Spatio-Temporal Land Use/Land Cover Dynamics In Ningli Watershed Of Jehlum Catchment In Kashmir Valley, North Western Himalaya Using Remote Sensing & Gis

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Abstract: ***Accurate measurement of landuse/landcover patterns are required for evaluations, development and managing of natural resources. An attempt was carried out to analyze the change detection patterns of landuse/landcover in Ningli watershed of Kashmir Basin. The study employed supervised classification-maximum likelihood algorithm, using multispectral satellite data, to carry out the landuse/landcover changes from 1992 to 2017. Eight landuse/landcover classes were demarcated during classification process. The results revealed that horticulture sector showed a prompt increase from 31.24 percent to 46.40 percent i.e., 15.16 percent increase between 1992 and 2017 while agriculture sector showedrapid decrease from 25.31 percent in 1992 to about 10.28 percent in 2017 i.e., 15.03 percent decrease between 1992 to 2017.Similarly settlement increased 3.02 percent during the investigation period. There was not much significant changes in spatial extent of forests. The overall scenario of the study area reveals serious risk to watershed resourcesdue to landuse / landcover changes. Hence proper mitigation measures are required for better management and development of the study area.***

Key words: Land-use and land-cover, Remote sensing, GIS, Ningli Watershed, Change detection.

I. INTRODUCTION

Land is the source of the materials on the earth, required for human development and on which all human actions are carried out. People put the land resources in use, differs with the purpose it serves gives rise to the term “Landuse”. Land used for any purpose refers to the term landuse whereas landcover is the bio-physical state of land [1], [2]. The Landuse/cover are frequently used interchangeably as the two terms are of different in terminology [3]. It is essential to includethe historical reconstruction of past change transformations and prediction of future trends, for understanding the role of landused in regional and global environmental changes [4]. Remote sensing applications and Geographical Information Systems (GIS) are widely used in natural resources and land management processes. Remote sensing techniques and GIS tools have founded to be useful for evaluating the spatiotemporal changes of LU/LC [5], [6]. With the techniques and methods of remote sensing, it has become an approach to evaluate the spatio-temporal changes of land with better accuracy and in less time [7].Multi-temporal satellite data provide the ability for depicting landuse /landcover changes of any area. key environment information for many scientific resource management and Landuse/Landcover information are essential for planning and managing activities on the surface of earth,[8] because it constitutes policy purposes, as well as for a range of human activities. There stands out a large force due to human-induced actions as a cause for landuse/landcover changes [9]. For the basis of land classification and management, precise information of Landuse/Landcover is essential [10]. Landcover of an area is affected by landuse fluctuations and landuse is affected by landcover changes. Variations in landcover changes created by landuse do not essentially suggest that there is degradation of the land. However, shifting in landuse results changes in landcover and affects biodiversity, water and other practices that standout collectively to affect biosphere and climate [11]. For appropriate land management and decision improvement, it is necessary to understand land patterns, changes and connections between human activities and natural phenomenon. Change detection is the process of determining and noticing the difference in a body or phenomenon by imagining at difference times [12]. The changes in the interactions between biophysical and socio-economic processes and factors give rise to the changes in landcover in a particular area of land [13].

Watershed characterization is an important feature for development and implementation of the watershed management program. For the conservation of precious land resources, watersheds have been known as a best planning unit [14]. The landuse pattern changes due to development of watershed are affected by landuse changes resultant in increase of surface runoff, transfer of pollutants and reduced groundwater recharge [15] Hence, it is essential of the specific watershed to evaluate landuse patterns and changes for planning and management and landuse of the particular watershed. Watershed development refers to the conservation, utilization and regeneration of the resources and to bring about an optimal balance in the ecospecies between natural resources and living beings in a specific watershed. Watershed approach, is applied in the various development program like in soil and water management, soil erosion control, flood control, river valley projects, and resource dynamics etc. An essential part of basin is studied for characterize watershed demarcation with the objective of choosing watersheds to undertake soil and water conservation measures by means of remote sensing and GIS techniques.

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II. OBJECTIVES

The research work was carried out keeping the above discussed points in consideration with the following two objectives:-

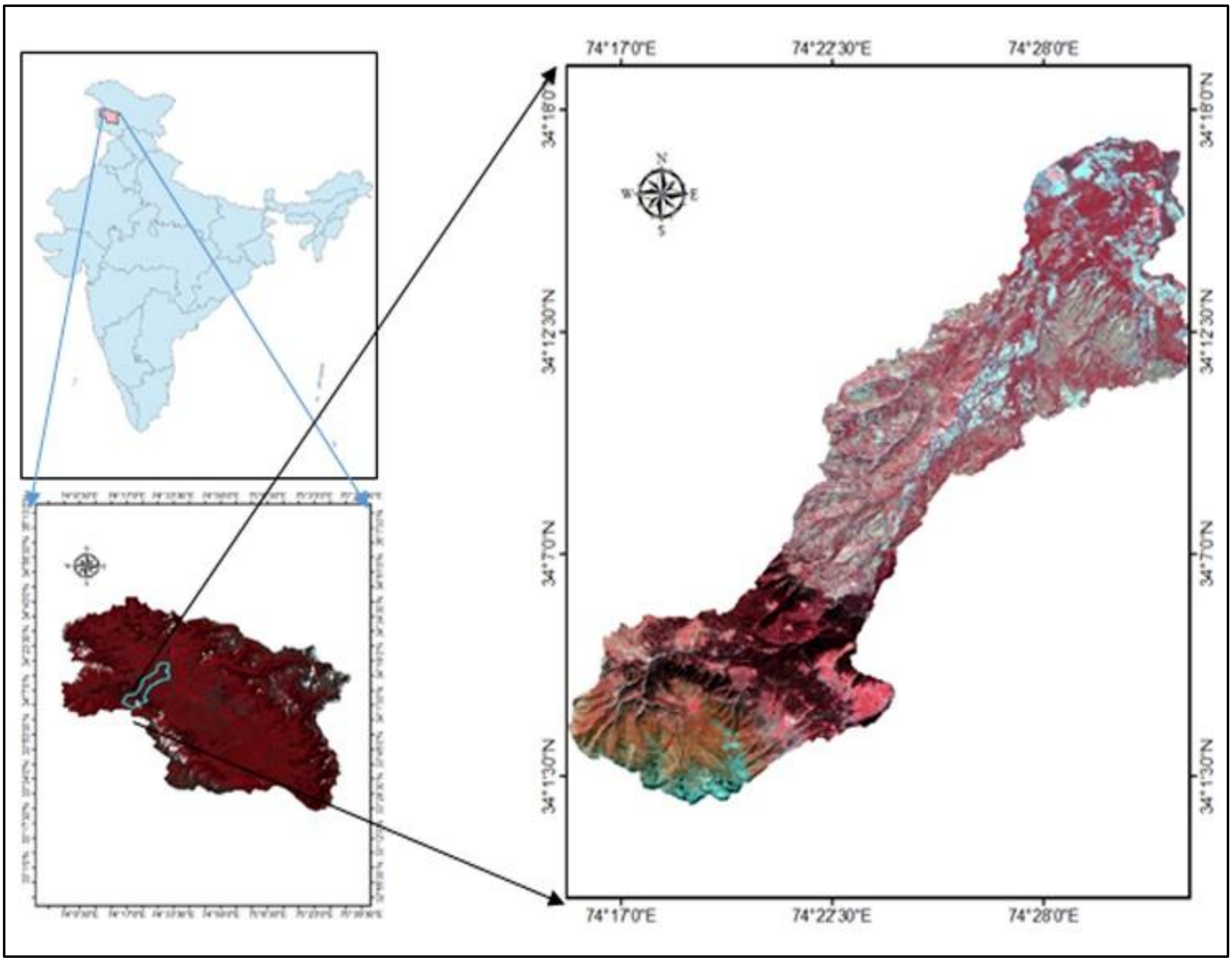
a. To analyze the change in Landuse/Landcover (LULC) of the study area.
b. Assess the magnitude and nature and analyze the possible reasons of the Landuse/landcover change.

III. MATERIALS AND METHODS

A. Study Area

The Ningli watershed located in the Baramulla district of Kashmir valley has been taken as study area for analysis. Geographically the Ningli Watershed lies between 34^{o} 00' 16" to 34^{o} 01' 78" north latitude and 74^{o} 15' 22" to 74^{o} 31' 5" east. The location map of the study area is shown in Fig. 1. The Ningli watershed spreads over the slopes of the North Kashmir, with 23180.394 hectares of catchment area. TheNingli Nallah is having its origin in Allapatri Naag situated 8 Km from Gulmarg. Melting snow and ice on Affarwat mountains also contributes to the flow of Ningli Nallah. It flows in the north-east direction into the valley, passes through village's kalantra, wagoora and shrakwara and finally joins the Jhelum River near Sopore. This Nallah irrigates most areas of Kalantra, Muqam, Darwa, Wagoora etc and is considered as a backbone for agricultural activities in the whole area and and also supplies drinking water to many areas of Sopore, Kreeri, Sangrama etc. It is also rich in sources of supplying boulders, sand, pebbles and cobbles. Besides this, the area is of particular interest because of its famed picnic spots, wide lush green meadows, water fall (shranz fall) and natural resources. On the upper region (Shranz Fall) of the Ningli Nallah is having potential for construction of Mini dam for hydroelectric generation because of higher head. The stream carries large loads of debris mostly in spring season results in soil erosion and is a serious problem in the area. The area is dominated by rocks of Proterozoic (Salkhalas), overlain by Permo-carbaniferous Formation (Panjal Traps), which in turn are overlain by Neogene-Quaternary deposits (Karewas). Thick mantle layer of recent alluvium covers the whole sequence, which has been carried down the slope by Ningle Nala in Fig. 2.

Fig. 1: Location map of the study area.



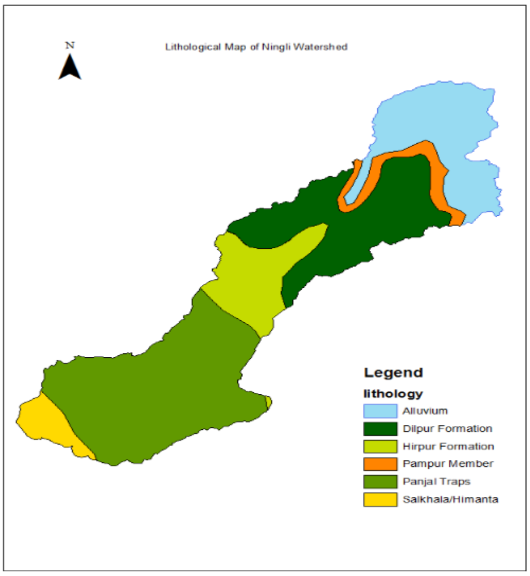


Fig. 2: Geological Map of the study area.

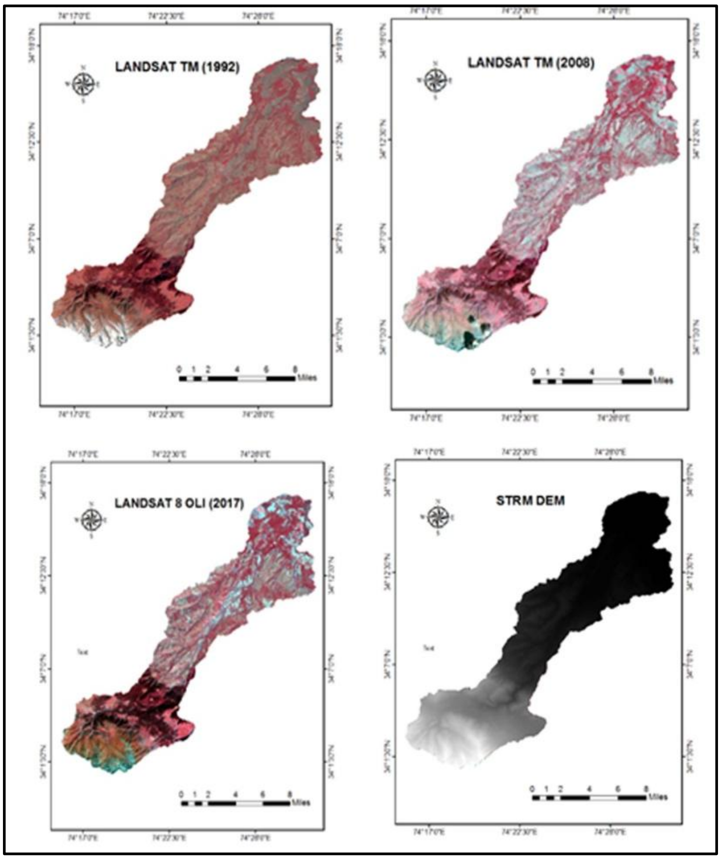


Fig.3: Landsat images (1992, 2008 and 2017) and DEM of the study area.

C. Preprocessing of Satellite Imagery

The data were extracted and imported in ERDAS Imagine 2014 and the process of layer stacking was done to create false colour composite (FCC). Different contrast enhancements viz; spatial filtering, contrast stretching, convolution etc were used for all the satellite imageries of the study area for analysis to enhance the interpretability of the images and to generate new image in order to have more information that can be visually interpreted from that data. All the images were projected into the world geodetic system 1984 (WGS84) and the universal transverse Mercator (UTM) coordinate system.

B. Data Acquisition and collection

The multitemporal, multi spectral satellite imagery and Shuttle Radar Topographic Mission (SRTM) DEM were analyzed for present study. The SRTM (30m) acquired from http://srtm.usgs.gov/data/obtaining.html, Landsat TM 1992, 2008, Landsat 8 OLI 2017 acquired from (http://earthexplorer.usgs.gov) Fig. 3, Table 1 and global Landcover facility (GLCF) acquired from(http://glcfapp.glcf.umd.edu:8080/esdi/).

Table 1: Summary of the characteristics of the satellite images used.

Satellite series	Acquisition Date	Sensor	Band/Colour	Resolution (m)	Source
Landsat-5	1992 (October)	TM	Multispectral	30	USGS, Glovis
Landsat-5	2008 (October)	TM	Multispectral	30	USGS, Glovis
Landsat-8 (OLI)	2017 (October)	OLI	Multispectral	30	USGS, Glovis

D. Methodology

The watershed was delineated using numerous Arc Hydro processes done on DEM to obtain several data sets necessary for describing the drainage system of the area. Various raster analysis were done to create data on flow direction, stream segmentation, flow accumulation and finally watershed outlining.

The images were visually interpreted, using the elements of visual image interpretation. At least two time period data sets are involved for detection of landuse and landcover changes [16]. In this case, three time period data sets viz Landsat TM (1992), Landsat TM (2008) and Landsat 8 OLI (2017) were assessed for the proposed research. The data were received in dry season to minimize seasonal effects viz; free from fresh snow fall and free from clouds [17], [18].After image enhancement and processing, the images were classified with respect to spatial distribution of identifiable earth surface features. All the pixels of the image were categorized into different landuse/landcover classes. The Supervised maximum livelihood classification method was performed to classify the Landsat TM (1992), (2008) and Landsat 8 OLI (2017) into eight LULC classes by using ERDAS IMAGINE 2014. The numerical data were collected from training sites on the spectral response patterns and classification was done by comparing the unknown pixels to the spectral pattern of the training sites. Finally, the results were presented in the form of maps, tables of area data and digital files.

IV. RESULTS AND DISCUSSION

A. Classification of Landuse and Landcover image analysis

The classification of landuse and landcover images analyses were done for the Landsat TM (1992), Landsat (2008) and Landsat 8 OLI (2017), using the supervised maximum likelihood classification algorithm. The study area was extracted from the Landsat images. Various signatures were created on the images and were classified into eight LULC classes, such as agriculturalland, barren land, horticulture, snow, grasslands, settlements, forests and water body.

To determine the quality of information, the classification accuracy assessment of 1992, 2008 and 2017 classified images was done. Based on ground truth data and visual interpretation using 150 points, the accuracy assessment was carried out.The error matrices method was carried out statistically for calculating the accuracy assessment of the results obtained from classified images. The accuracy assessment of the results obtained from land-use/land-cover classified images showed overall accuracy was 87%, for 1992 Lansat image, 89.5% for Landsat 2008 and was 91.3% for Landsat 2017.

B. Analysis of LULC status for the year of 1992 Landsat image

From the LU/LC classification map of the year 1992 Fig.4 and from the results of statistics of landuse landcover classes Table 2**,** the forest area in terms of percentage was 20.47% of the total area of Ningli watershed. Similarly the horticulture land accounts for 31.24%, agriculture land 25.31% of the total area of watershed. Settlements comprises for 4.17% of land. The barren land, water bodies, snow and grass lands holds 4.35%, 3.14%, 4.70% and 6.62% respectively. In terms of hectare the forests area covers about 4757.290 hectares of land, horticulture land 7259.555 ha, agriculture land 5881.117 ha, barren land 1009.787 ha. The area under water body, settlements, snow and grass lands in terms of hectares are 728.913, 968.039, 1091.094 and 1538.968 respectively Fig.5. From the results it suggests that the horticulture sector is the dominant feature in the watershed of the study area.

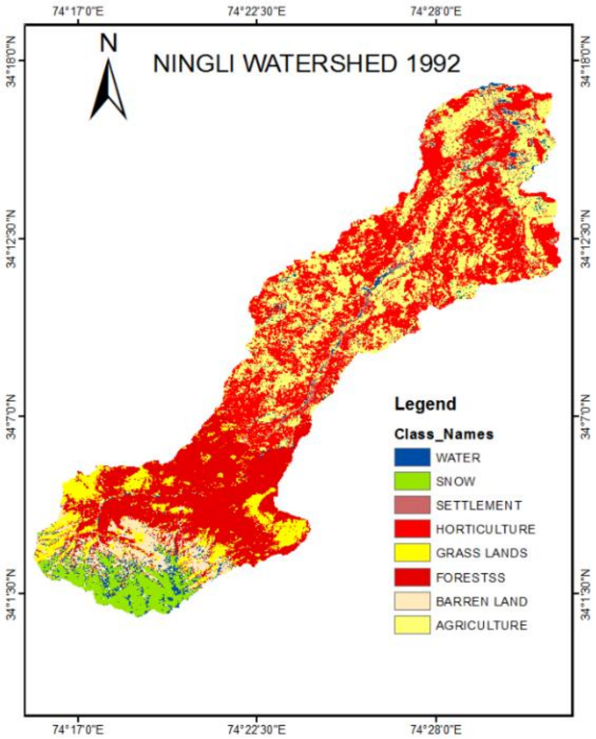


Fig. 4: Land-use/land-cover map (1992)

Table showing area of different landcover classes-1992			
S.No.	Class Names	Area (Hectares)	Area (%)
01	Forests	4757.290	20.47
02	Horticulture	7259.555	31.24
03	Agriculture	5881.117	25.31
04	Barren Land	1009.787	4.35
05	Water	728.913	3.14
06	Snow	1091.094	4.70
07	Settlement	968.039	4.17
08	Grass lands	1538.968	6.62
Total	08	23238.76	100

Table 2: Land-use/land-cover status (1992)

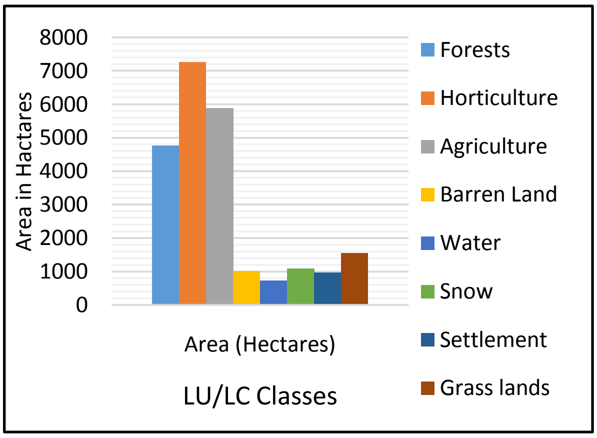


Fig. 5: Area under different LU/LC classes-1992

C. Analysis of LULC status for the year of 2008 Landsat image

In the year 2008 landsat image Fig.6 and from the results of statistics of landuse landcover classes of Landsat image Table 3 shows rapid increases in horticulture area. According to the statistics calculation as shown in Fig. 6, the forests land consists 19.93% covering an area of 4631.07 ha of land. Horticulture accounts for 10154.6 hectares of land which is about 19.93% of the total area. The barren land holds an area of 1598.13 hectares which accounts for 6.88% the watershed area. The area under water bodies is 426.99hactares and it accounts for 1.84% of the total land. Settlement a vital landuse class; occupies about 1109.83 hectares which is about 4.78%. The snow and grass lands occupies about 643.57 and 1332.03 hectares of land which accounts for 2.77 and5.73 respectively of the total area Fig. 7.

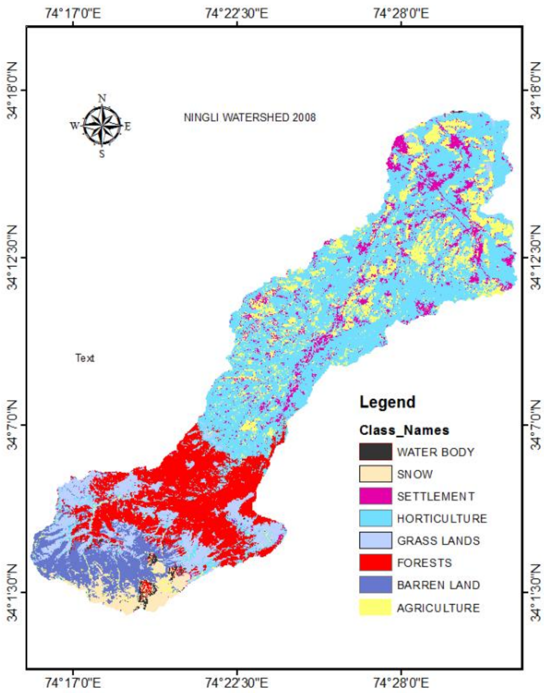
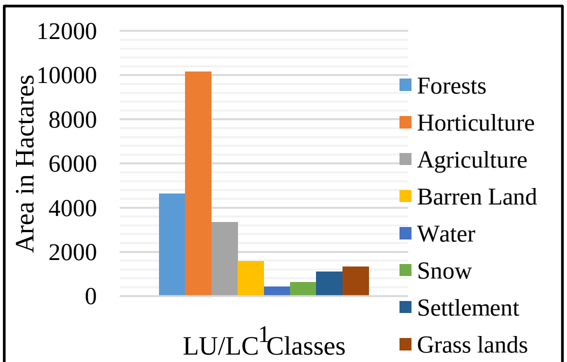


Fig. 6: Land-use/land-cover map (2008)

Table showing area of different landcover classes-2008			
S.No.	Class Names	Area (Hectares)	Area (%)
01	Forests	4631.07	19.93
02	Horticulture	10154.6	43.70
03	Agriculture	3337.89	14.37
04	Barren Land	1598.13	6.88
05	Water	426.99	1.84
06	Snow	643.57	2.77
07	Settlement	1109.83	4.78
08	Grass lands	1332.03	5.73
Total	08	23234.11	100

Table 3:Land-use/land-cover status (2008)

Fig 7: Area under different LU/LC classes-2008



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D. Analysis of *LULC* status for the year of 2017 Landsat image

It has been observed from the LU/LC supervised classification map of the area for the year 2017 Fig. 8 and from statistical results Table 4, that there is a rapid increase in horticulture and settlement areas and a rapid decrease in agriculture area. The horticulture and settlement classes covers an area of about 10783.156 and 1671.964 hectares of land which accounts for 46.40% and 7.19% respectively of the total area and agriculture landcovers about 2386.488 hectares which accounts for 10.28% of the total land. The forests land consists of 19.74% covering an area of 4586.158 hectares of land. The area under water class is 482.219 hectares and it accounts for 2.08% of the total land. The barren land holds an area of 1793.592 hectares which accounts for 7.72% of the watershed area. Snow and grass lands occupies about 428.125 and 1103.218 hectares of land which accounts for 1.84 and 4.75 respectively of the total area. Area covered by different landuse and landcover classes of the classified image 2017 are shown in Fig. 9.

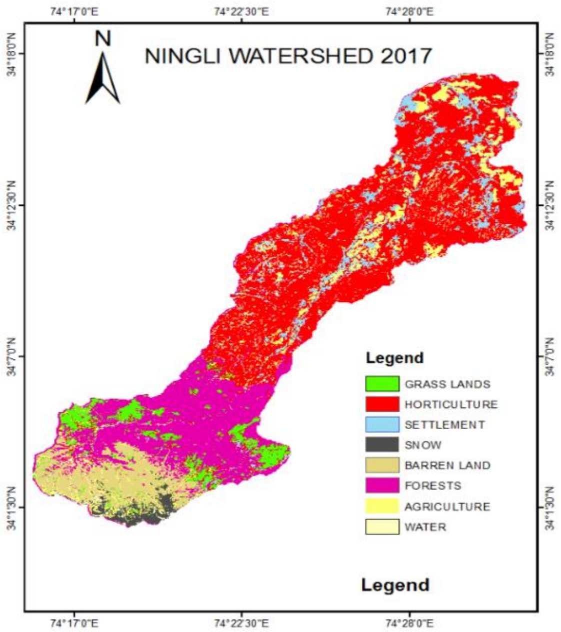

Fig. 8: Land-use/land-cover map (2017)

Table 4:Land-use/land-cover status (2017)

Table showing area of different landcover classes-2017			
S.No.	Class Names	Area (Hectares)	Area (%)
01	Forests	4586.158	19.74
02	Horticulture	10783.156	46.40
03	Agriculture	2386.488	10.28
04	Barren Land	1793.592	7.72
05	Water	482.219	2.08
06	Snow	428.125	1.84
07	Settlement	1671.964	7.19
08	Grass lands	1103.218	4.75
Total	08	23234.92	100

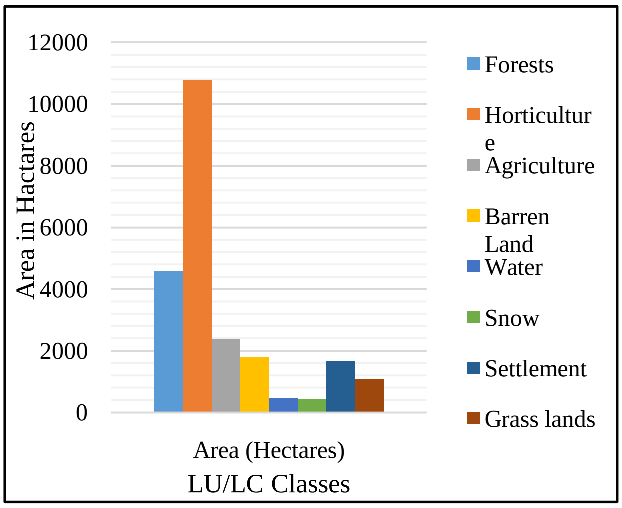

Fig. 9: Area under different LU/LC classes-2017

E. Change detection analysis of Landsat 1992, landsat 2008 and landsat 2017

The catchment area has been classified into eight landuse and landcover categories using maximum livelihood supervised classification. In order to analyze the change detection phenomenon of landuse and landcover from 1992 till 2017, it is very necessary to compare the statistics of different landuse and landcover categories from 1992 and 2017. The catchment area of river Ningli has undergone various changes in the landuse and landcover pattern as depicted from Fig. 10. The overall change detection comparison between period from 1992 landsat image to 2008 landsat image and period from 2008 landsat image to 2017 landsat image is shown in the Table 5.

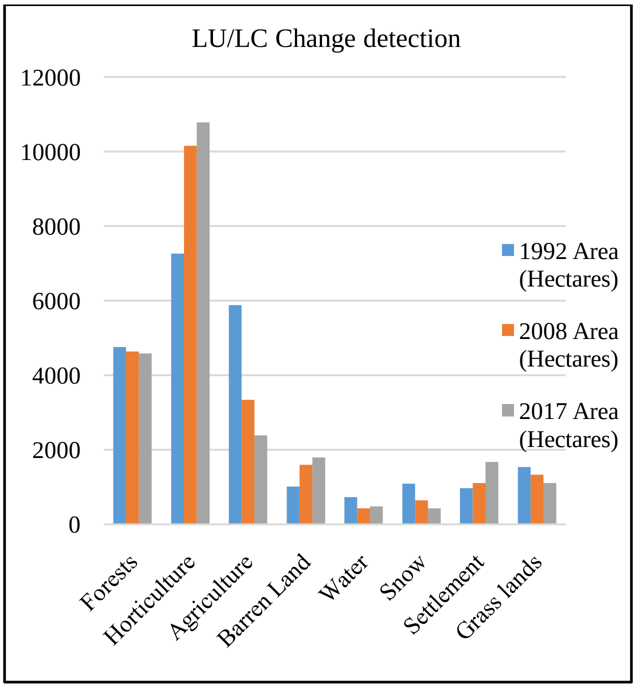

Fig. 10: Bar graph showing change in area (Ha) of different LU/LC for year 1992, 2008 and 2017

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Class Names	1992 Area (Ha)	Area (%)	2008 Area (Ha)	Area (%)	Area 2017 (Hectares)	Area (%)	Total Area (Change)	Total (%) (Change)
Forests	4757.290	20.47	4631.07	19.93	4586.158	19.74	-171.132	-0.73
Horticulture	7259.555	31.24	10154.6	43.70	10783.156	46.40	3523.6	15.16
Agriculture	5881.117	25.31	3337.89	14.37	2386.488	10.28	-3494.629	-15.03
Barren Land	1009.787	4.35	1598.13	6.88	1793.592	7.72	783.805	3.37
Water	728.913	3.14	426.99	1.84	482.219	2.08	-246.694	-1.06
Snow	1091.094	4.70	643.57	2.77	428.125	1.84	-662.969	-2.86
Settlement	968.039	4.17	1109.83	4.78	1671.964	7.19	703.925	3.02
Grass lands	1538.968	6.62	1332.03	5.73	1103.218	4.75	-435.75	-1.87
08	23238.76	100	23234.11	100	23234.92	100	0	0

Table 5: Comparing statistics of LU/ LC of year 1992, 2008 and 2017

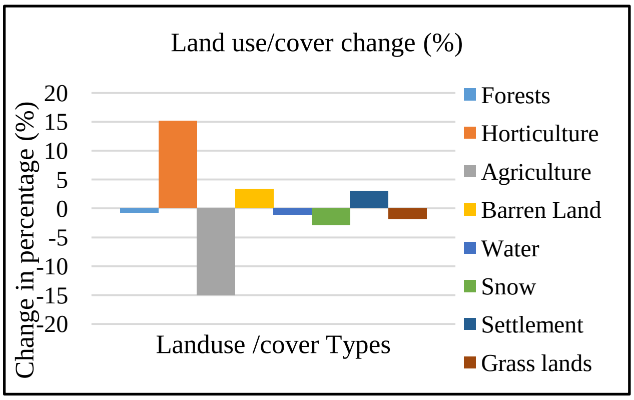

Fig. 11: Bar graph showing change in area (Ha) of different LU/LC for year 1992, 2008 and 2017

V. DISCUSSION

Landuse and landcover of an area is important component in understanding the interactions between the human activities and environment. Based on the results of statistics from classified images, it has been noticed that Landuse/ landcover pattern of the study area as highly dynamic and shows losses as well as gains in some landuse classes. A lot of changes in the landuse/landcover patterns have been noticed shown in Fig. 10 in Ningli watershed. Major changes have been noticed in horticulture, agriculture, barren, and settlements sectors. The overall change in the horticulture area during the periods from 1992-2008 and from 2008-2017, has increased by 15.16 percent (3523.6 ha). Similarly the agriculture has decreased by about 15.03 percent (3494.629 ha) during the same period. The settlement and barren land have also shown gains in their areas about 3.02% (703.925 ha) and 3.37% (783.805 ha) respectively from the period 1992 to 2017 Fig. 11. From output maps, it is easily inferred that most of the agriculture land has been shifted into horticulture land also some portion of forest land has been converted into horticulture land. The implication of decrease in the rate of changing agriculture sector into agriculture sector is because of that horticulture offers much opportunities in the areas where cropping is not profitable. As the nallah is considered as a backbone for the agricultural activities in the area, but from the past few decades, it has been observed water scarcity in the area especially in the needy hours of ripening of crops. It is also considered a reason behind the shifting of agriculture land into horticulture land. The Horticulture in the area provides much opportunities for the source of income and also for providing protection to the degraded lands in the area. But from the other side it could result in increase in water pollution and decrease in agriculture results decrease in food production in the area. The result can be finished by saying that the results of the current study are true or at least near to facts, we would be able to predict changes and impact of various changes in landuse and landcover by using GIS Modelling.

VI. CONCLUSION

The statistics of different LU/ LC classes generated from 1992, 2008 and 2017 satellite images were compared with each other for analysis of change detection phenomenon in the catchment of the Nallah Ningli. Increase in horticulture land was concluded to come mostly from agriculture land where as decrease in agriculture land was accounted to be 3884.27 Ha. The increase in settlements was compensated by conversion of some horticulture land, agriculture land and pasture land.

Based on the results of statistics obtained by LU/LC classified images to reach on the specific objectives, it is concluded that the landcover/landuse practices in the study area have changed significantly in 25 years. The random increase of settlement and horticulture and decrease of agriculture area in the watershed is mainly concerned due to lack of proper management and landuse planning in the study area. The decline in the trend of runoff flow in peak hours of season in Nallah Ningli, is also considered one of the main reason behind the shift of agriculture land into horticulture land.

It is concluded that remote sensing techniques and GIS tools provide an outstanding platform from which accurate information on Landuse changes and patterns can be obtained and that the catchment of Nallah Ninglihas experienced various changes in landuse in between 1992, 2008 and 2017. So, efforts should be made to regularly update available data in order to have further development and proper management of natural resources of the study area.

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