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Research Paper

Identify Groundwater Potential Zone of Gomai River Basin Using GIS & RS

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Abstract
Balanced water supply is necessary for the rural and urban areas in the Gomai River basin to maintain a healthy lifestyle and in the process enhance their living standard, aid in economic growth and overall development, etc. Present study focuses on groundwater resource potential zone identification. The Landsat 8 Satellite data, GEO EYE Satellite image and 30 m DEM have been used in the present study. The groundwater potential zones were obtained by overlaying all the thematic maps in terms of weighted overlay methods using the spatial analysis tool in ArcGIS 10.5. By integration of all the thematic maps (Soil, Geomorphology, Geology, Slope, Land use/ Land Cover, Lineament, Stream frequency and Drainage Density), groundwater potential zones were delineated and classified as very high potential, high potential, moderate potential, low potential and very low groundwater potential. Overall, the results of this study demonstrated that the Remote sensing and GIS technology is a powerful tool for assessing groundwater potential zone, based on which suitable locations for groundwater withdrawals could be identified.

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I. INTRODUCTION

Balanced water supply is necessary for the rural and urban areas in the Gomai River basin to maintain a healthy lifestyle and in the process enhance their living standard, aid in economic growth and overall development, etc. Groundwater is that the most possible various because the price of exploitation via hand-dug well and boreholes is way cheaper compared to traditional surface water programs which will need the construction of seizure reservoirs, piping network, etc. however, a significant constraint is that the complicated and erratic nature of groundwater occurrences in crystalline basement terrains with the attendant high rate of well/borehole failure within the absence of correct and adequate pre-drilling hydrogeological investigations (Fashae et al., 2014). geology techniques at the side of alternative standard ways like geologic, hydrogeological, and photogeological techniques are used to delineate groundwater potential zones (Lillesand and Kiefer, 1994; Teeuw,1995; Edet and Okereke, 1997; Sander et al., 1996; Taylor and Howard, 2000; Srivastava and Bhattacharya, 2006). However, integration of varied standard ways with Remote sensing (RS) techniques and Geographical Information System (GIS) technology helps to extend the accuracy of ends up in the delineation of groundwater potential zone and to scale back the bias on any single technique (Rao and Jugran, 2003).

Remote Sensing and GIS hold nice potential in rising our ability to explore groundwater potential. Also, the incorporation of local field observations into the conventional GIS-based models helps improve local results as exemplified by Adeyeye (2015). However, as pointed out by Jha et al. (2007), it is evident that groundwater studies using RS and GIS techniques in developing countries is very limited, and most studies are ad hoc in nature. It is the will of this analysis work to spotlight a few of the changes inherent within the application of RS and GIS in groundwater studies. The systematic planning of groundwater exploitation using modern technologies is essential for the proper utilization of this precious natural resource (Jaiswal et al., 2003). GIS and RS have emerged as some of the powerful tools in analyzing and quantifying multivariate aspects of groundwater occurrence. Using GIS, it is very helpful in the delineation of groundwater prospect and deficit zones integrating multi-criteria evaluation (Carver, 1991). Many studies have additionally been dispensed mistreatment satellite imagery for mapping the hydrogeomorphological units and groundwater potential zones

(Anbazhagan et al., 2011; Sahai et al., 2005; Reddy et al., 1996; Mohanty et al., 2010; Subramanian et al., 2010).

II. MATERIAL AND METHODS

The Landsat 8 Satellite data, GEO EYE Satellite image and 30 m DEM have been used in the present study. Survey of India (SOI) Toposheet at 1:50,000 scales have conjointly been used. Secondary data on hydrology and ground water well data have been collected from Central Ground Water Board, Nagpur and from the field to support mapping. Geographic Information System and Image Processing (ARC GIS 10.5 and ERDAS IMAGINE 2011 software) have been used for analysis and mapping of the individual layers.

The groundwater potential zones were obtained by overlaying all the thematic maps in terms of weighted overlay methods using the spatial analysis tool in ArcGIS 10.5. During the weighted overlay analysis, the ranking has been given for every individual parameter of every thematic map and therefore the weightage was appointed in step with the influence of the different parameters and was presented in Table (1). These weightages have been taken considering the works carried out by researchers such as Srinivasa & Jugran (2003), Krishnamurthy et al. (1996), Saraf & Choudhary (1998). All the thematic maps were converted into grid (raster format) and superimposed by weighted overlay method (rank and weightage wise thematic maps and integrated with one another through ArcGIS 10.5. As per this analysis, the whole weights of the ultimate integrated grids were derived because the total of the weights appointed to the various layers supported suitableness (Environment System Research Institute Inc.'s ArcView GIS Software, 1997). The full potential of remote sensing associate with GIS may be used once an integrated approach is adopted. Integration of the 2 technologies has tested to be associate degree economical tool in groundwater studies (Krishnamurthy et al., 1996).

In models derived through integration of various thematic maps using a GIS approach, several parameters are commonly involved to assess groundwater potential in the study area. The modeling involves delineation of zones of varying groundwater potential based on integration of Eight thematic maps in a raster-based GIS. The Eight parameters considered are: soil, Geomorphology, Geology, Slope, Land use/ Land Cover, Lineament, Stream frequency and Drainage Density. Every category within the thematic layers was placed into one in every of the subsequent classes viz. (i) Very High (ii) High (iii) Moderate (iv) Low (v) Very Low, depending on their level of groundwater potential.

Table 1 *Thematic layers, their categories and weights*

Thematic Layers	Categories	Weight
Geology	Alluvium and Colluvium	5
	Basalt	2
	Dolerite	1
Soil	Deep black soil	5
	Shallow black soil	2
Slope	$0^{\circ} - 2^{\circ}$	5
	$2^{\circ} - 5^{\circ}$	4
	$5^{\circ} - 15^{\circ}$	3
	$15^{\circ} - 30^{\circ}$	1
	$30^{\circ} - 60^{\circ}$	1
Geomorphology	Butte	1
	Channel Island	5
	Pediment-Pediplain Complex	3
	Piedmont Slope	2
	Dyke / Sill Ridge	1
	Active Flood plain	5
	Older Flood plain	5
	Younger Alluvial plain	5
	Gullied Tract	4
	Pediment	3
	Pediment-Corestone-Tor Composite	2
	Pediplain	4
	Plateau Remnant	2
	Residual Mound	1

	Ridge	1
	Highly Dissected Lower Plateau	2
	Highly Dissected Upper Plateau	2
	Low Dissected Lower Plateau	4
	Moderately Dissected Lower Plateau	3
	Moderately Dissected Upper Plateau	3
Lineament	Joint/Fracture	5
	Fault	4
	Dyke	1
Land use	Agriculture land	4
	Forest land	5
	Bare land	1
	Settlement	1
	Water Bodies	5
Drainage Density	Very low	5
	Low	4
	Moderate	3
	High	2
	Very high	1
Stream Frequency	Very low	5
	Low	4
	Moderate	3
	High	2
	Very high	1

(Source: Generated by researcher)

III. RESULT AND DISCUSSION

By integration of all the thematic maps (Soil, Geomorphology, Geology, Slope, Land use/ Land Cover, Lineament, Stream frequency and Drainage Density), groundwater potential zones were delineated and classified as very high potential, high potential, moderate potential, low potential and very low groundwater potential (Table 5.5). Only 20.72 % (283.185 km^2) of the study area was classified as having very high potential at northeast, northwest, south and central regions, 27.09 % (370.167 km^2) was of high potential at northeast, western, eastern and southern regions of the Gomai River basin and 21.86 % (298.739 km^2) was classified as having moderate potential. Hence, a total of 30.33 % of the area (414.509 km^2) can be classified as Low to very low potential. Very high groundwater potential zones cover an area of only 283.185 km^2, where nearly younger alluvium plain, very near distance to main rivers drainage channel, very near distance to lineament, very shallow water table levels (< 3 m) observed, very deep weathered zone thickness (>10 m) and very high well yields have been present in very high groundwater potential zone. High groundwater potential zones cover an area of 370.167 km^2, were very gentle to level slopes, near distance to streams, deeply weathered zone thickness 6 to8 m observed, high good yields and shallow water table levels (4–6 m) and have been present in younger alluvium to moderately weathered pediplains. Moderate groundwater potential zones cover an area of 298.739 km^2, where very gentle to moderate slopes, near to moderately far distance to streams, in Satpura hilly region it observed near lineament, and where weathering depth is moderate. Low groundwater potential zones cover an area of 176.535 km^2 where moderate to the steep slope, extremely far to farthest distances to streams and lineament, deep to very deep water table levels, shallow to very shallow weathered zone thickness, and low to very low well yields are present over the whole study area. Very low groundwater potential zones are present in the central, eastern and northern part of the study area and comprise an area of 237.974 km^2 where mostly area occupy rocky surface, high relief. The flat surfaces are observed in younger alluvium plain, peneplain and valley fill units having a high density of dug wells & bore wells. The lineaments are acting as pathways of groundwater movement in the Gomai River basin. As a result, the groundwater level is increasing considerably during the monsoon period. The geomorphological units such as active flood plain, older flood plain, channel island and pediplain are prospective zones for groundwater exploration and development in the study area. Presence of faults and lineaments in the area enhance the potential of these units. Groundwater potential map clearly indicates that active flood plain, older flood plain, channel island and younger alluvial plain which is composed of sand, silt and clay with nearly level slope and very low drainage density has the excellent potentiality of groundwater. Piedmont plain with a gentle slope and low drainage density poses high to very high groundwater potential while in some area Structural hills and linear ridges with a steep slope and high drainage density but due to presence of high lineament density offer high to very high groundwater potential. Pediment, residual hills and parts of structural hills having a steep slope and very high drainage density lie in very low groundwater potential zones. Thus, the generated groundwater potential map serves as a baseline for future exploration in the Gomai River basin.

Table 2 Spatial analysis of groundwater potential zone of Gomai River basin

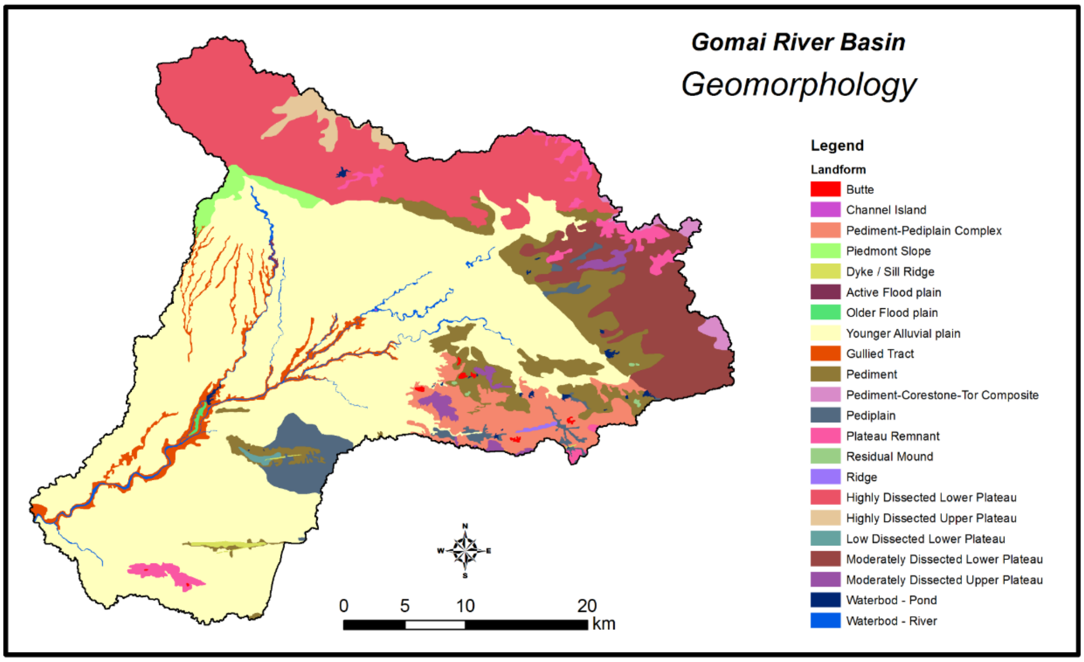
Groundwater Potential Zone	Area (sq. km)	Area (%)
Very Low	237.974	17.41
Low	176.535	12.92
Moderate	298.739	21.86
High	370.167	27.09
Very High	283.185	20.72

(Source: GIS Analysis & generated by researcher)

IV. CONCLUSION

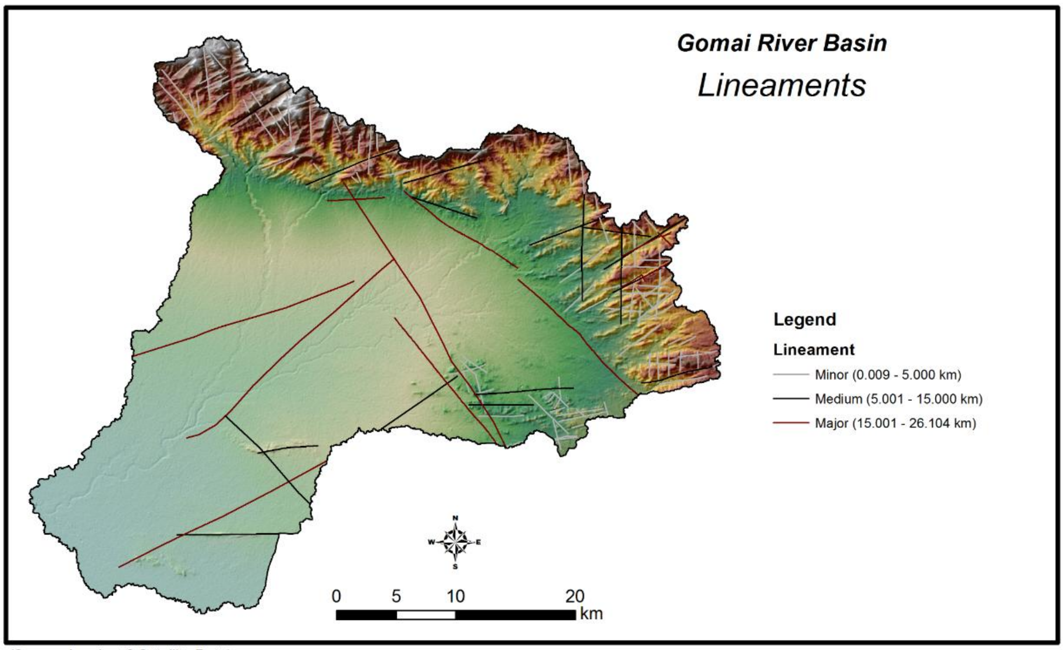
In this study, multi-criteria weighted overlay evaluation technique using raster-based GIS analysis is attempted to delineate the groundwater potential zones. Remote sensing and GIS have proved as very important tools in delineating groundwater potential zones based on the integration of various thematic maps layers. The occurrence of groundwater has a direct relationship with the geomorphology, soil, drainage density and slope of the area. In hard rock area potentiality for groundwater, the occurrence is influenced by the presence of lineaments. The study area is dominated by weathered basalt geomaterial with nearly level slope. Consequently, about 21.86 per cent area has moderate potential and 47.81 per cent area has very High to High potential for groundwater occurrence. Residual hills, structural hills and ridges with a steep slope and high drainage density have either very Low to Low groundwater potential which is influenced by the presence of lineaments.

Overall, the results of this study demonstrated that the Remote sensing and GIS technology is a powerful tool for assessing groundwater potential zone, based on which suitable locations for groundwater withdrawals could be identified. Consideration of an adequate number of thematic layers and proper assignment of weights are keys to the success of Remote sensing and GIS techniques in identifying groundwater prospects. Based on the results of this study, concerned decision-makers can formulate an efficient groundwater utilization plan for the study area to ensure the long-term sustainability of this vital resource.



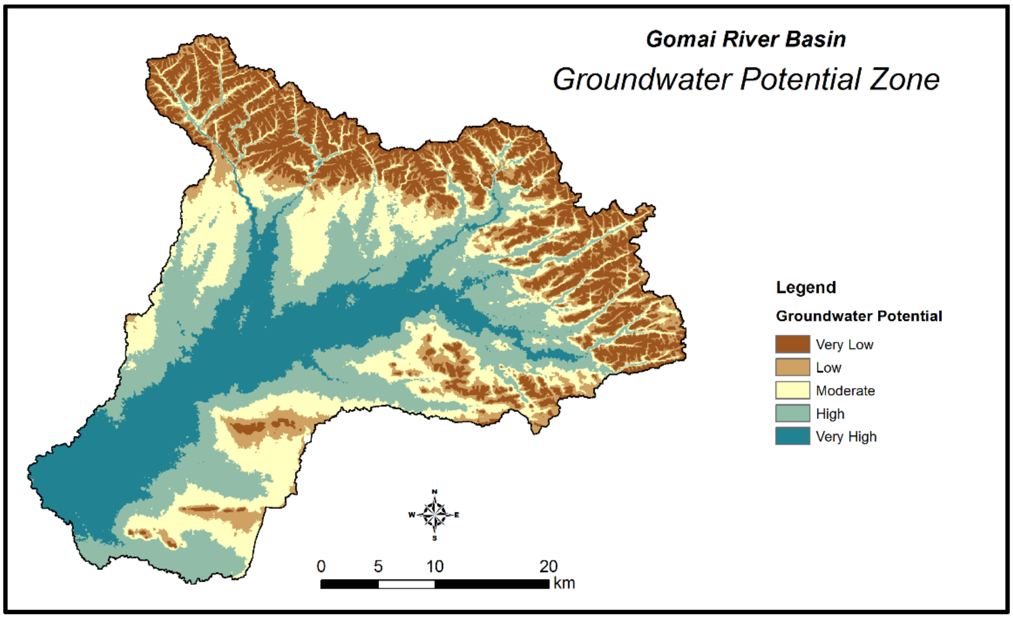
(Source: Geological Survey of India, Landsat 8 & Field work data)

***Fig. 1** Landforms of the Gomai River Basin*



(Source: Landsat 8 Satellite Data)

Fig. 2 *Lineaments in the Gomai River Basin*



(Source: GIS Analysis & Field work data)

Fig. 3 *Groundwater potential zone of the Gomai River basin.*

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