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RESEARCH ARTICLE

Runoff Assessment and Response to Land use and Land Cover Changes by using Remote Sensing and GIS

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ABSTRACT

India is on the 2nd largest most excessively populated country all over the world, and at present the requirement for food and water is in huge amount. The State production and supply of essentials needed to be assess, for this purpose its very much necessary to know the pattern of the resources like land and water etc. The Changes in the environment which occurs indirectly or directly affects the ecosystem. Due to rapid urbanization, globalization and industrialization many of the major cities is been growing larger and larger and the merging of the nearby areas with the cities is being done without any proper planning. The water cycle has been affected very strongly by all the anthropogenic activities and the quantity and quality of the water availability is affected by water cycle due to that effect it's not astounding that many of the river basins experiencing water scarcity due to sudden changes in hydrological cycle. It's very important to know the different effects of changes occurring in land use/land cover and envisage the consequences and steps to be followed to reduce the effect consequently. In the present study SWAT platform is used where the inputs are given and simulation is done by using RS and GIS for the prediction of parameters which contributes to changes. The given study emphases on the surface runoff which is commonly effected by the land cover changes over there. The study is done by entering the processed data in GIS environment. This data gives all the essential parameters for the input in **SWAT (Soil and water assessment tool).** The simulation run in SWAT was carried out by using the runoff inputs which is generated for the specific time period in the study area. GIS Environment processes the input given to SWAT and then reading the responses of the runoff of the basin catchment for the period given. There is a chance to envisage the concerns and consequences and find out the changes and which can decrease the complications of futures and can be recommended the given strategies to reduce the extreme changes which distresses the ecosystem and possibility for development of sustainable ecosystem.

Keywords: Remote Sensing, GIS, Land use, Land cover, SWAT, Arc GIS, Rainfall, Runoff.

INTRODUCTION

Kinnerasani is the study area which is located in the state of Telangana (T.S). Telangana state is mostly an agricultural state in that state total 70% population depends on agriculture for getting its livelihood. The considerable attention has been taken for the development of large scale, medium scale and small scale industries in the Telangana districts. Due to this the urban the urban population was increased over the years. In general, natural resource base is limited. The current study area provides irrigation to the agricultural areas and provides water to (KTPS) Kothagudem thermal power station at Palvancha for thermal power generation.

Objectives Of The Study

1. Collection and assessment of data for the natural cover changes of the study area by input of parameters for the period 2009 and 2013.
2. Annual runoff generation of the study area in the time period given.
3. To calculate and evaluate the runoff response of the study area for the given period.
4. Development of strategies for the mitigation of the objectionable effects on land use/land cover.

Location and Extent

Kinnerasani, is a very important tributary of Godavari river. The study area covers an area of 910sq. km. The study area is located at 17^0 41' N and 80^0 40' E. The Kinnerasani basin storage capacity is 233 m^3at the reservoir full level of 124.05m. The mandals Tekulapalli, Gundala, Plvancha and Burgampadu are under command areas and the catchment areas. Fig 1 Shows location map of the Study area.

Climatic Conditions

The climatic condition of the city is impartially justifiable with winter summer and rainy seasons. Based on the previous studies on climatologically data shows that south-west monsoon gives more than (75%) the average. Rest of the 25% summer showers constitutes from North- East monsoon. So the maximum amount of rainfall is received in south-west monsoon

Physiography

The details of physiographic area are the undulating terrain with a slope of 1-6%, varying from nearly level to a very steep slope. Among overall 13% of the area is nearly level and around 58% of the area is moderate sloping. The mean sea level elevation of the study area is 107m (351 ft.)

Soils

The Kinnerasani basin is mainly consists of two types of soils clay soils and clay loam soils. Whereas majority of the area around 84% is clay soils and 14% of the area occupies as clay loam soil rest of the 2% is under water bodies and rocks. Fig 2 shows the soil texture of the study area. The spatial variation of depth of soil is given in the fig no.3. About 62% of soils are moderately shallow to deep depth and about 36 % of soils are very shallow Kinnerasani basin soil productivity spatial variation has been depicted in fig 4. 14.72 % soils are ascetically productive and only 1% soils are non-productive Shown in the table 1

Soil And Water Assessment Tool (SWAT)

SWAT is a Hydrological model and is well organized for the users the long term impacts. SWAT functions on a regular time step at scale basin with ArcView GIS interface which is developed to envisage the impact on LU/LC (land use and land cover) by providing the parameters like Evapotranspiration runoff and potential evapotranspiration of large area uniformly and completely covered with continuous growing vegetation and unlimited supply of soil water. SWAT model simulates the quantity and quality of surface water and it also gives the impressions on all the parameters of the environment and ungauged watersheds by compelling specific data as the inputs and it as well as provides the precise data as inputs and it also make available the reflection to changed. SWAT is computationally effective for very large basins also. SWAT Methodology Flow chart is shown in fig no 5 and 6

Process For Running SWAT

SWAT Project Setup

First Click on SWAT PROJECT SETUP in ArcGIS software and give an output location

Delineation of Watershed:

For Delineation of watershed Click on watershed delineator and give DEM map as input for watershed delineation, Flow accumulation and direction, Watershed outlets and sub basin parameters and click on watershed delineation. Shown in the fig 7

HRU Analysis

- Click on HRU ANALYSIS in ArcGIS software and then on soil/land/slope definition.
- Then Input landuse/land cover layer, soil map of a year and then reclassify it by giving slopes values and overlay them and create HRU'S Analysis. Shown in the fig 9

Weather Data

Process of weather station

Nine weather stations are identified around the study area among all one weather station is selected for the collection of weather data. Shown in the Fig 10

Running SWAT in GIS

Stepwise methodology of Running SWAT in GIS shown in the fig 11

Implementation

Land Use/Land Cover Maps

land use land cover map of the study area shown in fig no. 12 showing changes in the year 2009 and 2013. The vegetation covers in the year 2009 is 18.94% as compared to 2013 the vegetation cover is 13.4 %

RESULTS

2009 Results

Swat reduced output is shown in the table2. Among which august month has received highest rainfall i.e. 355.4 cm and highest runoff i.e. 67.71. June July and August are the months for receiving highest precipitation. Fig 13 shows the graph of the year 2009 SWAT reduced output. Table 3 shows area wise feature present in study area of the year 2009. Wet land vegetation covers the highest % of the area i.e. around 43.93%. Among all of the features total water bodies covered in the total area is 1.57%. River catchment is around 20.6%. Graphical representation of features present shown in the fig. 14.

2013 Results

Table 4 shows the 2013 SWAT reduced output of the study are. As per this data in the month of July the area receives the highest rainfall i.e. 863.5 cm and runoff is also highest in this region i.e. 350.44 cm. Fig. 15 shows the runoff and precipitation simulated graph of the year 2015. Table 5 shows the features present in the region. Where wetland vegetation is the highest% in the region i.e. 35.8% and water bodies present is 1.6% only. Fig 16 shows the graph of features present in the study area.

Comparison Of 2009 And 2013 Results

Table 6 shows the compared runoff of the year 2009 and 2013. As per this data runoff is the highest in the month of Julyi.e. 350.44 for the year 2013. This is due to the reduced vegetation in the year 2013 i.e. from 43.93% to 35.8% of wet land vegetation and 18.94% to 13.4% of healthy vegetation, which had made the soil water holding capacity less and increased rate of runoff has been observed. Fig 17 shows the runoff graph simulated upon comparing both the years and fig18 shows the graph of difference in area of the features.

CONCLUSION

Planning decision making and implementation through an efficient management call for the generation of comprehensive information system The obtained results show in the study there is increase of the features like river catchment with sand, scrub land which is clear indication of there is increased runoff in the year 2013 and the area under which is under built up land and agriculture is increased whereas forest area is decreased. The results obtained by objective 3 shows that there is runoff increase in land use/land cover it is observed that there is decrease in healthy vegetation which results to increase in barren land and scrub land which finally leads to more runoff and less precipitation

Recommendations

Some strategies to mitigate the effect of heavy runoff are:

- Add plants and Protect trees
- Catch runoff with modern techniques
- Cover soil .
- Use modern methods of Agriculture.
- Methods implemented for deep percolation.
- Increase rain water harvesting structures and collect as much as rainwater without wasting it as runoff.
- Use fewer chemicals and use Natural resources for agricultural purpose.
- Every individual should be responsible and take ownership of responsibilities and give hand in development of self and also surroundings.

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Table 1: Details of soil productivity in the study area

S. No	Description	Area km^2	Percentage
1.	Highly Productive	105.83	11.63
2.	Non Productive	12.52	1.38
3.	Low Productive	132.37	14.55
4.	Moderately Productive	659.32	72.45

Table 2 2009 SWAT Reduced Output

2009 SWAT REDUCED OUTPUT		
MONTH	**PRECIPITATION**	**RUNOFF**
JANUARY	0	0

FEBRUARY	0	0
MARCH	3.7	0
APRIL	0.4	0
MAY	127.1	23.1
JUNE	208	46.17
JULY	343.5	64.63
AUGUST	355.4	67.71
SEPTEMBER	180.6	18.38
OCTOBER	6.4	5.08
NOVEMBER	105.1	9.2
DECEMBER	6.2	0
TOTAL	**1397.4**	**234.27**

Table 3 Area wise feature present in the study area of the year 2009

NAME OF THE FEATURE	AREA(%)
WATER BODIES	1.57
HEALTHY VEGETATION	18.94
WETLAND VEGETATION	43.93
SCRUB LAND	14.96
RIVER CATCHMENT WITH SAND	20.6

Table 5 Area of the features present in 2013

NAME OF THE FEATURE	**AREA(%)**
WATER BODIES	1.6
HEALTHY VEGETATION	13.4
WETLAND VEGETATION	35.8
SCRUB LAND	21.3
RIVER CATCHMENT WITH SAND	27.9

Table 6 Comparison of 2009 and 2013 results

MONTH	RUNOFF(2009)	RUNOFF(2013)
JANUARY	0	0
FEBRUARY	0	0.19
MARCH	0	0
APRIL	0	0.28
MAY	23.1	0
JUNE	46.17	104.14
JULY	64.63	350.44
AUGUST	67.71	75.89
SEPTEMBER	18.38	44.46
OCTOBER	5.08	31.66
NOVEMBER	9.2	0.16
DECEMBER	0	0.01

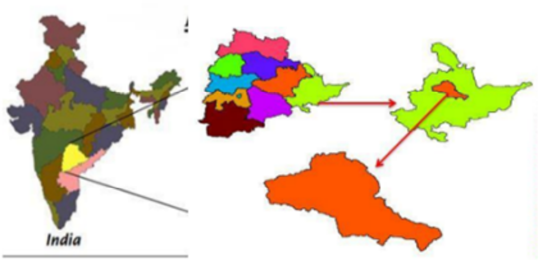

Fig. 1The location map of study area

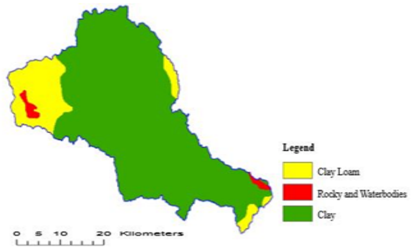

Fig 2: Soil Texture Map of the Study Area

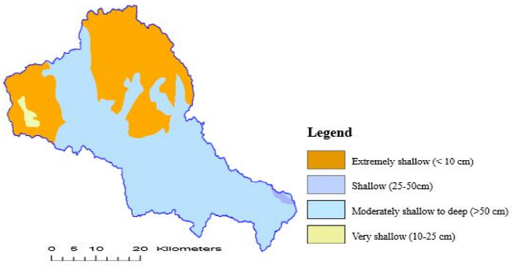

Fig 3: Spatial variation of soil depth in study area

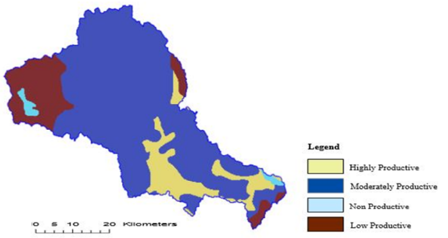

Fig 4 :spatial variation of soil productivity in the Study area

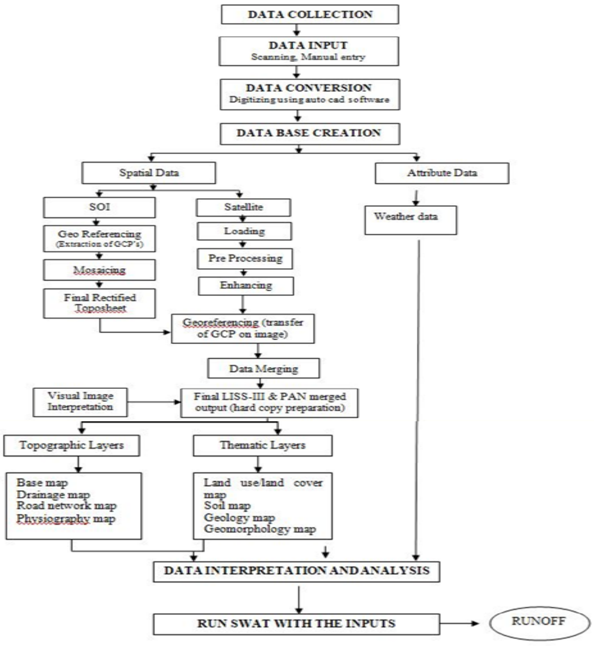

Fig 5 Methodology flowchart of the study area

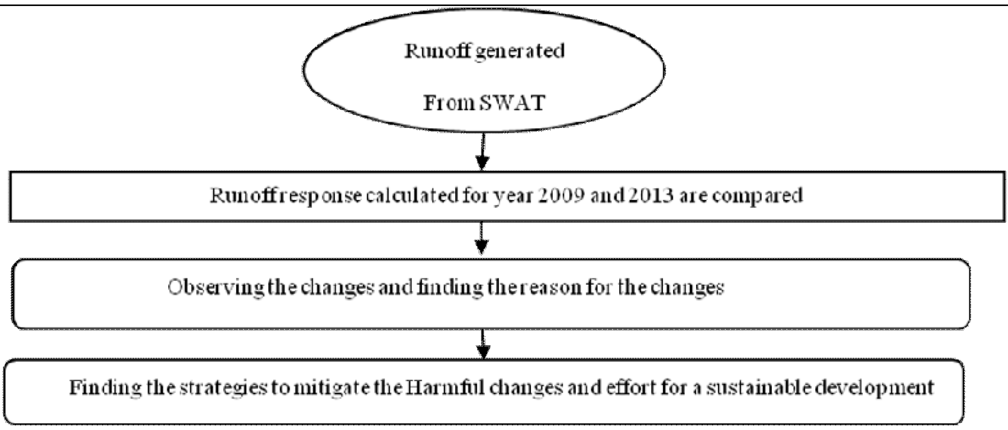

Fig. 6 SWAT Methodology flow chart

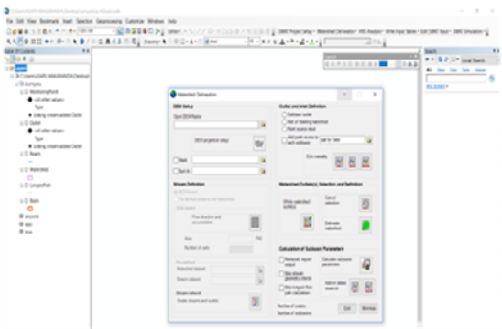

Fig 7 watershed delineation in SWAT tool

Fig 8 watershed delineation Map of Kinnerasani Basin

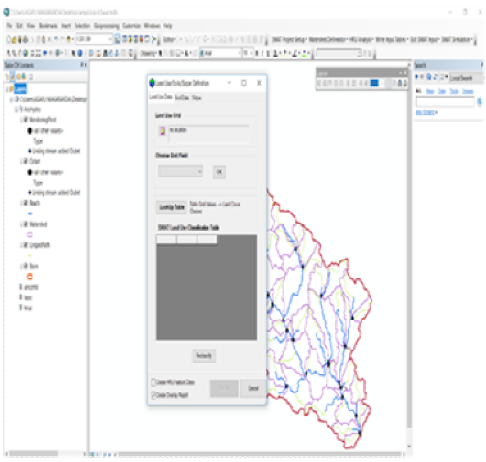

Fig 9 HRU analysis process

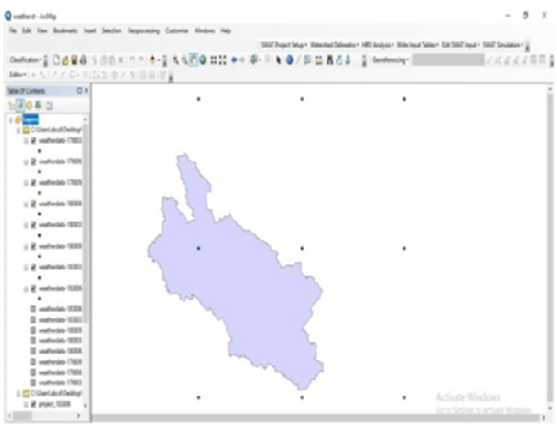

Fig 10 Available weather stations in and around study area

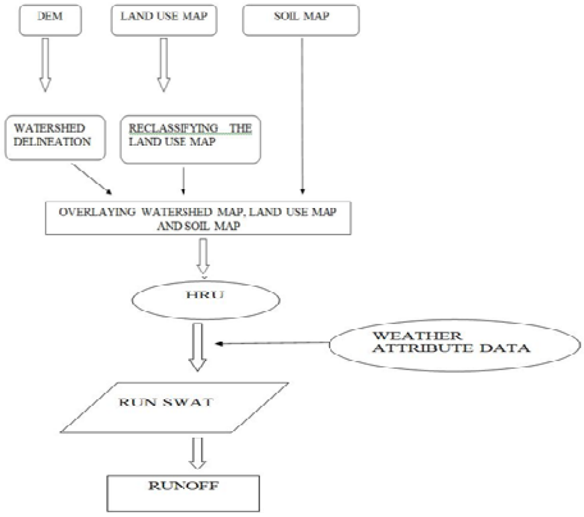

Fig 11Implementation for Running SWAT in ArcGIS

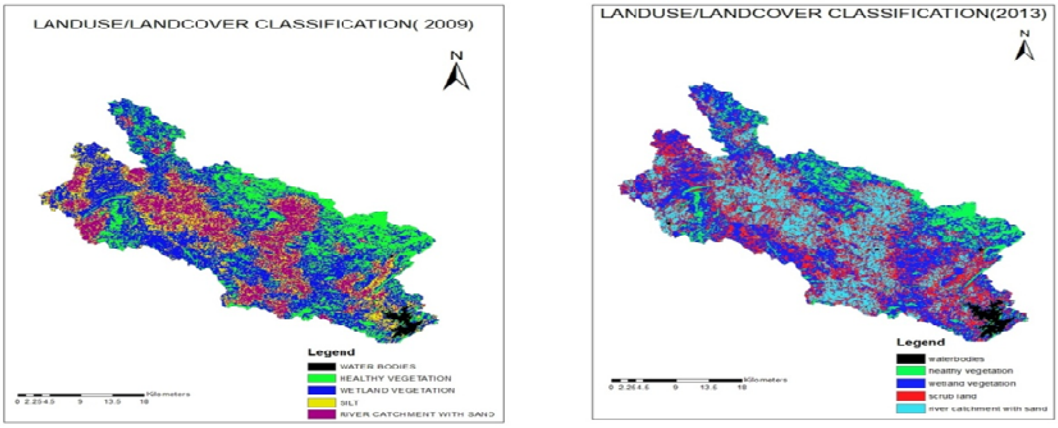

Fig 12 Land use/ Land Cover Map of the Study Area in the year 2009 and 2013

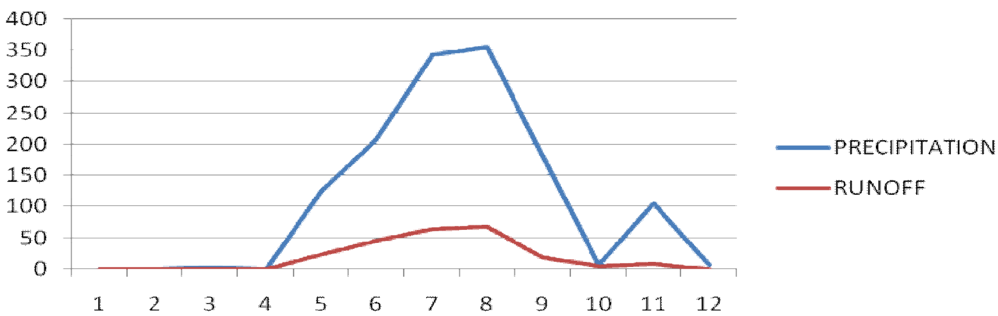

Fig 13 Runoff and Precipitation graph simulated for the year 2009

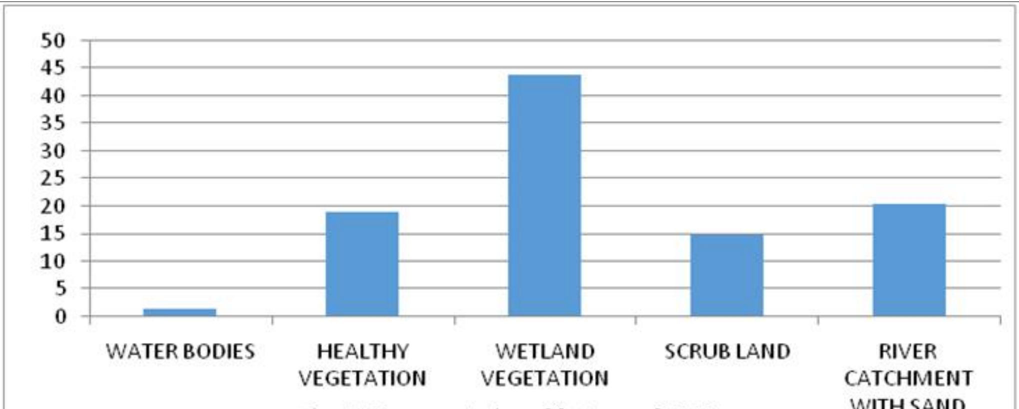

Fig: 14 Representation of features of 2009

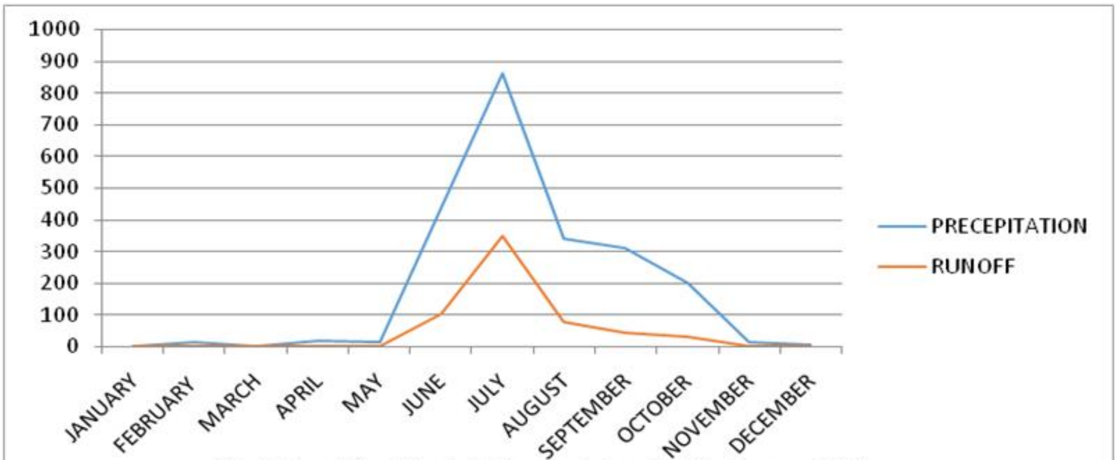

Fig 15 Runoff and Precipitation graph simulated for the year 2013

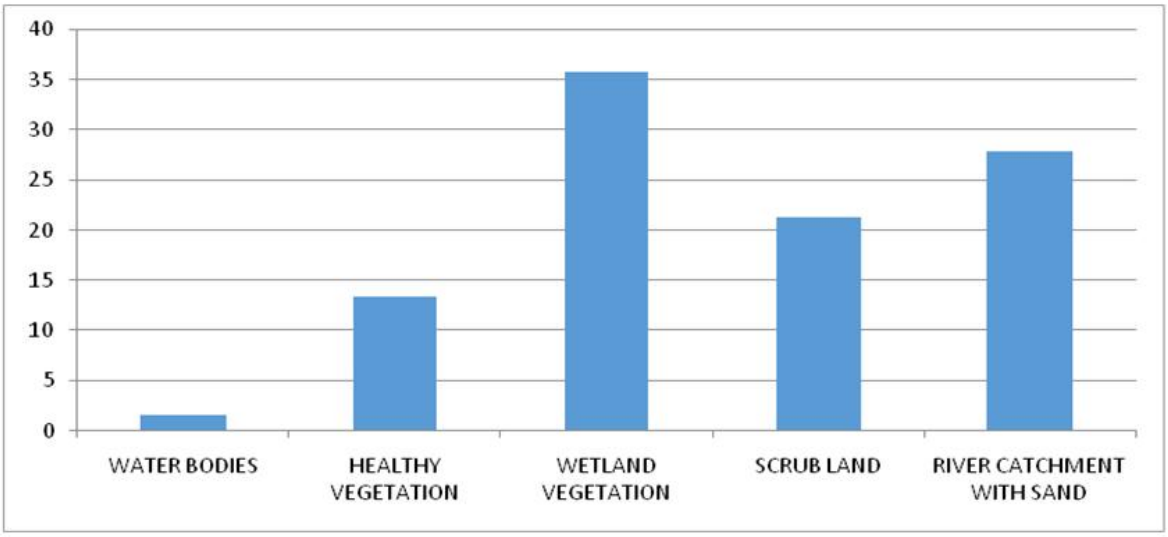

Fig. 16 Area of the features present in 2013

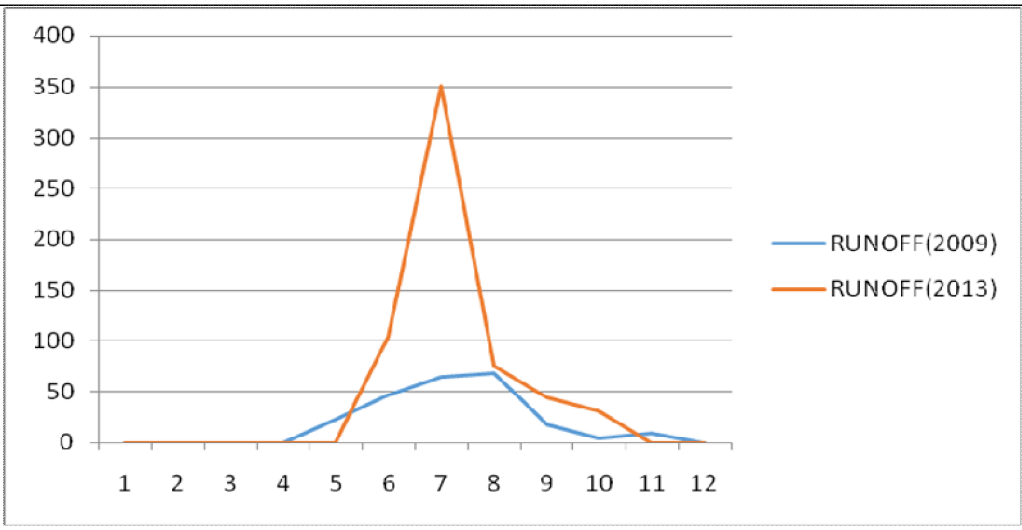

Fig 17Runoff graph simulated upon comparing both years

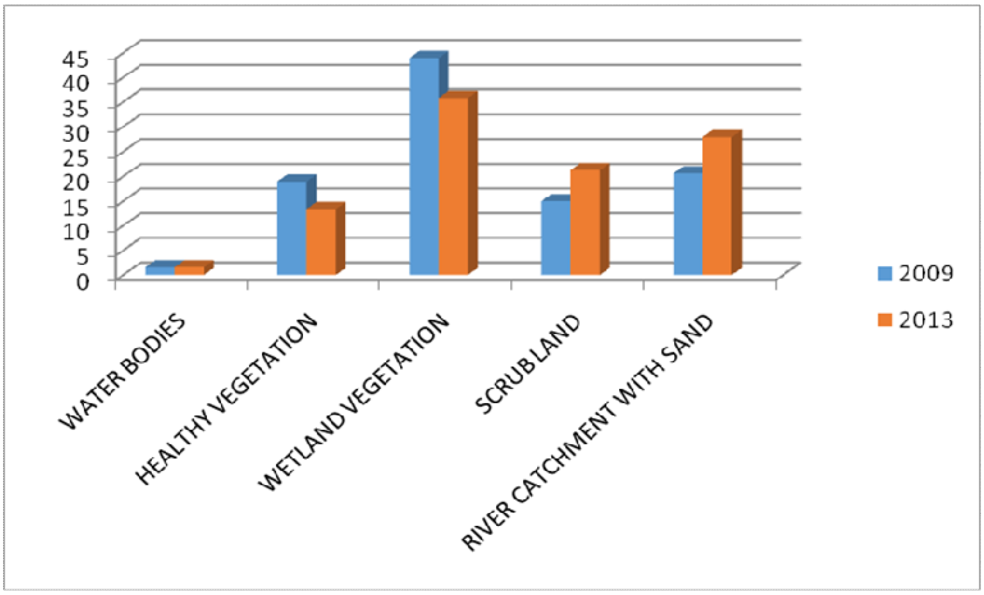

Fig:18Difference in Area of the features