Research Paper Engineering

"Controling the Soil & Land Pollution in Sabarkantha District by Using an App Lication of Remote Sensing and Geographical Information System"

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ABSTRACT

The present study is focused on the identification of suitable sites for location of water harvesting structures on micro-watershed prioritization using Morphometric analysis . The region prone to high rate of soil erosion associated with scarce irrigation facilities or scarcity of water are identified and considered for the study purpose. SabarkanthaDistrict experiencing heavy rainfall accompanied with high intensity rains having excessive runoff and soil erosion are considered for study purpose. Remote Sensing and Geographic Information system (GIS) techniques are being effectively used in recent time as tools in determining the quantitative description of basin geometry. The Results of Morphometric analysis, used in the present study to prioritize watersheds and to locate sites for water harvesting structures. The Morphometric parameters are considered for prioritization of all the micro-watersheds under study. The results from Morphometric analysis suggest that the ratio between cumulative stream length and stream order is constant throughout the successive orders of a basin. The Morphometric parameters The form factor values indicate that the basin has moderately high and short duration peak flows. It is observed from the prioritization of micro-watersheds that the watershed consists of 13 micro-watersheds out of which the micro-watershed-13 is given the highest priority because of high erosion. Similarly, for . The micro-watershed 13 of a subwatershed fall under priority-1 indicates that the Morphometric analysis could be used for prioritization of micro-watershed even if the reliable soil maps of the area under study are not available.

Keywords : RS . GIS . MorphometricAnalysis .Prioritization

Introduction

A watershed is a geo-hydrological unit, which drains at a common point. Rain falling on the mountain starts flowing down into small rivulets. Many of them, as they come down, join to form small streams. The small streams form bigger streams; and finally the bigger streams join to form a nullah to drain out excess water from a village. The entire area that supplies water to a stream or river, that is, the drainage basin or catchment area, is called the watershed of that particular stream or river.Watershed management may be defined as an integrated approach of greenery for a better environment. The scientist of the world believe that an environment catastrophe is occurring by way of global warming, change in climate and hazard to health due to green house effect. Ozone depletion is another feature of concern in response to increase chlorofluorocarbons. These ominous effects are caused by several phenomena like carbon dioxide accumulation and their interplay. Some optimistic veterans question these effects on the premise of inconclusive nature of the available data. Every one agrees that greenery consumes the superfluous carbon dioxide, stores the deleterious gas, releases oxygen much in demand, provide the basic needs, plays a role in restoring climate and thus revives a better environment. Watershed management applied locally for developing green foliage, enriches environment globally in due course of time.

Description of Study Area

The study area is located at Idartaluka in a Sabarkantha district. It is lying between 23050'40"and 24002'00" north latitude, and 73000'30" and 74001'00" east longitude, covering a total area of 128654.55 ha. The study area falls in Survey of India (SOI) Topographical map No. 46-A-13, 46-A-14, 46-E-01, 46-E-02

Methodology

In the present study, morphometric analysis and prioritization of miniwatersheds in Ver watershed is based on the integrated use of remote sensing and GIS techniques. The satellite images taken by The satellite image of IRS-P6 PAN + LISS-III merged geocoded products on 1:50,000 scale are used for classification of various themes. The satellite data dated 20.4.2005 were used for preparing the drainage layer. The remotely sensed data was geometrically rectified with respect to Survey of India (SOI) topographical maps at 1:50,000. Image enhancement techniques were applied for better interpretation of drainage from images. The digitization of dendritic drainage pattern was carried out in GIS environment. The stream ordering was carried out using the Horton's law. The fundamental parameters namely; stream length, area, perimeter, number of streams and basin length were derived from the drainage layer. The morphometric parameters for the delineated watershed area were calculated based on the formula suggested by Horton (1945), Strahler (1964), Schumn (1956), Nookaratnam et al. (2005) and Miller (1953) given in Table 1. The morphometric parameters values namely; stream length, bifurcation ratio, drainage density, stream frequency, form factor, Shape Factor, texture ratio, elongation ratio, circularity ratio,and compactness constant were calculated. Prioritization ratting of all the Thirteen miniwatersheds of Hathmati river watershed was carried out by calculating the compound parameter values. The miniwatershed with the lowest compound parameter value was given the highest priority.

Results and Interpretation

The drainage mapandLocation Map of the Hathmati river watershed (Fig. 1& 2) is prepared using the spatial tools . The stream order analysis is carried out using the neworder software developed by Bhaskaracharya Institute for Space Applications and Geo-informatics (BISAG). The number of streams of a given stream orders for all the Thirteenrniniwatersheds of Hathmati river watershed are shown in Table 2.

The fundamental parameters namely stream length, area, perimeter, basin length,bifurcation ratio, drainage density, stream frequency, form factor,Texture Ratio. elongation ratio, Shape Factor, circularity ratio, and compactness constant of streams for each of the miniwatersheds are calculated and shown in Table 3. The compound parameter values of Fivem-iniwatersheds of Hathmati riverwatershed are calculated and prioritization rating is shown in Table 4.

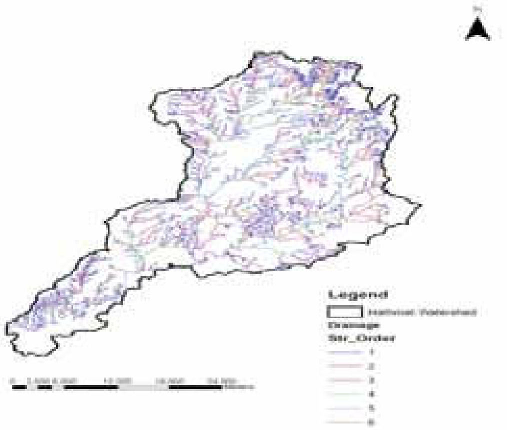

Fig 1: Drainage Order Map

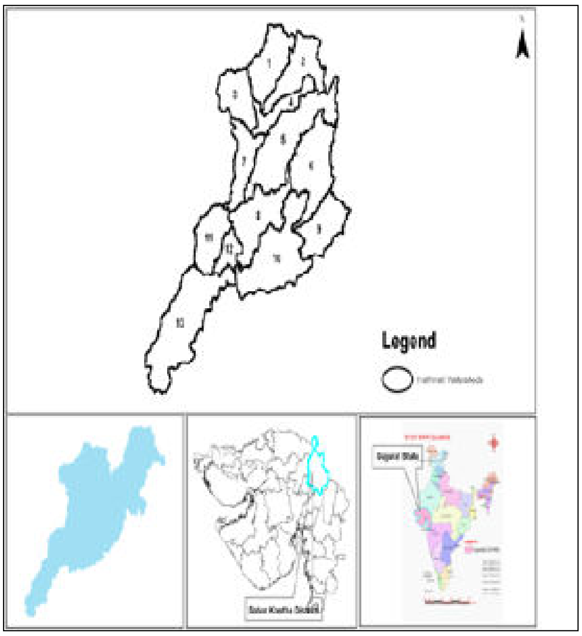

Fig. 2: Location Map of the Study Area

Table 1 : Formula for Computation of Morphometric Parameters

Morphometric Parameters	Formula	Reference
Stream Order (u)	Hierarchical rank	Strahler (1964)
Basin Length (Lb)	Lb = 1.312×A0.568 Where,Lb = Length of Basin(km) A = Area of Basin (km2)	Nookaratnamet al. (2005)
Stream Length (L)	Length of the stream	Horton (1945)
Bifurcation Ratio (Rb)	Rb= Nu/Nu+1 Where,Rb = Bifurcation Ratio Nu = Total number of stream segment of order'u' Nu+1 = Number of segment of next higher order	Schumn (1956)
Drainage Density (Dd)	Dd = Lu/A Where, Dd = Drainage density Lu = Total stream length of all order A = Area of the basin	Horton (1945)
Stream Frequency (Fu)	Fu = Nu/A Where, Fu = Total number of streams of all order A = Area of the Basin (km2)	Horton (1945)
Texture Ratio (T)	T = Nu/P Where, Nu = Total number of streams of all orders P = Perimeter (km)	Horton (1945)
Length of Overland Flow (Lo)	Lo = ½ Dd Where, Lo = Length of the Overland Flow D = Drainage density	Horton (1945)
Form Factor (Rf)	Rf = A/Lb2 Where, Rf = Form Factor A = Area of the basin (km2) Lb2 = Square of the basin length	Horton (1945)
Shape Factor (Bs)	Rf = Lb2/ A Where, Bs = Shape Factor A = Area of the basin (km2) Lb2 = Square of the basin length	Nookaratnamet al. (2005)
Elongation Ratio (Re)	Re= (2/Lb) × (A/π) ½ Where, Re = Elongation Ratio Lb = Length of basin (km) A = Area of the basin (km2)	Schumn (1956)
Compactness Constant (Cc)	Cc = 0.2821P/A0.5 Where, Cc=Compactness Constant A = Area of the basin (km2) P = Perimeter of the basin (km)	Horton (1945)
Circularity Ratio (Rc)	Rc = 4pA/P2 Where, Rc = Circularity Ratio A = Area of the basin (km2) P = Perimeter (km)	Miller (1953)

Table 2: Stream analysis

W.S	Stream orders						
	I	II	III	IV	V	VI	TOTAL
1	114	61	31	17			216
2	191	105	39	28			355
3	82	40	30	10	2		151
4	70	31	9	20	19		147
5	202	95	40	33	20		388
6	128	69	37	6	26		261
7	59	37	10	2	13		116
8	118	68	30	15	2	9	239
9	27	15	7	7			56
10	178	85	69	15	15	5	359
11	42	24	3	14			81
12	45	24	13	7			89
13	241	112	54	18	55		478

Table 3 : (Table A,B,C)Stream Morphometric Parameters Table A

W.S	Basic para.					
	A	P	L	N	N1	Lb
1	73.7	57.1	131.7	216	114	15
2	72.72	71.96	189.9	355	191	15
3	54.47	45.08	98.24	151	82	12
4	38.56	64.88	91.05	147	70	10
5	137	110.8	234.4	388	202	21
6	106.4	85.75	175.0	261	128	18
7	56.5	64.18	80.9	116	59	13
8	90.8	86.11	146.5	239	118	17
9	66.82	58.7	56.16	56	27	14
10	138.6	104.1	215.7	359	178	21
11	59.05	46.67	69.81	81	42	13
12	25.64	42.08	55.5	89	45	8
13	162.3	109.7	133.0	478	241	23

Table B

W.S	Linear para.				
	Rb	Dd	Fu	T	Lo
1	1.88	1.78	2.93	1.99	0.89
2	1.96	2.61	4.88	2.65	1.30
3	2.84	1.80	2.77	1.81	0.90
4	2.05	2.36	3.81	1.07	1.18
5	1.84	1.71	2.83	1.82	0.85
6	2.52	1.64	2.45	1.49	0.82
7	2.61	1.43	2.05	0.91	0.71
8	2.00	1.61	2.63	1.37	0.80
9	1.64	0.84	0.83	0.46	0.42
10	2.64	1.55	2.58	1.70	0.77
11	3.32	1.18	1.37	0.90	0.59
12	1.85	2.16	3.47	1.06	1.08
13	1.88	0.82	2.94	2.19	0.41

Table C

W.S	Shape para.				
	Rf	Bs	Re	Cc	Rc
1	0.32	3.08	0.64	1.87	0.28
2	0.32	3.08	0.64	2.38	0.17
3	0.33	2.96	0.65	1.72	0.33
4	0.35	2.82	0.67	2.94	0.11
5	0.29	3.36	0.61	2.67	0.14
6	0.30	3.24	0.62	2.34	0.18
7	0.33	2.98	0.65	2.40	0.17
8	0.31	3.17	0.63	2.54	0.15
9	0.32	3.04	0.64	2.02	0.24
10	0.29	3.36	0.61	2.49	0.16
11	0.33	2.99	0.65	1.71	0.34
12	0.37	2.67	0.69	2.34	0.18
13	0.2	3.43	0.60	2.43	0.16

Table 4: Prioritization Results of Morphometric Ranking

W.S	Rb	Dd	Fu	T	Lo	Rf	Bs	Re	Cc	Rc	Cf	Rank
1	11	12	2	2	2	13	12	13	11	4	8.2	11
2	3	10	4	13	4	10	4	10	3	5	6.6	6
3	10	2	12	1	12	5	3	5	1	8	5.9	3
4	7	11	13	5	3	6	7	6	9	10	7.7	10
5	6	13	1	3	1	8	11	8	12	13	7.6	9
6	4	9	5	10	5	1	9	1	6	7	5.7	2
7	8	8	3	6	6	2	2	2	2	2	4.1	1
8	2	6	8	8	8	9	1	9	7	6	6.4	5
9	13	4	10	4	10	11	8	11	13	12	9.6	13
10	1	7	6	12	7	7	6	7	10	9	7.2	8
11	12	3	7	7	11	3	5	3	8	1	6	4
12	5	5	11	11	9	4	10	4	5	3	6.7	7
13	9	1	9	9	13	12	13	12	4	11	9.3	12

Miniwatershed no. 7 with a compound parameter value of 4.1 receives the highest priority (one) with the next in the priority list is miniwatershed number 6 having the compound parameter value of 5.7. Highest priority indicates tile greater degree of erosion in the particular miniwatershed and it becomes potential candidate for applying soil conservative measure. The final prioritized map of the study area is shown in Figure 3. Thus soil conservation measures can first be applied to miniwatershed area 7 and then to the other miniwatersheds depending upon their priority.

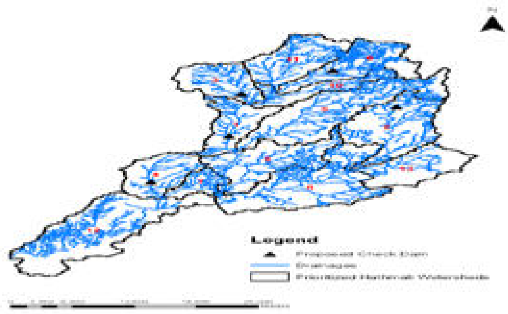

Fig. 3 Ranking Map of Hathmatiriver Watersheds

Conclusions

Prioritization of micro-watershed has been done by morphometric analysis, . Micro-watershed 7, 6, and 3 of sub-watershed has a high priority as shown in Tables.4. Micro-watershed which are identified for very high priority, have very high sediment yield value and have excellent drainage density with value greater then 1.5 indicating higher erosion. Texture ratio values of these basins are also indicating high runoff. The low bifurcation ratio values indicate stable geological structures.A morphometric analysis proves to be an efficient technique for prioritization of micro-watersheds for location of suitable sites for ***Water Harvesting Structures*** (Check Dam, Boulder Bunds, Nallah/Gully plugs, Trench Bunds or contour Bund with Vegetative cover, concrete wall, polders). The morphometric parameters has been done to prioritize of the micro-watersheds on the basis of soil conservation. The results obtained showcased the precision based site suitability evaluation for water harvesting structures. Suitable soil conservation structures are suggested at appropriate location based on the topographical and morphological conditions and based on hydrogeomorphometric and groundwater prospective maps.The study demonstrated utility of remote sensing and GIS combination with morphometric analysis for the sustainable development of watersheds. Some of the important conclusions deduced are surmised as:

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