Prioritization of Gomti Nala Micro-Watershed using land cover, Ground Water Prospects and Morphometric Parameters

Babita Kumari
Jamia Millia Islamia

Prioritization of Gomti Nala Micro-Watershed Using Landcover, Ground Water Prospect and Morphometric Parameters

Babita Kumari and Somashree Mazumdar
Department of Geography, Faculty of Natural Science , Jamia Millia Islamia
E-mail: pihu.mital@gmail.com

Abstract

Watershed prioritization is the scientific process of watershed delineation and monitoring. It has gained importance in natural resource management, especially in the context of watershed management. Present study has been undertaken in the Gomti Nala micro watershed falling in Gola block, Ramgarh district of Jharkhand State, India. Primary aim of the study is to prioritize micro watershed. Priority maps was prepared using land use land cover, ground water prospect and morphometric parameters. To fulfil the objective satellite data- IRS-P6, LISS-IV and Cartosat-1 are being incorporated with Survey of India (SOI) toposheet of 1:50000 scale for the study area. Ground water prospect map is generated using the integration of spatial layers of geomorphology, slope, soil and lineament density with the help of weighted ranking method and Hortan's technique is used for morphometric analysis.

Keywords: Geo-hydrological, morphometric, watershed, lineament, weightage

Introduction

Watershed is a geo-hydrological unit where water drains at a common point [1-3]. For optimum utilization of natural resource without harm, watershed management is the best suited tool. Watershed management adopts the holistic development of both natural resources and societies [5, 6]. For this management delineation of watershed is necessary on the basis of different priority [4-7]. So, main aim of my study is prioritization of micro watershed on the basis of its land use/land cover (LU/LC), morphometric characteristics and prospects of ground water.

Data sets

Satellite imagery of IRS-P6, LISS-IV and CARTOSAT-1 merged data is used in this study. Survey of India (SOI) toposheet of 1:50000 scale is used for preparation of basic thematic map like drainage, road and administrative boundary.

Methodology

Satellite imagery of IRS-P6, LISS-IV having 5.8 meters resolution and Cartosat-1 having 2.5 meters resolution is used for generation of various natural resources maps on 1:10,000 scale. Merging of Satellite Imagery of IRS-P6, LISS-IV and Cartosat-1 is done with the help of image processing technique, where the output data is in 2.5 meters resolution. Drainage map is updated using the satellite data for delineation of micro watershed of the study area. Land use land cover, Geomorphology, Transportation network, Lineament is prepared using high resolution satellite imagery on 1:10,000 scale. Available thematic layers like Soil resources and slope information on 1:50,000 scale are collected from the concerned department. Further area of micro watershed is delineated based on the drainage map of the study area. Micro watershed wise morphometric characteristics are observed and analyzed using the Horton's method. Ground water prospect zones are identified by ranking and weightage method using Geomorphology, Soil, Slope, drainage density and lineament density maps. Micro watershed are prioritized based on each resources layers like land use land cover, ground water prospect zones and morphometric parameters with the help ranking and weightage method. Final prioritization of Micro watersheds is prepared with the help of priority maps prepared using land use land cover, ground water prospect and morphometric parameters.

For prioritization of watershed ranking and weighted method shown in equation 1 is used.

$$GWK = \frac{[\sum_{K=1}^{nK}(W_K * V_{JK})]}{100} \ldots\ldots\ldots equation\ 1$$

Where nk = number of attributes
Wk = Weightage of attribute k
Vjk = value assigned to class j of attribute k

Study Area

Study area Gomti Nala watershed is located in Gola block of Ramgarh district in Jharkhand (Figure 1), the geographical extent and location of the study area is situated in 23˚33'37"N to

23°30'37"N latitude and 85°41'52"E to 85° 51'9.759"E longitude with the area of 65.95 Sq. km. and area fall under the 73E/10 and 73E/14 of Survey of India Toposheets.

Results and discussion

Micro watershed is delineated based on the drainage map (figure 2) and micro watershed map of Gomti Nala watershed is shown in table 1 & figure 3.

Ground water prospects: In order to delineate the ground water prospects zones integrated analysis was carried out with the help of interpreted thematic maps such as geomorphology (table 3 & figure 4), soil (table 4 & figure 5), slope (table 5& figure 6), drainage density (table 6 & figure 7) and lineament density (table 7& figure 8). Numerical approach, which is better, suited for quantitative and computer aided integrated analysis of multi thematic information is adopted in this study. The attributes are assigning Weightage (W_k) depending on their relative influence of ground water potential. Similarly the category of each attribute were also assigned numerical values (V_{jk}) based on their influence. This enabled in performing numerical integrated analysis and semi-quantitative evaluation. The Weightage have been given to each maps such as 20 for geomorphology, 15 for soil, 15 for slope, 10 for drainage density and 10 for lineament density. The classes (categories) in each map were given class values in such a way that the class, which is highly favorable for ground water potential, was given the highest value i.e., of the attribute itself. The Weightage given for the attributes and the values corresponding to classes are shown in (Table 8). The integration analysis was carried out by superimposing all the maps (attributes) by multiplying the Weightage for each map with corresponding Weightage for each class. The product of Weightage factor (W_k) for all the maps and the class values (V_{jk}) of each pixel are summed up and 100 divided the sum, i.e., nk

The resultant output values were regrouped into five different ground water potential zones. They are poor, moderate, good, very good and excellent ground water prospects zones [8,9,10]. The detailed of weightages and classes for each thematic layers along with the calculated values based on above weightage analysis formula are shown in Table 8.

The final ground water prospect zones of the study area are identified and categorized as Excellent, Very Good, Good, Moderate and Poor zones in which 47.36 percent of area covered under excellent prospect zone, 30.40 percent of area falls under very good prospect zones and 17.95 percent area under Good prospect zones, remaining area covers under moderate and poor (Table 9 & figure 9). The ground water prospect zones of the study area are ranked and compound values are calculated and categorized into three priority levels like low priority, medium priority and high priority. Zone which has lowest compound value ($C_{p)}$ ranked into 1, next high value ranked as 2 and so on. It means zone which has highest C_p value has least scope of development [2,4,5]. The results shows that 2A2H1a3d micro watershed come under low priority, 2A2H1a2d, 2A2H1a2c, 2A2H1a2b, 2A2H1a1c, 2A2H1a1a, 2A2H1a2e come under medium priority and 2A2H1a2a, 2A2H1a1b, 2A2H1a3c come under high priority (figure 10).

Prioritization Based on Land use/ Land cover Analysis: Common land use categories such as Fallow land, cultivated land, open forest, blank forest, scrub forest, tree clad, wastelands with dense scrub, wastelands with open scrub, gullied land, brick klins, rock outcrop, settlement rural, settlement urban, tank/pond/lake, river, river sand, in all micro watershed were considered for prioritization of micro watershed based on land use/land cover analysis[8,12,13]. Percentage area of each land use categories is calculated and ranking was assigned on the basis of area under each land use (Table 2 & figure 11). For micro watershed prioritization on the basis of land use categories highest value under land use were rated as rank 1, second highest value were ranked as 2 and so on. Finally all categories were added up to arrived at compound value (Cp). Lower is the Cp value higher is the priority and vice-versa. The final ranking was given by classifying the highest and lowest range of Cp value into three classes as high range between 2 to 3.5, medium range is from 3.6 to 5, lowest range will be greater than 5 priority. 2A2H1a1a, 2A2H1a2c micro watershed come under high priority, where 2A2H1a2e, 2A2H1a1c, 2A2H1a2a, 2A2H1a1b come under medium priority and 2A2H1a2b, 2A2H1a3d, 2A2H1a2d, 2A2H1a3c come under low priority (table 13 & figure 12).

Prioritization based on Morphometric Analysis: The Morphometric Parameters i.e. bifurcation ratio (Bf), basin shape (Bs), compactness coefficient (Cc), drainage density (D), stream frequency (Fs), drainage texture (Rt), length of overland flow (Lo), form factor (Rf), circulatory ratio (Rc), elongation ratio (Re) are also termed as erosion risk assessment parameter [11-13] and has been used for prioritizing micro watershed of Gomti Nala watershed (table 10). The linear parameter such as bifurcation ratio, basin shape , compactness coefficient , drainage density, stream frequency, drainage texture, length of overland flow have a direct relationship with erodibility means higher the value, more is the errodibility [15-18].

Hence for micro watershed prioritization highest value ranked as 1, second highest value was ranked as 2 and so on. Shape parameter such as form factor, circulatory ratio, elongation ratio, compactness coefficient, basin shape have inverse relationship with value, means lower the value higher the rank [15-18]. Hence, the ranking of the micro watershed has been determined by assessing the highest priority/rank value based on highest value in case of linear parameter and lowest value in case of shape parameter. After the ranking has been done based on every single parameter, the ranking values for all the parameters of each micro watershed were added up for each of the ten micro watersheds to arrive at compound value (Cp) (table 11).

Based on the average values of these parameters, the micro watersheds having the least rating value was assigned highest priority, next higher value was assigned second priority and so on[14-17]. The sub watershed which got the highest Cp value was assigned last priority. The sub watersheds were categorized into three classes as high priority value range from 2.00 to 5.00, medium priority range between 5.01 to 5.50, low priority >5.5 on the basis of the range of Cp value. The compound parameter values ten micro watersheds of Gomti Nala watershed were calculated and prioritization rating is shown in (Table. 12) Micro watershed code of 2A2H1a3c with a compound parameter value of 3.55 receives the highest priority (1) with next in the priority list is 2A2H1a2e micro watershed having the compound parameter value of 3.64 (figure 13). Highest priority indicates the greater degree of erosion in the particular sub-watershed and it becomes potential area for applying soil conservative measure. Thus soil conservation measures can first be applied to micro watersheds area 2A2H1a3c and then to the other subsequent micro watersheds depending upon their priority.

Final Prioritization of Micro watersheds: The results obtained from morphometric, land use/land cover analysis and ground water prospect zone were correlated to find out the common micro watershed falling under each priority. For final prioritization there is a rank given to priority micro watershed based on morphometric, land use/land cover and ground water prospect zone. All priority rank of each microwatershed are summed up to get common priority (CP). Finally five category of micro watershed is delineated from the watershed. They are very high, high, medium, low, very low priority. The correlation of morphometric analysis, land use / land cover analysis and ground water prospect shows that 2A2H1a1a, 2A2H1a2a, come under very high priority, 2A2H1a2e, 2A2H1a1b, 2A2H1a3c micro watershed come under high priority, 2A2H1a2c, 2A2H1a2d micro watersheds come under moderate priority, 2A2H1a1c micro watershed comes under low priority. This zone has only cropland, cultivated land and built-up area. Soil, slope, geomorphology of these zones are good. So there is very less scope of further planning. So this zone comes under low priority and 2A2H1a2b, 2A2H1a3d micro watersheds come under very low priority (Figure 14).

Conclusion

The land use / land cover, geomorphology, soil, drainage, lineament map were prepared from Cartosat 1 and LISS IV merged data and slope map was procured concerned department which is mapped on 1:50000 scale. There is 18 category of Land use and land cover are identified in gomti nala watershed area. Mainly Fallow land, cultivated land, scrub land, forest and water body are prominent in the study area. Drainage network mapping is done using the high resolution satellite data and used as one of the component for morphometric analysis and to demarcate the micro watershed. Horton's method is used for Morphometric analysis and also implements the Strahler modified method. For morphometric analysis two parameters are considered: line parameter and shape parameter. According to morphometric analysis watershed of the study area is less elongated in shape with moderate drainage density and coarse texture. Slope, soil, drainage, lineament and geomorphology thematic information were used for ground water prospects mapping. The attributes are assigning Weightage (W_k) depending on their relative influence of ground water potential .Similarly the category of each attribute were also assigned numerical values (V_{jk}) based on their influence. Five ground water prospect zones are identified they are poor, moderate, good, very good, excellent prospect zones. Land use / Land cover, morphometric analysis and ground water prospects spatial information were used for micro watershed prioritization. In land use and land cover analysis for micro watershed prioritization all category of land use have given a rank according to their percentage of area to total area. Highest value ranked as 1 and second highest as 2 and so on. Finally all categories were added up to arrived at compound value (Cp). Lower is the Cp value higher is the priority and vice-versa. The final ranking was given by classifying the highest and lowest range of Cp value into three classes as high, medium, low priority. In Morphometric analysis for watershed prioritization the ranking of the micro watershed has been determined by assessing the highest priority/rank value based on highest value in case of linear parameter and lowest value in case of shape parameter. After the ranking has been done based on every single parameter, the ranking values for all the parameters of each micro watershed were added up for each of the ten micro watersheds to arrive at compound value (Cp). Based on the average values of these parameters, the micro watersheds having the least rating value was assigned highest priority, next higher value was assigned second priority and so on. The micro watershed which got the highest Cp value was assigned last priority. In Ground water prospect of the watershed have been categories into three watershed low medium and high. Prospect zone which has lowest Cp value ranked as 1, next high value ranked as 2 and so on. It means zone which has highest cp value has least scope of development. For final prioritization ranking is given to each microwatershed based on morphometric, land use/land cover and ground water prospect and each category are summed up to get common priority (CP). Finally five category of micro watershed is delineated from the watershed. They are very high, high, medium, low, very low priority. Micro watershed 2A2H1a1a, 2A2H1a2a were fall in very high priority category, 2A2H1a2e, 2A2H1a1b, 2A2H1a3c in high priority, 2A2H1a2c, 2A2H1a2d in medium priority, 2A2H1a1c in low priority, 2A2H1a2b, 2A2H1a3d in very low priority

References

1. Ali Mirchi, David Watkins, Jr.and Kaveh Madani Modeling for Watershed Planning, Management, and, Decision Making In: Watersheds: Management, Restoration and Environmental... ISBN: 978-1-61668-667-3 Editor: Jeremy C. Vaughn © 2009 Nova Science Publishers, Inc.
2. Basudeo Rai1, A Tiwari and V S Dubey Identification of groundwater prospective zones by using remote sensing and geoelectrical methods in Jharia andRaniganj coalfields, Dhanbad district, Jharkhand state India. J. Earth Syst. Sci. 114, No. 5, October 2005, pp. 515–522.
3. Dr. Jyoti sarup Manish K. TiwariVardichand Khatediya Delineation of groundwater prospect zones and identification of artificial reacharg site using geospatial techniques. International Journal of Advance Technology & Engineering Research (IJATER), Vol. 1, Issue 1, November 2011.
4. Geena.G.B, Ballukraya.P.N Morphometric analysis of Korattalaiyar River basin, Tamil Nadu, India: A GIS approach Internationa Journal of Geomatics and Geoscience Volume 2, No 2, 2011.
5. K.Narendra and K.Nageswara Rao, (2006).Morphometry of the Meghadrigedda Watershed, Visakhapatanam District, Andhra Pradesh using GIS and Resourcesat data., Vol.34, No 2, 101-110.
6. M. Kavitha Mayilvaganan, P. Mohana and K.B. Naidu Delineating groundwater potential zones in Thurinjapuram watershed using geospatial techniques, Indian Journal of Science and Technology,Vol. 4 No. 11 (Nov 2011).
7. Miller (1953). A Quantitative Geomorphic study of drainage basin characteristics in the clinch mountain area, Virginia and Tennessee. Proj. NR 389-402, Tech Rep 3, Columbia University, Department of Geology, ONR, New York.
8. Nag (1998). Morphomeric analysis using remote sensing techniques in the Chaka sub-basin, Purulia district, West Bengal. J. Indian soc, of remote sensing, 26(1&2), 69-76.
9. Obi Reddy, G.P., A.K.Maji, and K.S.Gajbhiye (2002). GIS for morphometric analysis of drainage basins. GIS India, 11(4), 9-14.
10. Panhalkar S.S., Mali S.P., Pawar C.T Morphometric analysis and watershed development prioritization of Hiranyakeshi Basin in Maharashtra, India. International journal of Environmental science Volume 3, No 1, 2012.
11. Rabindra Kumar Das Sediment yield estimation for watershed prioritization: a remote sensing study Indian Journal of Science and Technology Vol. 5 No. 3 (Mar 2012).
12. Rajiv Chopra, Raman Deep Dhiman and P.K.Sharma, (2005). Morphometric Analysis of Sub-watershed in Gurdaspur District, Punjab using Remote Sensing and GIS techniques, J.Indian Soc.Rem.Sen.,Vol.33,No.4,531-539.
13. Sachin Panhalkar Land Capability Classification for Integrated Watershed Development by Applying Remote sensing and GIS Techniques. ARPN Journal of Agricultural and Biological Science VOL. 6, NO. 4, APRIL 2011.
14. Sharad Chandra Dwivedi Morphometric Analysis of four sub-watershed in Bah area of Agra District using Remote sensing and GIS techniques 12th Esri India User Conference 2011.
15. Sreenivasulu Vemu, Udaya Bhaskar Pinnamaneni sediment yield estimation

and prioritization of watershed using Remote sensing and GIS International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume XXXIX-B8, 2012.
16. XXII ISPRS Congress, 25 August – 01 September 2012, Melbourne, Australia.
17. S. P. S. Kushwaha, Suchismita Mukhopadhyay, V. Hari Prasad and Suresh Kumar Sustainable development planning in Pathri Rao sub-watershed using geospatial techniques current science, vol.98, no.11, 10 June 2010.
18. Sangita Mishra.S, Nagarajan.R Morphometric analysis and prioritization of subwatershed. International journal of geomatics and geosciences volume 1, no 3, 2010

Table. 1: Percentage wise area distribution of Gomti Nala Micro Watershed

Sl. No	Watershed	Area in Hectare (Ha)	Percentage (%)
1.	2A2H1a2e	358.11	5.43
2.	2A2H1a1a	684.93	10.39
3.	2A2H1a1c	965.29	14.63
4.	2A2H1a2b	400.05	6.066
5.	2A2H1a2c	832.8	12.63
6.	2A2H1a3d	555.06	8.42
7.	2A2H1a2d	610.82	9.26
8.	2A2H1a2a	616.8	9.35
9.	2A2H1a1b	1160.64	17.6
10.	2A2H1a3c	409.22	6.23
	TOTAL	**6593.72**	**100**

Table. 2: Area distribution of Land use Land cover in Gomti Nala Watershed

Sl. No	Land use Categories		Area in Hectare	%
1	Agriculture Land	Fallow Land	3265.46	49.52
		Cultivate Land	675.51	10.24
2	Forest	Forest-Open	831.51	12.61
		Forest -Blank	26.60	0.40
		Forest-Scrub	412.49	6.26
		Tree Clad	117.05	1.78
3	Waste land	Scrubland-Dense	381.02	5.78
		Scrubland-Open	471.45	7.15
		Gullied Land	23.04	0.35
		Rock Outcrop	12.24	0.19
		River Sand	7.86	0.12
4	Built-up	Settlement-Rural	208.73	3.17
		Settlement-Urban	52.73	0.80
5	Water bodies	River	46.66	0.71
		Tanks/Ponds/Lakes	51.04	0.77
		TOTAL	**6593.72**	**100.00**

Table 3: Area distribution of Geomorphology of Gomti Nala Watershed

Sl.No	Class	Area in Hectare	Percentage
1.	Pediplain	4091.96	62.06
2.	Valley filll	1133.55	17.19
3.	Denudational Hill	1084.18	16.44
4.	Pediment	284.03	4.31
	TOTAL	**6593.72**	**100.00**

Table 4: Area distribution of Soil Textural classes of Gomti Nala Micro Watershed

Sl.No	Soil Textural Classes	Area in Hectares (Ha)	Percentage (%)
1.	Fine loamy	3156	47.90
2.	Clayey	958	14.52
3.	Rocky Land	601	9.11
4.	Loamy Skeletal	591	8.96
5.	Gullied	332	5.03
6.	Coarse loamy	8	.12
7.	Water body and Settlement	1147.72	14.41
	TOTAL	**6593.72**	**100.00**

Table 5: Area distribution of Slope Categories of Gomti Nala Micro Watershed

Sl.No	Lineament Density	Length in Hectares	%
1.	Low	6238.97	94.58
2.	Medium	264.18	4.01
3.	High	76.65	1.16
4.	Very high	13.91	0.25
	TOTAL	**6593.72**	**100**

Table 6. Area distribution of Drainage Density of Gomti Nala Micro Watershed

Sl.No	Rank	Area in Hactares	%
1	Very Low	1950.58	29.51
2	Low	2677.17	40.50
3	Good	1479.46	22.38
4	Very Good	503.30	7.61
	Grand Total	**6610.50**	**100.00**

Table 7: Area distribution of Lineament Density of Gomti Nala Micro Watershed

Sl. No	Slope Categories	Percentage Distribution of Slope	Area in Hectares (Ha)	(%)
1.	Very Gentle Slope	1 -3 %	648.31	10
2.	Gentle Slope	3-5 %	3365.72	51
3.	Moderate Slope	5-10 %	438.91	7
4.	Strong Slope	10-15 %	565.72	9
5.	Moderate Slope-Steep Slope	15-35 %	273.08	4
6.	Very Steep Slope	> 35 %	1301.98	20
	TOTAL		**6593.72**	**100**

Table 8: Ground Water Prospects Zonation of Gomti Nala Watershed

Thematic Map	**Class**	**Category**	**Rank (V_{jk})**	**Weightage (W_k)**	**(W_k * V_{jk})**	$\sum_{k=1}^{nk}(Wk * Vjk)$	**GWP**
1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Geomorphology	Denudational Hill	Poor	1	20	20	200	2
	Pediment	Good	2		40		
	Pediplain	Very Good	3		60		
	Valley Fill	Excellent	4		80		
Lineament density	Low	Very Low	1	10	10	100	1
	Medium	Low	2		20		
	High	Good	3		30		
	Very high	Very Good	4		40		
Slope	Very Gentle Slope	Excellent	4	15	60	150	1.5
	Gentle Slope	Very Good	3		45		
	Moderate Slope	Good	2		30		
	Moderate Slope-Steep Slope, Strong Slope, Very Steep Slope	Poor	1		15		
Drainage density	Low	Very Low	1	10	10	100	1
	Medium	Low	2		20		
	High	Good	3		30		
	Very high	Very Good	4		40		
Soil	Rocky Land	very Poor	1	15	15	225	2.25
	Clayey, Gullied	Poor	2		30		
	Coarse Loamy	Moderate	3		45		
	Fine Loamy	Good	4		60		
	Loamy Skeletal	Excellent	5		75		

Table 9: Area distribution of Ground Water Prospect zone of Gomti Nala Micro Watershed

Sl.No	Ground Water Prospect Zone	Percentage (%)
1.	Excellent	47.36
2.	Very Good	30.40
3.	Good	17.95
4.	Moderate	4.24
5.	Poor	0.05
	TOTAL	**100.00**

Table 10: Morphometric parameters and analysis for Gomti Nala Watershed

Morphometric parameters	Formula	Results
Drainage Frequency (D_f)	D_f = N/A Where, N=Total number of stream A = Area of the basin (Sq km.)	0.075
Drainage Density (D_d)	D_d = Lu/A Where, Lu = Total Stream length of all orders A = Area of the basin (Sq km.)	4.20
Stream Frequency (F_s)	F_s = Nu/A Where, Nu = Total no. of streams of all orders A = Area of the basin (Sq km.)	12.65
Texture Ratio (R_t)	R_t = Nu/P Where, Nu = Total no. of streams of all order P = Perimeter(Km)	17.02
Form Factor (R_f)	$R_f = A/Lb^2$ Where, A = Area of the basin (Sq km.) Lb^2 = Square of Basin Length	0.33
Circulatory Ratio (R_c)	$R_c = 4\pi A/p^2$ Where, A = Area of the basin (Sq km.) P = Perimeter(Km)	0.345
Elongation Ratio (R_e)	$R_e = \sqrt{A/\pi}/Lb$ Where, A = Area of the basin (Sq km.) Lb = Basin Length	1.22
Total Relief (km)	Elevation difference between summit and basin outlet	0.29
Constant Channel Maintenance (C)	C = A/L Where, A = Area of the basin (Sq km.) L = Total Stream length of all orders	0.24
Length of over land flow (L_g)	L_g = C/2 Where, C = Constant Channel Maintenance	0.12
Ruggedness Number (R_n)	$R_n = B_h * D_d$ Where, B_h = Basin Relief D_d = Drainage Density	1243.2
Slope Index (S_i)	$S_i = Lb^2/A$ Where ,Lb = Basin length (km.) A = Area of the basin (Sq km.)	3.04
Relative Relief (Rhp)	Rhp = H× (100) / P Where, H = Maximum basin relief P = Perimeter of the basin (km.)	1277.55

Table 11: Morphometric parameters and analysis of Microwatershed of Gomti Nala Watershed

Sl.No	Micro Watershed	D_f	D_d	F_s	R_t	R_f	R_c	R_e	K_m	C	L_g	R_n	S_i	R_{hp}
1	2A2H1a2e	1.12	3.14	10.33	4.11	0.49	0.56	0.65	20	0.10	0.05	69.36	2.05	3888.89
2	2A2H1a1a	0.58	3.14	12.26	6	0.45	0.44	0.75	20	0.15	0.16	62.73	2.24	2500
3	2A2H1a1c	0.41	3.54	8.70	4.67	0.43	0.37	0.80	20	0.28	0.14	70.76	2.08	1944.44
4	2A2H1a2b	1	3.27	9.25	4.11	0.48	0.62	0.66	20	0.37	0.18	65.41	4	3888.89
5	2A2H1a2c	0.48	3.72	8.89	4.93	0.44	0.46	0.78	47	0.27	0.13	174.64	2.30	2513.33
6	2A2H1a3d	0.54	4.11	7.93	7.33	0.46	0.23	0.71	19	0.24	0.12	78.14	2.17	6316.67
7	2A2H1a2d	0.49	3.87	10.31	3.94	0.45	0.30	0.73	181	0.26	0.13	46.8	2.20	3443.75
8	2A2H1a2a	0.65	4.56	7.62	4.27	0.45	0.64	0.73	103	0.22	0.11	469.42	2.20	4300
9	2A2H1a1b	0.34	4.32	12.75	8.22	0.42	0.45	0.84	246	0.23	0.12	1062.65	2.40	3477.78
10	2A2H1a3c	0.97	4.79	13.88	6.33	0.48	0.64	0.67	150	0.21	0.10	718.11	2.09	6111.11

Table No 12: Watershed Prioritization on the basis of Morphometric Analysis

Sl.No	Micro Watershed Code	R_{bm}	D_f	D_d	F_s	R_t	R_f	R_c	R_e	C	L_g	S_i	C_p	FP	priority
1.	2A2H1a2e	6	1	9	4	2	7	7	1	1	1	1	3.64	2	**High**
2.	2A2H1a1a	3	5	9	3	6	4	4	6	2	7	6	5.00	3	**High**
3.	2A2H1a1c	5	9	7	8	4	2	3	8	9	6	2	5.73	6	**Low**
4.	2A2H1a2b	7	2	8	6	2	6	8	2	10	8	9	6.18	8	**Low**
5.	2A2H1a2c	2	8	6	7	5	3	6	7	8	5	7	5.82	7	**Low**
6.	2A2H1a3d	8	6	4	9	8	5	1	4	6	4	4	5.36	4	**Medium**
7.	2A2H1a2d	9	7	5	5	1	4	2	5	7	5	5	5.00	3	**High**
8.	2A2H1a2a	6	4	2	10	3	4	9	5	4	3	5	5.00	3	**High**
9.	2A2H1a1b	4	10	3	2	9	1	5	9	5	4	8	5.45	5	**Medium**
10.	2A2H1a3c	1	3	1	1	7	6	9	3	3	2	3	3.55	1	**High**

Table 13: Prioritization of sub watershed on the basis of land use/ land covers analysis

Sl No	LULC Classes	Micro Watersheds									
		2A2 H1a 2e	2A2 H1a 1a	2A2 H1a 1c	2A2 H1a 2b	2A2 H1a 2c	2A2 H1a 3d	2A2 H1a 2d	2A2 H1a 2a	2A2 H1a 1b	2A2 H1a 3c
1	Brick Klins	Na	1	2	Na	3	Na	Na	Na	Na	Na
2	Cultivated Land	6	3	1	4	2	7	8	5	10	9
3	Crop Land	4	7	2	3	5	1	8	6	9	10
4	Forest Blank	Na	Na	4	Na	Na	Na	2	Na	3	1
5	Forest Open	Na	Na	6	5	Na	7	3	4	2	1
6	Forest Scrub	Na	Na	Na	5	Na	6	4	3	1	2
7	Gullied Land	7	5	2	Na	3	4	6	Na	Na	1
8	River	2	3	7	10	5	6	9	4	1	8
9	River Sand	2	4	3	6	1	Na	5	Na	Na	Na
10	Rock Outcrop	Na	Na	Na	Na	2	Na	Na	Na	Na	Na
11	Scrubland Dense	3	2	6	10	5	9	4	7	1	8
12	Scrubland Open	2	6	3	10	1	8	7	5	4	9
13	Settlement Rural	2	4	7	3	1	5	8	6	9	10
14	Settlement Rural	3	1	4	2	Na	Na	Na	Na	Na	Na
15	Tanks/Ponds/Lakes	7	5	2	3	6	1	4	4	8	9
16	Tree clad	5	1	7	3	2	2	4	9	6	8
17	CP Value	3.91	3.50	4.00	5.33	3.00	5.09	5.54	4.91	4.91	6.33
18	Final priority	Medium	High	Medium	Low	High	Low	Low	Medium	Medium	Low

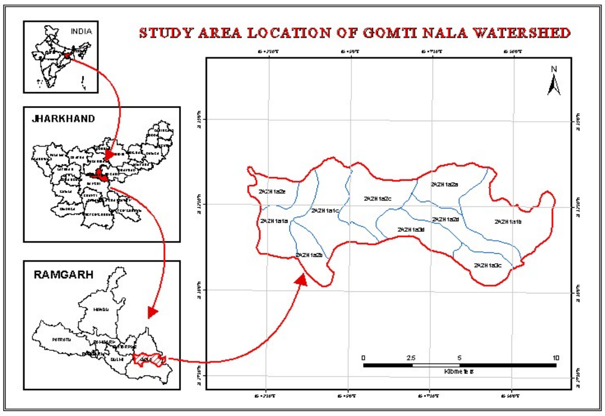

Fig. 01

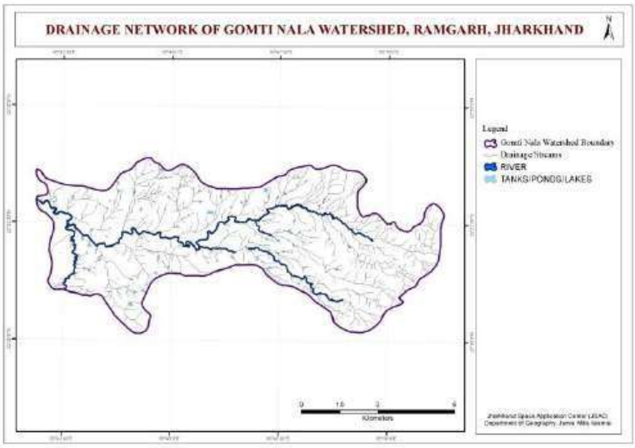

Fig. 02

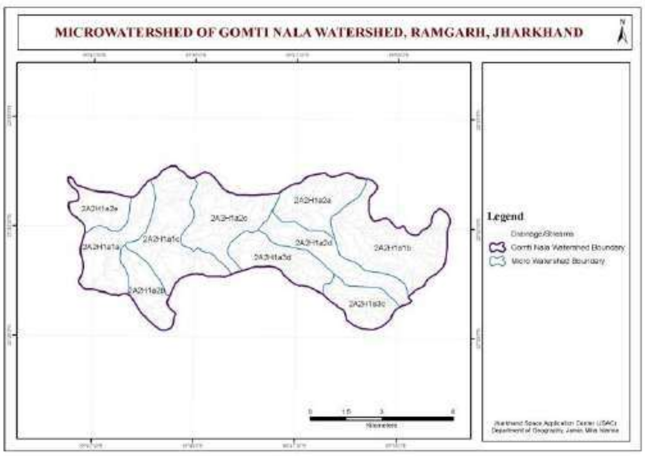

Fig. 03

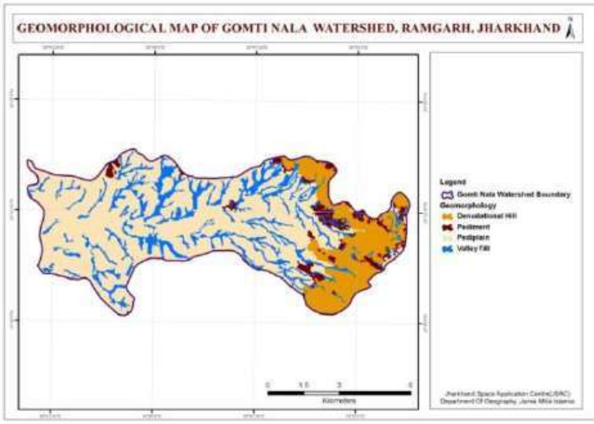

Fig. 04

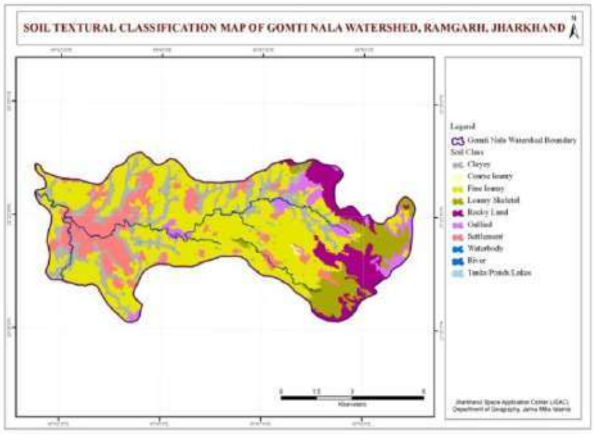

Fig. 05

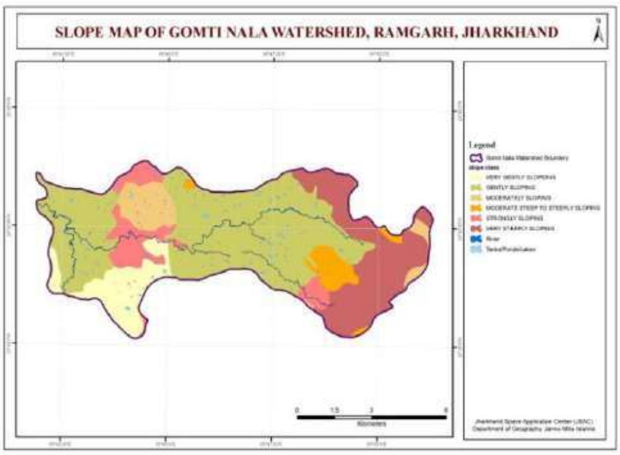

Fig. 06

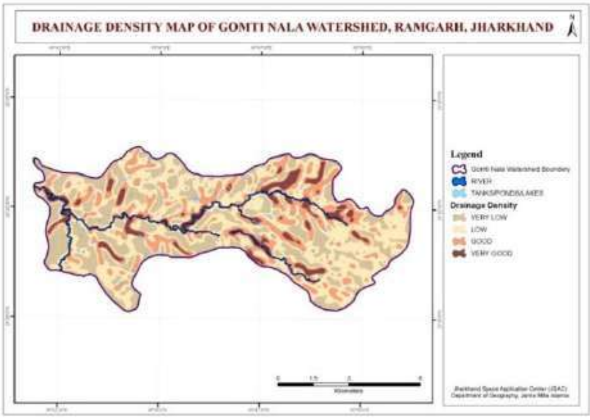

Fig. 07

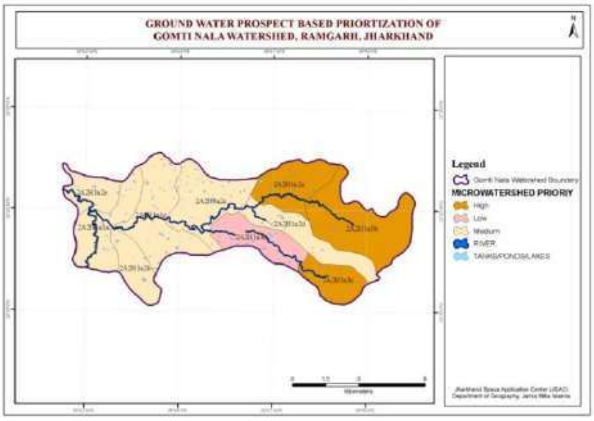

Fig. 010

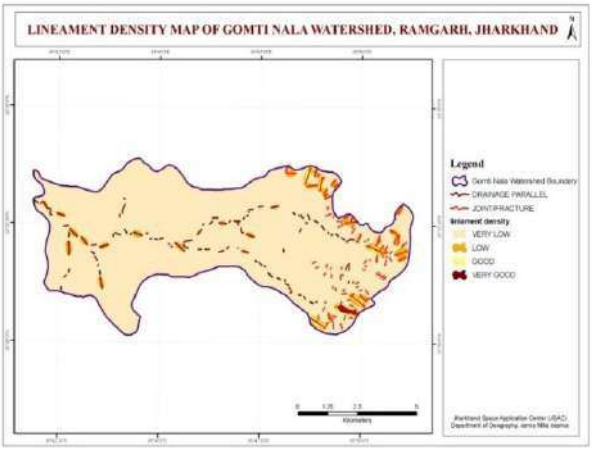

Fig. 08

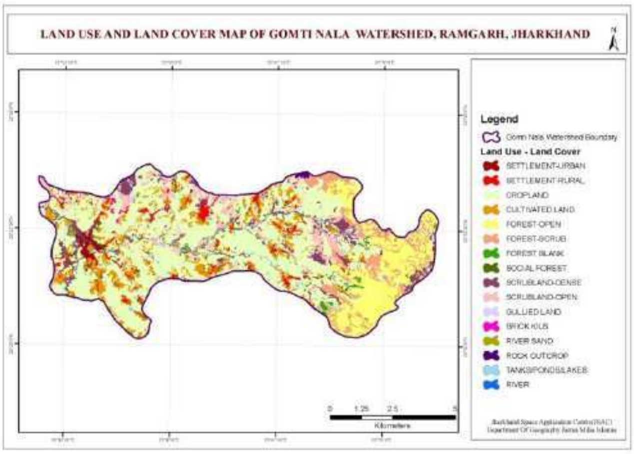

Fig. 11

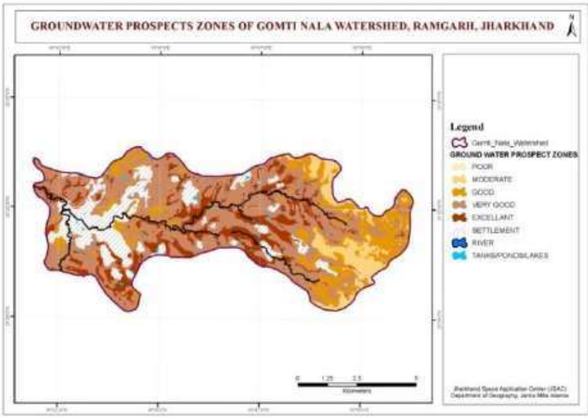

Fig. 09

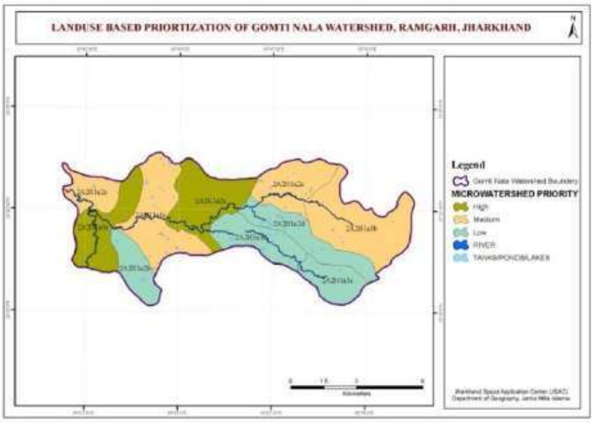

Fig. 12

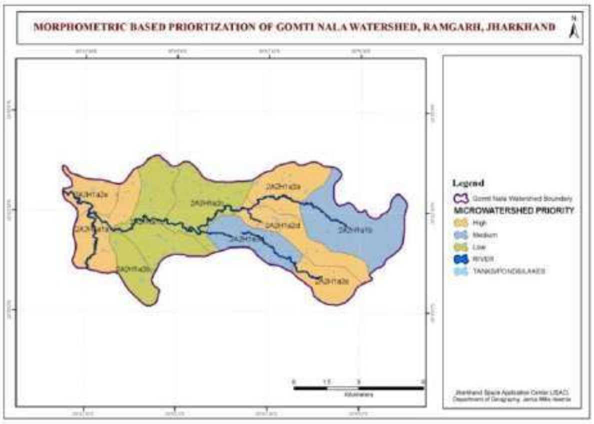
MORPHOMETRIC BASED PRIORTIZATION OF GOMTI NALA WATERSHED, RAMGARH, JHARKHAND
N
Legend
Gomti Nala Watershed Boundary
MICROWATERSHED PRIORITY
High
Medium
Low
RIVER
TANKS/PONDS/LAKES
Kilometers
Jharkhand Space Application Center (JSAC)
Department of Geography, Jamia Millia Islamia

Fig. 13

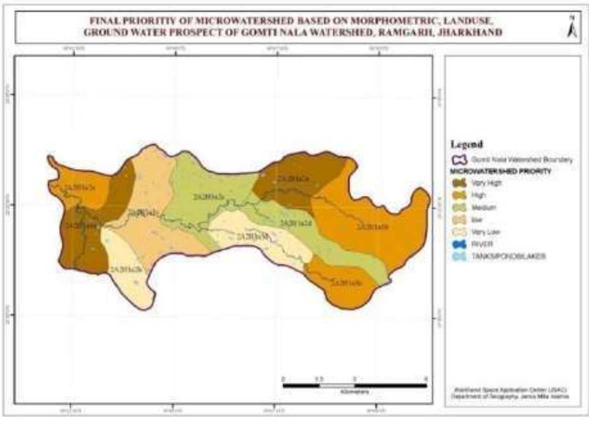
FINAL PRIORITIY OF MICROWATERSHED BASED ON MORPHOMETRIC, LANDUSE,
GROUND WATER PROSPECT OF GOMTI NALA WATERSHED, RAMGARH, JHARKHAND
N
Legend
Gomti Nala Watershed Boundary
MICROWATERSHED PRIORITY
Very High
High
Medium
low
Very Low
RIVER
TANKS/PONDS/LAKES
Kilometers
Jharkhand Space Application Center (JSAC)
Department of Geography, Jamia Millia Islamia

Fig. 14