Analyzing Land Use/ Land Cover Change Using Remote Sensing and GIS Techniques in Pohru Watershed of Kashmir Valley

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Abstract
Land use and land cover changes have been among the most important perceptible changes taking place around us and this change is the outcome of natural and socio-economic factors. Increased demand, or pressure on land resources, shows up a declining crop production, degradation of land quality and quantity, and competition for land. This study analyses changes in landuse/ cover in the Pohru watershed of Kashmir Valley. It has an area of about 1, 83, 474 hectares and is characterized by stupendous growth in population in the last few decades. The multi-temporal land use/ land cover mapping and change detection analysis was carried out using Land sat TM (1992), IRS ID LISS III (2002) and IRS P6 LISS III (2012) with adequate ground validation. The results revealed that during the last two decades, a major change has occurred in dense forest class with decrease of 3.79 percent. Horticulture have registered a positive growth of 3.05 percent. Within two decades from 1992- 2012, a decrease of 1.52 percent change has occurred in the agriculture category.
Keywords: Land cover changes, remote sensing, Pohru Watershed, Kashmir.

Introduction

Land is a basic natural resource for mankind. The future of the nation depends largely on the effective utilization, management and development of resources in an integrated and comprehensive manner (Ahmed and Mir, 2014). Over the span of antiquity, man has drawn most of his sustenance and much of his fuel, clothing, and shelter from land. Man fulfills his needs by putting the available land to different uses. Nature has provided human beings with plentiful resources where he benefits himself with minimum efforts.

Land use and land cover are distinct yet closely concomitant characteristics of the earth's surface. Landuse means the use to which the land is being put or the utilization of land devoted to human activities (Mir and Ahmed, 2014). Land cover classes differ from land use classes for landscape dominance and processes (Andrea and Maria, 2016). The landuse/cover change analysis has become a central component in current strategies for managing and monitoring environmental changes. Human activities play an important role/part in virtually all natural systems and act as a force for change in the environment at local, regional, and even global scales. In fact, humans are increasingly being recognized as a dominant force in a global environmental change (Turner 2001, Lambin *et al.*, 1999). Over the past 200-300 years, humans have been dominant drivers of landscape transformations (Vitousek *et al.*, 1997).

Landuse and land cover changes, apart from changing the physical dimension of spatial extent of the landuse and land cover classes, also influence many of the secondary processes which lead to the eventual degradation of the ecosystem of the earth (Dregne and Chow, 1992). Rapid and extensive modification of landuse/cover due to

accelerated human activities has been a major cause of global environmental change in the past three decades (Ahmed and Rashid. 2009). First and foremost, the impact of landuse and land cover changes is the reduction of vegetation cover. The lush green forests which dotted the landscape have started dwindling because of the unprecedented anthropogenic impact. The loss of vegetation cover in turn leads to many other hazardous effects on the environment. Land use / land cover change in mountainous areas has wider ramifications. The ecosystem is fragile and is susceptible to the negative impacts of this change.

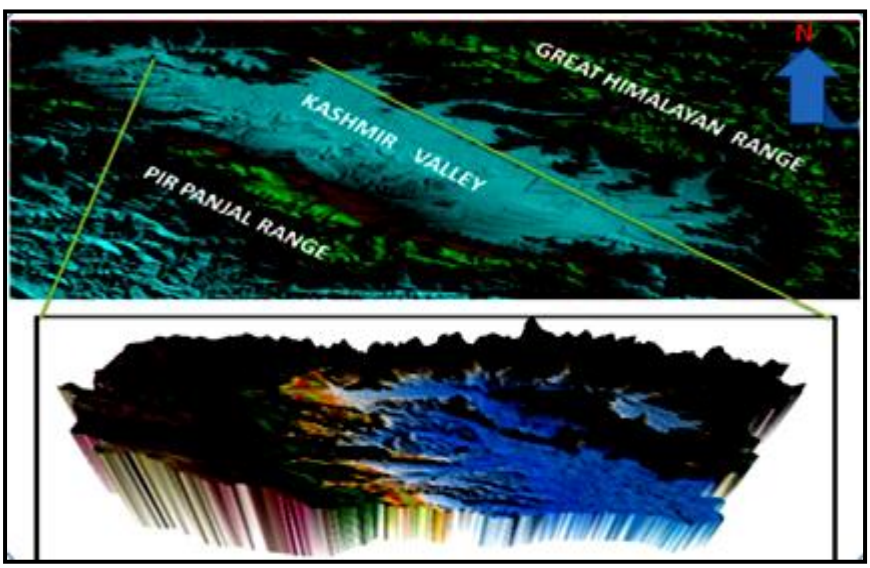
Landuse and land cover information is important for several planning and management activities concerned with the surface of the earth because it constitutes key environmental information for many scientific resource management and policy purposes. An accurate knowledge of landuse/cover features help in better understanding of land classification and management procedures.

GIS technology provides a flexible environment for entering, analyzing, and displaying digital data from various sources necessary for different feature identification, change detection, and database development. (Weng, 2001).

An integrated approach of remote sensing (RS) and geographic information system (GIS) has been widely applied and has been recognized as a powerful and effective tool in detecting land use and land cover change dynamics. (Ehlers *et al.,* 1990, Treitz *et al.,* 1992).

Study Area

The Pohru catchment lies in the north west of the Kashmir Valley between 34^0 15´ and 34^0 42´ N latitude and 73^0 54´ and 74^0 42´ E Longitude (Raza *et al.,* 1987) and is covered by Survey of India Toposheets (SOI) of 1971 at 1:50,000 scale bearing no. 43F/14, 43F/15, 43J/02, 43J/03, 43J/04, 43J/06, 43J/07, 43J/10, and 43J/11. Pohru is an oval shaped catchment, with a perimeter of nearly 200 kms and extends over an area of 1,83,474 ha. (AIS&LUS, 2002). The catchment area falls within administrative boundries of Handwara and Kupwara tehsils of Kupwara district, and Sopore and Baramulla tehsils of district Baramulla of Jammu and Kashmir state **(Figure 1)**. Pohru is the last major tributary of river Jhelum, the northern and western part of the area consists of mountain ranges, rising up to an elevation of about 4500 mts., above sea level.



Source: ASTER DEM (30mts.)

Figure 1. **Location map of Pohru catchment, J&K**

The area is bounded on the northern and north western sides by the main water parting ridge between Kishenganga and Jhelum basin, the eastern boundary is marked by Wular Lake while on southern side it is bounded by small ridges separating south flowing tributaries of Jhelum and east flowing tributaries of Pohru.

Materials and Methods

The methodology in this paper was multi-tier. The satellite data for three time periods viz, 1992, 2002, and 2012 were used for this study. The satellite data of Landsat TM at 30 mts. resolution for 1992, IRS 1DLISS III (23.5 mts.) for 2002, and Resource Sat P6 LISS III data for 2012 were used. The Visual/ Digital interpretation techniques were employed to generate many different LU/LC classes. The study area was categorized into seven LU/LC classes. Pre-field and post field exercises were carried out for validation of mapping units. Final maps were prepaid for all the three time periods. Overlay analysis was carried out for change detection. Statistical data was generated which was used for subsequent analysis.

Results and Discussions

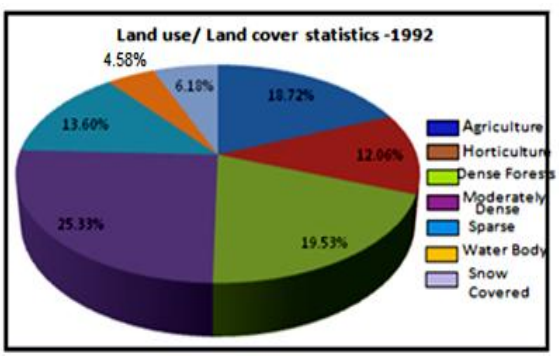
Landuse/cover status (1992)

The Landuse/cover statistics of 1992 in the Pohru catchment is given in **Table 1 and Figure 2.** The perusal of this table reveals that forests in aggregate i,e. dense, moderate and sparse were the major class with 58.46 percent followed by agriculture with 18.72 percent area. Horticulture with 12.06 percent area was the other major class.

Table 1: Landuse/cover of Pohru catchment (1992)

Landuse/cover Category	Area in ha.	Percentage of the total area
Agriculture	34362	18.72
Horticulture	22137.4	12.06
Dense Forests	35838.08	19.53
Moderately Dense Forests	46488.5	25.33
Sparse Forests	24962.66	13.60
Water Body	8342.12	4.58
Snow Covered	11342.92	6.18
Total	**183474**	**100**

Source: Land Sat TM (1992)



Source: Land Sat TM (1992)

Figure 2: Land use / land cover statistics, 1992

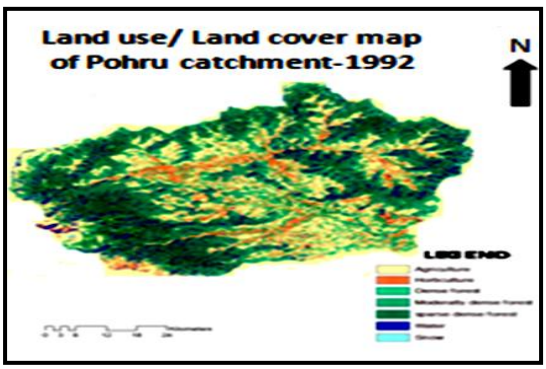
Landuse/cover of Pohru catchment (2002)

Again a total of seven landuse/cover classes were generated wherein, forests in aggregate were the major class, followed by agriculture land with 18.85 percent of the study area. Horticulture covered 13.16 percent of the total area. A total of 4.34 percent of the study area was occupied by the water bodies. A detailed description of each of the landuse classes is given in the **Table 2 and Figure 3 &** 4.

Table 2: Landuse/cover of Pohru catchment (2002)

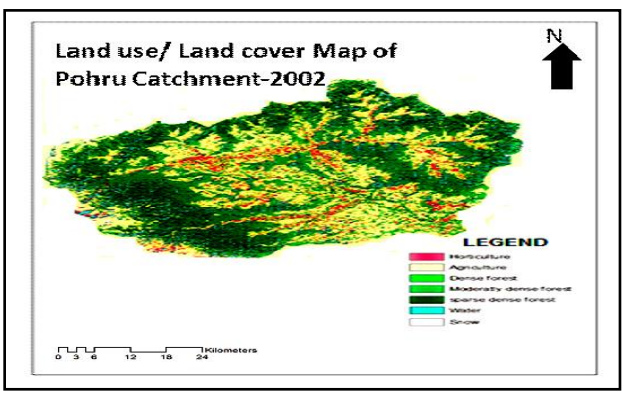
Landuse/cover Category	Area in ha.	Percentage of the total area
Agriculture	34599	18.85
Horticulture	24148.5	13.16
Dense Forests	29221.3	15.87
Moderately Dense Forests	50667.1	27.61
Sparse Forests	26220	14.29
Water Body	7816.37	4.34
Snow Covered	10801.33	5.88
Total	**183474**	**100**

Source: IRS 1D LISS III (2002)



Source: Landsat TM (1992)

Figure 3. Landuse/cover map (1992)



Source: IRS 1D LISS III (2002)

Figure 4: Landuse/cover map (2002)

Landuse/cover Change Detection (1992-2002)

The Landuse/cover change that has occurred in the study area from 1992 to 2002 is shown in the **Table 3.** The data reveals that the highest change has occurred in the dense forest cover class. It has declined from the total area of 35838.08 ha. in 1992 to 29221.3 ha. in 2002, showing a decrease of 3.66 percent. Agriculture in the study area is witnessing an increasing trend as the total area under it in 1992 was 34362 ha. and by 2002 it had increased to 34599 ha. The total area of 237 ha. has been added to agriculture category.

Table 3: Landuse/cover change-Pohru catchment (1992-2002)

Landuse/cover Category	**Area in ha. 1992 (%age)**	**Area in ha. 2002 (%age)**	**Change in ha. 1992-2002 (%age)**
Agriculture	34362 (18.72)	34599 (18.85)	237 (0.13)
Horticulture	22137.4 (12.06)	24148.5 (13.16)	2011.1 (1.1)
Dense Forests	35838.08 (19.53)	29221.3 (15.87)	-6616.78 (-3.66)
Moderately Dense Forests	46488.5 (25.33)	50667.1 (27.61)	4178.6 (2.28)
Sparse Forests	24962.66 (13.60)	26220 (14.29)	1257.34 (0.69)
Water Body	8342.12 (4.58)	7816.37 (4.34)	-525.75 (-0.24)
Snow Covered	11342.92 (6.18)	10801.33 (5.88)	-541.59 (-0.3)
Total	**183474 (100)**	**183474 (100)**	**15368.16 (8.4)**

Source: 1) Landsat TM (1992), 2) IRS 1D LISS III (2002).

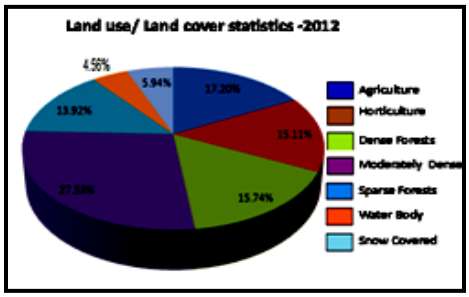
Landuse/cover of Pohru catchment (2012)

The Landuse/cover statistics presented in **Table 4** for year 2012 reveals that forests in aggregate were the major class followed by the agriculture with 17.20 percent area. Horticulture covers 15.11 percent area of the Pohru Catchment. Water body and snow covered were the other major land cover classes comprising of 4.56 and 5.94 percent respectively **(Figure 5 & 6).**

Table 4: Landuse/cover-Pohru catchment (2012)

Landuse/cover Category	**Area in ha.**	**Percentage of the total area**
Agriculture	31565.09	17.20
Horticulture	27734.01	15.11
Dense Forests	28881.06	15.74
Moderately Dense Forests	50518	27.53
Sparse Forests	25541	13.92
Water Body	8335.7	4.56
Snow Covered	10899.14	5.94
Total	**183474**	**100**

Source: IRS P6 LISS III (2012)



Source: IRS P6 LISS III (2012)

Figure 5. Land use/ Land cover Statics-2002

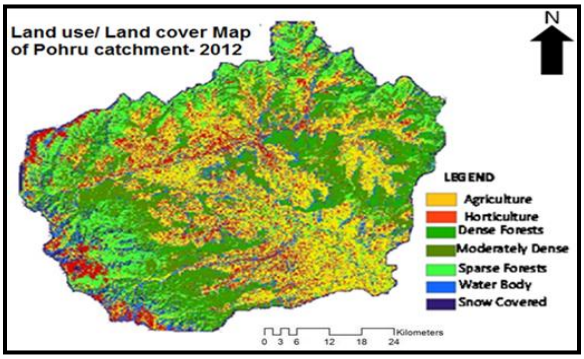


Figure 6: Landuse/cover map (2012)

Landuse/cover change-Pohru catchment (2002-2012)

The **Table 5** depicts the landuse/covers change from 2002 to 2012 in the study area. The figures in the table reveal that the highest change has occurred in the horticulture as such it has increased from 13.16 percent in 2002 to 15.11 percent in 2012, thus registering an increase of 1.95 percent within a period of one decade.

Agriculture occupied 18.85 percent of the study area in 2002, which has come down to a total of 17.20 percent in 2012 showing a net decrease of 1.65 percent. Water body and snow covered area had witnessed an increase of 0.22 and 0.06 percent respectively.

Table 5. Landuse/cover change-Pohru catchment (2002-2012)

Landuse/cover Category	**Area in ha. (2002) (%age)**	**Area in ha. (2012) (%age)**	**Change in ha. (%age)**
Agriculture	34599 (18.85)	31565.09 (17.20)	-3033.91 (-1.65)
Horticulture	24148.5 (13.16)	27734.01 (15.11)	3585.51 (1.95)
Dense Forests	29221.3 (15.87)	28881.06 (15.74)	-340.24 (0.13)
Moderately Dense Forests	50667.1 (27.61)	50518 (27.53)	-149.1 (-0.08)
Sparse Forests	26220 (14.29)	25541 (13.92)	-679 (-0.37)
Water Body	7816.37 (4.34)	8335.7 (4.56)	519.33 (0.22)
Snow Covered	10801.33 (5.88)	10899.14 (5.94)	97.81 (0.06)
Total	**183474 (100)**	**183474 (100)**	**8404.9 (4.46)**

Source: IRS 1D LISS III (2002), 2) IRS P6 LIS III (2012)

Landuse/cover change-Pohru catchment (1992-2012)

From 1992 to 2012, a major change has occurred in dense forests with decrease of 3.79 percent. Decrease of forest cover means more and more degradation of environment. Deforestation, horticulture expansion and increasing build up are putting tremendous pressure on the forest resources of the study area. Horticulture have registered a positive growth of 3.05 percent. An increase of 2.2 percent has occurred in the moderately dense forests category. Snow cover class also depicts negative change from the last two decades as the precipitation and temperature regime have shown a discernable change not only in the study area but also in the whole Himalayan regions. Within two decades from 1992 to 2012, a decrease of 1.52 percent has also occurred in the agriculture category. In an aggregate, a total change of 11.14 percent of the study area from 1992 to 2002 has occurred. A detailed description of each of the landuse/cover class are given in the **Table 6 and Figure 7.**

Table 6. Landuse/cover change-Pohru catchment (1992-2012)

Landuse/cover Category	Area in ha. (1992) (%age)	Area in ha. (2012) (%age)	Over all Change in ha. (%age)
Agriculture	34362 (18.72)	31565.09 (17.20)	-2796.91 (-1.52)
Horticulture	22137.4 (12.06)	27734.01 (15.11)	5596.61 (3.05)
Dense Forests	35838.08 (19.53)	28881.06 (15.74)	-6957.02 (-3.79)
Moderately Dense Forests	46488.5 (25.33)	50518 (27.53)	4029.5 (2.2)
Sparse Forests	24962.66 (13.60)	25541 (13.92)	578.34 (0.32)
Water Body	8342.12 (4.58)	8335.7 (4.56)	-6.42 (-0.02)
Snow Covered	11342.92 (6.18)	10899.14 (5.94)	-443.78 (-0.24)
Total	**183474 (100)**	**183474 (100)**	**20408.58 (11.14)**

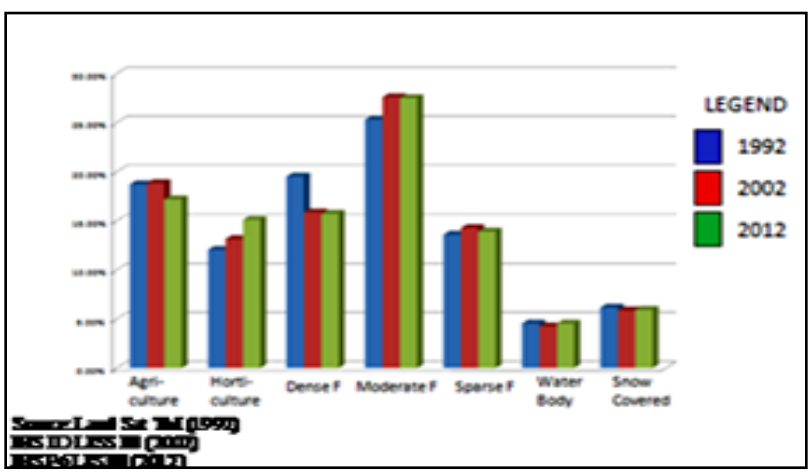


Figure 7: Landuse/cover change (1992-2002-2012)

Conclusions

Pohru being a mountainous region is experiencing unprecedented LU/LC change over the past few decades, and is susceptible to degradational problems. This change is being driven by rapid human population growth and intensifying anthropogenic activities such as agriculture and expanding human settlements. Population growth and mis-management of agricultural practices are creating threatening ecological conditions in the catchment.

Overall the analysis of data from 1992 to 2012 amply describes the change that has taken place in the study area since last two decades. The discernible change in the forest area primarily in terms of density change reveals the

sorry state of affairs. Considerable area under agriculture has also shifted to horticulture and settlement which has got its own ramifications. The forest cover has decreased not only in extent but also in terms of density. This land has been brought under agriculture, settlement and horticulture uses. Most important impact of land change is the decreasing self sufficiency in the food grains production which will impact the staple food of Kashmir valley (Rehana *et. al.*, 2016).

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