The Andhra Agric. J 56(4):498-502, 2009

Prioritization of Subwatersheds Based on Geomorphological Characteristics of Ag2 Watershed in Krishna River Subcatchment in Karnataka

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ABSTRACT

Quantitative analysis of morphological parameters of 11 subwatersheds of Ag2 watershed was carried out, which are important from hydrological studies point of view. The priority fixation of subwatersheds in Ag2 watershed is needed because it is difficult to implement soil conservation measures in entire subwatersheds at the same time for the shortage of time and manpower. The priority fixation was done using seven morphological parameters *viz*. form factor, drainage texture, time of concentration, bifurcation ratio, relief ratio, average slope and drainage density of subwatersheds separately. The value of different factors was ranked in descending order. Priority was given based on the rank number (lowest to highest). Finally an overall priority index was preferred which was an average of rating values of all individual parameters so that effect of any particular parameter showing diversion to other normal values, may be diluted. The number of subwatersheds under very high priority, high priority and lower priority were found 4, 6 and 1, respectively.

Key words : Geomorphological Characteristics, Priority, Subwatershed

Morphometry deals with the management and mathematical analysis of the configuration of the earth's surface and of the slopes and dimensions of its landforms. It is used to determine the geometry of the watershed especially among its stream network. Morphometry gives a little idea of erodibility of soil. Watershed characteristics play a vital role on the hydrologic performance of watersheds. Hence, a number of parameters, which signify the watershed characteristics, are evaluated from the topographical maps.

Various morphometric parameters are computed to evaluate the geomorphic stage of the basin, which is the indication of intensity of erosion from the basin. The evaluation of geomorphologic stage of development of a drainage basin needs exhaustive data and information, which is very dynamic in nature and temporally changes over time and space due to natural and external influences on agro-climatic environment. The morphologic and climative characteristics of a basin govern its hydrologic response to a considerable extent. The morphological characteristics of a basin represent its attributes, which may be employed in synthesizing its hydrologic response. The importance of morphological factors cannot be overlooked in accurate prediction of runoff. Basin characteristics when measured and expressed in quantified morphologic parameters can be studied for their influence on runoff. Hence, linking of morphologic parameters with the hydrologic characteristics of the basin can lead to a simple and useful procedure to simulate the hydrologic behavior of various basins, particularly the ungauged ones. They are variables useful in the analysis of a drainage basin in numerical terms. Morphologic analysis was carried out in a number of Indian watersheds and same was subsequently used for water resource development and management projects as well as watershed characterization and prioritization (Ali and Singh, 2002, Kumar *et al.*, 2001 and Srinivasan and Subramanian, 1999). Estimation of sediment yield is required for the planning erosion control measures. In the case of shortage of hydrologic data, morphometric parameters play an important role in predicting the response of the catchment. Sebastian *et al.* (1991) and Chaudhary and Sharma (1998) have also carried priority fixation of watersheds for soil conservation works using priority index based on morphological parameters.

MATERIAL AND METHODS

The present investigation was conducted for selected subwatersheds in the Ag2 watershed of the Krishna river basin in Raichur taluka of Karnataka. The Ag2 watershed is situated in the lower reach of Krishna river subcatchment. Agro-climatically, the Ag2 watershed belongs to the

Table 1. Form factor, drainage density, drainagertexture, time of concentration, relief ratio and average slope of 11 subwatersheds in Ag2 watershed

Sub-watershed code	Morphological parameters						
	Form factor	Drainage density (km /km^2)	Drainage texture (No. of 1st order streams/km^2)	Bifurcation ratio	Time of concentration (min.)	Relief ratio	Average slope (%)
Ag2k	0.1028	1.185	0.969	3.395	84.68	0.0056	11.85
Ag2m	0.2739	1.039	0.583	5.250	64.10	0.0053	12.46
Ag2n	0.1358	1.217	0.481	2.944	71.56	0.0076	19.47
Ag2p	0.1645	0.965	0.655	4.678	77.07	0.0060	17.37
Ag2q	0.0959	2.002	1.984	4.667	73.99	0.0038	16.00
Ag2r	0.2123	1.554	1.275	6.285	60.38	0.0049	12.40
Ag2s	0.1403	1.573	1.199	4.083	62.04	0.0051	15.73
Ag2t	0.1270	1.832	1.562	3.800	59.19	0.0075	25.60
Ag2u	0.1170	2.284	2.099	4.264	48.40	0.0045	44.20
Ag2v	0.1776	2.536	2.437	4.393	56.10	0.0050	18.30
Ag2w	0.2196	2.252	1.960	4.518	53.46	0.0050	22.50
Mean(μ)	0.1606	1.676	1.382	4.388	64.63	0.0055	19.62
Standard deviation(σ)	0.0530	0.520	0.643	0.855	10.47	0.0011	8.77

Northern-Eastern dry zone in Northern Karnataka, which is categorized as one having a semiarid tropical climate. Geographically, the Ag2 watershed is located between 16^{0}00' to 16^{0}20' N latitude and 77^{0}05' to 77^{0}40' E longitude (Fig.1 and Fig. 2).

Morphometric analysis has been carried out using topographical maps. The work involved assigning stream orders, counting stream numbers as per stream orders, measuring stream lengths as per stream orders besides measuring the basin area, perimeter, maximum length of basin, maximum width of basin etc. This data were utilized to calculate the morphometric parameters namely form factor, drainage density, drainage texture, length of overland flow, circulatory ratio, elongation ratio, relief ratio, time of concentration, average slope etc.

RESULT AND DISCUSSION

Geomorphological characteristics of 11 subwatersheds in Ag2 watershed are presented in Table 1.

In order to prioritize the subwatersheds for soil conservation work, an overall priority index was preferred for rating so that effect of any particular parameter showing diversion to other normal values may be diluted. Goel and Sharma (1996) and Chaudhary and Sharma (1998) adopted overall priority index criteria for priority fixation in Satluj catchment and Giri catchment, respectively, in Himachal Pradesh.

Form factor for 11 subwatersheds ranged from 0.096 to 0.2739 with an average value of 0.1606. The lowest and the highest value of form factor were observed to be for subwatersheds Ag2q and Ag2m, respectively. The high value of form factor indicates that sedimentation rate will be less for those subwatersheds and *vice versa*. The value of drainage density for various subwatersheds ranged from 0.965 to 2.536 km/km^2 with an average value of 1.676 km/km^2. The lowest and the maximum value of drainage density were observed to be in the subwatersheds Ag2p and Ag2v, respectively. Drainage density indicates the drainage efficiency of the basin. The subwatersheds, which are having high values of drainage density indicate well-developed network and torrential runoff resulting intense floods, while the low values of drainage density indicates moderate and high permeability of the terrain. The value of drainage texture for various subwatersheds ranged from 0.481 to 2.437 number / km^2 with an average value of 1.382 number/km^2, indicating a dense network of drain or gullies. High value of drainage texture for the catchment indicates greater erosion hazard in the area. The lowest and the maximum value of drainage texture were observed to be in the subwatersheds Ag2n and Ag2v, respectively. The value of bifurcation ratio for various subwatersheds ranged from 2.444 to 6.285 with an average value of 4.388. The lowest and the maximum value of bifurcation ratio were observed to be in the

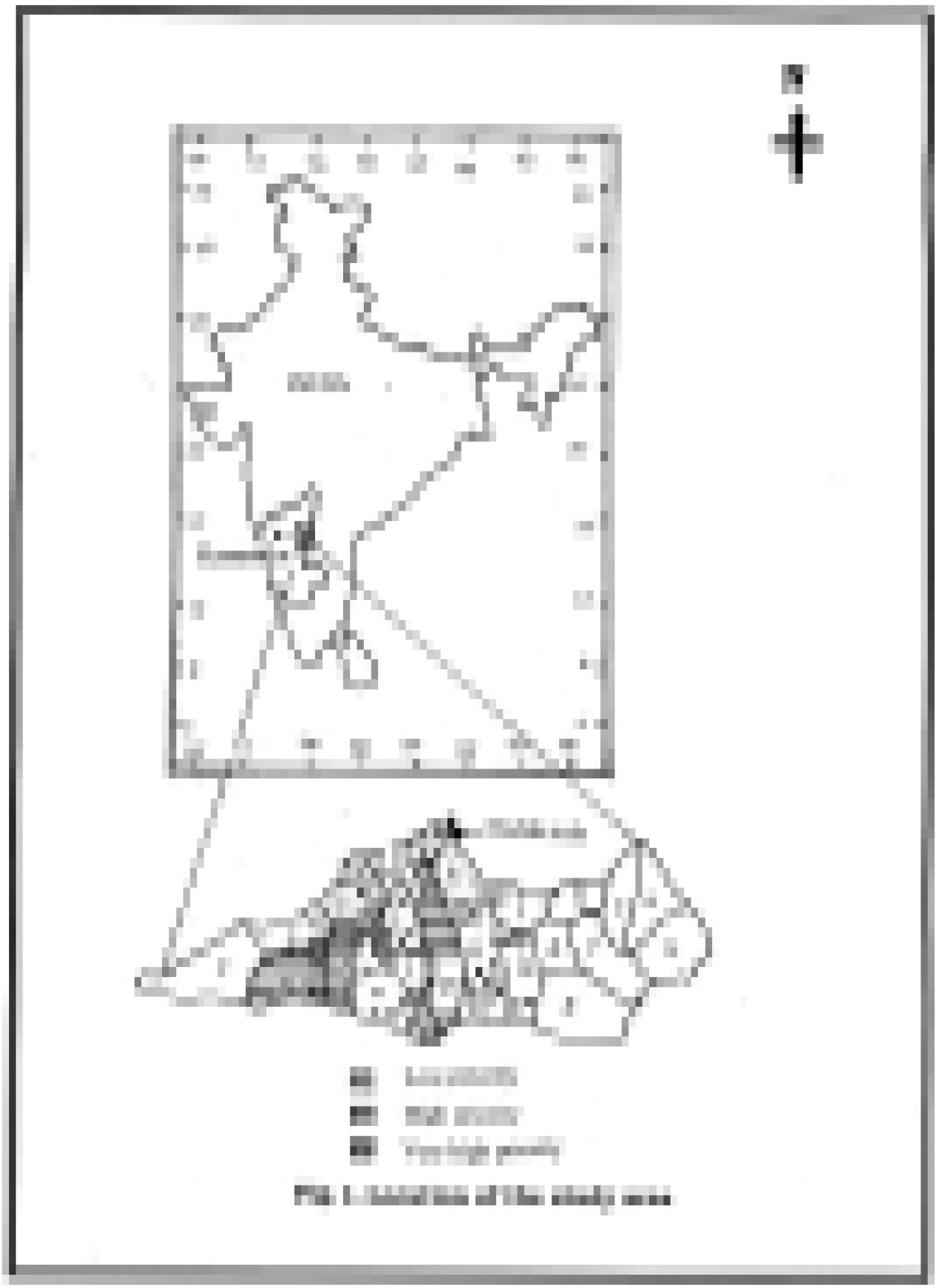


Table 2. Priority fixation of subwatersheds for soil conservation works

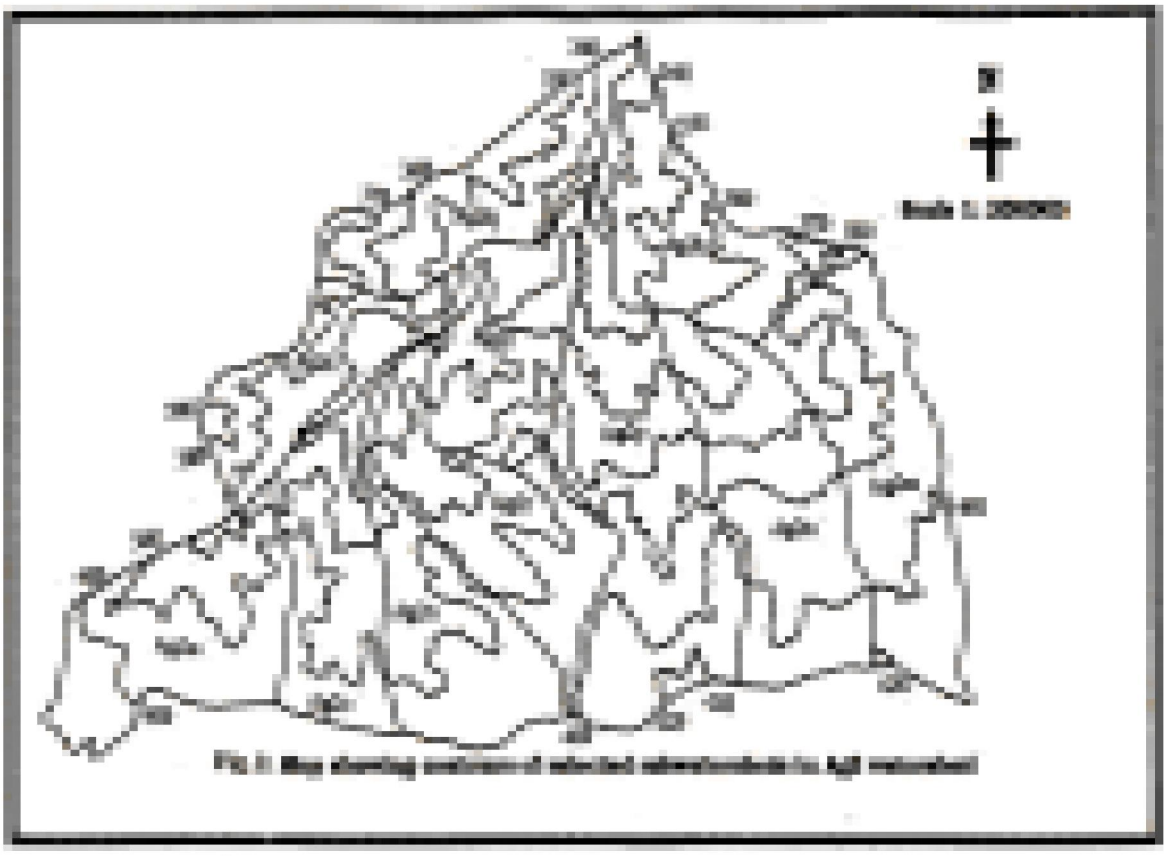
Sub-watershed code	Priority fixation based on									
	Form factor	Drainage density (km /km^2)	Drainage texture (No. of 1st order streams/km^2)	Bifurcation ratio	Time of concentration (min.)	Relief ratio	Average slope (%)	Overall priority index	Overall priority rating	Priority class
Ag2k	10	9	8	10	1	4	11	7.571	1	LP
Ag2m	1	10	10	2	5	5	9	6.000	5	HP
Ag2n	7	8	11	11	4	1	4	6.571	3	HP
Ag2p	5	11	9	3	2	3	6	5.571	10	VHP
Ag2q	11	4	3	4	3	11	7	6.120	6	HP
Ag2r	2	7	6	1	7	9	10	6.000	8	HP
Ag2s	6	6	7	8	6	6	8	6.714	2	HP
Ag2t	8	5	5	9	8	2	2	5.571	8	VHP
Ag2u	9	2	2	7	11	10	1	6.000	5	HP
Ag2v	4	1	1	6	9	8	5	4.857	9	VHP
Ag2w	3	3	4	5	10	8	3	5.143	10	VHP

LP- Low Priority HP- High Priority VHP-Very High Priority

subwatersheds Ag2n and Ag2r, respectively. High value of bifurcation ratio indicated high soil erosion rate from the subwatershed. The value of time of concentration ranged from 48.40 to 84.68 minutes with average values of 64.63 minutes. The lowest and the maximum values of time of concentration were observed to be in subwatersheds Ag2u and Ag2k. The sub watershed, which is having high value of time of concentration, will produce less sediment rate and *vice-versa*. Relief ratio is a measure of potential energy available to move water and sediment down slopes. The values of relief ratio ranged from 0.0038 to 0.00762. The lowest and the maximum values of relief ratio were observed to be in subwatersheds Ag2q andAg2n, respectively. If the relief ratio is more, the intensity of erosion will be more for that particular sub watershed. The value of average slope of subwatersheds ranged from 11.85 to 44.2 per cent with mean value of 19.625 per cent. This showed that some subwatersheds were very steep the watershed. The lowest and the maximum values of average slope were observed to be in subwatersheds Ag2k and Ag2u, respectively. These values are in agreement with the fact that most of the subwatersheds are subjected to heavy erosion. The overall priority rating of different subwatersheds was given Table 2. The number of subwatersheds under very high priority, high priority and lower priority were found 4, 6 and 1, respectively.

The 11 subwatersheds in the Ag2 watershed have been divided into three priority levels based on overall priority rating index value i.e., 4.8-5.8 (Very High Priority), 5.8-6.8 (High Priority) and 6.8-7.8 (Low Priority). Four subwatersheds namely Ag2p, Ag2t, Ag2v and Ag2w were selected under very high priority. Six subwatersheds namely Ag2m, Ag2n, Ag2q, Ag2r, Ag2s and Ag2u were selected under high priority. One subwatershed namely Ag2k was selected under low priority.

The subwatersheds, which fall under very high and high priority, need to be providing adequate soil and conservation measures. All active gully head should be treated with suitable vegetative and masonry barriers. Small and medium gullies should be provided with silt detention dams to conserve the storm water runoff and lessen the problem of floods. Laying suitable watlings amongst other soil conservation measures must stabilize the landslides and landslip faces. River bank vulnerable to erosion may be protected by



providing suitable water deflecting structures like embankments, toe walls and spurs made of gabions. Sloping agricultural land should be bench terraced using vegetative barriers. The catchment must be meaningful vegetation by striking a balance between the demands for material needs and its biotic resource.

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(Received on 19.06.2009 and revised on 29.06.2009)