
	Forest	5
	Vegetation	5
	Fallow land	1
	Others features	1
Drainage density	Very low	1
	Low	2
	Moderate	3
	High	4
	Very high	6
Lineament density	Very low	1
	Low	2
	Moderate	3
	High	4
	Very high	6
Slope	Nearly level	9
	Very gentle	8
	Gentle	4
	Moderate	2
	Moderate to steep	1
Aspects	South	5
	North	5
	East	4
	West	2
	North-East	2
	North-West	2
	South-East	3
	South-West	3
	South	4

3.9. Ground water potential zonation

The groundwater potential zones of the study area were generated on the basis of weighted overlay analysis of various thematic maps i.e. LU/LC, drainage density, lineament density, slope and aspect using GIS techniques. The delineation of groundwater potential zones within Ranchi city and its nearby area was completed by a grouping of the interpreted layers through weighted multi influencing factor and lastly, given different potential zones. The groundwater potential zone of the study area has divided into four categories namely very good, moderate, poor and very poor as presented in Figure 11.

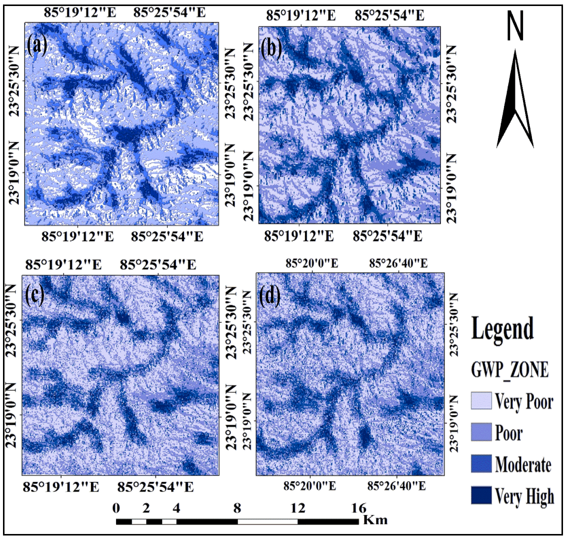

Figure 11*: GWP map of study area over the years 1998, 2004, 2010 and 2016 respectively (a), (b), (c) and (d)*

Throughout the analysis of prepared GWP maps, it is noted that ground water prospects have regularly decreased over the years 1998 to 2016. Very high GWP has gradually decreased at the rate of 1.73 Sq.km per year which is 0.14% per year. Very high GWP was 49.48 Sq.km in 1998 while it constantly declined to 36.01, 27.85 and 28.75 Sq.km in 2004, 2010 and 2016. Moderate GWP zone also steadily decreased time to time, in 1998 it was 175.68 Sq.km but in 2016 it moves down to 141.28 Sq.km which is 18.66% of the study area. Consequently, in 2004 and 2010, moderate GWP was 150.78 Sq.km and 120 Sq.km which is 19.92% and 15.86% respectively; it got decreased at the rate of the 1.81 Sq.km per year. The poor potential zone also shows the gradual variation over the years, in 1998 it was 389.23 Sq.km but in 2004, 2010 and 2016 it come down to 327.03, 312.93 and 322.61 Sq.km respectively. Although very poor zone has gradual increment over the years, it was 142.64 Sq.km in 1998 after that it has a continuous increment in 2004 and 2010 to 243.21 and 296.15 Sq.km; but it decreased in 2016 to 264.38 Sq.km (Table 4). During the analysis of all the observed maps, it has been noticed that very high and moderate ground water prospect lies along with the tributaries of drainage pattern as shown in Figure 11. Some differences have been observed when the prepared map has validated with the national wide prepared map of ground water prospects information by NRSC, ISRO under the Rajiv Gandhi National Drinking Water Mission (RGNDWM). As per the NRSC prepared map, mostly moderate ground water prospects has been detected along with the tributaries of drainage pattern within the study area which is shown in inclined hatches (http://bhuvan.nrsc.gov.in/projects/gwis/gwis.php).

Similarly shallow and deep water prospects have been also observed in very small part of the study area. Due to the less number of parameters used in present study, there have been some differences between the observed maps and prepared map by NRSC has been identified. Present investigation considered mainly five parameters (i.e. LU/LC, drainage density, lineament density, slope, and aspect) for ground water prospects mapping whereas NRSC, ISRO has considered elaborated parameters (i.e. lithology, geomorphology, structural, hydrology and base map etc.) for ground water prospects mapping (http://bhuvan-noeda.nrsc.gov.in/projects/gwis/docs/GW_Manual.pdf)

Table 4: *GWP area with it remarks over the years 1998, 2004, 2010 and 2016*

GWP	1998		2004		2010		2016	
	Area (sq.km)	**%**	**Area (sq.km)**	**%**	**Area (sq.km)**	**%**	**Area (sq.km)**	**%**
Very poor	142.64	18.84	243.21	32.12	296.15	39.12	264.38	34.92
Poor	389.23	51.42	327.03	43.20	312.93	41.34	322.61	42.62
Moderate	175.68	23.20	150.78	19.92	120.09	15.86	141.28	18.66
Very good	49.48	6.54	36.01	4.76	27.85	3.68	28.75	3.80

An attempt has in use to correlate the ground water prospect variation with LU/LC conversion. Throughout the analysis, it is noted that as the area of settlement increased the ground water prospect decreased. Settlement area has increased at the rate of 5.03 Sq.km per year which is 0.64% per year. It shows that very good groundwater potential zone decreased at the rate of 0.14% per year whereas settlement area increased at the rate of 0.64% per year which is 4.57% multiple of very good water potential zone. Its shows inverse relation to GWP, as the settlement, increased the GWP decreased. Due to the increment in impervious surface in settlement region, the groundwater prospects fall down over the years constantly. As the survey states, the construction of the heavy underground piles mostly obstructs the base flow of water which plays a significant role in recharging surface intakes; thus it retards the recharging of surface sources. Likely 0.06% per year forest area has degraded whereas the very good GWP decreased with the rate of 0.14% per years and moderate GWP decreased with 1.81% per years. Forest and GWP have direct relation; as the forest area will decrease the GWP will also decrease. Such as vegetation has also direct relation with ground water prospects, in present study slight variation in vegetation area has been detected. Further water body has also little mix variation but there is very less probability for such variation, it may due to an error in satellite data or classification error. Water body has also direct relation with ground water prospects. During the analysis it is also observed that fallow land of study area has mix variation also, fallow land imparts an interesting relation with ground water .if the land is with sufficient moisture content it directly shows that water table depth at that place is quite shallow, on the contrary, if land is with inadequate moisture content the water table depth would be quite deep. Area of LU/LC features over the years has tabulated in Table 5.

Table 5: *LU/LC area with it remarks over the years 1998, 2004, 2010 and 2016*

LU/LC	1998		2004		2010		2016	
	Area (sq.km)	**%**	**Area (sq.km)**	**%**	**Area (sq.km)**	**%**	**Area (sq.km)**	**%**
Water bodies	17.91	2.28	15.06	1.92	16.33	2.09	18.90	2.41
Settlements	76.16	9.72	107.78	13.77	140.24	17.92	171.80	21.94
Forest	110.61	14.13	101.54	12.97	107.21	13.69	102.14	13.04
Vegetation	20.71	2.65	17.31	2.21	15.38	1.96	23.49	3.00
Fallow land	417.65	53.35	391.15	49.96	346.83	44.30	295.57	37.76
Other features	139.89	17.87	150.09	19.17	156.92	20.04	171.00	21.84

The correlation of ground water prospect and LU/LC variation throughout the study time periods has well compared with the help of prepared graph as presented in Figure 12. Variation of ground water prospect zone with its remark can simply relate to the change in land use/ land cover features. In presented graph, it can easily interpret the trend of variation that how the ground water prospect is varying and which land use land cover features are influencing and how these features are correlated to each other.

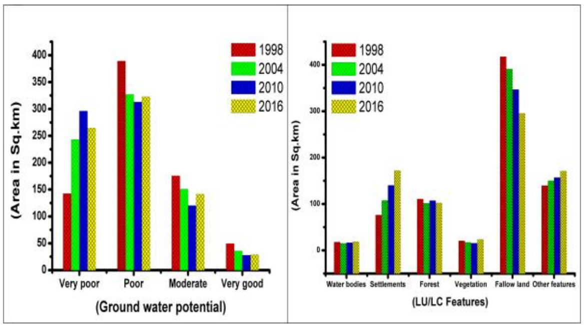

Figure 12: *Graph presenting ground water prospect variation with transformation in land use and land cover features*

4. Conclusions

In the present study, the effectiveness of geoinformatics has been demonstrated. Where the groundwater prospect is controlled by numerous parameters, primarily Land use/ land cover, drainage density, lineament density, slope and aspects map. Four zones of groundwater prospect– Very good, Moderate, Poor and Very Poor zones have been delineated based on different algorithms perform in GIS environment. Throughout the present investigation it is observed that groundwater potential zone of Ranchi city and its nearby area has gradually decreased with 0.14% (very good), 1.81(moderate) per years similarly poor zone also have varied with 0.52% per years and very poor zone increased at the rate of 0.79% per years till 2010 after that it fall down as rate of 0.7% per years till 2016. Hence geoinformatics is proving as most dynamic, innovative and efficient tool for mapping, monitoring, and management of water resource.

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