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Land Use and Land Capability Mapping for Resource Planning of Godawari-Purna Sub-basin Using RS & GIS

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Abstract

The Godawari-Purna sub basin is located between 76°36' to 77059' E and 19°07' to 19°17' N with an area of 34413.87 ha falls in assured rainfall region. Majority of the area under basin is used for agricultural purpose. The basin boundary is updated using the updated drainage and terrain information from high resolution satellite data of LISS-IV using GIS tool. Based on the derived thematic maps of land use and land capability class, the GP sub basin is divided into 11 sub catchments. Thematic maps *viz*., land use cover, has been interpreted using the visual interpretation techniques by heads-on digitization in the GIS environment using the enhanced high-resolution satellite imagery. Slope map has been generated from CartoDEM using the surface tools of the spatial analyst toolbox in ArcGIS. Land use mapping indicated that 85.68 per cent land is under cultivation with cropped area indicating a good vegetative cover in basin area. Digital Elevation Model (DEM) indicated that majority of the area of basin is having a slope in the range of 0 to 3 per cent. Majority of the area was found to be under class III and class IV category. All the generated thematic maps of Godawari-Purna sub basin will be useful for land resources planning.

Key words : Land use, Land Capability, Remote Sensing, Sub-basin.

The need for application of modem approaches like Remote Sensing and GIS techniques has been emphasized for efficient management of land resources. Rapid advances in the development of Geographical Information System (GIS) provides spatial data integration and tools for natural resource management and have enabled integrating the data in an environment which has been proved to be an efficient and successful tool for surface and ground water studies (Meijerink, 1996). In recent years, use of satellite remote sensing data along with GIS and topographical maps has made it easier to establish the base line information on land and water resource planning. (Sreenivasan and Krishna Murthy, 2018). Agarwal *et al*. (2004) used an integrated approach of remote sensing, GIS and geophysical techniques for hydrological studies.

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Godawari-Purna sub basin is located in Parbhani district of Maharashtra State. The agriculture in an area is mostly depend on rainfall as more than 85 % area is rainfed. Majority of the population depend upon rainfed agriculture and the productivity is uncertain due to deficiencies of rainfall, occurrence of frequent dryspells resulted to moisture stress, land slope and other parameters. Rain water management plays an important role in increasing crop productivity. Thus critical hydrological interventions are required to develop need based location specific technologies based on land slope, land use and land capability. In the present study, Remote Sensing and GIS tools were used for development of land resource related thematic maps and thereby futuristic land use planning based on land slope.

Materials and Methods

Godawari-Purna sub basin, located between

76°36' to 77°59' E and 19°07' to 19°17'N. The geographical area of the basin is 34413.87 ha. The basin area falls under assured rainfall zone of Marathwada region of Maharashtra. The average annual rainfall of the area is 885 mm. The location of the study area is shown in Fig. 1.

The SOI Regional Remote Sensing Centre-Central, NRSC, ISRO, Nagpur. The scientific data are listed as below and was procured from National Remote Sensing Centre (NRSC) ISRO, Hyderabad. In the present research work, the manual method of basin boundary delineation has been followed. The reference basin area was first delineated from the drainage and terrain information from 1:50 K topomaps. Further, this basin boundary was updated using the updated drainage and terrain information from high resolution satellite data.

Satellite data acquisition : The Resource sat 2, LISSIV data of 15th October 2011 and 24th April 2012 were used for undertaking this study. The recent data for of Resource sat 2 LISS IV of 25th March 2019 i.e. before monsoon season and of 20th November 2019 i.e. of post monsoon season were utilized for detailed study. The basic soil depth, soil texture and hydrological soil group maps on 1:250000 scales were procured from the NRIS project of ISRO. ERDAS IMAGINE software was used for satellite data processing, geo-referencing, digital image processing. ARC GIS 10.3.1 software package was used for generating the GIS database of thematic layers and their integration and analysis. Basin boundary was delineated by manual method using DEM as input. In manual method, the drainage lines and contours were taken as the reference. Firstly, the point was chosen as the basin outlet, which will be the pore point for all the water draining out of that basin. Basin boundary was delineated by drawing lines perpendicular to the elevation contours for the land that drains to the point of interest.

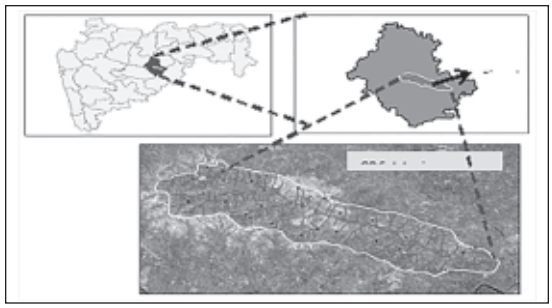

Fig. 1. Location of the Godawari-Purna sub basin (study area)

Generation of thematic maps : Thematic maps *viz*., land use cover, has been interpreted using the visual interpretation techniques by heads-on digitization in the GIS environment using the enhanced high-resolution satellite imagery. Image interpretation element keys namely tone, texture, shape, size, pattern, association, etc. have been used for mapping these features. Other thematic layers namely soil depth, soil texture and hydrological soil groups have been sourced from the existing NRIS database and updated using the high-resolution satellite imagery. Slope map has been generated from CartoDEM using the surface tools of the spatial analyst toolbox in ArcGIS. Based on the derived thematic maps of land use, hydrological soil group and land capability class using high resolution satellite image of LISS-IV and all these thematic maps will be used for futuristic crop planning and water budgeting of the basin.

Land slope map : The slope and related information is essential for delineating watershed boundary, planning soil and water conservation measures and for deriving the land resources action plan. Conventionally, slope map was prepared using the elevation information from topomaps. The elevation information was used to generate a DEM and further the slope map using the ARCGIS tools. The Indian Remote Sensing satellites like IRS-1C/1D and the latest Indian Remote Sensing satellite CARTOSAT-1

have the stereo imaging capabilities to generate the DEM and further its derivatives such as slope, aspect and contours using the Satellite Photogrammetric Software Packages. The slope classes were classified as per the application requirement.

The slope of a particular terrain is an important factor in groundwater studies. The slope map for the study area was prepared using Digital Elevation Model(DEM). The DEM was subjected to two directional gradient filters(one in x- direction and another in y-direction).The filtering was done by using the in-built linear filters (dfdx and dfdy) available in the Arc GIS software. Then, the resultant maps were used to generate a slope map of the study area. The slope map was divided into different slope range classes and suitable numbers were assigned to each class.

Land capability map : The various land capability classes were marked on the satellite image as updated from the basic map procured from NRIS project of ISRO and final land capability map was generated. Same map was used in assessment of surface runoff potential. Dutta et al. (2001) applied remote sensing and GIS based approach for watershed morphometry and land characteristics for watershed hydrological. Javed *et al*. (2009) used Remote Sensing and GIS Techniques for prioritization of sub-watersheds based on Morphometric and Land Use Anlaysis.

Results and Discussion

Various thematic layers were generated using merged product of Cartosat-1 and high resolution satellite data of Resourcesat-2, LISS-IV images.

Land use map : The thematic map of land use and land cover was generated using GIS and presented in Fig. 2.

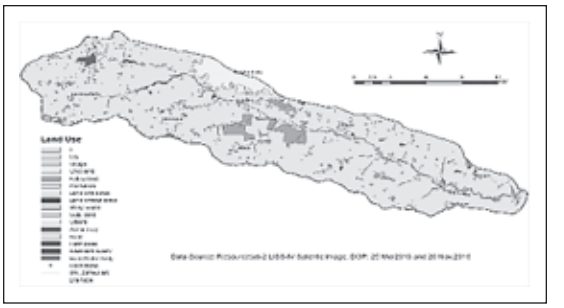

Fig. 2. Land use / land cover map of GP sub basin

Land use mapping indicated that 85.68 per cent land is under cultivation with cropped area indicating a good vegetative cover in basin area. The area under each land use category and its percentage with respect to total area of basin is presented in Table 1.

Table 1. Area under various land use units in Godawari-Purna sub basin

Land use	Area, ha	Per cent of the total area
Settlements		
City	1136.55	3.30
Village	333.05	0.97
Agriculture		
Crop land	29482.29	85.68
Fallow	1390.50	4.04
plantation	148.00	0.43
Waste land		
Land with scrub	1136.56	3.30
Land without scrub	120.03	0.35
Stony waste	58.63	0.17
Gullied land	136.85	0.40
Others	136.48	0.40
Water body		
Percolation tank lake	118.54	0.35
River	115.86	0.34
Farm pond	28.67	0.08
Others		
Abundant quarry	67.24	0.19
Total	34409.25	100.00

Land use pattern indicated that majority of the area 29482.29 ha (85.68%) was under crop land and 4.04 per cent area was under fallow land. Habitation area in the watershed was recorded as 3.30 per cent. One percolation tank is existed in the sub basin near Jamb village occupying an area of 118.54 ha. The drainage pattern i.e. river and streams occupied an area of 115.86 ha and the farm pond occupied an area of 28.67 ha i.e. 0.08 per cent which was found to be very less. The area under waste land was observed as 4.62 per cent. The sub-catchment wise area under crop land, plantation, fallow land and waste land is presented in Table 2.

In all the sub-catchment, major area was under crop land/cultivated land indicated a good vegetative cover in the entire sub basin. The noticeable area under horticultural plantation was found in sub-catchment No. I, II, IV. The major fallow land was found to be in sub-catchment No. II, IV,V, and VI. Overall, in Godawari-Purna sub basin, 1390.46 ha and 3101.75 ha land was under fallow and waste land respectively. Mohamed Elhag, (2015) and Muley *et al*. (2002) developed thematic maps of watershed using Remote Sensing technique and GIS tools for planning of hydrological studies. Similar types of maps are generated in the present study for futuristic basin planning.

Land slope map : Using the Digital Elevation Model (DEM), the thematic map for land slope was prepared and shown in Fig. 3.

Digital Elevation Model (DEM) indicated that majority of the area of basin is having a slope in the range of 0 to 3 per cent. The land slope was categorized in 7 sub classes. Majority of the area was found to be under 0 to 1 per cent and 1 to 3 per cent slope except steep slope in some area at upper catchment. Similarly at confluence point, the slope was found to be in the range of 5 to 8 per cent.

Table 2. Land use area (ha) in sub catchments of Godawari-Purna sub basin

Sub catch-ment no.	Crop land area, ha	Planta-tion area, ha	Fallow land area, ha	Waste land area, ha
I	4516.00	79.32	35.68	260.23
II	4421.77	5.50	112.11	310.72
III	1041.14	22.54	49.76	233.11
IV	4196.27	23.54	384.94	320.80
V	1646.17	2.35	120.92	340.85
Vi	3305.95	3.16	532.63	342.68
VII	1692.82	4.03	9.52	252.03
VIII	2436.36	3.73	47.62	241.01
IX	1914.90	0.00	31.29	250.89
X	2456.92	1.52	39.51	287.24
XI	1853.96	2.28	26.48	262.19
Total	29482.26	147.97	1390.46	3101.75

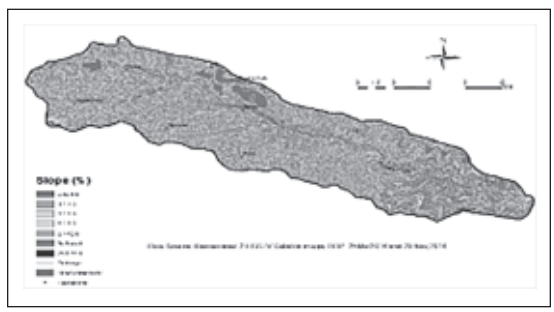

Fig. 3. Land slope map of GP sub basin

Land capability map : The land capability map was derived from base map of NRIS project of ISRO and updated using high resolution

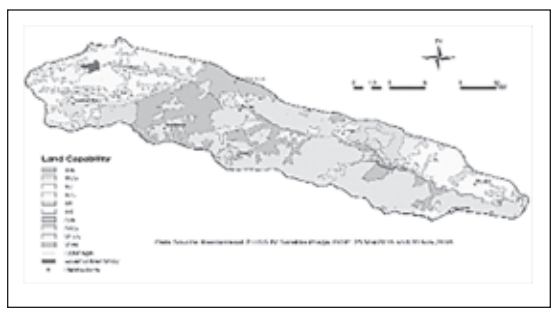

Fig. 4. Land capability map of GP sub basin

satellite image as shown in Fig. 4. The area under various land capability classes in the GP sub basin are shown on the map. Majority of the area was found to be under class III and class IV category

Conclusions

1. Land use mapping indicated that 85.68 per cent land is under cultivation with cropped area indicating a good vegetative cover in basin area. Digital Elevation Model (DEM) indicated that majority of the area of basin is having a slope in the range of 0 to 3 per cent. Majority of the area of GP sub basin was found to be under class III and class IV category.

2. All the land resources thematic maps of Godawari-Purna sub basin will be useful for land resource planning for rainwater management.

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