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REMOTE SENSING AND GIS IN SUB WATERSHED PRIORITIZATION FOR GROUND WATER PROSPECT BASED ON HYDROGEOMORPHOLOGICAL STUDY

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Abstract: *Hydrogeomorphological study of the area provides a broad spectrum to comprehend various dimensions regarding the natural resources, their distribution, occurrences, planning and management, etc. The study basically deals with the action of water with the landforms, including surface and subsurface water. Thus hydrogeomorphological maps so generated depict important landforms, significant prospective zones for ground water occurrences and scope of resources planning and management.*
Keywords: *Hydrogeomorphology, Remote Sensing and GIS, Ground water Prospect*

Introduction: Hydrogeomorphology is the specific description of applied geomorphology that includes three interrelated themes (hydro+geo+morpho). Hydro means water, including both surface and ground water; geo- means the earth (lithology) and morphology expresses the features in the form of land forms. As such, hydrogeomorphology deals with the aspects of water, rocks and earth's morphological features (land). Of these, water and land are most important natural resources for human beings [1]. Defines hydrogeomorphology as the study of landforms caused by action of water which is the most important geomorphic agent in sculpting the landform. Identification, mapping and analysis of hydrogeomorphic features have great implications in the planning and management of natural resources [2].

Hydrogeomorphological mapping is one of the most complex phenomena to be investigated through remote sensing. Its complexity lies in the fact that the ground water is not directly observed on aerial photographs or satellite imagery. Hydrogeomorphological map depicts important geomorphic units, landforms and underlying geology, so as to provide better understanding of the processes, materials, lithology, structure and geologic control *vis-a-vis* ground water occurrences and prospects. Such map depicting prospective zones for ground water targeting are used as an essential base for planning and execution of ground water exploration. For the evaluation of ground water resources, a geomorphological terrain classification leading to the delineation of hydromorphological units is useful taking both morphological and lithological factors into consideration [3,4,5].

Credited to initiate remote sensing techniques in mapping and analysis of geomorphic features [6,7,8,9]. Geomorphological mapping of a terrain is a pre-requisite for the soil resources mapping, ground water potential zone identification, landscape ecological planning, hazard mapping and other environmental applications [10].

Objectives

1. Preparation of hydrogeomorphological map using satellite data, IRS P6, LISS-III (2014).
2. Identification and delineation of sub watersheds using morphometric parameters.
3. Sub watershed wise analysis of different hydrogeomorphic features (area in %).
4. Prioritization of sub watersheds for the ground water prospect.

Study Area: Chakia *tahsil* came into existence in 1997 along with the two other *tahsils* namely Sakaldiha and Chandauli *tahsil* of Chandauli District (U.P.). The extent of study region is between 24º4' N to 25º3' N and 83 º 3' E to 83 º 24' E. Physiographically, it constitutes the alluvial plain in the north and Vindhyan upland in the south. Alluvial plain shows the sediments of Quaternary age, whereas namely *Kaimur* Upland exposed in the southern portion of the *tahsil*. It comprises of a stratified unmetamorphosed group of rocks of sandstone, shale, sandoquartizite and limestone. Karmanasa, Chandraprabha and Garai are the three main rivers draining the region (Fig. 1).

Database and Methodology: Based on morphometric parameters and local, regional terrain variations, Karmanasa, Chandraprabha and Garai which constitute the three watersheds and are further divided into 15 micro-level units/sub watersheds taking into account the fourth level hierarchy of stream orders. In doing so, Garai (GN1 and GN2), Chandraprabha (CN1, CN2, CN3, CN5, CN5 and CN6) and Karmanasa (KN1, KN2, KN3, KN4, KN5, KN6, and KN7) watershed constituting two, six and seven sub watersheds respectively (Fig. 2).

In the present investigation, remote sensing techniques using IRS P6, LISS-III (2014) data have been applied to delineate various hydrogeomorphic features. The two groups of features like flood plain and Vindhyan plateau and their sub units are carefully marked through visual image interpretation techniques and digitized under GIS environment (Fig.3). Plate 1 shows identified hydrogeomorphic features through satellite image of Chakia *tahsil*. Their percentage share in the area has been shown in Table 1 and sub watershed prioritzation in the Fig. 4.

Table 1 : Sub Watershed Wise Hydrogeomorphic Units and Their Area (%)

Hydrogeom-orphic Unit	Sub Watershed															Area (Sq Km)	Area (%)
	KN 1	**KN 2**	**KN 3**	**KN 4**	**KN 5**	**KN 6**	**KN 7**	**CN 1**	**CN 2**	**CN 3**	**CN 4**	**CN 5**	**CN 6**	**GN 1**	**GN 2**		
							Alluvial Plain										
AP1							25.48						22.54			94.97	7.58
AP2							52.16						33.40			171.12	13.66
SB							0.16									0.34	0.03
Total							**77.80**						**55.94**				
							Vindhyan Upland										
P1	8.27	10.96	5.31	5.87		10.09	0.87	15.29								50.31	4.01
P2	2.80						0.66	6.83								14.54	1.16
Total	**11.07**	**10.96**	**5.31**	**5.87**		**10.09**	**1.53**	**22.12**									
BP1	8.33		0.22	1.31		29.39		1.63				0.85				30.90	2.47
BP2	48.28							6.59	10.41		0.73					145.16	11.58
BP3	3.41		2.19					6.51								15.52	1.24
Total	**60.22**		**2.41**	**1.31**		**29.39**		**14.73**	**10.41**		**0.73**	**0.85**					
DP	9.71	81.30	51.00	70.41	58.16		1.90	61.42		89.99	75.67	77.31		89.11	62.24	387.16	30.89
SH				2.02	3.47	28.60	4.48		89.59		3.57		5.91		1.88	47.19	3.77
DH	6.20	7.74	32.20	6.51	14.38	27.46				10.01	7.48	8.90		10.89	4.41	96.25	7.68
RH				1.30		1.03	1.56						6.73		0.50	17.15	1.37
Total	**15.91**	**89.04**	**83.20**	**80.24**	**76.01**	**57.09**	**7.94**	**61.42**	**89.59**	**100.00**	**86.72**	**86.21**	**12.64**	**100.00**	**69.03**		
IV			1.13	10.39	15.92	3.43	12.54				2.32		31.29		23.95	116.36	9.29
V			5.53	1.17	4.21		0.19									5.85	0.47
Total			**6.66**	**11.56**	**20.13**	**3.43**	**12.73**				**2.32**		**31.29**		**23.95**		
Rd	4.47										3.97	4.75				18.67	1.49
Rw	8.53		2.42	1.02	3.86			1.73			5.58	8.19	8.53			37.18	2.96
Total	**13.00**		**2.24**	**1.02**	**3.86**			**1.73**			**9.55**	**12.94**	**8.53**				
VF															7.02	3.68	0.29
G											0.68					0.78	0.06
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	1252.95	100

Note: AP I,II -Alluvial Plain , SB-Sand Bar, P-I & II-Pediment,, BP- I,II & III-Buried Pediment, Dp-Dissected Plateau, SH-Structural Hill, DH-Denudational Hill, RH- Residual Hill, I V-Intermontane Valley, V-Valley, Rd-Reservoir with dry bed, Rw- Reservoir with water

Hydrogeomorphology largely influences the nature, spatial distribution and utilization of natural resources. In order to decide the priority of sub watersheds, the weighted score technique has been applied in which lower weights are given to features of lower significance, whereas higher weights are given to those features which plays a significant role in the development and prosperity of a region. For example, sand bar, dissected plateau and stony dry beds of the reservoir are given lowest weighted, *i.e*., 1. Pediment Type-I, structural hill and residual hills are given weightage of 2 and denudational hills, characterized with better forest cover are kept under weightage 3. Weightage 4 is given to pediment type II and buried pediment type III while weightage 5 is assigned to buried pediment type -II. weightage 6 is given to alluvial plain type -II, whereas highest weightage is assigned to alluvial plain type-I, buried pediment type-I, intermontanne valleys and valley fills. By using their weightings, the weighted score of each sub watershed is computed by multiplying the weightages of features with their percentage share in respective units. Sum of weighted scores of a sub watershed, i.e., total weighted score takes into account to assess the priority of that particular sub watershed. First priority is given to those sub watersheds whose scores are lower, it means their quality of features are poor, hence they need special attention for resource development and planning. The third priority status has been assigned to sub watersheds who are associated with features of higher weighted scores that indicates good quality status.

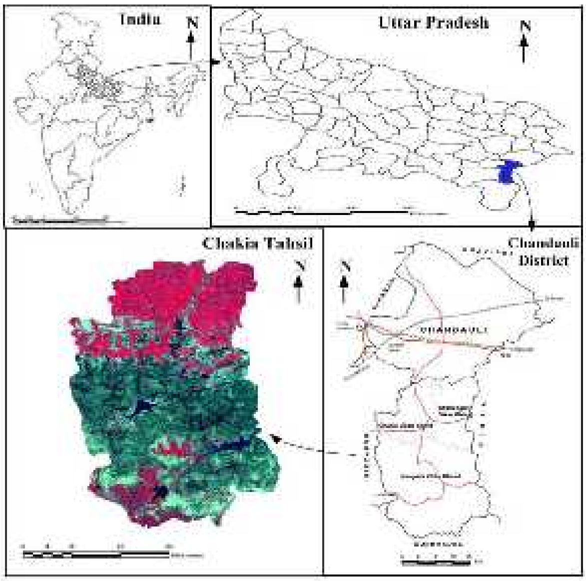


Fig. 1 Chakia Tahsil: Location Map

Fig. 3 Chakia Tahisl: Hydrogeomorphic Features

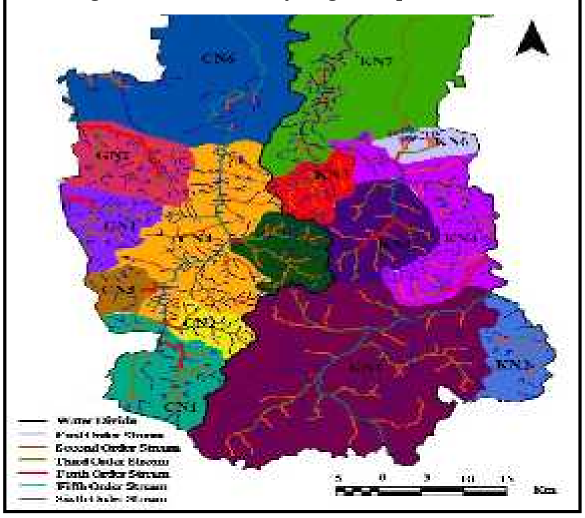
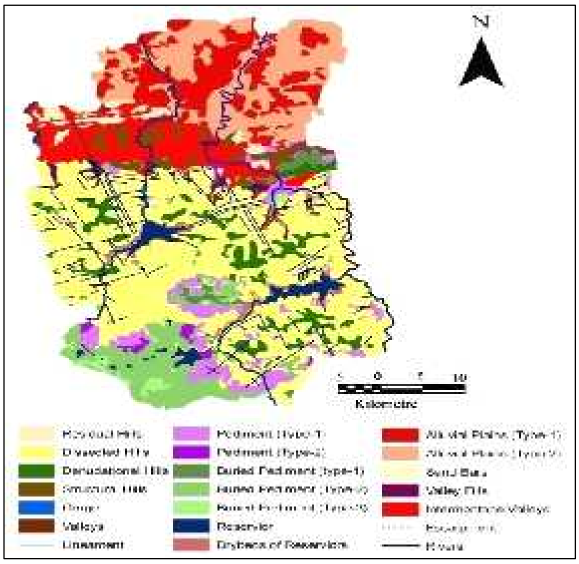


Fig. 2 Chakia Tahsil: Delineated Sub Watersheds



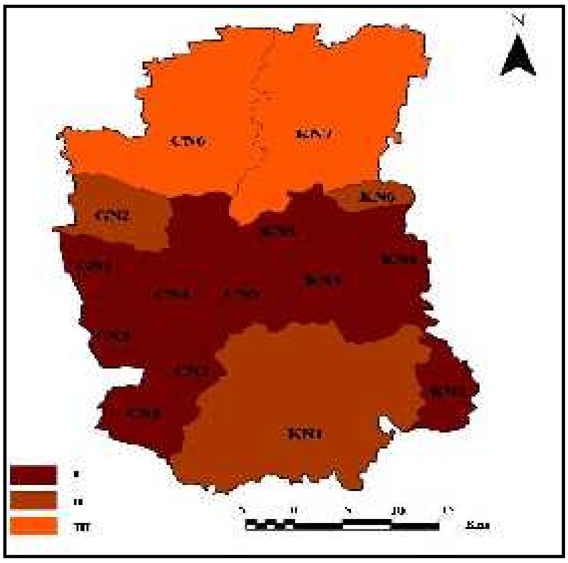
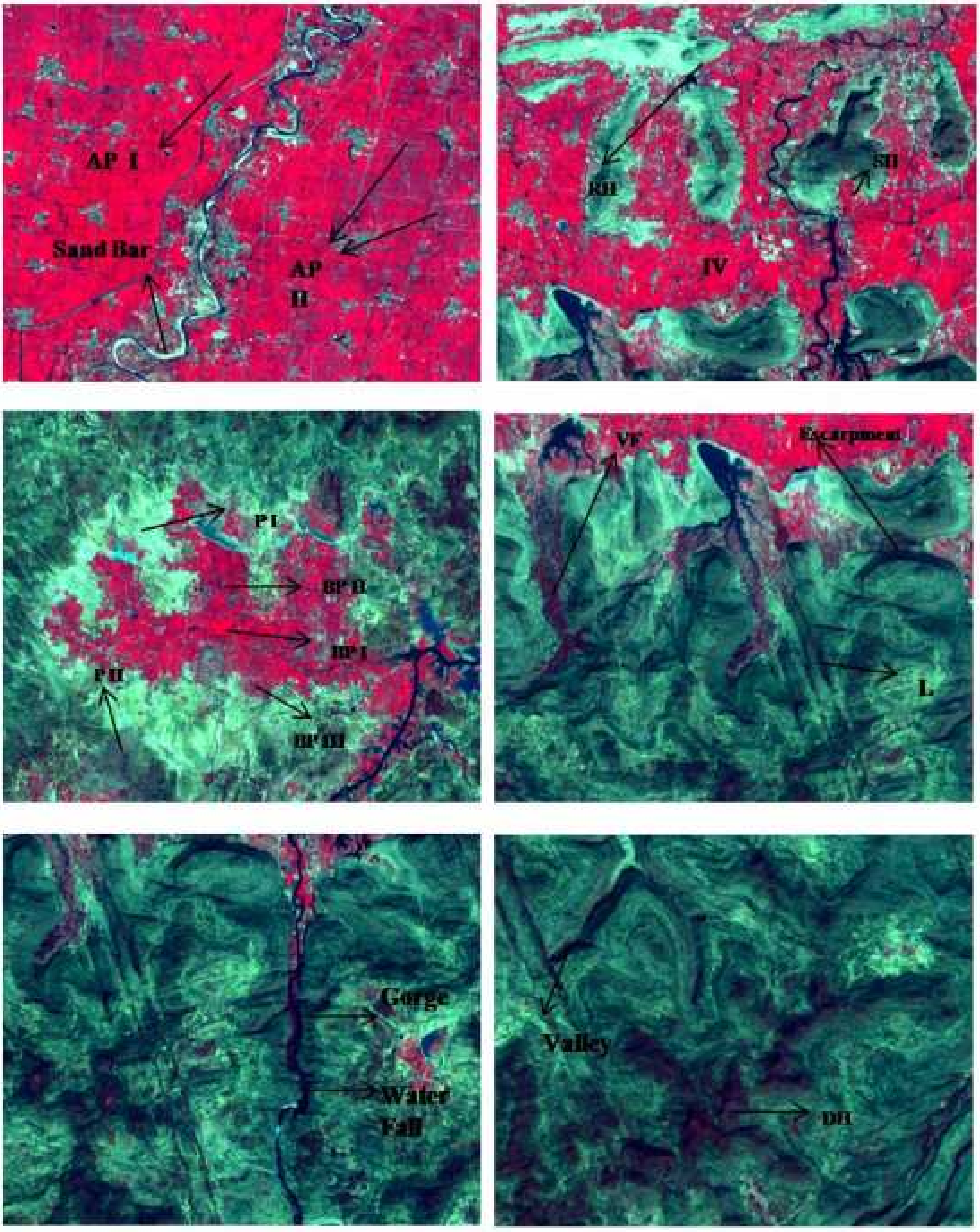


Fig. 4 Chakia Tahsil: Sub watershed Prioritization based on Hydrogeomorphic Characteristics

HYDROGEOMORPHIC FEATURES THROUGH SATELLITE IMAGES



AP I: Alluvial Plain (Type I), APII:Alluvial Plain (Type II)

RH: Residual Hill, SH: Structural Hill, IV: Intermontane Vallley

P I: Pediment (Type I), PII: Pediment (Type II), VF: Valley Fill, L: Lineament

DH: Denudational Hill

Results and Discussion

In the Table **1**, sub watersheds wise hydrogeomorphic units with and their priority status based on those units are shown respectively. It is evident from the tables that the maximum area is covered by a dissected plateau in this region. After that alluvial plain covers more than 20% of the area. Buried pediments cover nearly 15% of the total area. The final priority of sub watersheds based on these features is shown in the Table 2 and 3, sub watersheds KN2, KN3, KN4, KN5, CN1, CN2, CN3, CN4, CN5 and GN1 are categorized under first priority with weighted score value 280 and below. These sub watersheds are mostly covered with dissected plateau. Somewhere in the plateau region, existence of buried pediment and irrigation facility offers good cultivation as well as are the moderate prospect for the ground water potentialities. The three sub watersheds namely KN1, KN6 and GN2 got second priority. These sub watersheds are marked with hydrogeomorphic features like buried pediment, pediment, valley fills and intermonatne valleys which offers moderate to good condition of ground water resources and land resource utilization prospects. The hydrogeomorphic units like alluvial plain and intermonatne valleys have the predominant share in sub watershed KN7 and CN6. These two sub watersheds gained a weighted score of 450 and above and enlisted under third priority, indicating good status in terms of hydrogeomorphic features and also there is good to very good ground water prospect.

Table 2: Sub Watersheds and Tsheir Priority Status Based on Hydrogeomorphic Features

Hydrogeo morphic Unit	Sub Watershed														
Alluvial Plain															
AP1							178.36						157.78		
AP2							312.96						200.40		
SB							0.16								
Vindhyan Upland															
P1	16.54	21.92	10.60	11.74		20.18	1.74	30.58							
P2	11.20						2.64	27.32							
BP1	58.31		1.54	7.91		205.73		11.41				5.95			
BP2	241.54							32.95	52.05		3.65				
BP3	13.64		8.76					20.04							
DP	9.71	81.30	51.00	70.41	58.16		1.90	61.42		89.99	75.67	77.31		89.11	62.24
SH				4.04	6.94	57.20	8.96		179.18		7.14		11.82		3.76
DH	18.60	23.22	96.60	19.53	43.14	82.38				30.03	22.44	27.70		32.67	13.23
RH				2.60		2.06	3.12						13.46		1.00
IV			7.91	72.73	22.92	24.01	87.78				16.24		219.03		167.65
V			5.53	1.17	4.21		0.19								
Rd	4.47										3.97	4.75			
Rw	42.65		12.10	5.10	19.3			8.65			27.90	40.95	42.65		
VF															49.14
Total Weighted	**416.66**	**126.44**	**194.04**	**195.23**	**154.67**	**391.56**	**597.81**	**183.72**	**231.23**	**120.02**	**157.69**	**165.66**	**645.14**	**121.78**	**297.02**
Priority	**II**	**I**	**I**	**I**	**I**	**II**	**III**	**I**	**I**	**I**	**I**	**I**	**III**	**I**	**II**

Source: Based on computation by the researcher

Table 3: Sub-Watershed and Their Priority Based on Hydrogeomorphic Characteristic

Weighted Score	Priority	Sub Watershed	Total
450 and Above	III	KN7, CN6	2
280-450	II	KN1, KN6, GN2	3
280 and Below	I	KN2, KN3, KN4, KN5, CN1, CN2, CN3, CN4, CN5, GN1	10

Source: *GIS based computation by the Researcher*

Conclusion: From the point of view of hydrogeomorphology, alluvial plain, intermonatnne valley, buried pediments and valley fills are the good to excellent zone for the ground water prospect. Pediment, dissected plateau, structural hills, denudational hills and residual hills, which varies from various litho-units, offers very poor to moderate prospects for ground water resources. Sub watersheds lying in the northern alluvial plain indicate excellent zones, whereas southern plateau region has spatially varying prospect of ground water resources. Morphometric analysis of a watershed provides a quantitative description of the drainage system which is an important aspect of the characterization of watersheds [11]. These sub watersheds further provides a base for other resource inventories, planning and management.

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