DETAILED PROJECT REPORT
on

Management and rehabilitation of coastal habitats and biodiversity for Climate Change Adaptation and Sustainable Livelihood in Gulf of Mannar, Tamil Nadu, India

Submitted to

Ministry of Environment, Forest & Climate Change

Government of India

Prepared By

NABARD Consultancy Services Ltd.

Submitted on behalf of

Department of Environment

Government of Tamil Nadu

November, 2015

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PROJECT SUMMARY

Project Title :	Management and rehabilitation of coastal habitats and biodiversity for Climate Change Adaptation and Sustainable Livelihood in Gulf of Mannar, Tamil Nadu, India
Project Objectives :	The main objectives of the proposal are
	To carry out a baseline study to assess vulnerability to climate change of both coastal ecosystems (including biodiversity and fishery) and coastal communities in the Gulf of Mannar
	To restore Habitats (Coral reef and seagrass rehabilitation) in Kariyachalli and Vilanguchalli Islands as a climate adaptation strategy.
	To build climate change resilience to the fast eroding Vaan Island through deployment of artificial reef modules
	To promote Eco development activities among coastal communities to enhance their adaptive capacity and to sustain livelihood and food security
Project Sector :	Coastal Zone Management
Name of Executing Entity:	Department of Environment, Government of Tamil Nadu
Beneficiaries:	Fishermen and associated coastal communities
Project Duration:	4 years
Start Date:	2015-16
End Date:	2019-20
Amount of Financing Requested:	INR 247406000
Project Location:	Gulf of Mannar
State:	Tamil Nadu
District:	Thoothukudi
Contact Details of Nodal Officer of the Executing Entity:	Dr. H. Malleshappa, IFS. Director, Dept. of Environment, Panagal Maligai (Ground Floor), No.1, Jeenis Road, Saidapet, Chennai – 600 015
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1. PROJECT BACKGROUND

1.1. Project / Programme Background and Context

i. Provide brief information on the problem that the proposed project / programme is aiming to solve

The key coastal habitats such as mangrove, wetland, seagrass, estuary and coral reefs are of high importance for their functions and services like carbon management potential and increase of resource productivity for livelihood to dependent communities. They are vital for the food security of coastal communities in developing countries, providing nurseries and fishing grounds for artisanal fisheries. They also provide natural coastal defence that mitigate erosion and storm action. Therefore, better protection of these ecosystems will not only make carbon sense, but the co-benefits from ecosystem goods and services are clear (IUCN report, 2009).

Coral reefs are known as the "rainforests of the sea." Even though coral reefs occupy only 0.1% of the sea, one-third of all known marine species live on them. Seagrasses support different aquatic lives including marine turtles and juvenile shrimps. About 1 sq. km of seagrasses absorbs approximately the same carbon-dioxide (CO_2) as 50 sq. km of tropical forests! Seaweeds are important marine living resources with a lot of commercial value. The reefs provide humans with various benefits including food from reef fish, recreation for tourists and coastal protection. They are also highly productive, and sustain human society through a range of provisioning and supporting services. Tropical coral reefs cover about 250,000 sq. km of the ocean and while representing only less than one-tenth of 1% of the marine environment. One of the main functions of global coral reefs is the protection of around 150,000 km of shoreline in more than 100 countries and territories as they dissolve wave energy and reduce damages from erosion, floods and storm thus protecting human settlements, infrastructure, and coastal ecosystems.

D"Eath et al. (2009) presents evidence that coral calcification on the Great Barrier Reef may have diminished by about 14% since 1990. The projected increases in ocean temperatures in the 21st century are expected to exacerbate the stressors already affecting many coral reefs, resulting in additional coral bleaching and mortality (Pockley, 2000; Hughes et al., 2003; Pandolfi et al., 2003). The assessments from the Global Coral Reef Monitoring Network (GCRMN) in late 2000 are that 27 percent of the world's reefs have been effectively lost, with the largest single cause being the massive climate related coral bleaching event of 1998. This destroyed about 16 percent of the coral reefs of the world in 9 months during the largest "El Nino" and "La Nina" climate changes ever recorded. While there are signs that many of the 16 percent of damaged reefs will recover slowly, probably half of these reefs will not adequately recover within the next 50 years (Wilkinson, 2004)

Climate change has become the most significant threats to coastal areas, posing serious harm to both the coastal ecosystem as well as coastal communities. As per the INCAA 2014 report,

the climate change impacts on the coastal zone include increase in sea surface temperatures, increase in rain fall intensity, rising sea levels, increase in intensity of cyclones and storm surges, especially in the east coast. This in turn will impact the ecosystem and health of the dependent communities. It is projected that in the east coast the surface annual air temperature is set to rise by 1.6 to 2.1°C (28.7±0.6°C to 29.3±0.7°C). The projected rainfall in this region is likely to range between 858±85.8mm to 1280±204.8mm, with the intensity of rainfall set to increase between 1mm/day and 4mm/day.

Impacts on the ecosystem include, increase in salinity due to incursion of coastal waters due to rise in sea level affecting habitats, agriculture and availability of fresh water for drinking, changes in distribution and productivity of marine as well as fresh water fisheries, submergence of habitats and special ecosystems such as the mangroves. With regard to health impacts, it is projected that there could be an increase in morbidity and mortality due to increase in water borne diseases associated with cholera epidemics and increase in salinity of water, loss of livelihoods due to effect on agriculture, tourism, fisheries and hence impacting health and life expectancy, forced migration, loss of housing and drowning will result due to sea-level rise.

The other major threat due to climate change impacts is the coastal inundation. Here again, the east coast of India is more vulnerable than the west coast, because the former is low-lying and more prone to the occurrence of cyclones than the latter (INCAA, 2014). In some parts of the East Coast, in Tamil Nadu, the extent of probable inundation zone goes up to approximately 40 km landward.

Tamil Nadu being a coastal State is highly vulnerable to seasonal fluctuations in terms of rainfall, temperature, relative humidity, wind speed, etc., causing uncertainty in Agriculture production. Due to the effects of Cyclones and Monsoon in the Bay of Bengal, heavy damage to the crops in coastal areas are caused almost every year.

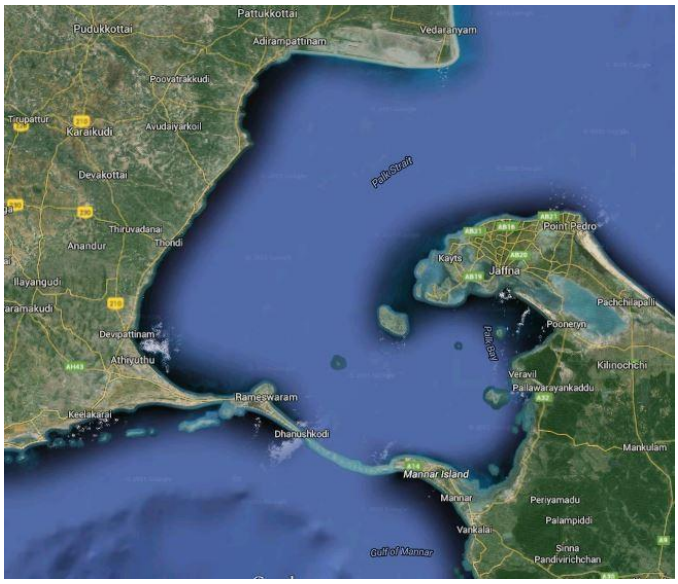
Impact on Coastal ecosystem and biodiversity - In Tamil Nadu the coastal ecosystem is vulnerable to climate change. Climate change may have a wide range of possible effects on ocean currents and processes that can affect fish resources (Everett 1996). Aquaculture enterprises are likely to be very vulnerable to impacts of climate change. Aquaculture activities on shore are usually in low-lying coastal areas. These are likely to be inundated as sea level rises. They are also likely to be threatened by loss of protection to the coast such as by degradation of mangroves, sea grasses and coral reefs. Many impacts are envisaged in the coastal areas/ecosystems harbouring a variety of biodiversity and associated livelihoods. However, more focused and systematic studies in these areas with respect to climate change impacts on the living resources mentioned is required for protection and conservation of coastal biodiversity. Also the impact of climate change is clearly visible in the Indian Ocean with many reefs, previously regarded as near pristine, seriously affected. The maximum numbers of affected corals are in the shallow waters. Any adverse changes to the number or

intensity of the frequent seasonal cyclonic storms in the Bay of Bengal could also adversely impact the State.

Enhanced Climate impacts on accretion or erosion rates - Action or erosion along Tamil Nadu coast is alarming. The natural littoral transport processes along the coastal region led to changes in the shoreline during the past 25 years. A large number of manmade developments towards seaward alter the coastal dynamics. The maximum accretion/erosion has occurred in the coastal areas of Mahabalipuram (5450m), Manakudi (3650m), Ammapattinam (3600m), Rameswaram (3295m), Ennore (3265m) and Marina beach (2968m). However, due to climate change as it is perceived that there will be stronger storm surges and more intense cyclones, further erosion may extend to larger areas along the coast thus effecting infrastructure and livelihoods (SAPCC, Chp 8).

The impacts of climate change coupled with human activities have severely degraded the coral reefs which are a coastal ecosystem having great socio-economic importance to the region. As per IPCC 2001, small islands are the most vulnerable to impacts of climate change while contributing minimal to the GHG emissions.

The Gulf of Mannar, the first Marine Biosphere Reserve (GOMMBR) in the South and South East Asia, is situated between Longitudes 78˚08" E to 79˚30" E and along Latitudes from 8˚35" N to 9˚25" N (it stretches down south from Rameswaram to Kanyakumari in Tamil Nadu). With its rich biodiversity of about 4223 species of various flora and fauna, northern part of this Gulf of Mannar between Pamban and Thoothukudi covering 21 islands and the surrounding shallow coastal waters has been declared as a Marine National Park in 1986 by the Government of Tamil Nadu and later the first Marine Biosphere Reserve of India in 1989 by the Government of India.



Map of Gulf of Mannar

Coral reefs in Gulf of Mannar are developed around a chain of 21 uninhabited islands that lie along the 140 km stretch between Pamban and Thoothukudi (between latitude 8˚47" N and 9˚15"N and longitude 78˚12"E and 79˚14"E) and the average distance of these islands from mainland is about 8 km. In addition, luxuriant seagrass beds are also distributed. Coral Reefs play an important role in global biochemical processes and are also important breeding, spawning, and feeding areas for many economically important varieties of fishes

and other marine organisms. Coral reefs act as a barrier against wave action along coastal areas thus preventing coastal erosion.

The coral reefs in the Gulf of Mannar is degraded due to human interference such as coral mining, destructive fishing methods, seaweed collection, commercial shell collection, introduction of exotic seaweed cultivation, changing land use practices, deforestation and industrial waste input etc. and natural activities like monsoon, wave action, ocean current and elevated temperature.

The loss of fish due to the destruction of habitats like coral reefs and seagrass beds is impacting the sustained livelihood of the dependent fishermen. The climate change impacts on corals such as bleaching and mortality; on fish population such as migration; erosion of islands and loss of fish catch to dependent fisher folk are posing serious threat on the environment and community.

Key issues and threats

Population growth: During 1989 – 2009, there has been an increase of about 34% in population along the coast of Gulf of Mannar and proportionately the fishing crafts and gears have also increased.

Fishing: Unsustainable and unregulated fishing and related activities are the major threats to the reefs and associated biodiversity. The commercial fisheries make vulnerable many deep sea species, retarding their reproduction and growth rates. Once the main fish stock has been depleted, it will take decades and potentially centuries to recover. Though reef areas are protected, illegal fishing, using destructive fishing practices such as inshore trawling, shore seine operation, trap fishing near the reef area and boat anchoring on the corals cause physical damage to the reefs and associated fauna and flora.

Traditional fishermen who form the majority population have increased in numbers during the last decades. Crowded fishing grounds, increasing demand for fisheries products, and declining catch deprive artisanal fishermen families of income and food security. In general, the fishermen communities are socio economically weak characterized by low literacy rate, lack of awareness of environmental issues, low income and a resulting reluctance among fishermen folk to take up livelihood options other than fishing. This led them to involve in more effective but illegal, destructive and unsustainable fishing practices, such as shore seine, purse seine and push net fishing.

In Gulf of Mannar, two islands (Poovarasanpatti and Vilanguchalli) are already submerged due to excessive mining. Erosion has been noticed in several other islands (Vaan, Koswari and Kariyachalli) (Patterson et al., 2007). The bottom trawling by big mechanized boats using banned gears (roller madi, and pair trawler madi), which completely sweep the seafloor, depleting fishery resources and causing damage to critical habitats, such as corals reefs and seagrass beds (Bavinck, 2003) is another issue. Trap fishing for marine ornamental fishes is also practiced near the reef area. Indigenously fabricated fish traps are set in and

around the reef areas. To keep safe the traps in the reefs, the nearby live and dead corals are broken. Therefore, the reefs are disturbed while laying and retrieving the traps. In most cases, the traps are laid mainly to catch reef dwelling herbivore fishes (e.g. Parrot fish), which in turn cause the proliferation of algae over live coral colonies due to lack of predator, leading to coral mortality and also ecological imbalance.

Seaweed and shell collection: Seaweed collection is also a major threat in the Manadapam, Keezhakkarai and Vembar coasts. Fishermen folk mostly women, collect tons of seaweeds daily around the islands damaging the corals. They break the corals while collecting the sea weeds. In Gulf of Mannar Marine National Park, both live and dead corals are found together around the shallow areas of the islands. The sea weeds grow mainly on the dead corals. The dead corals also form suitable substratum for attachment of new coral recruits (coral larvae). Due to the removal of seaweed along with dead corals, the new coral recruits attached to dead corals are also removed along with seaweeds. Several people (more than 10 people) involve in seaweed collection in an area at a time and so the live coral damage is very severe and the collectors also disturb the reef environment due to their activities, causing increased turbidity and sedimentation in the reef area. Due to this, sediment deposition on the live coral colonies is more which leads into coral mortality. The anchoring of boat on the reef area also causes very severe mechanical damage to the live coral reefs continuously. Further, women do not use any protective gear and use their bare hands to harvest sea weed which poses a threat to their safety as well. Often most women face injuries to their fingers and hands owing to this method of harvest.

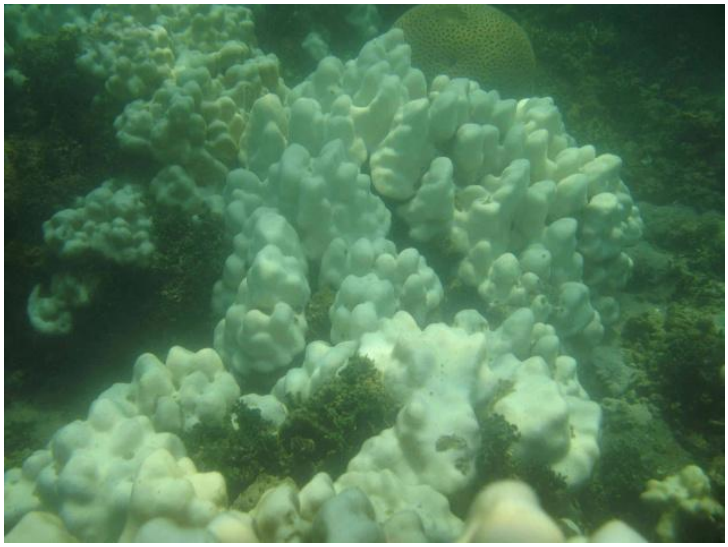
Coral mining: In the early 1970"s it was estimated that the exploitation of corals was about 60,000 cubic meters (about 25,000 metric tons) per annum from Palk Bay and Gulf of Mannar, combined (Mahadevan and Nayar, 1972). In 2001, the Union Government included all Scleractinan, Antipatharian, Millipora sp., Gorgonians and Tubipora under schedule I of the Wildlife (Protection) Act, 1972. In 2005, honourable Supreme Court stayed the coral mining activities. As a result of various conservation and protection measures, the coral mining was completely stopped in Gulf of Mannar since 2005. The Indian Ocean tsunami in December 2004 has also helped in creating awareness among the local fishermen community about the role of coral reefs and islands in coastal protection.

Due to the 3-4 decade long coral mining activity until the year 2005, the Gulf of Mannar lost about 32 $km^2$of reef areas. However, there has been an increase in live coral cover from 37% in 2005 to 43% in 2009, possibly due to a reduction in human disturbance in the area, in particular due to a complete halt on coral mining, in combination with high recruitment rates and proper enforcement of law.

Pollution and other hazards: The southern part of the Gulf of Mannar region has many industries, factories and power plants. Thoothukudi for example is the city which harbour's a major Port, thermal power plants, Heavy Water Plant (HWP), several chemical industries,

chain of salt pans and also affected from the untreated sewage. The northern region of Gulf of Mannar basically suffers from domestic sewage let out directly into the sea.

Climate change and corals: Climate Change impacts such as changes in increase in elevated temperatures, particularly during recurrent ENSO (El Niño Southern Oscillation) events stresses the corals making it to expel their pigmented microalgae endosymbionts, called zooxanthellae, and become pale or white. This bleaching effect causes coral mortality and also loss of productivity in fisheries (Hughes et al. 2003). In 1998, severe coral bleaching was reported in the Indian Ocean due to elevated Sea Surface Temperature (SST). The reef areas of Gulf of Mannar have faced annual elevated sea surface temperature and resultant coral bleaching during summer since 2005. Significant coral mortality was only recorded in 2010 when elevated temperatures (32.2 to 33.2°C) persisted for four months (April to July). An estimated amount of 9.99% of live coral colonies has been bleached and more than 50% mortality has occurred among the bleached colonies (Patterson et al., 2012). Coral reefs are also key indicators of climate change.



Bleached massive coral from Mandapam coast in Gulf of Mannar

Climate change and fisheries: The reef area in Gulf of Mannar is shallow (up to 6 m depth) and elevated temperature causes migration of several fish species. A case study on Big Jawed jumper, *Lactarius lactarius* fishery in Gulf of Mannar shows tremendous loss in catch. A decade ago, the Thoothukudi shallow coastal region in Gulf of Mannar had abundant Big jawed Jumper in depths of 2 fathoms, but now the fishermen have to fish this species in the deep water in depths over 20 fathom or deeper. Similarly several reef associated fishes have now migrated to deeper areas with over 15 m depth (Patterson et al., 2012). In 2004, the Suganthi Devadason Marine Research Institute (SDMRI) conducted a case study with the funding support from WWF-India on the "Effect of climate change on the loss of finfish, *Lactarius lactarius* fishery and dependent fishermen in the Gulf of Mannar (GoM)". The study has revealed that increased water temperature and decreased rain, which generally flushes

critical nutrients from the land into the Gulf of Mannar has contributed to a drastic decline of the economically important fishery over the last few years (Patterson and Samuel, 2004). Climate change and coastal erosion: There are 21 uninhabited islands in Gulf of Mannar. Rampant coral mining around these islands till the year 2005, has led to the substratum becoming unstable and the island shores becoming vulnerable to the impacts of climate change leading to erosion. Two islands have already submerged and the third island is on the verge of submergence. The islands are also serving as a resting ground and protective area to the traditional fish during rough climatic conditions.

Climate change impacts on local livelihood: Over 100,000 traditional fishermen live along the coasts between Rameswaram and Thoothukudi and are dependent on the associated fishing resources. The loss of fishery due to habitat destruction and migration of fish species is impacting the sustained livelihood of the dependent fishermen communities.

Climate change and mangroves: The Gulf of Mannar islands possess unique mangrove vegetation, it is interesting to note that such vegetation consists of species belonging to

Rhizophora, Avicennia, Bruguiera, Ceriops, Lumnitzera, etc. Although mangroves are obtained on a good majority of the islands, this vegetation on Manalli is striking for its luxuriance and diversity. The coastal erosion and rising temperatures are posing a serious threat to this ecosystem as well. Coral reef rehabilitation will also protect mangroves. In this project activity however, the target islands do not have mangroves.

Rehabilitation of coral reef and seagrass ecosystem would help the coastal ecosystem in making it climate resilient by restoring its ecosystem services and would build up the adaptive capacity of the fishing communities inhabiting the region by increased fish productivity and protection from climate induced disasters (Tsunami and cyclones) to coast and people by shoreline protection.

The goal of this project is to build resilience among coastal ecosystems and communities through habitat recovery and improvement and through sustainable livelihood development

ii. Outline the economic, social development and climate change in line with the State Action plan on Climate Change and relevant Missions under National Action Plan on Climate Change

Realizing the importance of the impact of climate change, Department of Environment (DoE), Government of Tamil Nadu has initiated Tamil Nadu State Climate Change Cell (TNSCCC) responding to the call of India's National Action Plan on Climate Change (NAPCC). The vision of the cell is to respond to global climate change by building capacity at local level particularly in the context of Tamil Nadu State and to make it as a resilient State to combat climate change. This will be addressed through effective climate change governance and climate services by connecting climate change science- policy-society by the climate change cell. However, the mission of the cell is to establish a platform to collect,

collate and disseminate climate change information pertaining to Tamil Nadu State to various stakeholders ranging from farmers, fishermen, general public to policy planners, decision makers, bureaucrats and others in order to enable effective climate change governance and services. As part of this initiative, a web portal has been created to update and disseminate the information and activities of the cell (TNSCCC). Importantly, the web portal will act as a central hub of information, data and reports on climate change of entire Tamil Nadu State. Further, it provides a web-based platform to assist in capacity building and knowledge development on climate and climate-related issues. The Government of India is also considering expanding the eight national missions on climate change and a new mission on Coastal Resources is likely.

As per Chapter 8 of the SAPCC, biodiversity conservation is an element of the ICZMP for Tamil Nadu. This element will include assessment and monitoring of coastal biodiversity for developing base line data and assessment and monitoring of the environment for the entire TN coast. This element will also include conservation and rehabilitation of ecologically sensitive area such mangroves (Muthupet, Pichavaram, Manakudy and Punnakayal); Conservation of wetlands at Point Calimere which is a Ramasar site, Pallikarnai Marsh which is a reserved forest and Pulicat lake; Conservation and rehabilitation of coral reefs and sea grass in Gulf of Mannar and Palk Bay; and Conservation and rehabilitation of forests along the coastal zone.

Further the economic and social development is in line with ICZM plan envisaged in the SAPCC which has focus on:

Livelihood improvement plans: As the people settled in the coastal rural areas are dependent on marine fishery, agriculture, and other ecosystem services from the sea, that are vulnerable to the existing climate variability and extreme events such as cyclones, heavy rains, and long term sea level rise, therefore, the ICZM plan, aims to identify alternative livelihood options, impart training to coastal communities on alternative livelihoods and support trainees to set up units

Improvement of fishery resources: Under the aegis of the ICZM, it is also planned create artificial reef environment at various locations, undertake hatchery production of ecologically sensitive fish species and commercially important species, encourage pen and cage culture, build capacity of fisher communities for utilising eco-friendly fishing techniques etc.

iii. Include climate analysis and vulnerability analysis.

Climate of Thoothukudi - Temperature

The district enjoys a hot tropical climate. The annual mean minimum and maximum temperature are 23°C and 29°C respectively. The climate is conducive for Agricultural and

Horticultural crops. Average temperatures of January is 27°C, February is 27°C, March is 29°C, April is 31°C, May is 31°C.[12]

Temperature Projections for Thoothukudi

The annual maximum and minimum temperature normal (1970-2000) of the district are 32.9 °C and 24.5°C respectively[3]. Projections of maximum temperature over Thoothukudi for the periods 2010-2040 (2020s), 2040-2070 (2050s) and 2070-2100 (2080s) with reference to the baseline (1970-2000) indicate an increase of 1.0°C, 1.9°C and 2.8°C respectively. Similarly, the projections of minimum temperature for the same periods indicate an increase of 1.1°C, 2.2°C and 3.2°C respectively.

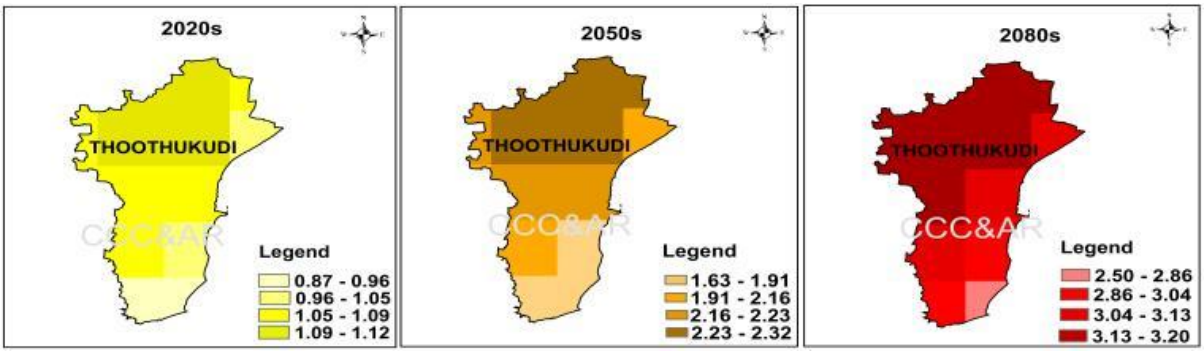


Fig - Changes in Min. Temperature for 2020s, 2050s & 2080s

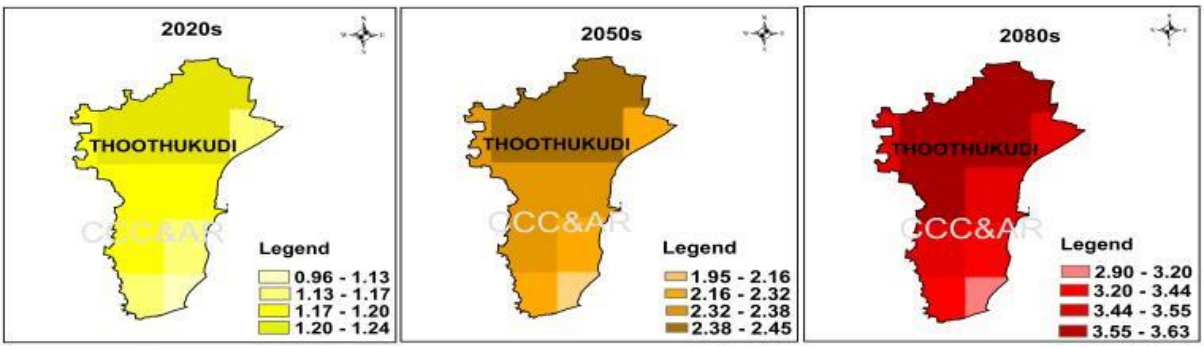


Fig - Changes in Max. Temperature for 2020s, 2050s & 2080s

Table showing changes in Minimum and Maximum Temperature for 2020s, 2050s & 2080s

Parameter	2020s	2050s	2080s
Maximum Temperature	+1.0°C	+1.9°C	+2.8°C
Minimum Temperature	+1.1°C	+2.2°C	+3.2°C

[1] ENVIS 2015. Thoothukudi District. ENVIS Centre Tamil Nadu, Available at tnenvis.nic.in/files/THOOTHUKUDI%20.pdf

[2] Central Ground Water Board 2009. District ground water brochure Thoothukudi district, Tamil Nadu. Central Ground Water Board South Eastern Coastal Region, Chennai. Available at cgwb.gov.in/District_ Profile/ Tamil Nadu/Thoothukudi.pdf

[3] IMD, 2013.Temperature of Thoothukudi District. Regional Meteorological Centre, Chennai.

Key Finding - The average change of maximum and minimum temperature for Thoothukudi district are expected to increase by 2.8°C and 3.2°C respectively by the end of the century.

Climate of Thoothukudi - Rainfall

Thoothukudi depends mainly on Northeast monsoon rains, which are brought by the troughs of low pressure establishing in south Bay of Bengal. The average annual rainfall over the district varies from about 570 mm to 740 mm. It is the minimum around Arasadi (577.4 mm) and Thoothukudi (582.8 mm) in the central eastern part of the district. It gradually increases towards south, west and north and attains a maximum around Kayattar (722.5 mm) and Kovilpatti (734.8 mm) in the north western part.

Rainfall Projections for Thoothukudi

The annual rainfall normal (1970-2000) of Thoothukudi district is 655 mm.5 Projections of rainfall over Thoothukudi for the periods 2010-2040 (2020s), 2040-2070 (2050s) and 2070-2100 (2080s) with reference to the baseline (1970-2000) indicate an increase of 2.0%, 8.0% and 10.0% respectively.

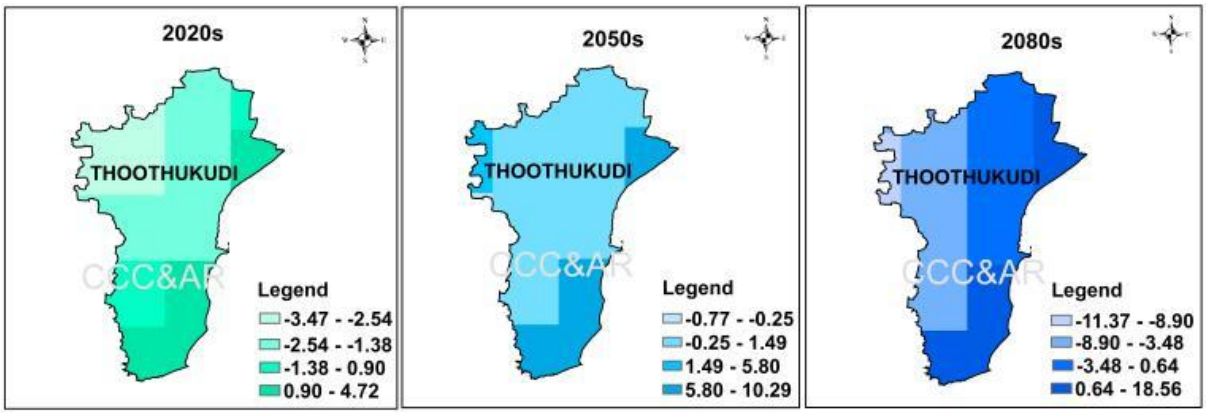


Fig - Percent change in Annual Rainfall for the period 2020s, 2050s and 2080s

Key Finding - The annual rainfall for Thoothukudi district may increase by 10.0% by the end of the century as per the emission scenario of A1B.

Climate Analysis - Effects of Sea Surface Temperature on Coral Reefs

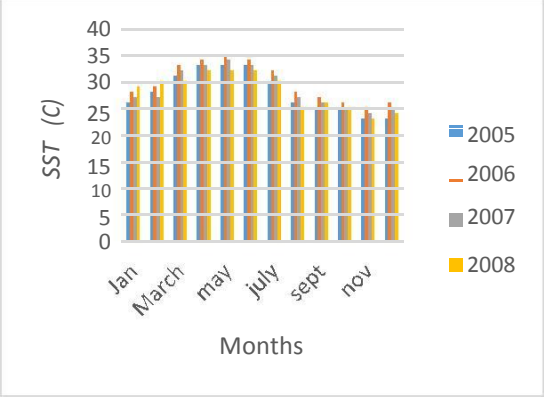
An intensive survey of the response of the corals to elevated temperatures in the Gulf of Mannar region was carried out. It was observed that the GoM region had experienced at least 99 days of elevated temperature during this study. The SST had risen to 3 °C above seasonal averages. This temperature rise correlated with the coral bleaching especially with the encrusting corals, which showed that 6.5% of the healthy corals were bleached in the event. It was also observed that with respect to 99 days of elevated temperature, 24.98% of the corals surveyed were pale, 41.26% were bleached, 23% were dead totaling the affected corals to 89.24% (Arthur, 2000).

Another instance of coral bleaching was observed by Joyson et al 2013, where the massive

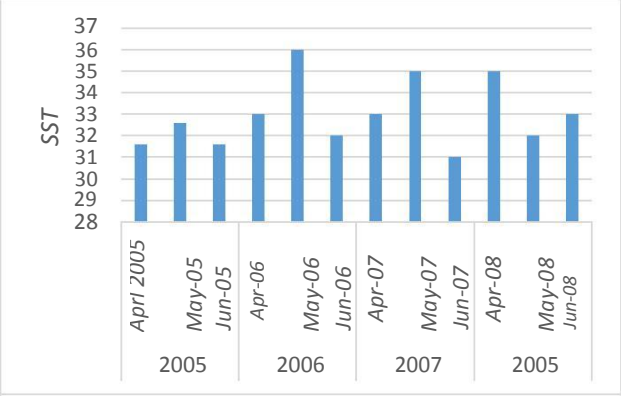
branching corals were affected by the SST increase. A sudden increase of temperature from 29.9 to above 30.9°C and persistence of temperature up to 31°C for seven weeks. Anomalies of mean SST showed great increase from 1 to 2.2° C with respect to the baseline period of 1950-1979. Prolonged existence of increased SST for nearly 50 days caused the corals to bleach. The mean SST has been increasing at a rate of 0.02°C/decade and along with 0.1°C rise per decade in minimum SST. This has led to a shift from coral to algal phase.

It is projected by Vivekanandan et al, 2009 that the annual average SST may increase by 3.0°C to 3.5°C in the Indian seas. The maximum SST in summer months may rise up to 34 ° C or more. Subsequently, the degree heating months greater than 2.5, which are indicators based on the coral threshold, may also increase. Given the implications that the reefs will not be able to sustain catastrophic events more than three times in a decade, reef building corals would lose dominance. It is projected that during the decade 2030-2040, the corals in the Gulf of Mannar may begin to decline and during the decade 2050-2060, the reef building corals would lose their dominance.

A study by J.K.P.Edward et al (2009) brought out that temperatures in the Gulf of Mannar are never below 26 ºC. Summer temperatures (April to June) varied between 31.0º C to 33.5ºC. Sea Surface temperature peaks during May (overall range 26.5 to 30.5ºC)

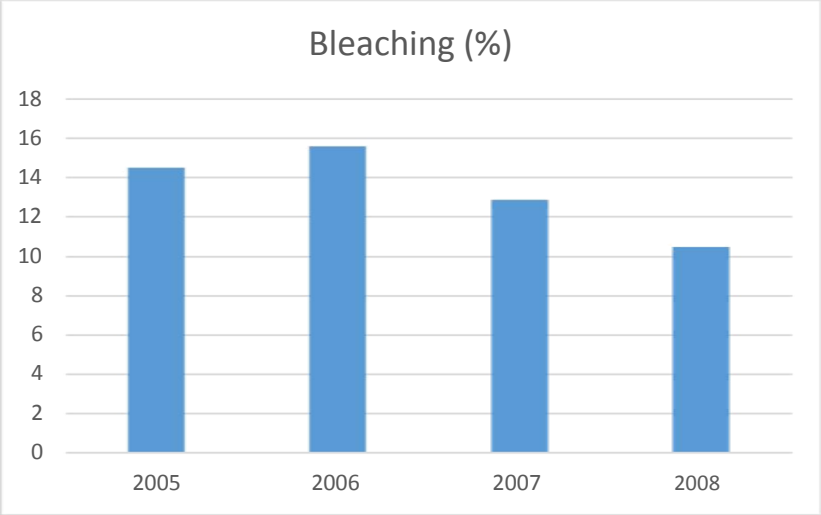


Sea Surface Temp. in summer (April, May & June



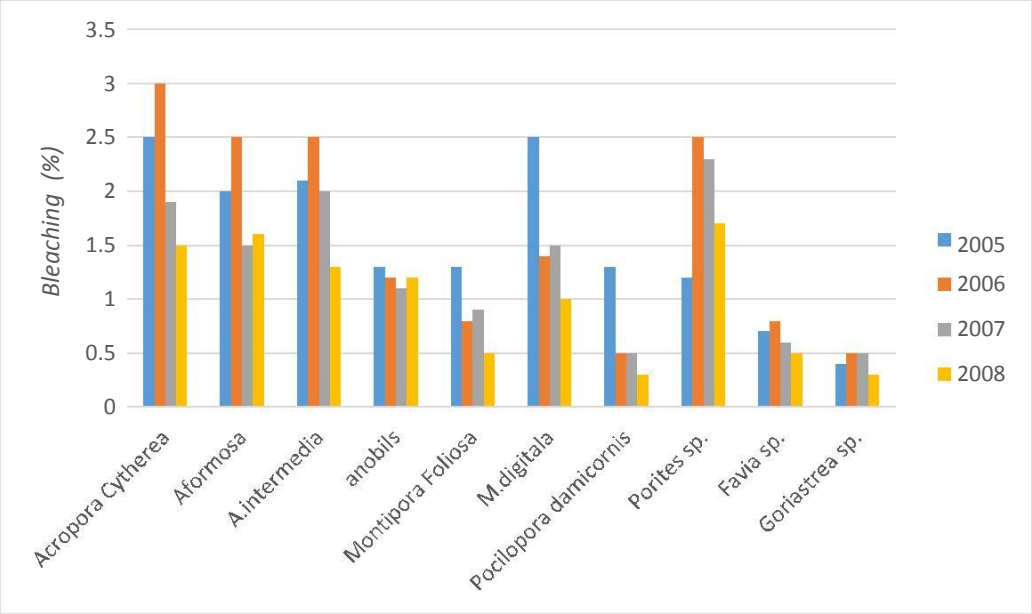
Average monthly SST values in the Gulf of Mannar during 2005 to 2008

Corals bleached every year since 2005 during summer starting from April. Average percentage of bleached corals was 15.6% during 2006, 14.6% in 2005, 12.9% in 2007 and 10.5% in 2008.



Percent of bleaching in summer (April, May and June)
during 2005 to 2008 in the Gulf of Mannar

Massive corals especially *Porites* sp. were the first to be affected and the other dominant coral species partially or fully bleached were *Acropora cytherea*, *A. formosa, A. intermedia, A. nobilis, M.foliosa, M. digitata* and *Pocillopora damicornis*. *A. Cytherea* bleached the most (2.91% during 2006) followed by *A. Formosa* with 2.55%. In 2005 the most affected species was *A. Cytherea* with 2.44% followed by *M. digitata* with 2.12%. In 2007, the highest affected was *Porites* sp. with 2.05% followed by *A. Cytherea* and *A. intermedia* and in 2008 it was *Porites* sp. with 1.75% followed by *A. Formosa* with 1.66%.



Percent of bleaching in common coral species in the Gulf of Mannar

Incidence of bleaching was not uniform every year in terms of area and depth, but the pattern was comparable. Depending on rainfall and winds, recovery began during June-July and was completed in 1-4 months. The branched corals recovered quickly after temperature reduction, but massive corals recovered slower. The fastest recovered coral size groups were 40-80 cm and 80-160 cm. There was no coral mortality in 4 years due to elevated SST, but

80% of the bleached recruits were dead in 2007 (J.K.P. Edward et al, 2009). The projected increases in ocean temperatures are expected to exacerbate the stressors already affecting many coral reefs, resulting in additional coral bleaching and mortality (Pockley, 2000; Hughes *et al.*, 2003; Pandolfi *et al.,* 2003). However, the reported annual bleaching in the Gulf of Mannar did not result in any appreciable mortality, maybe because the area has already been severely disturbed. In the Gulf of Mannar, corals tend to bleach when exposed to 2 to 3ºC elevated temperature level in late April every year. Hoegh-Guldberg (1999) predicted that mass bleaching could become an annual occurrence by 2020 in Southeast Asia and the Caribbean, by 2030 on the Great Barrier Reef and by 2040 in the central Pacific. This prediction is already reality in the Gulf of Mannar since the bleaching event happens every year in the same time since 2005.

Vulnerability of communities to climate change (and non-climatic stresses)

The Gulf of Mannar (GoM) coast between Thoothukudi and Rameswaram is heavily populated and over 100,000 traditional fisher folk depend on the reef associated fisheries outside the marine national park for their daily livelihood. Traditional fishermen who form the majority population along GoM have increased in number during the last decades. The loss of reef and seagrass habitats due to elevated temperature and other local stressors like destructive fishing activities, coral mining and pollution, several native fish species disappeared from the area, which in turn affected the livelihood of the dependent fisher folk. In 2004, SDMRI conducted a case study with the funding support from WWF-India on the "Effect of climate change on the loss of finfish, *Lactarius lactarius* fisheries and dependent fishermen in the

Gulf of Mannar (GoM)". The study revealed that increased water temperature and decreased rainfall, which generally flushes critical nutrients from the land into the GoM has contributed to a drastic decline of the economically important fishery over the last few years (Patterson and Samuel, 2004). The introduction of exotic seaweed, *Kappaphycus alvarezii* in South Palk Bay in Mandapam coast in 2005 without adequate environmental impact assessment facilitated its invasion into coral reef areas in the northern Islands (Shingle, Krusadai and Poomarichan) of GoM. It was observed in March 2011 that the exotic seaweed spreads over 1.24 km2 reef area in Krusadai Island. The most affected coral species are

Acropora nobilis, A. formosa, A. cytherea, Monipora digitata, M. foliosa and Porites lutea with coral colony sizes 20-160cm. Out of the total live coral area of 5.4 km2 in Krusadai Island in 2009, over 23% reef area are now fully covered and destroyed by *Kappaphycus*. The abundance of benthic communities and fish were significantly less in the affected sites than the non-affected site. The fishes, *Lujanus* sp., *Lethrinus* sp., *Siganus* sp., *Scarus* sp.,

Chaetodon sp., and *Upeneus* sp. (0.71 to 3.21 per 50 m2) were common in the non-affected reef area, while *Siganus* sp., *Chaetodon* sp. and *Upeneus* sp. were the only genera seen rarely (0 to 1.1 per 50 m2) in affected sites (Patterson et al., 2012).

iv. Project Location details – villages, block/ mandal, district.

Thoothukudi district has 163.5 km of coast line. Fishing and salt making are predominant activities in the district. Salt pans are quite prevalent in the coastal region. The district produces 70% of the total salt production of Tamil Nadu and with 30% of the National salt production, ranks second next to Gujarat. Coast sand is rich in mineral deposits of garnet, titanium, ilmenite, rutile, zircon etc. Thoothukudi harbour, is one of the major harbours in Southern India, the first to get ISO 9002 certification and it is the Southern Gateway of India. The district lies between 8º 19 and 9º 21 north latitude and between 77º 40 and 78º 10 east longitude and is bound on the north by Virudhunagar and Ramanathapuram districts, east by Gulf of Mannar, south and west by Tirunelveli district. The district is classified into seven Agro-Climatic sub zones viz., Chittar Plain, Tamirabarani Plain, Nanguneri Plain, Kovilpatti Plain, Teris, Tiruchendur Coast and Thoothukudi Coast.

The soil type prevailing in the district are red loam in Udangudi, Kayathar and Sattankulam Blocks, laterite soil in Srivaikuntam and Tiruchendur blocks, black soil in Kovilpatti, Kayathar, Thoothukudi, Vilathikulam and Ottapidaram blocks, sandy coastal alluvium in Tiruchendur block and red sandy soil in Udangudi, Sattankulam, Srivaikuntam, Karungulam.

The unique feature of the district is that three blocks of the district viz., Alwarthirunagari, Karungulam and Srivaikuntam are in the River Tamirabarani basin and irrigation-intensive crops like paddy and banana are being cultivated. The other nine blocks are totally rain fed and dry land crops like pulses, oilseeds and millets are being cultivated.

One of the district's major source of irrigation is the Tamirabarani Irrigation Channel, which is the major source of tank based irrigation. Silting and encroachments of feeder channels have resulted in poor storage. Over the years, bunds have weakened, resulting in erosion and run-off.

Gulf of Mannar Bio-sphere Reserve of Forest Department comes under this district.

Fisheries sector may be broadly divided into three sub-sectors, viz., Fresh Water, Marine & Brackish water depending upon the resources available in the district. Marine fisheries can be further classified into inshore, offshore and deep-sea depending on the depth of fishing operation. The exploitation of these resources are done either by capture (fishing) or culture. The district has a coastal length of 163.5 km and a network of fresh water and brackish water resources and hence offers potential for all major sub-sectors. The average annual marine fish catch for the district is 42000 MT. The share of inland fisheries was 5500 MT.

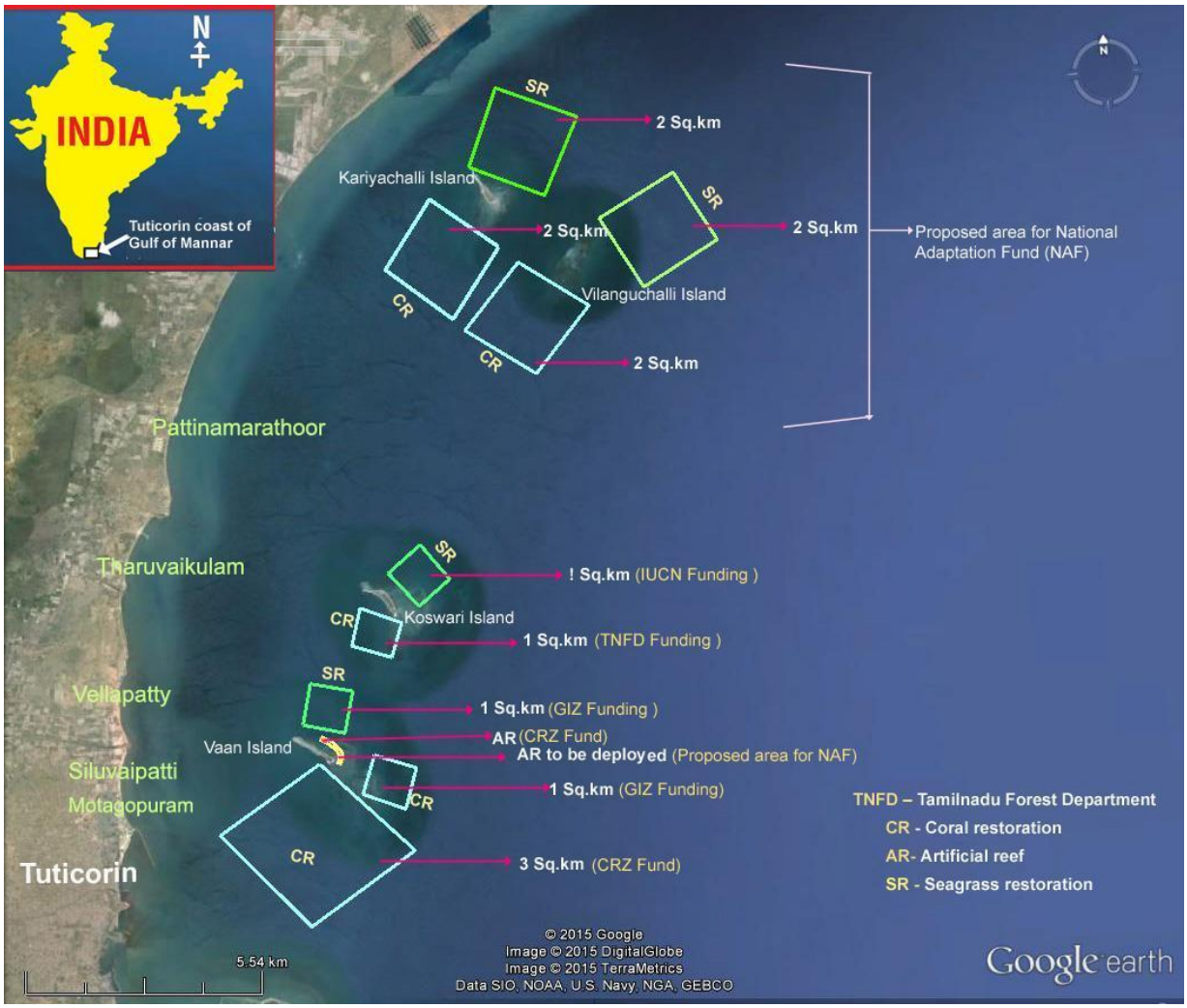
There is a steady growth in the ground level credit in fisheries sector. It was INR 1.12 crore, INR 2.61 crore and INR 3.41 crore in 2011-12, 2012-13 and 2013-14 respectively. A credit potential of INR 13166.03 lakh has been projected for Fisheries.

The district has 23 fisher folk villages. 42086 marine and 1478 inland fisher folk had enrolled in the fishermen Welfare Board. There are 25 Fishermen Co-operative Societies with membership of 30265 fishermen and 24 Fisherwomen Co-operative Societies with

membership of 18335 fisher women. There are 22 fishing centres in the eleven blocks of the district.

The River Thamirabarani stretches through the district up to a distance of 47 kms, providing water sources for 15 major irrigation tanks and 211 minor irrigational tanks. Besides, there are 10,127 tanks/ponds in the district. Kadamba Tank is the only tank, which is under the control of Fisheries Department with an area coverage of 667.30 ha. There are 3 Inland Fishermen co-operative Societies with membership of 1274 fishermen.

The district has one major Fishing harbour covering land area of 21 acre. For berthing the mechanised boats, an exclusive area of 2.7 acre had been allocated which can handle 400 boats and 50 nova. There are 448 mechanised boats, 2073 wooden vallams, 1606 FRP vallams, 2 FRP catamaran, 1020 catamaran in the district registered with Fisheries Department.



Map showing proposed area for NAF project and areas treated under earlier projects

There is a fish landing centre at Therespuram with an area coverage of 17 acre, which has one auction hall, two toilet blocks and one high mask light. However, the existing auction platforms are highly congested and lack hygiene. They require expansion and modernisation.

There are 3 freezing plants and 19 ice plants/cold storages and 23 seafood manufacturing units in the district. 10 sea food manufacturing units are EU approved units. Sea Food Exporters Association for Southern Region is located in the district.

Tuticorin district consists of 23 fishing villages which has a population of 17,50,176 (2011 census), with a male population of 8,65,021 and female population of 8,85,155.

In this project, a total of three islands at the Gulf of Mannar in Tamil Nadu i.e. Kariyachalli Island and Vilanguchalli Island for Coral and seagrass rehabilitation and Vaan Island (half submerged) for Artificial Reefs deployment is proposed.

The communities from the 5 villages in proximity to the three islands as stated, who are dependent on fisheries viz. Mottaikopuram, Siluvaipatti, Vellapatti, Tharuvaikulam and Pattinamaruthoor are the targeted villages to understand the impact of the activity in terms of adaptation to climate change, both in terms of livelihood generation and income enhancement among the community.

2. Mottaikopuram village has a population of 350 people with male female sex ratio at 1:1 and 100 active fishermen. This village has a total of 4 *Vallam* boats, 35 fibre boats and 8 non mechanised boats.
3. Siluvaipatti village has a population of 400 people with male female sex ratio at 1:1 and 159 active fishermen. The total number of boats in this village is 8 *Vallam*, 30 fibre boats, 4 non mechanized boats.
4. Vellapatti village has a population of 3000 people (1250 men; 1500 women) and 900 active fishermen. There are 50 fibre boats and 30 *Vallams*.
5. Tharuvaikulam has a population of 12,000 people with male female sex ratio at 1:1 and 3000 active fishermen. This village has 95 Trawls, 30 *Vallams*, and 1 FRP.
6. Pattinamaruthoor village has a population of 900 people with male female sex ratio at 1:1 and 300 active fishermen. There are 15 *Vallam*s, 5 fibre boats, and 7 non mechanised boats.

(The population data is according to the Census of India 2001)

1.2. Project / Programme Objectives:

The project proposes to have following activities under each objective:

Objective 1: To carry out a baseline study to asses vulnerability to climate change of both coastal ecosystems (including biodiversity and fishery) and coastal communities in the Gulf of Mannar

The baseline data will provide the basis for adaptation planning and implementation of the restoration and rehabilitation activities and the eco development activities. Specific tools will be used to carry out the baseline survey and assessment.

Activity 1.1: Survey and assessment of biodiversity to understand the current scenario and carry out an analysis and identify risks under climate change and the key challenges to be

addressed to implement this project activity in Ramanathapuram, Tuticorin, Kanyakumari and Tirunelveli districts. Although Suganthi Devadason Marine Research institute (SDMRI) has a database on biodiversity in the region and for corals in the year 2003-2005, however since this is now a decade old, hence needs to be done again.

Activity 1.2: Baseline survey to assess the current fishing patterns and pressure, based on which the sustainability of this activity can be projected and managed in Ramanathapuram, Tuticorin, Kanyakumari and Tirunalveli districts..

Activity 1.3: Survey for need assessment of the communities in terms of recommending and planning eco development activities and training programmes for alternate livelihoods in the identified project villages of Tuticorin district. Existing SHGs will also be consulted for this need based study to analyze the success and failure of activities conducted earlier, which will serve as learning for this assignment.

Objective 2: To restore Habitats (Coral reef and seagrass rehabilitation) in Kariyachalli and Vilanguchalli Islands as a climate adaptation strategy.

Baseline Scenario: Currently, the islands are facing severe threats from increased human disturbances leading to erosion and submergence. This leads to habitat loss and poses a threat to the associated fish resources. Coral reefs exposed to temperatures of more than $30^{O}C$ will decolour or bleach. If corals are exposed to such temperatures for 2-3 weeks and then temperature gets lower the bleaching would not be permanent. If on the other hand the corals are exposed to high temperatures for a longer duration of time the bleaching would be permanent and such corals will eventually die.

A. Coral Rehabilitation

Activity 2.1.1: The rehabilitation site/s will be selected by underwater survey. Low tech and low cost transplantation techniques will be followed. The concrete frames [1m X 1m X 0.25m] were found most suitable based on the stability of the substrate and fast attachment of fragments on the substrate (Patterson et al. 2005; Patterson et al., 2006). The substrates will be deployed in the identified degraded area in clusters of concrete frames (each cluster will have 10-15 concrete frames) covering the required project area.

Activity 2.1.2: The coral fragments (8 - 11 cm size) identified native coral species will be precisely cut at the nearby donor reefs with the maximum of 3-5% of the colony size and tied with cement slabs (20 cm x 5 cm x 1.5 cm), and tied firmly using nylon rope and then tied on the cement frames, which have already deployed. Due precision and care will be taken during fragmentation and transportation of fragments from donor site and fixing (vertical / horizontal) with substrates. Different native species of corals will be transplanted to facilitate heterogeneity in the rehabilitation site. In order to encourage regeneration of highly endangered coral species in Gulf of Mannar, a minimum of 15% of endangered / threatened species will be preferred in the restoration site. To study the sedimentation rate

in the restoration sites, sedimentation traps will be placed. Branching and non-branching coral species, preferably resistant and resilient species / colonies to elevated SST will be used. Activity 2.1.3: Regular monthly monitoring will be carried out to study the survival and growth of the transplanted fragments and community structure at the rehabilitated areas. To study the sedimentation rate in the restoration sites, sedimentation traps will be placed. Contribution to climate resilience: The rehabilitated reefs will not only increase the biodiversity in the area, but will also protect the islands from coastal erosion and submergence due to sea level rise. Further, these areas will provide sustained livelihoods for fishermen.

The Substrate, Concrete frames

Cement slabs

Transportation and deployment of substrates using raft

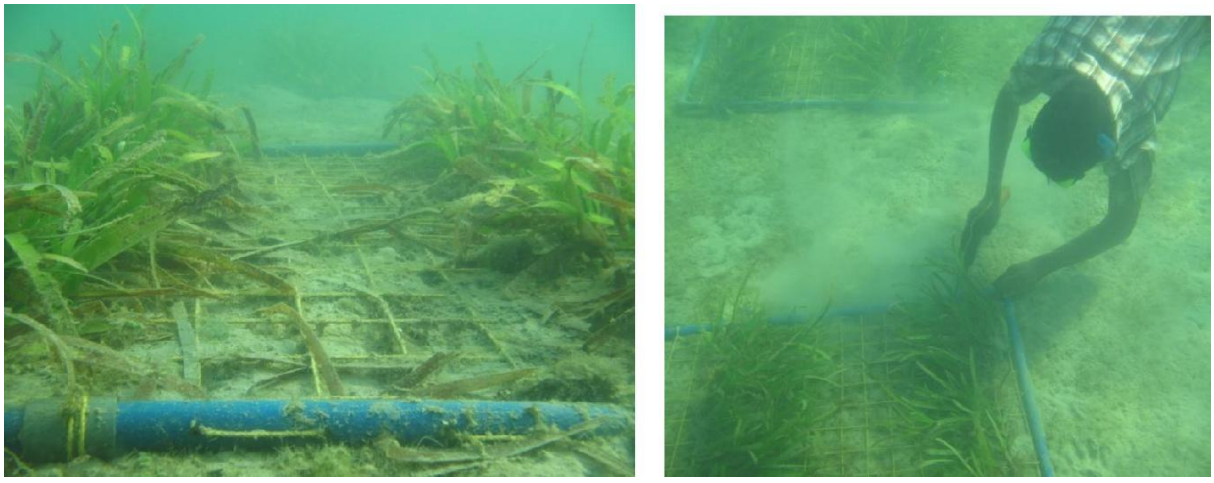
Transportation cement slabs tied with coral fragments for placing on substrates

Placing of slabs with fixed coral fragments on the concrete frames

B. Seagrass Rehabilitation: Currently, seagrass is also diminishing in these areas owing to bottom trawling activities where the entire sea bed is swept away. Loss of seagrass forces fish and other species to migrate or diminish in numbers.

Activity 2.2.1: A low cost, low tech and suitable method for the environmental conditions of Gulf of Mannar i.e. Sprigs method (Quadrate method) as described by Calumpong and Fonseca (2001) will be adopted. In this connection, SDMRI has tried several (three) methods through its pilot scale research and found the quadrate method as most successful in terms of cost, stability, growth and survival.

Activity 2.2.2: Regular monthly monitoring will be carried out to study the survival and growth of the transplanted seagrass and community structure at the rehabilitated areas. Contribution to climate resilience: The rehabilitation of seagrass ensures habitat creation for several corals, fish and associated species which will lead to protection of islands against the impacts of climate change.



Fixing of Seagrass to frames

Objective 3: To build climate change resilience to the fast eroding Vaan Island through deployment of artificial reef modules

While this method is practiced for several purposes such as fishing and recreational activities, in this instance it will be carried out only for the purpose of rehabilitation and as a climate change adaptation measure, focusing mainly to protect the island.

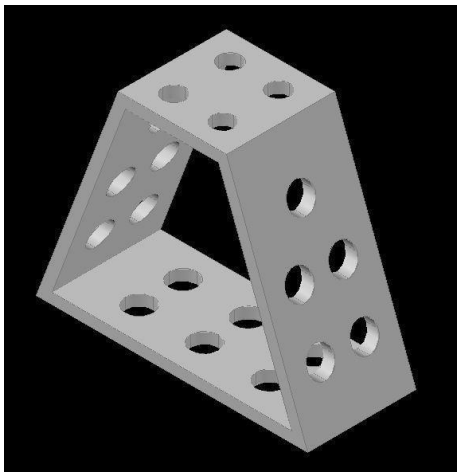
Activity 3.1: Construction of 6000 Nos. Artificial Reef modules (each size 2.5m width, 2m height and 1 m longitudinal length) with Ferro-cement and reinforcement steel, in identified premises

Activity 3.2 : Deployment of 2 layers in a zigzag (staggered) of AR units with a gap of 25m around 250m from the periphery of Vaan island so as to form a staggered curve approximating a near circular curve. The protection structures will be submerged for a width of 20m and a height of 2m. The depth of submergence will be up to the top level of the units. This deployment will be to reduce the wave intensity.

Once the deployment has been carried out biodiversity in the area will flourish. The activity will also lead to a year around opportunity for fishing for the fishermen community. This will attract coral larvae which would get attached to this substratum and grow.

This process has about 80% of success rate. It helps in coastal rehabilitation as it acts as a habitat for both corals & fishes. The process of Artificial Reef deployment is easy for new people to pick-up and implement. As it is a cost effective measure other measures like sea-walls is not considered.

Contribution to climate resilience: The artificial reefs will not only increase the biodiversity in the area, but will also protect the islands from erosion and submergence due to sea level rise. Further, these areas will provide sustained livelihoods for fishermen.



3D view AR module

Construction of AR module under TNSCZMA funding

Objective 4: To promote Eco development activities among coastal communities to enhance their adaptive capacity and to sustain livelihood and food security

Activity 4.1: SHG related activities which will include areas such as micro-credit provision, revolving funds, SHGs nurturing wherein alternate livelihood opportunities will be generated for the communities.

Activity 4.1.1 - Conservation of marine ecosystem through awareness creation SHGs
Activity 4.1.2 - Reviving and nurturing SHGs
Activity 4.1.3 - Issuing SHG loans to fishermen

Activity 4.1.4 - Construction of community hall and multipurpose training centre for SHGs
Activity 4.1.5 - Training to SHG members on sea weed culture and creating an awareness on its importance on maintaining biodiversity and adaptation to climate change.

Activity 4.1.6 - Engaging the women and SHGs / JLGs in ecotourism and other related activities to compensate for the loss in income due to sea weed generation and also prevent them to collect sea weeds in an illegal manner. Eco tourism activities such as snorkelling, boating etc.

Activity 4.1.7 - Imparting local specific skill up gradation training to fisherwomen SHG members. (i.e. Tailoring, embroidery, etc.)

Activity 4.2 - Imparting vocational training to fisher folk youth
Activity 4.3 - Biodiversity training

Activity 4.4 - Improvement of major and minor fish landing shelter in the 5 villages
Activity 4.5 - Construction of interpretation centre to carry out dissemination of information regarding GoM.

Activity 4.6 - Mud crab fattening/ culture- Mud crab seeds are not readily available hence it has not gained popularity. If the seeds are made available through CMFRI, this intervention could turn into a profitable enterprise. The villagers have also evinced in taking up this activity. The value of molted crab at present is INR 20-50 KG^{-1}. About 2-3 weeks of value-addition activities would convert these crabs to fully developed crabs with hard shells which

would earn on an average about INR 200-300 KG^{-1} and a maximum of about INR 600-800 KG^{-1}.

Activity 4.7 - Marine ornamental fish breeding for Scuttle Fish, Parrot Fish, Clown Fish, Sea Bass, etc. since this enterprise is very popular

Activity 4.8 - Rearing Cobia fish 300-500 MT inside the sea from the shore as cage culture is a profitable venture which can be promoted among the fisher folk.

Activity 4.9 - Shrimps farming is done by farmers and not by traditional fishermen as the fisherman community does not have cultivable land. It is a lot difficult to obtain the licenses for shrimps farming in an area of more than 5 Ha as there is a lot of paperwork is involved. In Tuticorin area, only two big entrepreneurs are actually doing business as against 10 issued licenses. This activity can be promoted with co-operation from the Fisheries and also with buyback arrangements.

1.3. Details of Project/ Programme Executing Entity:

i. Name, Registration No. & Date, Registered Address, Project Office Address (for the proposed project)

Director,

Dept. of Environment

Government of Tamil Nadu, Panagal Maligai (Ground Floor),
No.1, Jeenis Road, Saidapet, Chennai – 600 015

Phone: 044 - 24336421, 24336928, Fax : 044 – 24336594

A project office will be established in the headquarters of Tuticorin district wherein a Project Management Unit will be set up to facilitate the activity at field level.

The executing agency is the Department of Environment, Government of Tamil Nadu under the State Steering Committee for Climate Change. Realizing the importance of the role of State government initiatives on climate change and in line with India's National Action Plan on Climate Change, Department of Environment (DoE), Government of Tamil Nadu has established a Climate Change Cell herein referred as Tamil Nadu State Climate Change Cell (TNSCCC) on 1st December, 2014. The cell provides the central focus for Tamil Nadu State Government's climate change related initiatives and activities, operating as a unit of the DOE, Government of Tamil Nadu.

Through the TNSCCC the DoE collects, collates and disseminates climate change information pertaining to Tamil Nadu State to various stakeholders ranging from farmers, fishermen, general public to policy planners, decision makers, bureaucrats and others in order to enable effective climate change governance and climate change services.

The main objective of TNSCCC is to:

(a) Enhance effective climate change governance;

(b) Facilitate effective climate change services to various stakeholders of Tamil Nadu state.

For more information log on to http://tnsccc.in/

ii. Available technical manpower for the proposed project implementation:

The technical support required for the baseline study on coastal habitat (coral reef and seagrass beds) and associated biodiversity; rehabilitation (coral and seagrass rehabilitation) and deployment of artificial reef modules and monitoring would be provided by

- Tamil Nadu Forest Department
- Suganthi Devadason Marine Research Institute (SDMRI)[4] , located at 44-Beach Road, Tuticorin – 628 001, Tamil Nadu (www.sdmri.in).

The technical support required for the baseline study on fishery including fishing pressure, catch per unit effort and study on the optimum fishing pressure would be provided by o Tamil Nadu Forest Department

- Tamil Nadu Fisheries University
- Central Marine Fisheries Research Institute

The technical support required for the baseline study on coastal mangrove habitats, coastal forest cover and associated biodiversity would be provided by

- Tamil Nadu Forest Department

The technical support for the eco development activities including capacity building training on livelihood schemes suitable to each village, options to introduce marine eco-tourism would be provided by the Gulf of Mannar Biosphere Reserve Trust (GOMBRT), Ramanathapuram. GOMBRT was established in 2002 by the Govt. of Tamil Nadu and the Chief Secretary to Govt. of Tamil Nadu as its Board Chairman. GOMBRT was established to implement the GEF-UNDP project and after the completion of the project from 01.01.2013, Govt. of Tamil Nadu has taken over the trust. Standardised Coral and seagrass rehabilitation techniques are available.

- Artificial reefs design and deployment locations are available as suggested by IIT Madras
- For the overall management and coordination of the project the TNCCC has adequate staff with Director and Additional Director to supervise and support staff like Assistant Engineers and Programme Officers.
- To coordinate the project at field level, a project monitoring unit will be set up for 3 Managers / Scientists and support project staff shall be recruited.

[4] SDMRI is a Marine Research and Higher Education organization, established in 1998 and recognized by the Manonmaniam Sundaranar University, Govt. of Tamil Nadu as "Research Centre" in 2000. The University Grants Commission (UGC) of Govt. Of India recognized SDMRI to receive Central Assistance and to teach up to Ph.D. level. SDMRI developed baseline data for coral reefs in Gulf of Mannar during 2003-2005; standardized coral rehabilitation techniques during 2002-2005; successfully rehabilitated over 8 Km2 degraded reef areas; standardized seagrass rehabilitation in 2008; implemented Artificial Reef programme and monitoring in 2003; and started PADI accredited SCUBA diving training in 2010.

iii. Three largest Climate Change Adaptation Projects handled (if already implemented)

The Department of Environment is the nodal agency for coordinating the activities. Though projects on climate change adaptation have not been fully handled since the TNSCC has been recently established, however it has the adequate skills and resources to implement the programme as discussed in section (b). Some of the projects taken up by the Government and other partner institutions on Climate Change adaptation are:

- The Suganthi Devadason Marine Research Institute has standardized the rehabilitation techniques with the funding support from MoEF&CC during 2002-2005 and has carried out the work. For corals, baseline data has been collected during 2003-2005.
- GIZ has implemented a demonstration project and conducted coral rehabilitation work in 1 km^2 area and seagrass rehabilitation in 1 km^2 area.
- IUCN has implemented seagrass rehabilitation work in 1 km^2 area.
- A pilot scale project sanctioned by the Tamil Nadu State Coastal Zone Management Authority is in progress to protect Vaan Island from erosion. A total of 10,600 AR modules are required, but only 705 modules were sanctioned in the pilot project.

The projects implemented as described above have been summarized in the table below to indicate the funding utilized toward implementation of these projects.

S. No.	Funding Agency	Focus Area	Project area	Funding utilized (INR Lakhs)
1	GIZ	Pilot demonstration project on coral reef and seagrass rehabilitation	Vaan Island(1.0 km2 area coral rehabilitation and 1.0Km2 area seagrass rehabilitation) , Tuticorin coast	34
2	IUCN	Seagrass assessment and rehabilitation	Near Koswari Island (1.0. Km2 area), Tuticorin coast	16.5
3	TN state coastal zone management authority	Artificial reef deployment for protection of Vaan Island	Vaan Island (3.0. Km2 area coral rehabilitation & a total of 705 Nos AR modules) , Tuticorin coast	187
4	MoEFCC, through the State	Coral rehabilitation in the degraded reef areas	6 islands (0.5 km area each), Gulf of Mannar	40

	Forest Department under Conservation Management of Coral reef Scheme (2008 - 2014)	around islands in Gulf of Mannar Marine National Park	with less number of substrates	

However, the projects have not focused on the work proposed in this report such as assessment of vulnerability to climate change of coastal resources and communities, climate adaptation strategy and building climate resilience. Further, only a few baseline studies have been done in the area between Rameswaram and Tuticorin and Coral rehabilitation was carried out in a small 1 km^2 area. The area proposed for the present project (Kariyachalli and Vilanguchalli Islands) for coral and seagrass rehabilitation has not been taken up for any work earlier.

iv. Three largest community based NRM based projects handled

Integrated Watershed Management Programme (IWMP) – To promote balanced use of Natural Resources and Livelihood by Watershed approach and efficient watershed management by mobilizing social capital for restoring ecological balance by harnessing, conserving and developing national resources the Integrated Watershed Management Programme (IWMP) was developed.

The watershed Development Programmes under IWMP 2009-10 is being implemented in 24 districts f Tamil Nadu from 2009-10 onwards. The share of the Central and State funding pattern is 90:10. The area proposed to be treated will be covered in 544 watersheds. With a target of INR 1,237.80 crore till 2015-16, the expenditure incurred up to the reported month stands at INR 521.41 crore.

Tamil Nadu Afforestation Project (Phase-II) - In order to uplift the quality of life of the forest dependants and poorer sections of the society and to restore the degraded forests through their participation, a massive Joint Forest Management based Tamil Nadu Afforestation Project-II was implemented at a cost of Rs.567.42 crore, with funding from the Japan International Cooperation Agency (JICA) since 2005-06. From 2005-06 to 2012-13, afforestation works were taken up over an extent of 1,77,500 hectares of degraded forests besides carrying out developmental works in 800 forest fringe villages including 150 tribal villages.

JICA Funds - A two year plan has been conceptualized for about Rs.50 crore to ensure sustainability of the project activities by utilizing the balance loan amount available under Tamil Nadu Afforestation Project Phase-II.

State Funds - Maintenance of plantations and soil moisture conservation works in TAP Phase–I areas were carried out at a cost of Rs.27.34 crore under TAP Phase-II during 2011-12 and 2012-13. During 2013-14, the scheme was implemented at a cost of Rs.12.28 crore. This scheme will be continued during 2014-15.

Establishment of permanent water storage structures in the forests and in the adjacent non forest areas. Construction of percolation tanks, check dams, catch water pits, rainwater harvesting structures involving a total outlay of Rs. 439.30 crore.

v. Three largest Climate Change Adaptation / NRM projects of State / Central Government

Tamil Nadu Biodiversity Conservation and Greening Project (TBGP) - An externally aided

'Tamil Nadu Biodiversity Conservation and Greening Project' at an outlay of Rs. 686 crore is under implementation from 2011-12, which will continue till 2018-19. This project focuses on biodiversity conservation through forest protection and socio-economic development of forest fringe villagers and tribal communities. It will also help to continue the State's efforts in increasing tree cover outside forests by taking up tree cultivation in private lands. During 2013-14, the project was implemented at an outlay of Rs.96.80 crore. This scheme is being continued in 2014-15 with an outlay of Rs.143.69 crore.

The GEF-UNDP programme has in collaboration with Tamil Nadu State Government implemented a project titled "Conservation and sustainable use of Gulf of Mannar Biosphere Reserve's coastal bio-diversity" during 2002-2012, the four important thrust areas of the project are as follows:

- Strengthening the capacity and infrastructure of the Gulf of Mannar Marine National Park for its enhanced conservation and management.
- Base line research and monitoring on key ecological, biological, environmental and management aspect of Gulf of Mannar Biosphere Reserve.
- Building capacity of various groups of stakeholders

Eliciting local community's participation in conservation and sustainable marine resource use through building awareness, capacity and skill, organizing local communities at the grass route level, empowering the communities to take judicious decisions for adopting alternate / enhanced livelihood options and to bring down the pressure on the fisheries resources.

S. No.	Funding Agency	Focus Area	Project area	Funding utilized (INR Lakhs)
1	GEF - UNDP	Biodiversity conservation in Gulf of Mannar for sustainable livelihood	Ramanathapuram and Tuticorin, more focus on Ramanathapuram	3500

vi. Comment of availability of suitable infrastructure for implementation proposed projects (vehicles, computers, required software/ tools, etc.)

Vehicles – 4, Computers – 5, required software/tools: Not available

vii. Whether Executing Entity (EE) was blacklisted, barred from implementation of projects, faced any charges / legal cases related to mismanagement of project and funds. (Please list any such incidences and reasons):

No

1.4. Project / Programme Components and Financing:

S. No.	Project/Programme Components	Expected Concrete Outputs	Expected Outcomes	Amount (Rs)
1.0	Baseline study on vulnerability to climate change of coastal ecosystems (including biodiversity and fishery) and coastal communities covering an area of 364.9 km coast line (from shore up to 10 km towards marine zone)	• Data Collection of present status of coastal habitats (Coral reefs, seagrass beds and mangroves) and associated biodiversity information (diversity, distribution and abundance) and threats for better conservation and management for sustainable utilization • Data compilation and analysis for complete understanding and of current fishing patterns, using formula based approach to arrive at Catch per Unit effort and the optimum fishing pressure. • Data compilation and analysis for complete understanding on socio economic and biophysical vulnerability to climate change. • Socio economic vulnerability of fishermen and other coastal communities mapped in the study site. • Key livelihood issues and biodiversity threat is mapped	• Vulnerability of ecosystems (biodiversity and fisheries) to climate change completely mapped for first time. • Vulnerability and challenges faced by the fishing patterns followed currently. • Roadmap for sustainable fisheries management	90,00,000
2.0	Coral Rehabilitation in 4.0 sq. kms (each island	• Substrates with transplanted native species of corals in clusters	• Enhancement of live coral cover to	1,10,00,000

	with 2 sq. kms) degraded reef area	of concrete frames deployed in the project area. • Regeneration of native and highly endangered coral species (15%) in the restoration sites	as well as provide habitat for fishes & other diverse species • Improved adaptation measure to climate change impacts & erosion	
3.0	Seagrass Rehabilitation in 4.0 sq. kms (each island with 2 sq. kms) degraded seagrass area	• Fixed PVC frames with transplant units of seagrass in the project area. • Growth & establishment of transplanted seagrass & community structure in the rehabilitated area	• Enhancement of live coral cover to as well as provide habitat for fishes & other diverse species • Improved adaptation measure to climate change impacts & erosion	70,00,000
4.0	Artificial Reef deployment in semi-circular form around Vaan Island	• Deployment of 6000 nos. (each of 2.5m width, 2m height and 1m longitudinal length) of substrate made of Ferro-cement and reinforcement steel	• Protection from erosion and submergence due to seal level rise • Provide habitat for fishes & other diverse species • Improved adaptation measure to climate change impacts	12,60,00,000
5.0	Eco-development activities in 23 coastal villages	• Adoption of alternative livelihood activities so as to reduce dependence on catch fisheries • Promotion of Eco-tourism	• Coastal community adapting effectively to overcome climate change impacts	7,20,00,000
	Project/Programme Execution cost			22,50,00,000
6.0	Project Execution Cost (Capacity Building, M&E	• Timely implementation of the project interventions	• Monitoring and Evaluation	1,52,00,000

	Cost and Project Cycle Management Fee charged by the Implementing Entity)			
7.0	NABARD Fee			72,06,000
8.0	Total Project Cost			24,74,06,000
	Amount of Financing Required			24,74,06,000

1.5. Projected Calendar:

Indicate the dates of the following milestones for the proposed project/programme (projects which have four or more than four years of implementation period would require to have mid-term review after two years of implementation).

Milestone	Date
Project Start Date	01 January 2016
Completion of First Annual Cycle	31 December 2016
Completion of Second Annual Cycle	31 December 2017
Midterm Review	June 2017
Completion of Third Annual Cycle	31 December 2018
Completion of Fourth Annual Cycle	31 December 2019
Final Review	January 2020

2. Project Justification

a) Component-wise details and justification of the project components

i. What is the business-as-usual development for the targeted sector?

In the early 1970s, it was estimated that the exploitation of corals was about 60,000 cubic meters (about 25,000 metric tons) per annum from Palk Bay and Gulf of Mannar, combined (Mahadevan and Nayar, 1972). In 2001, the Union Government included all Scleractinan, Antipatharian, Millipora sp., Gorgonians and Tubipora under schedule I of the Wildlife (Protection) Act, 1972. In 2005, honourable Supreme Court stayed the coral mining activities. As a result of various conservation and protection measures, the coral mining was completely stopped in Gulf of Mannar since 2005. The Indian Ocean tsunami in December 2004 has also helped in creating awareness among the local fishermen community about the role of coral reefs and islands in coastal protection.

Due to the 3-4 decade long coral mining activity until the year 2005, the Gulf of Mannar lost about 32 $km^2$of reef areas. However, there has been an increase in live coral cover from 37% in 2005 to 43% in 2009, possibly due to a reduction in human disturbance in the area, in particular due to a complete halt on coral mining, in combination with high recruitment rates and proper enforcement of law.

The State so far does not have any programme or scheme for Coral Reef & Seagrass Rehabilitation and neither does it have for Artificial Reef development. Although several livelihood interventions have been targeted towards fisher folk residing in the 23 coastal villages of Tuticorin district through Government programmes, the adoption rate for alternative livelihood activities has not been to the extent to counter the effects of climate change. This project therefore proposes to rehabilitate coral reef and seagrass which will provide the apt ecosystem for fisheries development. Further, the eco development activities proposed for the communities dependent on catch fisheries in the project area, will facilitate adoption of alternative / supplementary livelihoods and make them climate resilient.

ii. What are the specific adaptation activities to be implemented to reduce the climate change vulnerability compared to the business-as-usual situation?

Exposure

The project area is facing increased climatic stress such as increase in sea surface temperature in Gulf of Mannar region (Kumaraguru et al., 2003, Patterson et al., 2008 and Patterson et al., 2012).

Sensitivity

- Coral reef is very sensitive to temperature increase. Corals live in environments that are close to their thermal threshold (the upper temperature limit for life), and even

temperature increases of 1 or 2ºC above average over a sustained period of time (i.e. a month) can cause mass bleaching (Hoegh-Guldberg, 1999).

- The community's sensitivity is the fact that they do not have an alternative livelihood source. The loss of reef and seagrass habitats due to elevated temperature and other human interferences, have led to several native fish species disappearing from the region. The rehabilitation would bring back the habitat structure as well fishery production through providing adaptive environmental mechanism.

Adaptive capacity

- Carrying out need based assessment study for taking up eco-development activities
- Awareness creation on the effects on climate change on livelihoods
- Focused income generation programmes, training and capacity building for women and other vulnerable groups on alternate income generation activities, ecotourism activities, maintenance of Marine Aquarium and Interpretation Centre etc.
- Increased livelihood benefits from ecosystem restoration
- Role of community in project implementation such as coral reef rehabilitation, sea grass transplantation
- Making ecosystem resilient to climate change impacts

Specific Objective 1: To carry out a baseline study to asses vulnerability to climate change of both coastal ecosystems (including biodiversity and fishery) and coastal communities in the Gulf of Mannar

Baseline Scenario: The Suganthi Devadason Marine Research institute (SDMRI) has created a database on biodiversity in the region and for corals in the year 2003-2005, which is more than a decade ago. However, a more recent survey and assessment to understand the current scenario carry out an analysis and identify risks under climate change and key challenges will be required to implement this project activity.

Activity No.	Baseline Survey Component / Activity	Methodology / Tools to be used for the survey	Area
1.1	Biodiversity Assessment	• Scuba diving for primary data • GIS / Remote Sensing data • Line Intercept Transect (LIT) method following English et al., (1997) for coral assessment • Saito and Atobe (1970) for Seagrass assessment • Mangrove assessment will be conducted by following the Transect Line Plots method of English et al, (199&)	Ramanathapuram, Tuticorin, Kanyakumari and Tirunalveli

1.2	Assessment of fishing pressure	• Underwater fish density and diversity will be assessed by visual census applying Belt Transect method (English et al., 1997) • Fish landing data will be collected by following the method of Srinath et al., (2005)	Ramanathapuram, Tuticorin, Kanyakumari and Tirunalveli
1.3	Need assessment of the communities	• Questionnaires • Focussed Group Discussions • Interviews	23 fishing villages of Tuticorin

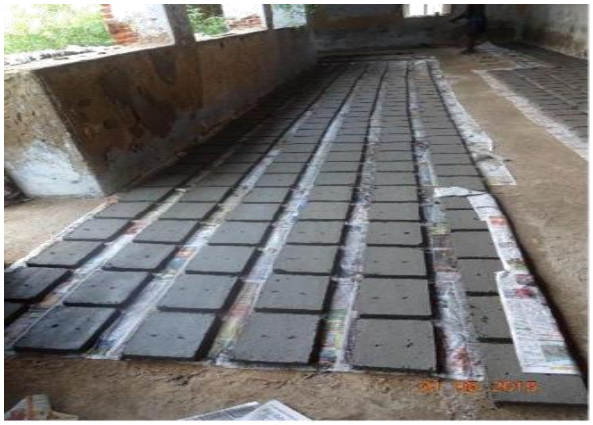
Adaptation Activities: The baseline data will provide the basis for planning and implementation of the restoration and rehabilitation activities and the eco development activities

Objective 2: To restore Habitats (Coral reef and seagrass rehabilitation) in Kariyachalli and Vilanguchalli Islands as a climate adaptation strategy.

Baseline Scenario: Currently, the islands are facing severe threats from increased human disturbances leading to erosion and submergence. This leads to habitat loss and poses a threat to the associated fish resources.

Activity No.	Rehabilitation Component / Activity	Methodology / Tools to be used for the survey	Area
2.1.1	Coral Rehabilitation Site/s selection by underwater survey and deployment of substrates.	Low tech and low cost transplantation techniques will be followed. The concrete frames [1m X 1m X 0.25m] were found most suitable based on the stability of the substrate and fast attachment of fragments on the substrate (Patterson et al. 2005; Patterson et al., 2006). The substrates will be deployed in clusters of concrete frames (each cluster will have 10-15 concrete frames)	Kariyachalli and Vilanguchalli Islands
2.1.2	Identification & cutting of coral fragments and tying to cement slabs,	The coral fragments (8 - 11 cm size) identified native coral species will be precisely cut at the nearby donor reefs with the maximum of 3-5% of the colony size and	

	transportation and tying to cement frames (substrates) already deployed	tied with cement slabs (20 cm x 5 cm x 1.5 cm), and tied firmly using nylon rope and then tied on the cement frames, which have already deployed. Due precision and care will be taken during fragmentation and transportation of fragments from donor site and fixing (vertical / horizontal) with substrates. Different native species of corals will be transplanted to facilitate heterogeneity in the rehabilitation site. In order to encourage regeneration of highly endangered coral species in Gulf of Mannar, a minimum of 15% of endangered / threatened species will be preferred in the restoration site. To study the sedimentation rate in the restoration sites, sedimentation traps will be placed. Branching and non-branching coral species, preferably resistant and resilient species / colonies to elevated SST will be used.	
2.1.3	Regular monthly monitoring	Study the survival and growth of the transplanted fragments and community structure at the rehabilitated areas. Study the sedimentation rate in the restoration sites, sedimentation traps will be placed.	
2.2.1	Seagrass transplantation through Sprigs method (Quadrate method) as described by Calumpong and Fonseca (2001)	Transplant units are selectively removed from the donor seagrass bed by hand. Then planted by being anchored / secured into the sediment or unanchored, singly or in units of multiple rhizome locations	
2.2.2	Regular monthly monitoring	Study the survival and growth of the transplanted seagrass and community structure at the rehabilitated areas	




Preparation of Slabs

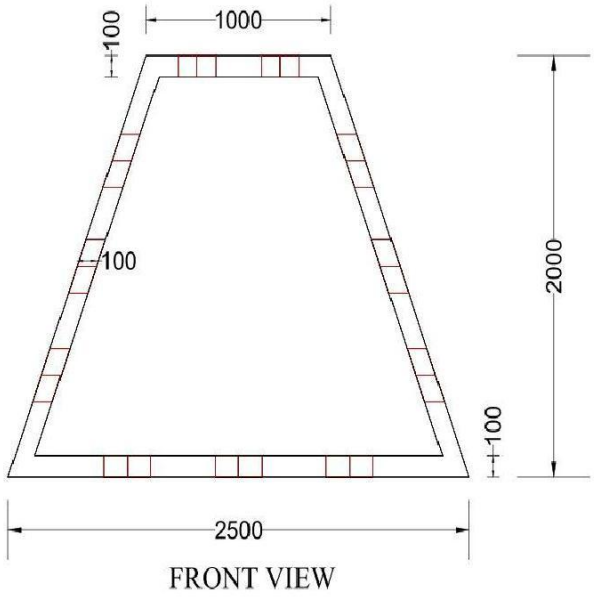

Substrate frames

Substrate

Specific Objective 3: To build climate change resilience to the fast eroding Vaan Island through deployment of artificial reef (AR) modules

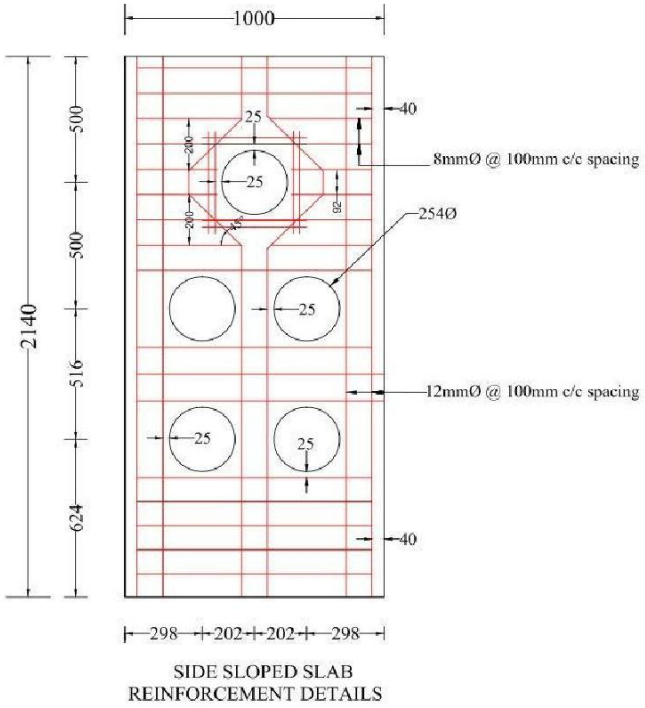
Baseline Scenario: Currently, the islands are facing severe threats from increased human disturbances leading to erosion and submergences. Northern part of the Vaan Island has submerged.

Activity No.	Adaptation Component / Activity	Methodology / Tools to be used for the survey	Area
3.1	Construction of Artificial Reef Modules in identified premises	6000 Nos. Artificial Reef modules (each size 2.5m width, 2m height and 1 m longitudinal length) with Ferro-cement and reinforcement steel	Vaan Island
3.2	Deployment of AR units in modules	2 layers in a zigzag (staggered) of AR units with a gap of 25m around 250m from the periphery of Vaan island so as to form a continuous curve approximating a near circular curve. The protection structures will be submerged width of 20m and a height of 2m. The depth of submergence up to the top level of the units. This deployment will be to reduce the wave intensity.	Vaan Island
3.3	Regular monthly monitoring	• For any damages or shifting • Study the change in biodiversity Change in fish recruitment • Attraction of coral larvae which would get attached to this substratum and grow.	Vaan Island



Artificial module – Section view

(All dimensions are in MM)



Reinforcement details of Artificial Module

Adaptation Activities: This process has about 80% of success rate. It helps in coastal rehabilitation as it acts as a habitat for both corals & fishes. The process of Artificial Reef deployment is easy for new people to pick-up and implement. As it is a cost effective measure other measures like sea-walls is not considered.

Specific Objective 4: To promote Eco development activities among coastal communities to enhance their adaptive capacity and to sustain livelihood and food security Eco-development activities

Baseline Scenario: The Gulf of Mannar Biosphere Reserve Trust, owned by the Government of Tamil Nadu used to carry out these activities earlier in the same area. This component will use the same model to replicate and follow the same activities.

Adaptation Activities: The activities would include micro-credit provision, revolving funds, SHGs nurturing wherein alternate livelihood opportunities will be generated for the communities. More than 25 village specific activities have been planned. This activities would enhance the adaptive capacity of fishermen and other coastal communities.

Self Help Groups leading to women empowerment - The existing SHGs are driven by women and the activities undertaken so far include dry fish making, palm leaf making, marketing clothes, charcoal making, Jasmine cultivation, coir making etc. During the need based assessment study, a detailed understanding and practical requirements of these SHGs will be sought to plan and implement future activities to generate livelihood for women.

Currently there are over 15 SHGs per village, across the 23 villages chosen. Therefore, over 6900 women will be the benefited from the project activity.

A majority of the women in the region are engaged in sea weed collection as well. Initially, they would set out to the sea in "Vathais" (small shore boat propelled with the help of a pole) on all days but restricted to 12 days a month now, six days before and after new moon and full moon to conserve the islands in the Gulf of Mannar. The main species of seaweed collected are *Gelidiella acerosa* and *Sargassum*, which are sold fresh to the trader, who collects it from the village, at a rate of INR 4 – 10 per kg. The traders collect the seaweed, dry them and sell them to the two agar-processing companies in Madurai[5]. However, post declaration of the Gulf of Mannar as a Marine Biosphere Reserve, sea weed collection is prohibited in the area which has impacted the income generated through this activity. In the year 2006, a joint meeting with seaweed collectors, wholesale merchants, manufacturers of seaweed products (the All India Agar and Alginate Manufacturers Association), research institutes, GOMBRT and the management of the Gulf of Mannar National Park was held to discuss the action plan to address this ban on sea weed collection. The outcome was that non-destructive methods of collection should be adopted, and that seaweed collection should be banned in the months of March, April and May, considered the growing season for seaweed, which would help in further propagation of seaweeds. In addition, SHGs need

[5] http://www.icsf.net/en/yemaya/detail/EN/1230.html

to be trained on sea weed culture and creating an awareness on its importance on maintaining biodiversity and adaptation to climate change.

In light of the above, engaging the women and SHGs in ecotourism and other related activities will compensate for the loss in income due to restriction on sea weed collection and also prevent them to collect sea weeds in an illegal manner.

Some of the activities that may be considered include:

- Reviving and nurturing SHGs
- Issuing SHG loans to fishermen. In some of the villages, the fisher folk are heavily indebted to the local moneylenders / middlemen of some industries, for procurement of boats and fishing gears. There has to be a mechanism to provide some relief to these fisher folk from the exploitative interest rates and also the pressure exerted in getting a good catch from every trip made to the seas.
- Imparting local specific skill up gradation training to fishermen SHG members. (i.e. Tailoring, embroidery, etc.,)
- Eco tourism activities such as snorkelling, boating etc. - The SHG members have also formed the Eco Development Council (EDC) who are in charge of overseeing and implementing some of the activities such as managing the Marine Aquarium, ecotourism activities such as snorkelling and boating, with technical support.

  Boating: A boat service to have a ride in the sea would help the visitors to feel an oceanic atmosphere. It is to note that the reef areas in Gulf of Mannar are shallow and turbid and hence not suitable for glass bottom boat service

  Underwater exploration through snorkelling: Several good coral reef and seagrass areas are located outside the marine national park. Interested visitors can be taken for snorkelling experience to explore under water beauty with the assistance of trained and experienced divers.
- Conservation of marine ecosystem through awareness creation
- Imparting vocational training to fisher youth
- Biodiversity training
- Construction of community hall
- Construction of Self Help Group activities and multipurpose training centre
- Improvement of major and minor fish landing shelter at fishery villages
- Marine Aquarium and Interpretation Centre - Construction of interpretation centre is also carried out for disseminating information regarding GOM. The establishment of a Marine Interpretation Centre near the marine aquarium would help to highlight and showcase the importance of various marine habitats, ecological and biological role of marine organisms, wealth of ocean, fishing pattern, crafts, gears and the importance of conservation and management. Setting up of a technically supported small scale marine aquarium would help to make visitors understand the wealth the ocean bears. The explanation of role of marine habitats like coral reefs, impacts of climate change and the

need for awareness and adaptive capacities would be a good means to improve the awareness levels among the communities. The fee collected from visitors could be used for the purpose of maintenance and salary to the technical and workers who are local villagers.

- Mud crab fattening / culture - As mud crab seeds are not readily available the business idea is not gaining popularity. If the seeds could be made available this intervention would turn into a profitable business. The value of moulted crab is INR 20-50 KG^{-1}. About 2-3 weeks of value-addition activities would convert these crabs to fully developed crabs with hard shells which would earn on an average about INR 200-300 KG^{-1} and a maximum of about INR 600-800 KG^{-1}. Fattening (Crab / Lobsters) and Cage Culture (Fish / Shrimp / Crab / Lobsters) are well developed and can easily be adopted by the villagers, if seeds are made available and value chain (backward-linkages) is developed for this.
- Rearing Cobia fish 300-500 MT inside the sea as cage culture fisheries is a viable proposition and does not disturb the natural ecosystem.
- Marine ornamental fish breeding for Mollies, Platy, Swordtails, Scuttle Fish, Parrot Fish, Clown Fish, Sea Bass, etc. since this enterprise is very popular
- Shrimp farming is done by farmers and not by traditional fishermen as the fisherman community does not have cultivable land. To promote shrimp farming, the Fisheries Department issues licenses to farmers having less than 5 ha. land. It is difficult to obtain the license for shrimps farming in an area of more than 5 Ha as this involves a lengthy process. However, since very few farmers show interest, the entrepreneurial firms manage their shrimp farms. For example in Tuticorin area, two entrepreneurial firms are actually doing business as against 10 issued licenses.

Organizations like CMFRI are well placed for giving technical and training support.

iii. Please justify with regards to components as on the concrete adaptation activities of the project, and how these activities contribute to climate resilience

The components of the adaptation activities have been detailed in the previous section (ii), and the following brings out how these activities contribute to climate resilience.

Contribution of Baseline survey to climate resilience: The baseline data will provide the basis for adaptation planning and implementation of the restoration and rehabilitation activities and the eco development activities.

Contribution of Coral reef rehabilitation to climate resilience: The rehabilitated reefs will not only increase the biodiversity in the area, but will also protect the islands from erosion and submergence due to sea level rise. Further, these areas will provide sustained livelihoods for fishermen.

Contribution of Sea grass rehabilitation to climate resilience:-The rehabilitation of seagrass ensures habitat creation for several corals, fish and associated species which will lead to protection of islands against the impacts of climate change.

Contribution of Artificial Reef deployment to climate resilience: The artificial reefs will not only increase the biodiversity in the area, but will also protect the islands from erosion and submergence due to sea level rise. Further, these areas will provide sustained livelihoods for fishermen.

Contribution of Eco-development adaptation activities to climate resilience: Climate change induced impacts such as sea level rise, coastal erosion are a constant threat to fishermen communities, therefore promoting an alternate source of income will ensure a steady income and an improved standard of living among the local communities. The income generation potential of the various eco development activities have been provided in section 3 (e) of this document.

The contribution of the project activity are as follows:

- Sustained livelihood of communities: Coral and seagrass rehabilitation using native resistant and resilient species in the degraded area along with the deployment of artificial substrates will increase source for fish aggregation and production and thereby ensuring the livelihood security thus strengthening the adaptive capacity of the community. Also, the rehabilitation helps in saving and protecting the corals, seagrass and associated fish species from elevated temperature by providing suitable substrates. Furthermore rehabilitation reduces sensitivity of the communities by protecting them due to climate induced events like cyclones and tsunami; thus in restoring the ecosystem services. The restoration of coral reef and seagrass ecosystem has long term benefits and this would continue to increase as many of the ecosystem services would rejuvenate and surface after a few years when the corals are have fully grown. The intangible benefits incurred due to the project would be higher than the tangible benefits received.
- Complement similar activities: The proposed rehabilitation activities would complement the other ongoing conservation activities in Gulf of Mannar and also reduce the anthropogenic stresses on the reef ecosystem by making communities aware of the conservation benefits.
- Scope for upscaling: The success of proposed project activity would also help attract other interested agencies to involve in large scale activity in the coming days and the project has the potential to be scaled up in similar ecosystems in other regions.
- Dovetailing with the State Action Plan: The learnings from the successful project could feed into the Tamil Nadu State Action Plan on Climate change in the coastal zone section.
- Community based monitoring through involvement in project: The participation of community in the rehabilitation process would bring about efficient natural resources management by involving them in the artificial reef and seagrass rehabilitation process. This makes them aware of the importance of ecosystem thus increasing their efforts in project monitoring and also conservation of ecosystem. The communities are the long term stakeholders in the project.

- Enhancement of skills: The project implementation such as planting of substrates, transplantation of sea grass will be carried out using fishermen from the local communities. They will be training appropriately on the technical know-how as well the benefits. The youth would not only benefit from the additional income paid as daily wages, but will enhance their skill sets in the process.
- Climate change resilience: The increase of reef and seagrass areas with resistant and resilient native species and also deployment of artificial reefs to enhance habitat will counteract the identified climate change impacts through provision of habitat for fish species in the degraded areas and also prevent coastal erosion and inundation.

b) Details on Economic, social and environmental benefits project / programme

(Reference to the most vulnerable communities, and vulnerable groups within communities, including gender considerations)

Components/Activities	Key Benefits (Direct)		
	Social	Economic	Environmental
Coral Rehabilitation	• Awareness of community about conservation benefits of the ecosystem • Improved quality of life for fishermen and related communities owing to improved fish catch	• Improved income generation due to increase in coastal habitats and fish populations • By one estimate, the total net benefits of Coral reefs across the world is around 30 billion US $ per year (Cesar et. al. 2003) • In India, the estimated value of 1 km2 coral reef area in the Gulf of Kachchh, India is around Rs.7.95 million per year (Dixit et al., 2010), the services including fisheries, tourism, biodiversity and protection against salinity and coastal	• Increase coral live cover • Increase diversity of fishes • Immediate improvement of physically destroyed sites • Prevent migration of associated species due to loss of habitat. • Decrease in the coral bleaching

		erosion, wherein fisheries is most important followed by protection against coastal erosion.	
Seagrass Rehabilitation	• Promote public awareness • Improved quality of life for fishermen and related communities owing to improved fish catch	• Enhanced income due to improved coastal habitats and fish populations	• Controls erosion • Increases diversity of fishes and other fauna • Prevents migration of species due to loss of habitat.
Artificial Reef Deployment	• Promote public awareness • Improved quality of life for fishermen and related communities owing to improved fish catch	• Enhanced income due to improved coastal habitats and fish populations	• Increases substrate for reef organisms • Increases species diversity • Immediate increase in immigration of diverse reef dwelling species • Prevents migration of species due to loss of habitat. • Protection of island from climate change impacts
Eco- development activities	• Training and capacity building on alternate livelihood options such as cattle rearing, petty shop management etc. • Gender empowerment through the increase of fishery resources for the	• Enhanced income due to increased tourism and other alternative income generation activities in the region. • The SHGs will be provided with alternative sources to	• Improved environmental aspects such as drinking water and sanitation, waste management and protected

	ongoing supplementary income generation activities like pickle making • Strengthening of village institutions to manage the ecosystem even when the project period ends • Improved quality of life	the extent of INR 103 Lakhs (potential) per annum through various activities • The fishermen and local community will have the potential to earn INR 184 Lakhs per annum (the detailed table on potential revenue generation has been provided in section 3 (e).	biodiversity • Improved community resilience to climate change impacts

c) Sustainability of intervention

i. How will the project assure that the benefits achieved through its investments are sustained beyond the lifetime of the project?

The management and rehabilitation project aims at restoring the natural habitat at the Gulf of Mannar which would ensure protection of the Islands and also help sustain livelihoods of the dependent communities. The project activities will result in enriched biodiversity and increased population of fish which will ensure a steady income for fishermen throughout the year. Further, these coral reefs will also act as barriers to coastal erosion and prevent further submergence of these Islands.

The project activity follows a community based approach. The nearby Mottaikopuram, Siluvaipatti, Vellapatti, Tharuvaikulam and Pattinamaruthoor villages are the targeted villages to understand impact of the activity in terms of adaptation to climate change, both in terms of livelihood generation and income enhancement among the community.

As one of the main focus areas of the project is to develop adaptation to climate change and creation of livelihood to the local fisher community, the community will be first informed on the purpose of the project, its benefits in terms of livelihood creation and food security on long term basis. This will ensure their 100% participation in the project activity and sustainability of the same, post the termination of the project.

The activity sites were also selected in consultation with active traditional fisher folk who are regularly doing fishing in this area. Local fishermen from the villages will be utilized toward execution of the project activity. Their labour will be used for coral reef / sea grass rehabilitation as well as artificial reef deployment. The chosen fishermen will be trained on the project activity and the mechanisms for substrate deployment and transplantation. The labour costs could vary between INR 700 – INR 900 for a minimum of five hours of work.

While, this activity provides additional income, it more importantly develops the skill set of these fishermen on the techniques of coral reef and seagrass rehabilitation.

To sustain the intervention beyond the project period, efforts would be made to maintain the artificial reefs placed. Sustainable fishing practices shall be continued through increased awareness and regulations. It is expected that community strengthening through sustainable livelihood shall also continue with the self-help group and village committees.

d) Analysis of the cost-effectiveness of the proposed project / programme:

> *Cost effectiveness will compare alternative options available and how the proposed components/ intervention are best for given climatic conditions. It will also how the community has preferred the selected interventions and their views / concerns are addressed while designing the project / programme The proposal should compare to other possible interventions that could have taken place to help adapt and build resilience in the same sector, geographic region, and/or community.*

The project would deploy tried and tested methods for the coral reef, sea grass rehabilitation and artificial reef deployment thereby reducing both the costs (in terms of trial runs) as well risks included in the success rate of the methodologies. Further, a detailed understanding of the site is already available and therefore very specific adaptation interventions have been proposed which will help in achieving the project objectives. For instance, mangrove forest covers will be part of the baseline assessment study; however they will not be part of the project implementation since there are no mangroves in the chosen sites for project deployment. This will further save costs in terms of including inappropriate components in the project action plan. Similarly, the eco-development activities will also be planned in consensus and as per the need and requirement of the community (using the analysis of the need assessment study). This will again lead to cost savings or rather lead to utilization of funding for the most appropriate actions.

In terms of the choice of the methodology to be deployed, the project will utilize the most suitable method which will ensure a high success rate in increasing the coral reef and seagrass cover in the region. The region, temperature, wave intensity, depths of coral reef, climate and cost and availability of technology have been taken into consideration while selection of these methods.

A comparison of the chosen options vis-à-vis alternative options has been provided in the table below:

S.No.	Activity	Proposed Alternatives	Benefits
1.	Baseline data on vulnerability to climate change of coastal ecosystems (including biodiversity and fishery) and coastal communities	No alternative	Adaptation planning and understanding of optimum fishing pressure
2.	Coral Rehabilitation	The proposed methods for these activities are the most cost effective approach available and have been discussed as a separate table below.	Habitat improvement that in turn increases fisheries thus supporting local livelihood, and also from coastal erosion, and sea level rise
3.	Seagrass Rehabilitation		
4.	Artificial Reef Deployment		
5.	Eco development Activities	Least cost approach is proposed in this project	Increased community awareness, and adaptive capacity

S. No	Project component	Methodology	Description	Reason for non-suitability
1	Coral Rehabilitation	Coral colony transplantation	Restocking the degraded site with large colonies extracted from donor site and fixed using glue, nails, and wires or simply left to attach naturally.	This method is expensive, time intensive and can be done only on small scale. Also, high mortalities and decrease in coral biomass have been reported[6].
		Electrically stimulated coral growth enhancement	Wire construction with a cathode and an anode are connected to a power source such as solar panels. The accretion of brucite and aragonite depositions through	All the corals tested, exhibited fast growth and increase of biomass. The major hurdle for the method is the high infrastructure input, small-scale operation, high costs

[6] Clark S and Edwards AJ (1995) Coral transplantation as an aid to reef rehabilitation: evaluation of a case study in the Maldives Islands. Coral Reefs 14: 201-213.

			mineralization process of seawater supports the coral growth	and is not suitable for all regions [7,8]
		Larval ranching	The larvae obtained from the corals (maintained in aquaria or collected from slicks after spawning events) are maintained in tanks for some time and released in the target area in net enclosures or in naturally occurring eddies.	The major disadvantages of this method are time intensive, high mortalities during reseeding and high cost of maintenance of corals in aquarium[9,10]
		Coral fragment re-seeding (This method is practiced in Gulf of Mannar)	The coral fragments are cut off from donor colonies and deployed in the rehabilitation site with or without being attached individually to substratum[11]	This method is cost effective, fast increase in biomass and large scale is also possible. Suitable species and site are the basic requirements for the large-scale restoration of coral in the degraded areas
2	Seagrass Rehabilitation	Plug	A PVC or metal core is used to remove a seagrass ramet and surrounding sediment An equivalent sized hole is excavated or softened at the restoration	This is an expensive method and also impacts the donor site

[7] Hilbertz, W., D. Fletcher and Krausse, 1977. Mineral accretion technology: applications for architecture and aquaculture. Industrial Forum, 8: 75-84

[8] Van Treek, P. and Schuhmacher, 1999. Artificial reefs created by electrolysis and coral transplantation: An approach ensuring the compatibility of environmental protection and diving tourism. Est. Coast Shelf Sci.,49: 7581

[9] Oren,U. and Y.Benayahy,1997. Transplantation of juvenile corals: a new approach for enhancing colonization of artificial reefs. Mar. Biol., 127: 499-505

[10] Sammarco, P.W., D.A. Brazeau, and T.N. Lee, 1999. Enhancement of reef generation processes. Supplementing coral recruitment processes through larval seeding presented at the Inter. Conf. on Scientific Aspects of Coral Reef assessment, Monitoring and Restoration. April 14-16, 1999. Ft.Lauderdale, Florida National Coral Reef Institute

[11] (Hughsmith, 1982, Harriot and Fisk, 1988 and Lindahl, 1998).

			site. The Complete ramet and core are installed in the new location	
		Sapling method	Use of seeds and seedlings for rehabilitation, avoiding destruction of sea bed and encouraging genetically heterogeneous beds.	Applicable in low energy environments and where seed predators are sparse. Currently, research on this method is not done on a large scale. This is also an expensive method.
		Cod (ECOSUB)	The machine is operated by two divers and is positioned over the seagrass. The ECOSUB then cuts a 0.5 m2 sod of seagrass and stores it in an on-board hopper. The ECOSUB is then floated to the surface using tanks and towed to the rehabilitation site where the cutter head clears a spot for the sod and it is transplanted	Highly mechanized and expensive approach
	Sprigs (Quadrate)	This method is practiced in Gulf of Mannar. The transplant units are selectively removed from the donor seagrass bed by hand. They can be planted by being anchored/secured into the sediment or	Greatest potential in shallow water with fine sands, moderate water movement & maximum light availability. Lower costs compared to the other methods.	

		unanchored, singly or in units of multiple rhizome sections.		

For Artificial Reef deployment there is no specific methodology and it needs to be customized based on the region and requirement of restoration and rehabilitation activity.

e) Weighting of project activities:

How much funding will be allocated to 'investment activities', 'capacity building activities' and 'project management activities' respectively?

Type of Activity	List of Activities	Funding Requirement
Investment Activities	Baseline survey	90,00,000
	• Construction of substrate for coral and seagrass rehabilitation Transportation • Deployment • Transplantation of coral fragments / seagrass shoots	1,80,00,000
	Artificial reef modules deployment	12,60,00,000
	Sub-total	15,30,00,000
Capacity Building Activities	Capacity Building of local fisherman communities on sustainable fisheries & promotion of alternative livelihoods Capacity Building of Govt. staff from Forest Dept., Fisheries Dept. on coastal ecosystem monitoring and management in the context of climate change	7,20,00,000
Project Management Activities	• Monitoring and evaluation of the project	1,52,00,000

	• Co-ordination between various stakeholders • Supervision of operational activities • Mid-year and Final Review	

f) Alignment with the National and State Action Plans and other Policies / Programmes:

(Describe how the project / programme is consistent with national or sub-national sustainable development strategies, including, where appropriate, national or sub-national development plans, poverty reduction strategies, national communications, or national adaptation programs of action, or other relevant instruments, where they exist)

This project is aligned with the Tamil Nadu's State Action Plan on Climate Change (SAPCC). Under the SAPCC, this activity would be aligned to the Coastal Zone Management programmes, specifically to the Gulf of Mannar Biosphere Reserve (GOMBR) project and the Biodiversity Conservation programme. The project is also clearly a climate change adaptation project and is aligned with climate change requirements under SAPCC.

Costal & marine biodiversity conservation is one of the strategies proposed by the Government of Tamil Nadu, in line with the Green India Mission toward addressing climate change concerns. As part of this strategy, conducting regular assessment & monitoring of coral reef as indicator species, coral rehabilitation using resilient and resistant native species, Alternative livelihood options for reef associated fishery dependent coastal people and conservation of mangroves and associated biodiversity have been identified. Further, focused research on impact of climate change on coral reefs and associated biodiversity is an activity which is part of the research and capacity building strategy.

g) Component wise technical standards:

(Describe how the project / programme meets relevant national technical standards, where applicable, such as standards for environmental assessment, building codes, standards related to pollution control, etc. The details need to be provided for each of the interventions proposed)

S.No.	Activity	Applicable Standard	Application to Project
1	Baseline survey	International approved methods (English et al., 1997)	As per standard methods
2	Coral rehabilitation	Standardised techniques in Gulf of Mannar by SDMRI	As per standard methods

3	Seagrass rehabilitation	Standardised techniques in Gulf of Mannar by SDMRI	As per standard methods
4	Artificial Reef Deployment	Standardised techniques in Gulf of Mannar by SDMRI	As per standard methods
5	Eco Development Activities	Standardised techniques in Gulf of Mannar by GOMBRT	As per standard methods

h) Duplication Check:

(Describe if there is duplication of project / programme with other funding sources, if any)

No.	Project	Objectives	Complementarity	Geographical Coverage/ Agency
1.	Proposed project	Baseline survey	New	Rameswaram to Kanyakumari in Gulf of Mannar, Tamil Nadu
2.		Coral rehabilitation	New	Kariyachalli and Vilanguchalli Islands in Tuticorin coast of Gulf of Mannar
3.		Seagrass rehabilitation	New	Kariyachalli and Vilanguchalli Islands in Tuticorin coast of Gulf of Mannar
4.		Artificial Reef Deployment	Complementary to Tamil Nadu State Coastal Zone Authority project	Vaan Island of Tuticorin coast of Gulf of Mannar
5.		Eco Development Activities	Complementary to GOMBRT activities	Tuticorin coast of Gulf of Mannar

i) Details on Stake-holder consultation:

(Describe the consultative process, including the list of stakeholders consulted, undertaken during project preparation, with particular reference to vulnerable groups, including gender considerations).

Consultation	Date/Place	Participation	Objective	Outcome
Tamil Nadu Fisheries Department	22.09.2014	• Researchers from University, SDMRI	Protection of Vaan Island and nearby islands to safeguard	Buy in from the participants on the need for protection using coral reef rehabilitation and also

		• Fishermen Association, Tuticorin • SHG members • Vellapatti Village Committee Fishermen • Ex- Panchayat President, Vellapatti	livelihood and protect the coastline	Large scale coral rehabilitation has to be initiated in the degraded area Large scale deployment of artificial reefs shall be done at outside the Marine National Park, using suitable design and materials, so that it will reduce erosion as well enhance fishery production.
Department of Environment	15.10.2015	• Director	Purpose of Project	• This will be first of its kind project through DoE (after its inception 7 months ago) • The various sectors identified by TNSAPCC o Sustainable Agriculture o Water Resources o Coastal Area Management o Forest & Bio-Diversity o Sustainable Habitat o Energy Efficiency, Renewable Energy & solar Mission o Knowledge Management • Focus of the Climate Change Cell towards Marine Ecosystems like Coral Reefs especially due to change in Sea Surface Temperature
Forest Department	15.10.2015	Wildlife Warden, National Park	Freshwater development and possible eco-development activities in the restricted areas	• Limited scope for freshwater development since the area receives scanty rainfall (150 cm) and underlying salt pan • However, good scope in the catchment areas of Tambrapani river • Tanks are auctioned and are used by the business people to rear fishes. The money earned by auctioning is used for maintenance of the tanks.
Gulf of Mannar Biosphere Reserve Trust	15.10.2015	Director	Role of GoMBRT and possible Eco-development activities	• It is understood by the forest department that the coastal population plays an important part in conservation of marine ecosystem. The department has planned to involve the local population with the working of the department through awareness creation programmes.

				• Possible activities : ○ SHG related (Tailoring, embroidery etc.) ○ Shrimp rearing ○ Goat rearing ○ Dissemination Centre ○ Eco tourism activities such as snorkelling, boating etc. ○ Mud crab fattening/ culture, ○ Sea weed farming ○ Marine ornamental fish breeding
Suganthi Devadason Marine Research Institute	15.10.2015	Director	Technicalities & Infrastructure involved in the proposed project	• Effect on Coral reefs due to increase in Sea Surface Temperatures • Effects of Ocean acidification on corals • Construction process of Artificial Reefs. 80% success rate of ARs. ARs provide habitat for both corals & fishes. Construction & deployment of Artificial Reef as a source of employment. A cost effective measure when compared to sea-walls. • Availability of moulds for construction of AR units • CR & SR substrates and AR are to be laid in different areas • It was pointed out that Sea weed is collected, not sea grass. Cultivation of sea-weed is possible but proper technology is missing.
Indian Institute of Technology (Chennai)	15.10.2015	Professor, Department of Ocean Engineering, IIT Madras	Wave Dynamics and Protection of Vaan Islands	• Oceanographic studies was done around the islands. • Simulation models were created to find the best suited design & model for artificial reef deployment. • It was observed that the reefs of rhombus shape is better than triangular AR. • It was also found that instead of a continuous layer of protection units viz. AR units, the deployment could be in two layers arranged in a zigzag fashion.
Anna University	16.10.2015	• Professor, Centre for Environmental Studies • Honorary Visiting	Obtain Climate data and related studies	• The project has been conceptualised based on the Knowledge Management practices of the state. Major data heads considered while formulating the project are :

		Professor, Centre for Climate Change & Adaptation Research • Research Professionals		○ Temperature & Rainfall data ○ Temperature & Rainfall projections ○ Climate change projections • District wise data is available • Baseline data from 1959-2000 was used for making projections for year 2040, 2070 & 2100. • Studies on present sea-surface temperature and projections have been done, although not published. • Presently the sea-surface temperature is considered from earlier research (Shobha et. al.)
Fisheries Department, Tuticorin, TN	16.10.2015	Asst. Director	Fisheries data and possible fisheries interventions	• Shrimps farming is done by farmers and not by traditional fishermen as the fisherman community does not have cultivable land. It is a difficult to obtain licenses for shrimps farming for more than 5 Ha due to process involved. Thus few people apply for licences in more than one name. In Tuticorin area on two farmers are actually doing business as against 10 issued licenses. • As mud crab seeds are not readily available the business idea is not gaining popularity. The value of moulted crab is INR 20-50 KG^{-1}. About 2-3 weeks of value-addition activities would convert these crabs to fully developed crabs with hard shells which would earn on an average about INR 200-300 KG^{-1} and a maximum of about INR 600-800 KG^{-1}.
Fishing Community	17.10.2015	• Village fisher folk (including families) into boat fishing without trawlers	Level of interest in taking up income generating alternative livelihood activities	• Fish catch is receding and fishermen have to go deep into the sea to get a good fish catch. • Money is to be borrowed from local money lenders on very high interest rates. • Repayment rules are highly biased towards profiting the money lenders. • Village level activities may be taken up by the support of government. • It is difficult to abandon fishing as other sources of income / livelihood options is not easy to adopt.

				• The villagers are highly motivated towards sending their children to school.
Central Marine Fisheries Research Institute	17.10.2015	• Principal Scientist, CMFRI	Fisheries development in the district & possible livelihood interventions	• Cultivation of fresh water fish is not popular, even with such fishes earning a good deal of money, as it requires more effort • There is scope for ornamental fisheries • Tanks are auctioned and are used to rear fishes. The money earned by auctioning is used for maintenance of the tanks. • Business of rearing Cobia fish 300-500 MT inside the sea with cage culture is a profitable venture and does not disturb the natural ecosystem. • Pearl culture technology needs to be developed. • Business Chain (backward-linkages) needs to be developed for crab fattening business. • Organizations like CMFRI are well placed for giving technical and training support. • Fattening (Crab / Lobsters) & Cage Culture (Fish / Shrimp / Crab / Lobsters) are well developed and easy to take-up by the villagers. • Mixed Culture by Pen Culture is an evolving technology. • Fishes that can be easily reared are Parrot Fish, Clown Fish, Sea Bass, etc. • Value addition by the villagers needs to be taken-up so that the produce can be directly sold to restaurants.
Suganthi Devadason Marine Research Institute	18.10.2015	Field Researchers of SDMRI	Visual observation of attachment of live corals to substrates in rehabilitated reef areas	Field visit to Vaan Island

There have been several stakeholder consultations that have been carried out in the past projects that have been implemented in the region. In the year 2012, there was a discussion of proposal on artificial reef rehabilitation with community members before deploying the same at the site. In the year 2013, GIZ officials were part of stakeholder consultations with SHGs and fishermen at the village. Review of the pilot project and also

possibility of scale up of project were discussed and analysed. The communities in all the villages have always been well aware of the interventions and the project activity to be deployed. The project team formally informs the communities on the action plan and adopts a community based approach in implementing the project. In addition, during the project implementation where there is a requirement for a technical input or for participation in stakeholder consultations, the Fisheries Department of the State Govt., ICAR Institutions like CMFRI and Fisheries University will be consulted.

Discussions with fisher folk, Vellapatti Seagrass and other dead species disentangled from fishing nets on the shore

Further, this proposal is based on the MoEF&CC endorsed Tamil Nadu State Action Plan on Climate Change (TNSAPCC). The TNSAPCC was developed through vide stakeholder consultations, and the proposal is based on Chapter 8 of the SAPCC on Coastal Resources Management, which has specific references to issues identified in coastal areas through stakeholder consultations.

j) Learning and knowledge management component to capture and disseminate lessons learned for the proposed project

The Tamil Nadu SAPCC has a chapter on knowledge management. The Tamil Nadu State Mission on Strategic Knowledge works toward building a better and detailed understanding of the climate change processes, its implications on various sectors, and vulnerabilities associated with the same to enable sustainable adaptation to climate change and mitigation of drivers of climate change (greenhouse gases emitted from anthropogenic sources). The following strategies have been identified to achieve the climate change vision of the State:

- Create an enabling institutional framework for developing and disseminating strategic knowledge on climate change
- Develop a scientific basis for a deeper understanding of climate change issues

- Support Research & Development of innovations to address climate change impacts and vulnerabilities
- Undertake Demonstration, Field Implementation & Extension
- Support regular monitoring of critical ecological parameters and urban landscape
- Mainstream traditional knowledge
- Undertake capacity building initiatives to integrate steps to manage climate sensitive natural resources and mitigate climate change drivers
- Support creation of Monitoring and Evaluation tools of various initiatives of the climate sensitive sectors
- Develop a Data bank and Create a Knowledge Portal

Under the final strategy, a data base will be created in collaboration with State Departments and their institutions, universities and other local institutions, local bodies such as the Panchayats or the Urban Local bodies, etc. The data base would have details on activities such as Land use data, production data, pollution data, natural resources, population, economy, regulatory framework and policies, latest technology developments and scientific updates on climate change adaptation and mitigation activities and other critical information related to this project. Being the nodal agency for the Knowledge Management Strategy, under the TNSAPCC the Centre for Climate Change and Adaptation Research, Anna University shall provide the technical support in coordinating and compilation of data on climate projection and the specific outcomes from the adaptation activities emanated from this project. This shall be compiled as a part of the Climate Services Information System (CSIS).

Along the same lines, this project activity will also utilize the existing framework for knowledge management. The baseline survey results will be documented and maintained as a database for future reference and analysis. The project implementation details along with monitoring and verification data will also be documented in the form of status reports as well as project report and submitted to the DoE and MoEFCC. This information will be made available for any future planned activities both in the region or elsewhere to be used as a case study. The eco development activities to be planned will be based on a need assessment study carried out during the baseline survey process to ensure providing practical and realistic solutions to livelihood creation. Therefore, the need based assessment study will also be documented in detail. Further, the eco development activities will be utilizing the knowledge from previous studies / projects carried out in the region. The success and failure of the previous activities will be taken into consideration. Similarly, this project activity will serve as a case study for future research studies or project implementation. The Marine Aquarium and Interpretation Centre will be one of the most important methods of knowledge dissemination to the general public while also providing livelihood to SHG group members.

During project implementation, a detailed feedback will be collected from the respective stakeholders including communities and SHGs to ensure meeting the ultimate objectives of the project activity.

The collected data through the proposed project activity will be the property of Govt. of Tamil Nadu. However, SDMRI will make use of the scientific data for publication / reports Articles with due acknowledgement to Dept. of Environment Climate Change Cell.

7. Sustainability of the project/programme outcomes has been taken into account when designing the project / programme

Expected Outcomes	Expected Concrete Outputs	Sustainability Mechanism	Responsible Party / ies
• Vulnerability of ecosystems (biodiversity and fisheries) to climate change completely mapped for the first time. • Vulnerability and challenges faced by the fishing patterns followed currently. • Roadmap for sustainable fisheries management	• Data Collection of present status of coastal habitats (Coral reefs, seagrass beds and mangroves) and associated biodiversity information (diversity, distribution and abundance) and threats for better conservation and management for sustainable utilization • Data compilation and analysis for complete understanding and of current fishing patterns, using formula based approach to arrive at Catch per Unit effort and the optimum fishing pressure. • Data compilation and analysis for complete understanding on socio economic and biophysical vulnerability to climate change. • Socio economic vulnerability of fishermen and other coastal Communities mapped in the study site. • Key livelihood issues and biodiversity threat is mapped	Analysis of existing situation of the fishing communities, biodiversity status as well as fishing patterns and fishing pressure which will be shared with the communities and roadmap on sustainable fishing will be jointly developed	• PMU of DoE • SDMRI
• Enhancement of live coral cover to as well as provide habitat for fishes & other diverse species	• Substrates with transplanted native species of corals in clusters of concrete frames deployed in the project area.	• Reducing erosion and protecting the Islands from submergence; enhancing fish production; facilitating	• PMU of DoE • SDMRI

• Improved adaptation measure to climate change impacts & erosion	• Regeneration of native and highly endangered coral species (15%) in the restoration sites	natural coral recruitment • Improved adaptation measure to climate change impacts such as erosion	
• Enhancement of seagrass cover to as well as provide habitat for fishes & other diverse species	• Fixed PVC frames with transplant units of seagrass in the project area. • Growth & establishment of transplanted seagrass & community structure in the rehabilitated area	• Participation of local communities in project activity Increased awareness levels on importance of coral reefs and their role in minimizing climate change impacts	• PMU of DoE • SDMRI
• Protection from erosion and submergence due to seal level rise • Provide habitat for fishes & other diverse species	• Deployment of 6000 nos. (each of 2.5m width, 2m height and 1m longitudinal length) of substrate made of Ferro-cement and reinforcement steel	• Improved adaptation measure to climate change impacts	• PMU of DoE • SDMRI
• Coastal community adapting effectively to overcome climate change impacts	• Adoption of alternative livelihood activities so as to reduce dependence on catch fisheries • Promotion of Eco-tourism	Implementation of eco development activities, based on need based assessment and buy in from local communities	• PMU of DoE • CMFRI • SDMRI • Fisheries University • Fisheries Dept.

ii. Provide an overview of the environmental and social impacts and risks identified as being relevant to the project / programme.

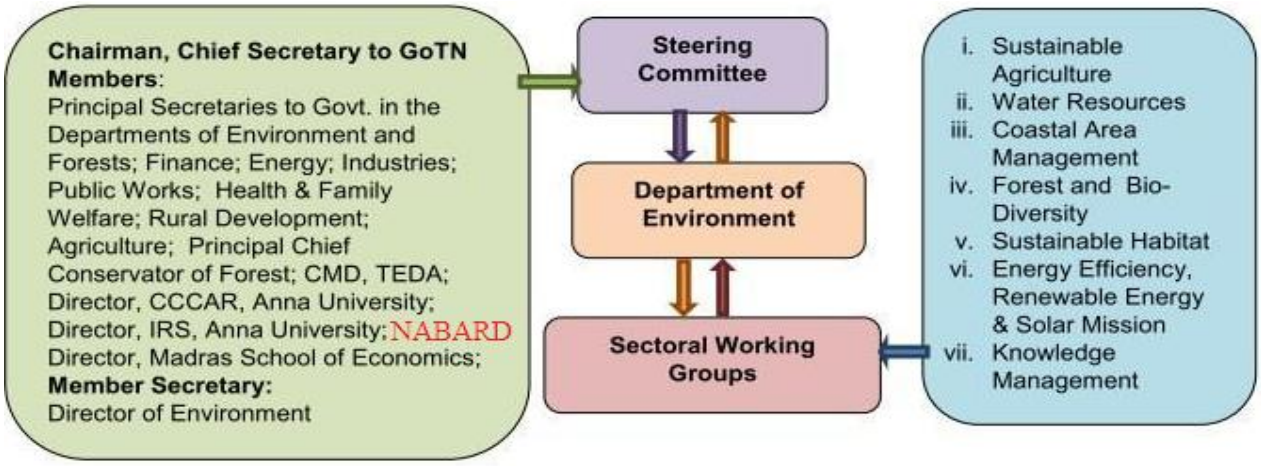
Checklist of environmental and social principles	No further assessment required for compliance	Potential impacts and risks- further assessment and management required for compliance
Compliance with the Law	√	None
Access and Equity	√	None
Marginalized and Vulnerable Groups	√	None
Human rights	NA	None
Gender Equity and Women's empowerment	√	None
Core Labour Rights	√	None
Indigenous Peoples	NA	None
Involuntary Resettlement	NA	None
Protection of Natural Habitats	√	None
Conservation of Biological Diversity	√	None
Climate Change	√	None
Pollution Prevention and Resource Efficiency	√	None
Public Health	NA	None
Physical and Cultural Heritage	√	None
Lands and Soil Conservation	√	None

3. Implementation Arrangements

iii. Describe the arrangements for project / programme implementation.

Who will implement the project and what are their comparative advantages and capacity compared to other potential implementing institutions?

The Department of Environment is the nodal agency for implementation. The overall implementation of SAPCC has been structured as below and similar implementation arrangement shall be followed



The overall project guidance will be under the State Steering Committee and the implementation will be done by the Department of Environment through various sectoral working group identified for Coastal Area Management.

Key Institutions and their responsibility for project implementation

Institution	Responsibilities
Department of Environment	Project coordination, supervision and monitoring
Tamil Nadu Forests Department & Suganthi Devadason Marine Research Institute	Coral and Seagrass rehabilitation; Baseline survey - Coastal habitats like coral reefs, seagrass beds and mangroves and associated biodiversity
Department of Environment and Suganthi Devadason Marine Research Institute	Artificial reef deployment in Vaan Island
DoE, Tamil Nadu Fisheries University and Central Marine Fisheries Research Institute	Baseline study on fishery including fishing pressure, catch per unit effort and study on the optimum fishing pressure

Department of Environment, Tamil Nadu Fisheries University and Central Marine Fisheries Research Institute	Eco development activities including training the community members and would be taking up the awareness raising part of the community
Local communities	Provide inputs for baseline study and need assessment for eco-development activities Assist with deployment of substrates in coral reef rehabilitation, transplantation of seagrass and other project implementation related activities, where required
SHGs, Local Bodies and other Voluntary Organisations	Assist with implementation and training and capacity building on climate change and importance of coral reefs Assist with the Ecotourism activities such as snorkeling and boating Assist with maintenance of the Marine Aquarium and Interpretation Centre

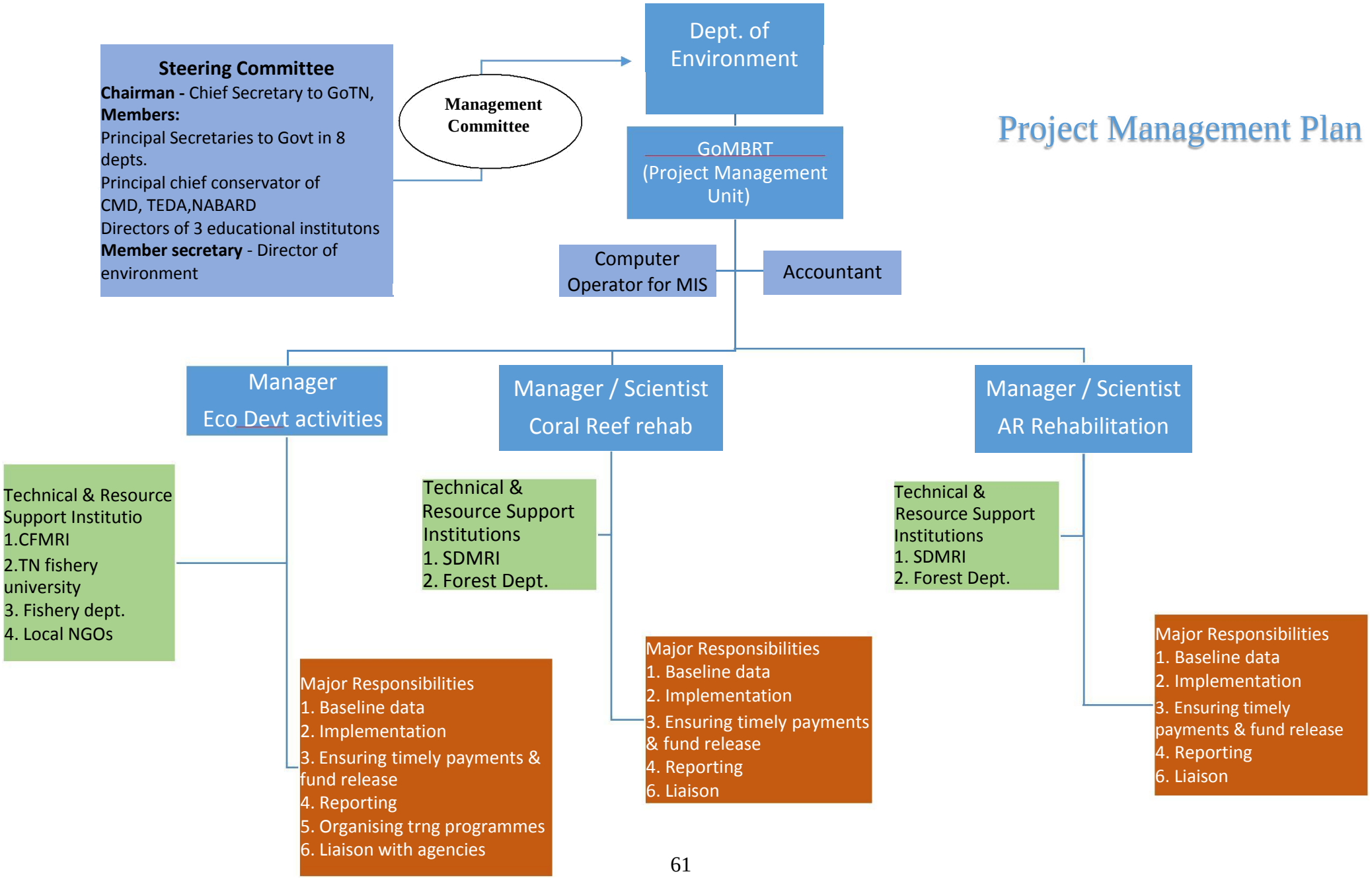
ii. How will the project be coordinated with (and/or mainstreamed into) related development activities of the targeted sector?

At National Level, the Ministry of Environment, Forests and Climate Change, Govt. of India and Department of Environment, Govt. of Tamil Nadu will be in charge for the project management and organization.

The project is proposed to be steered by Director, Member Secretary, Department of Environment, with members from National Bank for Agriculture and Rural Development (NABARD), TNSCCC, SDMRI, CMFRI, Anna University, IIT Chennai, Tamil Nadu Forest Department, GoMBRT, Fisheries Department of Tamil Nadu and one Representative from the fishing villages in the project area.

The State Steering Committee on Climate Change, which was constituted while preparing Tamil Nadu SAPCC headed by Chief Secretary with members from key departments, research institutions etc., will provide an overarching support in endorsing, implementing, monitoring & evaluating the project. The Project Management Plan can be seen in the following figure

Project Management Plan



b) Describe the measures for financial and project / programme risk management (also include environmental and social risk, if any).

No.	Risk	Rating (High/Medium/Low)	Mitigation Measure
1	Climatic changes	Medium	There are two clear seasons prevailing in Gulf of Mannar, i.e. 'calm' season from October to March and 'rough' season from April to September. Therefore, using past experience and knowledge of climatic conditions of the region will be used prior to planning project implementation
2	Coral reef survival	Medium	Use of successfully demonstrated technology and past experience of SDMRI
3	Seagrass survival	Medium	Use of successfully demonstrated technology and past experience of SDMRI
4	Success of Technology	Low	Use of successfully demonstrated technology and past experience of SDMRI
5	Lack of buy-in from local community	Low	A consultation in the project area has already been conducted during the pilot project implementation
6	Success of Eco development activities	Medium	A need based assessment before implementation of activities will ensure community buy in as well as providing practical support where it is needed. Further, past experience will also help in avoiding activities which has not been successful in the past.
7	Community risk (during collection of sea weed)	Medium	• Training and capacity building on safety measures to be adopted • Promote other means of income generation

c) Describe the monitoring and evaluation arrangements and provide a budgeted M&E plan. (Monitoring and evaluation cost need to be included in executing entity management cost).

Proposed budget for M&E amounts to Rs. 1.23 crores approx. (5 % of the total project cost). The activity wise budget will be worked out in consultation with NABARD as per MoEF&CC criteria.

Monitoring and Evaluation: The DoE, TN shall act as a Coordinating body. Monitoring and Evaluation (M&E) framework is important to assess the implementation process with respect to the targets envisioned, financial resources used and strategies accomplished. Further, measurable, reportable, and verifiable (MRV) frameworks for monitoring adaptation and mitigation will be established at the beginning of this project. The monitoring system of the project will comprise of the following components.

Inception Report: A Project Inception workshop will be held within the two months of the start of the project. The workshop will be attended by the members of the institutions that have been identified as members of the Steering Committee and the Technical Advisory Group. The Inception Workshop will be held for:

(i) Assisting stakeholders to understand the objectives of the project and visualize their respective roles and responsibility in the implementation and results of the project

(ii) Establishing reporting and communication protocols and familiarise with project decision making structure and processes

(iii) Presentation of project activities and major milestones and the expected outcome of the project

(iv) Presentation of the annual work plan to the stakeholders along with the indicators, means of verification, and monitoring and reporting frameworks and schedules. The Inception Report will be submitted within one month of holding the workshop.

Performance Monitoring: Performance monitoring will be done throughout the project period. The monitoring cycle will be quarterly and the report will be shared with the members of the Steering Committees. The Performance Monitoring Report will include the following components:

(a) Progress Tracking: Conduct of activities against their time line will be tracked every quarter. The process entails conduct of review meeting and each activity will be tracked in terms of its progress and state of implementation. The review will be followed up with finalizing the next quarter plan of activities that will incorporate spill over and inadvertent delays.

(b) Risk Management: Every quarter the risks will be monitored and the action taken for managing each risk will be reviewed. The exercise will also include identification of new risks and allocation of responsibility for managing it.

(c) Output to Outcome: Tracking Performance monitoring will undertake monitoring and review of output to outcome tracking.

(d) Financial Monitoring: Quarterly financial monitoring will be undertaken in order to review the progress of financial utilization and for ensuring that the expenditure for each head is according to the financial norms specified in the budget and agreed procurement processes. The accounts and audit will be maintained evaluated by the Tamil Nadu Department of Environment

Task Force for Monitoring

The following panel comprising of members from various departments and institutes will be responsible for monitoring of the project activity.

Chairperson : Director, Department of Environment

Members : Director, GOMBRT
Wildlife Warden, Gulf of Mannar Marine National Park
Expert from IIT Madras
Expert from IOM, Anna University

Project Completion Report: At the end of the project a Project Completion Report will be prepared and submitted on an agreed format that will consolidate all the activities carried out during the project, its achievements, and results along with evidence of impact and benefit.

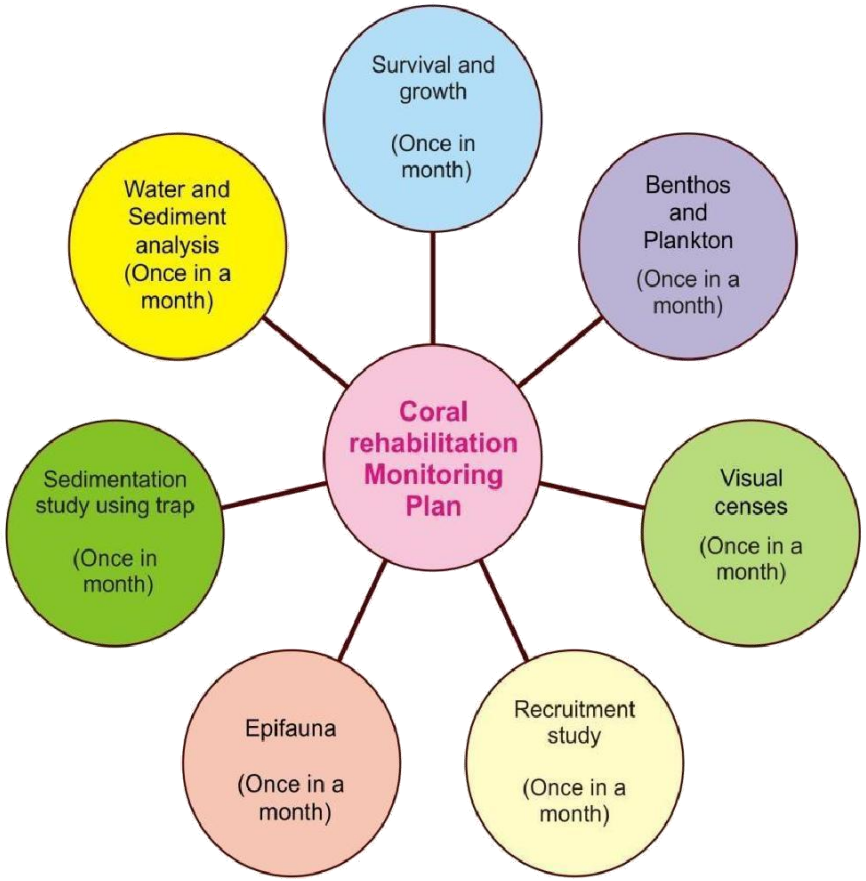
(a) Audited Statement A detailed Audited Statement of accounts will be prepared and submitted in funds received and spent under the project.

No.	Monitoring and Evaluation Plan Activity	Responsible Person	Yr.1	Yr. 2	Yr. 3	Yr. 4	Total	Timeframe
1	Project Inception report	Director, Department of Environment	First Quarter					Three months
A	Performance monitoring	Director, Department of Environment	4 times	4 times	4 times	4 times	32 days	Quarterly basis

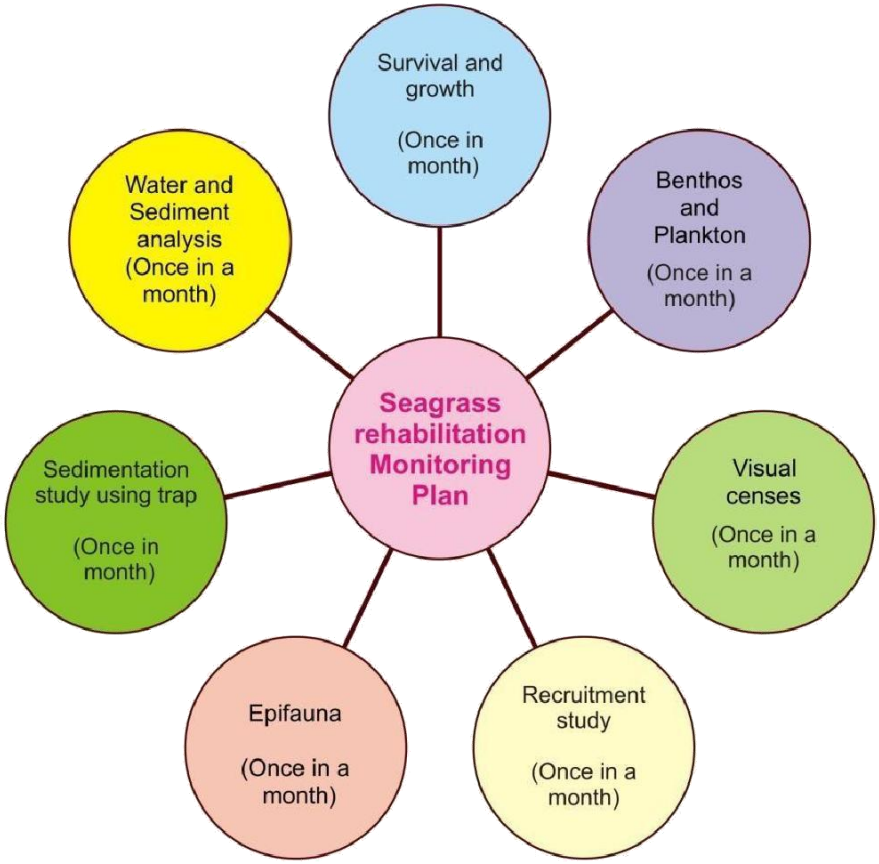
B	Financial monitoring	Designated Finance and audit officer of, Department of Environment	12 times	12 times	12 times	12 times	48 days	Monthly basis
C	Overall periodic monitoring of the activity	State Steering Committee on climate change	2 times	2 times	2 times	2 times	8	Six monthly review

In addition, there will be monitoring and evaluation mechanisms by the Project Management Unit on a monthly basis to monitor the technical progress of the project activities.

Schematic diagram for Coral rehabilitation monitoring frequency



Schematic diagram for Seagrass rehabilitation monitoring frequency



d) Include a results framework for the project proposal, including milestones, targets and indicators

Activity	Indicator	Baseline	Target	Means of Verification	Risk and Assumptions
Objective 1: Baseline data on vulnerability to climate change of coastal ecosystems (including biodiversity and fishery) and coastal communities					
Activity 1.1 – Conduct baseline survey to identify present status of coastal biodiversity	Species diversity, Species richness, habitat diversity etc.	Data collected during 2003-2005	Between Rameswaram and Kanyakumari coasts	Reports and indices	Assumptions: Standard biodiversity monitoring techniques shall be used Risks: in sampling errors,
Activity 1.2 –Identify vulnerable zones/areas based on diversity, distribution and abundance	Species diversity, Species richness, habitat diversity etc.	Data collected during 2003-2005	Between Rameswaram and Kanyakumari coasts	Reports	It is not envisaged any major risk in the implementation of the proposed project. However, climatic conditions in Gulf of Mannar are considered as risk. There are two clear seasons prevailing in Gulf of Mannar, i.e. "calm" season from October to March and „rough" season from April to September.
Activity 1.3 - Baseline vulnerability assessment of fishermen and coastal community done	Socio economic indicators like income, literacy, access to drinking water, health care etc.	• As observed during GEF, UNDP, and other programmes • Census data	Improved socio economic status of the targeted community at the end of project	Socio economic indicators	Assumptions: Standard socio economic survey tools have been used. Risks: in sampling errors

Activity	Indicator	Baseline	Target	Means of Verification	Risk and Assumptions
Activity 1.4 - Assessment of current fishing pattern	Catch per unit effort	• As observed during GEF, UNDP, and other programmes • Secondary data from Fisheries census	Sustained and optimum fishing pressure	Indices	Assumptions: Risks: in sampling errors
Objective 2.1 : Coral Reef Rehabilitation in Vilanguchalli and Kariyachalli islands					
Activity 2.1 - Substrate Construction, deployment, transplantation and coral rehabilitation in 4 km^2 degraded coral reef area	Concrete frame (CF) construction (1mx1mx0.25m) CF – 1200 Nos Cement slabs (CS) construction (20cmx5cmx1.5cm) CS – 12000 Deployment of substrates Transplantation of live corals from colonies on slabs and	No Coral cover in 4 km2 in degraded reef area alongside Vilanguchelli & Kariyachelli islands	1200 concrete frames fixed High coral cover, fishery production 1200 Slabs with fixed corals laid on the 1200 substrates Coral attachment takes place. Growth and regeneration visible Adaptation to livelihood – fishery production in rehabilitated area	Monthly surveys by scuba diving to assess fixing of (i) frames and slab placement (ii) Extent of coral attachment, failure and growth	Assumptions: Corals and fisheries respond to rehabilitation efforts Risks: Mortality of corals due to other factors beyond the project

Activity	Indicator	Baseline	Target	Means of Verification	Risk and Assumptions
	placement on substrates				
Objective 2.2 - Sea grass rehabilitation in Vilanguchalli and Kariyachalli islands					
Activity 2.2 - Substrate Construction, deployment, transplantation and sea grass rehabilitation	PVC frames construction (1mx1m) 2000 Nos Deployment of substrates Transplantation	Absence of seagrass cover in 4 km^2 degraded area	2000 substrates fixed Adequate Growth of seagrass Fishery production in rehabilitated area	Monthly surveys by scuba diving to assess fixing of (i) substrates (ii) Extent of seagrass growth (iii) Difference in fish recruitment	Assumptions: Seagrasses respond and recover to rehabilitation efforts Risks: sea grass damage to fisheries activities
Objective 3 – Deployment of Artificial Reef Modules					
Activity 3 – Artificial Reef deployment	Artificial reef modules construction (2.5mx2mx1m) 6000 Nos and deployment	Around Vaan Island at 3 m depth at places without any AR modules	Protection of island and resilience	Monthly surveys by scuba diving to assess Increase in Biodiversity, fish assemblage and production. New fish habitat created	Assumptions: Fisheries respond to artificial coral reef Risks: It is not envisaged any major risk in the implementation of the artificial coral reefs

Activity	Indicator	Baseline	Target	Means of Verification	Risk and Assumptions
				for sustained livelihood	
Component 5: Eco development activities					
Activity 5 – Training, awareness and assistance to trainees for eco-development	• Nos. of individual participants trained • Nos. of SHGs & other groups trained • Nos. of SHGs / Individuals given assistance activity wise & quantum wise	• Present income status of individuals, SHGs, other groups, • Present status of dependence on catch fisheries at the start of the project as per the baseline survey	Increase in adaptive capacity among the fisher community from 23 villages	Comparison of data at the State and end of project period	Although no major risk is envisaged in the implementation of the proposed project, however there might be several groups which can create resistance.

e) Include a detailed budget with budget notes, a budget on the Implementing Entity management fee use and an explanation and a breakdown of the execution costs.

Component	Activities	Details	Cost	Total (in lakhs)
Baseline Survey	Coastal habitats and associated biodiversity	Manpower(Underwater dive professionals)	28.80	59.0
		Hiring of Equipment's (Underwater dive equipment's)	12.20	
		Transportation (to bring dive equipment's)	5.0	
		Contingency	4.0	
		Boat hire	6.0	
		Others including travel	3.0	
	Fisheries	Manpower	10.0	21.0
		Travel	3.0	
		Contingency	3.0	
		Boat hire	3.0	
		Others	2.0	
	Socio economic vulnerability of fishermen and other coastal communities	Manpower	5.0	10.0
		Travel	2.0	
		Contingency	2.0	
		Others	1.0	
Sub total				90.0
		Concrete frame (CF)construction[1m X 1m X 0.25m] CF - 1200 Nos <u>Rate:</u> CF - @ INR.1050 per frame	12.60	

Coral rehabilitation	Substrate construction, deployment, transplantation and monitoring	Cement slabs (CS) construction [20 cm x 5-cm x1.5 cm]. CS – 12,000 Nos. (each concrete frame would have 10 slabs) <u>Rate:</u> CS - @ INR.80 per slab	9.60	110.0
		Deployment of substrates	9.0	
		Transplantation	10.0	
		Manpower(Underwater dive professionals)	28.80	

Component	Activities	Details	Cost	Total (in lakhs)
		Hiring of Equipment's (Underwater dive equipment's)	8.0	
		Transportation (to bring dive equipment's)	4.0	
		Contingency	5.0	
		Boat hire	8.0	
		Others (Monitoring - 3 years)	15.0	
Sub total				110.0
Seagrass rehabilitation		PVC frame construction (1 X 1 m) @ INR.400 per frame for 2000 nos.	8.0	
		Transplantation	8.0	
		Deployment	6.0	
		Manpower(Underwater dive professionals)	18.0	70.0

	Substrate (PVC frames) construction, deployment, transplantation and monitoring	Hiring of Equipment's (Underwater dive equipment's)	6.0	
		Transportation (to bring dive equipment's)	3.0	
		Contingency	2.0	
		Boat hire	4.0	
		Others (Monitoring – 3 years)	15.0	
Sub total				70.0
Artificial Reef Deployment	Artificial Reef Modules construction, deployment and monitoring	Artificial Reef Modules construction (Size: 2.5m width, 2m height and 1 m longitudinal length) - 6,000 Nos. @INR.15,000 per module.	900.0	1260.0
		Deployment	170.0	
		Manpower(Underwater dive professionals)	92.0	
		Hiring of Equipment's (Underwater dive equipment's)	15.0	
		Transportation fare (to bring SCUBA equipment's)	10.0	
		Contingency	15.0	
		Documentation and permission	8.0	
		Boat hire	15.0	
		Others (Monitoring – 3 years)	35.0	
Sub total				1260.0
		Training on livelihood schemes	30.0	

Eco development activities	Training, Awareness and assistance to trainees	Awareness	10.0	720.0
		Revolving fund	340.0	
		Infrastructure like boat, snorkelling set, aquaria and interpretation centre, up gradation of fishing landing, materials to start livelihood schemes	340.0	
Sub total				720.0
Admin Cost	Project Execution Cost (Capacity Building, M&E Cost and Project Cycle Management Fee charged by the Implementing Entity)			15200000
NABARD Fee			7206000	
Grand Total				247406000

Revenue

Sl No	Activity	Beneficiary Group	Income generation potential
1	Conservationof marine ecosystem through awareness creation	Local Fisher Community	Daily Livelihood for over 100,000 traditional small scale fisher folk @ INR.500 per day/person
2	Imparting vocational training to fisher youth	Local Fisher Community	Monthly INR.5,000/-per family for 75-100 families
3	Reviving and nurturing SHGs	Local Fisher Community	Monthly INR.5,000/-per family for 50 - 75 families

Sl No	Activity	Beneficiary Group	Income generation potential
4	Issuing SHG loans to fishermen	Local Fisher Community	Monthly INR.5,000/-per family for 50 - 75 families
5	Biodiversity training	Local Fisher Community	Knowledge on biodiversity - its importance and need for conservation
6	Construction of community hall	Local Fisher Community	Monthly INR.15,000/- to the community
7	Construction of Self Help Group activities and multipurpose training centre	Local Fisher Community	Monthly INR.15,000/- to the community
8	Improvement of major and minor fish landing shelter at fishery villages	Local Fisher Community	Monthly income enhancement of over INRs. 150,000/- on the catch due to hygienic practices
9	Construction of interpretation Centre is also carried out for disseminating information regarding GOM.	Local Fisher Community for income generation and General public for awareness building	The people who manage the facility would get a minimum of INR.5000/- month and in addition the value of awareness building is not measurable. The benefit is ultimately to the local fisher community
10	Imparting local specific skill up gradation training to fishermen SHG members. (i.e. Tailoring, embroidering, etc.,)	Local fisher community	SHG members (about 50 members) would earn a minimum of INR. 1,500/- to INR. 2,000/- per month. This could be supplementary income to other activities
11	Eco tourism activities - snorkelling	Local fisher community	The people who manage the facility would get a minimum of INR. 3000/- to 5000/- month
12	Boating	Local fisher community	The people who manage the facility would get a minimum of INR. 3000/- to 5000/- month

Sl No	Activity	Beneficiary Group	Income generation potential
13	Mud crab fattening/ culture,	Local fisher community	SHG members (about 10 members) would earn a minimum of INR.1500/- to INR. 2000/- per month. An SHG can complete 10-12 cycles of 25-30 days and reap an average yield of 90-120 kgs. of crab meat per cycle. This process has an earning potential of Rs. 120-140 per kg. of crab, once costs have been deducted
14	Sea weed farming	Local fisher community	In an area of 1 ha, with a minimum of 4 harvests in a year, a total of 120 tonnes (fresh weight) of crop could be obtained when the yield is 3 kg/m2. If the seaweed is dried (75% moisture) and marketed at a rate of Rs 2000/- per ton, the net profit would be Rs 6000/- for one year. If the harvested seaweed is dried and processed into agar-agar, the profits will reach around Rs 100,000. This activity is currently prohibited in the GoM
15	Marine ornamentalfish breeding	Local fisher community	SHG members (about 40 members) would earn a minimum of INR.5,000/ per month. For a unit size of 120 cu. ft. capacity, capital cost – INR. 90000/- and annual recurring expenditure of Rs. 10000/- for production of approximately 30000 fry per year
15.1	Mollies		Revenue – INR 30000/annum
15.2	Platy		Revenue – INR 30000/annum
15.3	Swordtails		Revenue – INR 30000/annum

f) Include a disbursement schedule with time-bound milestones at the component level

Instalment	Percentage	Amount	Year	Milestones
First	25%	6,00,50,000	January, 2016	Project Initiation, inception workshop, etc.
Second	25%	6,00,50,000	June, 2016	Progress implementation, monitoring & review by steering committee

Third	25%	6,00,50,000	June, 2017	Project implementation, monitoring & review by steering committee
Fourth	20%	4,80,40,000	June, 2018	Project monitoring & review
Fifth	5%	1,20,10,000	January, 2019	Final report, workshop and completion
TOTAL		24,02,00,000		

Major Activities	Year 1				Year 2				Year 3				Year 4				Yr 5
Quarterly milestones	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
Activity 1.1: Baselines survey of stal biodiversity																	
Activity 1.2 : Baseline survey of fishing patterns																	
Activity 1.3 : Base line Socio economic survey of Fisher folk villages																	
Activity 2.1 : Coral reef substrates construction, deployment and transplantation (2 sq. km in each year)																	
Activity 2.2 : Seagrass substrates construction, deployment and transplantation (2 sq. km in each year)																	
Activity 2.3 : Monitoring of growth & regeneration, repair / restocking / adjustment (wherever required)																	
Activity 3.1 : Artificial Reef module construction and deployment																	
Activity 3.2 : Monitoring, Readjustments & recording																	
Activity 4.1 : Planning for Eco-development activities																	
Activity 4.2 : Implementation of Eco-development activities																	
Activity 4.3 : Monitoring of Eco development activities																	
Activity 5 : Review of work done																	