

Mangroves in India: A Geographical Perspective

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Abstract:

Mangroves are special woody plants and shrub that inhabit the upper intertidal zones of saltwater. This type of plant found different parts of the world. India has also some patches of mangroves. Peoples are generally believed that mangroves are only found in Sundarban. But this is not right. This paper is aimed to break this misconception. The objectives of this paper are to find out the distribution of mangroves, statistical analysis of mangroves at present, to assess the trend of mangrove forest and to find out the species diversity in mangroves in India. Integrative literature review has been done for this study. Descriptive research method and statistical techniques such as time series analysis has been applied as research methods. The major findings are there are 12 states and union territories which are belong to mangroves. Maximum and minimum mangrove density is found in West Bengal and Daman Due respectively. Maximum species diversity is seen in West Bengal and Odisha. This study revealed that trend of mangrove forests is really growing. This result showing the sustainable character of mangroves that will brings a better environmental future for future generation.

Key Words: Mangroves, Intertidal zone, Sustainable, Time series.

1. Introduction:

Mangroves are woody plants and shrub that inhabit the upper intertidal zones of saltwater (30 to 90ppt) areas. Worldwide Mangroves are differently called as 'mangals', 'coastal woodlands', 'tidal forests' etc. The word "mangrove" is obscurely connected with the Portuguese word "mangue" and the Spanish word "mangal" and the English word "grove" and it dates its origin as 1613 AD. However, Marta Vannucci pointed out that the word was neither Portuguese nor Spanish and concluded that the term "mangue" derived from the national language of Senegal. It was probably adopted by the Portuguese, and later modified by the Spanish, because of their exploration of the West African coast. Mangroves are salt-tolerant plants of tropical and subtropical intertidal regions of the world. The specific regions where these plants occur are termed as 'mangrove ecosystem'. These are highly productive but extremely sensitive and fragile. Besides mangroves, the ecosystem also harbours other plant and animal species.

2. Literature Review:

There are several research work on mangrove have conducted in international perspective. Nusantara et al. (2014) studied to assess the survivor rate of the planted mangrove; to evaluate factors that cause which influence the growth of the mangrove planted; and to plan an appropriate future mangrove restoration. Mazda et al. (2007) worked on the Role of Physical Processes in Mangrove Environments. They published the manual of Preservation and Utilization of Mangrove Ecosystems. UNDP (1991) report has been prepared on research and its application to mangrove ecosystems management in Asia and the Pacific region. The raising of the awareness of the value and need to preserve and properly manage the mangrove ecosystems was largely achieved. Mangrove reforestation plans being developed. Management of mangrove forests for fodder could be done on a rotation system, with thinning and replanting if necessary to ensure recuperation and full regrowth of *Avicennia* trees (the genus that produces best fodder).

Bosold (2012) studied on role of man specially women in mangrove ecosystem for management. Coastal community can play important role for mangrove management. In the research of Chen et al. (2009) it is found that some key progresses in mangrove conservation, restoration and research in China during last two decades has been done. The population boom and rapid economic developments have greatly reduced mangrove areas in China since 1980s, leaving only 22 700 ha mangroves in mainland China in 2001. Giri et al. (2010) Studied on the Status and distribution of mangrove forests of the world using earth observation satellite data. They mapped the status and distribution of mangrove worldwide using remote sensing. They found out the total area of mangroves in the year 2000 was 137,760 km² in 118 countries and territories in the tropical and subtropical regions of the world in which 2.7% of global total mangrove belongs to India. The remaining mangrove forests are under immense pressure from clear-cutting, land-use change, hydrological alterations, chemical spill and climate change. In the future, sea-level rise could be the biggest threat to mangrove ecosystems.

Mangroves are under constant flux due to both natural (e.g. erosion, aggradations) and anthropogenic forces. In the last three decades, forest losses because of anthropogenic factors have increased significantly. The remaining mangrove forests are under immense pressure from clear-cutting, land-use change hydrological

alterations, chemical spill and climate change (Blasco *et al.*, 2001).

Ecological role and services of tropical mangrove ecosystems and its reassessment is very important in the present day context. The role of mangroves as C sinks needs to be evaluated for a wide range of biogeographic regions and forest conditions. Knowledge of thresholds, spatio-temporal scaling and variability due to geographic, biogeographic and socio-economic settings will improve the management of mangrove ecosystem services (Lee *et al.* 2014)

There are several research work on mangrove have conducted in national perspective. Sahu *et al.* (2015) assessed the mangrove area in India. He pointed out the implications of loss of mangrove. India lost 40% of its mangrove area during the last century. They focused on assessing the status and trends of mangrove area in India including the causes of loss and its restoration and traditional conservation.

Balachandran *et al.* (2009) have shown in their research the diversity of true mangroves and their associates in the Pondicherry region of South India and development of a mangrove knowledgebase. Lugo (1990) has revealed about the mangroves in Pacific Islands. He explored the species of mangroves. Upadhyay and Mishra (2014) has analysed the mangrove ecosystem of the Odisha on the eastern coast of India ecologically. They highlighted the investigation of mangrove ecosystem of Bhitarkanika sanctuary in Odisha. The mangroves of Bhitarkanika have lower heights, low basal area and higher number of plants compared to other mangroves of the world. The Riverine species of Bhitarkanika ecosystem have much higher complexity index values than other mangrove ecosystems of the world, which indicates that this ecosystem is favourable to a diversity of mangrove species.

Forest Research Institute of India has started published the report of the mangrove in India from 1987. In the report from 1987 to 2015 they have explored, analysed the mangrove status and distribution and trend. The trend of mangroves is positive increase in ten states and union territories except Andhrapradesh, Andaman Nicobar Island and west Bengal.

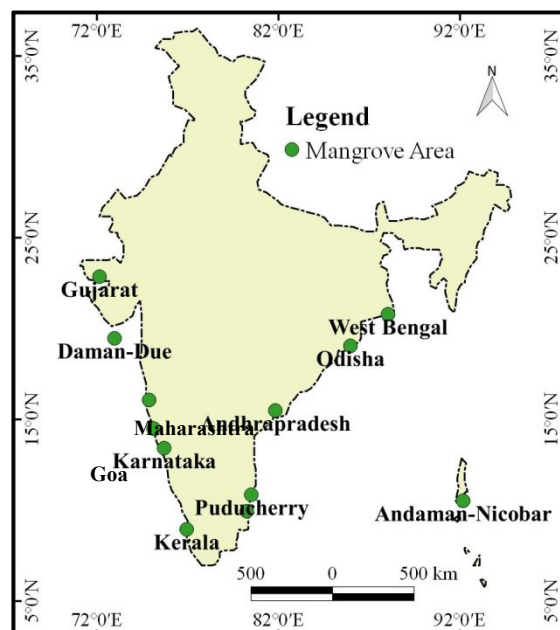


Figure 1: Mangrove location in India (Prepared by Author)

3.

Objectives:

Objectives of the study are to find out the present distribution of mangrove in India, to assess the recent trend of mangrove area in India and to analyse the temporal change of mangrove area and at last to build correct concept of mangrove distribution in India among the people.

4. Location:

These are primarily in tropical and subtropical coastal regions within 30° of the equator and form low diversity forests with complex food webs and unique ecosystem dynamics. Mangroves form a characteristic saline woodland or shrub land habitat, called mangrove swamp, mangrove forest, and mangrove or mangal, in coastal depositional environments where fine sediments often with high organic content collect in areas protected from high energy wave action. They occur both in estuary and along open coastlines. Mangroves dominate three quarters of tropical coastlines and cover roughly 172,000 sq. km. of the earth's surface in the large river deltas, estuaries and barrier islands.

5. Evolution of Mangrove:

Mangroves evolved around 114 MY¹ ago. The Indo-Malaysian region is considered to be the cradle of evolution of mangrove ecosystem as there are far more mangrove species present in this region than anywhere else. The mangrove plants then spread to other tropical regions through their unique floating propagules and seeds. These early mangroves, borne by ocean currents, spread westward to India and East Africa, and eastward to the Americas, arriving in Central and South America during the upper Cretaceous period and lower Miocene epoch, between 66 and 23 MY ago. During that time, mangroves spread throughout the Caribbean Sea across an once existed open seaway where Panama lies today. Later, sea currents propagated mangrove seeds to the western African coast and far south to New Zealand. This explains why the mangroves of West Africa and the America contain fewer, but similar colonizing species, whereas those of Asia, India, and East Africa contain a much fuller range of mangrove species. Presently, the Indo-Pacific region is known for its luxuriant mangroves. The Sundarbans of India and Bangladesh form the world's most colossal mangrove delta complex.

6. Mangroves in India:

The distribution of mangrove ecosystem on Indian coastlines indicates that the Sundarban mangroves occupy very large area followed by Andaman-Nicobar Islands and Gulf of Kachch in Gujarat. In India twelve states and union territories are covered by Mangroves.

Rest of the mangrove ecosystems is comparatively smaller. However, good number of studies has been carried out in almost all ecosystems. Over 1600 plant and 3700 animal species have been identified from these areas.

According to a status report of the Government of India publication, the total area of the mangroves in India, was reckoned at about 6,740 km². This covered about 7% of the world mangroves and 8% of the Indian coastline. But a recent Indian Remote Sensing Data showed that the total area of the mangroves increased to 4,740 km² (Table 3). The values shown by satellite data shows a decrease in the mangrove area, which may be due to several reasons such as - a) Grazing by domestic cattle and exploitation of mangrove woods for fuel and timber, b) The neo-tectonic movement of river courses, c) Abatement of upstream freshwater discharges due to construction of dams and reservoirs, d) Rapid trend of reclamation of mangrove forests for habitations, e) Pollutant discharges from cities and industries etc.

Recent data available from State of Forest Report 2015 of the Forest Survey of India, Dehra Dun shows that mangrove cover in the country is 4,740 sq.km, which is 0.14 percent of the country's total geographical area. The very dense mangrove comprises 1472 sq.km (31.05 % of the mangrove cover), moderately dense mangrove is 1391 sq.km (29.35%) while open mangroves cover an area of 1877sq.km (39.60%). Compared with 2013 assessment, in 2015 there has been a net increase of 112 sq.km in the mangrove cover of the country. This can be attributed to increased plantations particularly in Gujarat state and regeneration of natural mangrove areas.

7. Top Five Mangroves in India:

Mangroves Forest is the home of low and medium height of various types of trees. The swamps protect coastal areas of India and home to so many species of Aquatic Birds, water animals and reptiles. Myristica swamp of Karnataka, Western Ghats, Konkan, Ratnagiri, Gujarat and mangroves of Kollam are few more sites of wetland in India.

7.1 Sundarbans Mangroves: The Great Sundarbans is the largest Mangroves region in the world and a UNESCO World Heritage Site. Sundarbans region is densely covered by mangroves, it is a National Park, Tiger Reserve and a Biosphere Reserve Park of India simultaneously.

7.2 Bhitarkanika Mangroves: Bhitarkanika Mangroves is India's second largest forest, located in Odisha coast. Bhitarkanika is created by the two river delta of Brahmani and Baitarani river and one of the important Ramsar Wetland in India.

7.3 Godavari-Krishna Mangroves: The Godavari Krishna mangroves lies in the delta of the Godavari and Krishna rivers in Andhra Pradesh. Mangroves eco-region is under protection for Calimere Wildlife and Pulicat Lake Bird Sanctuary.

7.4 Pichavaram Mangroves: Pichavaram mangrove is one of the largest mangrove in India, situated at Pichavaram near Chidambaram in Tamil Nadu. Pichavaram ranks among the one of the most exquisite scenic spot in Tamil Nadu and home of many species of Aquatic birds.

7.5 Baratang Island Mangroves: Baratang Island Mangroves is beautiful swamp, located at Great Andaman and Nicobar Islands. Mangrove

¹ MY = Million Year

Swamps of Baratang Island are situated between Middle and South Andamans, capital city Port Blair.

Table 1: Year wise and State wise mangrove in India

S.No	States	Assessment Year												Change (1987-2009)
		1987	1989	1991	1993	1995	1997	1999	2001	2003	2005	2007	2009	
1	Gujarat	427	412	397	419	689	901	1031	911	916	991	1046	1046	619
2	Maharashtra	140	114	113	155	155	124	108	118	158	186	186	186	46
3	Goa	0	3	3	3	3	5	5	5	16	16	17	17	17
4	Karnataka	0	0	0	0	2	3	3	2	3	3	3	3	3
5	Kerala	0	0	0	0	0	0	0	0	8	5	5	5	5
6	Tamil Nadu	23	47	47	21	21	21	21	23	35	36	39	39	16
7	Puducherry	0	0	0	0	0	0	0	0	1	1	1	1	1
8	Andhra Pradesh	495	405	399	378	383	383	397	333	329	354	353	353	58
9	Odisha	199	192	195	195	195	211	215	219	203	217	221	221	22
10	West Bengal	2076	2109	2119	2119	2123	2125	2125	2081	2120	2136	2152	2152	67
11	Andaman and Nicobar Islands	686	973	971	966	966	966	966	789	658	635	615	615	-71
12	Daman and Diu	0	0	0	0	0	0	0	0	1	1	1	1	1
	Total	4046	4255	4244	4256	4533	4737	4871	4482	4448	4581	4639	4639	

Source: India State Forest Report, from 1987 to 2015, Forest Survey of India, Ministry of Environment and Forests, Government of India.

8. Recent Trends:

Mangroves covered 0.14% of India's geographical area. India has 3% of world's mangrove forests. Sundarban (WB) is covered 50% of the India's mangrove forests. Mangrove has decreased overall 34% in 2013 compared to 2011 but increased in 2015 compared to 2013. It has been assessed by better

satellite data with high accuracy rate. From the following Table-2 and Table 3 it has been observed that maximum decreasing mangrove area is Sundarban, which is 58 sq km (2011-2013) and 49 sq. Km (2011-2015) whereas increased slightly about 9sq.km. All other states mangrove forest data is showing that mangrove is increasing way. But recently increasing mangrove area has detected as Gujarat almost.

Table 2: Recent trend in different types of mangroves in India

Sl. No	State/UT	Very Dense Mangrove			Moderately Dense Mangrove		
		2011	2013	2015	2011	2013	2015
1	Andhra Pradesh	0	0	0	126	126	129
2	Goa	0	0	0	20	20	20
3	Gujarat	0	0	0	182	175	174
4	Karnataka	0	0	0	3	3	3

5	Kerala	0	0	0	3	3	5
6	Maharashtra	0	0	0	69	69	79
7	Orissa	82	82	82	97	88	95
8	Tamil Nadu	0	0	1	16	16	18
9	West Bengal	1038	993	990	881	699	700
10	Andaman & Nicobar	283	276	399	261	258	168
11	Daman & Diu	0	0	0	0.12	0	0
12	Pondicherry	0	0	0	0	0.14	0
Total		1403	1351	1472	1658.12	1457	1391

Table 3 : Continuation of Table 2

Sl. No	State/UT	Open Mangrove			Total			Change (2011-2015)
		2011	2013	2015	2011	2013	2015	
1	Andhra Pradesh	226	226	238	352	352	367	15
2	Goa	2	2	6	22	22	26	4
3	Gujarat	876	928	933	1058	1103	1103	45
4	Karnataka	0	0	0	3	3	3	0
5	Kerala	3	3	4	6	6	9	3
6	Maharashtra	117	117	143	186	186	222	36
7	Orissa	43	43	54	222	213	231	9
8	Tamil Nadu	23	23	28	39	39	47	8
9	West Bengal	236	405	416	2155	2097	2106	-49
10	Andaman & Nicobar	73	70	50	617	604	617	0
11	Daman & Diu	1.44	1	3	1.56	1	3	1.46
12	Pondicherry	1	1.49	2	1	1.63	2	1
Total		1601.44	1819	1877	4662.56	4628	4740	

Source: India State Forest Report, 2011, 2013, 2015, Forest Survey of India, Ministry of Environment and Forests, Government of India. (Calculated by Author)

9. Temporal Analysis:

Among the 12 mangrove area of India maximum mangrove area is found in West Bengal. If we look at the above Table 1, 2 and 3, we can see that the mangrove area decreased in Andhrapradesh and Andaman and Nicobar Island, but rest of the mangrove area increased in the time scale 1987 to 2011. Maximum decreasing rate has been found in Andaman and Nicobar

Island in 2009 compared to 1987. The above data table showing that mangrove area in Goa, Karnataka, Kerala, Puducherry and Daman and Diu were not in 1987. The most new mangrove areas are Kerala, Puducherry and Daman and Diu. If we look at the following time series graph (Figure-2) we see that over all mangrove area changing in India is positive trend. That phenomenon is positive and good sign for future. Maximum mangrove area increased in Gujarat in 2015 compared to 1987.

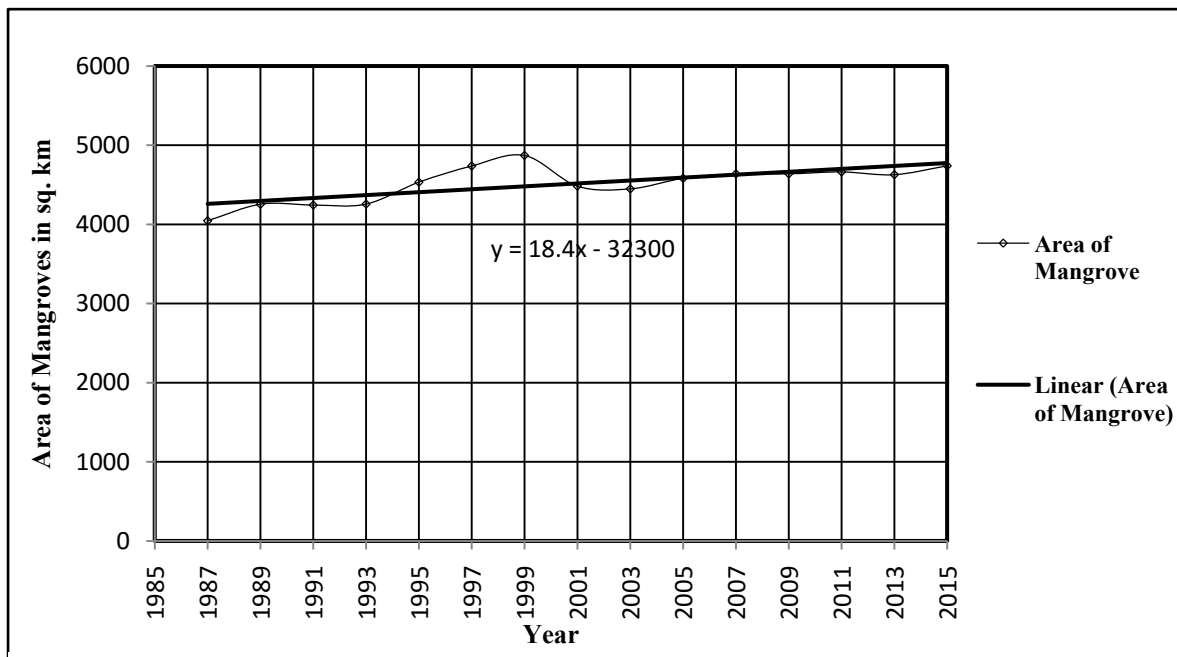


Figure 2: Time series graph showing trend of change in mangrove area in India

Conclusion:

Mangroves in India protects the coast from erosion, surge, storms, especially during hurricanes and tsunamis and their massive root system is efficient in breaking up the wave energy. Similarly, the mangroves also slow down tidal water enough so that its sediment is deposited as the tide comes in and is not re-suspended when the tide leaves, except for fine particles. By doing so, the mangroves build their own environment. This uniqueness of the mangrove ecosystems and their protection against erosion often makes Mangrove the object of conservation programs including national 'Biodiversity Action Plans'. It has been found several times that the wave energy is typically low in the areas where mangroves grow. The Mangrove in India also supports ecosystems, adapt low oxygen, limits salt intake and water loss, and also increase survival of offspring. From the above discussion over all mangroves increasing scenario showing afforestation and reforestation have been improved. This increasing phenomenon would guild the conservation and sustainable development of mangrove. At last it can be say that mangroves means not only Sundarban but also it distributed in distinct places in India.

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