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Watershed Characteristics of Pagladiya River using GIS and Digital Elevation Model

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Abstract: Catchment area and watershed delineation aerial extent, slope, aspect and drainage networks is prerequisite for watershed management. Digital Elevation Models (DEMs)are spatial grids which are used to automate watershed boundary determination. Geographical Information systems (GIS) with Digital Elevation model can be used for the computation of various watershed characteristics effectively and efficiently. This paper presents a case study generating digital elevation model (DEM) and extraction of geo-morphological characteristics from DEM using GIS of Pagladiya river. Several intermediate results were produced while model run and basic parameter of the Pagladiya river, has been defined at the end of model. The result of this study can be used in Rainfall-Runoff analysis and other advance research on the catchment area. Moreover, it would have support for decision making on ground and surface water resource, distribution and management.
Keywords: Watershed characteristics, GIS, DEM,SRTM Watershed delineation,

I. INTRODUCTION

Characterization of watershed is a essential and important step in planning and management of a watershed. Defining the geographic boundaries of watersheds and sub-watersheds helps in gathering and evaluating data for watershed management. Topographic characteristics of the watershed helps in determining runoff and sedimentation to the outlet of the watershed. Digital elevation models (DEM) are now a day's widely used for watershed delineation, extraction of stream networks and characterization of watershed topography (elevation map, slope map and aspect map) by using watershed delineation tool in GIS software. Digital elevation models (DEMs) are grid-based GIS coverage's that represent elevation. One DEM typically consists of thousands of grid cells that represent the topography of an area. Using DEM and GIS, morphometric parameters like basin ,Subbasin ,basin CN and stream length, were determined. Further during study some intermediate result of hydrological characteristics such as flow direction, flow accumulation, flow length, stream networks,longest flow path were also extracted for the watershed. Therefore, modern techniques and methods should be used to define basic parameters of river and its catchment area and the results can be used in research and decision making in near future.

II. STUDY AREA

Considering the land, issue related to data the upper part of Pagladiya river is selected as the study area for the present study**.** The study area lies between 91°19'41.097''E to 91°34'45.757''E longitude and 26°27'26 N to 27°0'9.289'' North latitude. Major portion of the study area lies within the state of Assam and a small patch of the upper reach lies in the Bhutan.

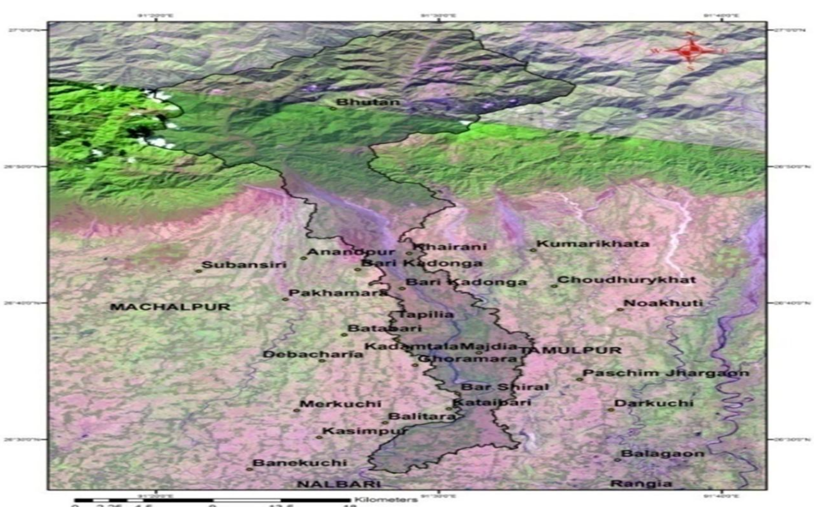

Fig1: Study area

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III. METHODOLOGY

Using Arc-Hydro model(ARCGEO- HMS,ARCGIS basic parameters of Pagladiya River and its watershed have been defined.. Primary data used for this model is DEM (SRTM). The SRTM (Suttle rader topographic mission) data collected from USGS. Based on the manual of ARC GEO HMS proper projection is assigned to SRTM data and entire process has been carried out. DEM preprocessing was executed through ArcHydro, such as Fill sink (Fig. 4), flow accumulation, flow direction, stream definition, Stream Segmentation,Catchment Grid Delineation(Fig. 5), Catchment Polygon, Drainage line and, adjointCatchment processing .Several intermediate results like flow direction map, flow accumulation map, catchment map, drainage map, watershed map are generated. Some important charterstic of sub-watershed like basin CN, Basin slope, area of each subbasin Basin lag are extracted for each sub basin using HEC-GeoHMS.

For preparation of CN GRID map landuse map is generated using LISS 4 satellite imagery and soil map is downloaded. Overlay operation (Union) is carried out using landuse map and soil map and CN Grid map is generated and whole methodology is shown in flow chart in fig 2.

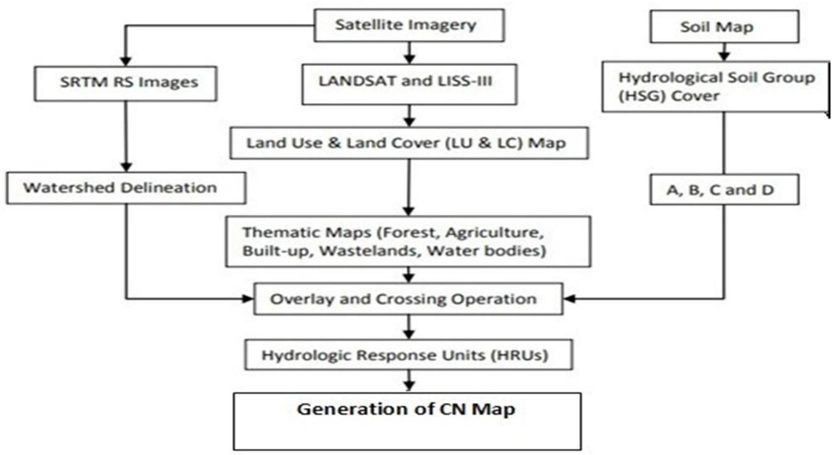

Fig: 2

IV. RESULTS

Pagladiya watershed was divided into 13 sub-watersheds whose statistics are presented in Table no 1 below. Total area of the present study area is 192 km^2. It can be seen from this table that sub watershed W240 has the maximum area of 27.12 km^2, whereas W160 has the minimum area of 5.76 km^2. The elevations of the sub watersheds vary from 330 m (MSL) to 1120 m (MSL) while the average slope varies from 2.7% (W250) to 33.11% (W150). This indicates highly undulated nature of the watershed topography. A classified average slope map of the sub-watersheds of the pagladiya watershed (Figure b) shows that 5 sub-watersheds, W150, W190, W170, W140 and W160 fall under ‘steep slope’ (30-50%) while three sub watersheds W200, W210 and W180 are Under ‘moderate steep slope’ (15-30%). However, W220 and W230 sub-watersheds have ‘moderate slope’ (8-15%) and sub-watershed W260, W250 andW240 has ‘gentle slope’ (3-8%).

Table

Subbasin293

FID	Shape *	Name	BasinSlope	LossMet	BasinCN	LagMethod	BasinLag	Area_HMS
0	Polygon	W140	30.82756	SCS	59.176263	CNLag	1.683574	14.34424
1	Polygon	W150	33.503036	SCS	58.395484	CNLag	1.500851	7.351246
2	Polygon	W160	30.463121	SCS	59.294151	CNLag	1.585298	5.763016
3	Polygon	W170	31.369621	SCS	59.540063	CNLag	2.026823	12.538163
4	Polygon	W180	27.68103	SCS	58.837533	CNLag	2.27225	13.730093
5	Polygon	W190	33.234478	SCS	59.723093	CNLag	1.196103	8.51422
6	Polygon	W200	29.626892	SCS	60.644631	CNLag	1.912157	16.201496
7	Polygon	W210	29.003004	SCS	59.112381	CNLag	3.067771	26.625834
8	Polygon	W220	11.150504	SCS	66.450778	CNLag	3.824516	20.88201
9	Polygon	W230	8.777875	SCS	66.53956	CNLag	2.994673	8.42331
10	Polygon	W240	2.898306	SCS	80.372932	CNLag	7.111804	27.121462
11	Polygon	W250	2.762812	SCS	75.799264	CNLag	3.937224	6.882555
12	Polygon	W260	2.847122	SCS	78.89474	CNLag	6.430342	23.353414

Table: 1

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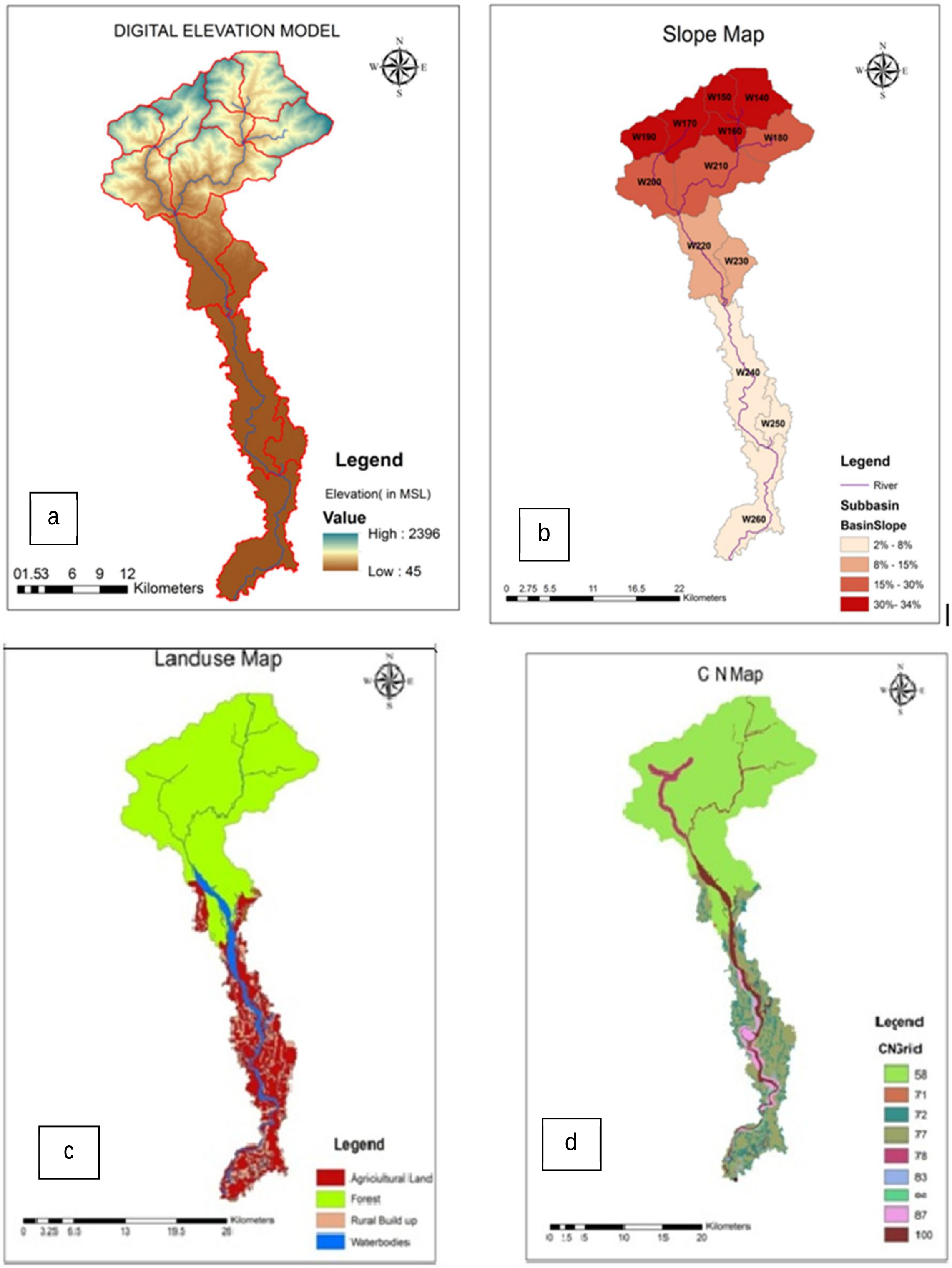

Fig: 3

V. CREATING CN GRID

Soil and land use data were merged and CNLookUp table was created using Arc Catalogue. After combining land use and hydrologic soil group maps using GIS, a CN grid was created using Hec-geoHMS. Hec-geoHMS uses the merged feature class (lc_soil_union) and the lookup table (CNLookUp) to create the curve number grid as shown in (Fig d).

VI. SUMMERY AND CONCLUSION

Aim of this study was to extract watershed characteristics with the help of GIS using DEM. Hence the process was carried out for the preparation of DEM using SRTM data related to the study area and delineation of watershed and sub-watershed boundaries. Based on the results of the study area of the watershed was found to be 192 km^2. Elevation map derived from the DEM revealed that altitude in the watershed ranges from 45 m (MSL) to 2340. m (MSL) . The average slope of the watershed varies from 3% to 50% with maximum area under the slope between (2% to 15 %).

GIS and Hec-GeoHMS are capable of building up most of the input data required to calculate CN. A CN of 100 is surface water with zero infiltration. High CNs (100-81) of the watershed, which has the potential to generate the greatest amount of runoff in a storm event. Low curve numbers (77-58) corresponded to the forested and agricultural areas of the watershed, which generates little runoff and high infiltration rate. CNs can be used with Long-Term Hydrologic Impact Assessment to calculate annual runoff. Information on watershed characteristics of the study area is very helpful to other researchers and decision makers involved in planning and management of the watershed.

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