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FOREST COVERS OF WEST BENGAL: A DISTRICT-WISE REVIEW

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Abstract: Forest cover mapping exercise for the state of West Bengal reflects the district-wise status of forests and its present trends and provides inputs for monitoring of forests and its restoration. District-wise statistics assessed from the biennial reports of the Forest Survey of India reveal the changes in the forest cover for the districts of West Bengal from time to time. Specifications of forest related information like forest types, and myths and history are included for all districts. District-wise forest cover change matrix reflects dwindling of the South Bengal's forest cover alarmingly from the eighties of the last century; yet a shift to joint forest conservation by making stakeholders in forestry initiatives and social forestry creation managed by the forest department has yielded the present results. Plantation under the social forestry scheme in almost all the districts of West Bengal has started showing results for the growing stocks. District-wise break-up revealed that South 24 Parganas, Uttar Dinajpur, Murshidabad and Howrah have recorded decrease in forest cover, while Bankura, Paschim Medinipur, Purulia and Birbhum have recorded a rise.There is a net increase of 54.51 sq km in the forest cover from the reported area in India State of Forest Report 2019 in comparison to the data available in the assessment report published by Forest Survey of India in 2017.

Keywords: Bengal Basin, Reclamation, West Bengal, Dense Forest, Moderately Dense Forest, Open Forest, Trees Outside Forest, Mangroves, Dooars, Sunderbans.

1. INTRODUCTION

The Bengal Basin at a time is covered with forest and coppice in major parts of its area in terms of its topographical diversity. Approximately twenty thousand years ago, human beings started migrating towards the hilly region of south-eastern direction covered with forests and fixed villages of permanent nature for the first time in the Bengal Delta. But the areas were not safe after dark or in the daytime from the wild animals or even by human beings of different order or genus. They took shelter in a safe place and in this way the human habitation zone had been formed in the clustered, compact, and linear pattern fixed within a village. They lifted soil to raise the place for the construction of their huts. The digging pit after being beautified with a definite shape introduced the pond in the rural domestic culture of Bengal. Pond was thus becoming an organ in the village households useful for drinking water for man and cattle, cooking and fish culture. Shepard by nature, the earlier men in the villages, habituated with the rearing or tending of cattle, converted their occupation and engaged gradually themselves in agriculture. For the preparation of food from the grains and greens,

produced of their own cultivation, they collected fuel wood from their surrounding forests. Forest was still there in abundance and the word forest is still the opposite in meaning to the word village. With time, more human habitation, in the Bengal Basin, more the area cleared in the rules of the kings and after them, by the Muslim invaders and rulers. Most of the forest cover in the undivided Bengal had been cleared by the skilful British East India Company rulers in the soil of the Bengal to earn more and more revenue from the converted agricultural land of the reclaimed forests areas. It was only 11879 sq km area i.e., 13.38% as the recorded forest area of the geographical area of West Bengal when the British rulers left India dividing the province of Bengal into the east and west.

The government formed in 1977 in West Bengal, considered the right of land, is especially important to the poor community. As a result of land reforms and decentralization of power, the poor land holders or landless villagers have received maximum benefit. From the data of National Sample Survey on ownership distribution of land holding that in West Bengal the ownership of 84% of the total agricultural land is in the hands of small and marginal farmers due to land reforms with respect to 43% of national ratio. The then West Bengal government has been continuing since and takes initiatives to distribute land among the poor villagers in the seventies of the last century. This kind of state sponsored act of empowerment of backward people particularly of the tribes is rarely experienced in other states or union territories of the country. Further, in West Bengal the share of permanent pasture and other grazing land, land under miscellaneous trees and groves, fallow land, waste land and current fallow land is incredibly low except the land of non-agricultural use and as recorded forest areas. Forests, fallows, and uncultivated land in the state are available in the districts of Birbhum Bankura Darjeeling Paschim Medinipur Purulia and Bardhaman. The then West Bengal government utilized its land in a proper way as agriculture will continue to be the base of the state. This strategy of the Left Front government for distribution of forest land among the people particularly to the tribe enhances the encroachment activities of the forest land and whenever the encroachment has already been done, the people beyond such effort seek patta with the approval of the political leaders. Consequently, the forest land has gradually been decreasing slowly but permanently, and agricultural land in some pockets of the surrounded forest areas increased rapidly. This is how the forest cover of West Bengal is declined to 8432 sq km i.e., 9.5% with respect to its recorded forest area 11879 sq km i.e., 13.38% in 1987 (Fig 1).

Forest cover has been decreased rapidly for exercising land reforms and distribution of patta (deeds of land for ownership) to the landless and poor farmers particularly to the scheduled caste and tribal people in and around the forest areas in West Bengal. The aims of the then Left Front government regarding rural development and decentralization of power are worth mentioning for the people to bring about a change in the correlation of class forces in favour of the poor and working people by involving them in an organized manner in the process of development, though the forest area was remained almost the same for the

period from the year of independence to the commencement of the left rules as per the similarity view in the recorded forest area.

In the current context, forest cover of 23 districts in West Bengal has recorded about half of a goal of nation-wide forest cover of 33 percent of the geographical area of the state which is envisaged in the National Forest Policy of India 1988. The current forests cover about 19.04% of the total geographical area of West Bengal and lie chiefly in the districts of Darjeeling, Kalimpong, Jalpaiguri, Alipurduar, South 24 Parganas, Jhargram, Paschim Medinipur, Bankura, Purulia, Paschim Bardhaman, and in some parts of Birbhum district. District-wise statistics and classification of forest types, forest models, and forest strategies provide a scientific basis for forest research, management of wildlife and biodiversity, identification and classification of floral and faunal assemblages, assessment of biomass and carbon stock at forest floors etc. of diverse applications.

2. DISTRICT-WISE FOREST SCENARIO OF WEST BENGAL

Due to the implementation of Joint Forest Management scheme, the forest scenario of West Bengal has gradually been changing. The forest cover in West Bengal, based on interpretation of IRS Resourcesat-2 LISS III satellite data of the period November 2017 to February 2018 is 16901.51 sq km, which is 19.04% of the geographical area of the state[1]. In terms of forest canopy density classes, West Bengal has 3018.52 sq km under very dense forests, 4160.26 sq km under moderately dense forests and 9722.73 sq km under open forests (Fig 1). There is a net increase of 54.51 sq km in the forest cover from the reported area in India State of Forest Report 2019 in comparison to the data available in the assessment report published by Forest Survey of India (FSI) in 2017. Forest type mapping using IRS Resourcesat-2 LISS III satellite data has been undertaken by FSI with reference to Champion and Seth Classification[1]. As per this assessment, West Bengal has 30 forest types which belong to the 8 forest type groups - 1. Tropical Semi Evergreen Forests, 2. Tropical Moist Deciduous Forests, 3. Littoral and Swamp forests, 4. Tropical Dry Deciduous forests, 5. Subtropical Broad Leaved Hill forests, 6. Montane Wet Temperate forests, 7. Himalayan Moist Temperate forests and 8. Sub Alpine forests. Tree cover of West Bengal has been estimated using a sampling-based method of Trees Outside Forests (TOF) inventory collected over a period of 2 years. The estimated tree cover in the state is 2006 sq km which is 2.26% of the geographical area of West Bengal. The tree cover of West Bengal has decreased by 130 sq km in comparison to the previous assessment report published in 2017.

The state has 5.47% of its geographical area under Protected Areas comprising 6 National Parks, 16 Wildlife Sanctuaries and 5 Conservation Reserves. There are 2 Tiger Reserves, namely, Sunderbans and Buxa in West Bengal. Sunderbans is a unique ecosystem covered with luxuriant mangroves. The vibrating mangrove ecosystem of Sunderbans has been identified as a special conservation value by the Government of India. Sunderbans, for such importance, has been declared as

Biosphere Reserve which includes a Tiger Reserve and a National Park. UNESCO recognized this amazing Biosphere Reserve and declared Sunderbans a World Heritage Site in 1987. There are two Elephant Reserves, namely, Eastern Dooars Elephant Reserve and Mayur Jharna Elephant Reserve, formed in the northern and southern parts of the State respectively. The recorded forest area of West Bengal is 11879 sq km which is 13.38% of the geographical area of the state. Reserved Forests constitute 59.38%, Protected Forests constitute 31.76% and Unclassed Forests constitute 8.86% of the Recorded Forest Area of West Bengal[2]. Recorded Forest Area may or may not have forest cover. Recorded Forest Area means forest area recorded as forests in Government Records. Anyway, in the present situation, the forest-lovers and the researchers would be hopeful in the news that in different forest areas of West Bengal, local communities are coming together to replant forests on abandoned recorded forest areas on request and remuneration paid by the forest department of the state government certainly keeping their patta-marked agricultural land aloof from the project. Bringing back the forests will help keep the communities together by reducing soil erosion and providing a source of income through selling of different forest produce, even the fishing in the mangrove swamps and marshes.

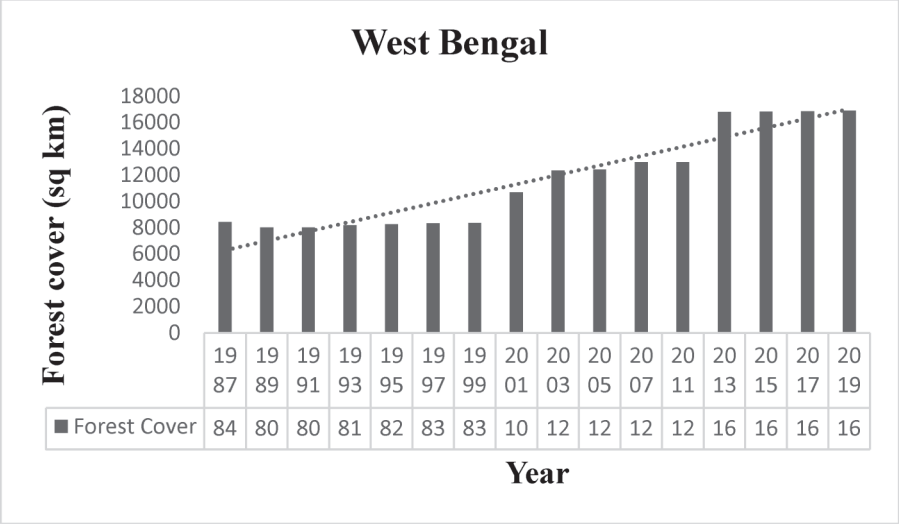

Fig. 1. Forest cover change matrix of West Bengal

2.1 Forest Cover of Bankura District

The jungle is the habitat of Sal Segun Sishu Sonajhuri Piyal Kendu Lohajangi Palas Bamboo date palm Amlaki Hartuki etc and infested with the wild animals like elephant wild boar jackal Bengal fox wild hen fishing cat mongoose porcupine along with the varieties of birds and snakes. Saltora, Gangajalghati, Simlipal, Taldangra, Sarenga, Joypur, Beliatore, Susunia are among the dense jungles, almost known to all, in the district of Bankura.

Bankura district is very much rich in forest canopy and dense forestry having plenty of timbers and trees. The forest cover in Bankura district, based on interpretation of IRS Resourcesat-2 LISS III satellite data of the period November 2017 to February 2018 is 1285.58 sq km which is 18.68% of the district's geographical area. In terms of forest canopy density classes, the district has 222.33 sq km area under very dense forests, 395.27 sq km area under moderately dense forests and 667.98 sq km area under open forests. There is a net increase of 15.58 sq km, the highest increase in the forest cover among all districts, in the state of West Bengal, as shown in the India State of Forest Report 2019. A diagrammatic account of the class-wise change is given in the forest cover change matrix in the Fig 2.

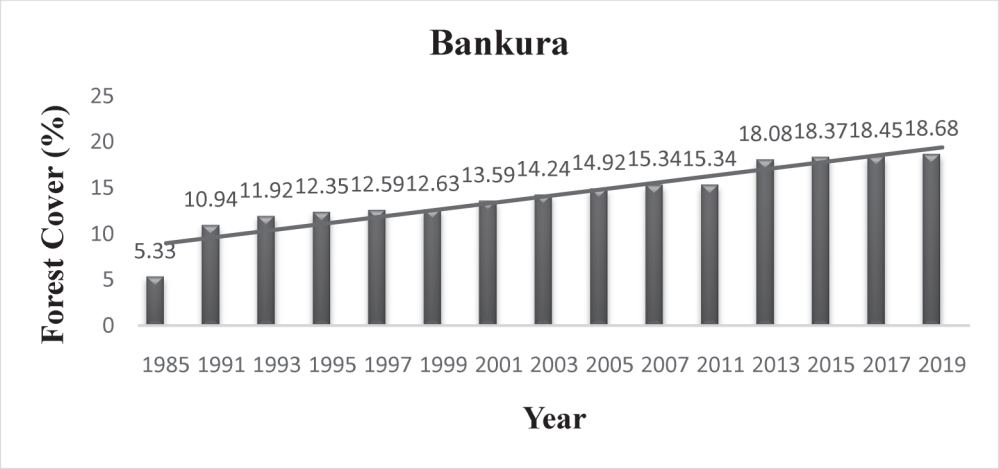

Fig. 2. Forest cover change matrix of Bankura district, West Bengal

Distribution of patta upon converted land changing land use pattern has been a great loss for the forest resources for the Bankura district as well as for the country as the great ancient natural forest is lost forever. Still, lots of possibility for afforestation are to be implemented for the enhancement of the forest cover of the Bankura district like social forestry, afforestation under the supervision of individual care and the last and the least is the introduction of Piyal plantation in the open space inside the forest areas or recorded forest area without greenery which are proved to be successful as evidenced from the plantation in the Sarenga forest, the author witnessed.

2.2 Forest Cover of Birbhum District

Illambazar forest, extended parallel along the metal road in the Birbhum district, is a typical forest of mixed occurrences of both natural and social forestry origin where plenty of timber trees of different species like Sal Piyal Asan Arjuna kashmani Jarul Kadam Babul Segun Mehagini Amalaki Hartaki Chhatim Bahera Neem Chatka Lambu Punyo Debdaru Tentul Jam Amaltas Champa Kanchan are very much common. Other notable forests in Birbhum district are Egaro Mile Forest, Ballavpur forest, Amkhoi Fossil Park etc under the forest division of the same

name and they are almost of social forestry origin. The forest area of the Birbhum District is 184.40 sq km which is only 4.07% of the district's geographical area, but once the district was covered with the green canopy all around and for that reason, the district was named after the luxuriant occurrences of the forest ('Bir' means copses; bhum - place). Ruthless exploitation of the forests by the people, an ecological as well as social loss, cast a gloom in the entire area of the Birbhum District. Forests were free for use by local villagers for household purposes and cleaning for cultivation, which is available in the history of forest and its management during the 16th century in the entire West Bengal including the forests of Birbhum Division. Land revenue system was introduced by Todar Mal during the Mughal period, where local zamindars had to pay "Ruba" or share of ¼th part of revenue to Mughal Emperors for the protection being given by them. Permanent settlement was introduced by the East India Company in 1773 where the Zamindars were considered as the proprietor of forests including the landed properties. Railways opened railway lines during 1890-1905 which helped the transport of forest products to far off places with ease and less cost and this followed by two world wars took a heavy toll of forest resources in the then Bengal. Zamindars or the local chiefs held the forests of this division who maintained their respective forests in a feudal tenure system. The forests of this area became accessible with the coming up of Railway lines. Due to easy transport to distant places by railway services with less cost and swiftly, the value of the forest produces suddenly increased and the forests are considered as a source of earning with a higher return to the Zamindars. The forests were subjected to deforestation and in the advanced stages of degradation caused by ruthless exploitation on a rotation of 4–5 years by the savage acted Zamindars. The Zamindars continued this system of such mismanagement up to 1948. Later the Government of West Bengal took initiatives upon exercising control over the management of forests under the West Bengal Private Forests Act, 1948, but had not bettered the previous records of the occurrences of natural forests of the Birbhum District. Accordingly, possession of the forests was being taken by the Forest Department as per availability of records, evidence and Court's Orders that came into consideration for scientific management and control. The Estates Acquisition Act came into force in 1953 and the forests so long captured by the Zamindars were vested to the government from 1954-55. After taking over by the State Government, the forests were brought under scientific management, though, by this time, the productivity of the forests had declined to such a level that they could not meet the growing demands of forest produces from ever-increasing population of fringe areas outside the forests of the entire district of Birbhum.

Natural forest and forestry of the Birbhum district, at present, is nearly void, though a few numbers of forests are grown up with the plantation programme of social forestry scheme under the supervision of the forest department. The increase in the forest cover in 2007 and 2013 respectively in the district is due to coppice growth and afforestation inside the forests and growth of commercial plantation under individual care. Total

increase in the forest cover not only pertains to the period of 2011-2013, but a major part of increase has been attributed to inclusion of Trees Outside Forest (TOF) areas of Birbhum district which could not be captured earlier assessment by the Forest Survey of India (FSI) team due to limitation and dearth of modern device for computation. Anyway, there is no separate statistics available for forest cover of Birbhum district in the report of Forest Survey of India from 1987 to 1989. Further, forest area of Birbhum district is amalgamated with the other districts like Burdwan, Nadia, Kolkata, Hugli, Howrah, Malda, Medinipur, Murshidabad, 24 Parganas and West Dinajpur as shown in the report of FSI for the period from 1991 to 1997.

Birbhum district is not enriched with the natural forest canopy. The forest cover of Birbhum district in 2019, based on interpretation of IRS Resourcesat-2 LISS III satellite data of the period November 2017 to February 2018 is 184.40 sq km which is 4.07% of the district's geographical area. In terms of forest canopy density classes, the district has only 1 sq km area under very dense forests, 34.14 sq km area under moderately dense forests and 149.66 sq km area under open forests. There is a net increase of 7.80 sq km of the forest cover in Birbhum district as per the Forest Report 2019. A diagrammatic account of the class-wise change is given in the forest cover change matrix in the Fig 3.

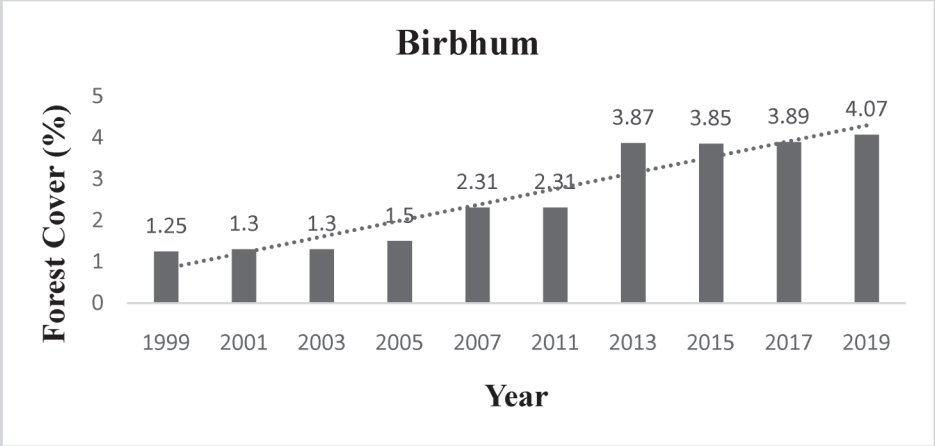

Fig. 3. Forest cover change matrix of Birbhum district, West Bengal

Further, no report was published in 2007 by the Forest Survey of India and the report published in 2009 contains only the forest statistics for the year 2007. This is the reason behind non-availability of forest statistics for the year 2009. Needless to mention that the Forest Survey of India (FSI) took initiatives for forest survey of the entire country and commenced publishing forest reports since 1987 in every two years consecutively.

2.3 Forest Cover of Cooch Behar District

In Cooch Behar district, the jungle flora includes Sal Malita Lampate Gamar Moyna Simul Champ bamboos creepers grass and fruit trees. The forests are inhabited by leopard elephant gaur (wild cattle) and rhinoceros, as well as other animals like reptiles and birds. Other than Kodalbasti

forest, Rasomati forest is well known to almost all forest-lovers that is situated on the Torsa River basin under Pundibari range of Cooch Behar forest division of West Bengal. The Rasomati forest consists of mixed deciduous forest and the house of many important flora and fauna, which are highly vulnerable due to the anthropogenic activities as this forest is surrounded by many villages. In the forest area, in and around the water bodies, migratory birds, along with many local species, are found during the interpretation of IRS Resourcesat-2 LISS III satellite data of the period November 2017 to February 2018 is 349.06 sq km which is 10.31% of the district's geographical area. In terms of forest canopy density classes, the very dense forests area of the district is nil, 27 sq km area under moderately dense forests and 322.06 sq km area under open forests. There is a net increase of 0.06 sq km available from the reported area in India State of Forest Report 2019. Total increase in the forest cover not only pertains to the year

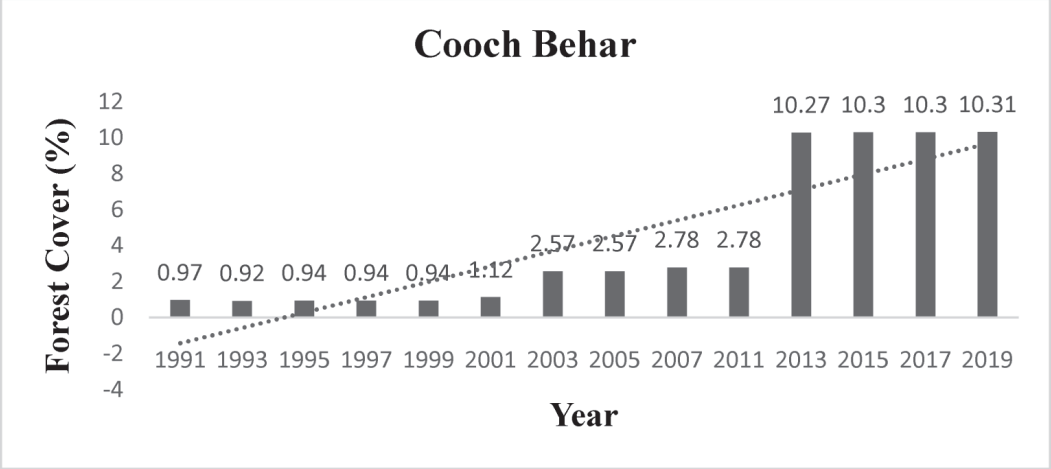

Fig. 4. Forest cover change matrix of Cooch Behar district, West Bengal

wintertime. Rasik Bill is that type of a small lake that attracts a lot of migratory birds which make nests in the trees around the lake during the winter. There are deer parks, crocodile rehabilitation centers, leopard houses, Python house, aviary, and a tortoise rescue center in and on the Rasik Bill water bodies.

Cooch Behar district is very much rich in forest canopy and dense forestry having plenty of deciduous trees. The forest cover of Cooch Behar district in 2019, based on of 2013 with respect to 1991, but a major part of increase has been attributed to inclusion of Trees Outside Forest (TOF) areas of Cooch Behar district which could not be captured earlier assessment by the Forest Survey of India (FSI) team due to limitation and dearth of modern device for computation. Anyway, there is no separate statistics available for forest cover of Cooch Behar district in the report of Forest Survey of India from 1987 to 1989. A diagrammatic account of the class-wise change is given in the forest cover change matrix in the Fig 4.

2.4 Forest Cover of Darjeeling District

Roadside area and mountain top is covered with the evergreen Northern Montane Wet Temperate and Sub-Alpine forests where trees are particularly Oak Magnolia Champ Kawla Pipli Chilaune Katus Panisaj Lampate Angare Utis Toon Malangiri Rhododendrons Salix Berberis Yew Junipers Birch and Gokul

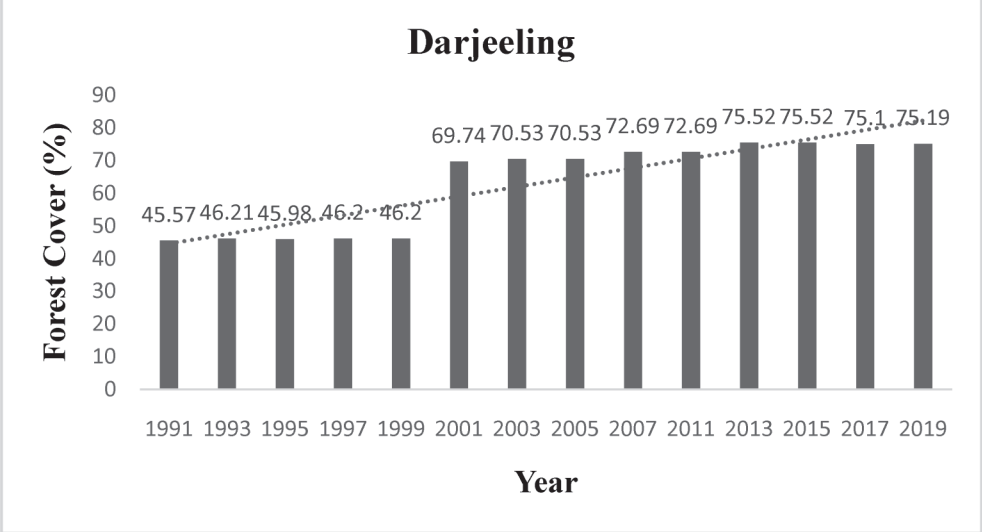

Fig. 5. Forest cover change matrix of Darjeeling district, West Bengal

having the characteristics of the Central Himalayan flora. Darjeeling is the only district of West Bengal, almost covered with the natural evergreen forests, and that ever-green forest of Darjeeling district is infested with the wild animals like leopard Asian elephant bison wild boars barking deer hog deer spotted deer tiger and clouded leopard. In Darjeeling, three-fourth part of its geo-graphical areas is covered with ever-green forests.

Darjeeling district is very much rich in forest canopy and dense forestry having plenty of evergreen trees. The forest cover of Darjeeling district in 2019, based on inter-pretation of IRS Resourcesat-2 LISS III satellite data of the period November 2017 to February 2018 is 2367.80 sq km which is 75.19% of the district's geographical area. In terms of forest canopy density classes, the district has 720.76 sq km area under very dense forests, 654.52 sq km area under moderately dense forests and 992.52 sq km area under open forests. There is a net increase of 2.80 sq km, having the highest percentage of the forest cover in Darjeeling among all the districts in the state of West Bengal, from the reported area in India State of Forest Report 2019. Total increase in the forest cover not only pertains to the year of 2001 with respect to 1987, but a major part of increase has been attributed to inclusion of Trees Outside Forest (TOF) areas of Darjeeling district which could not be captured earlier assessment by the Forest Survey of India (FSI) team due to limitation and dearth of modern device for computa-tion. Anyway, there is no separate statistics

available for forest cover of Darjeeling district in the report of Forest Survey of India from 1987 to 1989. A diagrammatic account of the class-wise change is given in the forest cover change matrix in the Fig 5.

2.5 Forest Cover of Howrah and Kolkata Districts

A man-made forest is created within an area of approximately 13.40 hectares earlier by Howrah forestry division under the social forestry scheme of forest directorate, at Garchumuk, located at the confluence of Hooghly and Damodar rivers on the district of Howrah. Considering its scenic beauty as well as suitability for wild animals, the spot, offering the spectacular view of the Ganges, a deer park, within this man-made forest, is established on 31.01.1991 recognized by the Central Zoo Authority. It is a deer hub or deer park, rather than a deer forest as large areas are almost all devoid of trees. The forest land area, in the Damodar basin, is suitable for afforestation, though no step is taken by the forest department for plantation of trees of greater or less extent inside the deer hub. A few trees are seen standing outside the wire gauze surrounded area of the deer park, where plantation programmes may be taken as rescue strategies for alternative afforestation or reforestation. Rescue strategies of the forest regeneration means the rescue of the present forest environment by the settlement of an alternative one to be useful in necessity in near future. When the seedlings outside the deer park are grown up enough or mature by 5-7 years, deer are to be released in the newly established greenery, and the inside area of the existing deer park will undergo a plantation programme. In this way, both inside and outside areas of the deer park within the entire surroundings of the man made forest will be covered with the green canopy through the strategies of rescue forestry under social forestry schemes. Except the man made forest of Garchumuk, another important greenery is The Acharya Jagadish Chandra Bose Indian Botanic Garden previously known as Indian Botanic Garden and the Calcutta Botanic Garden in Shibpur, Howrah. The garden, on the bank of the river Hooghly, exhibits a wide variety of rare plants and a total collection of 12000 specimens spread over 109 hectares under the management and supervision of Botanical Survey of India.

There are no separate statistics available for forest cover of Howrah district in the report of Forest Survey of India from 1987 to 1989. Further, forest area of Howrah district is amalgamated with the data of the other districts like Burdwan, Birbhum, Kolkata, Hugli, Midnapur, Nadia, Malda,Murshidabad, 24 Parganas and West Dinajpur as shown in the report of FSI for the period from 1991 to 1997. Separate data of these districts of the state of West Bengal have been inventoried in the forest report of 1999 for the first time. Further, no report was published in 2007 by the Forest Survey of India and the report published in 2009 contains only the forest statistics for the year 2007. This is the reason behind non-availability of district-wise forest statistics for the year 2009. Total increase in the forest cover not only pertains to the year of 2013 with respect to 1999, but a major part of increase has been attributed to inclusion of Trees Outside Forest (TOF) areas of Howrah district which could not be captured earlier assessment by the Forest Survey of India

(FSI) team due to limitation and dearth of modern device for computation. Needless to mention that the Forest Survey of India (FSI) took initiatives for forest survey of the entire country and commenced publishing forest reports since 1987 in every two years consecutively. Anyway, the forest of Howrah district is covered with artificial plantations. Among fauna, jungle cats, jungle fowl, python, wild boars and varieties of birds and reptiles are increasingly being reported.

Howrah is a district which is very much poor in forest canopy and forestry. The forest cover in Howrah district, based on interpretation of IRS Resourcesat-2 LISS III satellite data of the period November 2017 to February 2018 is 303.77 sq km which is 20.71% of the district's geographical area. In terms of forest canopy density classes, the district has no area under very dense forests, 50 sq km area under moderately dense forests and 253.77 sq km area under open forests. There is a net decline of 0.23 sq km in the forest cover from the reported area in India State of Forest Report 2019. A diagrammatic account of the class-wise change is given in the forest cover change matrix in the Fig 6.

It is not surprising to most of the people that the forest cover in the Kolkata metropolis is almost about nil. In the past, Calcutta (presently Kolkata), was covered with the jungle in the era of Job Charnock. At present there is no existence of any forest in and around the Kolkata metropolis, but the greenery covers a little space at Eden Gardens, Rabindra Sarobar and Subhas Sarovar with respect to that of the metropolitan area, though there are a lot of urban spaces that belong to various government agencies where urban forestry can happen. Likewise, HIDCO plans to set up an urban forest at New Town while a similar initiative is being taken by Kolkata Port Trust on a plot it owns near Hyde Road. This type of alternative social forestry initiatives helps enhance greenery inside the Kolkata metropolis as a strategy of rescue forests. Such social forestry work in the city area has started showing results.

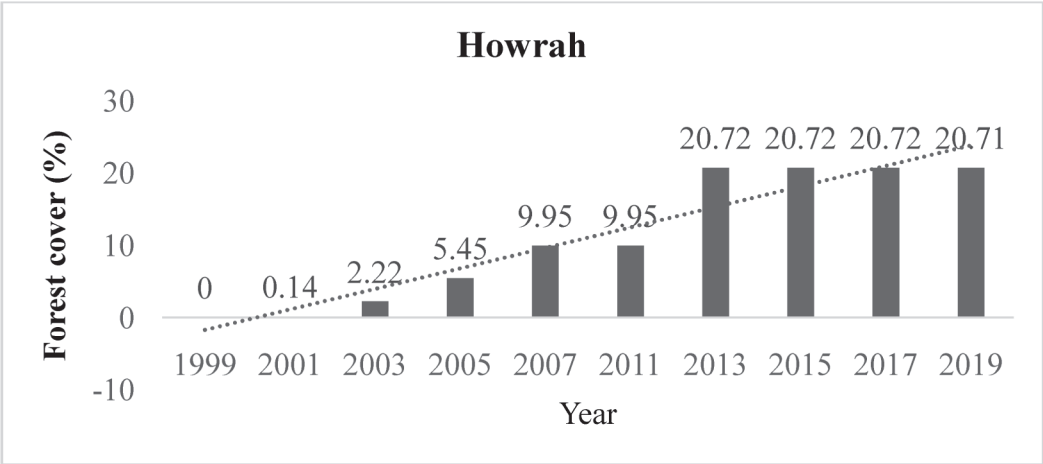

Fig. 6. Forest cover change matrix of Howrah district, West Bengal

Kolkata is a district which is very much poor in forest canopy and forestry. The forest cover in Kolkata metropolis, based on interpretation of IRS Resourcesat-2 LISS III satellite data of the period November 2017 to February 2018 is only 1 sq km which is 0.54% of the district's geographical area. In terms of forest canopy density classes, the district has no area under very dense forests and moderately dense forests and only 1 sq km area under open forests. There is no increase or decline of the forest cover from the reported area in India State of Forest Report 2019. A diagrammatic account of the class-wise change is given in the forest cover change matrix in the Fig 7.

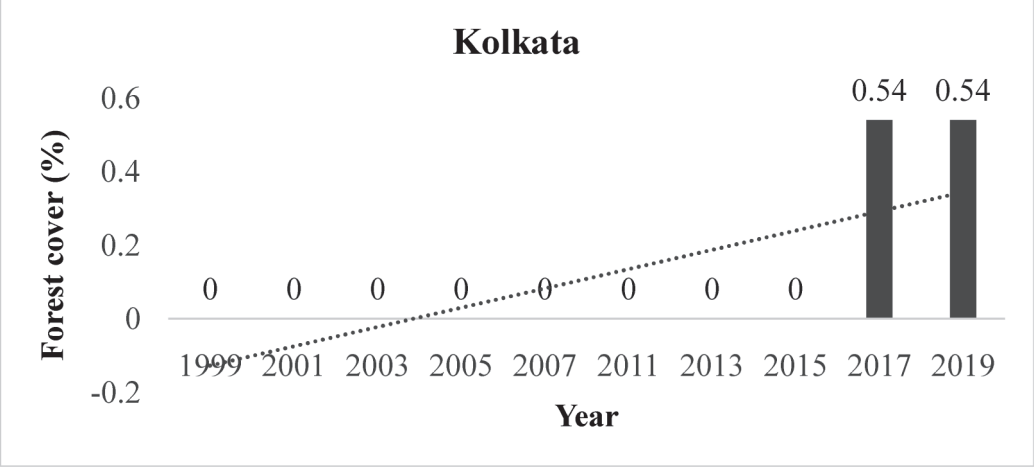

Fig. 7. Forest cover change matrix of Kolkata district, West Bengal

2.6 Forest Cover of Hugli District

The Hugli District gains credit for an island-forest, namely SabujDwip. SabujDwip, created at the confluence of Behula and Hooghly rivers with the accumulation of sand silt and clay, spanning over an area of 180 bigha, is covered with the green canopy of Sonajhuri, Eucalyptus Mehagani Segun Kadam Chhatim Jarul Amaltas and other trees grown under the plantation programme of Social Forestry Scheme of the forest department. SabujDwip is now a picnic spot and it hosts a watchtower, restaurant, children's park, flower garden including the arrangement of boat rides in its surrounding river waters. But if the SabujDwip is allowed for the picnic spot and open for visit to the tourists round the year, the Hugli district certainly will lose a moderately dense island forest soon. Forest regeneration through afforestation is the solitary path for conversion of the SabujDwip, a moderately dense forest making at least relevant of the meaning of the word, Sabuj Dwip to that of its nature. This effort certainly comes to be fruitful as the rural population in Sabuj Dwip is nil and the people in farming communities live in the mainland area, far away from the island. Well-organized local groups or the forest department ensure enforcement of the forest act by reforestation through plantation programmes in this isolated riverine island. One of the most exciting assisted natural regeneration strategies is called applied nucleation, also known as 'tree islands',

which involves playing only a small number of trees that attract birds and other seed dispersers, which can spread seeds around the tree islands. Gradually, these tree islands turn into intact forests. Likewise, SabujDwip, another well-known forest area in Hugli district is the Garh Mandaran which is also to be regenerated similarly through this tree-island strategy. Afforestation and regeneration of forest are very much essential to combat the environmental crisis due to global warming and climate change. Regretfully, every second, more than a hectare of tropical forests is destroyed or drastically degrades - reported IUCN Forests group. They added that forest landscape restoration not only protects nature while providing livelihoods for local people, but it also helps address issues like climate change and food and water security. Healthy soils limit the effects of climate change and provide food and water security, but the loss of soil biodiversity is undermining these benefits. Anyway, there are no separate statistics available for forest cover of Hugli district in the report of Forest Survey of India from 1987 to 1989. Further, forest area of Hugli district is amalgamated with the data of the other districts like Burdwan, Birbhum, Kolkata, Malda, Howrah, Nadia, Medinipur, Murshidabad, 24Parganas and West Dinajpur as shown in the report of FSI for the period from 1991 to 1997. Further, no report was published in 2007 by the Forest Survey of India and the report published in 2009 contains only the forest statistics for the year 2007. This is the reason behind non-availability of district-wise forest statistics for the year 2009. Needless to mention that the Forest Survey of India (FSI) took initiatives for forest survey of the entire country and commenced publishing forest reports since 1987 in every two years consecutively.

Hugli district is extremely poor in forest canopy having only deciduous trees generated through plantation. The forest cover of Hugli district in 2019, based on interpretation of IRS Resourcesat-2 LISS III satellite data of the period November 2017 to February 2018 is only 160 sq km which is 5.08% of the district's geographical area. In terms of forest canopy density classes, very dense forests area of the district is nil, 14 sq km area under moderately dense forests and

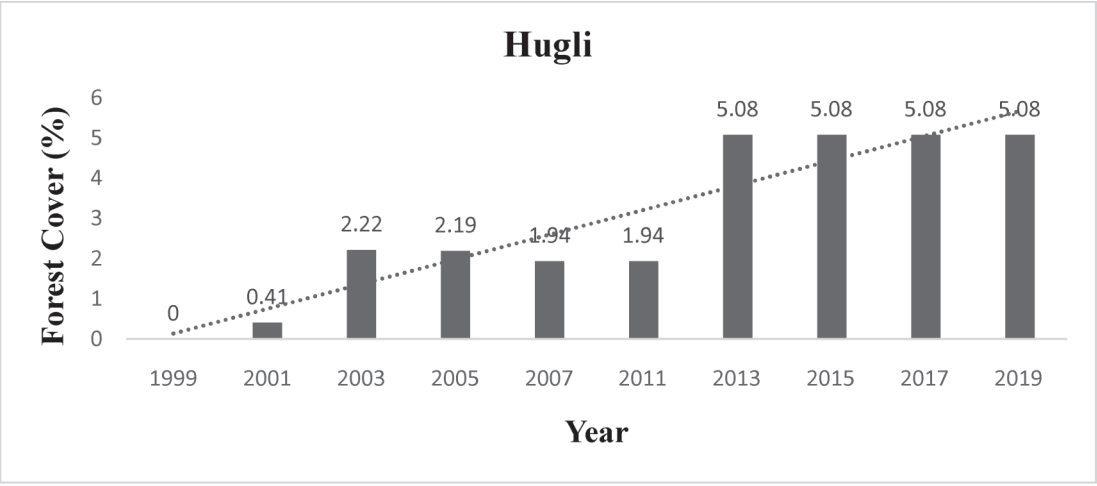

Fig. 8. Forest cover change matrix of Hugli district, West Bengal

146 sq km area under open forests. The report shows no rise or decline of forest area of the district in the India State of Forest Report 2019. Total increase in the forest cover not only pertains to the year of 2013 with respect to 1999, but a major part of increase has been attributed to inclusion of Trees Outside Forest (TOF) areas of Hugli district which could not be captured earlier assessment by the Forest Survey of India (FSI) team due to limitation and dearth of modern device for computation. Anyway, there are no separate statistics available for forest cover of Hugli district in the report of Forest Survey of India from 1987 to 1989. A diagrammatic account of the class-wise change is given in the forest cover change matrix in the Fig 8.

2.7 Forest Cover of Jalpaiguri District

In the territory of North Bengal, numerous rivers like Turturi, Gadadhar, Cheko, Kalkut, Nonai, Kaljani, Halong, Torsa, Ekti, Birbiti, Dimdima, Diana, Jaldhaka, Murti, Mal, Tuntunia, Chaiti, Jayanti are flowing, from north to south, from the hill to the plain, with icy cool water, round the year. These rivers traverse the forests covered with Gamar Champ Lampate Moyna Malita Sal Simul all along their meandering path. The herd of bison, a few elephants, rhinos, leopards are seen to wander within the forest off and on. Perhaps these wild animals win in the struggle for existence or selected by nature in the ancient dense forest of Dooars in the Jalpaiguri district. Here too, a group of people from the urban area enjoy a lot inside the forest area which is befitted with the nature of ecotourism. Forest here seems to be nature's poetry entangled with the green canopy, rivers, falls, wilds, and the birds. In the natural beauty and essence of the forest of the Dooars, even an imaginary hard cover felt by a solitary wayfarer, is going to be melted after encountering the billowy stream producing a sweet jingling sound. Forest area of Dooars in Jalpaiguri infested with wild animals is rich in biodiversity. Leopards, Asian elephants, tigers, bisons, wild boars, barking deer, spotted deer, clouded leopard, hispid hare, pigmy hog here are quite common among the wild animals. Varieties of snakes and birds are very much interesting to the naturalists and birdwatchers in different forests scattered in the Dooars. Dooars region forms the gateway to Bhutan which is about 30 km wide and stretched over about 350 km from the Teesta River in West Bengal and Dhansiri River in Assam.

Natural forest and forestry are scattered all over the district of Jalpaiguri, though a few numbers of forests are grown up with the plantation programme of social forestry scheme under the supervision of the forest department. In 1991, 1537 sq km area of forest cover of the district was increased to 2344 sq km expansion in 2001 as recorded in the India State of Forest Report 2001. There is a net increase of 807 sq km forest area in the district within a time span of only a decade. A class-wise change in the district is given in the forest cover change matrix in Fig 9. The increase in the forest cover in the district is due to coppice growth and afforestation inside the forests and growth of commercial plantations like tea gardens in the Dooars or canopy formation through plantation of saplings under individual care. Total increase of 1326 sq km with respect to 1991 in the forest cover not only pertains to

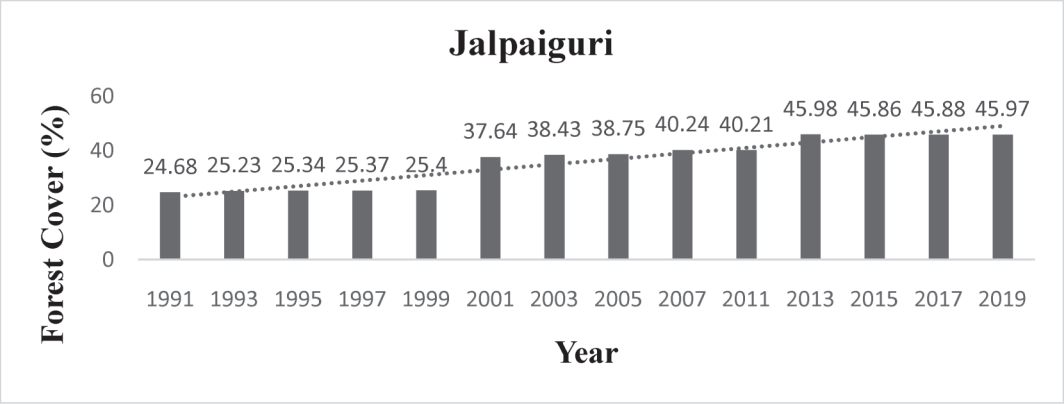

Fig 9 Forest cover change matrix of Jalpaiguri district, West Bengal

the period of 2013, but a major part of increase has been attributed to inclusion of Trees Outside Forest (TOF) areas of Jalpaiguri district which could not be captured earlier assessment by the Forest Survey of India (FSI) team due to limitation and dearth of modern device for computation.

Jalpaiguri district is very much rich in forest canopy and dense forestry having plenty of timbers and trees. The forest cover in Jalpaiguri district in 2019 report, based on interpretation of IRS Resourcesat-2 LISS III satellite data of the period November 2017 to February 2018 is 2862.40 sq km which is 45.97% of the district's geographical area, the second highest forest cover among the districts of West Bengal. In terms of forest canopy density classes, the district has 724.22 sq km area under very dense forests, 434.92 sq km area under moderately dense forests and 1703.26 sq km area under open forests. There is a net increase of 5.40 sq km in the forest cover in the Jalpaiguri district of West Bengal, from the reported area in India State of Forest Report 2019. A diagrammatic account of the class-wise change is given in the forest cover change matrix in the Fig 9.

2.8 Forest Cover of Malda District

In Malda district, Tilason forest, the only natural habitat of Hizal trees *(Barringtonia acutangula)* is covered in an area of about 150 sq miles. Tilason forest, a Tropical Littoral Swamp natural forest of the Malda district, located in the western side of Habibpur Community Development Block at no man's land of the India-Bangladesh border area is known for its habitation of Hizal trees grown naturally with abundant occurrences. In the Barrind region of the North Bengal, the Hizal forest of Tilason, a part of littoral and swamp forest, is referred as northern tropical deciduous forest has been taken up by the government forest department for conservation and protection. Tilason forest, covered with dense Hizal trees and diversified scrubs is situated in between the Tangan and Punarbhaba rivers of Malda district. Anyway, Tilason forest is subjected to an occurrence of a single large species of Hizal which is strongly influenced by climate and face disturbances for global warming and climate change. Disturbances such as fire, drought, landslides, species invasions, and insect and disease outbreaks influence the structure,

composition, and function of such Hizal forest. This type of large single species abundance can have the direct impact of climate change on such forest ecosystems because of the relationships between climate, disturbance agents and forests. Any of these disturbances can increase forest susceptibility to other disturbances. Considering the forest of Tilason, for example, if Hizal forests become infested with the bark beetles, after suffering damage from devastated cyclonic storms, the beetle outbreaks will cause extensive tree mortality resulting in an increase of fuel loads which severely will increase the risk of wildfires. Further, making predictions on the future impacts of a changing climate on forest disturbances is made more difficult by these interactions. Such effects of climate change are to be applicable on the other forests of Malda district enriched with species diversity. Other forests of Malda district, are Itabandha forest (Danga Akalpur, Rasikpur, Gajol); Salbona/Rajadighi forest (Chiriyadaha, Hatimari, Alampur); Adina forest (Gajol), Altar Forest; and Raniganj Dukla forest. Anyway, there is no separate statistics available for forest cover of Malda district in the report of Forest Survey of India from 1987 to 1989. Further, forest area of Malda district is amalgamated with the data of the other districts like Burdwan, Birbhum, Kolkata, Hugli, Howrah, Nadia, Medinipur, Murshidabad, 24 Parganas and West Dinajpur as shown in the report of FSI for the period from 1991 to 1997. Further, no report was published in 2007 by the Forest Survey of India and the report published in 2009 contains only the forest statistics for the year 2007. This is the reason behind non-availability of district-wise forest statistics for the year 2009. Needless to mention that the Forest Survey of India (FSI) took initiatives for forest survey of the entire country and commenced publishing forest reports since 1987 in every two years consecutively.

Malda district is very much rich in forest canopy and dense forestry having plenty of deciduous trees. The forest cover of Malda district in 2019, based on interpretation of IRS Resourcesat-2 LISS III satellite data of the period November 2017 to February 2018 is 491.69 sq km which is 13.17% of the district's

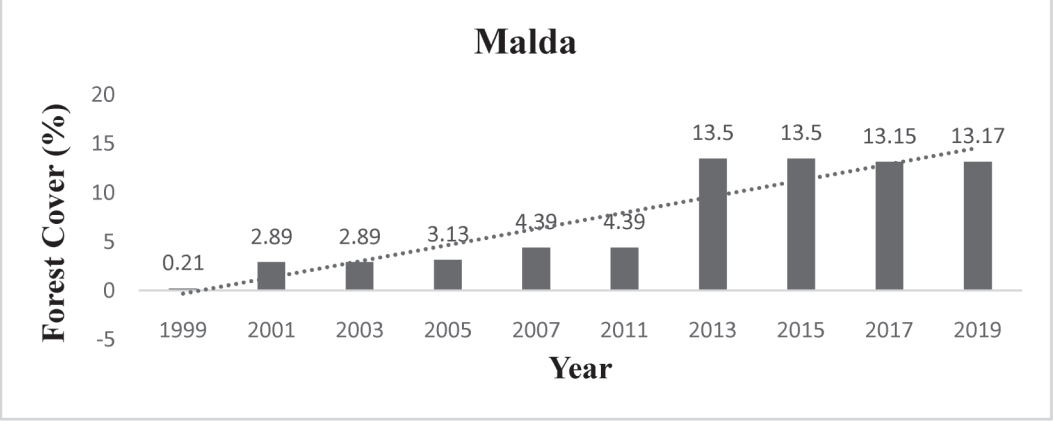

Fig. 10. Forest cover change matrix of Malda district, West Bengal

geographical area. In terms of forest canopy density classes, the very dense forests area of the district is nil, 209.04 sq km area under moderately dense forests and 282.65 sq km area under open forests. There is a net increase of 0.69 sq km available from the reported area in India State of Forest Report 2019. Total increase in the forest cover not only pertains to the year of 2013 with respect to 1991, but a major part of increase has been attributed to inclusion of Trees Outside Forest (TOF) areas of Malda district which could not be captured earlier assessment by the Forest Survey of India (FSI) team due to limitation and dearth of modern device for computation. Anyway, there is no separate statistics available for forest cover of Malda district in the report of Forest Survey of India from 1987 to 1989. A diagrammatic account of the class-wise change is given in the forest cover change matrix in the Fig 10.

2.9 Forest Cover of Murshidabad District

The green infrastructure sustaining the life on the earth feat is the forest. Trees make the forest. Trees are useful when it comes to multi-solving, that is tackling multiple problems simultaneously. Not just carbon sinks and reserves for biodiversity but also great allies when tackling pollution, food supply, economic growth, to name just a few. Keeping this in mind the inhabitants of the Murshidabad district have drawn the framework of their own for years after years, through nature-based solutions, launched to show which trees are best for tackling economic crisis through mitigation of poverty of the people of the grass root level. Certainly, the people of Murshidabad chose the cultivation of mango and lichi, irrespective of much interest in the plantation programme under agroforestry schemes managed and planned by the government's agricultural department. Further, the forest has been degraded over hundred years and land use pattern, thereon, has gradually been changing. At present, the area of green canopy of the district is moderately nice because of the agroforestry of both mango and lichi that enhances the economic growth of the people of the district of Murshidabad.

Forest degradation leads to deforestation where forest degradation is a process in which the biological diversity of the forest is diminished permanently, and degradation makes the forest less valuable and results in deforestation. Ultimately forest degradation and deforestation accelerate the issue of land degradation of the Murshidabad district. A few forests, at present, is still there, namely Jitpur forest at Domkal, Deer forest at Farakka, Islampur forest, Aahiran forest, but with fewer trees, plants, or animals, though the green cover is seen in the border area of the district like Lalgola etc through the scheme of agroforestry strategy by the orchard plantation of mango, lichi, banana etc in the district of Murshidabad.

For statistical interpretation, no data is available separately for Murshidabad district up to the forest survey report of 1997. There are no separate statistics available for forest cover of Murshidabad district in the report of Forest Survey of India from 1987 to 1989. Further, forest area of Murshidabad district is amalgamated with the data of the other districts like Birbhum, Kolkata, Hugli, Midnapur, Nadia, Malda, Bardhaman, 24 Parganas, Paschim Dinajpur and Howrah as shown in the report of FSI for the period from 1991 to 1997. Separate data of the district of

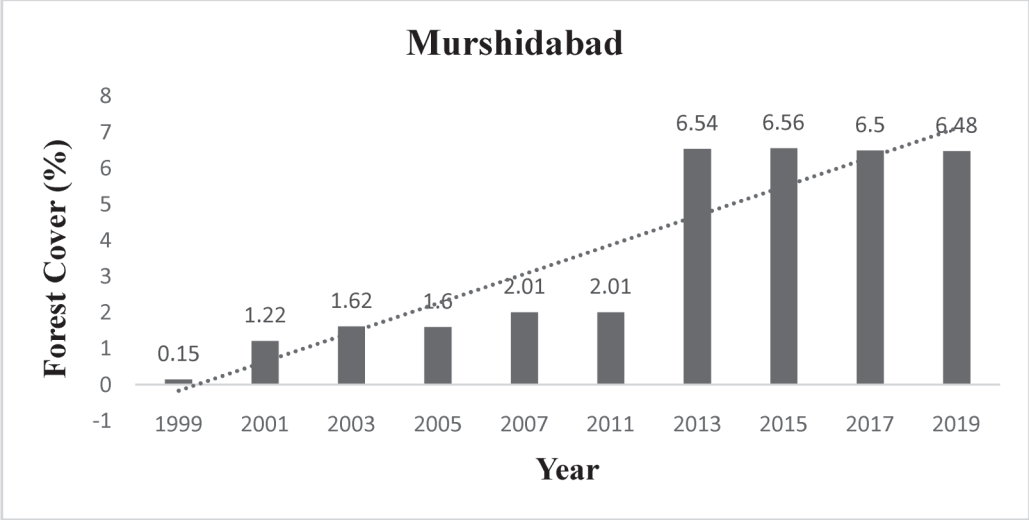

Fig. 11. Forest cover change matrix of Murshidabad district, West Bengal

the state of West Bengal have been inventoried in the forest report of 1999 for the first time. Further, no report was published in 2007 by the Forest Survey of India and the report published in 2009 contains only the forest statistics for the year 2007. This is the reason behind non-availability of district-wise forest statistics for the year 2009. Total increase in the forest cover not only pertains to the year of 2013 with respect to 1999, but a major part of increase has been attributed to inclusion of Trees Outside Forest (TOF) areas of the Murshidabad districts which could not be captured earlier assessment by the Forest Survey of India (FSI) team due to limitation and dearth of modern device for computation. Needless to mention that the Forest Survey of India (FSI) took initiatives for forest survey of the entire country and commenced publishing forest reports since 1987 in every two years consecutively. Anyway, the forest of Murshidabad district is covered with artificial plantations. Among fauna, jungle cat, jungle fowl, python, monkeys, wild boar and varieties of birds and reptiles are increasingly being reported.

Murshidabad is a district which is very much poor in forest canopy and forestry in terms of the percentage to its geographical area. The forest cover in Murshidabad district, based on interpretation of IRS Resourcesat-2 LISS III satellite data of the period November 2017 to February 2018 is 344.89 sq km which is 6.48% of the district's geographical area. In terms of forest canopy density classes, the very dense forests area of the district is nil, 53.06 sq km area under moderately dense forests and 291.83 sq km area under open forests. There is a net decline of 1.11 sq km in the forest cover from the reported area in India State of Forest Report 2019. A diagrammatic account of the class-wise change is given in the forest cover change matrix in the Fig 11.

2.10 Forest Cover of Nadia District

A person living in a crowded metropolis breathes fresh air taking a solitary walk along the jungle passage covered with the green canopy as 'solitude is needful to the imagination'. A place for such solitude is

Bethuadahari sanctuary in the district of Nadia under Nadia-Murshidabad Forest Division. The sanctuary is open for visit from 9 am to 12 noon and 2 pm to 4 pm daily round the year. Bethuadahari sanctuary is a typical forest of social forestry origin where plenty of timber trees of different species like Arjun Akashmani Jarul Kadam Babul Segun Mehagini Amalaki Haritaki Chhatim Neem Chatka Lambu Punyo Debdaru Tentul Jam Amaltas Champa Kanchan are very much common. Bethuadahari, a wildlife sanctuary, covering an area of 67 hectares, and established in 1980 to preserve an eco-zone, has a large population of 297 spotted deer, jackal, Bengal fox, porcupines, common langur, monitor lizards, gharial and rock pythons. Two hours is enough for meandering in and around the sanctuary. A nature interpretation centre is also founded in the name of veteran dramatist of the district, Dwijendralal Roy where different ecological aspects about flora and fauna of the wildlife sanctuary are displayed. It is a good effort by the forest department to enrich in situ knowledge-based education for the students and young budding scientists.

Likewise, Bethuadahari sanctuary, Anandanagar forest is established at Ranaghat range of Nadia district having dense vegetation of timber trees, plenty of flora and fauna and chirping sounds of birds. A visitor meandering inside the forest reported that there are many Bengal foxes in the jungle and they often attack the visitors even in the daytime. Other notable forests in Nadia district are Simanagar forest (Chapra), Banguria (Bagula), MahatpurGalay Dari (Karimpur), Kulgachhi, Khisma (Birnagar) and Bahadurpur Reserved forest under Nadia - Murshidabad forest division and they are all social forestry origin.

Natural forest and forestry of the Nadia district, at present, is without form and void, though a few numbers of forests are grown up with the plantation programme of social forestry scheme under the supervision of the forest department. In 1991, only 10 sq km area of forest cover of the district was increased to 480 sq km expansion in 2019 as recorded in the India State of Forest Report 2019. There is a net increase of 470 sq km forest area in the district within a time span of only two decades. A class-wise change in the district is given in the forest cover change matrix in Fig 12. The increase in the forest cover in the district is due to coppice growth and afforestation inside the forests and growth of commercial plantation under individual care. Total increase in the forest cover not only pertains to the period of 2011-2013, but a major part of increase has been attributed to inclusion of Trees Outside Forest (TOF) areas of Nadia district which could not be captured earlier assessment by the Forest Survey of India (FSI) team due to limitation and dearth of modern device for computation. Anyway, there is no separate statistics available for forest cover of Nadia district in the report of Forest Survey of India from 1987 to 1989. Further, forest area of Nadia district is amalgamated with the other districts like Burdwan, Birbhum, Kolkata, Hugli, Howrah, Malda, Medinipur, Murshidabad, 24 Parganas and West Dinajpur as shown in the report of FSI for the period from 1991 to 1997. Further, no report was published in 2007 by the Forest Survey of India and the report published in 2009 contains only the forest statistics for the year

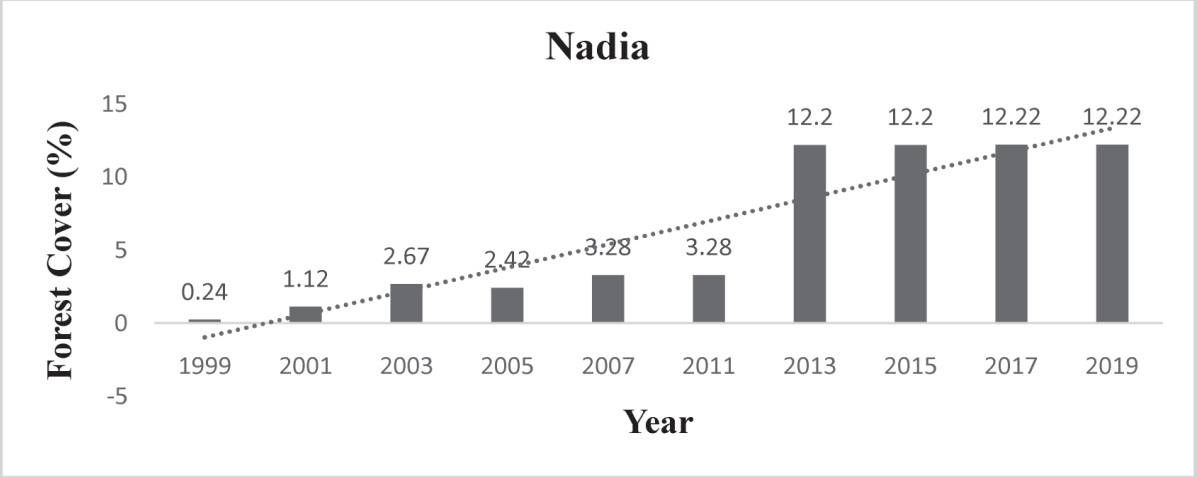

Fig. 12. Forest cover change matrix of Nadia district, West Bengal

2007. This is the reason behind non-availability of forest statistics for the year 2009. Needless to mention that the Forest Survey of India (FSI) took initiatives for forest survey of the entire country and commenced publishing forest reports since 1987 in every two years consecutively. Nadia district, at present, is covered with 12.22% forest cover with respect to its geographical areas of 3927 sq km. The people of the district are very much keen for plantation of trees roadside, canal side and even in their own land for commercial exploitation for enhancement of the green cover of the district, and in this way the green canopy of the district is to be increased outside the forest in near future. In terms of forest canopy density classes, the Nadia district has only 1 sq km area under very dense forests, 160.16 sq km area under moderately dense forests and 318.84 sq km area under open forests. There is no change of the forest cover in Nadia district as per the Forest Report 2019. A diagrammatic account of the class-wise change is given in the forest cover change matrix in the Fig 12.

2.11 Forest Cover of North 24 Parganas District

System of reclamation changes the dense mangrove forest canopy of the Sunderbans, particularly of wilderness inclusive briefing of the natural habitat of the Royal Bengal tigers and crocodiles and as a result, human habitation and agricultural land is introduced within the reclaimed land. The then Collector of Jessore, Tilman Henckell was the pioneer of such a system of reclamation in the Sunderbans in the present day North 24 Parganas district during his tenure of 1781–1790. He played an incredibly positive role in taking initiative of reclamation clearing the dense jungle of mangroves and tried an utmost effort for the welfare of the molungees who were engaged in salt preparation. His scheme failed as the members of the Board were not convinced with his proposal. But ultimately progress of reclamation has been going on steadily for about forty years after the tenure of Collector, Tilman Henckel. Further, he took initiatives for the welfare of the molungees of tribal origin namely

Chandabandas, from which the name of the Sunderbans was supposed to be introduced. The British first noticed the vast low-lying forest area and they immediately resolved to reclaim this forestland to collect the revenue by the introduction of agriculture on that mangrove habitat zone. Mr. Claude Russel (1770), the Collector General of 24 Parganas district first took initiatives followed by Tilman Henckell (1781), the Judge and Magistrate of Jessore district. A scheme of arrangement was drawn up for cultivation in the reclaimed area – Cultivation in the Sunderbans – Jessore. Collector was directed to submit a separate report on the present state of - , and to furnish information how far the original objects of the plan had been attained, together with an account of receipts and disbursements from the commencement of the undertaking to the present period. As the coast, salt manufacturing work was in progress adjacent to or inside the forest beauty of the Sunderbans in the present day North 24 Parganas district, the wild beast not only infested the area, but attacked molungees resulting in loss of so many lives. To avoid such a worst situation the Company rulers declared prize money for tiger-killing at the rate of Rs. ten per tiger. Locals of the Sunderbans of the Jessore district only (presently in Bangladesh) killed 33 tigers in a calendar year of 1788 and the disbursement of Rs. 330 is recorded in the Board of Revenue Index (20 July 1789). Hardworking labours from Santhal, Orano, Munda categories of tribal community were taken mainly from Hazaribagh, Singhbhum, Manbhum and Ranchi districts for the purpose of commencement of human habitation and settlement in the Sunderbans. Though cultivators and latdars from the neighbouring district of Midnapore settled first at the reclaimed zone of the Sagar Island, Namkhana and Patharpratima, before reclamation of land was started at Hingalganj area in the present-day portion of the North Twenty Parganas District. The duration of the human habitation in the Sunderbans region is never more than 115 years. The first tube well for drinking water facilities was sunk in 1950 in the newly settled and reclaimed zone considered for human habitation. Except, mangrove swamps and marshes, Parmadan sanctuary was established in this district very recently under social forestry schemes at the bank of river Ichamati in the name of great novelist Bibhuti Bhusan Bandyopadhyay.

For statistical interpretation, no data is available separately for North Twenty Four Parganas district up to the forest survey report of 1999, though North Twenty Four Parganas district was formed on 1 March 1986 after partition of Twenty Four Parganas district into North and South Twenty Four Parganas. Anyway, forest of North Twenty Four Parganas on an average of about 90% area is with mangroves and mangroves associated plants and outside the forest, the greenery is covered with artificial plantations. The forest cover of North Twenty Four Parganas district in 2019, based on interpretation of IRS Resourcesat-2 LISS III satellite data of the period November 2017 to February 2018 is 722.98 sq km which is 17.66% of the district's geographical area. In terms of forest canopy density classes, the district has 13.02 sq km area under very dense forests, 184.98 sq km area under moderately dense forests and 524.98 sq km area under open forests. There is a net decline of 0.02 sq km of the forest cover in

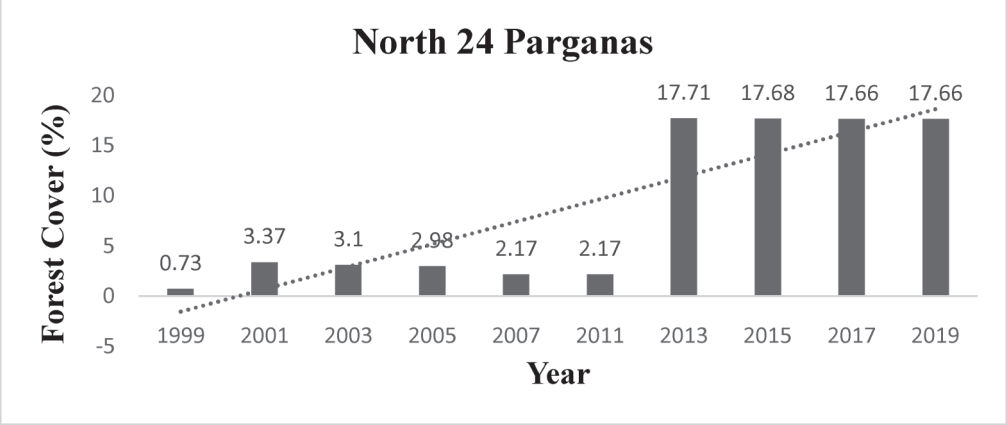

Fig. 13. Forest cover change matrix of North 24 Parganas, West Bengal

North Twenty Four Parganas district as per the Forest Report 2019. With respect to 1999, total increase in the forest cover not only pertains to the year of 2013, but a major part of increase has been attributed to inclusion of Trees Outside Forest (TOF) areas of North Twenty Four Parganas district which could not be captured earlier assessment by the Forest Survey of India (FSI) team due to limitation and dearth of modern device for computation. Anyway, there are no separate statistics available for forest cover of North Twenty Four Parganas district in the report of Forest Survey of India from 1987 to 1989. Further, forest area of North Twenty Four Parganas district is amalgamated with the data of the other districts like Birbhum, Kolkata, Hugli, Midnapur, Nadia, Malda, Murshidabad, 24 Parganas, Bardhaman, Paschim Dinajpur and Howrah as shown in the report of FSI for the period from 1991 to 1997. A diagrammatic account of the class-wise change is given in the forest cover change matrix in the Fig 13.

2.12 Forest Cover of Paschim Medinipur District

At Arabari, in the Paschim Medinipur district, local people or their residential places are not visible in and around this area other than the jungle. Dense jungle with a series of trees stands by the roadside. Except Sal trees, Kendu Mahua Kusum Bahera Muchukunda trees make the forest a dense greenery. Arabari, Jhitka, Lalgarh, Ramgarh, Karnagarh Garbeta, the natural forests, scattered in this area with a few kilometers distance from each other, are surrounded with Akashmani trees planted outside the forest area. Anyway, Arabari forest is a famous one in the history of forest manage- ment. Arabari is known all over India as the pioneering forest range in implemen-ting Joint Forest Management (JFM) scheme. A renowned forester Shri Ajit Kumar Banerjee, IFS, introduced joint forest management at 1272 hectares area of Arabari forest involving local people through a voluntary participation process from which the villagers in the surrounding villages are benefited of employment in silviculture and harvesting, sharing 25% of the profits from

the forest produce, collecting firewood and fodder from the jungle on a nominal charge[3]. The Joint Forest Management scheme is now practiced not only in the state of West Bengal, but all over India to fulfill the mission of greening one-third part of the geographical area of the country [4].

For statistical interpretation, no data is available separately for Paschim Medinipur district up to the forest survey report of 2015, though Paschim Medinipur district was formed on 1 January 2002 after partition of Medinipur district into Paschim Medinipur and Purba Medinipur. Further, on 4 April

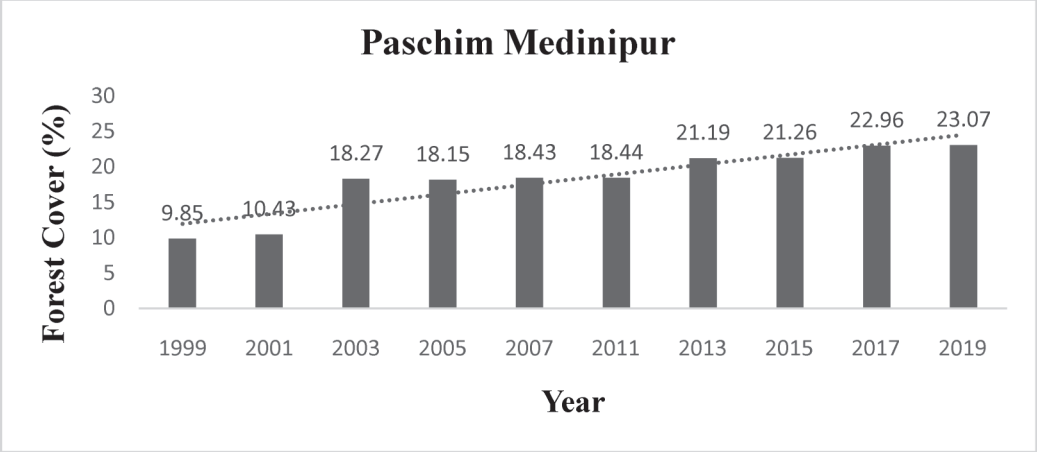

Fig. 14. Forest cover change matrix of Paschim Medinipur district, West Bengal

In this state of West Bengal, Paschim Medinipur is a district which is very much rich in forest canopy and dense forestry. The forest cover in Paschim Medinipur district, based on interpretation of IRS Resourcesat-2 LISS III satellite data of the period November 2017 to February 2018 is 2161.54 sq km which is 23.07% of the district's geographical area. In terms of forest canopy density classes, the district has 256.21 sq km area under very dense forests, 591.64 sq km area under moderately dense forests and 1313.69 sq km area under open forests. There is a net increase of 10.54 sq km in the forest cover from the reported area in India State of Forest Report 2019. A diagrammatic account of the class-wise change is given in the forest cover change matrix in the Fig 14.

2017, the Jhargram subdivision was converted into a district. Anyway, the forest of Paschim Medinipur on an average 60% area is with Sal trees of coppice origin and the rest is covered with artificial plantations. Among fauna, elephant, jungle cat, jungle fowl, baboons, python, wild boar and varieties of birds are increasingly being reported. Elephant-man conflict is common during paddy harvesting season due to the scattered nature of forests.

Man could not understand the importance of forest when it is plentiful and the same one is dear to them when it is scarce. Due to scarcity of land for conversion of forest land into agricultural land, adequate area within the forest cover in Paschim Medinipur district is unavailable for further plantation, though

plenty of barren land is covered with scrub. So, therefore, at present scenario of the district, tree cover through social forestry is to be increased taking thorough plantation programmes round the year on the roadside, canal side and riverside area. Villagers are to be encouraged for plantation through distribution of saplings from the forest sector by organizing gala festivals of afforestation annually. Only man could clearly perceive the good will for a better cause of recovery of greenery of their own surroundings for ecological balance of the nature, if not, what man has made of man - lament over the consequences of deforestation.

2.13 Forest Cover of Purba Bardhaman and Paschim Bardhaman Districts

Forests are strewn across the districts of Purba and Paschim Bardhaman of West Bengal and the forests of the districts have wide variations. There are few places of historical interest inside the jungles; some notable myths about some structures and persons related to the forests are mentioned even in the Manasamangal. Dense forests of Bardhaman offer diverse set of habitats for plants, animals, and micro-organisms, but these increasingly threatened biologically rich systems along with Deul, Garh jungle etc, the places with dense forest, thick foliage, and greenery around, are the oldest places as believed by the historians. Garh Jungle, the place where King Surath used to perform Durga Puja, also named as Dharam Garh, is an important place for the Hindu mythology, especially shakta. King Surath erected here a temple for Tridebi i.e., temple of Mahakali, Mahasaraswatiand Mahalakshmi which is seen today within the dense jungle. Deul, a dense wooded forest area is rich with legacies and legends of Ichhai Ghosh. Further, the Deul, the Ichhai Ghosh temple, a plain brick structure, is one of the few rekh-deuls in Bengal and it was possibly erected by the descendants of Ichhai Ghosh, to perpetuate his memory around the 16th-17th century. The deul of the famous Gopiraj Ishwar Ghosh, locally called Ichhai Ghosh, nestled in the bank of River Ajoy, is surrounded with the thick garh forest, and is frequented by herds of elephants from Bankura and Birbhum located nearby. Another forest namely Tilabani, along the Jhajhra Road, created, developed, and maintained by Eastern Coal Field Limited is created from artificial plantation under social forestry schemes. Ukhra lake, near the Tilabani forest houses varieties of migratory birds of about 45 species. The Bardhaman Forest Division is constituted with three ranges viz. Durgapur, Guskara and Panagarh. The natural vegetation of the forests in the district is Sal which is mostly in the protected and covering areas. Conservation of the forest is essential as the Tropical Forests alone is losing at least one higher plant species per day. It would require some effort to scale the forest area into its former size and shape, but the reality of the situation is quite different, sometimes the noble endeavour of the forest department has been desecrated by the inhabitants of the villages surrounding the forests.

For statistical interpretation, no data is available separately for Bardhaman district up to the forest survey report of 1997. Needless to mention that the Purba and Paschim Bardhaman districts were formed on 7 April 2017 after partition of Bardhaman

district into Purba and Paschim Bardhaman districts. There are no separate statistics available for forest cover of Bardhaman district in the report of Forest Survey of India from 1987 to 1989. Further, forest area of Bardhaman district is amalgamated with the data of the other districts like Birbhum, Kolkata, Hugli, Midnapur, Nadia, Malda, Murshidabad, 24 Parganas, Paschim Dinajpur and Howrah as shown in the report of FSI for the period from 1991 to 1997. Separate data of the district of the state of West Bengal have been inventoried in the forest report of 1999 for the first time. Further, no report was published in 2007 by the Forest Survey of India and the report published in 2009 contains only the forest statistics for the year 2007. This is the reason behind non-availability of district-wise forest statistics for the year 2009. Total increase in the forest cover not only pertains to the year of 2013 with respect to 1999, but a major part of increase has been attributed to inclusion of Trees Outside Forest (TOF) areas of the Bardhaman districts which could not be captured earlier assessment by the Forest Survey of India (FSI) team due to limitation and dearth of modern device for computation. Needless to mention that the Forest Survey of India (FSI) took initiatives for forest survey of the entire country and commenced publishing forest reports since 1987 in every two years consecutively. Anyway, the forest of Bardhaman district is covered with both natural and artificial plantations. Among fauna, elephants, jungle cats, jungle fowl, python, monkeys, wild boars and varieties of birds and reptiles are increasingly being reported.

Bardhaman is a district which is very much poor in forest canopy and forestry in terms of the percentage to its geographical area. The forest cover in Bardhaman district, based on interpretation of IRS Resourcesat-2 LISS III satellite data of the period November 2017 to February 2018 is 339.31 sq km which is 4.83% of the district's geographical area. In terms of forest canopy density classes, the district has 57.53 sq km area under very dense forests, 91.78 sq km area under moderately dense forests and 190 sq km

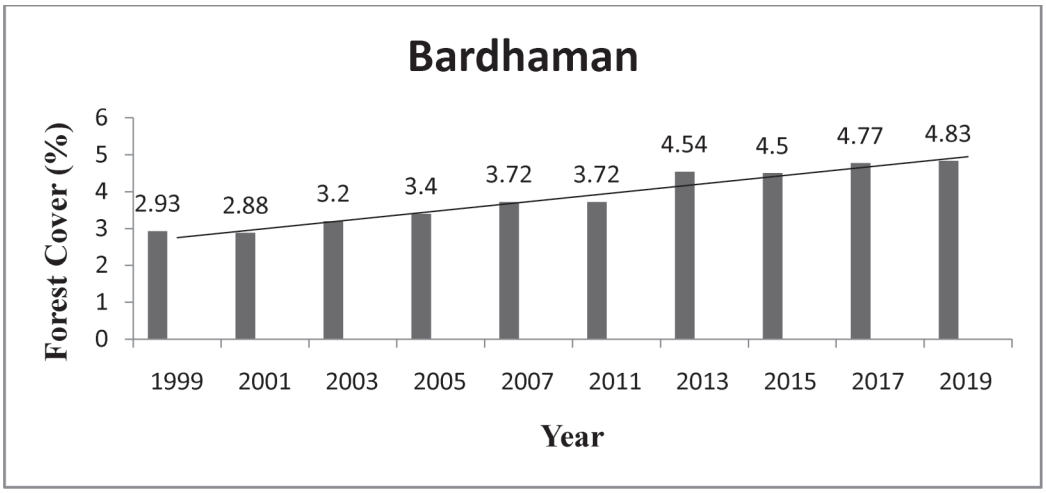

Fig. 15. Forest cover change matrix of Bardhaman district, West Bengal

area under open forests. There is a net increase of 4.31 sq km in the forest cover from the reported area in India State of Forest Report 2019. A diagrammatic account of the class-wise change is given in the forest cover change matrix in the Fig 15.

2.14 Forest Cover of Purba Medinipur District

The coastline forest in and around the Hooghly estuary along the Bay of Bengal can turn into a labyrinth when a void labyrinthine forest path is visible like that of the then Kapalkundala, a mystic character brought to the light by the author Rishi Bankim Chandra Chattopadhyay. Rishi Bankim, the popular novelist, presents the nature of forests as necessary mysteries, in his many other works like Debi Chowdhurani, Durgesh Nandini, Anandamath, Kapalkundala, with a more similar tone. All his novels have the known historical characters once moved in this materialistic world, and certainly not like mysterious creatures dwelling deep into the unknown jungles. The great novelist uses forest as metaphors and the life of the characters in his novel can be quite mysterious like the deepest dense jungles. Kapalkundala is such a mysterious one, which we suppose that she is still living in the mystic coastal forest adjacent to the lighthouse of Dariapur near Rasulpur of Purba Medinipur, and such mystic feelings regarding a character of transitional state in between wilderness and social approaches is certainly a universal spirit permeating all nature. Bankim tries to connect the forest with the society as the relationship between human beings and forests has been important for the development of society. It is based on various productive, ecological, social, and cultural functions of forests. Industrialization and urbanization have contributed to an alienation from nature and weakened the connection of humans to forests. Likewise, Bankim's novel, the series of casuarina trees along the coastal Purba Medinipur district including Junput, Shankarpur, Mandarmani, Tajpur, Mohana, Old Digha, New Digha and Udaipur connect the society with the forests with the same thread and same thoughts. Likewise, the forest with the series of the casuarina trees all along the coastal stretch, the people too are involved with the social contract by their language, dress, food habits, and style of house building, marital relationship, and other rituals in the society of coastal forest areas of Purba Medinipur district.

For statistical interpretation, no data is available separately for Purba Medinipur district up to the forest survey report of 2015, though Purba Medinipur district was formed on 1 January 2002 after partition of Medinipur district into Paschim Medinipur and Purba Medinipur. There are no separate statistics available for forest cover of Purba Medinipur district in the report of Forest Survey of India from 1987 to 1989. Further, forest area of Purba Medinipur district is amalgamated with the data of the other districts like Burdwan, Birbhum, Kolkata, Hugli, Howrah, Nadia, Malda, Murshidabad, 24 Parganas and West Dinajpur as shown in the report of FSI for the period from 1991 to 1997. Separate data of these districts of the state of West Bengal have been inventoried in the forest report of 1999 for the first time. Further, no report was published in 2007 by the Forest Survey of India and the report published in 2009

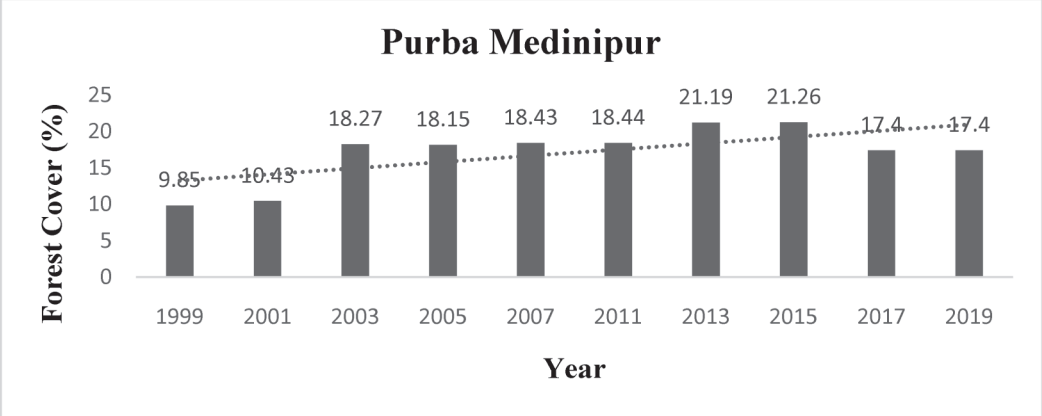

Fig. 16. Forest cover change matrix of Purba Medinipur district, West Bengal

contains only the forest statistics for the year 2007. This is the reason behind non-availability of district-wise forest statistics for the year 2009. Total increase in the forest cover not only pertains to the year of 2003 with respect to 1999, but a major part of increase has been attributed to inclusion of Trees Outside Forest (TOF) areas of Purba Medinipur district which could not be captured earlier assessment by the Forest Survey of India (FSI) team due to limitation and dearth of modern device for computation. Needless to mention that the Forest Survey of India (FSI) took initiatives for forest survey of the entire country and commenced publishing forest reports since 1987 in every two years consecutively. Anyway, forest of Purba Medinipur on an average 60% area is with Casuarina trees and the rest is covered with artificial plantations. Among fauna, jungle cats, jungle fowl, python, wild boars and varieties of birds and reptiles are increasingly being reported.

Purba Medinipur is a district which is rich in forest canopy and forestry. The forest cover in Purba Medinipur district, based on interpretation of IRS Resourcesat-2 LISS III satellite data of the period November 2017 to February 2018 is 820.05 sq km which is 17.40% of the district's geographical area. In terms of forest canopy density classes, the district has 1.99 sq km area under very dense forests, 197.96 sq km area under moderately dense forests and 620.10 sq km area under open forests. There is a net increase of 0.05 sq km in the forest cover from the reported area in India State of Forest Report 2019. Based on ground truthing, the main reasons for the increase of forest cover in the district of Purba Medinipur are protection and plantation of Acacia, Eucalyptus, Akasmani and Casuarina in the coastal area. A diagrammatic account of the class-wise change is given in the forest cover change matrix in the Fig 16.

2.15 Forest Cover of Purulia District

Forests in the Purulia District, the most important natural resources, exist in scattered patches and are unevenly distributed. Further, forests is the major land use in this district next to agriculture. The rural population depend on the forests for meeting their regular needs of fuel wood,

fodder for their cattle and partially for earning their livelihood, though the villagers cannot meet all their requirements of fuel wood from the forest area alone and must depend on sources outside the forest. The rural population, particularly the tribes, economically extremely poor, depend upon the natural produce of the forests extended in and around Bandwan, Manbazar, Burra, Balarampur, Jhaldah, Joypur and Matha forest ranges of the district. Geographically the forest area of Purulia district covers 915.88 sq km of forest land. Physiographically the forest area under this district falls under a sub-region of North-Eastern part of Chhotanagpur plateau with undulating and rolling topography. The degradation processes are active in the area as the presence of isolated hills and dissected plateaus. Biogeographically, the district represents Deccan Peninsula Chhotanagpur zone having varieties of fauna like mammals, amphibians, reptiles, birds, and fishes including different species of invertebrates particularly befitted to the habitat of plateau region. Among the flora, most interesting is Madras Tree Shrew, found on the top hills of the forest ecosystem of Purulia district which is found nowhere else in the other district of West Bengal. Forest canopy with greenery of this district is with very much outstanding heritage characteristics, though deforestation of 10.35% of the forest cover of the district for the period 1971-2011 remains one of the important problems in the plateau of the Purulia district that causes environmental degradation through agrarian invasion and huge loss of the forests.

In this situation, forests for the need of the local people as well as for effort to uplift the environmental conditions in the district of Purulia, implementation of social forestry schemes has been suggested as the demand of the population cannot be met alone from the forest cover. Saplings must be planted by the inhabitants of the villages to meet their sufficient requirements for domestic and commercial uses through social forestry schemes. Social forestry schemes will endeavour to meet the rural requirements of fuel wood, poles, small timber, bamboo, fodder of forest produce primarily through plantation. Fast growing species, planted closely in land outside the forest, could be easily harvested within the time span of 5-7 years interval and it would provide sufficient fuel wood supply as required by the locals living in the villages.

In this perspective, people of Purulia district, dependent on local forests for fuel wood and fodder, are to be best placed to look after the social forestry programme and that allowing communities to manage and use forest resources can have positive social, environmental, and economic impacts. It is now proved that social forestry can reduce deforestation, boost earnings, and settle conflicts over land use. Moreover, it could help the district in making progress towards the goal on climate change, forest protection and development. Social forestry is a broad term for approaches that empower communities to manage, protect and benefit from local forests - states the Social Forest Organization. Social forestry is useful, and its necessity is applicable in different dimensions having different names in different places like community forestry, village forestry, participatory forestry, community-based forest management and

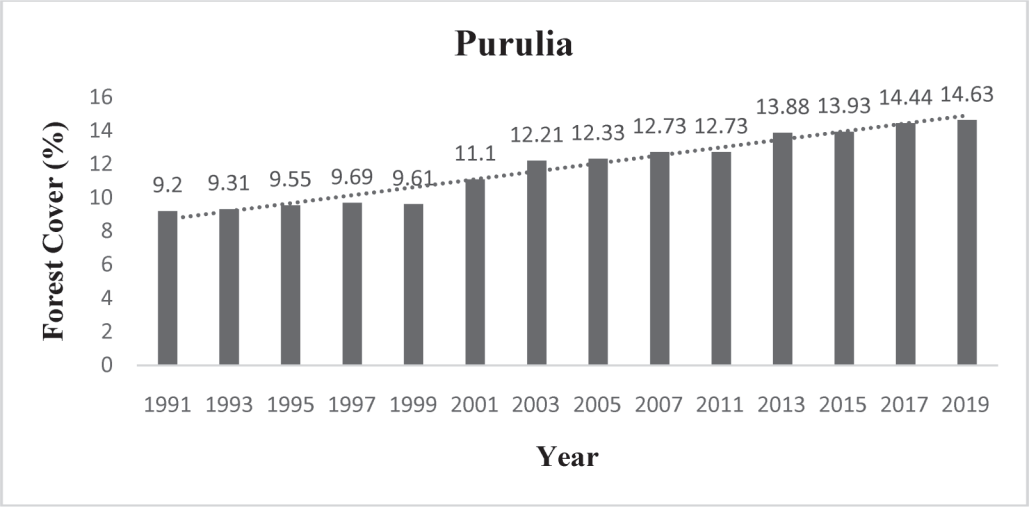

Fig. 17. Forest cover change matrix of Purulia district, West Bengal

people-cantered forestry. Different approaches to social forestry vary in the extent to which they give communities rights to use and benefit from forest resources. Some allow communities to set up enterprises and sell forest products including timber commercially. Such social forestry all over the world is rising and at present local communities manage 6.7 million hectares of forest under social forestry practices and this number is on rise - added members of the global Social Forestry sector.

Purulia district is very much enriched in forest canopy. The forest cover of Purulia district in 2019, based on interpretation of IRS Resourcesat-2 LISS III satellite data of the period November 2017 to February 2018 is 915.88 sq km which is 14.63% of the district's geographical area. In terms of forest canopy density classes, the district has 37.36 sq km area under very dense forests, 306.94 sq km area under moderately dense forests and 571.58 sq km area under open forests. There is a net increase of 11.88 sq km of the forest cover in Purulia district as per the Forest Report 2019. Total increase in the forest cover not only pertains to the year of 2013 with respect to 1991, but a major part of increase has been attributed to inclusion of Trees Outside Forest (TOF) areas of Purulia district which could not be captured earlier assessment by the Forest Survey of India (FSI) team due to limitation and dearth of modern device for computation. Anyway, there is no separate statistics available for forest cover of Purulia district in the report of Forest Survey of India from 1987 to 1989. A diagrammatic account of the class-wise change is given in the forest cover change matrix in the Fig 17.

2.16 Forest Cover of South 24 Parganas District

Here the amazingly quiet environment of the grand symphony of silence is uninterrupted. Wild bees in swarms come to Khalsi forest of Sunderbans during spring to produce honey and wax and cause pollination. Monkeys cover their bodies with muddy clay before tasting that honey from the honeycomb.

Kaora tree opens its petals of flowers with tens of stamina to tempt the bats to feed on and ensure pollination. The snails crawl to climb up the trees, the animals quench their thirst by drinking salty water in the scarcity of sweet water, the roots of some mangroves grow upwards opposite in direction to that of center of gravity instead of growing downwards. These roots are called pneumatophores which are breathing roots covered with mud and grow upward in search of oxygen. Some other mangroves grow on the stilt roots, which is an adaptive feature to stand erect on the shifting mud. During the high tidal phase of the day the semi-diurnal tide advances towards the land bathing it with water assuming a lover is clasping erotically his sweetheart; during the low tide, the water turns and goes back to the sea like one who slips off from the arms of his lover saturated after holding closely. This Sunderbans of Indian part is covering most of the south-eastern region of the district of South 24 Parganas, the southernmost district of West Bengal.

Sunderbans of the South 24 Parganas District–the largest prograding delta and the habitat of biggest contiguous mangrove patch of the world is with magnificent biodiversity including world famous Royal Bengal tiger and estuarine crocodiles. Sunderbans is a biogenous coast of numerous flora and fauna where the biological factors play significant roles in coastal evolution. There are 64 species of mangroves and its associated species and 1586 species of fauna are identified in Sunderbans.

A total number of 64 plant species are identified in the Sunderbans mangrove forest [5]. Among these 34 species are true mangroves while the rest are mangrove associated plants. The species diversity of mangroves is relatively poor, and they all show similarity in their general occurrence and physiological adaptations. Mangrove zonation depends upon soil characteristics, soil and water salinity, tidal amplitude, gentle sloping, shallow mudflats, mud substrates etc. Floral changes and community structures are causally related to the mudflat elevation[6]. It is observed that *Porteresia-coarctata* (Dhani grass) and saplings of *Avicennia marina* (Baen) are the pioneer species in an emerging mudflat followed by *Sonneratia* sp. (Keora), *Ceriops decandra* (Garan) and *Bruguiera* sp. (Kankra), *Aegialitis rotundifolia* (Tara), *Aegiceras* sp (Khalsi), *Excoecaria* sp. (Geoa) appear thereafter when the mud substrate of the newly emerged islands are stable, and the top of the island is no more inundated. Mangrove associated palm species are found to grow on the side of 31 large and narrow creeks and tidal inlets around the 48 mangroves dominated islands out of a total 102 islands of Sunderbans. Mangrove vegetation of intertidal mudflat accelerates the stability of the newly built-up islands and helps in configuring the new landmass.

Among numerous and rich faunal diversity of many 1586 species, the tiger occupies the pinnacle of the mangrove ecosystem. The famous estuarine crocodiles of Sunderbans are declared endangered species of late. The occurrences of king cobras and Indian Rock Python are recorded around buffer areas of the Sunderbans. Several species among

mammals are recorded endangered namely Indian Otter, Gangetic dolphin and Irrawaddy dolphin, Fishing cats and Leopard cats, Black porpoise etc. The fishes in estuaries of Sunderbans among fin fishes include a variety of 120 species. There are abundant occurrences of tiger shark, dog shark and 22 species of prawn in the Sunderbans river waters. Common birds in the Sunderbans are predator birds like white bellied sea-eagle, osprey, fishing eagle, Bramhani kites, monsoon herons like open bill stork etc. Some migratory birds from Siberia region like curlew. Plover Goliath Heron also breeds in the mangrove forest of Sunderbans. Traditionally, the wealth of natural resources of Sunderbans was assumed to be an unlimited gift of nature [7]. However, with increased knowledge and development of awareness of the locals on conservation of nature, this myth has been demolished. Inhabitants of 54 islands for human habitation have realized that the natural resources, although renewable, are not infinite and need to be effectively managed and conserved.

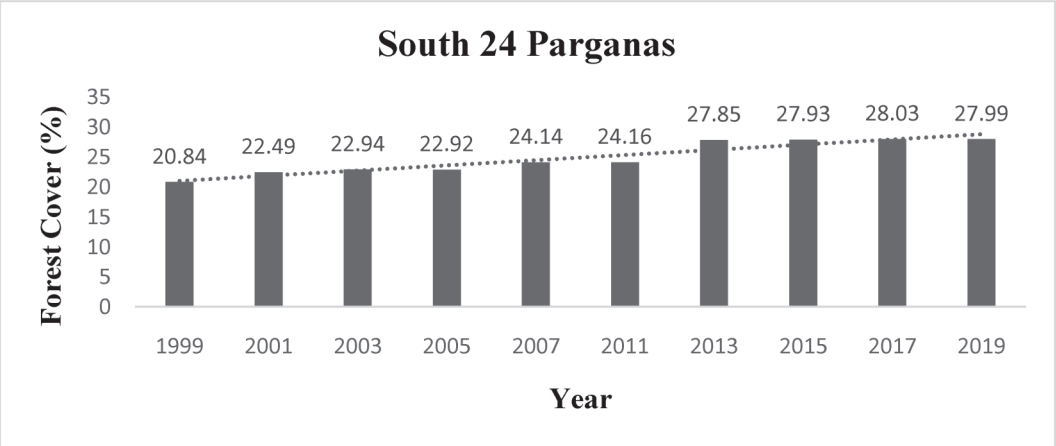

Fig. 18. Forest cover change matrix of South 24 Parganas, West Bengal

For statistical interpretation, no data is available separately for South Twenty Four Parganas district up to the forest survey report of 1999, though South Twenty Four Parganas district was formed on 1 March 1986 after partition of Twenty Four Parganas district into North and South Twenty Four Parganas. Anyway, forest of South Twenty Four Parganas on an average of 100% area is with mangroves and mangroves associated plants and outside the forest, the greenery is covered with artificial plantations.

South Twenty Four Parganas district is known for mangrove swamp. The forest cover of South Twenty Four Parganas district in 2019, based on interpretation of IRS Resourcesat-2 LISS III satellite data of the period November 2017 to February 2018 is 2788.71 sq km which is 27.99% of the district's geographical area. In terms of forest canopy density classes, the district has 983.10 sq km area under very dense forests, 745.03 sq km area under moderately dense forests and 1060.58 sq km area under open forests. There is a net decline of 3.29 sq km of the forest cover in

South Twenty Four Parganas district as per the Forest Report 2019. With respect to 1999, total increase in the forest cover not only pertains to the year of 2013, but a major part of increase has been attributed to inclusion of Trees Outside Forest (TOF) areas of South Twenty Four Parganas district which could not be captured earlier assessment by the Forest Survey of India (FSI) team due to limitation and dearth of modern device for computation. Anyway, there are no separate statistics available for forest cover of South Twenty Four Parganas district in the report of Forest Survey of India from 1987 to 1989. A diagrammatic account of the class-wise change is given in the forest cover change matrix in the Fig 18.

2.17 Forest Cover of Uttar Dinajpur and Dakshin Dinajpur Districts

Over the years, forests were revered by the people of undivided Bengal not only that, but many ceremonial occasions were also centered on trees and plants. The great emperor Ashoka started preservation and protection of forests and wild animals. But in the medieval era, many people had to flee from the attacks and take refuge in the forests during the Muslim invasions and the people cleared vast areas of forests to make way for settlements. This happened to the people of undivided Dinajpur district who destroyed forests without development for their settlement as evidenced by some myths still talked about in the districts. The myth has Pandavas (in the Mahabharata) hiding their arms and weapons in a hollow of a tree inside the forest at Harirampur of Dakshin Dinajpur and the forest gave them a good hiding. Another version of the story has the people hid themselves inside the forest feared after Muslim invasion and their arms and weapons were hidden reserves in the hollow of a tree inside the forest at Harirampur. The latter is most likely. Anyway, the effect of onslaught encroachment for habitation of the fearsome people enhances deforestation in both the Uttar and Dakshin Dinajpur districts. Loss of forests causes degradation of soil of the land, though that soil is the biggest terrestrial carbon sink, but land degradation is reducing its ability to fight. Forests serve as natural storage for carbon, and deforestation is the second leading cause of carbon emissions that contribute to climate change. At present, there is no forest grown naturally in these two districts, but a few forests created through plantation programmes under social forestry schemes of the government. Among them, Kulik and Sapnikla forests of Uttar Dinajpur and Sarengbari and Dogachhi of Dakshin Dinajpur district are popular and known to all.

For statistical interpretation, no data is available separately for Uttar Dinajpur district up to the forest survey report of 1997, though Uttar Dinajpur district was formed on 1 April 1992 after partition of Paschim Dinajpur district into Uttar Dinajpur and Dakshin Dinajpur districts. There are no separate statistics available for forest cover of Paschim Dinajpur district (known before 1 April 1992) in the report of Forest Survey of India from 1987 to 1989. Further, forest area of Paschim Dinajpur district is amalgamated with the data of the other districts like Burdwan, Birbhum, Kolkata, Hugli, Midnapur, Nadia, Malda, Murshidabad, 24 Parganas and Howrah as shown in the report of FSI for the period from 1991 to 1997. Separate data of the district of the state of West Bengal have

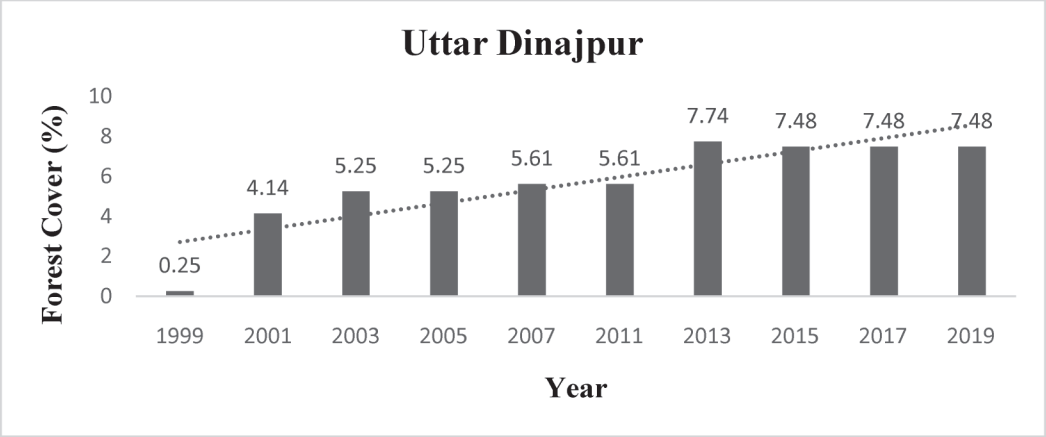

Fig. 19. Forest cover change matrix of Uttar Dinajpur district, West Bengal

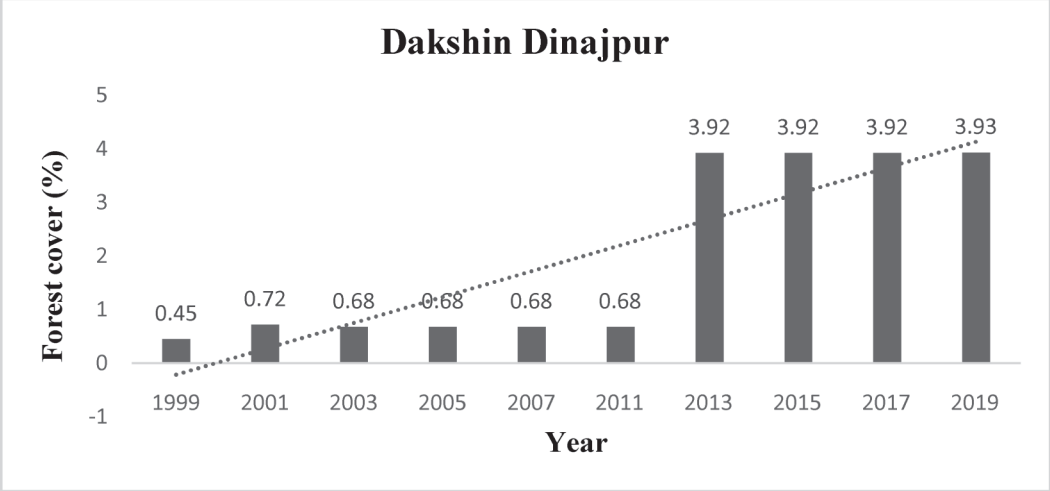

Fig. 20. Forest cover change matrix of Dakshin Dinajpur district, West Bengal

been inventoried in the forest report of 1999 for the first time. Further, no report was published in 2007 by the Forest Survey of India and the report published in 2009 contains only the forest statistics for the year 2007. This is the reason behind non-availability of district-wise forest statistics for the year 2009. Total increase in the forest cover not only pertains to the year of 2001 with respect to 1999, but a major part of increase has been attributed to inclusion of Trees Outside Forest (TOF) areas of the Uttar Dinajpur districts which could not be captured earlier assessment by the Forest Survey of India (FSI) team due to limitation and dearth of modern device for computation. Needless to mention that the Forest Survey of India (FSI) took initiatives for forest survey of the entire country and commenced publishing forest reports since 1987 in every two years

consecutively. Anyway, forests of Uttar Dinajpur district are covered with artificial plantations. Among fauna, jungle cats, jungle fowl, python, wild boars and varieties of birds and reptiles are increasingly being reported.

Uttar Dinajpur is a district which is very much poor in forest canopy and forestry. The forest cover in Uttar Dinajpur district, based on interpretation of IRS Resourcesat-2 LISS III satellite data of the period November 2017 to February 2018 is 234.93 sq km which is 7.48% of the district's geographical area. In terms of forest canopy density classes, the district has no area under very dense forests, 3.99 sq km area under moderately dense forests and 230.94 sq km area under open forests. There is a net decline of 0.07 sq km in the forest cover from the reported area in India State of Forest Report 2019. A diagrammatic account of the class-wise change is given in the forest cover change matrix in the Fig 19.

Dakshin Dinajpur is a district which is very much poor in forest canopy and forestry. The forest cover in Dakshin Dinajpur district, based on interpretation of IRS Resourcesat-2 LISS III satellite data of the period November 2017 to February 2018 is 87.12 sq km which is 3.93% of the district's geographical area. In terms of forest canopy density classes, the district has no area under very dense forests, 5.83 sq km area under moderately dense forests and 81.29 sq km area under open forests. There is a net increase of 0.12 sq km in the forest cover from the reported area in India State of Forest Report 2019. A diagrammatic account of the class-wise change is given in the forest cover change matrix in the Fig 20.

3. DISCUSSIONS

The goal of greening one-third part of the geographical areas of India is running beyond 12% as the total forest cover of India stands at 7,12,249 sq km which is 21.67% of the total areas of the country, though the forest cover has gradually been increasing since 1987, the year mark of first survey on the forests of the country by the Forest Survey of India. The forest cover recorded an increase of nearly 0.6% in 2019 in comparison to that of 2017 survey as reported by the Forest Survey of India in their India State of Forest Report 2019. Country's green cover is rather different including forest cover, tree cover and the trees outside the forest amounting to a total of 8,07,276 sq km which is 24.56 % of the geographical areas of India. Tree cover, more specifically, Trees Outside Forest (TOF), accounting for 95,027 sq km in 2019 comprises scattered trees on the roadside and canal side trees under social forestry scheme including personal or private plantation i.e., trees of all formations outside the forest. The increase of forest cover by 3976 sq km and tree cover by 1212 sq km accounts for the rise of total green cover of the country at 8,07,276 sq km, which is 24.56% of the total geographical area of India. Recorded forest areas may or may not have forest cover, this area is recorded as forest in the Government records. Such recorded forest area in India is 7,67,419 sq km and 11879 sq km in West Bengal inclusive of Recorded Forest, Protected Forest and Unclassed Forest as classified by the forest sector. The present forest cover of 21.67% in India is yet to reach the 23.34% of recorded forest areas of the country's total geographi-

cal areas of 3,287,469 sq km though the changing forest scenario of India as recorded by the India State of Forest Report 2019 certainly raises a signature of hope for a green India in near future.

Social forestry work in all districts over West Bengal has started showing results. South Bengal's forest cover had dwindled alarmingly in the 1970s and 1980s, a shift to joint forest conservation by making stakeholders in forestry initiatives has yielded results. District-wise break-up revealed that South 24 Parganas, Uttar Dinajpur, Murshidabad and Howrah have recorded decrease in forest cover, while Bankura, Paschim Medinipur, Purulia and Birbhum have recorded a rise. While Bankura logged a growth of 15.6 sq km in its forest cover, South 24 Parganas, which houses a vast stretch of the Sunderbans, has witnessed a dip in forest cover by 3.3 sq km. In terms of forest canopy density classes, Bankura district has 222.33 sq km area under very dense forests, 395.27 sq km area under moderately dense forests and 667.98 sq km area under open forests. There is a net increase of 15.58 sq km, the highest increase in the forest cover among all districts, in the state of West Bengal, from the reported area in India State of Forest Report 2019. Birbhum district has only 1 sq km area under very dense forests, 34.14 sq km area under moderately dense forests and 149.66 sq km area under open forests. There is a net increase of 7.80 sq km of the forest cover in Birbhum district as per the Forest Report 2019. Very dense forests area of the Cooch Behar district is nil, 27 sq km area under moderately dense forests and 322.06 sq km area under open forests. There is a net increase of 0.06 sq km available from the reported area in India State of Forest Report 2019. In terms of forest canopy density classes, the Darjeeling district has 720.76 sq km area under very dense forests, 654.52 sq km area under moderately dense forests and 992.52 sq km area under open forests. There is a net increase of 2.80 sq km, having the highest percentage of the forest cover in Darjeeling among all the districts in the state of West Bengal, from the reported area in India State of Forest Report 2019. Total increase in the forest cover not only pertains to the year of 2001 with respect to 1987, but a major part of increase has been attributed to inclusion of Trees Outside Forest (TOF) areas of Darjeeling district which could not be captured earlier assessment by the Forest Survey of India (FSI) team due to limitation and dearth of modern device for computation. Howrah district has no area under very dense forests, 50 sq km area under moderately dense forests and 253.77 sq km area under open forests. There is a net decline of 0.23 sq km in the forest cover from the reported area in India State of Forest Report 2019. In terms of forest canopy density classes, the Kolkata district has no area under very dense forests and moderately dense forests and only 1 sq km area under open forests. There is no increase or decline of the forest cover in Kolkata. Very dense forests area of the Hugli district is nil, 14 sq km area under moderately dense forests and 146 sq km area under open forests. The report shows no rise or decline of the forest area of the district. In terms of forest canopy density classes, the very dense forests area of the Malda district is nil, 209.04 sq km area under moderately dense forests and 282.65 sq km area under open forests. There is a net increase of 0.69 sq km

available from the reported area in India State of Forest Report 2019. Very dense forests area of the Murshidabad district is nil, 53.06 sq km area under moderately dense forests and 291.83 sq km area under open forests. Nadia district has only 1 sq km area under very dense forests, 160.16 sq km area under moderately dense forests and 318.84 sq km area under open forests. There is no change of the forest cover in Nadia district. North 24 Parganas district has 13.02 sq km area under very dense forests, 184.98 sq km area under moderately dense forests and 524.98 sq km area under open forests. There is a net decline of 0.02 sq km of the forest cover in North 24 Parganas district. Paschim Medinipur district has 256.21 sq km area under very dense forests, 591.64 sq km area under moderately dense forests and 1313.69 sq km area under open forests. There is a net increase of 10.54 sq km in the forest cover. Purba and Paschim Bardhaman districts were formed on 7 April 2017 after partition of Bardhaman district into Purba and Paschim Bardhaman districts. There are no separate statistics available for forest cover of Bardhaman district in the report of Forest Survey of India till date. In terms of forest canopy density classes, the Bardhaman district has 57.53 sq km area under very dense forests, 91.78 sq km area under moderately dense forests and 190 sq km area under open forests. There is a net increase of 4.31 sq km in the forest cover. Purba Medinipur district has 1.99 sq km area under very dense forests, 197.96 sq km area under moderately dense forests and 620.10 sq km area under open forests. There is a net increase of 0.05 sq km in the forest cover. Purulia district has 37.36 sq km area under very dense forests, 306.94 sq km area under moderately dense forests and 571.58 sq km area under open forests. There is a net increase of 11.88 sq km of the forest cover in Purulia district. South 24 Parganas district has 983.10 sq km area under very dense forests, 745.03 sq km area under moderately dense forests and 1060.58 sq km area under open forests. There is a net decline of 3.29 sq km of the forest cover in South 24 Parganas district. Uttar Dinajpur district has no area under very dense forests, 3.99 sq km area under moderately dense forests and 230.94 sq km area under open forests. There is a net decline of 0.07 sq km in the forest cover in the district. In terms of forest canopy density classes, the Dakshin Dinajpur district has no area under very dense forests, 5.83 sq km area under moderately dense forests and 81.29 sq km area under open forests. There is a net increase of 0.12 sq km in the forest cover from the reported area in India State of Forest Report 2019 (Table 1).

4. Conclusions

Global warming as a result of climate change often causes damage to the forest due to severe drought and wildfires. Such hazards, in a changing climate, the loss of forest cover will affect the growth and production of trees and timbers. In addition, forest fires, insect outbreaks, wind damage due to cyclonic hazards, and other extreme events result in substantial loss to forest canopy[8]. As a result, adverse effects reduce forest biodiversity, negative impacts on erosion and water events especially in the tourism sector. On the contrary, scientists reported that increasing concentrations of the atmospheric Carbon dioxide, aside from modifying the temperature and precipitation pattern, may enhance the growth and production of timbers and trees through the carbon

Table 1 District-wise forest cover change matrix in the state of West Bengal

ISFR 2019 Assessment (in sq. km)								
District	Geographical Area	Very Dense Forest	Mod. Dense Forest	Open Forest	Total	% of GA	w.r.t 2017 assessment	Scrub
Bankura	6,882	222.33	395.27	667.98	1,285.58	18.68	15.58	28.59
Bardhaman	7,024	57.53	91.78	190.00	339.31	4.83	4.31	7.35
Birbhum	4,545	1.00	34.14	149.66	184.80	4.07	7.80	8.90
Dakshin Dinajpur	2,219	0.00	5.83	81.29	87.12	3.93	0.12	0.00
Darjeeling	3,149	720.76	654.52	992.52	2,367.80	75.19	2.80	9.21
Howrah	1,467	0.00	50.00	253.77	303.77	20.71	-0.23	0.00
Hugli	3,149	0.00	14.00	146.00	160.00	5.08	0.00	0.00
Jalpaiguri	6,227	724.22	434.92	1703.26	2,862.40	45.97	5.40	39.65
Koch Bihar	3,387	0.00	27.00	322.06	349.06	10.31	0.06	0.00
Kolkata	185	0.00	0.00	1.00	1.00	0.54	0.00	0.00
Malda	3,733	0.00	209.04	282.65	491.69	13.17	0.69	0.00
Murshidabad	5,324	0.00	53.06	291.83	344.89	6.48	-1.11	0.00
Nadia	3,927	1.00	160.16	318.84	480.00	12.22	0.00	0.00
North 24 Parganas	4,094	13.02	184.98	524.98	722.98	17.66	-0.02	0.00
Paschim Medinipur	9,368	256.21	591.64	1313.69	2161.54	23.07	10.54	20.24
Purba Medinipur	4,713	1.99	197.96	620.10	820.05	17.40	0.05	2.50
Purulia	6,259	37.36	306.94	571.58	915.88	14.63	11.88	28.68
South 24 Parganas	9,960	983.10	745.03	1060.58	2788.71	27.99	-3.29	1.00
Uttar Dinajpur	3,140	0.00	3.99	230.94	234.93	7.48	-0.07	0.00
Grand Total	88,752	3018.52	4160.26	9722.73	16901.51	19.04	54.51	146.12

fertilization effect. In West Bengal, forest response to climate change is likely to have many implications, particularly in the case of social forestry, where other climate-friendly species will replace earlier species that are no longer suitable for changing climates. The forests and forestry of West Bengal may have little impact on wood production to the changing conditions of climate. A mild climate with fluctuating temperatures and a climate pattern that exerts a direct impact on the natural and rehabilitated forest will eventually lead to the luxurious growth and expansion of the forest in the state of West Bengal. In the current context, the Department of Forestry must play a key role in foresight to maximize and expand forestry in the state. Foresters or forest managers may need to lay out plans before proceeding with the plantation programme, whether for the development of social forests or tree rehabilitation within the forest cover as the selection of species will change to those suitable for the new climate.

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