Conservation of Mangrove Forests
For Fighting Coastal Disasters and Carbon Emissions
In order to be effective, our efforts at poverty eradication and sustainable development must take into account the challenges posed by climate change. I am of the firm opinion that India should view the current global focus on climate change as an opportunity to decisively change the quality of life of its citizens.
Mangroves are salt-tolerant flowering tropical plants that are largely restricted to tropical coastlines. Mangrove forests are among the most productive and biologically complex ecosystems on Earth. They provide habitat and food source to a wide variety of living organisms. The intricate root system of mangroves also makes these forests attractive to fish and other organisms seeking food and shelter from predators. This helps replenish fishery stocks and support fishery-based livelihoods. Loss in mangrove forests reduces marine biodiversity, as well as the fishery resources and has an adverse impact on the people dependent on them for their livelihoods.

This month, our cover story titled, ‘Conservation of Mangrove Forests for Fighting Coastal Disasters and Carbon Emissions’ highlights that mangrove plantations are not just a wall against coastal disasters, but also hold socio-economic importance for people dependent on them for their livelihood. Further, mangroves can absorb about 50 times more carbon as compared to other ecosystems, and can play a crucial role in mitigating the adverse impacts of climate change. In India, mangrove forests have a long history as biologically-rich regions. However, they have in the past decades been considered as wastelands, and large tracts of mangroves were rampantly destroyed, leading to massive decline in mangrove forests between 1980 and 2000.

Our cover story also discusses the role of mangroves as significant carbon sinks and as a bulwark against storms. However, their resilience is reducing due to the changes in temperature, carbon dioxide levels, precipitation, etc. Hence, the article points out that conserving mangroves has to be a priority for India’s conservation programme. Unfortunately, people’s unregulated land acquisition has pushed mangroves to the brink of extinction in some of our states. However, the Indian Ocean earthquake and tsunami in 2004, and other cyclones that have hit coastal regions in recent years have dramatically highlighted the protective role of mangroves, thus enabling the conservation of mangrove forests to rapidly gain importance.

The feature article this month discusses about the revisions in the draft ‘Marine and Coastal Regulation Zone (MCRZ) Notification 2017’ and the implications of these revisions on coastal populations and livelihoods. The draft proposes that temporary tourism facilities, local housing, and infrastructure will be permitted beyond 50 m of the high tide line, which will apply to ecologically sensitive areas as well. In India, with its massive population, the implications can be particularly adverse. Several biodiversity hotspots in the country have already been badly affected by increasing pollution levels, with climate change exacerbating the damage. Fish-catch has been particularly affected along our coasts. In such a scenario, healthy oceans and coasts are necessary both for livelihoods and to combat the adverse effects of climate change.

Ajay Mathur  
Director General, TERI
The cover story on representations of nature in Indian art is very pertinent one indeed as it shows that nature created a deep impression on Indian thought from a very early age, and that this inspiration is prominently manifested through various art forms and literature. Indian artists have depicted plants, trees, flora, and fauna, in many imaginative ways through paintings, sculptures, and decorative art. I also liked the article on hybrid solar system published in the TERI Analysis section. Nice to know that the weavers in Varanasi are now shifting to a hybrid solar system backed by cleaner, smaller, and more powerful lithium batteries.

Robin Sanyal
Kolkata, West Bengal

I immensely enjoyed reading the monthly column by Smt. Maneka Gandhi on service companies for dog care. I also have a 5-year-old pet and I wish there was a service company of that sort in India also to take care of our pets while we are away on an important assignment. The Rickshawbank article is also very novel in the sense that it talks about the persistent efforts of Dr Pradeep Sarmah in promoting cycle-rickshaws and rickshaw pullers in the country. What I like the most about your magazine is the diversity of topics that it covers.

Harshit Dhingra
Chandigarh

The feature article on ‘benefits of trees and plants in reducing air pollution and global warming’ is quite informative. We all know that absorbing carbon is, by far, the most important activity that forests carry out in reducing the harmful effects of climate change. The article very well brings out other important points in this regard. The information on C3 and C4 plants is also very relevant. The interview of the Editor-in-chief of the British Medical Journal is also a very good read. She has very subtly brought out the threats that humanity faces today, be it climate change or lifestyle diseases.

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Conservation of Mangrove Forests

For Fighting Coastal Disasters and Carbon Emissions
It was only after the Indian Ocean earthquake and tsunami in 2004, and many other cyclones that hit coastal regions of the world in the previous years, the conservation of mangrove forests gained importance. Mangrove plantations are not just a wall against disasters, but also hold socio-economic importance, for people dependent on these for their livelihood. In this article, **Sharada Balasubramanian** and **Rahul Chavan** look at how mangroves—the world’s most productive ecosystem—need to be conserved.

“Mangrove habitats pose both as a vulnerable resource and a potential deterrent to effects of climate change. They provide significant carbon sinks that hold greenhouse gases (GHGs) and protect against storms. However, their resilience is slowly being broken down by the changes in temperature, carbon dioxide levels, precipitation, etc.”
India’s rich coastline, spanning across 7,500 km in 13 maritime mainland states and union territories, supports coastal and marine ecosystems that are rich in biodiversity. Mangroves are a part of these ecosystems. In India, mangrove forests have a long history of being one of the most biologically-rich regions. India also holds 3 per cent of the mangrove cover of the world. Considered as wastelands in the past, large tracts of mangrove land were rampantly destroyed. As a result, between the years 1980 and 2000, mangroves declined massively. The Pichavaram mangroves in southern India reduced by almost 80 per cent during this time.

Developmental activities have pushed the destruction of mangroves to up to 70 per cent in some countries. And that has threatened this precarious yet productive ecosystem. After suffering from natural calamities, such as tsunami and cyclones, the conscience of people was jolted to take notice that these mangroves offer vast services; all for free. Referred as a tree, shrub; ‘mangroves’ can be either an ecosystem or individual plants. They are salt-tolerant flowering tropical plants that are largely restricted to tropical coastlines.

India’s Mangrove Lands

The Sundarbans in India is a mangrove forest that supports Royal Bengal tigers, among other animal species. India’s mangroves can be broadly categorized into deltaic, backwater-estuarine, and insular types. About 58 per cent of the mangroves occur on the east coast along the Bay of Bengal, 29 per cent on the west coast bordering the Arabian Sea, and 13 per cent on Andaman & Nicobar Islands. These forests ecosystems in India support 4,000 floral and faunal species, and 39 mangrove plant species, that is, 56 per cent of the world’s mangrove species.

Mangroves have a huge share in the coastal wetlands of India, in deltas of rivers like the Ganga, the Mahanadi, the Godavari, the Krishna, and the Cauvery as well as on the Andaman & Nicobar groups of islands. More than a dozen ‘marine protected areas’ in India cover over half of the total mangroves of the country. Out of eight states and union territories which support mangroves, West Bengal (2,115 sq. km), Gujarat (1,031 sq. km), Andaman & Nicobar Islands (966 sq. km), Andhra Pradesh (397 sq. km), and Odisha (215 sq. km) have the maximum areas of mangroves.
With the highest biodiversity of over 50 species, Asia has the largest area of mangroves in the world with the Sundarbans being the world’s largest contiguous mangrove patch covering an area of 10,000 sq. km. Mangroves take root in the mud on shallow water. This acts as a shelter from predators for many reef fish species and replenishes fisheries. They also support livelihoods of people depending on them. Mangroves combat against the force of storms and minimize damage to coastal communities.

Further, most importantly, mangroves can absorb about 50 times more carbon than other ecosystems, and can play a crucial role to mitigate the impact of climate change. Loss in mangrove forests can reduce the fishery resources and impact the people dependent on them for their livelihood.

**Uses of Mangroves**

- Mangroves supply forestry products (firewood, charcoal, timber, honey, etc.) and fishery products (fish, prawn, crab, mollusc, etc.)
- Mangrove twigs are used for making charcoal and firewood. One tonne of mangrove firewood is equivalent to five tonnes of Indian coal; the twigs produce high heat without smoke
- Mangrove wood is used as timber

**What Threatens Mangrove Forests?**

Over the last 50 years, about one-third of the world’s mangrove forests have been lost. People overexploited the forest resources through conversions into large-scale development and infrastructure and diversion of freshwater for irrigation. While mangroves are seen as a key ecosystem for food security of the world, its greatest threat came through establishment of shrimp aquaculture ponds that account for mangrove area losses between 20 and 50 per cent worldwide. A 25 per cent decline in mangroves is projected by 2025 due to rise in the shrimp industry, especially in developing countries.

A policy response from the Ministry of Environment, Forest and Climate Change (MoEFCC, then MoEF) in February 1991 put restrictions on the expansion of shrimp farming. The Coastal Regulation Zone (CRZ) notification under the Environmental Act, 1986, declared all coastal stretches of seas, bays, and estuaries up to 500 m from the high tide line on the landward side as CRZ. Unfortunately, none of the state governments actually implemented the notification until the Supreme Court’s notification. In 1991, the state governments prepared and enforced the coastal zone management plans. However, sustainable and traditional shrimp farming practices have been exempted from the restrictions.

While conversion of mangrove land to shrimp farms remains a huge issue, there are important losses in the ecological and socio-ecological functions of mangrove ecosystems, such as changes in hydrology, salinity, introduction of invasive species, diseases, pollution from effluents, chemicals, etc.

**Challenges in Mangrove Conservation**

Mangrove habitats pose both as a vulnerable resource and a potential deterrent to effects of climate change. They provide significant carbon sinks that hold greenhouse gases (GHGs) and protect against storms. However, their resilience is slowly being broken down by the changes in temperature, carbon dioxide levels, precipitation, etc.

The rate of dumping of GHGs into the atmosphere forced a rise in the mean temperature of the planet. Moreover, it is roughly reported that carbon dioxide released during the last century is stored in the oceans. This continuous deposition of atmospheric carbon dioxide into the oceans has altered the acidic levels, impacting the mangroves. Several studies predict temperature rise to reach 2–6 °C by 2100. These would not just affect the biodiversity, but also collapse the entire system. It is like the domino effect, where increase in carbon dioxide levels affects the mean temperature, which, in turn, will affect the sea level and, finally, the mangroves and their fragile ecosystem. Increase in temperature also affects the net productivity of photosynthesis of the mangrove plants.
It has also been predicted that poor rainfall and increased evaporation can lead to rise in the salinity of mangroves. This would lead to decreased productivity, poor seedling and growth survival. It can also lead to the decreased diversity of mangrove zones and may also cause reduction in mangrove area by altering the competition of existing species. The ongoing climate change is a looming danger for the mangroves, which has the capability to sequester carbon over three times better than the inland forests. Loss of these pivotal ecosystems will have serious consequences for the adjoining fragile ecosystems, such as coral reefs and seagrass beds.

Moreover, the ecological and socioeconomic values offered by mangroves are countless and endless. It is estimated that about 9 million people from India and Bangladesh are dependent on the Sundarbans for their livelihoods. In India, the Bitharkanika mangroves in Odisha generate about $38/hour and $1.9/hour of offshore and inshore fishery, respectively.

Hence, conserving mangroves should be a priority for any nation’s conservation programme. Unfortunately, in the Indian context, we are lagging behind in analysing the impacts of climate change on mangroves. Unregulated land acquisition has pushed mangroves to the brink of extinction in some of our mangrove states.

**Mangrove Conservation Efforts**

The ‘Mangroves for the Future’ initiative was launched by Mr Bill Clinton, the former President of the USA, in December 2006 and is being coordinated by the United Nations Development Programme (UNDP) and International Union for Conservation of Nature (IUCN) in the six tsunami-hit countries. It promotes coastal ecosystem conservation and under this initiative, India has already drafted a ‘National Strategy and Action Plan’ to sustainably mitigate the mangrove and coastal ecosystem. It also aims to promote sustainable investment opportunities and value ecosystem goods and services.

As a part of implementing the Sustainable Development Goal 14—conservation of the ocean and marine resources for sustainable development, includes mangrove restoration also. For this, Global Mangrove Alliance, a commitment from international communities, with founding organizations, such as the IUCN, The Nature Conservancy, and the World Wildlife Fund, enhance existing efforts and drive more attention to the critical role of mangroves in coastal systems. Their efforts aim to increase the mangrove habitat by 2030.

The alliance focusses on the following:

- **Climate adaptation:** Increase coastal communities’
resilience to the impacts of climate and ocean change through $10 billion of total investments

- **Climate mitigation**: Eliminate all mangrove-associated human-induced GHG emissions through the comprehensive protection, sustainable use, and restoration of mangroves
- **Sustain biodiversity**: Ensure the long-term continuity of mangrove-associated biodiversity by halting human-induced mangrove habitat loss and helping local stakeholders to sustainably manage mangrove resources
- **Food security and human well-being**: Improve the well-being of an additional 10 million people dependent on coastal ecosystems, including the most vulnerable communities, through restoration and conservation of mangroves

**Sri Lanka leads in mangrove conservation**

Sri Lanka-based NGO Sudeesa (formerly known as Small Fishers Federation of Lanka), along with US-based NGO Seacology and the Government of Sri Lanka announced a joint programme to protect mangroves in the small island nation. This was the first such project in the world to protect mangrove forests. Estimated to cost $3.4 million over a span of five years, the project aimed at protecting all 21,782 acres (8,815 ha) of Sri Lanka’s existing mangrove forests. This was planned by giving alternative job training and microloans to 15,000 poor women living in 1,500 small communities living close to the mangrove forests.

The project would engage in replanting 9,600 acres (3,885 ha) of mangrove forests that were cut down. For receiving these microloans, the 1,500 communities would be responsible for conservation of 21 acres of mangrove forest.

Further, a mangrove museum, as a first-of-its-kind initiative to educate people on protecting this natural resource was included as a part of this project. The government, private institutions, researchers, communities, and NGOs were roped in to protect the mangroves.

**The Pichavaram mangroves of India**

The Tamil Nadu state government’s initiative after 2004 tsunami led to increase in mangrove cover in Pichavaram. A decade post tsunami, scientists have found an increase of 72.87 ha.

The Institute for Ocean Management initiated a study focussed on the Pichavaram and Muthupet mangrove ecosystem in the state of Tamil Nadu. It was proved during tsunami that mangroves minimized losses to property and people. The government officials were convinced about this fact and took a step towards protecting these mangrove forests. The forest department did a commendable job in protecting the mangrove forests in Tamil Nadu.

**Mangrove app from India**

The storage capacity of the Vikhroli mangroves in Mumbai is six lakh tonnes of carbon. A study done by Godrej showed that this is mostly human-induced pollution that is released into the atmosphere.

To protect the mangroves, a one-of-its-kind initiative was started by the company. A mobile app on mangroves was launched, for the first time in India and Asia. The app covers 24 mangroves and their associated species found in Maharashtra and 16 species found in Vikhroli. It is believed that students, teachers, NGOs, researchers, and photographers would greatly benefit from this app. The app can help users identify the mangrove species. Further, they can know more about the mangrove ecosystem, plants in the mangroves, the biodiversity, threats and conservation measures, etc.
Corporate efforts for mangrove conservation in the Philippines

In yet another move towards mangrove conservation, Smart Communications and Ericsson inked a formal agreement in the Philippines to develop an Internet of Things (IoT) solution for mangrove conservation. Here, they use wireless connectivity to capture data relevant to the survival of mangroves, such as water level, humidity, soil moisture, and temperature, etc. This information is collected by waterproof solar-powered sensors which are attached to mangroves. Then, it will be transmitted over a cloud system to a dashboard from where stakeholders, such as local authorities and farmers can access the information.

The project was initiated by Ericsson in Malaysia. Here, illegal logging, fires, pollution, and sea farms, affected mangrove forests by 85 per cent in a decade. The project showed success. The maturity rate of mangroves increased from 20–40 per cent prior to the project to 70–80 per cent after its implementation.

Drones for mangroves in Myanmar

In the delta of the Irrawaddy River in Myanmar, villagers have been manually planting mangroves (2.7 million trees) to restore the disappearing ecosystem. A local NGO, in an aim, to speed up the project is now using drones, to cover a larger area. The drones from a startup BioCarbon Engineering, is believed to plant as much as 100,000 trees in a single day. The local community needs to just take care of the young trees that have already started to grow. The NGO aims to use drones to help plant 1 billion trees in an even larger area. Reports suggest that drones are at least 10 times faster than humans planting these trees by hand. Also, the process will only cost half as much as the manual method.

The Way Forward

Not everything is lost in the mangrove world. Since the early 1990s, emergence of policies and interventions with efforts from national governments, NGOs, and local communities around the world have come forward to rehabilitate and manage mangroves sustainably. The Environment Ministry and state forest departments in India, along with corporate houses joined hands to launch major programmes across the mangrove states to restore the mangroves.

Various models such as community-based restoration programmes have been initiated. These mass plantations have also resulted in better ecological and economical opportunities for the local communities through availability of fodder and fuelwood. In Gujarat, the communities benefitted economically by saving money on buying fodder for their cattle, and increase in milk production as mangrove leaves provide high quality nutrition.

Salinity ingress in agriculture lands has been mitigated by the mangroves. The mangrove belt has protected immovable and moveable properties from various natural calamities such as cyclones. Apart from this, mangrove plantation drives have provided opportunities of earning for the local communities.

Despite all actions and awareness campaigns, slogans and policies; there is still an enormous knowledge gap about the climate change impacts on our coastal ecosystems, especially on mangroves. Data captured through coastal surveillance systems, intensive interdisciplinary field research, and analysis, will help us understand this issue better. These robust studies will help us design and implement site-specific, stringent policies which will help us build resilient societies through resilient ecosystems.

Ms Sharada Balasubramanian is an award-winning environmental and development journalist. She writes on water, energy, wildlife conservation, agriculture, and climate change. Her co-author in this article, Mr Rahul Chavan is a biodiversity conservation expert whose focus research areas include understanding the complexities of urban biodiversity, human–wildlife interactions among others. He also enjoys documenting wildlife and its issues through his lens.
In order to be effective, our efforts at poverty eradication and sustainable development must take into account the challenges posed by climate change. I am of the firm opinion that India should view the current global focus on climate change as an opportunity to decisively change the quality of life of its citizens.

Shri Narendra Modi
Message from Hon’ble Prime Minister of India at the Delhi Sustainable Development Summit 2015

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