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Proposed megacity in A & N Islands: An ecological perspective

***Uma Shanker Singh, Ashok Chaudhary and Jyoti Kumar**
University Department of Botany, Ranchi University, Ranchi, Jharkhand, India

ABSTRACT

Proposed as a 'sustainable' and 'holistic' developmental project, the NITI Aayog's Sustainable Development of Little Andaman Island project will be one of the largest development projects to be undertaken in these islands. The project spans over 680 sq.km and is aimed at harnessing the strategic location of these islands for trade, tourism, and defence. In addition to these zones, the document also emphasized plans to develop the transportation sectors to make these islands more accessible by air, land, and sea. The plans included the creation of a) A 'Global Airport' deemed vital for growth, equipped to deal with all types of planes b) An expansion of the existing jetty on the island c) A 100 km ring highway and d) A mass fast transit community with stations at common intervals. As ambitious and attractive a project this may seem, the concerns it raises environmentally, ecologically, socio-culturally and financially, from its initial phase of planning itself are numerous.

Key Words - Semi Evergreen forest, fragile biodiversity, indigenous tribes, carbon sequestration, Very dense forest, forest loss, NITI Aayog.

***Corresponding author :** umashankar.87@gmail.com

INTRODUCTION

At a distance of 1400 km from the Indian Mainland lies a group of islands - The Andaman and Nicobar Islands, a region with a diverse and distinct ecological heritage with over 2,200 species of plants recorded in the island out of which 200 are found nowhere else in the world and 1300 do not occur in mainland India. Again, these islands have astounding wealth in terms of the fauna they house. Comprising only 0.25% of the country's geographical area, they have 11,009 species of which 1,067 endemic faunal species found only on the Andaman and Nicobar Islands and nowhere else.

In addition to the ecological wealth of the region, since prehistoric times, these islands have been home to six aboriginal tribes - the Great Andamanese, Jarawa, Onge & Sentineles in the Andaman group of Islands, and the Nicobarese and the Shompen in the Nicobar group. Thus, it is evident that the importance of these islands from ecological and socio-cultural standpoints cannot be emphasized enough. However, the Sustainable Development of Little Andaman Island proposed by the NITI Aayog places us at a crossroad where the choice we make can influence the future of these islands and our future to such extents that there may be no recovering from it. Homeland of the Onge community Little Andaman Island is the fifth largest island of the Andaman and Nicobar archipelago and is the southernmost island of the Andaman District.

Since the Andaman and Nicobar Islands are home to more than 10% of the country's fauna species, it makes these regions one of the richest ecosystems and biodiversity hotspots in the country. However, among the 46 terrestrial mammalian species found, three species have been categorized as Critically Endangered - Andaman shrew (*Crocidura andamanensis*), Jenkin's shrew (*C. jenkinsi*) and Nicobar shrew (*C. nicobarica*). Five

species are listed as endangered, nine species as vulnerable, and one species as near threatened. Among birds, endemism is quite high, with 36 among 344 species of birds found only on the islands.

Many of these bird species are placed in the International Union for Conservation of Nature (IUCN) Red List of threatened species under the Wildlife Protection Act (WPA). Eight species of amphibians and 23 species of reptiles are endemic to the islands, and thus are at high risk of being threatened. Increasing tourism in the regions is already raising concerns of anthropogenic stress on the fauna. Development projects such as the proposed Sustainable Development of Little Andaman Island will only further aggravate the stress and anthropogenic pressures in the region. A distinctive feature of the marine fauna in this region is the coral reefs which hold significance globally. Consisting of about 83% of maximum coral diversity found anywhere in the world the islands truly become an abode for ecological biodiversity. The little Andaman Island was originally inhabited by the ethnic Onge (a Palaeolithic Negroid tribe) community. This island continued to be known as Chetty Andaman till 1858. The modern name of Little Andaman appeared for the first time in the map of Port Blair in 1790 (Basu, 1990).

Geographically, the Little Andaman Island is situated between 10°30' to 10°54' north latitude and 92°21' to 92°37' east longitude. Hut Bay is the administrative center of this island which is about 140 km from Port Blair, the capital town of the Union Territory. This island covers an area of 732.8 square km with an elongated shape and spreads in north-south direction. Maximum length of the island is about 40 km and the maximum width is 25 km (Pandien, 2011 to 2021). Proposed construction of a mega financial-tourist complex on Little Andaman Island will place at risk a fragile ecosystem and result in habitat loss of the vulnerable Onge tribe and rare wildlife. A plan for the sustainable and holistic development of the 680 sq. km, fragile Little Andaman Island in the Andaman and Nicobar group has raised the alarm for the survival of humankind. The NITI Aayog has prepared a vision document to build a new Greenfield coastal city there that will be developed as a free trade zone and will compete with Singapore and Hong Kong. The proposal has been divided into three zones namely:

1. **ZONE-1:** The area is spread over 102 sq. km along the east coast of Little Andaman and this is proposed to be the financial district and medic city. This will also include an aero city, a tourism centric and hospital district.
2. **ZONE-2:** This covers the pristine forest of the little Andaman and is spread over 85 sq. km. This is supposed to have many activities namely, the leisure zone, a film city, a residential district and a tourism hub.
3. **ZONE-3:** This also includes a pristine forest of 52 sq.km and houses nature zone, further categorised into three districts: an exclusive forest resort, a nature healing district and a nature retreat, all on the western coast. A 100 km Greenfield ring road will be constructed parallel to the coastline from east to west and will be supplemented with a mass rapid transit network with stations at regular intervals.

There will be 'underwater' resorts, casinos, golf courses, convention centres, plug-and-play office complexes, and a fully equipped drone port with fully automated drone delivery system, nature cure institutes and more. An international airport capable of handling all types of aircraft will be central to this development vision. The only jetty on the island will be expanded and a marina will be developed next to the tourist entertainment district. This is simple to understand that the central government is trying to convert the little Andaman on the pattern of Singapore; the NITI Aayog not only compares the population density of both the places but also looks at the disparity in the per capita income. The population density of the Andaman and Nicobar is 47 people per sq. km while it's (sic) 7,615 persons per sq. km in Singapore. Its per capita income is $1,789 compared to Singapore's $55,182.

CHALLENGES FOR GOVERNMENT OF INDIA:

There are certain factors; the vision document also notes that could prevent Little Andaman from becoming the new Singapore. The difficulty with the project formulators is their lack of understanding about the forestry and the secondly, there is no forester posted in NITI Aayog to guide them on the issues involved into this. The vision document also recognises the following areas which "prevent them from developing these into veritable jewels for the country". These include:

1. Lack of good connectivity with Indian mainland and global cities
2. Fragile biodiversity and natural ecosystems and certain Supreme Court notifications that pose an impediment to development.
3. Another key factor is the "presence of indigenous tribes and concerns for their welfare".
4. 95% of Little Andaman is covered in forest, a large part of it the pristine evergreen type. Some 640 sq. km of the island is Reserve Forest under the Indian Forest Act, and nearly 450 sq. km is protected as the Onge Tribal Reserve, creating a unique and rare socio-ecological-historical complex of high importance.
5. In a note dated September 26, 2020, Divisional Forest Officer, Little Andaman, raised serious concerns about this vision on grounds of ecological fragility, indigenous rights and vulnerability to earthquakes and tsunamis.
6. The note sent by the DFO says that said such large diversion of forest land would cause obvious environmental loss leading to irreversible damage (more than 2 million trees stand in the forest land sought for these projects), that habitats of various wild animals including endangered sea turtles would be lost, and that the impact could not even be assessed because there was no environment impact assessment report and neither were there any detailed site layout plans for the proposed diversion.
7. The government is in tearing hurry and it is duly reflected that in its vision document the maps are presented with no legends or explanations and uses inappropriate photographs plagiarised from the Internet. It talks of conservation of national park/ wildlife sanctuary on Little Andaman when none exist here and it has no mention of the geological vulnerability of the place, which was amongst the worst-affected in the earthquake-tsunami combination in 2004. The waves hit Little Andaman so hard that on December 26, 2004 the breakwater there was not just breached, it was physically displaced and its orientation changed. Ships could not berth for weeks thereafter.
8. The plan has no financial details, no budgeting, or species-wise enumeration of forests and ecological wealth and no details of any impact assessment. The nature resort complex proposed at West Bay on the western coast is to have theme resorts, floating/underwater resorts, beach hotels, and high-end residential villas. It is today a secluded and difficult to reach part, one of the most important nesting sites of the globally endangered Giant Leatherback sea turtle which is being studied by the Dakshin Foundation, the Andaman and Nicobar Environment Team and the island administration's Forest Department.

NITI AAYOG TREADED ON A TECHNICALLY WRONG PATH:

The vision needs 240 sq. km (32.78%) of this land and therefore the best solutions that were suggested to them were very simple and straightforward on which the spineless forest bureaucracy always is willing to act. Whenever they are told to bend they crawled. The option was to de-reserve 32.78% of the reserved forest and de-notify this to begin the work and if the tribal become an impediment, the vision suggests that they "can be relocated to other parts of the island".

This option has been replicated once in a state by one of us. The entire operation was enacted in a scripted manner and a little more than 150 sq.km of land is already made available for Phase-I of a NITI Aayog-piloted 'holistic' and 'sustainable' vision for Great Nicobar Island, the southernmost in the Andaman and Nicobar group. This amounts to nearly 20.46% of the 732.8 sq. km. island, and will cover nearly a quarter of its coastline. The overall plan envisages the use of about 244 sq. km., a major portion being pristine forest and coastal systems. Projects to be executed in Phase-I include a 22 sq. km. airport complex, a trans-shipment port (TSP) at South Bay at an estimated cost of Rs. 12,000 crore, a parallel-to-the-coast mass rapid transport system and a free trade zone and warehousing complex on the south western coast. What stands out prominently in the whole process, starting with the designation in mid-2020 of the Andaman and Nicobar Islands Integrated Development Corporation (ANIIDCO) as the nodal agency, is the speed and co-ordination with which it has all unfolded. The other is the centrality of the NITI Aayog. There is incoherence in the steps taken to clear this project and rules are laid to rest. First, on 4thSeptember 2020, the Director, Tribal Welfare, A & N Islands, constituted an empowered committee to examine NITI Aayog's proposals for various projects in Little Andaman and Great Nicobar Islands. A copy of the 2015 'Policy on Shompen Tribe of Great Nicobar Island' was part of the communication sent out, giving an indication of the aims of the committee. Significant changes have also been effected to the legal regimes for wildlife and forest conservation. In its meeting on 5thJanuary, 2021, the Standing Committee of the National Board for Wildlife (NBWL) de-notified the entire Galathea Bay Wildlife Sanctuary to allow for the port there. Then, on January 18, another Environment Ministry expert committee approved a "zero extent" Ecologically Sensitive Zone (ESZ) for the Galathea NP to allow use of land in the south-eastern and south-western part of the island for the NITI Aayog plan. The October 2020 draft notification for this zero extent ESZ had ironically listed out in great detail the park's ecological uniqueness - that it is part of a UNESCO World Heritage Site, houses a range of forest types, has one of the best preserved tropical rainforests in the world, is home to 648 species of flora and hosts 330 species of fauna including rare and endemic ones such as the Nicobar wild pig, Nicobar tree shrew, the Great Nicobar crested serpent eagle, Nicobar paradise flycatcher and the Nicobar megapode.

It also notes that the park is home to the indigenous Shompen community. The notification says that an ESZ is needed to protect the park from an ecological, environmental and biodiversity point of view, but goes on in the very next paragraph to propose a zero extent ESZ for nearly 70% of the periphery of the park. The irony with the members of NBWL that either they were ignorant or knowing it fully well that India's National Marine Turtle Action Plan3that was under preparation and in fact it was released on 1stFebruary 2021 and had listed Galathea Bay as one of the 'Important Coastal and Marine Biodiversity Areas' and 'Important Marine Turtle Habitats' in the country and emphasized the area falling in the zone-1 under maximum protection. It is surprising that suddenly as if the unique diversity of life just listed disappeared because of an arbitrary line drawn to allow a slew of high value projects. There are reports which say that around 70 per cent of the Nicobar megapode (Megapodius nicobariensis), a large-footed bird that build nests on the ground, have disappeared over the last 12 years, (Wildlife Institute of India, Dehradun). Researchers surveyed the islands' wildlife after the 2004 tsunami and compared the findings with those of a 1993-1994 survey. The reports say that only 788 breeding pairs of megapodes are left in the coastal regions of the islands. The major reason for the sharp decline is the tsunami, which washed away the mounds (of soil and decomposed leaves) where megapodes nest. About 20 per cent believed to inhabit interior forests, were not affected by the tsunami. The researchers also found new mounds (barely a year old) in some parts of the region, which suggest that

some birds were able to escape when the tsunami struck.

Besides megapodes, other species are likely to be severely affected by the projects this government is bringing in are: the giant coconut crab, reticulated python, Malayan box turtle, coral reef, dugong and the crab-eating macaque. Therefore, the two magnificent species namely, the Giant leatherback turtle and the Nicobar megapode, for which Great Nicobar is very important, will become extinct with the completion of this project. The beaches here, like at the mouth of the river Galathea in South Bay are among the most prominent nesting sites globally of the Giant leatherback. It for this reason that the bay was declared a wildlife sanctuary in 1997, but has now been de-notified to allow for the transhipment port. In a study on Nicobar megapode, this was documented that 90% of this ground nesting bird's nests to be within a distance of 30 m from the shore (K. Sivakumar). He notes that the existing protected area network in Great Nicobar is not designed for the protection of the megapode and recommends that the entire west and southern coast of Great Nicobar, precisely the area sought for the NITI Aayog proposals, be protected for the megapode and other wildlife like nesting marine turtles. This is also in stark contrast to the current move to create a zero extent ESZ for the Galathea National Park.

THREAT TO SHOMPEN COMMUNITY IN THIS AREA:

Similar concerns exist about the impact on the Shompen community. The proposed project areas are important foraging grounds for this hunter-gatherer nomadic community and the official Shompen Policy of 2015 specifically noted that the welfare and integrity of these people should be given priority "with regard to large-scale development proposals in the future for Great Nicobar Island (such as trans-shipment port/ container terminal etc.)". Now, large forest areas here could become inaccessible and useless for the Shompen.

THIS IS SIESMICALLY ACTIVE ZONE:

Available evidence suggests that issues of the geological volatility of these islands are also not being factored in. The government is working so stealthily on this project that we never knew when the government asked for the tenders on the study of sea traffic but on 6th December 2019 the tender document by WAPCOS Limited for a 'Traffic Study for Creating transhipment port at South Bay, Great Nicobar Island' justifies the port here by noting that "the topography of the island is best suited, which has not been damaged much even by the tsunami on 26.11.2004 (sic)". Yet, a 2005 Earthquake Engineering Research Institute (EERI) Special Earthquake Report by a multi-disciplinary team from the Indian Institute of Technology (IIT) Kanpur, recorded witness accounts of 8-metre-high tsunami waves hitting the Great Nicobar coast on December 26, 2004.The report reveals that lighthouse at Indira Point, the southernmost tip of the Great Nicobar Island, which was on high ground before the earthquake, the report notes, but is now under water, indicating a land subsidence of about 3-4 meters. Loss of life and property then was limited because the Great Nicobar coast is largely uninhabited. This raises questions over safety of life, property and the investments in this zone and that too without accounting for the complex ecological, social and geological vulnerabilities here. Little, if anything is also known of the NITI Aayog vision document itself what is its rationale? What was the process of its creation? Which agencies/individuals were involved? What impact assessments, if any, have been done at all?

MANGROVE FOREST IN INDIAN AND GLOBAL PERSPECTIVE:

The word "Mangrove" is considered to be a combination of the Portuguese word "Mangue" and the English word "grove". Mangroves are one among the most productive ecosystems on the earth. They serve as custodians of their juvenile stock and form most valuable biomass (Odum, 1971). The term mangroves refer to an ecological group of halophytic plant species which is known as the salt tolerant forest ecosystem and provides a wide range of ecological and economic products and services, and also supports a variety of other

coastal and marine ecosystems. 'Mangrove' has been variously defined in literature.

GLOBAL SCENARIO:

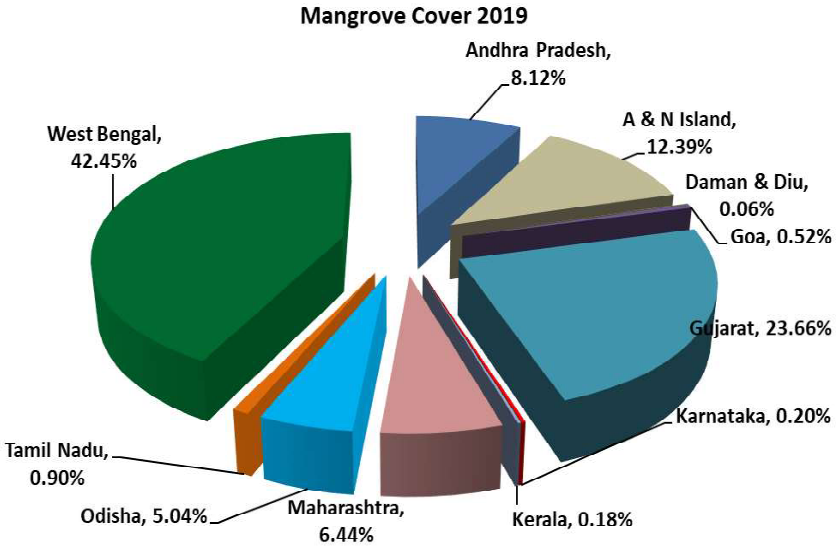
Mangroves occupy less than 1 % of the world's surface (Saenger, 2002) and are mainly found between the Tropic of Cancer and the Tropic of Capricorn on all continents covering an estimated 75 % of the tropical coastline worldwide. There are more than 18 million ha of global mangroves inhabiting in 112 countries and territories in the tropical and subtropical region. Around 34 major and 20 minor mangrove species belonging to about 20 genera in over 11 families have been recorded globally (Tomlinson, 1986). Mangroves of South and Southeast Asia form the world's most extensive and diverse mangrove systems comprising 41.4 % of global mangroves.

INDIAN SCENARIO:

India with a long coastline of about 7516.6 km, including the island territories, has a mangrove cover of about 6,749 km, the fourth largest mangrove area in the world (Naskar & Mandal, 1999). Indian mangroves make up 3.1 % of the total global cover and are distributed along all the maritime states, except the union territory of Lakshadweep, covering an area of about 4461 km along the 7,500 km long Indian coastline. These mangrove habitats (69°E-89.5°E longitude and 7°N-23°N latitude) comprise three distinct zones:

1. East coast habitats having a coast line of about 2700 km, facing Bay of Bengal,
2. West coast habitats with a coast line of about 3000 km, facing Arabian sea, and
3. Island Territories with about 1816.6 km coastline.

In India, the states like West Bengal, Orissa, Andhra Pradesh, Tamil Nadu, Andaman and Nicobar Islands, Kerala, Goa, Maharashtra, and Gujarat occupy vast area of Mangroves. The area under mangroves in Gujarat is the second largest along the Indian coast, after Sunder bans. Gujarat has about 23.66 % of India's estimated mangrove cover of 4975 sq km. Of the total mangrove cover in the state, the coastal district of Kutch covers almost 90%. Mangroves in India account for about 3% of the global mangroves and 8% of Asian mangroves (SFR, 2009; FAO, 2007). About 60% of the mangroves occur on the east coast along the Bay of Bengal, 27% on the west coast bordering the Arabian Sea, and 13% on Andaman & Nicobar Islands. Mangrove cover has been categorised into very dense (canopy density of more than 70% and 1476 sq.km in extent), moderately dense (canopy density between 40-70% and 1479 sq.km) and open mangrove cover (canopy density between 10-40% and 2020 sq.km in its extent). Gradual topography along the east coast is said to have an extensive intertidal expanse which favours major formation



SOURCE: ISFR 2019

of mangroves in the deltaic regions (Jagtap and Komarpant, 2003). Mangrove area is larger in the east coast of India around 80% as to 20% in the west coast owing to the terrain and slope and due to the river deltas of Ganges, Brahmaputra, Mahanadi, Godavari, Krishna and Cauvery which have nutrient rich alluvial soil. 60 species of mangroves are known to grow abundantly (Untawale, 1996).

Sundarbans (east coast) form a major portion of mangrove forests in India, covering about 9,600 sq. km of mangrove forest and water. The Sunder ban comprises essentially of numerous islands formed by the sediments deposited by three major rivers, the Ganga, Brahmaputra and the Meghna, and a dense network of smaller rivers, channels and creeks. Mangroves are the most dominant flora in Sunder bans and 30 species of mangroves occur in the Indian Sunder ban. Later on Debnath and Naskar (1999) identified 36 species as true mangroves. The east coast is endowed with the world's largest forest, the Indo-Gangetic sunder bans in West Bengal. The mangrove area in Odisha is nearly 200 km in extent and its degradation is placed at 20 km over ten years, as per recent estimates.

Andhra Pradesh possesses about 582 km of mangrove area. Tami Nadu is one of the nine maritime states of India endowed with the second longest coastline of 1076 km. The major mangrove wetlands in Tamil Nadu are Pichavaram mangroves and Muthupet mangroves, for which river Cauvery is the main supplier of freshwater. The area under mangrove ecosystem in Tamil Nadu is about 225 km. One of the largest and most unspoiled mangrove forests in Tamil Nadu is at Pitchavaram in Cuddalore District, extending over an area of 1100 km. (Venkataraman, 2007).

Historically, Gujarat has an extensive and diverse mangrove ecosystem. Goa has seven major micro tidal estuaries with the swamps composed of laterite, loamy and alluvial soils. Out of 130 km coastal wetland in the state 67.30 km is contributed by mudflats and mangroves. These mangroves are present in the narrow intertidal mudflats along the estuary banks and are of fringing nature which is said to be due to rising topography of the coast. These habitats are been reclaimed for urbanization and agricultural purposes. The state of Orissa has a geographical area of 155707 km with total forest cover of 51619 sq. km (33.15 %).

Bhitarkanika Wildlife Sanctuary is located in the estuarial region of Bramhani-Baitarani, in the north-eastern place of Kendrapara district of Odisha; the sanctuary covers an area of 672 square kilo meters of Mangrove Forests and Wetland. The mangrove ecosystem is basically of three types, the first being the deltaic mangroves located along the mouth of major estuaries on east coast and Gulf of Kutch and Khambhat Gulf on the west coast. These cover up to 53% of the total Indian mangroves out of which Sunder bans cover about 78%. Second types are the coastal mangroves which are found along the intertidal coastlines, minor river mouths, sheltered bays, and backwater areas of the west coast this constitute12% of the mangrove area of India and lastly the island mangroves which are found along shallow protected intertidal zones of bay islands such as Lakshadweep and Andaman's. They are approximately 16% of the total mangrove area (Ingole, 2005).

MANGROVE FOREST HAS BEEN UNDER PRESURE SINCE THE BEGINNG:

Mangroves are extremely important bio-resources which are not only crucial to the coastal environment but a great sink for carbon dioxide. Mangroves are declining rapidly but they don't get reflected in the ISFR, published by Government of India. India has lost 40% of its mangrove area during the last century. A study was carried out in order to assess and trend of loss of Mangrove India during 1987-2013 and this was found that the mean annual change during the period is 24.25 ± 82.57 Km^2(Hyde,1990). The decline of mangrove forest has been consistent since early till 2019 but the process has been hastened in the recent years in the name of developmental activities. In the year 2003-2005 the very dense mangrove forest (VDF) has declined to the tune of 15 Km^2 and the maximum loss has been recorded in the state of

Maharashtra (-8 Km^2) followed by A & N Islands (-7 Km^2).

Similarly, moderately dense forest (MDF) has also declined in the year 2003-05 and 2006-07. The maximum decline has been recorded in the state of Odisha (-59 Km^2), West Bengal (-14 Km^2), A & N Islands (-10 Km^2) and in Tamil Nadu (-2 Km^2). The year 2003-05 witnessed declined in one state of Odisha but the union territories of A&N Islands saw a massive decline of 40 Km^2. On a closer scrutiny of ISFR, between 2017 and 2019, this has been found that most of the states have shown declining trend in very dense mangrove forest and moderately dense mangrove forest. Tamil Nadu, West Bengal, A&N islands have shown a declining trend and they have lost 1.55 Km^2, 3.38 Km^2, and 0.59 Km^2 respectively. Similarly four states namely, Gujarat, Karnataka, Kerala and A&N islands have lost moderately dense mangrove forest to the tune 2.64 Km^2, 0.18 Km^2, 0.31 Km^2 and 0.22 Km^2 respectively (Table-1). There is a decline in very dense mangrove forest in the state of A & N Island in the year 2009-11 also to the size of roughly two square km and in the year between 2011 and 2013 and this loss continued further to expand to 45 Km^2 and 7 Km^2 in the state of west Bengal and A & N islands in their VDF.

Table 1 - Loss of mangrove forest area between 2003 and 2019 (sq.km) [VDF CHANGE]

CHANGE IN STATE WISE MANGROVE COVER									
AREA (SQ.KM.)									
VDF CHANGE									
S.NO.	STATE/UT	2003-05	2005-07	2007-09	2009-11	2011-13	2013-15	2015-17	2017-19
1	ANDHRA PRADESH	0	0	0	0	0	0	0	0
2	GOA	0	0	0	0	0	0	0	0
3	GUJARAT	0	0	0	0	0	0	0	0
4	KARNATAKA	0	0	0	0	0	0	0	0
5	KERALA	0	0	0	0	0	0	0	0
6	MAHARASHTRA	-8	0	0	0	0	0	0	0
7	ODISHA	0	82	0	0	0	0	0	-1.55
8	TAMILNADU	0	0	0	0	0	1	0	0.04
9	WEST BENGAL	0	146	0	0	-45	-3	9	-3.38
10	A&N ISLAND	-7	30	0	-2	-7	123	0	-0.59
11	DAMAN & DIU	0	0	0	0	0	0	0	0
12	PUDUCHERRY	0	0	0	0	0	0	0	0
	TOTAL	-15	258	0	**-2**	**-52**	**121**	**9**	**-5.48**

Table 2 - Loss of mangrove forest area between 2003 and 2019 (sq.km) [MDF CHANGE]

CHANGE IN STATE WISE MANGROVE COVER									
AREA (SQ.KM.)									
MDF CHANGE									
S.NO.	STATE/UT	2003-05	2005-07	2007-09	2009-11	2011-13	2013-15	2015-17	2017-19
1	ANDHRA PRADESH	0	111	0	0	0	3	84	0.18
2	GOA	4	0	0	6	0	0	0	0
3	GUJARAT	-3	-7	0	-6	-7	-1	-2	-2.64
4	KARNATAKA	0	0	0	0	0	0	-1	-0.18
5	KERALA	0	0	0	0	0	2	0	-0.31
6	MAHARASHTRA	14	11	0	0	0	10	9	0
7	ODISHA	-4	-59	0	0	-9	7	-1	0.33
8	TAMILNADU	0	-2	0	0	0	2	7	2.24
9	WEST BENGAL	1	-14	0	0	-182	1	-8	0
10	A&N ISLAND	-40	-10	0	-1	-3	-90	1	-0.22
11	DAMAN & DIU	0	0	0	0.12	0.02	-0.14	0	0
12	PUDUCHERRY	0	0	0	0	0	0	0	0
	TOTAL	**-28**	**30**	**0**	**-0.88**	**-200.98**	**-66.14**	**89**	**-0.6**

ANTHROPOGENIC FACTORS THAT IMPACT MANGROVES:

Another major cause for impairment of mangrove forests in India is due to anthropogenic activities such as conversion of mangrove habitats into agricultural land or for the promotion of aquaculture, tourism, and urban development in general (Sahu 2015). A majority of India's coastal communities are dependent on agriculture for their livelihood. It has been recorded that over the past 100 years, about 1, 50,000 hectares (N.C Duke *et al.*) of mangroves have been destroyed in India and Bangladesh in order to make land available for agricultural purposes (Sahu 2015). Mumbai city is a perfect example, as it was built on a cluster of seven islands each of which was surrounded by mangroves and today its infrastructure and its population has become extremely vulnerable from hurricanes and Tsunami. Navi Mumbai is precariously situated and sitting on the volcanoes of disasters as hundreds of acres of mangroves have been cleared for the construction of a new International airport in this area (Pathak,2019). Presently, Mumbai city has only 2 sq. km of mangrove forests in all. This is a huge loss for this city and it is waiting for a bigger catastrophe to strike. This is a well-known fact that mangroves are the first efficient natural defences against sea-level-rise and cyclonic storms, both of which have already begun to ravage the city. Today, the seemingly ceaseless unplanned and unsustainable development of coastal cities and islands is also contributing to mangrove degradation. For instance, the port of Mundra, in Gujarat, has been roundly condemned globally for severely degrading Indus delta mangroves. Likewise, Para dip Port in Odisha has also been reported to have built over dense patches of Mahanadi delta mangroves but a deaf ear to these developments today will take a heavy toll tomorrow. The opening of A&N islands will make our ecosystem more vulnerable and lead us to a financial losses which the country never accrued in past.

IMPLICATIONS OF LOSS OF MANGROVES:

The acceleration of unsustainable human activities, coupled with the adverse impacts of climate change, is threatening the mangrove ecosystem, placing the lives and livelihoods of millions of coastal residents at high levels of risk. Any further loss of mangrove forests would leave coastal communities without a vital line of defence against extreme-weather events that are becoming more frequent and more intense. Numerous studies have shown that mangroves play a critical role in protecting coastal communities from the impact of large storms. For instance, when Cyclone Bulbul hit Odisha and West Bengal on 9th November 2019, it was reported that the wind speed of Cyclone Bulbul was reduced by 20 km an hour because of the Sunder bans mangrove forest. This saved the rest of southern West Bengal from the disastrous storm, which might otherwise have proven to be cataclysmic for Kolkata and its environs.

On the other hand, the catastrophic impact of the unprecedented flooding in Mumbai, in 2005, was exacerbated by the lack of mangroves along the 18 km long Mithi River. These mangroves had earlier been cleared for construction purposes. Consequently, Mumbai was left without any natural buffer against flood surges. More often than not, biodiversity and the functioning of marine ecosystems are closely interlinked. A loss of biodiversity loss could limit the functioning of ecosystems, which subsequently reduces their capacity to provide goods and services to coastal communities.

Roughly 560 million people live along India's coastline and the vast majority of them are dependent on marine and coastal ecosystems, even if they and their elected representatives seem largely oblivious of this fact. Mangroves serve as a critical breeding ground and nursery habitat for a wide range of marine organisms, including shrimps and fishes. Importantly, commercial marine fish species such as cuttlefish, squid, lobster, shrimp, and certain types of finfish, contribute enormously to India's seafood exports(Untawale 1986) . India ranks second, globally, in fish-production; the fisheries sector employs 145 million people and contributes 1.07 per cent to the GDP, as per a recent

estimate of the National Fisheries Development Board. If conserved, mangroves have the potential to significantly enhance the productivity of fisheries.

On the other hand, a continuing loss of mangrove forests, will significantly and adversely impact not only the health and quantity of fisheries and hence the economic productivity of coastal communities but the health of the nation. The role of mangrove forest ecosystems, particularly in the tropics, in mitigating climate change through carbon sequestration can hardly be overstated, given that these ecosystems constitute one of the largest carbon sinks. Mangrove forest ecosystem is one of the important carbon sinks in the tropics. In a study carried out to assess carbon stocks of Mahanadi Mangrove Wetland (MMW) in east India was revealing and this was estimated that the mean carbon stock in the natural stand was around 143±8.2 mg C ha-1 and in plantation at 151.5± 7.9 mg C ha-1. A positive correlation (r = 0.87) was found between vegetation biomass and soil organic carbon in the surface soil (0-30 cm), indicating the role of vegetation in building surface soil/sediment organic carbon. The 6651 ha of mangrove forests in the MMW is estimated to store 0.98 Mt of C, which is equivalent to 3.59 Mt of CO_2e (Sudam Sahu 2016). Conversely, when these mangroves are cut down, they release significant quantities of stored carbon, accelerating global warming. India is currently the India is now the planet's third-largest emitter of carbon dioxide, although it is still well behind China, the world's largest emitter, and the United States. Therefore, mangroves are more critical now than ever to counteract the rise in carbon emissions from human activities and mitigate global climate change.

CONCLUSION

CONSERVATION OF MANGROVES IS THE ONLY WAY OUT- Conservation of mangroves can be enhanced by devising well-balanced coastal land-use plans, such as maintaining sustainable limits in logging and other harvesting activities. Mangroves also hold religious, cultural, and sentimental value to the local communities, which is another reason to protect and conserve them. The inland mangrove forests in Shravan Kavadia, Kutch, are considered sacred and the locals in that area strictly regulate any exploitation of the forests as such activities are believed to be inauspicious. Similarly, the Kagekanu forest patch, which is dominated by species such as *Rhizophora mucronata, Avicennia officinalis* and *Kandelia candel*, off the coast of Karwar in Karnataka, is one of the examples of traditional conservation through sacred groves. However, several reports based on initial post-impact surveys in south eastern India, the Andaman Islands, and Sri Lanka Dahdouh-Guebas *et al.* (2005); Kathiresan & Rajendran, (2005) indicated that mangroves offered a significant defence against the full impact of the tsunami. Ground surveys and Quick Bird pre-tsunami and IKONOS post-tsunami image analysis and multivariate analysis of mangrove field data Dahdouh- Guebas *et al.* (2005) covering the entire Tamil Nadu coast suggest less destruction of man-made structures located directly behind the most extensive mangroves. Mangrove forests can attenuate wave energy, as shown by various modelling and mathematical studies which indicate that the magnitude of the energy absorbed strongly depends on forest density, diameter of stems and roots, forest floor slope, bathymetry, the spectral characteristics (height, period, etc.) of the incident waves, and the tidal stage at which the wave enters the forest.

For instance, one model estimates that at high tide in a Rhizophora-dominated forest, there is a 50% decline in wave energy by 150 m into the forest (Brinkman *et al.*, 1997). Mazda *et al.* (2006) similarly found that waves were reduced in energy by 50% within 100 m into Sonneratia forests. (Mazda *et al.*,1997) and Tanaka *et al.* (2007) showed that another important factor is vegetation type, for example, the percentage of forest floor area covered by either prop roots or pneumatophores, as the drag coefficient of these structures is related to the Reynolds number (which differs for each species depending on diameter and

aboveground root architecture). The hydraulic characteristics of tsunamis are, however, likely to be very different from those of wind waves and tidal waves (Latief & Hadi, 2006). The period of a tsunami is usually between 10 min and 1 hour as compared with periods of 12 to 24 hour for normal waves Mazda *et al.* (2007).

A tsunami propagates like a tidal bore in that its momentum increases with movement upstream into shallower water. Model simulations using data from hydrological experiments to predict the attenuation of tsunami energy by mangroves were generated by Hiraishi and Harada (2003) based on the 1998 tsunami that destroyed parts of the north coast of Papua New Guinea. The model output suggests a 90% reduction in maximum tsunami flow pressure for a 100-m wide forest belt at a density of 3000 trees ha-1. Model results obtained by Hamzah *et al.* (1999), Harada and Imamura (2002), Latief and Hadi (2007), and Tanaka *et al.* (2007) for various types of coastal vegetation, including mangroves, were very similar. Tanaka *et al.* (2007) modelled the relationship of species specific differences in drag coefficient and in vegetation thickness with tsunami height, and found that species differed in their drag force in relation to tsunami height, with the palm, *Pandanus odoratissimus* and *Rhizophora apiculata*, being more effective than other common vegetation, including the mangrove *Avicennia alba*. These data point to the importance of preserving or selecting appropriate species to act as wave barriers to offer sufficient shoreline protection. In India and the Philippines, villagers tell how they have been protected from tsunamis, cyclones and other natural disasters in locations where mangroves are intact, but suffer where mangroves have been converted to shrimp farms or were lost due to human activities (Dahdouh-Guebas *et al.*, 2005; Walters, 2004).

In Vietnam, mangroves have been observed to limit damage from tsunamis and cyclone waves and have led to large savings on the costs of maintaining sea dykes (Asian Wetland Symposium, 2006). In Chidambaram district in Tamil Nadu, India, the shore protection role of mangroves is recognized by local people where a 113 km^2 forest is used as a sacred grove andis traditionally known in Tamil as Alaithi Kadukal, meaning 'the forest that controls the waves' (WWF, 2005). Remains of rows of mangroves planted by Maoris can still be seen in New Zealand with the aim of stabilizing the coast, indicating that mangroves helped in coastal protection (Vannucci, 1997). Wave energy of tsunamis may be reduced by 75 % in the wave's passage through 200 m of mangrove (Massel *et al.*, 1999). It has also been found that 1.5 km belt of mangrove may be able to reduce entirely a wave one meter high (Mazda *et al.*, 1997). Many observations suggest that mangroves also help to reduce the damage of a tsunami by dissipating the force of the tsunami and preventing the debris washed up by it (IUCN, 2005). In India, bathymetry and coastal profile were most important in determining the impact, but less erosion was observed in the Andaman Islands where mangroves were present than where there were no mangroves (Department of Ocean Development 2005. 63 tsunami events between 1750 and 2004 struck the Indian Ocean area and more than three wind generated waves struck per year (Dahdouh-Guebas *et al*., 2005). A satellite and field data study done by Selvam (2005) showed that mangrove forest plays important role in mitigating the outcomes of the tsunami disaster, especially in 2004. He showed that 30 trees per 100 m^2 might reduce the maximum flow of a tsunami by more than 90 %. Similar results were obtained by Hiraishi (2005) which showed that tsunami flow pressure can be reduced by increasing the density of the planted zone, reproduced by considering drag forces exerted by the individual trunk and leaf parts of trees.

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