Impact of change in forest cover on soil status in Kahmil Watershed, J&K, using Geo-spatial tools

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Abstract

This study is an attempt to analyse and highlight the present state of forests in Kashmir, which are under tremendous anthropogenic pressure. Extensive deforestation has resulted in harmful impacts on the overall environment especially on the health of the soil. The detailed studies were carried out in Kahmil Watershed of the Kashmir valley using Geo-spatial tools. The data of the Year 1974-75 and 2000 were used and changes in forest categories vis-a-vis soil erosion status have been analysed. The analysis revealed that the Kahmil watershed situated in the Kashmir valley is undergoing large scale deforestation. There has been a total loss of about 848 hectares of forest cover in about three decades. The most startling fact is the change in terms of density classes, where the change percentage is quite high. This deforestation has resulted in accelerated soil erosion. The area which was under the Moderate erosion class has reduced and that soil has further degraded and shifted to Moderate to severe class of erosion. Necessary remedial measures should be taken to check this deforestation and consequent soil erosion.

Introduction

Forests constitute the most valuable resource for the mankind. The maintenance of our soil ecosystem, on which our agriculture and food supply depends, is intimately related with the forest cover. They enrich the soil by providing much needed organic matter and enhance its water holding capacity. Kashmir valley, with its high mountains covered with lush green forests, is a paradise on earth. However, these forests are facing a grave threat because of severe anthropogenic pressure. The forest area of Kashmir Division is 8128 Sq. Kms. (Digest of Forest Statistics, 2000) and the total area under forests in the year 1961 was 8344 Sq. Kms (Digest of Forest statistics, 1961). This indicates a change of about 1.4 percent within a span of four decades. The Forest cover has not only decreased in terms of spatial extent but has also changed considerably in terms of density. The part of the area under dense class earlier has now shifted to open forests and likewise portions of open forest have shifted to degraded category. This large scale deforestation throughout the valley has resulted into soil degradation problems which have assumed alarming proportions.

Numbers of studies have been carried out which reveal that the forest line is receding in Kashmir valley and it has resulted in severe soil erosion problems (Kango and Qadri, 1984; Chadha, 1990). Remote Sensing and GIS technologies have proved to be quite fruitful in such studies. Use of Satellite remote sensing data for forest and related studies have been carried out by number of researchers with a high level of accuracy and reliability both at the national and international level (Behera et al., 2001; Fuller et al., 1998). With a view to highlight this problem of the Kashmir valley, remote sensing and GIS technologies were effectively used in this study. The detailed studies were carried out in Kahmil Watershed of the Kashmir valley with two main objectives:

i) To study the levels of deforestation from 1974-75 to 2000.
ii) To examine and analyze the impact of this deforestation on soil erosion status.
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Study area

The studies were carried out in the Kahmil Watershed of the Pohru Catchment of the Kashmir valley (Fig.1). The Kahmil watershed lies between 34° 15' to 34° 40' N Latitude and 73° 55' to 74° 20' E Longitude. The Kahmil Watershed is bounded by Harihama watershed in the east, Dangarwari watershed in the south and Kishenganga Catchment on the north and northwest. The Kahmil Watershed is the largest watershed of Pohru Catchment and its total area is 50902 hectares. It has been divided into forty eight microwatersheds by All India Soil and Landuse Survey (AIS&LUS) in accordance with the guidelines of the Watershed Atlas of India (WAI). Out of these forty eight microwatersheds, twenty four microwatersheds have more than sixty percent of their area under forests.

Fig. 1: Location map of Kehmil Watershed, J&K

This watershed can be divided into three distinct physiographic units i.e. the Mountains, the Karewas and the Floodplains. The main ridges of the mountain ranges run in a northwest to southeast direction. The mountains are conical in shape with steep to very steep slopes in all directions. The southern slopes, on account of less vegetation, have very excessive runoff leading to accelerated erosion, where as the northern slopes have comparatively thicker vegetative cover which checks erosion and runoff to a large extent. The Karewas are the remnants of lacustrine deposits, which are highly dissected. The Karewas of the higher reaches have coarser sediments, supporting good forests while Karewas nearer the flood plains have finer sediments. The terraces of the Kahmil river are of two types, the older flood plains, which are nearly level to gently sloping lands and the recent alluvium which consist of narrow valleys with recent deposits of cobbles, pebbles, coarse sands with a thin veneer of finer sediments on the surface. The recent deposits of the Kahmil river, in the point bar areas, are finer sediments. The three dominant species of trees found in the area are Cedrus deodara, Pinus wallichaina and Abies pindrow.

Database and Methodology

The satellite data of Indian Remote Sensing Satellite IRS-1C LISS III (FCC) with a resolution of 23.5 mts. was used for this study. The data was Geocoded and as such matched to a standard SOI toposheet of 1:50,000 scale. The study also used the Pohru Catchment Prioritization Map prepared by AIS & LUS, New Delhi in 1974-75. This map was prepared by interpretation of panchromatic vertical aerial photographs with the final map on
1:50,000 scale. The source material was collected from both published and unpublished records of various State Government departments, especially J&K Forest Department, Directorate of Economics & Statistics, Directorate of Environment & Remote Sensing and Soil Conservation Department etc.

The methodology for this study was divided into two parts. The first part comprised of generation of base map with mapping units from the AIS & LUS prioritization map of the year 1974 prepared from Aerial photographs on 1:50,000 scale. Different mappable units were delineated within individual microwatershed boundaries with emphasis on forest classes.

The second part comprised of visual interpretation of IRS-1C LISS III (FCC) of the year 2000 using standard visual interpretation techniques. A tentative legend with Erosion Intensity Mapping Units compatible with the 1974 prioritization mapping units were prepared. The Erosion Intensity Mapping Units imply a set of relevant parameters which are responsible for the detachment of soil (soil erosion) and also exert combined and reciprocal influence on soil detachment. The factors considered include physiography and slope, which control amount and velocity of runoff ; soil characteristics, that decide potentiality for erosion; vegetation cover conditions that afford protection to soil; landuse that indicates interference by human and biotic factors; present erosion status and existing soil conservation measures that modify the influence of other factors. This was followed by selection of sample strips with observation points for ground truthing exercise. While selecting the observation points, all the EIMUs were given due representation. After the field visit, the legend was finalized and final plotting of the mapping units was done.

The maps served as inputs to GIS and subsequent analysis for change detection was completed in GIS environment.

Forest status in 1974-75

The forests cover a major portion of the study area. The Forests in Kahmil are under Deodar, Kail and Fir species. The total area under the forest was 33488.9 hectares, which accounted for 65.8 percent of the total area. Three classes of forests on the basis of their crown density were taken i.e. Degraded Forests (Less than 10 percent), Open Forests (between 10-40 percent) and Closed Forest (more than 40 percent). The Degraded Forests accounted for 5198.9 hectares i.e. 10.2 percent of the total geographical area and 15.5 percent of the total forested area. The Degraded Forests were mostly confined to southern face of mountains under Ramhal, Domari and Bod Nambal forests. There were patches of degraded forests to the south of Kachama and Bod Bungas (Table-1).

The Open Forests covered an area of 13716 hectares. This accounted for 26.9 percent of the total area and about 41 percent of the total forested area. The Open Forests were confined to the southern slopes of the mountains under Roshinar, Satburn, Jabnar, Lokut Bangas and Bata Marg etc. The Closed Forests accounted for 14574 hectares, i.e. 28.6 percent of the total area of the watershed and 43.5 percent of the total forested area. The Closed Forests were spread over the northern aspects of mountains under the Ramhal, Kajpathra, Zun Reshi, Kachama, Bod Bungas and Dardnar Forests (Fig.2)
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**Fig.2:** Forest density map (1974-75), Kehmil Watershed, J&K

**Fig.3:** Forest density map (2000), Kehmil Watershed, J&K
Forest status in 2000

The total area under different classes of forests was 32640.2 hectares, which accounted for 64.1 percent area of the Kahmil watershed (Table-1). Out of that, the Degraded Forests accounted for 8763.3 hectares, which accounts for 17.2 percent of the total area and 26.8 percent of the total forested area. The Degraded Forest are generally found near Alachazab, Cherkot, big patches in Bod Nambal, Zun Reshi, pine forests in Lokut Bangas, Dardnar and Kachama. The total area under Open Forests is 15226.6 hectares, which accounts for about 30 percent of the total area and about 47 percent of the forested area. The Open Forests occupy considerable portions in Bod Bangas, Lokut Bangas, Roshinar, Satburn, Jabnar, Batamarg forests and patches in Dardnar forests. The total land under the Closed Forest is 8650.3 hectares, which accounts for about 17 percent of the total area of the watershed and 26.5 percent forested area. This type of forest class is mainly found in the Kanhama, Zun Reshi, Ramhal, Bod Bangas and Kajpathra forests (Fig.3).

Soil erosion status in 1974-75

In order to study the soil erosion problems in the study area, five soil erosion categories were identified: None to slight erosion, Slight to moderate erosion, Moderate erosion, Moderate to severe erosion, Severe to very severe erosion. In case of None to slight erosion class, the well managed cultivated areas show this type of erosion. There was no considerable forest area under this category (Table-2). As far as the Slight to moderate class is concerned, the total area under this category was 33255.6 hectares. This accounted for 65.3 percent of the total area. The Closed Forest with crown density of more than 40 percent and well managed agricultural lands had this type of erosion intensity. Moderate erosion category comprised of 3735.5 hectares, accounting for 7.3 percent of the total area of the watershed. Moderate to severe erosion class accounted for 1908.8 hectares, which was 3.7 percent of the total area. The areas having this type of erosion were Zarhama, Warsun, Foot slopes of Mountains near Gazarial, Nambal and slopes of southern aspects near Riddi. The total area under the Severe to very severe class was 5297.5 hectares, which accounted for 10.4 percent of the total area (Fig. 4). These were areas where gully erosion was widespread.

Soil erosion status in 2000

The soil erosion status by the year 2000 has changed considerably. The area under the None to slight erosion class is 2071.3 hectares. The landuse predominantly is agricultural with paddy cultivation. The Slight to moderate erosion class accounts for 30491.2 hectares, which is 60 percent of the total area of Kahmil. The Moderate erosion class covers an area of 597.8 hectares, which is 1.1 percent of the total area. The total area under Moderate to severe erosion is 5980.1 hectares i.e.12 percent of the total area. The Severe to very severe erosion class accounts for 7363.2 hectares i.e. 14.4 percent of the total area (Fig. 5; Table-2).

Change detection analysis

The change detection reveals that there has been a considerable change in the forest cover during the last twenty-five years. The most startling fact is the change in terms of density classes, where the change percentage is quite higher (Table-1). The perusal of the given table reveals that the Degraded Forest has increased its area by 11.2 percent where as the Open Forest class has also gained 6 percent area. So, the closed forests are the worst sufferers. The area has decreased by 11.6 percent and that land has shifted to the other classes. Technically, it is stage wise shift. The land from the closed class has shifted to
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**Fig. 4:** Soil erosion map (1974-75), Kehmil Watershed, J&K

**Fig. 5:** Soil erosion map (2000), Kehmil Watershed, J&K
the open category. In turn, there has been a transfer of area from open category to the degraded category on account of density changes.

**Table- 1: Comparative Forest Density (In Hectares)**

<table>
<thead>
<tr>
<th>Forest Class</th>
<th>Area in 1974-75</th>
<th>Area in 2000</th>
<th>%age Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degraded Forest</td>
<td>5198.9</td>
<td>8763.3</td>
<td>+ 11.2</td>
</tr>
<tr>
<td>Open Forest</td>
<td>13716.0</td>
<td>15226.6</td>
<td>+ 6</td>
</tr>
<tr>
<td>Closed Forest</td>
<td>14574.0</td>
<td>8650.3</td>
<td>- 11.6</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>33488.9</strong></td>
<td><strong>32640.2</strong></td>
<td><strong>- 1.7</strong></td>
</tr>
</tbody>
</table>

This deforestation has ultimately a very adverse impact on the soil. The major landuse in the study area is forestry. Large scale deforestation has ultimately resulted in the soil erosion problems. A comparative analysis reveals that the soil erosion status has considerably changed. Although there has been a minor change in the None to slight erosion class but as we move up in terms of intensity of erosion, the change becomes quite discernible. In the Moderate to severe erosion class, the total area in 1974-75 was 1908.8 hectares, which accounted for 3.7 percent of the total geographical area. In the year 2000, the area under this class was 5980.1 hectares accounting for 11.7 percent of the total area. This indicates an increase of about 8 percent. In the Severe to very severe class of erosion, the total area was 5297.5 percent in the year 1974-75, i.e.10.4 percent of the total geographical area, where as in the year 2000, the same class increased by 2065.8 hectares i.e.14.4 percent of the total area. This amounts to an increase of 4 percent. So, overall the change is quite visible.

**Table- 2: Comparative Areas under Different Erosion Classes (in Hectares)**

<table>
<thead>
<tr>
<th>Erosion Class</th>
<th>1974-75</th>
<th>2000</th>
<th>%age Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>None to slight</td>
<td>2306.1</td>
<td>2071.3</td>
<td>-0.4</td>
</tr>
<tr>
<td>Slight to Moderate</td>
<td>33255.4</td>
<td>30491.2</td>
<td>-5.4</td>
</tr>
<tr>
<td>Moderate</td>
<td>3735.5</td>
<td>597.6</td>
<td>-5.5</td>
</tr>
<tr>
<td>Moderate To severe</td>
<td>1908.8</td>
<td>5980.1</td>
<td>+8.0</td>
</tr>
<tr>
<td>Severe to Very Severe</td>
<td>5297.5</td>
<td>7363.1</td>
<td>+4.1</td>
</tr>
<tr>
<td>Snow Covered Area</td>
<td>4046.4</td>
<td>4046.4</td>
<td>NA</td>
</tr>
<tr>
<td>River</td>
<td>352.3</td>
<td>352.3</td>
<td>NA</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>50902</strong></td>
<td><strong>50902</strong></td>
<td><strong>NA</strong></td>
</tr>
</tbody>
</table>
Conclusion

This study reveals that deforestation is taking place at a large scale in the study area. This is authenticated by the fact that considerable area under the Closed Forest category has been shifted to the Open Forest category. Where as, a large area of the Open Forest category has turned into Degraded Forests due to continuous deforestation. There has been a total loss of about 848 hectares in about three decades as far as the forest area is concerned. This deforestation has ultimately resulted in large scale degradation of soil. This is clear by the perusal of the Table-2, which indicates considerable changes in the area under different categories of soil erosion. The area under the moderate erosion class has considerably reduced. The major reason being the shift of this soil to the higher erosion intensity class. That is the area which was under the Moderate erosion class has reduced and that soil has further degraded and shifted to Moderate to severe class of erosion. Sheet and gully erosion have affected considerable area. The soil conservation measures adopted have not been able to keep pace with the rapid changes taking place in the ecosystem. Proper soil conservation measures have to be adopted to address the problem. These conservation measures should be adopted under two sectors: the Forestry sector and the Soil Conservation sector and should include both biological measures and engineering measures. The biological measures should include afforestation, dibbling, vegetative gully plugging and vegetative hedges etc., whereas the engineering measures would include gunny bag check dams, crates, stream bank protection and landslip/slide control measures etc. However, suitability of various conservation measures should be in accordance to the intensity of the problem.

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