

# **RESEARCH ARTICLE**

### ASSESSMENT OF LAND USE LAND COVER CHANGE AND LAND USE DYNAMICS OF MICRO WATERSHED- A CASE STUDY OF ASIGANGA WATERSHED IN UTTARAKHAND.

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### Manuscript Info

#### Abstract

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*Key words:-*Watershed, Mountain ecology, Geohydrological units. Micro watersheds in Himalayas are the fulcrum of rural mountain economy since native people are directly depended on them for their livelihood and wellbeing. They are also integral to global water resource pool and functioning of the ecosystem. Asi Ganga watershed is one of the significant watersheds located in Uttarkashi region of Uttarakhand. The areal extends is of 189 sq. kms covering 9 villages located along the Asi Ganga Water channel. The study tries to analyse the land use land cover changes in the watershed along the period of 20 years from 1996 to 2016 and existing land use practices in the region. Landsat and Google Earth data has been collected for temporal analysis of the area. Anderson's land use land cover classification technique has been applied for change detection analysis of the area. Eighty Seven (87%) of the total area was under forest cover in 1996 which reduced to 82% in 2016, showing a decline of 6%. The mere 4.2% of agricultural area has also reduced to 2.6 in the past 2 decades especially after the flash floods of 2012 in Uttarkashi, which eroded the agricultural fields located along the Asi ganga water channel.

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#### Introduction:-

Mountain watershed are valuable for sustenance of life, since they support ecology and economy of mountain area. They are not only primary repositories of water but also provide range of ecosystem services. Network of such small micro watersheds are creators of huge river valley basins on which diverse ecosystem thrive and human beings exist. They not only fulfil the basic demand of water but also integral part of biosphere. Mountain watersheds in particular are more than mere geo-hydrological units, since they form basis of agriculture, economy and livelihood of mountain people. Ongoing global climate change and increasing human induced activities are likely to alter the water regime in the Himalayas. Therefore, Management of these head water streams is very essential to prevent ecosystem degeneration and for better livelihood. Micro watershed are considered central to water conservation and sustainable watershed development. Various land water management systems have been evolved in order to restore these micro water units as part of our recent understanding of their importance to our ecosystem.

Asiganga is a small watershed is located in Uttarkashi drained by small Asiganga River, which meets Bhagirathi .It supports small village economy of the region since people are dependent for their agricultural activities and water requirement on the watershed. The watershed was affected by the flash floods in 2012, were in the land use and land cover was affected mainly along the river channel course. In order to understand the changes in landscape over the

**Corresponding Author:-Abhilekh Chandra Jagoodi** Address:- Research Scholar (Ph.D.) Department of Geography, School of Earth Sciences, H. N. B. Garhwal University, Srinagar, Uttarakhand, India. span of 20 years land use land cover analysis has been done using Remote sensing data on GIS platform. Land use land cover analysis and has emerged as an essential technique in monitoring and assessing change in these micro water units. It is important elements for monitoring, evaluating, protecting and planning for earth resources and in understanding socio economic drivers of LU/LC.LU/LC studies are significant in determining Spatio temporal analysis of any landscape, supplementing need and challenges of Sustainable natural resource management. LU/LC studies are aided with remotely sensed data widely ranging in spectral and radiometric resolutions. These datasets are then analysed using numerous Geographical information system platforms to obtain the desired results. The particular study tries to highlight the changes in Asiganga water with respect to land use and land cover. It also aims to understand livelihood conditions and ongoing watershed management practices prevalent in the region.

### Study area:-

Asiganga is a Small head water stream of Ganga's primary tributary called Bhagirathi in Uttarkashi, Uttarakhand. (Figure-1). Two primary streams *Ghaiya Gaad* and *Kaldi Gaadh* meet near Sangamchetty to form Asiganga, from where it flows for 60 kms downstream to meet Bhagirathi River near Gangori Village. The catchment area of Asiganga river cover 189 sq. kms forming a Micro watershed unit located between 30°43' 47.00" N-30°55' 51.05" N latitude and 79°4' 46.13" E-79°16' 9.45" E longitude. The other tributaries of Asiganga are *Dodital, Dirga, Urkuti, Gundra, Kaliyani* etc. The Asiganga valley exhibits distinctively rugged topography of both higher and lesser Himalayan terrain with deeply insides valleys and strike ridges, with exposed quaternary deposits at several places. The total elevation of the area ranges from 1120 metres to 4520 metres and the slope varies from 35° to 40°.



Figure: 1- study area.

|                  |            | 2011       |                     |            | 2011       |            |
|------------------|------------|------------|---------------------|------------|------------|------------|
| Name of Village  | Total      | Total      | <b>Total Female</b> | Total      | Total      | Total      |
|                  | Population | Male       | Population          | Population | Male       | Female     |
|                  |            | Population |                     |            | Population | Population |
| Naugaon          | 517        | 277        | 240                 | 431        | 233        | 198        |
| Gajoli           | 709        | 408        | 301                 | 583        | 303        | 280        |
| Bhankoli         | 470        | 241        | 229                 | 421        | 210        | 211        |
| Dasda            | 187        | 101        | 86                  | 174        | 95         | 79         |
| Dandalka         | 142        | 63         | 79                  | 105        | 48         | 57         |
| Agoda            | 442        | 210        | 232                 | 457        | 228        | 229        |
| Seku             | 343        | 167        | 176                 | 308        | 147        | 161        |
| Uttron           | 824        | 400        | 424                 | 1014       | 491        | 523        |
| Nalda Urf Bodhar | 931        | 465        | 466                 | 939        | 470        | 469        |
| Total Population | 4565       | 2332       | 2233                | 4432       | 2225       | 2207       |

 Table: 1:- Population And Villages In Asi Ganga Watershed

The area has sub-tropical climate to temperate climate and experience heavy monsoonal rainfall in summers and snowfall during winters. The average temperature ranges from  $20-25^{\circ}$  in summers to  $0^{\circ}$  in winters. Dense subtropical and temperate montane forest are observed along the valley slopes. The Micro Watershed Supports population of 9 Villages practicing subsistence farming, on small agricultural terraces and animal husbandry. (Table -1)

# Methodology:-

The Land use land cover analysis is done using remotely sensed data on GIS platform. Remote sensing is the science and art of obtaining information about an object, area, or phenomenon through the analysis of data acquired by a device that is not in contact with the object, area or phenomenon under investigation (Lillesand & Kiefer,2008). Land use land cover analysis generally use wide range of Multispectral data. Wide range of Multispectral remotely sensed data, are being used for Land use land cover studies. For the current study the remotely sensed Landsat satellite data has been obtained of 2 time periods i.e. 1996 and 2016 from GLCF. Vectorised LULC classification has been done using ArcGIS Software where each category is digitised and layered. Google earth explorer and Bhuvan portal have also been used during the process of classification. For LULC classification Anderson LULC classification is being used. Based on Anderson Classification Seven land use/land cover classes were identified in the present study viz (i) Agriculture land, (ii) Built up (iii) Barren/Wasteland (iv) Snow (v) River (vi) Forest and (vii) Rangeland area.

### **Result and Discussion:-**

The land use land cover change detection has helped in the analysing the spatio-temporal changes in any area. Particular to watersheds the technique helps in monitoring the natural resource change, the forest resource, the channel morphology, settlement pattern etc. Land use and land cover change is an important component in understanding the interactions of the human activities with the environment over space and time. The total area of the watershed is 189 sq. kms where maximum area of 165 sq. kms was under forest cover in 1996 accounting for about 87 % of the total area followed by area under Agriculture (4%) and rangeland (4%). In the last 20 years the maximum decrease was observed for forest cover which declined from 165 sq. kms to 155 sq. kms showing maximum decline of 10 sq. kms among all LU/LC Categories (see fig- 2). Dense temperate forest with predominance of *Oak, Juniper, Surahi, Deodar, Fir* are spread along the mid and High altitudinal valley slopes. Towards the valley floor, subtropical open forest with patches of *Chir, Oak,* are found intermittent with *Lantana* and *Congress* grass weed out growth. People are directly dependent on forest resources for Fuel wood and fodder.



The decline in Forest cover is attributed to increase in snow cover area during 2016 winter season, increase in range land area along the snow line, a small portion was lost during flash floods and landslides of 2012. (Figure-3). Shrub and weed vegetation is predominant towards the valley floor making the area Rangeland. Hence forest cover along the valley floor has lost due to forest degration, agricultural clearings, now covered with weeds and shrub vegetation.

Figure 3:- destroyed (a) forest cover near chiwa village (b) agricultural fields in naugaon.



The total area under agriculture has also reduced from 4.2% in 1996 to 2.64 % in 2016. People generally practice agriculture on very small scale on agricultural terraces along the valley slopes and river channel. They grow coarse food grains like *Koda, Jhangora, Marcha* and seasonal vegetables in the area. Besides this, animal husbandry is also predominant economic activity. The main agricultural terraces were located along both the sides of River channel, which were eroded during events of flash floods in 2012. Hence, the main cause of reduced agriculture in the region was observed to be land sliding zones near agricultural fields, and events of flash floods. (Figure 3). The flash floods of 2012 also destroyed some settlement structure located along the edge of river channel especially near Rawara Village, (Figure-4) but the settlement area decreased slightly from 0.63% to 0.52%.Villages supporting large population are located downstream like Utron, Nald, Gajoli etc. Dasda village has minimum population in the region

with just 41 households. Aghora and Naugaon villages are located in higher altitudinal ranges and support medium population.



Figure: 4:- Settlement Structure Destroyed During Flash Floods In Rawara Village

The Wasteland and land sliding zones in the region have also slightly increased in the recent past from mere 1% to 4% in last 20 years, especially along the steeper unstable slopes. Increased Landslides can be seen along Rishikesh – Gangotri National high way and Sangamchetty road near *Ganghori, Utron, Rawara, Chiwa*. Near Chiwa and Naugaon village's fertile agricultural terraces and forest area was degraded because of Land sliding events making it wasteland. (Figure: 3).

| S. no | LU/LC Classes | Area (Sq. Kms) 1996 | Area ( Sq. Kms.) 2016 | Change 1996-2016 |
|-------|---------------|---------------------|-----------------------|------------------|
| 1     | Forest        | 165                 | 155                   | -10              |
| 2     | River         | 3.5                 | 5.1                   | 1.6              |
| 3     | Snow          | 2                   | 5.9                   | 3.9              |
| 4     | Agriculture   | 8                   | 5                     | -3               |
| 5     | Built up      | 1.2                 | 1                     | -0.2             |
| 6     | Rangeland     | 7.5                 | 10                    | 2.5              |
| 7     | Wasteland     | 1.8                 | 7                     | 5.2              |
|       | Total         | 189                 | 189                   |                  |

 Table 2:- lu/lc change, asiganga watershed.

1996

2016



Figure 5:- lu/lc asiganga watershed,1996-2016.

Wasteland in the region has Primary caused being the slope failure, slope instability, Abandoning of agricultural terraces and slumping. Steady increase was also observed in Rangeland area also. Fallow and abandoned agricultural plots, pasture lands, covered with lantana, and congress grass weeds can be seen in the area.



Figure 6:- Lu/Lc Change Detection In Asiganga Watershed (1996-2016)

Along the high attitudinal region, alpine grassland region have pushed into the forest line, therefore the rangeland area can be seen along the river channel and towards the upper altitudinal regions. It has grown from 3.9% to 5.2% from 1996 to 2016. Flash floods of 2012 led to slumping, and landslides in some region of the valley, which are mainly wasteland located along with abandoned agricultural plots. (Table -2, Figure -5, 6).

### Watershed management practices in the region.

The Asiganga watershed is delineated as micro areal developmental unit under the Uttarakhand watershed management programme, and numerous structural and non-structural programmes are undergoing to manage the watershed. Primary among them is integrated watershed management programme. Integrated watershed management (IWM) is a process which promotes the coordinated management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems (GWP, 2000). Conservation through integrated watershed management is most appropriate in rejuvenating the degraded water resources of the area providing, adequate base for the existing agricultural practices and providing appropriate livelihood to the marginalized communities. Under the process local communities are sensitized regarding the utility and importance of watershed management. Community participation and involvement is seen primary for watershed management activities. Construction of check dams, concrete embankment near untorn village, Nald village, have been started as part of structural watershed management project. Distribution of plant saplings, fruit plants has also been started in the region and community afforestation programmes are taking pace. Although village Naugaon has emerged as an important centre for knowledge and training centres for villages in the recent past with help of Active Ngo's. Initiatives towards transportation and networking for services is also essential for better livelihood in the region.

## **Conclusion:-**

Land use land cover planning of micro watershed not only helps in understanding the morphological conditions of the area, but also important in formulation of area based developmental plans and systematic implementation of watershed management practices. Since its evident that forest have been degraded over the past years and agricultural practices are also on the decline. Villages like *Bhakoli* and *Dhandankala* have prospects of mixed farming, yet to be explored. Similarly linkages in terms of market facilities are also limited to downstream villages. Participatory afforestation and genuine boost in implementation of alternative agricultural practices through commercial farming is needed to restore the degrading ecology and village economy of the region.

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