# VIDYASAGAR UNIVERSITY

## (D.D.E)

## REVIEW ON
## EFFECT OF CLIMATE CHANGE
## ON INDIAN MANGROVE

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# CERTIFICATE

This is to certify that the review done with the title **"EFFECT OF CLIMATE CHANGE ON INDIAN MANGROVE"** has been carried by SAGNIK BOSE under the supervision and guidance of Dr. N. C. Halder, Head of the Department of Botany, Uluberia College under PG Study Centre of Vidyasagar University, West Mindapore. He has followed the rules and regulations as led down by Vidyasagar University for partial fulfillment of requirement of the Degree of M.Sc. (Part-II) in Botany.



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Sincerely,

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# CONTENTS

# Climate Change on Indian Mangroves

## ABSTRACT

Mangroves are one among the important coastal habitats which are highly loaded with immense nutrient and always share it with adjoining coastal habitats. Interestingly this system supports number of endemic and endangered species throughout the tropical coast. India has more than 7500 km coastal line within this, it supports 4, 87,100 ha of mangroves and harbours 3985 species of flora and fauna. During late 80s India lost considerable areas of its mangrove cover due to several anthropogenic pressures. The ongoing climate change turned out to be a potential threat to the remaining Indian mangroves and other coastal ecosystem. Ironically there is no sound study till date about the impacts of ongoing climate change on Indian mangroves. The loss of mangroves will spread its impact on the adjoining system in a significant way. So, the mangrove loss will negatively influence the fishery resource of the tropical region and initiate regional and global socio-economical crisis.



**Key words:** Climate change, Coastal system, Mangroves, India.

# INTRODUCTION

From biodiversity, ecological and socioeconomic points of view, the coastal habitats are the most important one in this biosphere. For instance the intertidal zone out to the continental shelf break are estimated to provide over US $14 trillion worth of ecosystem goods and services every year. It was reported that more than one third of the world's population lives in coastal areas (UNEP, 2006) and more than 10% of people live within 10 m of sea level (G.D Mchrahan 2007). Furthermore it deserves to mention that 70% of the Asian and approximately 20% of India's population depends on the coastal habitats for food and employment (K. Kathiresen .et. al. 2007) Coastal system is endowed with unique habitats such as coral reefs, sea grass beds, tidal flats and mangrove swamps. Interestingly all the habitats along the coastal line supports unique species throughout the world and most of the species are biologically and economically important.

Mangrove forests are one among the pivotal coastal systems around the world. Interestingly mangroves are one of the world's richest storehouses of biological and genetic diversity (Kathiresen and sandilayan.) Moreover 90% of the marine species need to spend some stages of their life in this precious ecosystem. Furthermore it has been proved that dependent on tropical mangroves. It is mainly due to the immense productivity, nutrient and suitable microclimate offered by mangroves since ages (M.V.leh .et.al.1992) Especially the nutrient load is incomparable, for instance the Pichavaram mangroves of southern India alone produce 7,457 tones of leaf litter per year (K.Krishnamurty 1993)Moreover, dense mangroves always inhibit the speed and intensity of tropical cyclones and storms and

minimize the damages Number of studies in different parts of the tropical regions elucidate the ability of mangroves against the impacts of cyclones In India, the 1999 super cyclone over 250 km of Orissa's coastline uprooted almost all the trees in the immediate vicinity of the coast and caused much damage to trees several kilometers inland. Notably mangrove forests and terrestrial trees in the shadow of mangrove cover remained intact. (T.Balasubramanium and S.Vijalakhshmi 2004).

Indian mangrove has a long history that received attention right from the 17 century itself. The first status report on Indian mangroves was submitted in 1987 to the Ministry of Environment and Forest, Government of India and after a decade another report entitled "Status Report on Mangroves of India" was published (A.H.Baird A.M. Kerr 2007). Inter alia Forest Survey of India (F.S.I. 1999) stated that within the 7500 km coastal line, India supports 4,87,100 ha of mangrove wetlands, in that nearly 56.7% *i.e.* 2,75,800 ha is spread along the east coast region and 23.5% (1,14,700 ha) in the west coast region and the remaining 19.8% (96,600 ha) is found in Andaman and Nicobar islands.



# MANGROVES

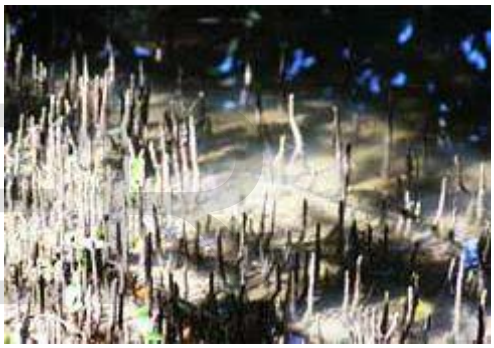
The word 'Mangroves" refers to a group of plants which may actually belong to several families (species that distinctly belong to their own evolutionary group). The term therefore indicates an ecological rather than a taxonomical (scientific classification) grouping - the species are not related. They are unique plants because of their ability to grow in unstable tough environments. Mangroves are unique because they are able to thrive in areas where the water is poor in oxygen content, in salt water, in fresh water and in brackish water (a mixture of salt and fresh water). Mangroves are fast-growing trees taking several years to reach up to 25 meters when they are fully grown. Of the seven types of mangroves, three are most dominant, the red, black and white types.

## Types of Mangroves

### Black Mangroves or 'Courida'(*Avicennia germinans*)

**Description**

Easily identified by its roots which are specialized to take in oxygen. Roots look like tubular bristles which stick out vertically and trap oxygen for its oxygen-starved root systems. These bristles are known as pneumatophores.



**Roots of the Black Mangrove**

The Black Mangrove is tolerant of high saline conditions and the trees grow in isolated groups or woodland formations. Individual trees are fairly large and may grow up to 20-25 meters in height and 40 centimetres in diameter at breast height. Black mangroves produce seeds in abundance which occur throughout the year. The seeds are viviparous in nature, meaning their seeds terminate while still being attached to the parent tree. This species regenerates and coppices well and can therefore be managed under a coppice system, which is an even-aged silvicultural system for which the main regeneration method is vegetative sprouting of either suckers (from the existing root systems of cut trees) or shoots (from cut stumps).

**Leaf and Flower of the Black Mangrove**

## Uses

The Black Mangrove is the most important and dominant mangrove species in the open mud flats of Guyana . The seeds are actually edible and can be prepared into a delicious meal- but caution! Unless prepared in a certain way, your meal can be toxic!

**Roots of the Black Mangrove**

**Leaf and Flower of the Black Mangrove**

**Red Mangrove or 'Red Mango'** ( *Rhizophora mangle* )

This is an evergreen tree, which grows to about 25 meters in Height and 40 centimetres in diameter at breast height. These are immediately recognized by their elaborate prop and aerial root system which stabilizes the trees. The roots contain a waxy substance that helps keep salt out. Where salt gets through, salt is deposited in older leaves and the tree then sheds them. The seed-like parts - the propagules - are large pre-germinated 'seedlings' known locally as 'monkey whistles'. A single seed germinates inside the conical fruit forming a long narrow first root (radicle), which is green except for the brown enlarged and pointed end up to 1.25 centimetres in diameter. It can grow up to 30 centimetres in length before it detaches from the mother tree and falls. They need a longer period from 16 to 30 months to mature from flower bud to mature seedlings.

**Leaf of Red Mangrove**

Red Mangroves does not respond well to cutting, and are very sensitive. If 50% or half the leaves are removed from the tree then it will die.

## Uses

The wood can be converted into good quality charcoal and the bark produces high quality tannin which is suitable for leatherwork.

## White Mangrove

( *Laguncularia racemosa* )

### Description

These are the shortest of the three species (reaches 5.6 meters and a diameter of 30 centimetres) and have un-buttressed roots. This species normally grows in the back portion of mangrove swamps, which remains unaffected by tidal inundation, except during spring tides. The bark is light brown to reddish dark brown, and the leaves are ovate. The leaves have adapted to their salty environment by developing special openings (glands) that allow salt to pass from inside the tree to the outside. The leaves are then coated with speckled white salt crystals which are what gives this species its name white mangrove. Germination is epigeous (the cotyledons - part of the embryo of the seed- of the germinating seed expand, throw off the seed shell and become photosynthetic above the ground) and un-opened seeds are carried up to 4 - 8 centimetres on a slender green stalk. Further, the roots are fibrous, and this species coppices reasonably well. It normally grows in the back portion of mangrove swamps, which remains unaffected by tidal inundation, except during spring tides. The soil is generally clayey to silty clay.

**Leaf and seed of the White Mangrove**

# MANGROVES IN INDIA

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 (Krishnamurthy, 1987) and 8% of the Indian coastline (Untawale, 1987). But a recent Indian Remote Sensing Data (Nayak, 1993) showed that the total area of the mangroves decreased to 4,474 km2 (Table. 1). 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 cattles 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 2011 of the Forest Survey of India, Dehra Dun shows that mangrove cover in the country is 4,662.56 sq.km, which is 0.14 percent of the country's total geographical area. The very dense mangrove comprises 1,403 sq.km (30.10 % of the mangrove cover), moderately dense mangrove is 1,658.12 sq.km (35.57%) while open mangroves cover an area of 1,600.44 sq.km (34.33%). Compared with 2009 assessment, there has been a net increase of 23.34 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.



## STATE/UT WISE MANGROVE COVER 2011 (Area in km²)

| S. No | State/UT | Very Dense Mangrove | Moderately Dense Mangrove | Open Mangrove | Total | Change w.r.t. 2009 assessment |
|---|---|---|---|---|---|---|
| 1 | Andhra Pradesh | 0 | 126 | 226 | 352 | -1 |
| 2 | Goa | 0 | 20 | 2 | 22 | 5 |
| 3 | Gujarat | 0 | 182 | 876 | 1058 | 12 |
| 4 | Karnataka | 0 | 3 | 0 | 3 | 0 |
| 5 | Kerala | 0 | 3 | 3 | 6 | 1 |
| 6 | Maharashtra | 0 | 69 | 117 | 186 | 0 |
| 7 | Orissa | 82 | 97 | 43 | 222 | 1 |
| 8 | Tamil Nadu | 0 | 16 | 23 | 39 | 0 |
| 9 | West Bengal | 1038 | 881 | 236 | 2155 | 3 |
| 10 | Andaman & Nicobar | 283 | 261 | 73 | 617 | 2 |
| 11 | Daman & Diu | 0 | 0.12 | 1.44 | 1.56 | 0.34 |
| 12 | Pondicherry | 0 | **0** | 1 | 1 | 0 |
| **Total** | | **1403** | **1658.12** | **1601.44** | **4662.56** | **23.34** |

## MANGROVES IN TAMIL NADU



Mangroves in Tamil Nadu exist on the Cauvery deltaic areas. Pichavaram has a well-developed mangrove forest dominant with *Rhizophora* spp., *Avicennia marina, Exocaria agallocha, Bruguiera cylindrica, Lumnitzera racemosa, Ceriops decandra* and *Aegiceras corniculatum* as the dominant flora. Mangroves also occur near places like Vedaranyam, Kodiakarai (Point Calimere), Muthupet, Chatram and Tuticorin. Inspite of the fact that Pichavaram mangrove is very small in area, it has been very well studied in all aspects of studies like biology, chemistry, microbiology etc. by the scientists of the Centre of Advanced Study in Marine Biology, Department of Botany and Faculty of Agriculture of Annamalai University and also M.S. Swaminathan Research Foundation, Chennai.

## DISTRICT WISE MANGROVE COVER IN TAMIL NADU (2011)

| S. No. | Districts of Tamil Nadu | Very Dense Mangrove | Moderately Dense Mangrove | Open Mangrove | Total | Change w.r.t. 2009 assessment |
|---|---|---|---|---|---|---|
| 1 | Chidambaranar | 0 | 0 | 7 | 7 | 0 |
| 2 | Cuddalore | 0 | 9 | 10 | 19 | 0 |
| 3 | Nagapattinam | 0 | 2 | 1 | 3 | 0 |
| 4 | Ramanathapuram | 0 | 5 | 3 | 8 | 0 |
| 5 | Thanjavur | 0 | 0 | 2 | 2 | 0 |
| **Total** | | **0** | **16** | **23** | **39** | 0 |

## PICHAVARAM MANGROVE

Pichavaram mangrove forest is located about 200 km south of Chennai (Madras) city in the southeast coast of India. This mangrove is actually sandwiched between two prominent estuaries, the Vellar estuary in the north and Coleroon estuary in the south. The Vellar - Coleroon estuarine complex forms the Killai backwater and Pichavaram mangroves. Pichavaram mangrove is present in the higher land of Vellar-Coleroon estuarine complex. The mangrove extends to an area of 1,100 hectares, representing a heterogeneous mixture of mangrove elements. The source of freshwater to this mangrove is from both the estuaries and that of seawater is Bay of Bengal. The whole of the mangrove comprises about 51 small and large islands with their sizes ranging from 10 m2 to 2 km 2. The mangrove soil usually consists of alluvium derived from the mangrove plants. About 40% of the total area is covered by water ways, 50% by forest and the rest by mud flats, sandy and salty soils. There are numerous creeks, gullies and canals traversing the mangroves with a depth ranging from 0.5 to 1.5 m and discharging freshwater into the system. A major irrigation channel is mainly discharging agricultural waste water from the entire upper reaches to this mangrove. Pichavaram mangrove did not receive much attention during pre and post independence periods. A map published by the Cuddalore District authorities in 1882 is the document which was first made available to public. Then, only during the later part of 20th century (Thirumalairaj, 1959) explored the Pichavaram mangrove and Venkatesan (1966) listed the floral communities in the region in relation to environmental factors. French institute, Pondicherry is one of the pioneering institutes in exploring Pitchavaram and contributed several publications on the wealth of the mangroves (Blasco, 1975; Meher Homji, 1979)). The Centre of Advanced Study in Marine Biology, right from its inception in 1961 has been involved in various research activities in Pichavaram mangrove. Water quality, floral and faunal composition, microflora, ichthyofauna, bioactive substances from mangroves, fishery resources, larval development, heavy metals and organochlorine residues, methanogens,

cyanobacteria, wood biodeterioration and UV - radiation are all studied extensively by this Centre. During 90s, M.S. Swaminathan Research Foundation (MSSRF), Chennai, India established a mangrove Genetic Resource Conservation Centre here by adopting 50 ha forest area. In addition, Centre for water Resources, Anna University, Chennai has remotely sensed Pichavaram forest with satellite imageries. The mangrove flora in India comprises 35 species under 16 genera and 13 families. Of these 33 species (16 genera and 13 families) are present along the east coast (Kathiresan, 1998). The east coast of India and Andaman and Nicobar islands show high species diversity. Pichavaram mangrove is one of the rare mangrove forests in India and it represents 14 exclusive mangrove species (Kannupandi and Kannan, 1998). *Avicennia marina* alone constitutes nearly 30% of the total population followed by *Bruguiera cylindrica* (17%) and *Avicennia officianalis* (16%). The population density of other species is poor and many of the species are on the verge of total extinction. According to a recent statistics, it is found that nearly 62.8% of the Pichavaram mangrove forests were degraded between 1897 and 1994. Tissot (1987) investigated the change that has taken place in the vegetation of the Kaveri delta over a period of 2000 years. It has been found that the breadth of the beach protecting the mangrove areas from wave action at Pichavaram mangrove has reduced by 550 m between 1970 and 1992.The substantial reduction in the forest cover is due to frequent cyclones at least every alternate year which devasted several mangrove species and reduced the total area from 4000 ha in the beginning of the century to nearly 1100 ha at present. As a result of this, many plants previously recorded from Pichavaram mangrove have completely vanished. For example, the pollen analysis of the sediments from Pichavaram showed that Sonneratia was abundant here in the past (Caratini *et al*., 1973), which is on the verge of extinction at present. Further, occurrence of *Aegiceras flordium* reported from this area by Krishnamurthy (1978) could not be confirmed by Muniyandi (1985). Certain species like *Xylocarpus granatum, Rhizophora stylosa* and *Bruguiera gymnorrhiza* which were once collected from this mangrove are not available at present (Kannupandi and Kannan, 1998). It is also found that most of the individuals of *Rhizophora* sp. are aged and the rate of reproduction is also low at Pichavaram mangrove. It seems to be on its way to extinction at this mangrove, being replaced by the much more dynamic *Avicennia marina* (Kannupandi and Kannan, 1998). From the Pichavaram mangrove ecosystem about 100 species of diatoms, 20 species of dinoflagellates, 40 species of tintinnids, 30 species of copepods, 30 species of prawns, 30 species of crabs, 30 species of molluscs and 200 species of fish have been recorded (Anon, 1987).

# CURRENT STATUS OF MANGROVES

Importance of mangroves was not properly recognized by the global community in the previous decades, which resulted in huge decline of mangroves throughout the tropical region. Losses of mangroves occur almost every country that harbours mangroves, on the other hand the developing countries which supported huge mangrove cover witnessed significant decline ( FA.O.. 2007>90% ) (Duke *et al)* disclosed that mangrove forests have been declining at a faster rate than inland tropical forests and coral reefs. To support his, Millennium Ecosystem Assessment MA reported, 35% of mangrove losses form 1980 to 2000 in the tropical region. Furthermore recent report by Global Marine Species Assessment declared, Southeast Asian countries alone lost 80% of its mangrove India also lost maximum cover during this period (e.g. Pichavaram mangroves South East Coast of India lost 80% of its mangrove cover . Concerned over this large scaled decline, United Nations General Assembly declared 2010as the International year for biodiversity and 2011 for forest conservation mainly to highlight the importance of biodiversity values of forest.



Image of Nypa fruticans

Table 1: Flora and fauna species recorded from Indian mangroves up to 2008.

| Groups | Number of Species |
|---|---|
| Floral groups | |
| Mangroves | 39 |
| Mangrove associates | 86 |
| Sea grass vegetation | 11 |
| Marine algae (Phytoplankton + sea weeds) | 557 |
| Bacteria | 69 |
| Fungi | 102 |
| Actinomycetes | 23 |
| Lichens | 32 |
| Faunal groups | |
| Prawns and lobsters | 55 |
| Crabs | 134 |
| Insects | 705 |
| Mollusks | 302 |
| Other invertebrates | 740 |
| Fish parasites | 7 |
| Fin fish | 543 |
| Amphibians | 11 |
| Reptiles | 82 |
| Birds | 419 |
| Mammals | 68 |
| Total number of species | 3985 |

Source: K.Karthisen

# BIODIVERSITY VALUES OF INDIAN MANGROVES:

Biological resources are the untapped capital of any country. Number of national and international research organizations emphasize that biodiversity is the most commercially important natural resources like oil and gold (K. Prathapan and P.Dharmarajan2009)

**Image of Goran**

Indian mangrove supports a unique group of fungi, microbes, plants and animal species including crustaceans, mollusks, fishes, water birds and a number of endangered mammals like fruit bats, dolphin and the Royal Bengal tiger It was reported that Indian mangroves support 3985 species of flora and fauna that includes 919 (23%) flora and 3066 (77%) of fauna (Table 1).Interestingly 2 million water birds of about 200 species over-winter in Indian coast heading back to colder northern climates. in April (P.E.Hulme 2007) and among them most of the species effectively utilize the Indian mangroves S.Sandaliyan No other country in the world supports so many species in the mangrove ecosystem alone and most of the species are endemic to this habitat. Notably Indian mangrove support numerous endangered flora and fauna (Table 2).Ironically such an important ecosystem is in continuous

jeopardy and in recent decades this vital ecosystem is facing unimaginable threat due to continuous human intervention throughout India and faces a profound emergency. Moreover natural calamities such as cyclone and tsunami are the great challenges to this system. Above all, it has been predicted that the ongoing climate change could be the greatest threat to the existing global mangroves (E. Gliman and J.Ellison 2008) 100% of the mangrove forests could be lost in the next 100 years if the present situation continues everywhere

Table 2: Endangered flora and fauna recorded in India mangroves up to 2005.

| Species Name | IUCN status |
|---|---|
| **Plants** | |
| *Acanthus ebracteatus* | Endangered |
| *Acrostichum specisum* | Endangered |
| *Cynometra ramiflora* | Endangered |
| *Excoecaria indica* | Endangered |
| *Lumnitzera littorea* | Endangered |
| *Nypa fruticans* | Endangered |
| *Rhizophora annamalayana* | Endangered |
| *Rhizophora lamarckil* | Endangered |
| *Rhizophora stylosa* | Endangered |
| *Scyphiphora hydrophyllacea* | Endangered |
| *Sonneratia griffithii* | Endangered |
| **Invertebrate** | |
| *Cardisoma carnifex* | Endangered |
| *Gelonia erasa* | Endangered |
| *Uca tetragonon* | Endangered |
| *Macrophthalamus convexus* | Endangered |
| *Pilodius nigrocrinitus* | Endangered |
| **Fishes** | |
| *Boleophthalmus dussumieri* | Endangered |
| *Scartelaas viridus* | Endangered |
| **Reptiles** | |
| *Crocodilus porosus* | Endangered |
| *Varanus bengalensis* | Endangered |
| *Varanus salvator* | Endangered |
| *Varanus flavescens* | Endangered |
| *Lepidochelys olivacea* | Endangered |
| *Lissemys punctata* | Endangered |
| *Trionyx gangeticus* | Endangered |
| *Trionys, hurun* | Endangered |
| *Batagur baska* | Endangered |
| *Python molurus* | Endangered |
| **Birds** | |
| *Pelecanus philippensis* | Endangered |
| *Theskiornis melanocephalus* | Endangered |
| *Ardea goliath* | Endangered |
| **Mammals** | |
| *Panthera tigris* | Endangered |
| *Platanista gangetica* | Endangered |

Source K.Karthisen

# MANGROVES AND CLIMATE CHANGE

The ongoing global climate change is recognized as a great threat to natural habitats and ravage species survival. Worldwide researchers investigate the ecological and hydrological impacts resulting from the ongoing climate change in several important habitats. It was recognized that the issue of climate change is a great challenge to wetland conservation (S.Ditteman .et. al) and the restoration. Especially climate change will significantly alter many of the world's coastal wetland habitats Considering the global importance, coastal marine environments are a major focus of concern regarding the potential impacts of anthropogenic climate change



It was predicted that the ongoing global climate change is expected to intensively alter the air and water temperatures, ocean and atmosphere circulation, sea-level rise, the intensity and incidence of hurricanes and the timing, frequency and magnitude of precipitation In natural conditions, coastal wetlands have the ability to adjust the rising seas and changes in local storm patterns, but unfortunately combination of climate changes and human activities jointly alter natural conditions and disrupt coastal wetland hydrology, biogeochemical cycling and other processes (S.Sandaliyan 2007)

It was established that various extreme climatic events can significantly affect most of the wetlands species (e.g. Plankton, Benthic animals) which also can significantly affect the demographic rates in the given year and the productivity of the wetland. But unfortunately limited studies related to mangroves are available and especially there are no case studies in India. To support this, a recent international conference on climate change

and sustainable agriculture held in the Indian capital concluded that there are no conclusive studies in India on the prospective impact of climate change on several fronts including coastal habitats and admitted that the knowledge and understanding of implications of climate change at the national level is inadequate and fragmentary or still in its infancy (K.L.Erwin 2007). So, the foregoing review is highlighting the impacts of extreme climate on Indian coastal system. It is needless to state that mangroves are one among the coastal system and the numbers of problem which affect the coastal system are applicable to mangroves also.

# EFFECTS

i) **Increasing $CO_2$ :** Climate change events are accelerated mainly due to the dumping of green house gases such as CO, $CO_2$ and $CH_4$. Especially elevated level of $CO_2$ together with other green house gases result in global mean temperature rise and which will yet again result in a cascade of physical and chemical changes in marine systems. The atmospheric concentration of $CO_2$ has increased 35% from a pre-industrial level from 280 parts per million by volume (ppm) in 1880 to 379 ppm in 2005 and it is expected to rise further Moreover, it was reported that roughly half of the $CO_2$ released by human activities between 1800 and 1994 is now stored in the ocean. The continuous entry of atmospheric $CO_2$ is expected to substantially decrease marine pH and expected to change the saturation horizons of aragonite, calcite and other minerals essential to calcifying organisms.

It was found that for some mangrove species, the response to elevated level of $CO_2$ may be sufficient to induce substantial change of vegetation along natural salinity and aridity gradients However, the

impact of more $CO_2$ on mangroves is poorly understood and there is a less understanding in this area till date in India. On the other hand the annual automobile sales trend in India gets increasing in an alarming way in which will further increase the anthropogenic gases in the Indian environment. It is worth to mention here that India is the fifth largest crude oil consumer in the world and during 2009-10 India's motor sprit consumption was estimated to 1, 28,18, 000 tonnes.

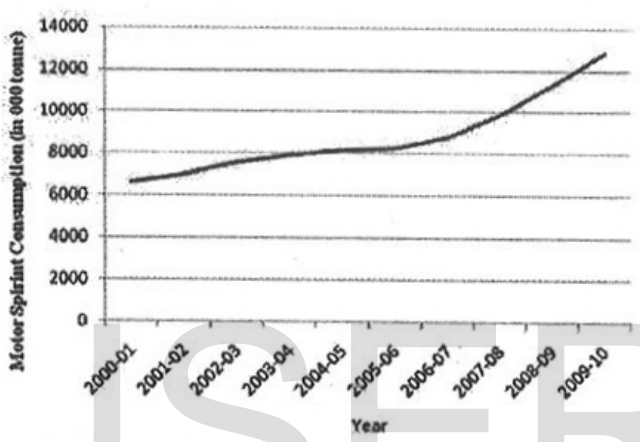



Fig. 5: Motor spirit consumption trends in India for the lost one decade.

(Source. (www.indiastat.com)

ii) **Increasing Temperature:** Increasing CO level in the atmosphere resulted in increasing global mean temperature Between 1906 and 2005, the global average surface temperature has increased by 0.74° C (±0.18 ° C) and it is further expected to increase 1.1-6.4° Cat the end of this century

Several studies emphasize the negative impacts of rising temperature on species. The increasing temperature not only affects the biodiversity but also devastates the entire system. For instance, as a result of warming seawater, the world oceans are expanding, which

coupled with freshwater input from 'ice-melt' and thermal expansion of the oceans is causing sea level to raise both at regional and global scale This will strongly affect the mangrove forest (refer sea level rise heading of this paper).

Furthermore it is stated that increasing temperature affects physiological processes ranging from protein damage to membrane fluidity to organ function Especially the marine organisms are highly prone to increasing temperature, because many coastal organisms already live close to their thermal tolerances So, naturally further increase in temperature can negatively alter the performance and survival of marine organisms. For instance, several planktons and larval forms of several marine organisms are particularly susceptible to thermal effects particularly young benthic stages of many organisms are more vulnerable to stress than their adults It is a well-known fact that Indian mangrove supports unique group of fungi, plankton and other benthic community (Table 1) which might face potential risk by the increasing temperature .Furthermore rising temperature also affects the timing of ontogenetic transitions. So the ongoing climate change may decouple changes in the larval environment from the cues used by the adult population Field and Ellison emphasized that the mangrove might face the species composition change and changes in the flowering and fruiting periods. Moreover the mangrove plants need an ideal temperature for photosynthesis (28-32° C). So, photosynthesis is significantly reduced when leaf temperatures reach 38-40 ° C which will affect the net productivity. Continuous monitoring and detailed analysis indicate that the maximum temperature has been increasing during the last century over all the regions of India. The coastal region which supports mangroves will show a maximum increase of 0.6° C Extreme

temperature events also have increased in the recent pasting several parts of the country and the highest temperature varied between 45 and 50° C in several parts of the east coast, which supports 56.7% on country's mangroves.

iii) **Sea Level Rise:** Global sea-level rise is one of the more certain outcomes of global warming, it is already taking place (12-22 cm occurred during the 20th century) The most obvious consequence of sea level rise will be an upward shift in species distributions. For example, intertidal habitat area may be reduced by 20-70% over the next 100 years in ecologically important zones Climate modeling clearly pointed out that larger changes in sea level have led to mangrove ecosystem collapse In the future, landward migration of fringing mangrove species, such as *Rhizospora mangle*, will likely be limited due to coastal development and associated anthropogenic barriers So sea level rise will be the greatest threat to Indian mangroves.



iv) **Cyclones:** Recent evidence suggests that human induced global warming has already increased both the intensity and the frequency of cyclones that can cause severe damage to coastal life Muniyandi (1986) stated that almost every alternative year Indian mangroves are affected by major cyclones. Recent data disclosed that' severe cyclonic storms crossing east coast shows an increasing trend

The increased intensity and frequency of tropical cyclones naturally increase the damage to mangroves through defoliation, uproot of trees and tree mortality. In addition to causing tree mortality, the nature of the soil sediments also get modified. Moreover, it will lead to ecosystem conversion. And it has been established that a cleared

mangrove forest had failed to recover even after several years mainly due to changed hydrodynamics, salinity and acidity, as well as low nutrient levels and poor essential substrates.

v) **Poor Rain Fall:** Globally, rainfall is predicted to increase by about 25% by 2050 in response to climate change. However, the regional distribution of rainfall will be uneven A recent assessment of IPCC highlights the significant increase of precipitation in parts of Central Asia and poor in parts of Southern Asia for the forthcoming years

Naturally the poor rainfall and increased evaporation will lead to the rise in salinity in mangroves (refer For the impacts of salinity on mangroves) and decreasing net primary productivity of mangroves, growth and seedling survival, altering competition between mangrove species, decreasing the diversity of mangrove zones and causing a notable reduction in mangrove area which is due to the conversion of upper tidal zones to hyper saline flats.



# REVIEW ON LITERATURE

1. A. Sasi Kumar, Ving Ching Chong, M.U.Lch RD Mangrove Laboratory (1992).

   Mangrove intels and creeks in Selangor are habitat for 119 species of fishes and 9 species of prawn. The majority of fish and all prawn small samples. The common fish in the intelento in terms of weight were Arius Sagonmbicasubvirides,Tonotesjaculator.

2. Kathiresan K 1996 estuaries is India

   The report covers the diverse field of research in Indian estuaries between 1985 and 1995. It includes total 29 estuaries.

3. N.C Duke, J.O Meydeck, S. Deteman et al 2007 A world without mangrove

   Reforestation of mangrove forests which have extra daily high rates of productivity

4. I. Balasubramonium & S Vijayalakshimi (1999) Pollution threats to mangrove and water quality

   Marine plants colony wise several interconnected ecosystem in human activities. Losses of mangrove and other tidal wetlands communities for the result of reclamation. Coastal sea grasses meadows are characterised by small ephemeral species. Conservation and management is hamper by scarce ecological knowledge.

5. A. M Kerr and A.H Bard (1998) Pionier of mangrove in an anthropology in Indian Mangrove.

   Anthropological significance of mangrove diversity in India. The Indian mangrove by approximity have 59 species from 29 family of the 59 species 34 species belonging to 21 family.

6. J.A. Kely R.W. Buddemenar D. Archer, B.N Monotype A coral reef represents the net accumulation.

   It calcification declines then reef capacity also declines. Coral reef clarification depends on saturation state of the carbonate mineral a rayon of surface mater. Coral reefs are particular threatened.

7. B.A. Tester (2001) on determine of the upper limits of internal distribution of for scales Observations distribution, mater content of survival branches in the field are interpreted in light of known response to laboratory controlled physical factors.

8. S. Sandaliyan K. Thiyagsen R Nagarjun 2006

Salinity rise in Indian Mangroves a looming danger of coastal biodiversity India has long coastal line over 7500 km supporting vast habitants such as lagoons back waters estuaries, coral reefs and mangroves.

9. K. Muniyadi (2006) studies of mangrove in Pichavaram.

The mangrove ecosystems are store house of economically important resources like trees, fished, prawns and other marine organism

10. (2010) Impact on climate change on mangrove.

Inter related and spatially variable climate on mangrove ecosystem a region by region interview this review spatially regime and increasing temperature are impact at regional scales. All these factors interplay to determine spatially variability resiliency to climate change impact.

# CONCLUSION

The ongoing climate change is a looming danger for the pivotal Indian coastal systems, especially the mangroves which are highly vulnerable to climate change. Adverse effects on mangroves extend its serious consequence to the adjoining fragile and important ecosystems such as coral reef and sea grass bed. It was reported that mangrove is the only marginal ecosystem which share the resources with the adjoining ecosystem . Moreover, the ecological and socioeconomic values offered by the mangroves are innumerable, immeasurable and incomparable. So conserving mangroves might be a vital agenda in any nation's conservation programs. Practically conserving the mangroves from ongoing climate change is not an easy task and on the other hand it is high time to adopt a road map to minimize the damages.



As far as India is concerned, we have not started to analyze/estimate the impacts of climate change on mangroves. Unfortunately India is one among the countries which dumps huge quantity of $CO_2$ in atmosphere by combustion of fossil fuel from almost all the energy need sectors. Reports stated that flourishing of automobile industry in India is quadrupled over the past 15 years, which will result in further more dumping of anthropogenic gases. Apart from that, highly populated Indian metro cities are located on coastal line(e.g. Mumbai, Chennai and Calcutta) which will accelerate the pollution load resulting in vanishing mangroves. For instance, the mangroves in some places of the Indian state Maharashtra are almost extinct due to continuous human exploitation.

For a viable conservation, linking individuals and populations in conservation oriented action plans and making them to understand about the local-scale impacts to broader-scale changes, will improve their understanding of the biological consequences of climate change on mangroves Apart from that considerable reduction in CO2 is a vital at least at the regional scale, unless the conservation of the mangrove from ongoing climate change will be a pipe dream.

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