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Research Article

SPATIO -TEMPORAL CHANGE OF FOREST IN SONAMUKHI C.D. BLOCK OF BANKURA DISTRICT, WEST BENGAL, INDIA

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A R T I C L E I N F O

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A B S T R A C T

Forest is a natural resource and considered a complex ecosystem as well as the storehouse of different life forms. It has been maintaining not only ecological balance, hydrological cycle, nutrient cycle, bio-geo chemical cycle, ground water cycle, environmental stability-sustainability but also providing food, fodder, fuel, fiber, medicine and employment opportunities and also reducing soil erosion and pollution. No life form on the earth surface cannot think of life without fresh air, which is coming from the forest. Primitive men worship trees as God. Such sustainable thinking of primitive men have travelled a long distance in handing from one civilization to another civilization and have reached in modern decade. At the same rhythm the men have gradually erased of such values, believes and thinking and the eco-centric views of the biological man is replaced as techno-centric views of the technological man. Now the men have always involved in money making process for their contemporary life style and they do not spent a single moment in thinking of environmental sustainability. The research article is an empirical investigation to chalk out the status, causes and consequence of Spatio-temporal change of forest in Sonamukhi C.D. block of Bankura district. The endless demand of the increasing human population, human's need and greed, thinking of more profit-more gain and lack of proper environmental education have played an important role for the changing forest scenario of the ill-fated study area.

INTRODUCTION

Spatio-temporal change of forest simply means the change of forest covered area in respect of space and time. The change of forest has been occurring either the reduction of forested area or the changing trees patterns in the forest area. But here it means the expansion of agricultural land (mainly paddy crop) and settlement which have become a threat for forest cover (sing *et al*., 2006). Lund (1998) has defined deforestation as the removal of vegetation and exposure of bare soil throughout at least one growing season. Rowe *et al*., (1992) estimated that world deforestation occurred at the rate of 16 million hectare per annum from 1990-2000 and decrease to 13 million hectare per annum from 2000-2010. Chakravarty *et al*., (2012) have mentioned two causes of deforestation like direct causes (expansion of farming land, plantation, logging and fuel wood, overgrazing, fires, mining, urbanization and industrialization, air pollution and tourism) and indirect causes (colonialism, exploitation by industrialized countries, over population and poverty, land rights, corruption and political causes). Sonamukhi is such a block of Bankura district where the forest covered area have gradually encroached by different anthropogenic pressure like expansion of agricultural land, settlement, error plantation, overgrazing, fuel wood, natural and man-made forest fire etc.

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Study Area

Sonamukhi block is situated under the forest and the riverine environment of eastern part of Bankura district (Map 1 and 2). The block is bounded by the latitudes of 23°10' N to 23° 25′ N and longitude of 87°15′ E to 87° 30′ E encompassing 368.3 sq. km area and consists of ten gram panchayats with 158697 population and 430 persons / Sq. K.m population density (Census of India 2011). The surface elevation is 75 meter from Mean Sea Level (MSL). Total forest cover area of the block is 8494.70 hactres (Census of India 2011). The study area has unique physiographic landscape by which the area get a unique character from the other surrounding areas (Table 1).

Objectives of the study

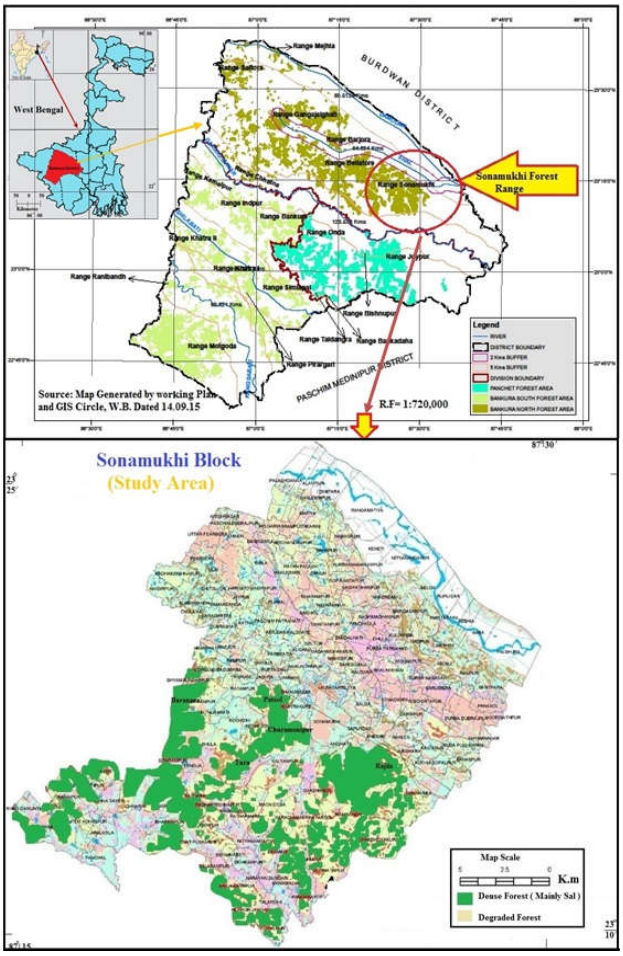
The main objectives of this research article are as follows

- To study the overview of land use and land cover change in the concern study area.
- To study the forest status and the Spatio-temporal change of forest cover land in the study.
- To chalk out feasible causes of changing forest cover land in relation to the increasing population pressure.

Table 1 Geographical account of Bankura District and Sonamukhi Block

Parameters	Bankura District	Sonamukhi Block
Area (Sq. k.m)	6882	368.3
Altitude	50-150 m	75 m
Latitude	22° 38' - 23° 38'	23° 10' N - 23° 25' N
Longitude	86° 36' - 87° 46'	87° 15' E - 87° 30' E
Highest Hills	Susunia (440 m)	-
Climate Temperature	Tropical, dry and sub-humid. Summer- 26°c – 38°c Winter – 15°c – 24°c	Tropical, dry and sub-humid. Summer- 24°c– 36°c Winter – 12°c – 20°c
Rainfall Humidity	140 cm 50- 82%	140 -150 cm 60 – 80%
Landscape Types	Slightly undulating, Rarh plain	Alluvial plain with slight undulating surface
Soil Types	Laterite - gravel mixed red soil, Alluvial soil	Alluvial soil and mixed laterite and red soil
Vegetation Types	Dry Deciduous Types - Sal, Mahua, Palas, Thorny Shrub, Palm, Mango	Sal, Palas, Mahua, Kusum,
Forest Cover(H)	98598	8494.70

Source: District Census Handbook, Bankura, 2011



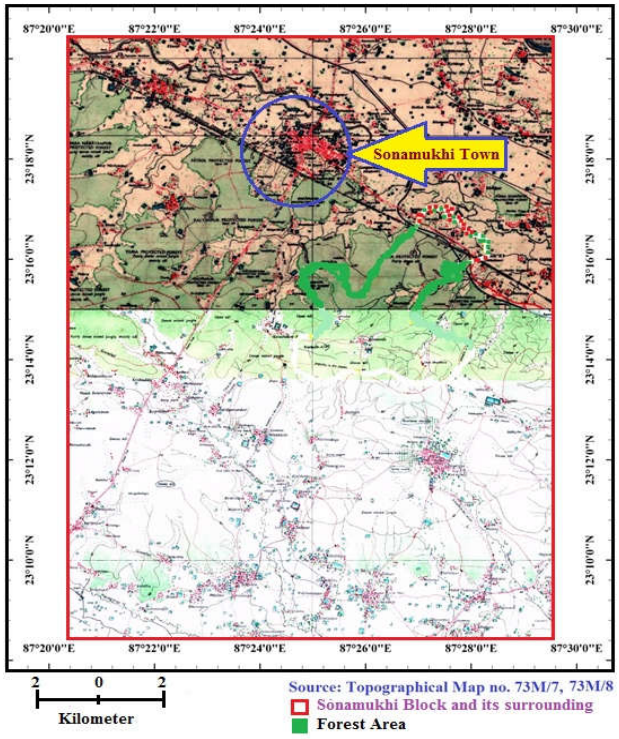
Map1 Location of the study area

Source: Prepared by authors based on working plan and GIS circle, W.B, 2015

Data Base and Method

The entire work has been done based on primary as well as secondary information (Table 2). The primary data have been collected through field survey and face to face interview based on structured questionnaire of 125 households in one hand and on the other secondary data have been collected from District Census Handbook (DCH), District Statistical Handbook (DSH) of Bankura District in different years. Topographical map is another important source of secondary information which have collected from Survey of India (SOI). Some of these data have been collected from Land and Land Reforms Department (LLRD), Government of West Bengal, Divisional Forest Officer (D.F.O) of Bankura north division, Forest Ranger Officer (FRO) and the Block Development Officer (B.D.O) of Sonamukhi block. Besides these, many reports, books, journals and Government publication *Viz.* Gazetteer, socio-economic abstract etc. have also consulted. Most of the Census data and collected data have been analyzed through Microsoft Office Excel 2010 (MOE) (Microsoft Office Software package 2010) for data processing, calculation, tabulation and analyzed with suitable diagram, chart, graph and statistical methods and techniques. For the preparation of mapping Arc GIS version 9.5, Q GIS version 2.6.1 have been used. Here two images have been classified on the basis of Normalized Difference Vegetation Index (NDVI).The formula stands as

$$NDVI = NIR - RED / NIR + RED$$



Map 2 Sonamukhi Town and its Surrounding Areas

Table 2 Source of Information

SLNo.	Source of Information	Publishing Authority	Out put
1.	Police Station map and Cadastral map	Government of West Bengal	Location map, Forest Division (FD) map
2.	Topographical maps number 73M/7, 73M/8	Survey of India	Surface elevation, Forest coverage map
3.	Census of Bankura district(Block wise) in 1971, 1981 1991,2001,2011	Government of India and West Bengal	Distribution of forest, forest density, total population, population density (Choroplopleth map)
4.	District statistical hand book, Bankura district (1971,1981,1991,2001,2011)		
5.	Perception survey through questionnaire schedules	Primary interviews from door to door households survey	People's Perception on this area and the issue

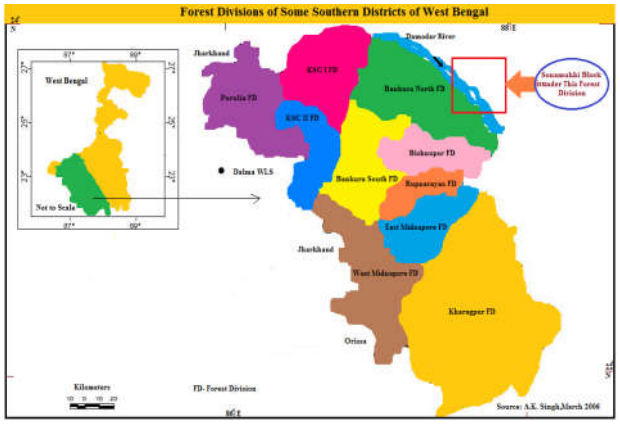
Source: Survey of India, census of India and District statistical hand book, Bankura district (1971-2011), Field survey, 2017

RESULT AND DISCUSSION

Forest Divisions of some Southern districts of West Bengal

Bankura district have four forest division such as Bankura North FD (Forest Division), Bankura South FD, Rupnarayan FD and Bishnupur FD. The Purulia district consists of three

forest divisions such as Purulia FD, KSCI FD and KSCII FD whereas the Midnapore district have three forest divisions like East Midnapore FD, West Midnapore FD and the Kharagpur FD.



Map 3 Forest Division of some southern district of West Bengal

Source: Prepared by authors based on A.K. Singh, 2006

The study area Sonamukhi Block is under Bankura North forest division (FD) of Bankura district (Map 3). The Sonamukhi forest range is further divided into four forest beats such as Sonamukhi beat, Indkata beat, Hamirhati beat and Manikbazar beat. Among four beat Indkata is covered by natural sal forest in large scale (Figure 1 and 2). The topographic as well as cultural land scape of southern part of west Bengal is considerable dissimilar from the other areas.The region have a unique plateau fringe character, which is the extended and elongated part of chhotanagpur plateau where East Midnapore district is a part of coastal land. Sal is the dominant plant species. Besides sal tree, the other predominant plant species are *palash, mahua, kendu, piyal* etc. In recent times, eucalyptus and akashmoni plantation have been increased day by day in the concern districts. As areas are considered as water scarcity area of west Bengaland most of the areas are not used for agriculture so, these areas are used for the plantation of eucalyptus or akashmoni trees in large scale. These species are economically valuable but not environmentally sustainable. Because, these type of trees turn to maturity within short period of time.

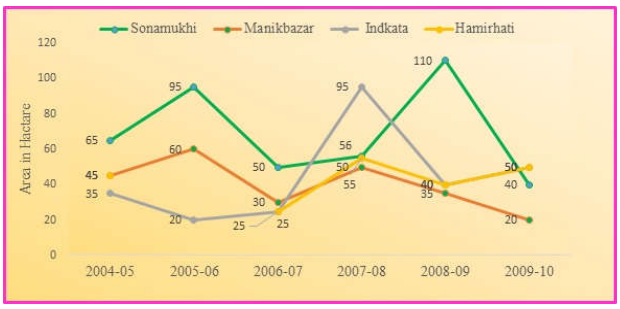


Figure 1 Temporal change of forest area in Sonamukhi Block (2005-2010)

Spatio-Temporal Change of Forest Area in Sonamukhi Block

Forest is considered as a natural biotic resource. Forest hasdynamic character and also influenced by climate, soil and topographic difference.

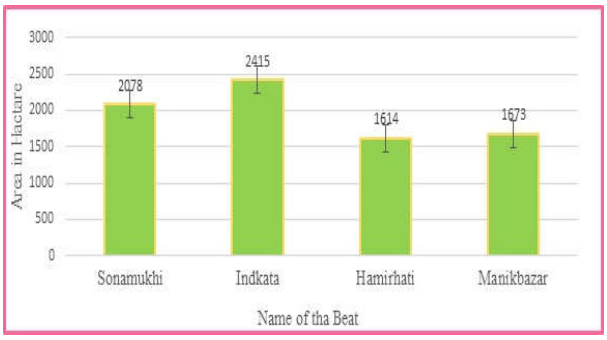
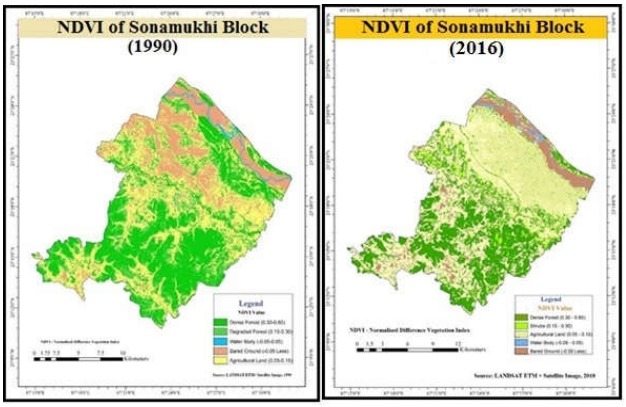


Figure 2 Total Forest cover Area in Sonamukhi Range, 2011



Map 4 Change of Forest Area using NDVI

NDVI is used to show the changing forest cover as well as changing Land use Land cover. The value of NDVI ranges from -1 to + 1. Higher value indicates the healthy vegetation where lower value indicates the sparse vegetation. In Sonamukhi Block the NDVI values are changed from the year 1990 to 2016 The following table shows a short description:

Attributes	NDVI Values 1990	2016	Remarks
(1) Dense vegetation	0.30-0.60	0.30-0.58	Reduction Health vegetation
(2) Degreded Forest	0.15-0.30	0.15-0.31	Increased sparse vegetation
(3) Water Bodies	-0.005-0.05	-0.05-0.05	Remain same
(4) Bared Ground	Less -0.05	-0.05-0.05	Increased
(5) Agricultural Land	0.05-0.15	0.05-0.20	Maximum increased

Source: Computed by authors, 2017

Source: LANDSAT ETM+ Satellite Image, 1990 and 2016

Figure 3 Short description about NDVI of Sonamukhi Block from 1990-2016

Source: Prepared by authors based on NDVI value

The natural sal forest has been existing in five G.Ps out of ten G.Ps in Sonamukhi block. The forest cover G.Ps are Manikbazar, Panchal, Dhansimla, Hamirhati and Kochdihi. In these Corresponding G.Ps there are 15, 10, 7, 4 and 10 number of mouzas are covered by natural sal forest out of 16, 11, 13, 4 and 10 number of mouzas respectively. The forest cover area of the respective G.Ps are 93.75%, 90.91%, 53.85%, 25% and 100% individually. The changing patterns of the forest is very much remarkable from the census year 1971 to 2011. The negatively change of forest has been found in Dhansimla (-27.11%), Hamirhati (-47.12%) and Panchal (-46.43%). At the same time the forest has been positively changed in Kochdihi (16.26%) and Manikbazar (1.41%). Five forest based G.P.s are Manikbazar, Panchal, Dhansimla, Hamirhati and Kochdihi. Here the population have been changed respectively 85.25%, 49.30%, 110.54%, 53.30% and 73.49% from the census year 1971 to 2011. The uppermost and lowermost population have been changed in Hamirhati G.P (18.95%) and in Panchal G.P (9.00%) and other G.Ps are Manikbazar (13.02%), Dhansimla (14.64%) and Kochdihi (10.06%) (Map 4 and Figure 3). The Panchal and the Kochdihi G.Ps are the motivating character

among the other forest cover G.Ps From the year 1971 to 2011. The forest of Panchal and Kochdihi has been positively and negatively changed from the census year 1991 to 2011. Panchal (-46.43%) has turned in to destructive position whereas the Kochdihi (16.26%) arises in constructive position. The percentage of forest has been remarkable changed between in two G.P like Hamirhati (-47.12%) and Panchal (-46.43%). The change of forest has slightly positive in Manikbazar (1.41%) and Kochdihi (16.26%) and the moderately negative change has been occurring in Dhansimla (-27.11%)(Figure 5). The anthropogenic activities like the expansion of agricultural land due to the pressure of increasing population and settlements has been playing an important role for the reduction of forest cover area in this block (Figure 4 and plate 1a,b,e)

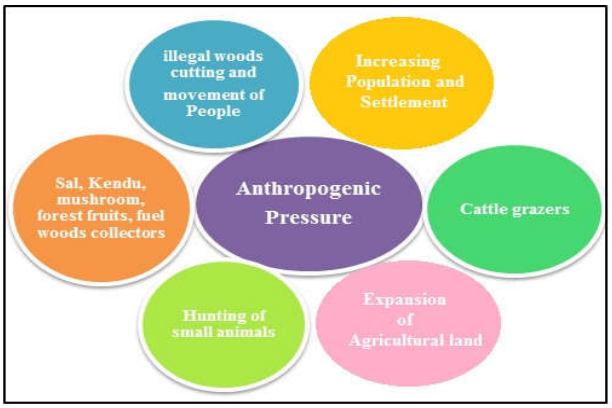


Figure 4 Anthropogenic pressure within the forest in Sonamukhi Block, 2017

Source: Prepared by authors based on primary information from the residents, 2017

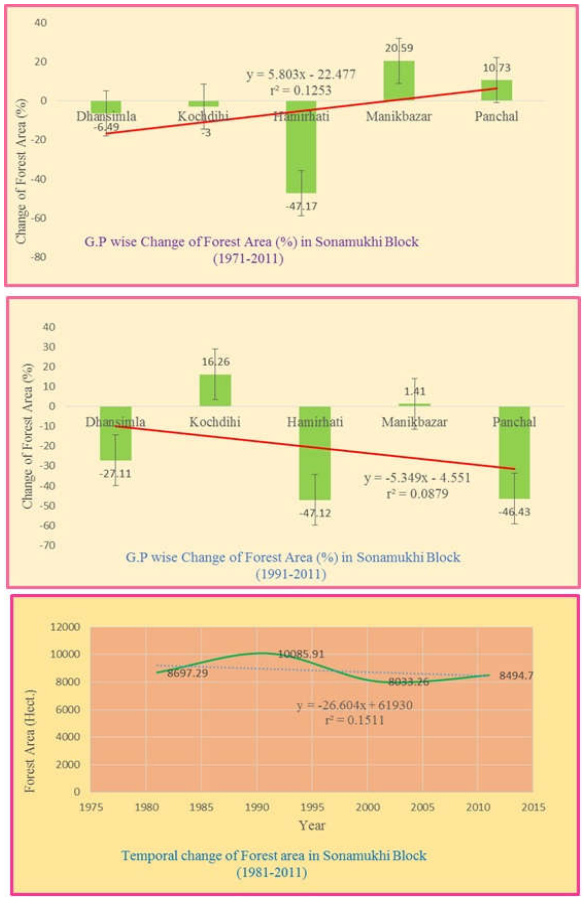
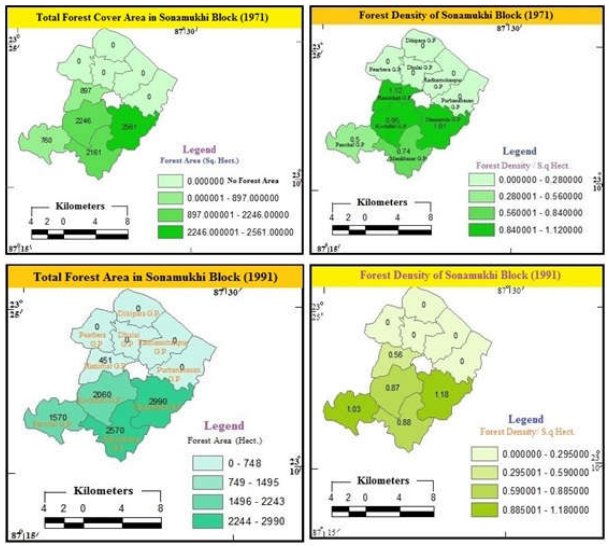


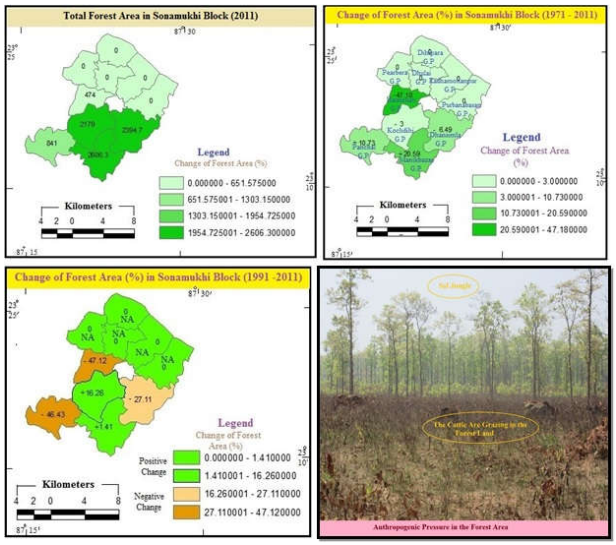
Figure 5 Spatio-Temporal Change of Forest in Sonamukhi Block



Map 5 Spatio-Temporal Change of Forest and Forest Density

Source: Prepared by authors based on census data, 2011

The total forest cover area in Sonamukhi block has been changing over time. The total forest covered was 8697.29 hectare in the year 1981 but in 1991 the forest hasbeen surprisingly changed into 10085.91 hectare due to the causes of large scale plantation. But in the year 2001 the forest has negatively changed into 8033.26 hectare due to the causes of anthropogenic pressure like deforestation, grazing, man- made forest fire and the expansion of agricultural land. Now in the year 2011 the forest area is amazingly changed into 8494.7 hectare as the vacant forest area has filled up with eucalyptus and akashmoni plantation at random. Here the G.P wise forest status is very much significant. In the year 1971 the highest forest cover area and forest density has been found in Dhansimla G.P. (2561 hect.) and Hamirhati G.P (1.12 / sq. hect.) G.P. and the other forest cover G.Ps are in better position like Kochdihi (2248hect.), Manikbazar (2161 hect.), Hamirhati (897 hect.) and Panchal (760 hect.). The forest density of the respective G.Ps were Dhansimla (1.01 sq. hect.), Kochdihi (0.95 sq. hect.),



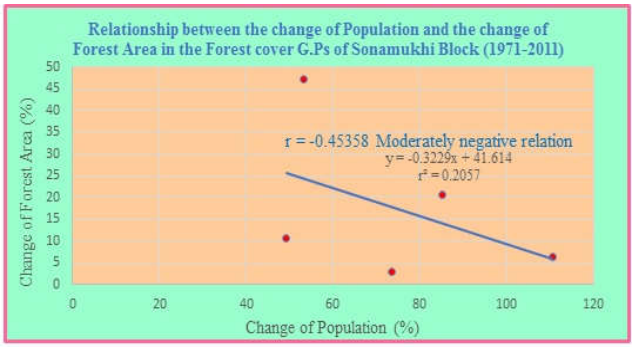
Map 6 Spatial Change of Forest in Sonamukhi Block

Source: Prepared by authors based on census data, 2011 and photograph retrieved by the authors, 2017

Manikbazar (0.74 sq. hect.) and Panchal (0.5 sq. hect.) (Map 5 and 6). In the year 1991 the forest cover area and the forest density has positively changed through all the G.Ps except Kochdihi and Hamirhati G.Ps. In Kochdihi and Hamirhati G.Ps the reduction of the forest has been correspondingly 188 hectare, 446 hectare and the forest area has positively changed the rest other three G.Ps. The enlargement of the forest area of the consisting three G.Ps were Dhansimla, Manikbazar and Panchal. The rate of expansion was429 hectare, 409 hectare and 801 hectare (Map 5 and 6).The forest area has remarkably changed from the year 1971 to 2011 in concern block. The forest has negatively changed in the three G.P like Hamirhati (-47.18%), Dhansimla (-6.49%) and Kochdihi (-3.0%).

Relationship between change of population growth and change of forest area

In the study area the growth of population increasing year after year at the same time the forest covered area has been changed continuously (Map 7 and Figure 8). The correlation value (r) between change of population and the change of forest covered area as well as change of forest density is – 0.4586 and -0.45358 respectively (Figure 6 and Table 3). The correlation value indicate the moderately negative relationship between the population and the forest covered area and the forest density in this block. These change of forest directly impact on the bio-physical environment in one hand and the diversification of forest based rural livelihood on the other in the study area (Figure 7 and 9a,9b).



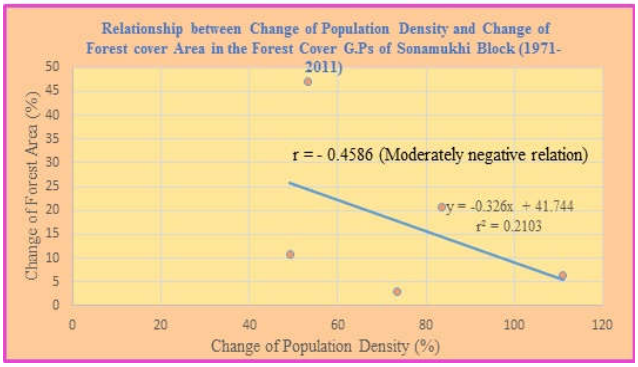


Figure 6 Change of Forest area in Relation to Population and Population Density

Source: Source: Prepared by authors based on census data, 2011

Table 3 Relationship between Population growth and Forest cover area

Census Year	Population	Forest Cover area (Hectare)
1971	86956	8697.29
1991	123665	10085.91
2001	138368	8033.26
2011	156636	8494.7
Total no. of Observation (N)		**4**
Total	**505625**	**35311.16**
Mean Value	**126406.25**	**8827.79**
Standard deviation (S.D)	**25596.67**	**765.2**
Co efficient of Variance (C.V)	**20.25%**	**8.67%**
Comment	As the C.V value of population (20.25%) is greater than the forest cover (8.67%) area so, i. The forest area is more consistence than the population ii. The forest area is more stable than the population iii. The population is more variable or reliable than the forest area	
Co efficient of co relation (r)	**-0.228**	
Comment	As the correlation value (r) is -0.228 so, there is a poor negative relation between population and forest cover area	

Source: Census of India (1971-2011)

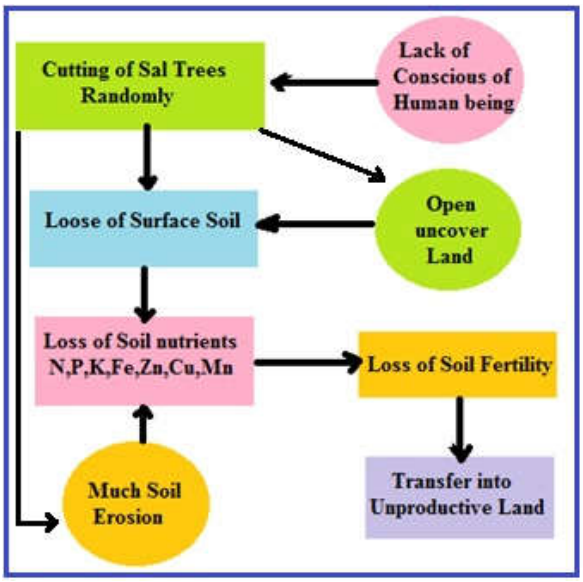


Figure 7 Problems related to Deforestation in the Study Area, 2017

Source: Prepared by authors based on perceptions study of the respondents, 2017

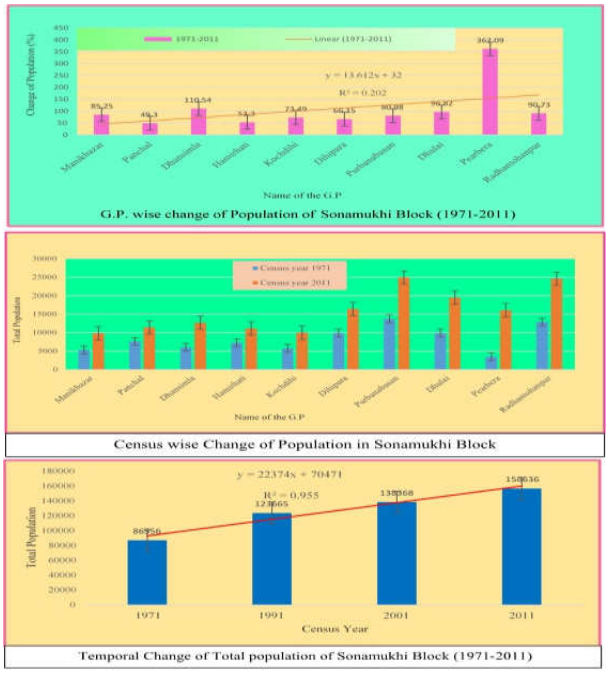
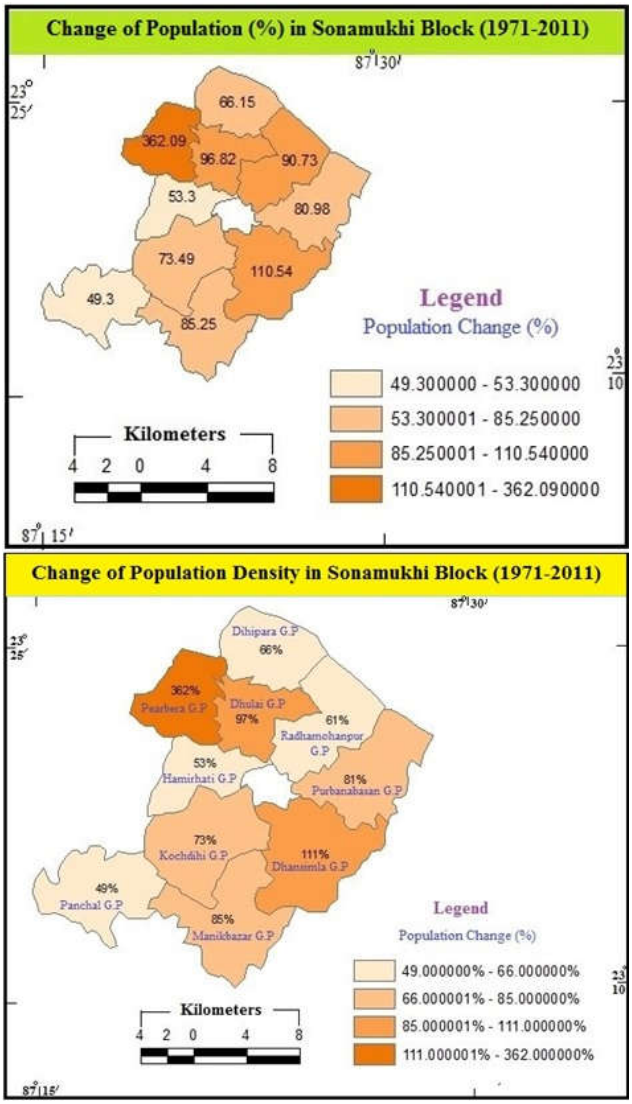


Figure 8 Spatio-temporal change of population in Sonamukhi Block (1971-2011)

Source: Source: Prepared by authors based on Census Data (1971-2011)



Map 7 Spatio-Temporal Change of Population and Population Density

Source: Source: Prepared by authors based on Census Data (1971-2011)

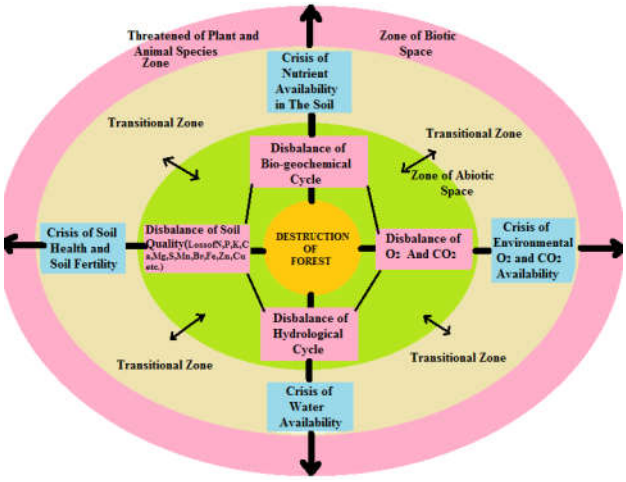


Figure 9a: Impact of Deforestation on Bio-Physical Environment in the Study Area

Source: Prepared by authors based on perceptions study of the respondents

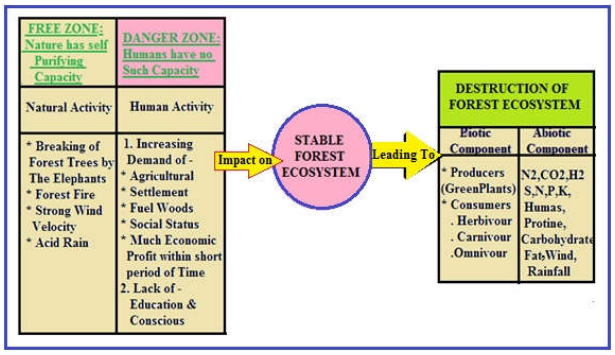


Figure 9b Impact of Deforestation on Bio-Physical Environment in the Study Area

Source: Source: Prepared by authors based on perceptions study of the respondents

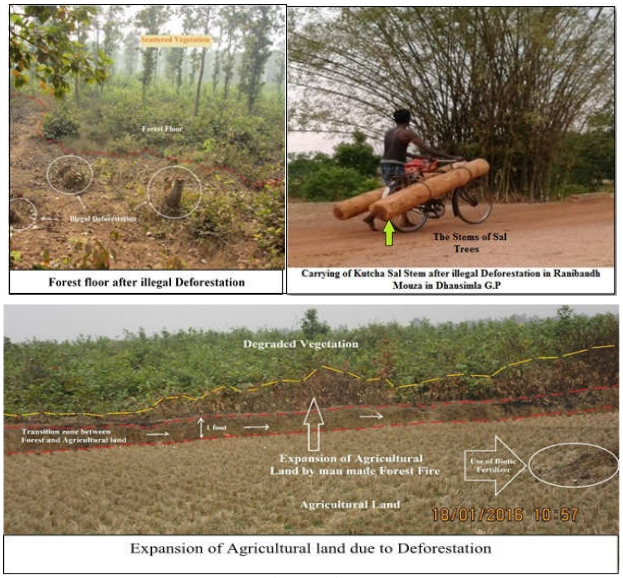


Plate 1a,b,c

CONCLUSION

At the end of the above discussion it may be concluded that in the study area the natural forest has been changed over time and space. Sometimes, the residents have been cutting the forest trees for the requirements of their domestic needs like fuel, making agricultural utensil and rural household furniture. The needs of the residents are progressively transferred into greed and cutting trees randomly in absence of forest officers at night and selling to the wood mafia with minimum prices. It is the enjoyment cum profit to the teen aged boy and young people. These activities are not continuing day by day but during these time of operation the climax species communities have gradually been lost and finally abolished. At the same time the ecological balance is also interrupted. In the vacant forest area the Government have planted eucalyptus and akashmoni trees in large scale, but these species are not the substitute of the climax trees. These activities can fill up the vacant area but cannot return the same eco-balance within the area. It is true that, most of the residents of the study area are involved in collecting NTFPs and earning household income. Sometimes when the elephants are coming into the forest the people have stopped their collecting activities in one hand and on the other some of the unconscious people cutting climax sal trees from the local forest as the elephants destroyed their agricultural products. In these way large number of climax sal trees have been abolished during last decade. Environmental

education, proper training and governmental rule and regulations have been increased from the grass root level so that the environmental ethics have also been increased either by forced or by spirituality. Otherwise the seminar symposium have been increased day by day for protecting trees as well as environment, but how these valuable words can reached to the common people? The top-down approach must be stopped and bottom-up approach has adopted so that we can get and give a beautiful world for our future generation.

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