ASSESSING THE EFFECTS OF DIFFERENT FOREST MANAGEMENT REGIMES ON FOREST CONDITION IN CHITWAN, NEPAL, USING SATELLITE REMOTELY SENSED DATA AND FOREST CANOPY DENSITY MAPPER

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Abstract

Although an appreciable success in community forestry intervention has been perceived in the Hills of Nepal, it is still debatable issue in Terai. Government seems reluctant to handover the productive forest of this region to the local communities not because of the provisions of legislation, it is because of its intention to manage this region's forest as production forest. bDifferent management scenarios can be seen in practice in the Terai. Debate cannot be resolved without evaluating the effects resulted from the different management practices. This research stepped in that issue and compared the forest condition under three management regimes (Community forest, Government forest inside the bufferzone and Government forest outside the bufferzone). This research used satellite images and Forest Canopy Density Mapper to assess the condition of the forest.

1. Introduction

Nepal encompasses diverse ecological zones and comprises of variety of ecosystems. It covers wide altitudinal range (60-8848m). Five major types of forests, *i.e.*, tropical, sub-tropical, lower-temperate, upper temperate and alpine forest are found in Nepal. More than 75% of all households and 90% of rural households rely on wood products for domestic purposes for their daily needs of timber, fuel wood, fodder, grasses, litter and traditional herbal medicines mainly from forests. In addition, role of forests in stabilizing areas of high erodibility and to increase agricultural productivity is equally important. These facts signify how crucial are the forest resources in ecological as well as social perspectives in Nepalese context. However, Nepal's forest is declining in both quantity and quality. Several proximate causes and underlying driving forces are responsible to accelerate the deforestation and forest degradation. Legal and illegal conversion of forestland for agriculture and infrastructure developments, unplanned and overexploitation (extraction) of the forest products, free access for grazing and uncontrolled forest fire are major causes in depleting forests that create deficit of forest products in one hand and aggravate soil erosion, downstream sedimentation and decrease in agricultural productivity on the other hand. Therefore, there is an urgent need of effective policy and implementation mechanism to manage the depleting and deteriorating forestland to turn it into productive and sustainable forest.

Government seems reluctant to handover the productive forest of this region to the local communities not because of the provisions of legislation, it is because of its intention to manage this region's forest as production forest. Different management scenarios can be seen in practice in the Terai. Debate cannot be resolved without evaluating the effects resulted from the different management practices. This research stepped in that issue and compared the forest condition under three management regimes (Community forest, Government forest inside the bufferzone and Government forest outside the bufferzone).

The canopy density distribution was characterized for the two dates (1988 and 2001) in the whole study area in general and in three management regimes in particular. Current forest growing stock statuses of these three regimes were also assessed and comparative analysis was carried out. For each selected regime, historical (1988) and current (2001) FCD maps were prepared by using Landsat satellite data and Forest Canopy Density Mapper (Rikimaru, and Miyatake, 1997). Using the field survey data, mean DBH, mean stem density and mean basal area were calculated and compared among three management regimes. The changes and differences in results were translated as the effects of management. Here, significant findings and management implications are highlighted.

2. Results

The total area of the classified image is 30024 ha. Altogether 11 classes (10 canopy classes and one non-canopy class) appeared as a classification result. The FCD map is shown in Fig.1. The bar graph (Fig.2) portrays the area (ha) per class and percentage share of each class out of total area. Forest covers about 46 percent of the area and non-forest covers about 54 percent area. Among canopy classes, maximum area falls in class 5 and negligible area in class 10. Class 1 and 9, class 2 and 8 have similar area figures. Class 6 has second highest figure after class 5 and followed by class 4, class 7 and class 3. If we exclude zero class, the area distribution above class 5 is seen a bit higher than the area distribution below class 5.

Lower canopy density classes have occupied most of the marginal forest areas close to the settlement, agriculture fields and rivers. Neck-like area of north (North of the highway) can be observed more degraded. Few patches of forest can be seen out of the main forest block, which might be the trees outside the forest (TROF). The north and northeast portion of the neck possess highly dense forest canopy areas. Middle parts of the highway south areas seem moderately dense (50-70% FCD). South of the Rapti river is the forest under RCNP, which can be seen, mixed pattern of various canopy classes and bare areas of Rapti river.

The classification of Landsat ETM$^+$ 2001 data (1-7 bands) also results in 11 classes (one zero class and 10 forest canopy density classes). Zero class occupies about 58 percent of the area. Class 10 has almost disappeared because it has only very few pixels. Class 9 also seems not significant coverage. Class 1 and 8 have similar area coverage. Besides zero class, class 4 has the highest area figure but not much difference than class 5. Figure 3 and 4 and show map and FCD area distribution in 2001. The area classes below class 5 is 22 percent except zero class and above class 5, the total coverage is about 11 percent. Zero class has increased by 1309 ha. It means this much area is converted into non-forest areas from forested areas between 1988 and 2001. Beyond class 4, the canopy cover areas have been decreased and the classes below that class (except class 1), they have been increased in comparison to 1988. The increase of zero class area indicates that some forested areas have been converted into non-forested areas.

The spatial distribution of forest canopy density classes can be observed in the map (Fig. 3). Southern part of the highway except few places, are found more degraded. Some forest area has completely lost in the northeast part where there was dense forest in 1988. Canopy class conversion can be visualized more negative in 2001 in comparison to 1988 in overall.

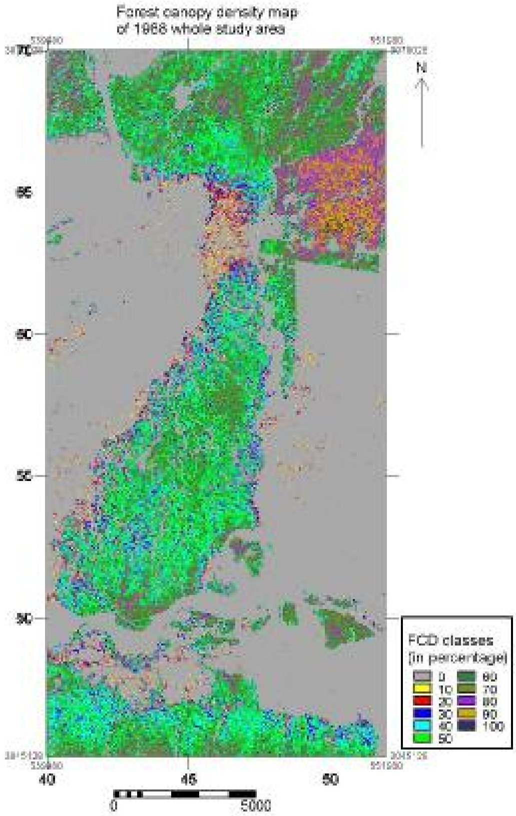

Figure 1 FCD map of whole study area in 1988

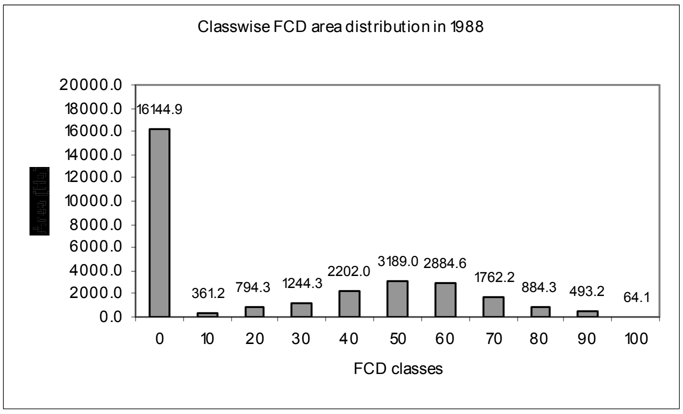

Figure 2 Classwise FCD area distribution in 1988

The comparison of 1988 and 2001 canopy density maps show which class of 1988 has been changed to which class of 2001. The matrix in Table1 reveals that the diagonal value is the *agreement value* (no change) between two dates. The row value right to this agreement value points to the positive conversion from 1988 to 2001 and left to this agreement value point to the negative conversion from 1988 to 2001. For example, class 5 has canopy cover area of 3189 ha. The no change class area (agreement value) is 662 ha. The row values right side to the agreement value indicates positive conversion from class 5 canopy cover area. Similarly, row values left of this agreement value indicate the negative conversion from this class. Positive conversion means area from lower canopy class is converted into higher canopy classes and negative conversion means vice versa of this. On the other hand, column values except agreement value shows which classes of 1988 contribute to the canopy class area for 2001. For instance, area of zero class in 2001 is the sum of the converted areas from the different canopy classes from 1988. The Classwise difference of canopy cover areas between 1988 and 2001, gives a clear indication that areas have been increased in classes 0, 2, 3 and 4 and decreased in classes 1, 5, 6, 7, 8, 9 and 10.

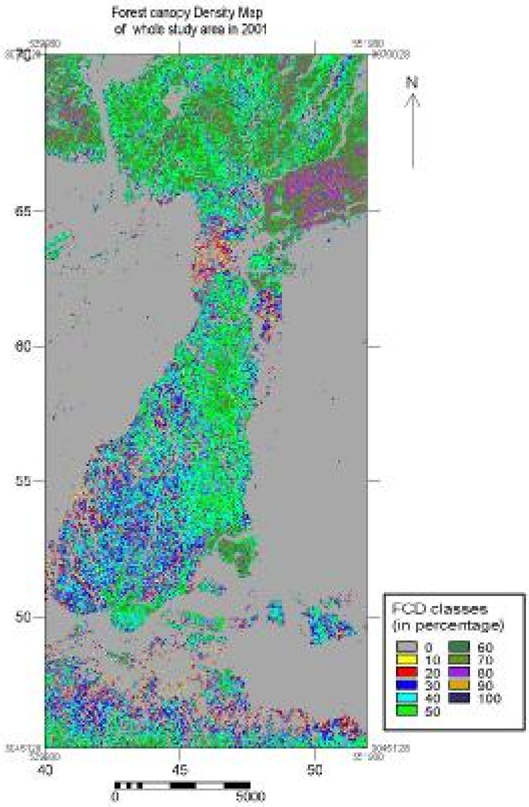

Figure 3. FCD map of whole study area in 2001

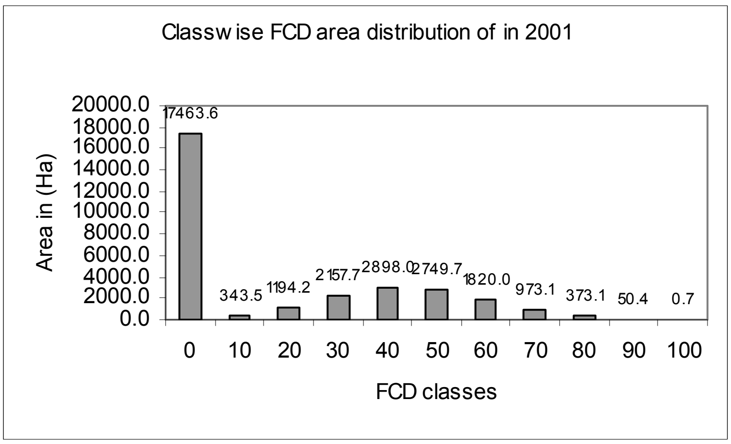

Figure 4. FCD area distribution in 2001

Canopy cover areas increased in zero indicate deforestation. Deforestation might be according to government resettlement programs or illegal encroachment from squatters. The areas increased in lower classes indicate that the forest getting worse in condition. Trees might have been cut or lopped. Forest is not growing in healthy condition. Disturbance from biotic and abiotic factors might have continuous effects. Protection mechanism of the concerning authority is not effective. Based on comparison of these results of 1988 and 2001, it can be concluded that forest condition has been severely degrading during this time interval. Table 1 gives a glimpse of conversion of forest canopy density from one class to next from 1988 to 2001. Conversion from the lower classes to higher ones might be the causes of growth from residual stands as well as plantation. The opposite case is due to the degeneration caused by natural (such as flooding, wind, dying etc) and human disturbances.

Table. 1 Transformation of forest canopy density

FCD area (Ha) distribution in 1988	FCD area (Ha) distribution and change in 2001											
	0	10	20	30	40	50	60	70	80	90	100	Grand Total
0	**14574**	118	302	354	340	254	133	56	12	1	0	16145
10	190	**14**	40	44	38	24	8	1	1			361
20	304	25	**86**	125	127	85	30	9	1	0		794
30	350	39	125	**226**	250	170	65	18	3	0		1244
40	491	54	205	405	**491**	360	148	41	7	0		2202
50	540	52	232	517	742	**662**	336	92	15	1		3189
60	382	29	136	327	598	710	**489**	182	30	2		2885
70	226	10	54	125	251	376	401	**244**	69	6	0	1762
80	175	3	12	28	53	93	167	211	**126**	17	0	884
90	190	0	2	7	7	15	40	112	100	**19**	0	493
100	41		0	0	1	1	2	7	10	2	**0**	64
Grand Total	17464	344	1194	2158	2898	2750	1820	973	373	50	1	30024

3. Discussions and Conclusions

FCD mapping results of 1988 in the areas presently occupied by three forest management regimes revealed that community forests and government-managed forest inside bufferzone (BZF) were almost in similar statuses except class zero. Government forest outside bufferzone (NBZF) was more degraded condition.

Community forest areas were found promisingly high FCD coverage in 2001, followed by non-bufferzone areas and the lowest in bufferzone forest. FCD improvement is remarkable in community forest between 1988 and 2001 and slightly improving in NBZF (inside study area but not in general). It reflects that the recovery of FCD condition is due to the effective management measures implemented by forest user groups. However, FCD deterioration is noticeable in BZF between 1988 and 2001 because of the ineffective management (or protection) measures as well as inability of the government forest authority.

Results of forest parameters, i.e., stem density, basal area, stem diameter at breast height showed that community forests possess higher stock per unit area (although all figures area not significantly difference than others) except the case of basal area of >10cm DBH class. Observed newly established forest patches (saplings and poles) and vigorous regeneration growth in several places indicated that ecological condition (productive capacity) of community forests have been remarkably improved. Activities such as cattle grazing, cutting of trees/poles/saplings and lopping of tree branches have either completely been stopped or effectively regulated in CF. Bufferzone forest was found comparable (except the case of basal area of 2-10cm DBH class) with community forest and significantly different than non-bufferzone forest in terms of the results of forest parameters. Current field observation showed positive protection status in most of the places of bufferzone forest. According to the local people, for 2-3 years this situation has been seen and they claimed that this was because of their active roles either by protecting marginal bufferzone areas as community forests formally or informally. In NBZF extremely poor results were found which were not comparable with other two forests. Human-induced activities responsible for forest degradation were found common in this forest.

Management effectiveness was expressed through some biophysical indicators. Temporal image analysis showed that FCD condition has remarkably improved in community forest. Current analysis of forest parameters also indicated healthy condition of forest. Healthy forest condition and local people's concern on local forest resources reflect the sound management. But forest areas under government management regimes (inside bufferzone and outside bufferzone) were seen either more degradation or relatively low FCD improvement. It reflected forest degradation, which continued until 2001 in these areas. Although current results of some forest parameters in BZF were not found significantly different than CFs as well as protection status was observed satisfactory, very severe forest degradation was observed in NBZF areas. It can be concluded that community forests have been effectively managed than government forest.

References

Rikimaru, A. and Miyatake, S. (1997). Development of forest canopy density mapping and monitoring model using indices of vegetation, bare soil and shadow, (www.gisdevelopment.net, date of access: September 10, 2003).