Van Panchayat forest management as option in conserving biodiversity and carbon storage

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ABSTRACT

Many developing nations around the world have been promoting decentralization of natural resource management with the hope that by providing secure tenure to resource use, people dependent on the natural resources for livelihood will seek to conserve them. Forests managed by communities are not only contributed to overall improvement in forest conditions but has also resulted in positive impacts on biodiversity conservation. The environmental services provided by community forests are reducing soil erosion and increased water supply from forest springs. The present study indicates the significance of community forests and advocates that if the forests are managed properly with the involvement of the local community these forests can play a role model in conserving biodiversity. If payment for carbon credit is made to these Van Panchayats, added benefits may provide communities relying on the forests incentive to stop deforestation and opt for long term benefits that are more sustainable in mitigating climate change.

Key words: Van Panchayat, Bhatkholi, forest management, biodiversity, carbon storage.

1. INTRODUCTION

Forests of the Himalayan region are mainly dominated by Quercus leucotrichophora and Pinus roxburghii. Quercus leucotrichophora and its associate species cover the most extensive forest area followed by Pinus roxburghii dominated forests. Both the Quercus leucotrichophora and Pinus roxburghii species are evergreen with concentrated summer leaf fall and simultaneous renewal of the canopy (Rahlan et al., 1985). Pinus roxburghii often forms a pure crop in this area, but sometimes it also mixes with certain broadleaved species like Quercus leucotrichophora, Myrica esculanta and Rhododendron arboreum. The oak species occupy most of the areas (approximately 20,000 km²) from 1000 to 3000 m altitude in central and western India (Kumaun, Garhwal and Himanchal Pradesh) (Singh et al., 2000). The exploitive management practices and the biotic stress exerted by hill population in relation to oak species have encouraged the expansion of Pinus roxburghii (chir pine) in various ways (Saxena et al., 1994). Much of the area now occupied by chir pine was originally under the natural vegetation of oaks (Champion and Seth, 1968). Conversion of oak forests to chir pine is still proceeding on larger scale and this trend may lead to disappearance of large area of the oak forest from the region. A reversal of this trend requires a true evaluation of current management practices including local people participation. The proportion of the old growth forests are being removed at a faster rate than young forests are being constituted, as a result the proportion of the middle aged forest is not stabilized, but is instead increasing (Saxena et al., 1994). In order to maintain such a structure of forests indefinitely, heavy subsidy in the form of cultural practices is required. Conservation of biological resources under community based conservation system is a key tool to lessen the depletion of biodiversity. The active participation and involvement of local people either at community or individual level is essential towards conservation of the forest and other natural resources. The Van Panchayats represent one of the largest and most diverse experiments in devolved common property management ever developed (Arnold and Stewart, 1991). Major objective of Van Panchayat is to rejuvenate and manage patches of civil soyam forests for local use; it also prevents neighbouring villages from intruding into this zone, once formally demarcated as a Van Panchayat forest. According to recent estimates, there are about 12,089 Van Panchayats managing an area close to 0.5 million ha in Uttarakhand. The area under each Van Panchayat ranges from a fraction of a hectare up to over 2000 ha. In the present study we have tried to access the importance of management practices of the Van Panchayat on conserving and regenerating forest under their control.

2. MATERIALS AND METHOD

2.1. Site description

The present study has been carried out in the Van Panchayat forest of Bhatkholi situated between 29°32.98'-29°34.32'N latitudes and 79°41.44'-79°43.2'E longitude of Lamgara Developmental Block of Almora District (Uttarakhand) located between 1646 to 1715 m elevation (Table 1). In this area villagers put efforts to conserve the surrounding Van Panchayat forests. The basic climate pattern is governed by the monsoon rhythm. The average annual rainfall varied from 274.5 to 463.2 mm. The mean maximum temperature varied from 17.31°C to 27.87°C (January) to 14.87°C (June). The vegetation type mainly comprises Himalayan moist temperate oak forest and subtropical pine forest. The dominated tree species of the Van Panchayat are Quercus leucotrichophora, Pinus roxburghii, Rhododendron arboreum and Myrica esculenta. Information on socio-economic parameters was collected by questionnaires distributed to 30% of the households in the Van Panchayat. The house holds were selected randomly on the basis of number of family members and categorized in to small (<4), medium (5 to 9) and larger (>10). Four aspects south west, east, North West, and noth were identified. With in each aspect trees were analyzed by placing randomly 10, 100 m² circular quadrats. Saplings, seedlings and shrubs were studied in 10, 5×5 m² quadrats placed randomly. The vegetational data were calculated for density, frequency, abundance (Curtis and McIntosh, 1950). Importance value index (IV) for trees was determined as the sum of the relative density, relative frequency and relative dominance (Curtis and,s 1959). Individuals of the tree species were divided in to three classes. Trees were considered to be individual >30 cm cbh (Circumference at breast height), sapling 10 to 30 cm cbh and seedling <10 cm cbh (Saxena et al., 1994). Species richness was determined following Whittaker (1972). Species diversity was computed by using Shannon-Wiener's Index (Shannon-Weaver, 1949) and Concentration of dominance was calculated following Simpson (1949). For the soil analysis six replicated soil samples were collected from each aspect (0 to 10, 10 to 20, 20 to 30, 30 to 40, 40 to 50, 50 to 60, 60 to 70, 70 to 80, 80 to 90 and 90 to 100 cm soil Vardan Singh Rawat, Van Panchayat forest management as option in conserving biodiversity and carbon storage, Indian Journal of Science, 2012, 1(1), 32-35, http://www.discovery.org.in/ijis.htm

Table 1 Site description

<table>
<thead>
<tr>
<th>Stand</th>
<th>Aspect</th>
<th>Elevation (m)</th>
<th>Dominant vegetation</th>
</tr>
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<tbody>
<tr>
<td>I</td>
<td>South west</td>
<td>1678</td>
<td>Quercus leucotrichophora</td>
</tr>
<tr>
<td>II</td>
<td>North west</td>
<td>1695</td>
<td>Quercus leucotrichophora</td>
</tr>
<tr>
<td>III</td>
<td>East</td>
<td>1646</td>
<td>Pinus roxburghii</td>
</tr>
<tr>
<td>IV</td>
<td>North</td>
<td>1715</td>
<td>Pinus roxburghii</td>
</tr>
</tbody>
</table>

(December)
depths). The samples were thoroughly mixed depth wise, sieved and used for subsequent analysis. Soil textures were determined following standard methods outlined by Jina (2006) while soil moisture was determined on fresh weight basis following Jackson (1958), while soil carbon estimation was based on rapid titration method of Walkey and Black following Jackson (1958). Linear regressions were developed between elevation and herb density, elevation and tree density. Correlation coefficient (r value) was also determined for various species richness and diversity parameters.

3. RESULTS

3.1. Socioeconomic status

The area under the Van Panchayat is approximately 50 ha. Forest wood is the primary source of energy for cooking and heating in the Village, only 1 to 3 families are using LPG occasionally. The total income of the Bhatkholi Village was 28,580 per family of which the maximum contribution was of the milk production (46.06% per family), followed by daily labouring at 100 day (30.87% per family) and minimum contribution of the income was shared by the agricultural and floricultural (23.05% per family). The daily requirements of fuelwood vary from 5 to 6 kg of dry fuelwood per family. The total fuelwood consumption in the Van Panchayat was 1300 kg and the consumption was higher in the winter season (2560 kg.). The major fuelwood tree species are Quercus leucotrichophora and Pinus roxburghii.

3.2. Forest protection and management practices

Van Panchayat members watch over their forests for irregular movements such as illegal lopping, animal grazing, forest fires etc. Penalties are also levied on members found adopting unsustainable forest resource extraction practices. The penalty rates vary for illegal fodder and litter collection, timber and fuelwood extraction, grazing livestock etc. The main products under harvesting include timber, dried and green fuelwood, fodder, litter and NTFP’s. A decision to harvest is taken by the community members together. The forest products can be collected by community members when the forest is opened for collection activities during the 15 allotted days. The members decide the days and dates in which harvesting of these products is allowed and accordingly, informs all villagers. On special occasions such as marriages, religious ceremonies, villagers can harvest 350 kg of fuelwood by paying small fee. Products extracted collectively after a thinning or clearing operation are distributed equally amongst villagers. Community members may sell their personal excess of these products to the villagers, but the products may not be sold commercially outside the village.

<table>
<thead>
<tr>
<th>Table 2 Average tree, shrub, herb and litter biomass and carbon sequestration rate in Bhatkholi Van Panchayat forest</th>
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<tbody>
<tr>
<td>Components</td>
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<td>------------</td>
</tr>
<tr>
<td>Bole</td>
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<td>Branches</td>
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<td>Twig</td>
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<td>Total above ground</td>
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<td>Stump root</td>
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<td>Lateral roots</td>
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<td>Fine roots</td>
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<tr>
<td>Total below ground</td>
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<td>Total</td>
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3.3. Biomass and carbon sequestration rate

The average above ground biomass of the Bhatkholi Van Panchayat forest was 31.9±1.37 t ha⁻¹ in the previous year (2008) which increased to 37.13±1.46 t ha⁻¹ in the next year (2009), while the total below ground biomass was 11.2±1.04 in the previous year (2008) which increased to 12.7±2.13 in the next year (2009). Of the total biomass the percent contribution of the bole was maximum 41.15% followed by stump root (20.20%), branches (20.10%), twigs (9.06%), lateral roots (4.61%), foliage (4.08%) and minimum contribution was shared by fine roots (4.61%). The mean carbon sequestration rates was 3.41 t ha⁻¹ yr⁻¹ across four aspects (Table 2).

3.4. Soil and vegetational parameters

3.4.1. South west aspect

Across the various soil depths the sand percent varied from 30.29±3.11 to 42.33±3.69 at 10 and 60 cm soil depth, silt between 14.11±2.71 and 18.79±0.34 and the clay percent varied from 39.32±3.59 to 55.34±5.22. The moisture percent varied from 9.77±1.36 to 14.52±1.15 and organic soil carbon percent varied from 1.45±0.75 to 3.05±0.02 (Figure 4). The total tree density was 193 ind/ha and total basal area recorded was 5.29 m²/ha (Figures 1 and 2). The highest tree density was observed for Quercus leucotrichophora (153 ind/ha) followed by Pinus roxburghii and Myrica esculenta (20 ind/ha each). The total sapling density at this aspect was 159 ind/ha. The highest density was recorded for Quercus leucotrichophora (86 ind/ha). The total seedling was 365 ind/ha. The seedling density was highest for Quercus leucotrichophora (266 ind/ha). The shrub density was highest for Pyracantha crenulata (240 ind/ha). The highest herb density was that of Apluda mutica (11200 ind/ha).

3.4.2. North West aspect

Across the various soil depths the sand percent varied from 23.21±3.88 to 35.68±2.64, silt between 11.71±2.17 and 17.45±1.56 and the clay percent varied from 48.53±4.41 to 63.64±6.20. The moisture percent varied from 7.08±1.26 to 11.28±3.39 and organic soil carbon percent varied from 1.85±0.41 to 2.91±0.40 (Figure 4). The total tree density at this aspect was 238.6 ind/ha and total basal area was 6.69 m²/ha (Figures 1 and 2). The highest tree density was of Quercus leucotrichophora (173 ind/ha). The highest sapling density was of Quercus leucotrichophora (173 ind/ha). The total seedling density at this aspect was 845 ind/ha. The highest density was for Quercus leucotrichophora (626 ind/ha). The shrub and the herb density was highest for Pyracantha crenulata (366.66 ind/ha) and Apluda mutica (1133.34 ind/ha), respectively.

3.4.3. Eastern aspect

Across the various soil depths the sand percent varied from 27.41±3.68 to 38.39±3.31, silt between 11.73±2.33 and 16.77±0.87 and the clay percent varied from 45.73±4.69 to 60.86±6.01. The moisture percent varied from 6.52±1.09 to 9.96±0.82 and organic soil carbon percent varied from 1.82±0.46 to 2.88±0.45 (Figure 4). The total tree density at this aspect was 206.6 ind/ha and total basal area was 5.26 m²/ha (Figures 1 and 2). The highest tree density was of Pinus roxburghii (200 ind/ha) while the least density was of Quercus leucotrichophora (6.8 ind/ha). The total sapling and seedling density at this aspect was 252 ind/ha and 119 ind/ha respectively. The shrub density was highest for Pyracantha crenulata (193.33 ind/ha). The total herb density at this aspect was 9466.68 ind/ha.

3.4.4. Northern aspect

Across the various soil depths the sand percent varied from 50.93±4.92 to 70.51±2.42, silt between 9.31±0.75 and 12.22±0.52 and the clay percent varied from 17.87±1.9 to 38.86±2.53. The moisture percent varied from 7.92±0.86 to 14.38±0.56 and organic soil carbon percent varied from 1.41±0.54 to 3.49±0.38 (Figure 4). The total tree density was 159 ind/ha and total basal area was 5.29 m²/ha (Figures 1 and 2). The highest density was of Pinus roxburghii (200 ind/ha) while the least density was of Quercus leucotrichophora (6.8 ind/ha). The total sapling and seedling density at this aspect was 252 ind/ha and 119 ind/ha respectively. The shrub density was highest for Pyracantha crenulata (193.33 ind/ha). The total herb density at this aspect was 9466.66 ind/ha.


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The seedlings and saplings of *Pyracantha crenulata* in most of the ecosystems, were present on all the aspects. The number of seedlings of *Quercus* was higher for *Pinus roxburghii* (44.76 ind/ha) compared to *Pinus leucotrichophora* (5.26 ind/ha). The total seedling density was 249.98 ind/ha. The highest seedling density was of *Myrica esculenta* (133.33 ind/ha) while *Quercus leucotrichophora* shows the least density (16.66 ind/ha). The shrub density was highest for *Pyrcanthes crenulata* (325 ind/ha). The herb density was highest for *Apluda mutica* (6266.67 ind/ha).

**3.4.5. Regeneration**

The population structure of some dominant tree species is given in Figure 3. The seedlings and saplings of *Quercus leucotrichophora* were present on all the aspects. The number of seedlings of *Quercus leucotrichophora* was higher on eastern aspect where as the *Pinus roxburghii* seedlings were higher on south western aspect. Majority of trees were of the young size class (30 to 60 cm, Figure 3). Conversion of seedlings to saplings to trees of *Quercus leucotrichophora* was satisfactory indicating well regeneration pattern and effective forest management. The correlation between tree species diversity and species richness, herb density and tree density, herb species richness and species diversity, were strongly correlated as indicated by correlation coefficient values (significant at p<0.01). Contrary to this, the species richness and concentration of dominance, herb density and shrub density was negatively correlated (p<0.01).

**4. DISCUSSION**

The total basal area of the present study (5.26 and 9.41 m²/ha) was lower than the pattern reported earlier by Singh (2009), Singh et al. (1994), Rawat and Chandhok (2009), Saxena and Singh (1982), Upadhyay (1982), Balhan et al. (1982), (35.02 to 83.77 m²/ha) for different central Himalayan oak and pine forest. The lower total basal area of the present study shows that the forest is in young stage. Oak (Quercus spp.) forests are most extensively distributed between the altitudes of 1000 m to timberline and represent the climax stage, throughout the central Himalaya (Champion and Seth, 1968). The ecosystem functions, distribution and occurrence of species had been affected by human interventions (Singh and Singh, 1987). Among human influence, commercial exploitation, agricultural requirements, forest fire, and grazing pressure are the important source of disturbance (Singh and Singh, 1992). Repeated disturbances release carbon directly into the atmosphere. Deforestation is a major anthropogenic cause of net carbon release to the atmosphere, next only to fossil fuel emissions (Pandey, 2002). However the removal of atmospheric carbon by forest ecosystem through carbon sequestration and converting the sequestered carbon in to the soil organic carbon has provided a great opportunity for shifting GHGs emission to mitigate climate change. In most of the ecosystems, carbon is stored in the plant biomass in Sal and Oak dominated forest, the proportion being 80 to 92%, while in Chir Pine and Chir Pine dominated forests, the proportion being 50% of the ecosystem carbon (Jina, et al., 2008). The availability of carbon is important in controlling nutrient cycling and soil biological activity. Soil stores 2.5 to 3.0 times as much as that stored in plants in the terrestrial ecosystem (Post et al., 1990). Land-use and soil-management practices can significantly influence soil organic carbon dynamics and carbon flux from the soil. Forest vegetation of a Van Panchayat forest is a major determinant of the soil organic carbon. As Van Panchayats had a major potential for increasing soil carbon through restoration of degraded soils and widespread adoption of soil conservation practices. The soil organic carbon in the present study was closer to dense semi-evergreen forest of different soil layers (Ramachandran et al., 2007). Soil organic carbon values of the present study varied from 1.41±0.54 to 2.97±0.46. These values are generally comparable with the values reported earlier for the surrounding Community managed forests (Singh 2009; Jina, 2006). It can be concluded that the Van Panchayats are playing important role in recovering of damaged oak forest of Central Himalaya. They are also playing important role in mitigating rise in CO₂ level of the atmosphere and enhancing carbon sequestration rate. The replacement of oak by pine in Himalaya can be minimized by creating Van Panchayats in Himalaya.

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REFERENCE