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Abstract-
Due to increasing demand for basic human needs and welfare of ever growing population there is seen remarkable changes in land use land cover of particular areas. Land use land cover has become a important component in current strategies for managing natural resource and managing environmental changes in present days. The objectives of this research were to analyse the land use land cover change for two periods 2005-06 and 2011-12 and comparing the changes, to study the impact of LULC change on runoff and to estimate the runoff of a watershed area i.e. Gangua Jhumka watershed. Accurate estimation of runoff is an important work for proper watershed management. Direct runoff of a catchment is depended on soil type, and cover and rainfall. Among all the methods available for estimation of runoff SCS-CN method is the most popular. The curve number depends on soil and land use characteristics. This study was carried out in Gangua Jhumka watershed located Khurda District of Odisha using remote sensing and GIS. The total area of watershed 685.711 sq. km. Soil map, Land use map, elevation maps are generated from GIS Environment. In this research work as the study area is a fast developing city and the population growth is remarkable so most of the agricultural land and forest lands are converted to built up lands. Land sat satellite image was used to obtain land cover information. The thematic maps like soil map, elevation map, and land cover map were created in Arc GIS 10.3. Curve numbers are assigned for different land cover and soil types. In present study the runoff calculated are 1307.6 mm and 1434.8 mm for the year 2005-06 and 2011-12 respectively. Due to increase urbanization runoff has decreased in the study area.

Keywords- Arc GIS, LULC, Hydrologic Soil Group, Runoff, SCS Curve Number

I. INTRODUCTION
One of the recent interests in hydrologic modelling is the assessment of the effects of land use change on water resources. Runoff water and its resulting impacts have become more important and have increased along with local economic development. As a watershed becomes more developed, it also becomes more hydrologically active with changing runoff components, stream flow and flood volume. The influence of land use on storm runoff generation is considerable factor. Land use and type of soil present in a watershed have an effect on interception, surface retention, evapo transpiration and resistance to overland flow. An increase in impervious area due to the construction of urbanization may reduce infiltration and shorten the time of concentration. Generally, urbanization will increase peak discharge and runoff volume.

In order to evaluate impact from land use land cover change on runoff, many hydrological models have been developed and used in various studies. Geographical information system (GIS) is a computer based tool for mapping and analysing spatial data. Using GIS several parameters such as Land use/land cover change, soil, topographical and hydrological conditions are analysed in most parts of the world. Land use/Land cover is the category in which remote sensing and GIS made largest impact and comes closest to maximizing their capabilities.

Land use and land cover is changing rapidly in most part of the world. In this situation accurate, meaningful and availability of data is highly essential for planning and decision making. Remote sensing is
particularly attractive for the land cover data among different sources. Satellite remote sensing techniques have started to be used as a modern tool to detect and monitor land cover changes at various scales with useful results. It is shown that the information of land use and land cover change which is extracted from remotely sensed data is vital for updating land cover maps and the management of natural resources and monitoring phenomena on the surface. The importance of land cover mapping is to show the land cover changes in the watershed area and to divide the land use and land cover in different classes. For estimation of runoff various empirical and conventional methods are used. Here in this study SCS CN method is used for estimation of runoff using a watershed area. Remotely sensed imagery are used for processing in GIS platform to collect the data needed for SCS CN model. This is a quite easy process to handle.

II. LITERATURE REVIEW

Gajbhiye et al. has estimated runoff of Kanhayia Nala watershed using remote sensing and Arc GIS. Here land sat images are used and processed in Arc GIS platform to get information about land use and land cover. Since the curve number method used here is distributed model, it is necessary to get information concerning a large number of sub-catchment in the watershed.

Tiwari et al. (1991) have modified SCS runoff curve number for the kaliaghati River Basin of West Bengal, India from a digitized land use/land cover map derived from the IRS-1A (LISS-II) data. Here using remotely sensed data information about land use and land cover changes was derived.

Looking to these facts a study is undertaken with the objective to estimate surface runoff using Arc GIS and remotely sensed data.

III. STUDY AREA

The present study covers Gangua-Jhumka watershed is situated in Khurdha District of Odisha state. The study area Gangua-Jhumka watershed lies between 20°16'23.268''N and 21°15'20.0''N latitudes and 85°15'00'' E and 85°44'52.695''E longitudes, with elevation ranges from 20m to 300m above Mean Sea Level (MSL). The major nala Gangua is the tributary of Kuakhai River and it originates from gadakan and meets Daya River near Jatni. The river Daya at southern region and Kuakhai at eastern region shares their catchment within the study area.

Fig. 1 Location of Study Area

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The watershed covers an area of 685.712 km². Based on topographical setup, the study area is divided into four natural divisions i.e. Coastal dune, Alluvial Plain, Lateritic upland and Hilly Terrain. There are three types of soils generally found in this study area i.e. Matured, Red and Lateritic soil (Alfisols), Mixed Grey soil (Inceptisols) and Unaltered soil with Coarse Parent material (Entisols). There are many drainage channels within the area. The main channel which flows through the catchment is Gangua Nala. This Nala drains into the river Daya. The Gangua Nala is the distributary of river Kuakhai. The Jhumka Nala is another major Nala flows through the study area. As the study area is a fast growing city so most of the land cover type is under Urbanization. Here in the study area six types of land use and land covers are classified i.e. agricultural land, Forest land, built up land, Waste land, Wet land. Geographically this watershed lies in tropical zone and experienced tropical climate. The average annual rainfall in the area is recorded as 1500mm.

IV. METHODOLOGY

A. Data Collection and Analysis

1) **Image:** Data collection method in this study area is done mostly from ORISSA SPACE APPLICATION CENTRE (ORSAC), Bhubaneswar, Odisha. Most of the data are obtained from the satellite images. Ancillary data such as Topographical maps, aerial photos and Land sat images for the year 2005-06 and 2011-12 area obtained from ORSAC. The details are presented in the table given below.

<table>
<thead>
<tr>
<th>Satellite Images</th>
<th>Spatial Resolution</th>
<th>Acquisition Date</th>
<th>Source</th>
<th>Path and Row</th>
</tr>
</thead>
<tbody>
<tr>
<td>LISS III</td>
<td>23.5m</td>
<td>2005-06(Rabi-Kharif Season)</td>
<td>NRSC(National Remote Sensing Centre)</td>
<td>Column-106 Row-58</td>
</tr>
<tr>
<td>LISS III</td>
<td>23.5m</td>
<td>2011-12(Rabi-Kharif Season)</td>
<td>NRSC(National Remote Sensing Centre )</td>
<td>Column-106 Row-58</td>
</tr>
</tbody>
</table>

2) **Toposheet:** In this thesis work the study area is covered using four numbers of toposheet. The topo sheets having numbers H/11, H/15, 73 H/12 and H/16 are used in this research work. H/11 consists of longitude 85°25' and latitude 20°35', H/15 is having longitude is having longitude 85°25' and latitude 20°55', 73 H/12 toposheet is having longitude 85°5' and latitude 20°35' and the toposheet H/16 consists of longitude 85°25' and latitude 20°55'.

3) **Rainfall Data:** Changes in river flow characteristics may be influenced by the amount of rainfall in the watershed area. The rainfall data for a period of 15 years extending from the year 2000 to the year 2015 is collected from the Department of Water Resources (DoWR), Govt. Of Odisha, Bhubaneswar, Odisha. The rainfall data for the year 2005-06 and 2011-12 is represented in table.

<table>
<thead>
<tr>
<th>Year</th>
<th>Jan</th>
<th>Feb</th>
<th>Mar</th>
<th>Apr</th>
<th>May</th>
<th>Jun</th>
<th>Jul</th>
<th>Aug</th>
<th>Sep</th>
<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Yr. Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>12.0</td>
<td>0.0</td>
<td>51.0</td>
<td>0.0</td>
<td>40.0</td>
<td>110</td>
<td>200.0</td>
<td>164.0</td>
<td>560.0</td>
<td>273.0</td>
<td>42.0</td>
<td>0</td>
<td>1452</td>
</tr>
<tr>
<td>2011</td>
<td>81</td>
<td>0</td>
<td>51</td>
<td>139</td>
<td>251</td>
<td>351</td>
<td>378</td>
<td>296</td>
<td>32</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1579</td>
</tr>
</tbody>
</table>

4) **Data Analysis:** Data collected were first pre processed before any quantitative and qualitative analysis. To analyse remotely sensed images, the different images representing different bands were stacked. This allowed for different combinations of RGB to be shown in the view. After image stacking the satellite images were imported into Arc GIS 10.2. Remote sensing technique, because of its capability of synoptic viewing and repetitive coverage, provides useful information on land use dynamics. It can provide a measurement of many hydrological variables used in hydrological and environmental applications comparable to traditional forms of land-use data collection.

B. Preparation of maps

Topo sheets of the study area collected from Survey of India are scanned and then loaded to Arc GIS 10.3. All the required actions like Georeferencing and mosaic are done. Thus preparation of base map is done in the first
step. After preparing the base map all other thematic maps are prepared. The boundary line of the watershed is digitized through the ridges present on the base map. The prepared base map is shown in the figure below.

Using the base map the drainage lines are digitized. The map is presented in the figure below.

The Land Use Land Cover map was generated with the help of satellite data using unsupervised classification. The data model is developed based on certain parameters namely base line data, cadastral maps, central survey maps, SOI toposheet, satellite data and ground truth data. This work is done by visual interpretation approach. The interpretation was based on the relationships between ground features and image elements like texture, tone, shape, location and pattern. In Gangua-Jhumka watershed six land use land cover classes were identified i.e. agricultural land, Built up land, Forest land, Waste land, Water body, Wet land. The masked satellite images for the year 2005-06 and 2011-12, which are used to analyse the land coverings are shown in the figure.
Here in this thesis work for the Gangua Jhumka watershed area hydrological soil grouping classification of soil is taken into consideration. This hydrological grouping is done considering the infiltration rate of the soil.

The contour map is used to generate the Digital Elevation Map. From DEM the nature of terrain is known as the nature of terrain is useful to get the information about characteristic of runoff.

Fig. 4 Masked Satellite image 2005-06

Fig. 5 Masked Satellite image 2011-12
Fig. 6 LULC Map 2005-06

Fig. 7 LULC 2011-12
Fig. 8 Hydrological Soil Group Map

Fig. 9 Digital Elevation Map
C. Generation of CN Map

Generation of CN map is the most important step in this thesis work. To create the CN map, the soil map and land use map were uploaded to the ArcGIS platform. The soil map and land use map were selected for intersection, after intersection a map with new polygon representing the merged soil land map was generated. In both the time period 2005-06 and 2011-12 there are six land use land cover classes and four hydrological soil group present in the study area.

In the next step the curve number calculation is done in ArcGIS 10.3 through the union process of attribute combined to one of the land use and hydrological group of soil. Using Technical Report (TR-55), 1986, SCS the creation of the CN table that has curve number values for different combination of hydrologic soil group and land use has been made. The appropriate CN value for each polygon of the soil-land merged map was assigned. To assign curve number by referencing the land covers and hydrologic soil classification, merged soil land maps for the year 2005-06 and 2011-12 are generated. The maps are shown in figures below.

The curve number assigning process is done in ArcGIS attribute table for the soil-land merged map. The assignment of curve number is done in reference to table. As this entire study area is covered with four hydrologic groups A, B, C, and D; so the assigning of curve number is done by following process. In the first step the six land use classes are taken into consideration in the merged soil-land map i.e. agricultural land, built up land, forest land, waste land, water body and wet land. The curve number is assigned land use land cover area wise. Let us Agricultural land class is taken into consideration. In the soil-land merged map at first the small polygons which comes under agricultural land and considering their respective hydrologic soil group the CN value is assigned by referencing the SCS TR 55 1986. These values are filled up in the attribute table using ArcGIS 10.3. Likewise all the other classes are also assigned with suitable curve numbers.
After assigning the CN value primarily for each polygon, the weighted curve number is calculated using the following empirical formula.

\[ CN = \left( \sum (CN_i \cdot A_i) \right) / A \]

Where,
CN = Weighted Curve Number
CN_i = Curve Number from 1 to any no. 100
i = Area with curve number CN_i
A = the total area of watershed

It gives the value 68.27 for the year 2005-06 and 68.41 for the year 2011-12, for accuracy in result and for easy doing the evaluation process of runoff.

For generation of curve number map of 2005-06 and 2011-12 year, maps i.e. The land use and land cover map and soil maps for year 2005-06 and 2011-12 are uploaded in Arc GIS 10.3 work space. Here the curve number for each land use class has been calculated using the empirical formula. The curve number for year 2005-06 and 2011-12 varies between 38 to 100. The curve number maps for the following years are shown in figures.

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D. Calculation of Weighted Curve Number

Weighted curve number for period 2005-06 and 2011-12 are calculated using Microsoft Excel. At first for each land use land cover category the weighted CN is calculated using formula for each time period; then again using the formula for the whole area one weighted CN is assigned. The weighted curve number of the watershed for the year 2005-06 and 2011-12 are shown in table below. Here we can see for the time period 2005-06 the weighted CN assigned is 68.27 and for time period 2011-12 the weighted CN is 68.41.
E. Estimation of Runoff using SCS Model

The SCS Model is a widely used model for runoff estimation. Using the following SCS formula here runoff is estimated.

\[
Q = \frac{(P - 0.3S)^2}{(P + 0.75)}
\]

\[
S = \frac{25400}{CN} - 254
\]

Where,

- Q=Run off depth (mm)
- S=Maximum Recharge Capacity
- CN=Curve Number
- P=Rainfall depth (mm)

For the year 2005 the collected amount of rainfall is 1452mm. The calculated weighted curve number for the time period 2005-06 is 68.27. The required estimated runoff is 1307.613 mm. Likewise the rainfall amount for the year 2011 is 1579mm. The calculated CN for the time period 2011-12 is 68.14. From the calculation the required surface runoff is 1434.80mm.

### V. RESULT AND DISCUSSION

A. Analysis of Land Use and Land cover change between 2005-06 and 2011-12

The actual percentages covered by different land-use and land cover types in the years 2005-06 and 2011-12 are presented in figures below.
There has been a significant land use/land cover change in the watershed area where the agricultural land covered 39.37% in 2005-06, decreased to 32.39% in 2011-12. This could be attributed to increase in population that has increased the demand for the agricultural and built up land in the study area. A comparison of land use land cover demand between the year 2005-06 and 2011-12 has been shown below in bar chart for better understanding.

From the ground truth data obtained from classified land sat images of 2005-06and 2011-12; the watershed has under gone various land use and land cover changes. Considering the analysis it is noted that the agricultural land is decreased 17.72% in the six years of time period, built up land is increased by 35.03%, forest land is decreased by 4.29%, water body is decreased by 4.62%, waste land is decreased by 12.31% and wet land is increased by 12.31% in the six years of time period. The comparison of percentage change in increase and decrease of various LULC for 2005-06 and 2011-12 is shown in figure.
B. Comparison of Runoff

Runoff for the year 2005-06 and 2011-12 has been estimated using SCS model. It is noted that the estimated runoff for the year 2011-12 is more than 2005-06. Runoff has increased 9.72% in the period of six years. It is also noted that due to increase in built up land the runoff also increases. As in the present study area urbanization process is frequently growing so more construction work is needed. Due to rapid construction work the compaction of soil is more so the runoff calculated for the year 2011-12 is more.

Fig.17 Comparison of Runoff

VI. CONCLUSION

Mapping and monitoring of land use/land cover is important for many management and planning activities as it is considered as an important element for understanding the earth and its whole system. The present study shows how well LU/LC classification and its change analysis can be easily carried out using Remote Sensing and GIS technology. Satellite remote sensing allows retrospective, synoptic viewing of large regions, thus providing the potential for a geographical and temporarily detailed assessment of land use and land cover change in the watershed. Here from the study it is concluded that changes in Land use/Land cover affect the runoff amount of the study area. By using the land use land cover and runoff change aspect further modelling of a sustainable watershed can be done. Using the SCS CN model and Arc GIS, it is also possible to find the runoff of the places where no records for the runoff is found.

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