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Assessment of Variation of Biomass Level Using LANDSAT™ Data A Case Study of Foothill Zone of South Kamrup

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ABSTRACT

The foot hill zone of south Kamrup is one of the richest areas of Assam in terms of forest resources. The area selected for study is lies within 91°00′03″ E to 91°3′28″ E longitude and 25°43′57″ N to 26°04′44″N latitude. Bestowed with varieties of resources, the forests of the area played a vital role in the socio economic life of the inhabitants. At present there are 35 reserved forests providing habitats for a large variety of flora and fauna. But the habitats are increasingly under pressure from several factors resulting in a chaotic situation. The study emphasizes on the assessment of the variation of the vegetative cover of the area on the basis of NDVI (Normalized Difference Vegetative Index) and the associated causes of variation in between 1989 and 2010. The study shows a decrease of high level of biomass by 94.39% and medium level of biomass by 31.0% in the respective classes. As a result, low and very low and Low biomass level increased by 61.5% and 136.8% respectively.

KEYWORDS

Among the burning problems of the present day world, the problem of deforestation is one, which has posed a great threat to nature and human civilization. In most of the industrialized countries of the world, the forests have been exploited to such an extent that the balance of the local ecosystem got already deteriorated. There was a time when 70% of the land area of the globe was under forest and now the total area covered by forest has shrunk to only 16 percent.(FOA Global forest Resource Assessment 2010)

The per capita forest area fell globally from an average of nearly 1.2 ha in the 1960 to 0.6 ha in 1990 and it is projected to be less than 0.2 ha by 2020 (FAO 1995). Thus, between 1960 and 1990, there was a steep rise in the rate of deforestation worldwide with Brazil having the highest annual rate followed by India for 1,500 thousand hectares per year (Saxena, 2004). This huge loss of forest area over the globe has resulted in a number of environmental problems like climate change, land degradation, biodiversity loss, soil erosion, prolonged drought etc including imbalance in the local ecosystems. The major cause of loss of forest cover in India is the increasing pressure of biotic communities including man on forest land, as with only 2 percent of the total land of the world, India is supporting more than 15 per cent of the total world population (Singh, 1997).

Assam is famous for its rich forest resources and has been recognized as a part of the two mega biodiversity hot-spots, identified in India (Mittermeir et al). In 2005, the state had 26748 sq km under forest. In 2003 the figure was 27826 sq km. In between 2003 and 2005 therefore the loss of forest land in Assam was 1,078 sq km. According to the State of Forest, 2007 Assam occupied the second position in the country in terms of loss of forest land.

The foothill zone of south Kamrup is one of the richest areas of Assam in terms of biomass composition. The area selected for the study lies within 91°00′03″ E to 91°3′28″ E longitude and 25°43′57″ N to 26°04′44″N latitude comprising three revenue circles namely Palasbari, Chaygaon and Boko. Bestowed with varieties of resources, the forests of the area played a vital role in the socio-economic life of the inhabitants. The status of the reserved forests of south Kamrup foothill zone is also not satisfactory. Indiscriminate exploitation of forest resources has created serious problems in various spheres of the local environment. Among the numerous factors of biomass degradation, the unauthorized encroachment is the most conspicuous. According to the departmental assessment in 2005, the quantum of encroached forest land was 10,780 hectares out of its total area of 68125 hectares.

The objectives of the study are to focus on the variation of vegetative cover only and to suggest practical measures towards conservation and sustainable use of the forest resources available in the area. However, the objectives may be put as follows:

To prepare NDVI map for assessment of biomass level using Landsat data.

- To assess the cause and effect of variation in biomass level.
- To suggest remedial measures for future development.

The Landsat TM satellite images pertaining to1989 and 2010 were used to monitor the forest cover changes which has been analyzed in digital image processing systems in the GIS environment. ERDAS imagine 9.1 and Super Map deskpro-6 have been used to rectify images, Geo-coding, and preparation of NDVI maps.

Table: 1 – Characteristics of Satellite Data

Data type	Sensor	Date of Acquisition	Path	Row	spectral resolution
Landsat	TM	13th Feb/1989	137	42	28.5 m
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The geographical boundary of the study area is derived from the survey of India topographical maps bearing Map no. 78, 78, 78, 78, 78**,** and 78**,** on 1:50,000 scale. Subsets of the area of interest have been obtained overlapping the geographical boundary of the study area on the satellite images.

Generation of NDVI maps-

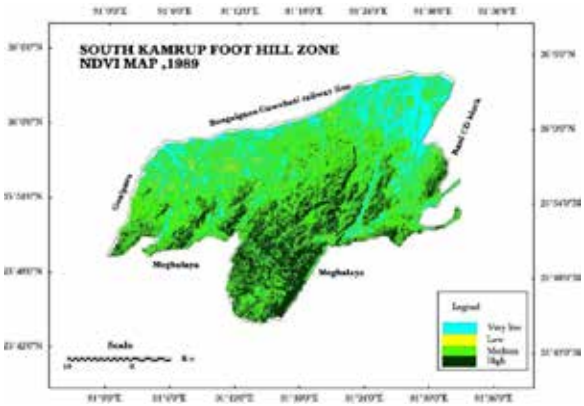
NDVI (Normalized differential vegetation index) was used for classification of the land cover because it is a good indicator of vegetation and helps to interpret the seasonal change in vegetation (Emerson et al. 1999). NDVI data sets provide unique opportunities for monitoring terrestrial vegetation conditions at regional and global scales (Saikia, 2008). Vegetative cover of generally yields high values of NDVI because of their

high near infrared reflectance and low visible reflectance. Water snow and cloud have negative NDVI values and rocks and soil have NDVI values around zero as because of almost equal reflectance in both the bands which is the indicator of land without vegetation. Only green vegetation has positive NDVI value and higher the value is the indicator of dense vegetative cover (Lillesand et al, 2000). NDVI maps are generated from the Landsat images using ERDAS imagine model maker and mathematically it can be written as-

NDVI = (NIR – R) / (NIR + R)
NDVI = (NIR – R) / (NIR + R)

Where "NIR" is satellite reflectance in near infra-red and "R" is reflectance in the red (Visible) region.

The NDVI maps pertaining to the study years exhibit a considerably unhealthy trend of vegetative covers during the year 1989 to 2101. This deceasing trend in the biomass health is due to the intensive anthropogenic activities on the forests.



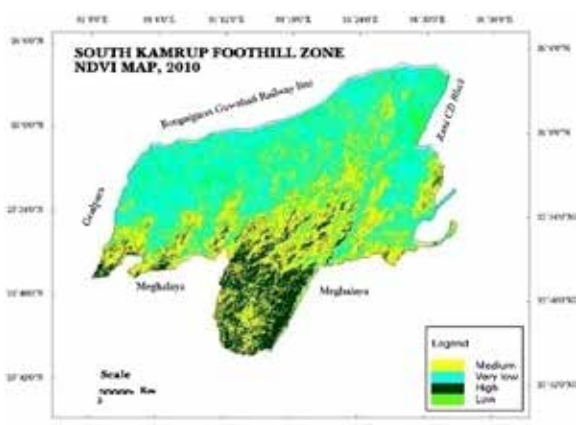


Table: 2 Variation of Biomass in the foot hill zone of South Kamrup

NDVI Values	Category	1989 Area in sq km	2010 Area in sq km	Change	% of change to Total	% of change to Respective class
-0.2 -.0	Very Low	196.64	465.68	269.04	+25.50%	+136.8
0 - .2	Low	181.61	293.33	11,1.71	+10.90%	+61.5
.2 - .4	Medium	406.08	280.50	12,5.57	-11.90.%	-31.0
.4 ->.5	High	270.32	15.14	255.18	-24.19%	-94.39
Total		1054.67	1054.67			

Data derived from Landsat Satellite image pertaining to 1989and 2010

The Normalized Difference Vegetation Index maps of the study area pertaining to the period 1989 to 2010 indicate a significant increase and decrease of different biomass level. The very low and low biomass level in the year 1989 was 196.64 sq km and 181.62 sq Km respectively which increased up to 465.68 and 293.33 sq Km in the year2010. This increase in the very low and low biomass level indicates a decrease in the healthy vegetative cover due to the severe interference of the human being on the reserved forests. On the other hand the medium and high biomass levels of the region are significantly decreased during the period of study. The area under medium level of biomass was 406.08. sq. km and 280.50 sq km in the year 1989 and 2010 respectively recording a loss of 125.58 sq km at the rate of 5.98 sq km per year. Similarly the category of high level of biomass also exhibits a significant loss of its status from 1989 to 2010. More than 24.19% of the biomass of the category has been loss during the period of 21 years at the rate of 12.15 sq Km per year. This significant loss of the biomass in this category is mainly due to the anthropogenic interferences on the virgin forest of the region which created nuisance not only in the status of the biodiversity of the region but also in the arena of the man environment relationship.

Causes of Biomass degradation

From the personal field observation, in the constituent three revenue circles of the study area namely Palasbari, Chaygaon and Boko and information obtained from the satellite images regarding variation of the biomass level changes, the following inferences have been drawn-

The dwellers of the forest villages have been maintaining an inseparable relationship with forest. They are spiritually and culturally entangled with the forest ecology for their sustenance. The survey reveals that 17.85% of sampled household are substantially dependent and 72.85% are marginally dependent on forest. Table -7

Table3 .Dependency on Forest					
Sl. No.	Revenue Circle	Total HH surveyed	Substantial Dependence	Marginal Dependence	No dependence
1	Palasbari	40	5 (13.00%)	31 (77.50%)	4 (10.00%)
2	Chaygaon	30	5 (17.00%)	21 (70.00%)	4 (13.30%)
3	Boko	70	15 (21.43%)	50 (71.40%)	5 (7.14%)
Total		140	25 (17.85%)	102 (72.85%)	13 (9.28%)
Source : Compiled from field survey *HH- Household					

In the recent past the commercial loggers exploited heavily the fine and durable hard wood like sal and teak. Timber smugglers of the locality, who work for the timber traders make attractive benefit for them and used to destroy the forest resources of the area. The social unrests prevailing in the area has helped a section of people for illegal treading of forest products mainly valuable timber. Most of the surrender extremist of different groups plundered the valuable forest resources of the area during the period of social unrest and even today the process is on. Study reveals that among the various factors of biomass degradation, illegal felling is the most crucial one, followed by departmental loopholes. Activities like firewood collection and natural calamities does not play significant role in variation

Table 4. Causes of Biomass degradation.cc deforestation						
Sl. No.	Revenue Circle	SCORE				
		Illegal Felling	Loophole in management	Firewood collection	Land Grabbing	Natural Calamity
1	Palasbari	209 (52.25%)	145 (36.25%)	19 (4.75%)	20 (5.00%)	7 (1.75%)
2	Chaygaon	163 (54.33%)	91 (30.33%)	15 (5.00%)	23 (7.66%)	8 (2.66%)
3	Boko	437 (62.43%)	184 (26.28 %)	28 (4.00%)	49 (7.00%)	2 (0.29%)
Total		809 (57.78%)	420 (30.00%)	62 (4.43%)	92 (6.57%)	17 (1.21 %)
Source : Compiled from field survey						

of the biomass level Table-8. Expansion of agriculture in and around the reserved forest is one of the major causes of deforestation as observed in the area. Low productivity of agriculture, small land holding size, subsistence nature of agriculture and poor economic condition of the area indulge the farmers to encroach the forest land.Table-9

Table 5.Number of Household with or without encroachment

Sl. No.	Revenue Circle	Household surveyed	No encroach	Encroachment (in hectares)			
				0 to 2	2 to 3	Above 3	Overall household
1	Palasbari	40	16 (40.00%)	23 (57.50%)	1 (2.50%)	0 (0%)	24 (60.00%)
2	Chaygaon	30	10 (33.33%)	14 (46.66%)	2 (6.66%)	4 (13.33%)	30 (66.66%)
3	Boko	70	24 (34.28%)	40 (57.14%)	5 (7.14%)	1 (1.42%)	46 (65.70%)
Total		140	50 (35.70%)	77 (55.00%)	8 (5.70%)	5 (3.57%)	96 (68.57%)

Source : ***Compiled from field survey***

Operation of trees in the private land in the name of patta land operation is the pivotal point which paves the way for unauthorized encroachment. Demarcation of private land for patta land operation is also a point of confusion. The respondents, who happen to be timber contractor earlier, disclosed that the departmental surveyor and the surveyor of the revenue department generally come to nexus with the patta holder and demarcate forest land with large number of valuable trees as patta land and after harvesting of the trees, the entire area is occupied for other use.

In the northern part of the study area, the density of population is very high and the agricultural practice is very intensive. Winter crops are produced in the area with irrigation from the rivers, deep tube wells and from the wetlands, which also affect adversely the soil moisture scenario of the area. In the recent time, a number of brick kilns have emerged in the area. These brick kilns burn bricks using fire woods collected mainly from the nearby forest causing great harm to the forests. Besides this, soil moisture is also lost in the process of burning resulting in the depletion of underground water level, which in turn plays negative role in the growth and development of forests.

Table 6. Protection Measures Taken by the Villagers

Sl. No.	Name of surveyed villages	Name of forest protection committee	Area protected (in hectare)		Under Reserve
			Sal	Teak	
1	Rajapara	Rajapara Forest Protection Committee	6.7	1	Barduar
2	Ghagrachook	Ghagrachook Unnayan Committee	20	3	Barduar
3	Santipur	Forest protection Committee	12	5	Gizang&Pantan
4	Mouman	Forest protection Committee	15	--	Mouman Reserve
5	Bamunigaon	Bamunigaon Peoples Assembly	25	8	Gizang
6	Jabepara	Jabepara Unnayan Samittee	10	0	Jarikhuri
7	Kompaduni	Village Committee	15	7	Mouman
8	Dhanipara	Bahatpur Village Committee	14	4	Kulsi, Barduar
9	Ratanpur	Ratanpur Village Committee	7	2	Pantan
10	Bhogdabari	Bhogdabari Village Committee	30	--	Jarikhuri

Source : Compiled from departmental report

Recently a movement for conserving forest resources has taken place among the natives of the locality. Vast areas under degraded forest have been conserved by the villagers and as a result regeneration of forest has been possible in the concerned areas. This is really a good sign which calls for support from relevant authorities in particular and the people in general.

The overall observation on the topographic and biological characteristics reveals that the forest areas under the foothill zone of south Kamrup is struggling hard for survival. The problem of forest loss is therefore, is serious and acute from the view point of the local as well as regional environment which calls for immediate scientific investigation and sustainable solution.

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