

Human Modification of the Tropical Rain Forest of Nicobar Islands: Indicators From Land Use Land Cover Mapping

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ABSTRACT Tropical forests are pre-disposed to human induced modification throughout the world. It has serious implications at local, regional and the global levels. Repercussions are more severe in the island ecosystems since they are ecologically vulnerable and fragile. The present paper attempts to investigate the linkages between socio-economic drivers and the consequent modification of the landscape in terms of forest loss, in the Nicobar group of islands based on indicators derived from land use land cover mapping of the satellite remote sensing data. Although these islands have more than 80% of the area under forests but the situation varies in each of the twelve inhabited island of the group and they are under the varying degree of human pressure. Most active driver is the coconut plantation in addition to time-to-time clearing made in the past. There is a need to investigate the on-going modification of the land cover in these islands and satellite remote sensing forms a useful tool for such studies

INTRODUCTION

Human beings are an integral part of the ecosystems and have sizeable impact on their function as well (von Bodungen and Turner, 2001). However, It is now considered that “human activities are influencing or even dominating many aspects of the earth’s environment and functioning” leading to the implication we are now in “another geological epoch, the Anthropocene era” (IGBP, 2001). More than half of the habitable surface of the earth has been altered by human activity in the recent years (Hannah and Bowles, 1995). Deforestation in the tropics has become a worldwide phenomenon, due to human activities. In the 20 years between 1960 and 1980 alone, Asia lost almost one third of its tropical forest cover, the highest rate of forest conversion in the world (Singh and Marzoli, 1995). The causes of deforestation are many and varied. Deforestation results from complex socio-economic processes, and in many situations it is impossible to isolate a single cause (Walker, 1987). The links between proximate causes (agricultural expansion, wood extraction and infrastructure development), underlying driving forces (social), land-use and land cover change have been conceptualized by various workers (Meyer, 1993; Ojima et al., 1994; Lambin, 1997; Ledec, 1985; Mather et al., 1998;

Bawa and Dayanand, 1997). The most obvious impact of the deforestation in the tropical has been the loss of bio-diversity. We have already been on the verge of mass extinction (Elliot, 1986).

The islands represent a very special ecosystem (Natrajan, 1994) and are endowed with limited natural resources. Over-exploitation of these resources may result in very fragile environmental situation. The size of arable land, soil conditions, and water availability provides limits to the agriculture practices, which are common elsewhere. Industrial development is also limited due to limited local markets and long transport distances. Due to these limitations islands are faced with very few alternatives of the development of cash economy and for the creation of employment (Peterson, 1992). Although tourism have proved to be good source of income in many of the island in Thailand, Singapore or Hong Kong with earnings ranging from US \$ 3 billion to US \$ 6 billion annually (Negi, 1992) but the situation in the Nicobar group of islands in India has been different. Due to their strategic location, these islands are not open for tourism unlike several other islands of the Andaman group. Their remoteness from the mainland India further put constraints on the industrial development in these islands (Dyal, 1994). Therefore the local tribes, Nicobarese dwelling in these islands depend mainly on coconut plantations for their subsistence. With the increasing population, pressure on the land is inevitable and more forests are being converted

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into settlement and plantations. These islands harbor tropical low land rain forests, which are floristically richest, potentially complicated and wildly developed. Out of 700 species occurring in great Nicobar Island alone, 74 are endemics, 210 are strictly Malaysian and only 416 remaining are having wide spread distribution (Bala-krishnan and Ellis, 1996). However, these forests have received no attention except for exploratory studies and very recent clear felling in Katchal and Great Nicobar Island. The tinkering of islands for non-sustainable, non-carrying load of resource utilization is of mounting concern

(Nayar, 1996) and there is a need to develop a firm understanding of human dimension of the land utilization pattern in these islands to address the issue of sustainability.

STUDY AREA

The Andaman and Nicobar is the archipelago of 319 islands with an area of 8249 Km² lies between latitude 6° to 14°N and longitude 91° to 93°E. Of the total 319 islands, only twenty-two belong to the Nicobar group, of which only twelve islands are inhabited. (Fig. 1). Each of

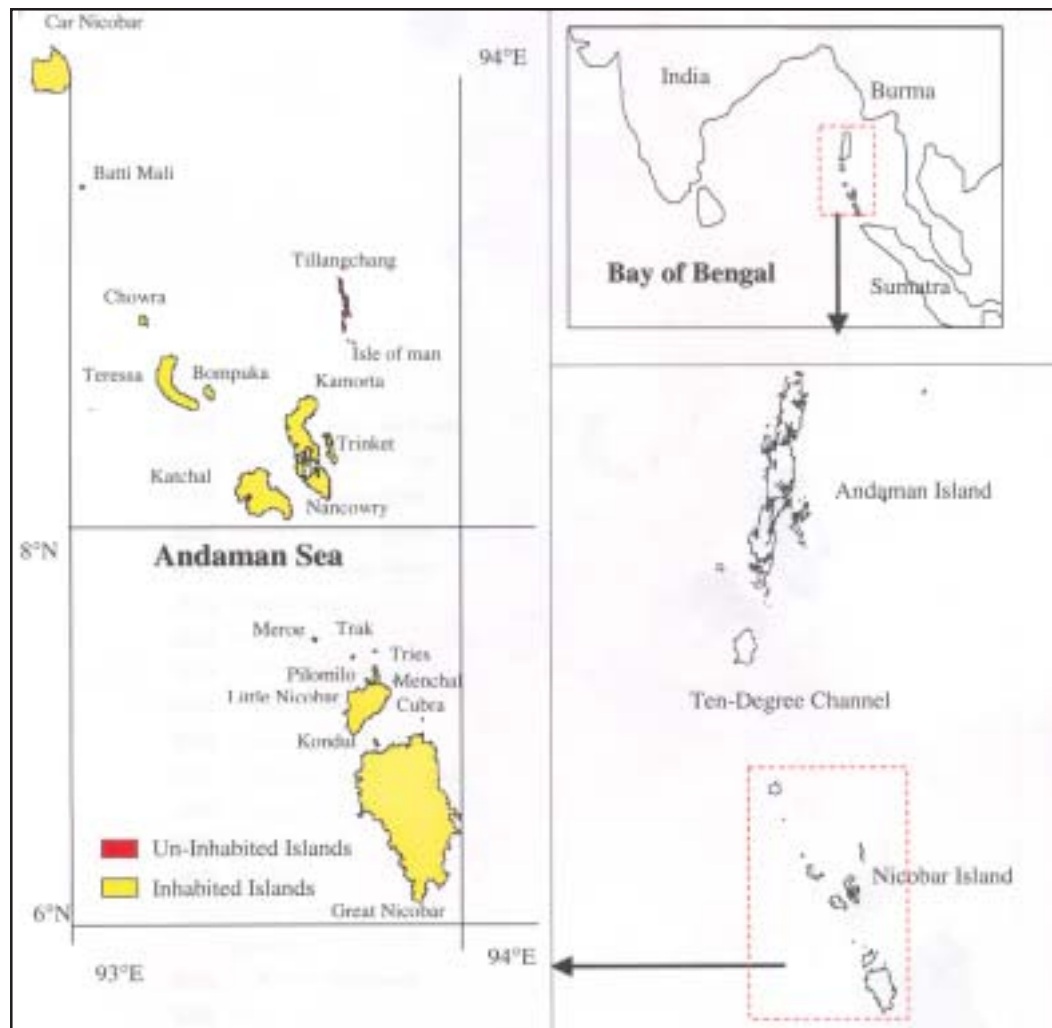


Fig. 1. Location map of the Nicobar Islands

these 12 inhabited islands is at various stages of transition and development. Car Nicobar is the headquarters of Nicobar district, about 250 Km. South of Port Blair, lying south of Ten-Degree Channel in the Bay of Bengal.

METHODOLOGY

The entire study is conceived in three parts. The socioeconomic data was collected from the statistical department and the relevant information was compiled in a tabular form for all the twelve islands. Data on decadal variation of population was also studied. Land use/ land cover mapping was carried out using on-screen visual interpretation of the IRS 1C LISS III data at 1: 50,000 scale and major classes were mapped. Total 22 classes were delineated on the satellite data. Next section based on literature survey and ground information the classes were grouped into four classes i.e. Natural, semi natural, manmade and others. This was followed by detailed analysis of the final classes with respect to socio-economic profile of each of the inhabited island.

RESULTS

Socio-economic Profile

The relevant information was collected on population structure and composition, occupation and land ownership pattern (Table 1).

Administrative Setup: Car Nicobar is the district headquarters but the administration primarily rests in the hands of the tribal Chief of the island community of the Nicobarese living in the village or a group of village (Roy and Choudhury, 2001). The Chief inherits the position by heredity or appointed by the Government. Usually the chief is the person who has risen to the influential position in the society by owning maximum number of pigs and the largest coconut plantation. The administration differs slightly in the Car Nicobar where population is comparatively more and villages are less. Each village therefore has a Chief (Captain) who with his deputy and the committee of elders decides all the disputes. Each village is further divided into groups under sub-chief. All the members of a group under a sub-chief are responsible for the material welfare of the individuals comprising the group.

Landownership Pattern: Only Great Nicobar is having revenue villages and panchayat bodies, rest of the islands have only tribal villages and no panchayat bodies. Also the Andaman and Nicobar Forest Department have declared a considerable part of Great Nicobar as Biosphere Reserve. In rest of the islands land holdings rest with the tribes only.

Population: The major population of these islands comprises of the local tribes the Nicobarese who belong to the mongoloid group. Their population has shown an increasing trend and has quadrupled over a century figuring 26, 122

Table 1: Socio-economic profile of Inhabited islands of Nicobar

Island Name	Area (km ²)	Villages (Inhabited + Un-inhabited)	Revenue Villages	Panchayat Bodies	Total Population (Tribal + Non tribes)	Population density	Main Occupation
Car Nicobar	126.90	16 (16 + 0)	Nil	Nil	19336(15781 + 3555)	152.37	Agriculture, Fisheries, Small scale Industry
Chowra	8.20	5 (5 + 0)	Nil	Nil	1225 (1196 + 29)	149.39	Agriculture
Teressa	101.40	11 (11 + 0)	Nil	Nil	1779 (1617 + 162)	17.54	Agriculture
Bompuka	13.30	1 (1 + 0)	Nil	Nil	51 (51 + 0)	3.83	Agriculture
Katchal	174.40	35 (34 + 1)	Nil	Nil	5072 (2491 + 2581)	29.08	Agriculture, Fisheries, Small scale industry
Nancowry	66.90	18 (16 + 2)	Nil	Nil	1041 (907 + 134)	15.56	Agriculture, Fisheries
Kamorta	188.20	32 (27 + 5)	Nil	Nil	2973 (1393 + 1580)	15.78	Agriculture, Fisheries, Small scale industry
Trinket	36.30	5 (4 + 1)	Nil	Nil	350 (350 + 0)	9.64	Agriculture
Pilomilo	1.30	1 (1 + 0)	Nil	Nil	122 (109 + 13)	93.84	Agriculture
Little Nicobar	159.10	22 (20 + 2)	Nil	Nil	308 (295 + 13)	1.94	Agriculture
Kondul	4.60	1 (1 + 0)	Nil	Nil	147 (139 + 8)	31.96	Agriculture
Great Nicobar	1045.10	44 (34 + 10)	7	6	6831 (524 + 6307)	6.54	Agriculture, Fisheries, Small scale industry

Source: Anon., 2001

according to 1991 census (Table 2). Bulk of Nicobarese live in Car-Nicobar Island, and to a lesser extent in the Nancowry, Katchal, Kamorta, Teressa, Bompuka, Chowra, Little Nicobar and Great Nicobar. Major proportion of the population in all the islands except Great Nicobar, Kamorta and Katchal is Nicobarese. Kamorta and Katchal have equal population of the tribes and non-tribal population. Non-Tribal population is composed of people from the various parts of mainland India e.g. Bihar, West Bengal, Andhra Pradesh, Tamil Nadu and Kerala. In Great Nicobar majority of the population is non-tribal and is composed of Sikh families of ex-servicemen settled here during post independence period (Singh and Gajja, 1987). Their population is confined to the seven revenue villages whereas the tribal population lives in remaining 27 villages. In addition to Nicobarese one more tribe is found in Great Nicobar Island the Shompens, which are still hunter-gatherer tribes.

The population is highest in Car Nicobar followed by great Nicobar and Katchal. Kamorta, Teressa and Chowra have moderate population and remaining islands are sparsely populated. However, as there exists a considerable difference in the area of various islands (smallest Chowra 1.30 Km² and largest Great Nicobar 1045.10 Km²) therefore the population density instead of population itself shall provide a better picture of existing population pressure. Highest population density is in Car Nicobar and Chowra

i.e. more than 150 persons per sq km. Pilomilo is having second position followed by Katchal and Kondul having population density 30 persons per sq km. Teressa, Nancowry and Kamorta have population density 15 to 18 persons per sq km and remaining four islands i.e. Trinket, Little Nicobar, Great Nicobar and Bompuka have population density less than 10 persons per sq km.

Occupation: The non-tribal population in these islands are either working as employees in various government departments or as the laborers whereas the tribal people i.e. Nicobarese are chiefly agrarians and derive their subsistence from hunting and gathering, pig rearing, fishing, coconut plantations and (only since the 1950s) the trading of copra in exchange for rice, cloth, sugar and other commodities (Singh et al., 2001). Fisheries and certain copra based small industries are also a source of income to these tribes in five of the twelve inhabited islands. However, the coconut plantation remains the mainstay and universal trade in all the islands (Das, 1982; Anon., 1985). The Nicobarese of the Car Nicobar are most developed and use modern systems of coconut plantations where old coconut plantations (older than 40 years) are replenished by undertaking systematic regeneration with selected good quality seedlings. The Nicobarese of the central group are somewhere in between but under the economic influence of the Car Nicobarese, who were the first to link up with the market economy through the export of copra and betel nuts. Good quantity of coconut and areca nut are transported in bulk to the mainland ports in Calcutta and Madras. Shalimar oil is the main purchaser of the Nicobarese copra for the production of oil (Roy and Choudhury, 1985). Another tribe i.e. Shompens are still largely hunter-and-gatherers are numbers only 214. They are restricted only in the dense forests of Great Nicobar Island.

Table 2: Decadal variation in tribal population of Nicobar Island

<i>Census Year</i>	<i>Shom-pen</i>	<i>Nico-barese</i>	<i>Total Tribal popu-lation</i>	<i>Population increase between census (in per-centage)</i>
1901	348	5,962	6,310	
1911	375	7,991	8,366	32.6
1921	375	8,032	8,407	0.5
1931	200	589	9,789	16.5
1941	NA	NA	NA	NA
1951	20	1,902	11,922	21.8
1961	71	13,903	3,974	17.2
1971	92	17,874	17,966	28.6
1981	223	21,984	22,207	23.6
1991	214	26,122	26,336	18.6

NA-not available

Source: <http://www.nicobar.org>

Indicators from Land Use Practices

Based on elements of image interpretation twenty-two classes were delineated on the satellite data (Fig. 2). Major classes mapped and area distribution is depicted in Table 3. The Andaman evergreen forest is the most dominant class in these islands (Fig. 3) but if we have a closer look in island wise distribution of this class most of it is confined to Great Nicobar, Little

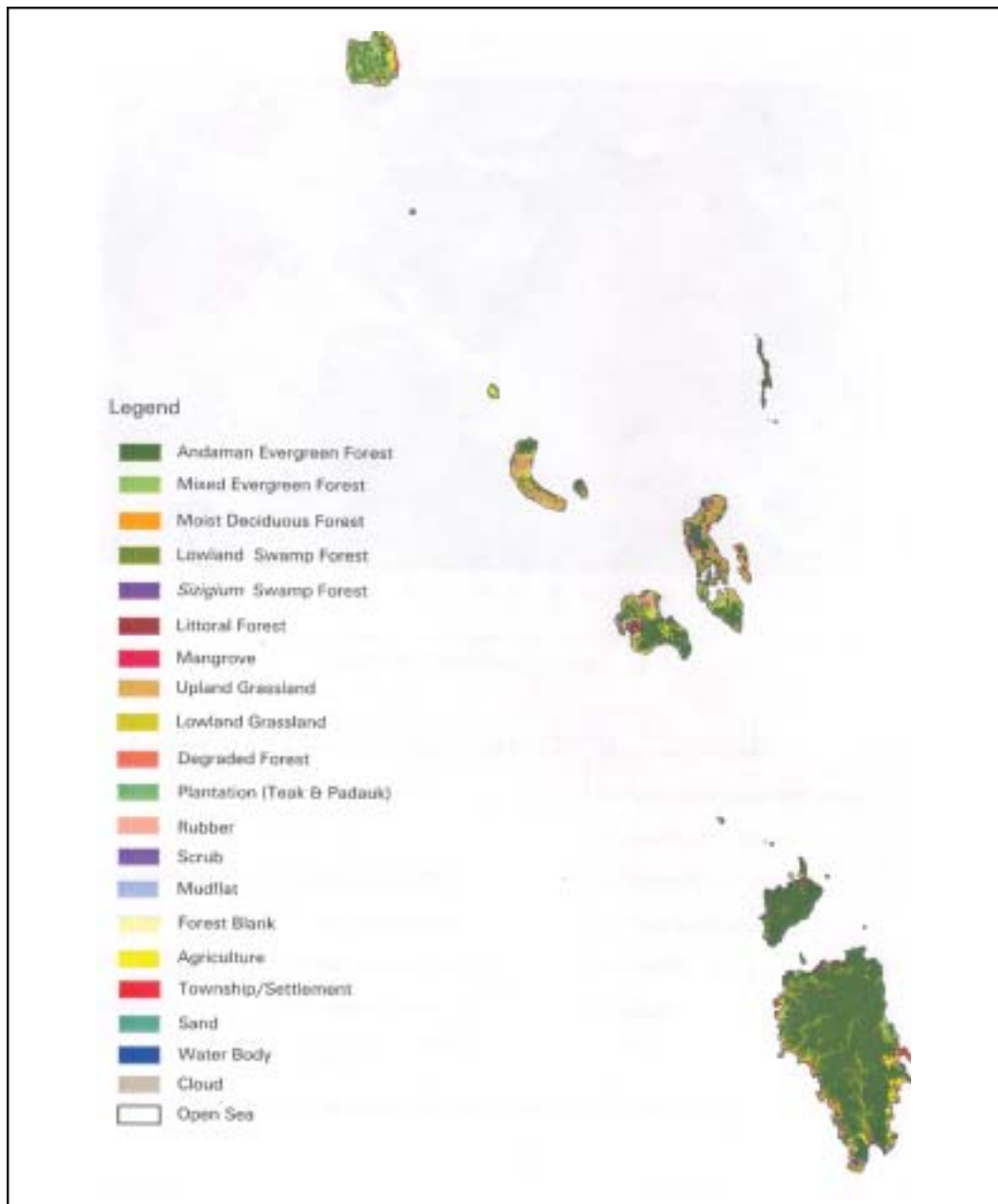


Fig. 2. Land use / Land cover Map of Nicobar Islands

Nicobar and the Katchal. Also, if we look in terms of percentage of the island area, more than 90% of the Kondul and more than 50% of Nancowry and Bompuka is still dense forest of

evergreen type. However, in rest of the islands forest is being converted into various other land use practices such as upland grasslands and the coconut/areca nut plantation. The major concern

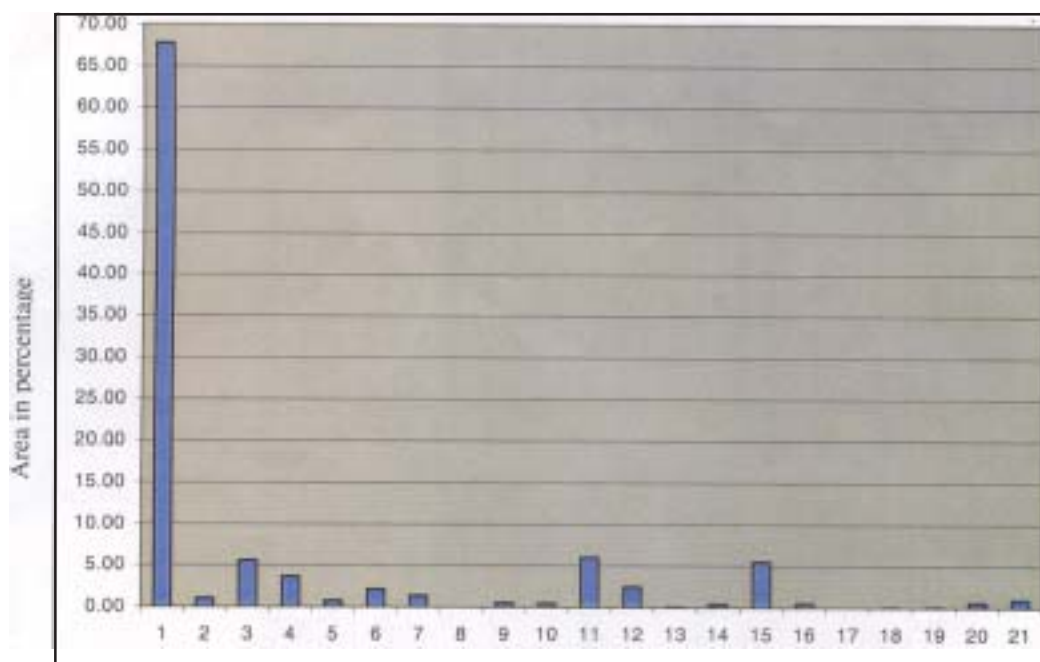


Fig. 3. Graphical distribution of land use land cover classes in Nicobar group

1 Andaman Evergreen Forest	8 Forest plantation (Teak & Padauk)	15 Coconut plantation
2 Moist Deciduous Forest	9 Degraded Forest	16 Agriculture/Village settlements
3 Mixed Evergreen forest	10 Scrub	17 Cashewnut plantations
4 Low land swamp Forest	11 Upland grassland	18 Fallow/ Barren
5 Syzygium swamp forest	12 Low land grasslands	19 Water bodies/creek
6 Mangroves	13 Mudflats/sandy beaches	20 Township settlements
7 Littoral Forests	14 Rubber plantation	21 Clouds

however rests with the coconut plantations alone, as the grasslands are more or less dormant/static class whereas the coconut plantation are increasing slowly and causing fragmentation of the forests. In Car Nicobar, mixed evergreen forest and coconut plantation are the main classes constitution 40% and 10.6 % respectively. In Teresa Kamorta and Trinket, upland grasslands cover substantial area followed by coconut plantation whereas the forests are very limited. In the remaining islands viz. Chowra, and Pilomilo coconut is the main class. Since, these three islands are very small and support sizeable population as seen in population density figures, most of the available land is converted into coconut plantation. Some coconut plantations also occur in the uninhabited islands but their origin is not known (Pande et al., 1991) but still however, most of the land cover in the uninhabited islands is largely forest vegetation.

Table 4: Island wise distribution of natural and human modified land use land cover classes in Nicobar

Island	Natural	Semi natural	Man made	Others
Bompuka	67.00	1.95	31.06	0.00
Car Nicobar	41.00	42.23	16.77	0.00
Chowra	37.16	0.00	62.83	0.00
Great Nicobar	93.50	3.51	2.61	0.38
Kamorta	48.51	6.22	43.30	1.97
Katchal	69.09	4.68	19.47	6.76
Kondul	96.00	0.00	4.00	0.00
Little Nicobar	98.48	0.11	1.40	0.00
Nancowry	57.77	16.53	25.57	0.13
Pilomilo	22.62	0.00	78.73	0.00
Teresa	29.47	2.74	67.21	0.00
Trinket	38.44	0.13	61.42	0.00
Un-inhabited	94.86	1.61	3.53	0.00
Nicobar islands	79.25	6.63	13.14	1

Human Induced Changes in the Landscape

Indicators from the land use were further

grouped into natural, semi natural and manmade classes (Table 4). One more class i.e. cloud, which was perpetual in Katchal, Great Nicobar and Nancowry was dealt separate class as others. Natural class comprises of Andaman evergreen forest, moist deciduous forest, lowland swamp, syzygium swamps, lowland grasslands, water bodies, mudflat and beach. This class is devoid of any human impact. Semi-natural class consists of mixed evergreen forest present predominantly in the Car Nicobar and represented by deciduous floristic component along with the evergreen forest. Scrub and degraded forest are also treated as semi-natural classes. This class is having moderate human influence. Forest plantation, rubber, coconut, agriculture, settlement, blanks and upland grassland are the man made classes and have resulted due to the complete modification of the natural land cover classes. It is believed that during middle of the 19th century patches of forest were cleared by the Danish colonizers in these islands for cattle grazing and this has resulted in the formation of upland grasslands (Saldana, 1989).

Total area under natural land cover classes in the Nicobar group is almost 80% of the geographical area, whereas the human modified land use practices represents only 20% (semi natural 7% and artificial 13%). This presents a satisfactory picture of the land utilization pattern if we consider the region as a whole. But in terms of individual islands the situation hold true only for Great Nicobar, Little Nicobar and the Kondul Island. Rests of the nine islands are under the extreme influence of human modification. Car Nicobar has the highest area under semi-natural class having moderate human impact whereas manmade and natural classes occupies 16.77% and 41.00% respectively. This signifies that although the present human impact is not severe but there are immediate threats in near future and the island will be left with very few patches of natural forest if the threat continues to exist. Also apparently, it is seen that highest area under human modified man made and semi natural classes after Pilomilo and Chowra lies in Teressa, Trinket, Car Nicobar and Kamorta. But the impact is more due to coconut plantation in Trinket and Car Nicobar whereas in Kamorta and Teressa it is due to the presence of upland grasslands. Since these grasslands are static, the major concern shifts to Trinket and Car Nicobar. Further, insight into the socio-economic data

shows that since Trinket is having a low population density i.e. only 1/15th of the Car Nicobar threat is not severe as long as the land use practices and population are not increasing. However, Car Nicobar remains the most modified islands in the entire group.

Most of the small islands except Kondul have more than 50% of the natural landscape modified due to human activity can be said to have reached the threshold of their carrying capacity. Other large islands i.e. Teressa, Katchal, Kamorta and Nancowry have varying degree of human impact. Katchal still have 70 of the area devoid of human influence. Nancowry also have almost 60% of its area as natural. In Teressa and Kamorta more than 50% of the resources are modified into man made classes.

CONCLUSION

None of the approach i.e. socio-economic profile or the land use mapping gives a true picture of the human impact on the natural resources when studied separately. It is only when both the approaches are studied in conjunction, some meaningful information can be derived. Thus population density instead of the total population and degree of human impact in the landscape instead of the land use land cover is a better index of measuring human impact on the landscape in these islands. When interpreted in conjunction with the available socioeconomic data, there is found to a positive trend between the land use/land cover pattern and socio-economic drivers in the Little Nicobar and Great Nicobar Island at one hand i.e. less population density and more natural landscape and Chowra and Pilomilo at the other i.e. more population density and more man made landscape. But for the remaining islands the interpretation of results is seemingly complex. However the indicators from the land use land cover mapping provides additional information on the modification of the land cover of these islands, which cannot be explained in terms of socio-economic data alone.

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