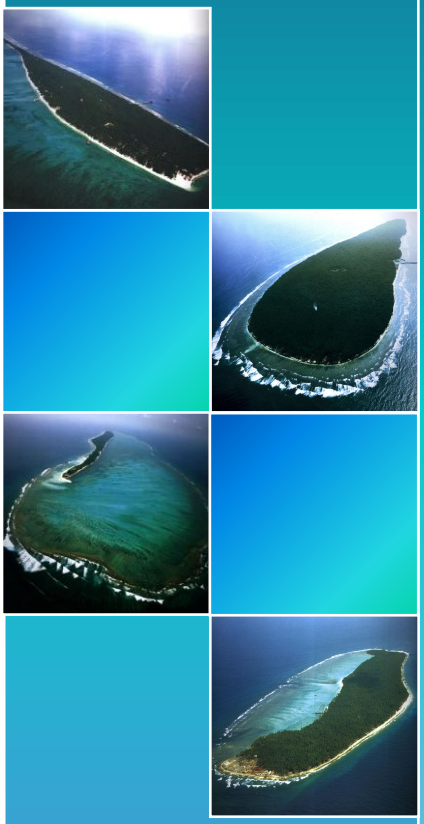
2012

LAKSHADWEEP ACTION PLAN ON CLIMATE CHANGE (LAPCC)



UNION TERRITORY OF LAKSHADWEEP

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LAKSHADWEEP ACTION PLAN ON CLIMATE CHANGE (LAPCC)

Department of Environment and Forestry

Union Territory of Lakshadweep

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Foreword

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List of Acronyms and Abbreviations

CESS	Centre for Earth Science Studies
CGD	Central Garbage Depositories
CHC	Community Health Center
CSD	Central Garbage Depositories
CRZ	Coastal Regulation Zone
CWC	Central Water Commission
DMHS	Director of Medical and Health Services
EAF	Ecosystem Based Approach
EEZ	Exclusive Economic Zone
FAD	Fish Aggregation Devices
FAO	Food and Agricultural Organization
HDI	Human Development Index
ICEF	India-Canada Environment Facility
LAPCC	Lakshadweep Action Plan on Climate
LK	Lakshadweep
LPCC	Lakshadweep Pollution Control
MSL	Mean Sea Level
NAPCC	National Action Plan on Climate Change
NDMA	National Disaster Management Authority
NIOT	National Institute of Ocean Technology
PHC	Primary Health Centers
PWD	Public Works Department
SPV	Solar Power Voltaic
SPORTS	Society for Promotion of Recreation and
UTL	Union Territory of Lakshadweep
MARK	Multiple access rural radio system
WLL	Wireless in local loop
IPCC	Intergovernmental Panel on Climate
IITM	Indian Institute of Tropical Meteorology
ISM	Indian summer monsoon
RH	Relative Humidity
SST	Sea Surface Temperature
AOGCM	Atmosphere Ocean General Circulation
SRES	Special Report on Emissions Scenarios
OWC	Oscillating Wave Column

Executive Summary

The Lakshadweep Action Plan on Climate Change (LAPCC) has been formulated in accordance with the principles and guidelines of the National Action Plan on Climate Change (NAPCC). The LAPCC integrates the action plan of the Union Territory of Lakshadweep (UTL) with the ongoing and proposed developmental programmes in the Union Territory, and in tandem with the eight national missions along with the principles and guidelines listed out in the NAPCC. In view of the limited availability of specific climate change related information on Lakshadweep, climate change response strategy for the islands have a 'precautionary adaptation approach'; which will be embedded largely as a sub-set of overall "sustainable" development. Such a strategy is envisaged to contribute to sustainable development, overall reduction in vulnerability, and improved resilience of natural resources and communities. The LAPCC is structured and organized into three main sections viz., Part A: Climate Profile, Part B: Climate Change Strategy and Part C: Climate Change Action Plan.

State Profile

The Union Territory of Lakshadweep (UTL) is the only atoll coral island chain in India. The Lakshadweep archipelago comprises of the most extensive coral reef and atoll system in the Indian Ocean as well as the largest atoll system in the world. Apart from harbouring significant biological diversity and acting as the breeding grounds for fishery stock, coral reefs also act as the 'natural defence mechanism' against sea-surges and storms in the Islands.

The islands are geographically isolated with a maximum distance of more than 400 km from the mainland, and have to depend on mainland for almost everything. Connectivity poses a very severe problem, both for the quality of life and for marketing of local produce in the islands. The distance from mainland affects the mobility of people for education, employment, social and religious purposes, medical treatment etc.

Ecosystem and Ecological Profile

Coral reefs provide up to 25% of the total fish catch in India and up to 75% of the animal protein consumed. Coral reefs of Lakshadweep support species of sponges, seaweeds, sea grass, crustaceans, echinoderms, molluscs, ornamental fishes, and various other species. Its associate biodiversity also include 4 species of Turtles and 4 species of mammals. Pitti Island has been declared as the only one bird sanctuary and the buffer zone around the island is also being declared as a Pitti Conservation Reserve. The vegetation is typical of Indo-Pacific atoll coral island flora. There is no declared forest in Lakshadweep, but 80 % of its land mass is covered by green vegetation, mainly with coconut trees.

Social profile

Demographics: According to 2011 Census, the inhabited islands had a total population of 64,429 covering 33,106 males and 31,323 females. The population density of Lakshadweep is 2013 persons per sq.km, one of the highest in the country. In Lakshadweep, the entire ethnic population is classified as Scheduled Tribes because of socio-economic backwardness, geographical isolation, etc.

There is little economic inequality (egalitarian society) in Lakshadweep and the poverty index is low. According to provisional figures of 2011 census, Lakshadweep has recorded its overall literacy rate as 92.28%, next only to Kerala which has 93.91% literacy rate. The level of unemployment in Lakshadweep despite its very small population is very high. Low levels of employment opportunities in the sectors of industry and agriculture, coupled with high levels of literacy seem to have brought about the high rate of unemployment in Lakshadweep.

Water Supply and Sanitation: Ground water occurs under phreatic conditions in these islands occurring as a thin lens floating over the seawater and is tapped by open wells. The only natural source of water is ground water (sub soil water) which is being replenished by rainwater mainly during the south west monsoon. All the inhabited islands are problem areas so far as the drinking water supply is concerned. Almost all households have wells; one or two shallow dug wells for extraction of this floating fresh water for washing, bathing, livestock and even drinking during critical periods of the year. Water supply scheme has been introduced in all the islands in Lakshadweep, but the supply is partial in quantity. Lakshadweep has also introduced rainwater harvesting system through tanks and distributed through a network of pipes and community taps set up at regular intervals.

The survey by NSS shows that 89% of the households do not have drainage facility, which is the highest in the country. The pattern of latrine usage and dependence on unprotected well for drinking water indicate poor drinking water quality in the islands. The conventional method of sewerage and sewage treatment is not feasible because of the coral sandy strata, inadequacy of space, high water table and flat terrain.

Health Indicators: In terms of health indicators such as birth and death rates, infant mortality rate, maternal mortality rate and life expectancy at birth, Lakshadweep stands ahead of the all India average. Major epidemics threatening the islands of Lakshadweep are waterborne diseases such as gastroenteritis and cholera. Malaria and pneumonia have also been reported in Lakshadweep. These diseases point towards the most widespread environmental problem namely, the lack of sanitation facilities posing grave risks to human health. Lakshadweep has no private hospitals. It is served by two Government hospitals, three Community Health Centers (CHCs), four Primary Health Centers (PHCs) and two First Aid Centers with a total bed strength of 200 in 11 islands.

Economic Profile

Livelihood: Coconut is the dominating agricultural crop in the district. There is potential for introducing fruits and vegetables, medicinal plants and also promoting value addition. The uses of chemical

fertilizers are practically banned in the islands, on ecological consideration. Animal husbandry in the islands mainly consists of poultry and goat rearing, with cattle coming thereafter. Owing to the scarcity of grazing lands and traditional factors, household farming of cattle is being practised instead of organised farming. The fishery resources of the islands inhabiting the reefs and numerous lagoons play a vital role in the economy of the islands. Lakshadweep has been declared as a "No Industry District" of the country in view of the fragile ecology of the islands. Industrial activity in Lakshadweep centres on coir and fish and has declared tourism also as an industry.

Transport: As the islands lie scattered in the Arabian Sea, and whenever a natural calamity occurs, the lifelines of these islands viz. communication and transportation are disrupted and the link between mainland and islands becomes non-functional. Mid-sea embarkation and disembarkation of passengers and cargo is very risky, especially in monsoon period (high sea, high speed wind) and therefore landing barges are urgently required. All the inhabited islands of Lakshadweep are serviced by all-weather cement concrete roads (main road and branch routes), providing at least the main connectivity within each island. Each island is serviced by a main road and branch routes.

Energy: Electricity generation is mainly through diesel generators. Diesel comes from the mainland, making it expensive and the process of transportation cumbersome. The transportation of high speed diesel oil to the islands is difficult and expensive. In order to meet monsoon requirements of the Diesel Generator sets, diesel oil is stored well in advance. The storage of diesel oil for long periods not only results in wastage of the diesel oil through leakage but also affects the ecological condition of these islands. Moreover, as the soil in these islands is highly porous, the seepage of oil from diesel generators as well as during transportation at various places such as loading and unloading locations, jetty, powerhouse, etc. and supply/storage in damaged leaky barrels pollute the water and the soil.

Lakshadweep has decided to extend the use of renewables in the islands, so that at least 20% of the total power demand is met by these alternate energy sources initially and then progress to 100% electrification through renewable energy. Solar energy has a lot of potential in Lakshadweep. There are 11 Solar Power Voltaic (SPV) plants established with capacity of one megawatt. Geographical location, ecological considerations and energy demand pattern of Lakshadweep make solar energy one of the most appropriate options to meet the energy demand of the island. The main limitation for the application of solar-based technology in these islands is the large land area requirement for setting up the solar photovoltaic power plants. The situation in the islands of Lakshadweep is favourable for wave power generation, even as a stand-alone system considering the non-availability of other sources and high cost of diesel power generation.

Climate Change Impacts and Vulnerability

The open sea coral islands of Lakshadweep are one of the low lying small groups of islands in the world. The low level of the islands of Lakshadweep makes them very sensitive to sea level rise and therefore

the foremost future threat to these island chains is potential global climate change. The IPCC Report (2007) predicts a global sea level rise of at least 40 cm by 2100 that shall inundate vast areas on the coast, and up to 88 per cent of the coral reefs, termed the "rainforests of the ocean", may be lost. Researchers have warned that in India, the region most vulnerable to inundation from accelerated sea level rise is the Lakshadweep archipelago.

Available data on the topography of Kiltan, Kavaratti, Kadmat, Kalpeni-Cheriyam and Agatti-Bangaram islands suggest that the predicted sea level rise scenario value of 1 m may be responsible for 19, 11, 19, 21 and 18% (respectively) land loss in these islands. Low-lying islands are at greater risk from sea-level rise. Androtт, Kalpeni and Minicoy lie in a cyclone belt. The remaining islands are subject to the Southwest and Northeast monsoons causing heavy damages to coconut crops, seashore land, sheds and dwelling houses that are not able to withstand cyclonic winds or in areas subject to flooding. There is no significant change in rainfall and temperature data for last 30 years recorded in Lakshadweep. Specific climate models/data on rainfall, temperature and sea level rise for Lakshadweep are not available.

Sectoral Impacts and Vulnerability

Crop and Animal Husbandry: Arable land for crop agriculture is increasingly in short supply and the likely prospect of land loss and salinization due to climate change and sea-level rise will threaten the sustainability of both subsistence and commercial agriculture. Since vacant agricultural land is scarce in Lakshadweep, the result could be ruin for farmers hit by the effects of land loss. The problems can be tremendous considering the high population density and paucity of land. In the livestock sector, a lower yield from dairy cattle is reported in the realm of climate change. Being the dominant crop, climate change impact on coconut assumes great significance for Lakshadweep.

Fisheries: Tuna is the main fishery in Lakshadweep. Climate induced changes and fishery overexploitation occurring elsewhere may have local repercussions in islands like Lakshadweep and Maldives, as tuna fishery of is part of the wider Indian Ocean tuna fisheries. Tuna movement and abundance in the Indian Ocean is closely linked to the monsoon driven ocean productivity. The projected climate change will have impacts on fisheries such as degeneration of coral reefs and lagoon ecosystem, changes in the seasonality and abundance of fish species, which can reduce the catch type, size and income for local fishermen.

Biodiversity: Coral reefs serve as natural breakwaters. Any sea-level rise will allow waves to over-top the reefs, increasing coastal vulnerability to erosion and storms, at least until reef growth can catch up with sea-level. Corals thrive in a narrow temperature range and are highly sensitive to changes in temperature. The hard corals of Porites species, found in

abundance in the lagoons of the Lakshadweep islands, are facing a threat to their existence. In sea grass communities, warming ocean temperatures are likely to result in distribution shifts, changes in patterns of sexual reproduction, altered growth rates, metabolism, and changes in their carbon balance. It is suggested that the global climate change has the potential to eliminate the production of male turtle offspring if mean global temperatures increase

Water Resource: It has been estimated that a 10 percent reduction in average rainfall by the year 2050 could produce a 20 percent reduction in the size of the freshwater lens on small islands. A reduction in the size of the island, resulting from land loss accompanying sea-level rise, is likely to reduce the thickness of the freshwater lens on atolls by as much as 29%. Studies conducted for small island atolls showed that a 50 cm rise in sea level accompanied by a reduction in rainfall of 25% would reduce the freshwater lens by 65%.

Health: Climate-sensitive health outcomes of concern in small islands include malaria, dengue, cholera and other diarrheal diseases, heat stress, skin diseases, acute respiratory infections and asthma. Rise in temperature will increase incidents of heat stress whilst projections for reduced rainfall, for instance, will reduce the amount of available freshwater for human use and consumption, leading to the increased risk of disease. Flooding associated with increased rainfall and high sea levels coupled with increased surface air temperature is likely to cause higher incidences of vector- and water-borne diseases. Harmful algal blooms (HABs) produce toxins that can cause human diseases, mainly by consumption of contaminated shellfish. Warmer seas may thus contribute to increased cases of human shellfish and reef fish poisoning (ciguatera) and poleward expansions of these disease distributions.

Energy: The energy infrastructure is very vulnerable to these extreme climatic events. For example, under strong winds with speeds over 100km/hr, electric wires and other electricity distribution components can easily collapse. With conventional and renewable technologies inherently reliant on climate, changes will result among other things in, altering availability of natural energy resources; changes in the quantity and timing of renewable resource extraction potential; and changes in operational performance of energy production systems. The proposed renewable energy sources (once implemented) viz., wave, tidal, or ocean thermal energy in Lakshadweep is also prone to climate change impacts.

Tourism: Climate changes will affect the tourism industry through increased infrastructure damage, additional emergency preparedness requirements, higher operating expenses (e.g., insurance, backup water and power systems, and evacuations). Changes in water availability, biodiversity loss, reduced landscape aesthetic, altered agricultural

production, increased natural hazards, coastal erosion and inundation, damage to infrastructure and the increasing incidence of vector-borne diseases will all impact tourism to varying degrees. Tourism in small islands like Lakshadweep is also vulnerable to climate change through extreme events and sea-level rise leading to transport and communication interruption.

Transport Sector and Infrastructure: Challenges have been identified that will confront the transportation sector as a result of climate variability and change. These include closure of roads, airports and bridges due to flooding and landslides, and damage to port facilities. The resulting disruption would not be confined to the transportation sector alone, but would impact other key dependent sectors and services including tourism, agriculture, health care delivery, clean water, food security and market supplies. The main infrastructure of the islands consists of houses, roads, buildings, ports and harbours, airports and helipads, boats, crafts and catamarans, automobiles and vehicles, communication facilities etc. As the islands lie scattered in the vast ocean, whenever a natural calamity occurs, the communication and transportation get crippled and people cannot move to other places as it is the case in mainland. Thereby the link between mainland and islands becomes non-functional. Moving away from traditional housing have increased vulnerability to thermal stress and slowed housing reconstruction after storms and flooding.

Livelihood Vulnerability: Coconut plantations are the first and the most affected causality of any cyclone surge. The loss of ripe coconuts and the uprooting of trees put an immediate pressure on the basic source of livelihood of the majority of the population. Traditionally it is said that the loss of crop in one season leads to poor harvest in the next season also. So, the farmers are basically affected for two consecutive years due to loss of coconut harvest. Uprooting of coconut trees, loss of standing coconut crops, limited tourism operations and fishery activity will slow down the economy and loss of livelihoods options for people. The number of fishermen engaged in fisheries sector constitutes about 25% of the total working population. In the longer run, losses to physical and social infrastructure further hamper development. Lakshadweep has limited scope for industrial development on account of ecological and economic reasons. Hence, the prospects for economic growth will have to focus mainly on agriculture, fisheries and allied activities. Tourism and small scale and industries provide supplementary livelihoods.

Key Challenges for Lakshadweep		
• Limited physical size and natural resources • Insularity and remoteness • Extreme dependence on mainland, high sensitivity to external market shocks, over which they exert little or no control (low economic resilience) • Distance to major markets • High population densities and high population growth rates; • Unique biodiversity in and as coral reefs; coral bleaching and manmade degradation • High susceptibility to natural hazards such as tropical cyclones (hurricanes) and associated storm surge, and droughts	• No ground water source; entirely dependent on rainfall • Relatively thin water lenses that are highly sensitive to the variability in rainfall and sea-level changes • Poor water supply and sanitation facilities; no drainage system • High levels of pollution due to inadequacies in sanitation and drainage, inadequate solid waste management • High dependence on non-renewable energy source; land area and technological constraints to promote non renewable energy sources • Huge quantum of unutilized coconut wastes	• Inadequate infrastructure and capacities in all sectors • Very low opportunity cost of labour • Limited scope for agriculture land expansion, limited knowledge on crop diversification and suitability, resource constrained animal husbandry activities • Unexplored and unutilized marine economic potential • Limited funds and human resource skills, which severely limit the capacity of small islands to adapt to the effects of climate change • Lack of scientific assessments/data on climate change impacts and vulnerabilities

Climate Change Strategy

The LAPCC has identified appropriate actions for expanding and broadening the range of coping strategies adopted by local communities such that they become resilient against the adverse impacts of climate change and are in a position to achieve the Millennium Development Goals (MDGs). For this purpose, an action plan has been drawn, for the next five years, highlighting the fruitful action to be taken up to meet the well-defined goals set up in the NAPCC based on the proposed Vision and Goal (details in concerned section) for the islands, through a multi-level consultative process. An overarching framework with five elements viz., developing and implementing appropriate adaptation measures for vulnerability reduction, contributing to reduction in greenhouse gas emissions, improving governance mechanisms and institutional decision making, improving the knowledge base and understanding climate change, and capacity development, education & awareness.

Key Sectors and Prioritized Adaptation Strategies
Agriculture and Allied Sectors • Promote good package of practices for the cultivation of coconut including adoption of proper spacing, use of bio-fertilizers, etc. • Identification and promotion of genetically superior coconut trees from the local species and supply of quality seedlings. • Promotion of diversification of coconut products and adoption of better marketing strategy including organic certification and premium marketing. • Revitalization and integration of traditional cropping methods with modern production practices. • Promotion of intercropping and home-stead agro-forestry, wherever feasible, for income augmentation, subsistence and nutritional security. • Promotion of high yielding varieties of livestock and diversification of products. • Promotion of agricultural extension services and conducting capacity building programmes • Effectively implement and widen the reach of crop and livestock insurance against calamities.
Fishery • Assess and estimate sustainable yield projections for fisheries in the UTL. • Adopt Ecosystem Based Approach (EAF) framework developed by Food and Agricultural Organization (FAO) for promoting sustainable fishing operations. • Expand the reach of modern technologies like Doppler Radar Systems and satellite data that would enhance and improve fishing operations. • Expand the reach and supply of improved fishing gear and equipment's to fishermen. • Installation of proper storage facilities, improved marketing of fishery products and product diversification. • Complete the procurement of mother vessel for fishery operations. • Explore the potential of promoting ornamental fishing including marketing and its impacts on marine biodiversity. • Ensure uninterrupted supply of diesel, oil, etc. to fisher-folk. • Integration of traditional fishing operations into modern systems. • Stricter compliance of Marine and Fisheries laws and strengthened enforcement against violations and illegal fishing operations. • Undertake periodic extension activities and capacity building.
Water Supply and Sanitation • Undertake detailed study of all inhabited islands of the UTL to delineate the geometry of fresh ground water lenses, assess storage potential, recharge dynamics, the sustainable yield potential, etc. in order to suggest appropriate, futuristic groundwater development and management options. • Complete and commission desalinization plants in the remaining inhabited islands. • Augment the capacity of rainwater harvesting systems. • Develop a fresh water use policy and water budgeting. • Undertake public awareness programmes for promoting rational use of water and water budgeting.
Ecology and Environment • Undertake periodic monitoring of the extent and health of coral reef system in the UTL by setting up a multi-disciplinary Coral Monitoring Team comprising of experts and staff from various department like Environment and Forests, Fisheries, Agriculture, scientific institutions, etc.

- Stricter enforcement of laws for the protection of coral reef and lagoon.
- Conduct regular awareness programmes on the conservation of coral reef including incorporation into school and college curriculum.
- Discourage the use of corals for construction works and provide alternatives.
- Restoration of degraded lagoons and corals including through coral transplanting in heavily degraded areas.
- Prevent disposal of wastes (both liquid and solid) into coral reef system and carry out periodic cleaning/ waste removal operations with active participation of local communities.
- Prevent discharge of pollutants from barges and ships into the lagoon and seas.

Forestry

- Envisage coverage of vulnerable seashore area with 3-4 rows of littoral, mangrove tree belt vegetation
- Social Forestry: Social forestry aimed at rejuvenation of littoral vegetation, raising of marine green belt with tree plantation and other social forestry activities.
- Reclamation and regeneration of vegetation in and around lakes and ponds: The natural lakes and natural ponds (wetlands) in various islands especially in Minicoy & Bangaram islands should be maintained. The mangrove vegetation (Ceriops tagal, Bruguiera parvifolra) around and other littoral associated trees are to be protected and conserved.
- Assistance to Lakshadweep Medicinal plant Board for rising and maintenance of medicinal plants: The protection and preservation of medicinal plants in the island required to check the extinction of the endangered species. The traditional use of these herbals in the traditional medicines and make awareness and keeping demonstration plots in various islands.

Medical and Public Health

- Sustained awareness among local communities on waste disposal, sanitation, public health, etc.
- Augment the facilities for the safe disposal and management of bio-medical wastes.
- Special efforts to recruit doctors with a mandatory time frame to work on islands.
- Arrange for extra manpower, doctors, paramedic's as well as storage and distribution of medicines and facilities for mobile hospitals, which can be installed on a ship/ vessel.

Flood Control/Anti Erosion

- Undertake long term and systematic monitoring of coastal erosion in various islands.
- Undertake thorough review of the existing systems of coastal protection including the methods of placement of tetra pods and spatial planting of woody, herbaceous vegetation and creepers.
- Stricter enforcement of rules and laws regarding the protection of corals reef including augmenting the current enforcement capacity (technical know-how and manpower).
- As suggested by CWC construction of a ring bund around the Islands may be considered as and when really required.
- Establish a fool proof coastal green wall using preferably indigenous species and species found to be effective against coastal erosion.
- Promote the growth of coastal creepers like Ipomea, etc. that act as a strong soil binder.
- Adopt natural solutions over engineering solutions as these are cost effective, affordable and provide multiple ecosystem benefits.
- Revitalize the local traditions for coastal protection – e.g., retting of coconut husks along the banks.
- Preparation/ revision of Integrated Coastal Zone Management Plan as envisaged in the Coastal Regulation Zone Act, 2011 that promotes the conservation of sand dunes, mangroves, lagoons, beaches, etc. and regulate

indiscriminate and ecologically non-sensitive interventions on coastal habitats.
- Ensure close coordination between the Departments (Environment & Forests, Public Works, Fisheries, Science and Technology, etc.) on coastal erosion control activities.
- Adopt a judicious combination of natural and physical methods for coastal erosion control.
- Awareness and capacity development among local staff, local communities and children on coastal and shoreline protection.

Energy
- Estimate the potential of the 'state of the art' renewable energy resources and identify energy efficiency opportunities and standards including setting up 'hybrid' energy systems.
- Promote the use of non-conventional energy sources in the UTL.
- Develop an energy policy for the UT to ensure effective utilization of feasible renewable energy and energy efficient technologies.
- Explore the potential of state of the art biomass based (coconut residues) Gasifier for energy generation.
- Provide adequate and safe storage facilities (including oil depots) for fuel in the UTL
- Promote the use of energy saving appliances (LED, solar heater, solar drier, lanterns, street lights, etc.), smokeless and fuel efficient stoves.
- Establish integrated hybrid systems for power generation
- Conduct capacity development programmes on the use of renewable energy and energy efficient equipment's.
- Review the technical and financial sustainability of existing and future renewable energy and energy efficiency installations and provide technical assistance to improve their performance and disseminate good practices and lessons learnt.
- Provide technical support to update national greenhouse gas inventories.

Transport
- Periodically review and improve the connectivity of islands (Inter-Island and with the main land) through air and sea route.
- Introduce sea planes for inter-island connectivity.
- Complete the upgradation of Agatti airport and complete the construction of new airport at Androtт.
- Rationalize the use of petroleum vehicles and promote eco-friendly mode of transport.
- Promote the use of bicycles for intra island mobility

Tourism
- Promote 'low volume high value tourism' in the UTL as they are less demanding on local ecology and bring in increased revenue per tourist.
- Scale up the branding of the UTL as an ideal destination and develop more tourism products and activities.
- Periodically monitor and assess the ecological and cultural impacts of tourism in the UTL.
- Promote community based nature based tourism.
- Adoption of better marketing and branding of tourism operations.
- Estimate the carrying capacity of tourism operations.

Disaster Management
- Develop contingency plan for disaster risk reduction and management
- Complete the construction of cyclone shelters.
- Install early warning systems in all islands
- Capacity development of staff and citizens

Climate Change Action Plan

Lakshadweep Action Plan on Climate Change (LAPCC) will build on the existing policies, programmes and schemes being implemented in Lakshadweep and those identified in the NAPCC. The LAPCC will be integrated into the UT level planning and budgetary process so that the resource allocation for implementing the identified adaptation/mitigation measures can be in consonance with the overall development goals of the UT. Developing a sound and pragmatic Climate Change Action Plan and its subsequent implementation in Lakshadweep requires strengthening/ evolving supportive institutions, information, finance, technology and public support. The strategy has been developed in consonance with national and regional developmental objectives and contexts, based on available sound scientific information and by following a participatory approach including consultation with local stakeholders and communities. The LAPCC also identified the priorities in different missions that are relevant to LAPCC. Details of LAPCC activities planned under each of the NAPCC Missions including the timelines and budget are presented in the section.

Process of Preparation of LAPCC

Stakeholder Consultations: The LAPCC was prepared and coordinated by the Department of Environment and Forest, which acts as the nodal department. The nodal department works in coordination with all the line departments at all stages during the LAPCC preparation. The LAPCC focuses on climate change adaptation, considering the small island status of Lakshadweep and the magnitude of climate vulnerability. The baseline information and adaptive strategies were compiled in consultation with the stakeholders in a participatory mode. Series of sectoral meetings and stakeholder consultations were organized with technical backstopping from the UNDP.

Institutional Framework for Coordinating Climate Change Action Plan: As envisaged in the frame work for preparation of the State Level Action Plan on Climate Change and in accordance with the strategy outlined in the National Action Plan on Climate Change, the Hon. Administrator, U.T of Lakshadweep constituted a State Steering Committee (SSC) and a State Advisory Board (SAB) on 30th March 2012 for providing overall guidance, supervision, and also coordinating the whole process of preparation of Lakshadweep State Level Action Plan on Climate Change and its subsequent implementation.

Monitoring and Evaluation: The M&E system for climate change adaptation will be coordinated by the State Advisory Committee under the overall direction of the State Steering Committee constituted by the UTL Administration for preparing the LAPCC and the implementation of the plan thereafter.

Part A: Climate Profile

1 LAKSHADWEEP - AN OVERVIEW

Climate change poses several environmental and developmental challenges for Lakshadweep Islands (UTL). Being a cluster of small 'sea-locked' coastal territory, it would deepen the already existing vulnerabilities of the islands such as isolation and remoteness. It may face additional threats from accelerated exposure to external shocks and natural disasters, sea level rise, salt water intrusion, reduced availability of fresh water, coral bleaching and breaching, debilitated functionality of ecosystems, shrinking livelihood base, and excessive dependence on external assistance and resources. This perilous situation would be further exacerbated by high transportation and communication costs, expensive public administration and infrastructure investments, and limited opportunities to create sustainable and self-reliant economies of scale. All economic, social and ecological sectors are likely to be adversely impacted, and the cost of adaptation will be high.

India's National Action Plan on Climate Change, 2008 (NAPCC) through its eight Missions[1] provides multi-pronged and integrated framework for addressing climate change. The focus of NAPCC is on promoting the understanding of climate change, adaptation, mitigation, energy efficiency and natural resource conservation. In line with this, it has become imperative to strengthen the coherence of strategies at national and sub-national levels as most of the actions to combat climate change are undertaken at sub-national level. Developing a Climate Change Action Plan for Lakshadweep (LAPCC) becomes relevant and important in this context.

LAPCC will build on the existing policies, programmes and schemes being implemented in the UTL and those identified in the NAPCC. The LAPCC will be integrated into the UTL level planning and budgetary process so that the resource allocation for implementing the identified adaptation/mitigation measures can be in consonance with the overall development goals of the UTL. Developing a sound and pragmatic Climate Change Action Plan and its subsequent implementation in Lakshadweep requires strengthening/ evolving supportive institutions, information, finance, technology and public support.

In view of the limited availability of specific climate change related information on UTL, climate change response strategy for the islands may start with a *'precautionary adaptation approach'*, as this would lead towards vulnerability reduction, poverty alleviation, prudent management of natural resources, and over all sustainable development. Further, as it may not be possible to foresee the entire range of impacts of climate change in the UTL at this stage, it would be unrealistic to prescribe an exhaustive array of climate change response measures in the LAPCC.

[1]National Solar Mission, National Mission on Enhanced Energy Efficiency, National Mission on Sustainable Habitat, National Water Mission, National Mission for Sustaining Himalayan Eco-System, National Mission for Green India, National Mission for Sustainable Agriculture and National Mission on Strategic Knowledge for Climate Change

1.1 DEVELOPMENT ISSUES AND PRIORITIES

The developmental problems of Lakshadweep are distinctive being a small island territory. The perspective SAPCC for Lakshadweep offers a set of challenges arising out of the peculiarities of its social, economic and ecological dimensions and geographical isolation from other states/ U.T's in the Indian Union. The islands are also subjected to natural disasters in the various forms which make ecosystem and the society particularly vulnerable. The limited resource base, though the islands are spread over a very large area surrounded by sea and paucity of land are great limiting factors in taking up many activities, which could generate resources, employment and build infrastructure.

Insularity and Remoteness

The UTL depends on mainland for everything and is geographically isolated from the mainland with a maximum distance of more than 400 km from the mainland. This makes these islands the remotest and the most challenging to live in. Shipping is the backbone of the islands, and Mangalore is the food lifeline while Calicut is the fuel lifeline. All other provisions are supplied from Kochi[2]. High cost of transportation for any produce of UTL to be marketed in the mainland, or possibly to other countries, poses as the greatest problem for the islands.

At present, a 90 per cent transport subsidy is provided for transportation of raw materials and finished products between the mainland and the islands. The UTL becomes inaccessible during the event of climate extreme events and/hazards. Basic infrastructure is limited and nearly 65,000 people inhabit the 11 islands. This also adds to the vulnerability of these islands at the time of evacuation as well as supply of essential commodities during the time of disaster. It is virtually impossible to evacuate a population of one or more islands during the disaster to the mainland and the supply of essential commodities during the extreme events poses a major challenge. Delays and reduced quality in information flows, geopolitical weakened environmental factors, small exposed interiors and large coastal zones are all consequences of the remoteness. Connectivity poses a very severe problem, both for the quality of life and for marketing of local produce in the islands. Wide dispersal of the population in small islands scattered far away from each other and from the mainland in the Arabian Sea making transport and communication a crucial elements. Owing to the distance between the island and the mainland and even among the islands themselves, the cost of transportation is high, making it non-viable for many commercial activities.

The strategic location of the islands of this Union territory in terms of the defence of the country is also important. These islands can be the natural sentinels of the west cost of India. They also provide

[2]Dadoo, J.K. 2010. Presentation during 55th National Development Council Meeting, Administration of The Union Territory of Lakshadweep, New Delhi. http://planningcommission.nic.in/plans/planrel/55ndc/lakshwdeep_55ndc.pdf

outposts capable of monitoring international maritime traffic and also for surveillance of the economically important western coast of India.

Sustainable Development Priorities

The sustainability vision is to move towards faster and sustainable development of the islands by using all the resources and potentials available in the islands without disturbing the ecology and environment and the socio cultural heritages so that the economy of islands grows rapidly and remains is self-sufficient and preserves its self-reliant socio-economic specialties. Apart from harbouring significant biological diversity and acting as the breeding grounds for fishery stock, coral reefs also act as the natural defence mechanism against sea-surges and storms in the UTL. Dredging in the lagoons, building jetties, collection of shingles, boulders, sand, movement of boats, and other such activities have impacted the health of the coral reefs.

With damage to coral reef and associated habitat loss, reef fish species which are specialists requiring specific types of habitats within a reef or specific type of food from a reef could be adversely affected. Raising the living standard of people (i) through enhancement of income, and (ii) increasing employment opportunities for youth, particularly the educated youth is one of the main priorities. Enhancing the quality of life, particularly in respect of improving drinking water supply (including exploration of alternate sources of water), promoting eco-friendly solid and liquid waste management practices and providing swift inter-island and islands-mainland connectivity will be given emphasis in all the developmental plans. The emphasis is also on preserving the existing social structure, vibrant community life and cultural values and also preventing migration from the mainland that might impact the carrying capacity of the islands. The climate change adaptive development frame work for the UTL needs to take care of within the Inter Island disparities as well as of the ecological sensitivities of the islands.

1.2 BASELINE SCENARIO OF LAKSHADWEEP

1.2.1 Geophysical Profile

1.2.1.1 Area and Location

Known originally as 'Laccadives', Lakshadweep is an enchanting group of islands in the Arabian Sea between N. Lat. 8^{o}-$12^{o}30'$ and between E. Long. 71^{o}-74^{o}. It forms an archipelago in the northern edge of the 2,500 km long, Chagos-Maldive-Laccadive sub-marine mountain ridge.

Union Territory of Lakshadweep – Facts

- Islands: 36
- Inhabited: 11
- Geographical Area: 32.20 km^2
- Lagoon: 4,200 km^2
- Territorial Water: 20,000 km^2
- Coastline: 132 km

The UTL encompasses 12 atolls with 36 islands on them, 3 reefs and 6 sub-merged sand banks. The total geographical area of UTL is 32.20 sq. km and the length of the coastline is 132 km. Although, it is the smallest union territory with only 32 sq.km of land area, but considering the lagoon area of 4200 sq.km, 20,000 sq.km of territorial waters and about 0.4 million sq.km of Exclusive Economic Zone (EEZ), it is one of the largest territories of the Indian Union. The details of the island clusters, reefs and submerged sand banks are given in Table 1.2.1, Table 1.2.2, and Table 1.2.3 respectively. The UTL lies at a distance ranging from 200 km (111 nautical miles) to 400 km (222 nautical miles) off the Indian mainland with most of the islands aligned in N-S to NE-SW direction except Andrott, which is aligned in E-W direction. Andrott is located nearest to Indian mainland at 228 kms from Calicut. The location of the islands relative to Indian mainland is shown in Figure 1.2.1. Details on the Geographic Location and Lagoon Area are given in Annexure IX.

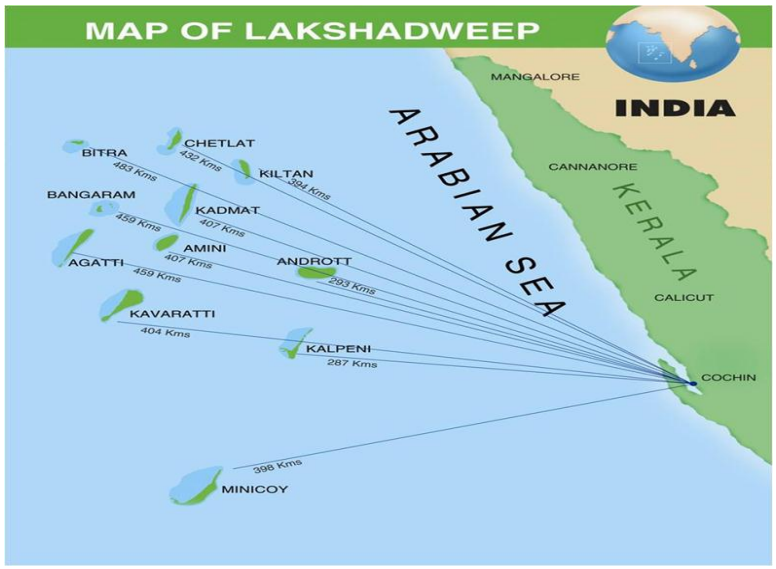


Figure 1.2.1 Location Map of Lakshadweep Islands

Table 1.2.1 Details of the Island Clusters in Lakshadweep

Name of the Cluster	Name of the Islands
Aminidivi group: Five inhabited islands	1) Amini 2) Kadmat 3) Kiltan 4) Chetlat 5) Bitra
Laccadive group: Four inhabited and 12 uninhabited islands	1) Androth 2) Kavaratti 3) Agatti 4) Kalpeni 5) Kalpitti 6) Bangaram 7) Tinnakkara 8) Parali 9) Tilakkam 10) Pitti 11) Cheriyam 12) Suheli 13) Valiyakara 14) Pakshi Pittiand 15) Kodithala (the first four and Bangaram are inhabited)
Minicoy group: Two islands	1) Minicoy, 2) Veiningili (only Minicoy is inhabited)
Submerged Reefs	1) Beliapani (Chebeniani) 2) Cheriapani (Byramgore) 3) Perumul Par
Submerged banks	1) Bassas de Pedro 2) Sesostris Bank 3) Cora Divh 4) Amini Pitti and 5) Kalpeni Bank

Table 1.2.2 Area and Location of Reefs

S.No.	Name	Lagoon Area (sq.km)	Latitude	Longitude
1	Beliapani	57.46	$12^{o}17'N$	$71^{0}52'E$
2	Cheriapani	172.59	$11^{o}49'N$	$71^{o}43'E$
3	Perumalpar	83.02	$11^{o}7'N$	$71^{o}59'E$

Table 1.2.3 Area and Location of Submerged Banks

S.No.	Name	Lagoon Area (sq.km)	Latitude	Longitude
1	Bassas de Pedro	2474.33	$12^{0}30'N$	72^{0} 14'E
2	Sesostris	388.53	$13^{0}00'N$	71^{0} 51'E
3	Cora Divh	339.45	13^{0} 34'N	72^{0} 04'E
4	Amini-Pitti	155.09	10^{0} 44'N	72^{0} 28'E
5	Elikalpeni	95.91	11^{0} 7'N	73^{0} 59'E
6	Investigator Bank	141.78	8^{0} 33'N	73^{0} 25'E

Source: CGWB, 2010

1.2.1.1.1 Origin and Geo-physical Features

Lakshadweep means a *hundred thousand* islands. The origin of the islands is attributed to the theory propounded by the English evolutionist Sir Charles Darwin in 1842. According to him, the origin of these islands can be traced to gradual submergence of some of the volcanic ridge into the Indian Ocean followed by accumulation of coralline deposits on the peaks and craters of these mountains. These deposits grew into coral islands resting on submerged mountain tops over a period of time. When the volcanic islands became completely submerged, the atoll was formed encircling the lagoon where, with the action of the wind, waves, reef to currents and temperature, the coral islands were formed. The Lakshadweep, Maldives and Chagos archipelagos form a contiguous mountain ridge in the ocean. The Chagos-Laccadive Ridge (CLR), also known as Chagos-Laccadive is a prominent volcanic ridge extending between the Northern and the Central Indian Ocean.

Notable feature of the individual islands of the ridge is that the relief of all the islands above Mean Sea Level (MSL) is uniformly low (4-5 m). However, height of the submerged banks and shoals varies considerably. This ridge is believed to be a continuation of the Aravalli mountain range of Rajasthan and Gujarat since the late tertiary times.[3] The Aravallis formed a great mountain chain in the Precambrian period extending from the Himalayas in the north to Lakshadweep in the South.

1.2.1.2 Natural Wetlands

Area estimates of various wetland categories for the UTL have been carried out using GIS layers of wetland boundary, water-spread, aquatic vegetation and turbidity[4]. In the UTL, 48 wetlands have been delineated. Total wetland area estimated is 79,586 ha (Table 1.2.4). Coastal-Natural wetlands are the only wetlands in these islands. There are only three wetland types namely; Coral reef, Lagoon and Sand/Beach and the share of the categories are given in Figure 1.2.4. Further information on the type of wetlands present in the UTL can be found in Annexure IX.

Corals are the most dominating of the three wetland types and accounts for 55,179 ha of area that amounts to 69% of wetland area in the UTL. Each island is fringed by coral sands, and is marked by huge, shallow, calm lagoon on the western side that separates it from incoming swells of the outer sea by the wall of a reef made up of massive coral boulders and live corals. Estimated total coral reef area in these islands is 276 km^2 including the reef flat area of 136.5 km^2.[5] As coral reefs tend to be positioned perpendicularly to the mean direction of wind generated swell currents flowing over the reefs, they can weaken the incoming waves, thereby minimising erosion and costal hazards behind the reefs. There is a

[3] Mukundan, T. K..1979. Laksdweep – a hundred thousand islands. Academy Press, New Delhi, 225 pp.
[4] National Wetland Inventory and Assessment (NWIA), 2011. An updated database of wetlands in India Space Applications Centre (SAC), Indian Space Research Organization (ISRO). Ministry of Environment and Forests.
[5] Bahuguna, A and Nayak S.1998.Remote sensingapplications for monitoring coralreefs. Proceedings ofthe symposium on status and protection of coral reefs,March 11 – 13, Kadmat Island, U.T. of Lakshadweep.Pp. 17–19

close and complex interaction of coral reefs, lagoons and the sea. A majority of the islands are blessed with large lagoons on the western side.

Figure 1.2.2 Aerial View of Lakshadweep

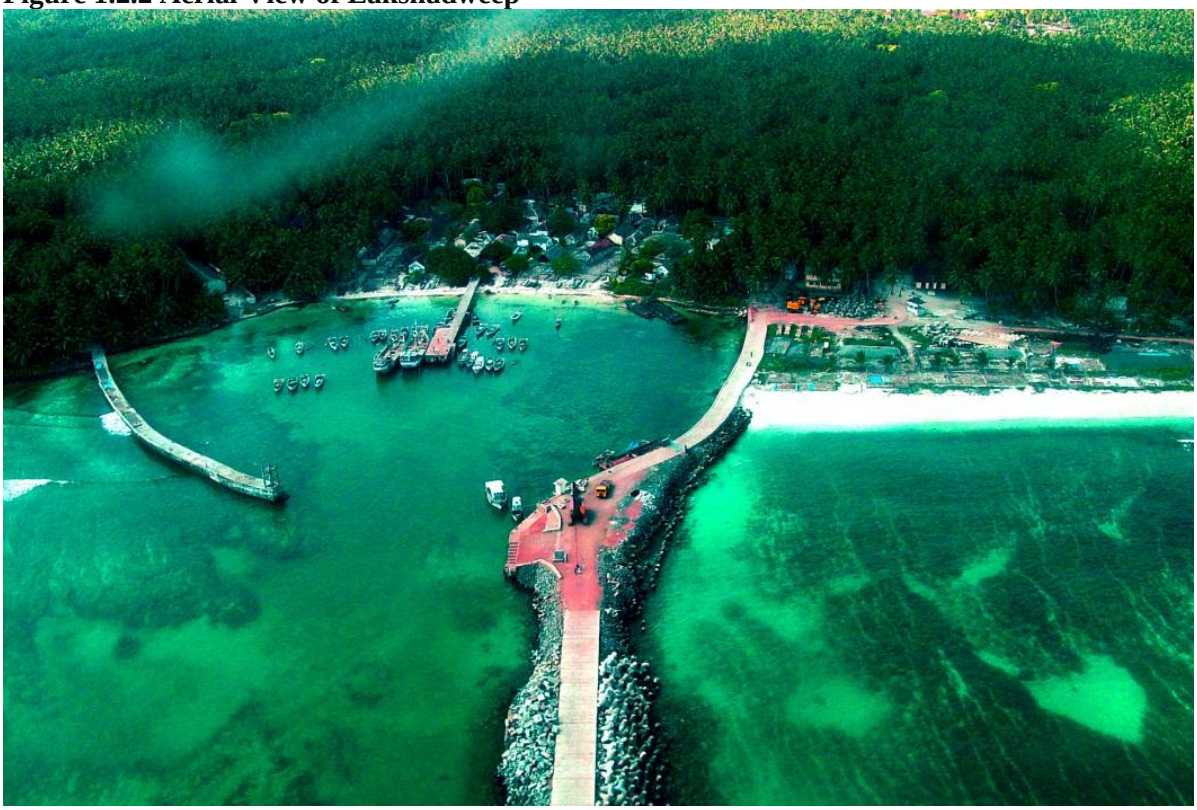


Table 1.2.4 Area Estimates of Wetlands in Lakshadweep

S.No.	Wettcode	Category	Number	Wetland Area (ha)	Percentage of Wetland Area (%)
	2100	**Coastal Wetlands-Natural**			
1	2107	Coral reef	15	55179	69.33
2	2101	Lagoons	15	23674	29.75
3	2103	Sand/Beach	18	733	0.92
		Sub-Total	48	79586	100.00
		Wetlands (<2.25 ha), mainly tanks	-	-	0.00
		Total	48	79586	100.00

1.2.1.3 Hydrogeology[6]

The hydrogeological environment of the islands is complex. Rainfall, averaging about 1600 mm annually, is the sole source of groundwater recharge in these islands. Seepage of water occurs a couple of metres below the land surface and replenished by the annual rainfall. Unlike the mainland seasonal or perennial streams, lakes or ponds do not exist in the UTL. Overall climate is of humid, tropical monsoon type. The topography is almost flat, soils are sandy, highly permeable and even local surface run-off marks are not seen. The fresh groundwater resource of the tiny coral atolls of Lakshadweep, by and large, occurs as lenses floating in hydraulic continuity with sea water. The fresh water layers occurs in floating lens within a carbonate sand layer of 0.5 to 1.15 meter and the portable fresh water for the island is met from this horizon. Cases of increased extraction from these fragile lenses and resultant salinization were reported from many islands where pumping activity has been on the increase, especially, during the last two decades. Further information on hydrogeology of the islands can be found in Annexure IX.

1.2.2 Ecological Profile

1.2.2.1 Ecosystems

The Lakshadweep Archipelago forms a terrestrial eco-region together with the Maldives and the Chagos. Ecologically these islands cannot be treated in isolation. There is the interaction of coral reefs, lagoons and the sea. These ecosystems harbour varieties of fauna and flora. The mucus produced by the coral plays a significant role in the coral ecosystem. These form an important food item for reef invertebrates, fish and shrimps. There is no declared forest in the UTL, but 80 % of its land mass is covered by the green vegetation, mainly with coconut trees.

The presence of coral reefs - the most productive ecosystems - makes these islands ecology very important. Phytoplankton or microscopic plants, sea weeds and sea grasses use the incident sunlight and plentiful supplies of nutrients to produce organic matter. Euphausiids, a group of zooplankton, especially rich in the seas around the UTL, are the staple food of the small fishes such as sprats which are in turn, consumed by the larger fish like the Tuna[7]. Small fishes like the bait fishes *Spratelloides spp* are the food of the tertiary consumers like terns and dolphins. Bird excreta deposited over thousands of years are believed to have contributed to the building of the islands[8].

[6]CGWB, 2010. Approach Paper on Ground Water Quality Issues In Islands (Andaman & Nicobar And Lakshadweep) Central Ground Water Board, Ministry of Water Resources, Government of India Island Report

[7]Nair, P.V.R., A.V.S. Muriby, C.P. Ramamirihmi, D.S. Rao and V.K. Pillai.1986: Environmental features in the sea around Lakshadweep. *Mar. Fish. In/or. Servo T&E Scr.,68: 10·13.*

[8](Jones 1986)

It is speculated that by spending long periods of time on the newly formed sand banks, the terns and waders fertilize and help to stabilize islands, reversing the process of erosion to some extent. The newly exposed sandbanks of the UTL which are a favourite resting spot of terns were found to be immensely fertile, and coconut trees grew well without external application of fertilizer. Eggs, juvenile and adult terns are eaten by human beings. Eggs and young are taken by crabs. The importance of crabs in recycling of nutrients by scavenging on the discarded and decomposing bodies of animals must be emphasized. The following flora and fauna have been designated as "***state symbols of the territory***": **Animal** - Butterfly fish locally known as "Fakkikadia, **Bird** - Sooty tern locally known as "Karifettu", **Tree** - Bread-fruit (Artocarpus incise) locally known as "Chakka.

Figure 1.2.3 Sooty Tern

1.2.2.2 Flora

The landmass, coastline, lagoon and the reefs along with the surrounding ocean form a continuum of biodiversity. The warm tropical climate and high relative humidity are conducive for good plant growth. The vegetation of the islands is described as *Strand Coral*[9]. This includes an open pioneer zone, woodland zone, and coastal zone, each with a dominant tree or plant[10]. In general, the strand coral vegetation consists of various groups of plants such as algae, fungi, lichens, mosses, pteridophytes and angiosperms. Shallow reliefs are dominated by algal elements and seaweed. The foreshore is free from vegetation being sandy and the backshore is composed of creepers and herbaceous plants, intermixed with shrubs and treelets in coconut groves.

Figure 1.2.4 Bread Fruit

The islands are also home to many medicinal plants. Absence of hills and river systems coupled with shallow soil severely limits the variety of plants that can grow in these islands, yet, nearly 400 species of plants have been reported from these islands. No endemic plants have been reported. Rather, the vegetation is typical of Indo-Pacific coral island flora. The plants present are primarily of pan tropical or cosmopolitan distribution (Sri Lankan, African, American, Australian, Burmese, West Indies, Chinese and Polynesian origin), the main components being Sri Lankan (44%), African (28%), Malaysian (25%), and the remainder from distinct coral habitats.[11] Little of the original vegetation is left. Remnants of original vegetation are found on some islands as stands of

[9]Rao, T. A. and A. R. K. Sastry. 1972. An ecologicalapproach towards classification of coastalvegetation of India. I. Strand vegetation.*Indian Forester*. 98: 614-615c

[10]Mathew, D. N. and T. Gandhi. 2000. Prioritising Sites for Biodiversity Conservation in Lakshadweep Islands. Pages 94-103 in Biodiversity Support Program (BSP), editor. Setting Biodiversity Conservation Priorities For India: Vol. 1 & 2.

[11]Rao, T.A. and J.L. Ellis. 1995. Flora of Lakshadweep Islands off the Malabar coast, peninsular India, with emphasis on phytogeographical distribution of plants. Journal of Economic and Taxonomic Botany **19:**235-250.

Scaevola and *Argusia (Tamara)*[12]. The island has creepers and herbaceous plants including several medicinal plants. *Ipomea* is a conspicuous ground runner, which play a strong role in preventing erosion of the Islands. Vegetation at several places is denuded due to anthropogenic factors and also by the grazing of goats. A majority of the plants that are found growing in these islands are naturalised exotics. One tract of the native mangrove *Bruguiera parviflora* remains on Minicoy Island, covering only 2,500 m^2.[13] Further information on the flora of the UTL can be found in Annexure IX.

1.2.2.3 Fauna[14]

The Lakshadweep lagoons, reefs and banks are very rich in marine species with living corals, sea-urchins, seaweeds, sea-cucumbers, starfish, cowry, clams and octopus, including many types of fish, such as butterfly fish, moray eels and the lagoon triggerfish. The aquatic realm is remarkable for the prolific reefs and the diversity of marine life. The corals are the most sensitive ecosystems of the UTL. The 12 Atolls, 3 reefs and 5 submerged banks have a coral reef area of 816.1 sq.km. The corals lead a symbiotic life along with the algae. Coral reefs of the UTL support 91 species of sponges, 114 species of seaweeds, 7 species of sea grass, 150 species of crustaceans, 225 species of echinoderms, 424 species of mollusks, about 300 species of ornamental fishes, and 601 species of fishes. Besides, it also supports many numbers of species of bacteria, fungi, phytoplankton, zooplankton many species of gorgonides, polychaetes, reptiles etc. Its associate biodiversity also include 4 species of urtles and 4 species of mammals. The lagoon is also home to a wide variety of organisms such as crabs, lobsters, and molluscan fauna including gastropods and bivalves, octopuses, sponges, turtles, surface living holothurians, cowries, sea cucumbers and dolphins.

Figure 1.2.5 Kavaratti Corals

Uninhabited atolls like Cherbaniani, Byramgore Reef and Perumal Par, as well as Pitti Island, are important as a breeding place for sea turtles and for a number of pelagic birds such as the Brown Noddy *(Anous stolidus)*, Lesser Crested Tern *(Sterna bengalensis)* and Greater Crested Tern *(Sterna bergii)*[15] Different species of tuna, wahoo and swordfish, as well as dolphins, are common in the pelagic waters off the islands. Owing to the wealth of marine life surrounding Suheli Par there was a proposal to declare the waters of this atoll a Marine National Park[16]. Native flora includes small trees and bushes typical of littoral zones, such as *Pandanus*, *Heliotropium*, *Foertherianum*, *Scaevola*, *Taccada*, *Tournefortia*, *Argentea* and *Pemphis acidula*. About 1680 species of birds, reptiles, fish,

[12] Ram Boojh., 2010. Biodiversity Conservation linked sustainable development – A case for setting up a Biosphere reserve in Lakshadweep Islands, India;
[13] *Op.Cit*. Mathew, D. N. and T. Gandhi. 2000.
[14] http://lakshadweep.nic.in/depts/laktech/fauna_of_lakshadweep.htmaccessed on 5 April 2012.
[15] Kurup, D.N, and Zacharias, V.J. Birds of Lakshadweep Islands, Forktail 10 (1994) 49-64
[16] Menon, A.G.K. 1976. *Marine Park of Lakshadweep, a report submitted to the Department of Science and Technology, Government of India*

crustaceans and corals have been reported from this archipelago[17], of which 172 species are terrestrial (birds, reptiles) and the remaining marine.

The marine biodiversity of the islands is predominantly and directly related to the diversity of the coral reefs. The calm waters of the lagoon which serves as a lake is home and nursery for large number of fishes, molluscs, echinoderms, sea grass, sea weeds, etc. The archipelago is poor in faunal species, probably due to the small area of the landmass, uniform topography, climatic conditions and lack of forest or other habitats[18]. Two species of amphibia, *Bufo melanostictus* and *Rana tigrina* have been recorded on the Kavarati and Minicoy islands but they were introduced.[19] Prawns and crabs are not fished in the UTL. In all, 41 species of crabs and two species of lobsters are recorded from this region[20,21]. The brachyuran crab *Grapsus albolineatus* and panulirid lobster *Panulirus homarus* are among the most common crustaceans in the lagoon and reef flats of this archipelago. Dugongs, reported to be historically present in the UTL, are probably extinct from this area now. However, there are some unconfirmed reports that islanders have sighted dugongs while fishing in offshore areas. Additional information on the varieties of fauna is available in Annexure IX.

Figure 1.2.6 Butterfly Fish

1.2.3 Social Profile

1.2.3.1 Governance

Prior to the formation of Union Territory of Lakshadweep on 1st November, 1956, these islands were known as Laccadive, Minicoy and Amindivi Islands. The Laccadive groups of islands (Kavaratti, Agatti, Androtт and Kalpeni) were under Malabar district of erstwhile Madras state and the Aminidivi group of islands (Amini, Kadmat, Kiltan, Chetlat and Bitra) were under the jurisdiction of South Canara district. All the islands now constitute as a single district with four Tehsils. The Administrative Head Quarters is at Kavaratti with the Administrator as the Head of the Union Territory. Each Island has a democratic set up with elected members.

UTL Administration constituted and established the first Panchayat set up in December 1997 and January 1998. According to the new Panchayat Regulation, there is a two-tier system of Panchayat in the UTL. At the island level, there is a Village Dweep Panchayat (VDP), and at the UT level, there is a

[17] Anonymous,1991. *Pitti Island Lakshadweep an ornithological study.* Madras Naturalist Society, Madras.
[18] Das, A. K..,2002. Islands. In: Ecosystems of India. Eds. Alfred, J. R. B., A. K. Das and A. K. Sanyal. ENVIS. Zoo. Surv. India, Kolkata: 1-410
[19] *Op.Cit.*Das, 2002.
[20] Meiyappan and Kathirvel, 1978; On some new records of crabs and lobsters from Minicoy, Lakshadweep (Laccadives). J. mar biol Ass India, 20,(1 &2): 116-119.
[21] Shankarankutty, C, 1961. On some crabs (Decapoda –Brachyura) from the Laccadive Archipelago. *J. Mar. Biol. Ass. India*, 3(1&2): 121-150.

District Panchayat (DP), with no intermediary Panchayat. There are thirty six seats in the District Panchayat which include directly elected 25 members, chairpersons of village/ dweep panchayats and the lone Member of Parliament, Lok Sabha. As such, of the 11 inhabited islands, 6 are Census towns and the remaining 5 are villages. These are grouped under 10 subdivisions which are co-terminus with CD Blocks. The details on basic amenities and infrastructure of UTL are given in Annexure IV.

Figure 1.2.7 Aerial View of Kavaratti

The UTL is under the jurisdiction of High Court of Kerala. The Munsiff courts present in Androtт and Amini also function as Court of Judicial Magistrate of First Class for their concerned jurisdiction. The Judicial Magistrate at Androtт is holding the charge of the Chief Judicial Magistrate. The Sub Court of Kavaratti was upgraded as District and Sessions Court with effect from April 1997.

Two special laws exist for the UTL, *viz.*: The Lakshadweep Prohibition Regulation, 1979; and LM&A islands (Restriction on Entry and Residence) Rules, 1967. Apart from this, several laws and regulations exist for preserving and conserving the unique and fragile ecosystem. The details are given in Annexure I and Annexure II. The Laccadive, Minicoy and Aminidive Islands Land Regulation, 1962, prohibit the transfer of land to non-natives the UTL, except government agencies.

1.2.3.2 Demography

1.2.3.2.1 Total Population

According to 2011 Census, the inhabited islands had a total population of 64,429 covering 33,106 males and 31,323 females. With this population the UTL contributes 0.01 percent to the total Indian population of 1,21,01,93,422. The gender ratio in the UTL at 946 is skewed towards men though better than the all India figure of 933. The break-up of the population across various islands is given in Table 1.2.5. Kavaratti, Androtт and Minicoy are the most populous islands.

Table 1.2.5 Demographic Profile of Lakshadweep Islands

Island	Geographical Area (sq.km)	Male	Female	Total Population	Population Density
Minicoy	4.39	5365	5079	10444	2379
Kalpeni	2.79	2336	2082	4418	1584
Andrott	4.84	5506	5685	11191	2312
Agatti	3.84	3889	3671	7560	1969
Kavaratti	4.22	6177	5033	11210	2656
Amini	2.59	3818	3838	7656	2956
Kadmat	3.12	2676	2713	5389	1727
Kiltan	1.63	2012	1933	3945	2420
Chetlat	1.04	1173	1172	2345	2255
Bitra	0.10	154	117	271	2710
Bangaram[22]	*0.58*	*56*	*9*	*65*[23]	*NA*
Total		33106	31323	64429	

Source: Census 2011

The population of the UTL was 13,882 in 1901 that increased to 21,035, 51707 and 64429 in 1951, 1991 and 2011 respectively. The details of population growth over decades are given in Table 1.2.6. The Growth Rate of Population from 2001 - 2011 is 6.23 percent which is 11.07 percent lower than the Growth rate of 1991 -2001 (i.e. 17.3%) and the trends in decadal population growth rate of is shown.

Table 1.2.6 Decadal population in Lakshadweep 1901-2011

Year	Male	Female	Total
1901	6728	7154	13882
1911	7325	7230	14555
1921	6727	6910	13637
1931	8045	7995	16040
1941	9096	9259	18355
1951	10295	10740	21035
1961	11935	12173	24108
1971	16078	15732	31810
1981	20377	19872	40249
1991	26618	25089	51707
2001	31131	29519	60650
2011	33106	31323	64429

Source: Basic Statistics, 2009, Lakshadweep Administration

1.2.3.2.2 Indigenous Population

In the UTL, the entire ethnic population, which constitutes 95% of total population, is classified as Scheduled Tribes because of socio-economic backwardness, geographical isolation, etc. The tribes have, however not been named. More than 93% of the population who are indigenous are Muslims and majority of them belong to the Shafi School of the Sunni Sect. According to the Scheduled Castes and Scheduled Tribes list (modification orders), 1956, the inhabitants of the UTL who and both of whose parents were born in these islands are treated as Scheduled Tribes. There are no Scheduled Castes in this Union Territory. Its Hindu tradition is reflected in the class-cum-caste divisions, among the Koyas, Malmis and Melacheris. The class/caste profile of the UTL is given in Annexure III. The principal

[22] *Basic Statistics 2009*, Directorate of Planning and Statistics, Secretariat, Lakshadweep-Kavaratti
[23] Not included in the census population total

languages of the UTL are Malayalam, Jeseri (Dweep Bhasha) and Mahl[24]. The people of all the northern islands speak a dialect of Malayalam with Tamil and Arabic influences, due to extensive trade activities of these people. Malayalam with Malayalam script was introduced as the official language of the UTL during the British Raj.

1.2.3.2.3 Egalitarian Society

There is little economic inequality in the UTL and the poverty index is low. The Gini Coefficient for both urban and rural population for the UTL is among the lowest in the country, indicating the prevalence of a fair degree of equity among the population[25].The island society is crime free with virtually no law and order problem.

The tension between non-indigenous people and the local population which is quite common in mainland states is also non-existent here. This is the result of the conscious steps taken by the government (such as Entry Permit, Land Laws, etc.) to check migration and to create positive disincentives for migrants to come over to the islands and stay here permanently. Given the extremely fragile resource base of the islands, their carrying capacity can under no circumstances absorb migrants. They would even find it difficult to absorb the growing local population unless out-migration is positively encouraged. This also underlines the need for identifying alternative areas and activities, encouraging and supporting local population in enhancing their skill base so that they are able to provide high quality services comparable to mainland. The Gini Coefficient for both urban and rural population for Lakshadweep is among the lowest in the country, indicating the prevalence of a fair degree of equity among the population.

1.2.3.2.4 Status of Women

Women in the UTL compared to their counterparts in the rest of the country are better educated and are aware of their rights and responsibilities. The self-help movement also has taken a lead in the blocks. There are a total of 295 women self-help groups functioning in all the islands. Moreover out of the total 86 elected members to the Panchayat, 33 members are females. There are total 10 VDP chairpersons out of which 4 are women (40%). In total, there are 25 DP members out of which nine are women (36 %)[26]. The Marumakkathayam system of inheritance, under which Tharwad property descends through the female line, saves the women from economic dependence. The predominance of women in every walk of life (including matrilineal mode of inheritance) is particularly noteworthy in Minicoy[27].

[24] Makhan, J. 1997. The Muslim Tribes of Lakshadweep Islands: An Anthropological Appraisal of Island Ecology and Cultural Perceptions.
[25] Op.Cit., Planning Report, 2007
[26] http://lakshadweep.nic.in/documents/Chapter%20III.pdf
[27] Pookkoya, 1960, 'Deepolpathy', Kalpeni

1.2.3.2.5 Education

During the last 40 years great developments have taken place in the field of education in the UTL. Educational facilities are not available for higher studies in the island. By stages, educational institutions were established in all the islands. Every island except Bitra has a high school. The junior colleges are functioning in Kadmat and Androtт. Each of the inhabited islands has junior and senior basic schools, nursery schools and *Madrassas*. There are 64 schools and 3 university centres in 10 islands. There are 107 Anganwadi centres in 10 islands. For technical education, 10 more National Institute of Technologies (NITs) have been approved in the 11th Five Year Plan and Goa NIT will cater to the needs of the UTL inter-alia with other UTs. Girls' education also has made tremendous progress. Out of the total enrolment in the schools 46.04% are girls. According to provisional figures of 2011 census, the UTL has recorded its overall literacy rate as 92.28 percent which is 5.58 percent higher than that was recorded during 2001. Highest literacy is one of the identities of Lakshadweep and accordingly the UTL elevated to second position in 2011 census ahead of Mizoram in terms of literacy rate from third position in 2001 among all the states and union Territories of the nation (next only to Kerala which has 93.91 percent literacy rate). This is well above the total literacy rate of the country at 74.04 percent (Table 1.2.7).

Table 1.2.7 Literates and Literacy rate

Particulars	Unit
Literates Person	52914 (nos)
Literates Males	28249 (nos)
Literates Females	24665 (nos.)
Literacy Rate Person	92.28 %
Literacy Rate males	96.11 %
Literacy Rate Females	88.25 %

Source: Census, 2011

1.2.3.3 Rural Development and Employment

The level of unemployment in the UTL, despite its very small population, is very high. In fact, at 13.2 per cent, it is next only to Goa (13.6) followed by Kerala, which is way below at 8.6. Low levels of employment opportunities in the sectors of industry and agriculture, coupled with high levels of literacy seem to have brought about the high rate of unemployment in the UTL. The UTL faces widespread unemployment, caused largely by the low levels of economic activities in industry and agriculture, coupled with high levels of literacy. Total labour engaged in Lakshadweep is 26 percent, inclusive of marginal labourers who account for 3 percent. Twenty seven percent of the population lives below the poverty line. The District Rural Development Agency (DRDA) came into existence in the UTL during 1982 and played a great role in poverty alleviation and income generating activities.

A separate Directorate of Rural Development has been established during November, 2008. The wage employment programme was started during 1983 onwards and now two schemes such as Jawahar Rozgar Yojana (JRY) and Employment Assurance Scheme (EAS) are being implementing under the guidance of Village (Dweep) Panchayat. Construction of roads, rain water storage tanks, public toilets, public tanks, compound walls, Anganwadi buildings, anti-sea erosion structures, planting of social forestry plants etc. are the major activities under this programme. Sectors and profile of activities

identified for MGNREGS are; Water Conservation, Renovation of Traditional Water Bodies, Rural Connectivity, Flood Control, Land Development and other works.

In view of the environmental and ecological conditions in the islands, it has become difficult to get locally available construction materials like coral shingles, coral boulders from the islands. To overcome this problem the administration proposed to set up Building Materials Development Board which will undertake procurement of building materials from mainland and transport to the islands for distribution to the local people. Lakshadweep Building Development Board (LBDB) has been constituted to import and provide construction materials so that local does not collect it from the Island and damage the ecology.

1.2.3.4 Water Supply and Sanitation

The only source of drinking water available in this territory is rainwater, which percolates down through the porous sandy soil and floats over the subsoil saline water. However, the entire water available in the floating sweet water lens cannot be extracted on account of technical problems in continuous and uncontrolled pumping. It is estimated that sufficient quantity of drinking water is available in the subsoil taking into account transportation, limitations of extraction of the ground water and so on. Water supply scheme has been introduced in all the islands in Lakshadweep, but the supply is partial in quantity. There is no village/ island in the group of Lakshadweep islands in the category of Not Covered (NC).

All the inhabited islands are problem areas so far as the drinking water supply is concerned. The survey by NSS shows that 89% of the households do not have drainage facility which is the highest in the country. The pattern of latrine usage and dependence on unprotected well for drinking water indicate poor drinking water quality in the islands. A central team consisting of Advisor (TM), Department of Rural Development along with experts from Central Ground Water Board, CSMCRI Bavanager, NEERI Nagpur, CESS Thiruvananthapuram, after their visit to Lakshadweep, came to the conclusion that no single system or approach to provide water supply to Lakshadweep Islands would be sufficient due to typical geological and hydrogeological nature of these islands. They suggested tapping of ground water to the extent of its sustainable yield and supplement it with additional activities such as installation of Desalination Plants, Rain Water Harvesting etc. Accordingly, the Water Supply scheme was modified to have a combination of ground water, Reverse Osmosis Desalination Plants and rain water harvesting. In all islands water supply system is in existence partially.

Figure 1.2.8 LTTD Plant at Kavaratti Island

Island population generate considerable amount of sewage (50,000-1,20,000 litre/ day) that often finds its way to the shallow fresh water lens. According to tests conducted during 1991, in Kavaratti and Minicoy, a number of drinking water wells contained excessive nitrate concentration originating from septic tanks, and other human wastes. Almost 95 per cent of the households in Lakshadweep get drinking water from open wells and sources other than tap water supply, hand pump or tube well. Most of the drinking water sources like hand pumps, wells and ponds, were seen contaminated with bacteria. Around 98% of 126 samples tested showed a positive *coliform* count. With the quantum of sewage generation projected to be doubled by 2025, and in the absence of adequate interventions, the ground water column would be almost completely contaminated and will no longer be potable. The conventional method of sewerage and sewage treatment is not feasible because of the coral sandy strata, inadequacy of space, high water table and flat terrain. There is a need to urgently explore the possibility of setting up a pilot project on disposal of waste water in the inhabited islands of Lakshadweep to study its efficacy and reliability under the prevailing local conditions and its replicability in other islands of Lakshadweep.

1.2.3.5 Health

Major epidemics threatening the islands of Lakshadweep are waterborne diseases such as gastroenteritis and cholera. Malaria and pneumonia have also been reported in Lakshadweep. These diseases point towards the most widespread environmental problem namely, the lack of sanitation facilities posing grave risks to human health. Facilities are still rudimentary or entirely lacking. During cyclones and droughts, these constraints can cause havoc to the island population causing more damage than the disaster itself. Serious efforts are required to improve sanitation facilities. The population of Lakshadweep Island is prone to various water borne diseases such as Diarrhoea, Cholera, Gastroenteritis, Dysentery, Infective Hepatitis, Poliomyelitis, Malaria/Filaria and some of the skin diseases. Tele medicine facilities are available in 5 islands and are being extended with the help of ISRO to other islands. Ayush centres are being created in all the islands to spread Indian system of medicines which is eco-friendly. Availability of well qualified medical personal on a sustained basis however continues to remain a challenge. The Administration has a provision of Medical Officer attached to a community health center on each of the inhabited island and a First-aid center at Bitra Island. Lakshadweep has no private hospitals. It is served by two Government hospitals, three Community Health Centers (CHCs), four Primary Health Centers (PHCs) and two First Aid Centers with a total bed strength of 200 in 11 islands. The Directorate of Medical & Health Services has achieved 100 percent immunization targets in islands. The absence of a full proof sewage system remain a serious health issue as it leads to the prevalence of water borne diseases in islands. In terms of health indicators such as birth and death rates, infant mortality rate, maternal mortality rate and life expectancy at birth, the UTL stands ahead of the all India average. The details of the Human Development Index (HDI) of the UTL over the years are given in[28,29] Table 1.2.8.

[28] *Op.Cit.* Basic Statistics, 2009
[29] SRS Bulletin Sample Registration System. 2011. Registrar General, India. Volume 46 No.1.

Table 1.2.8 Human Development Index of Lakshadweep (1997-2010)

Year	Birth rate	Death rate	Infant Mortality	Maternal Mortality	Still Birth Rate
1997	20.40	5.05	38.80	0.84	--
1998	20.92	5.20	29.15	0.81	--
1999	19.70	3.83	20.21	0.84	--
2000	21.38	3.98	25.70	--	--
2001	18.05	3.87	28.88	0.18	--
2002	17.60	3.15	25.54	0.91	14.95
2003	16.60	5.60	22.90	1.90	26.26
2004	14.73	3.50	20.29	0.19	25.30
2005	16.17	4.87	19.78	Nil	34.06
2006	15.79	4.16	16.71	Nil	23.59
2007	12.51	4.92	19.51	1.21	2.31
2008	11.61	4.97	14.08	2.56	11.52
2010	14.30	6.4	25	NA	NA

Source: Basic Statistics, 2009, Lakshadweep Administration
http://pib.nic.in/archieve/others/2012/feb/d2012020102.pdf

1.2.4 Economic Profile

Lakshadweep is the smallest UT in India with only 32.20 sq.km of land area; but considering the lagoon area of 4,200 sq.km, 20,000 sq.km of territorial waters and about 0.4 million sq.km of Exclusive Economic Zone (EEZ), it encompasses one of the largest territories of the Indian Union. There are eleven inhabited islands (Agatti, Amini, Andrott, Bitra, Chetlat, Kadmat, Kalpeni, Kavaratti, Kiltan and Minicoy) with one island (Bangaram) having a tourist resort only. Other islands are small and exist as satellites of the inhabited islands. All land is classified as agricultural land and the total cropped area is 25.20 sq. km. The inter-island distance varies from about 10 to 200 kilometres. The lagoons and the economic zone teeming with marine life and mineral resources enhance the economic importance of Lakshadweep.

1.2.4.1 Livelihood Pattern

The economic activities of Lakshadweep depend on the land, surrounding water bodies, lagoons, coral reefs and ocean. Land mass is limited and the soil has unique characteristics. The islands fall directly in the trade route between Africa, Arabia and Malabar. Local economy of Lakshadweep district consists of agriculture (mainly coconut), animal husbandry and fisheries. The traditional livelihoods revolve around tuna fishing, coir, vinegar, and copra making.

Although artisanal boat-building industry has suffered over the years, the traditional skills still exist. The people of Kavaratti have considerable skill as stone-masons and carpenters. Minicoy is an important center for tuna fishing. Tourism is emerging as an important economic sector over the last couple of decades. The importance of the reef fishery for the local population (household income and food) remains high, and growth in the fishery seems likely in view of the demographic structure of the island as well as a developing reef fishery targeting napoleon wrasse, parrot fish, groupers and snappers for export markets.

Coconut is the dominating agricultural crop in the district. A total of 592.17 lakhs of coconuts have been harvested in the district in 2006-07. Apart from this 2292.78 (000') litres of milk and 134.63 lakh eggs have been produced in the district in 2006-07 and this includes both private and public sector. A total of 11727 tonnes of fish have been landed in 2009 in the district including fish landing from Suheli Island which alone works out as 1452 tons. The revenue from this comes to around Rs.2350 Lakhs. There is an increase in revenue over years. The peak year was 1998 when the yield was 14626 tons and the revenue was Rs.2486.42. In Lakshadweep there are a total of 2624 full time active fishermen and 5516 part-time or occasional fishermen as per 2006-07 statistics[30]. Agriculture along with fisheries is the most widely prevalent economic activity in the territory. Almost all the households own small or marginal pieces of agricultural land. Over 87 per cent of the operational holdings are of less than 0.5 hectare size. Of the total geographical area of 3,228 hectares, the net sown area in Lakshadweep is 2,598 hectares, which works out to a little over 80 per cent of the total geographical area of the island[31]. Thus the share of net sown area is very high at more than 80%, as against the national average of about 43%. Hence, land available for any new development works / projects is very limited[32].Further information on the economic profiles of various sectors can be found in Annexure X.

1.2.4.2 Fisheries[33]

The fishery resources of the islands comprising the oceanic resources such as the tunas, billfishes pelagic sharks etc., and the other groups of food fishes, live baits and ornamental fishes inhabiting the reefs and numerous lagoons play a vital role in the economy of the islands. Fishing is the primary occupation here, and is dominated by a pole-and-line fishery for the pelagic skipjack tuna. Fishing on reefs and lagoons is, by contrast, fairly artisanal, and limited to local consumption, supplying the evening meal. During the monsoons, the lagoon and reefs take on an added significance, since tuna fishing stops, and these more protected habitats become the primary sources of fish for the island communities[34]. The Department of Fisheries and the Lakshadweep Development Corporation Ltd are the two agencies responsible for the development of fisheries in the UT. The fishery activities in

[30]UTL,2008. District Analysis of Perspective Plan of MGNREGA in Lakshadweep, http://lakshadweep.nic.in/documents/Chapter%20III.pdf

[31] UTL, 2007. Eleventh Five Year Plan (FYP), 2007-2012

[32]RBI, 2007. Report Of The. Working Group On Improvement. Of Banking Services In The. Union Territory Of Lakshadweep. http://rbidocs.rbi.org.in/rdocs/PublicationReport/Pdfs/84466.pdf, , Accessed on 1 April, 2012

[33]*Op.Cit.*CMFRI, 2006

[34]http://www.indiaenvironmentportal.org.in/files/file/turtles.pdf

Lakshadweep are concentrated in all the 11 inhabited islands and in the uninhabited island - Suheli. The main resource exploited is tuna and tuna-like fishes. It is estimated that the annual catchable potential yield of tunas is about 50,000 tonnes of tunas and an equal quantity of other fishes are available. The annual total landing is about 10,000 tonnes, which is only about 10% of the estimated fishable potential.

Figure 1.2.9 Pole and Line Fishing

The communities' reliance on the reef fishery and gleaning for protein and income is high. 20% of the households on Agatti report reef fishery and gleaning as their main occupation, 90% of the protein intake of poor households comes from reef fishing and gleaning[35]. The total annual catch was estimated at over 61 metric tons, harvested from a lagoon area of 12 km^2. Almost half of the total catch is obtained from only 2% of the catches, i.e. catches larger than 20kg. Most large catches are from more indiscriminate gears such as large-scale dragnets. Further information on the fisheries sector can be found in Annexure X.

1.2.4.3 Crop Production

The earliest settlers, who came from the Malabar cost, brought with them the coconut tree, their *Kalpavriksha (*the beneficent tree of heaven), and started cultivation. Islands were covered with various types of perennial shrubs and trees and thick coverage of ground with various species of grasses. Interior part of the island was excavated to create water-logged condition to cultivate rice, other cereals like jower, sorgum, ragi, sweet potato and banana. Wild colacasia and cowpea were also cultivated. Modern agricultural activities were commenced in the islands in the year 1955 by posting an Agricultural Demonstrator with his head quarter at Agatti Island. During 1958, Agricultural Demonstration units were established in all inhabited islands and a separate department for Agriculture has come to existence under the UTL Administration. Land Utilization Statistics of Lakshadweep from 1997 to 2007 is shown in Table: 1.2.16

Figure 1.2.10 Coconut Plantation

[35]Hoon, V., 2003: A case study on Lakshadweep islands in Whittingham, E., Townsley P. and Campbell, J. eds. Poverty and Reefs: Vol 2. published by IOC/UNESCO

Table 1.2.16 Land Utilization Statistics of Lakshadweep

Attributes	1999-2000	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009
Total geographical area	3200	3200	3200	3200	3200	3200	3228	3220	3220	3220
Total reporting area	3200	3200	3200	3200	3200	3200	3228	3220	3220	3220
Area not available for cultivation	511	621	621	625	621	625	630	650	680	700
Total cropped area	2689	2579	2579	3980	2579	2575	2598	2570	2540	2520
Net sown area	2689	2579	2579	2575	2579	2575	2598	2570	2540	2520
Area sown more than once	1404	1404	1404	1405	1401	1405	1560	1565	1500	1500

While agriculture remains the predominant land based economic activity for the island population and agriculture itself very largely means coconut cultivation. Cultivation is by and large rain fed with unique mixed farming practices. The yield in terms of nuts per tree and per hectare is very high, more than double the all-India average. Yet, coconut alone is unable to provide optimal returns from the land. The delicate ecology of these islands discourages large-scale use of chemical fertilisers. The uses of chemical fertilizers are practically banned in the islands, on ecological consideration. Further information on Crop Production can be found in Annexure X.

1.2.4.4 Animal Husbandry

Animal husbandry in the UTL mainly consists of poultry and goat rearing, with cattle coming thereafter. Besides being a subsidiary economic activity, these also provide useful by-products for preparation of organic manure. However, owing to the scarcity of grazing lands and traditional factors, household farming of cattle is being practised instead of organised farming. In tune with the religious beliefs of the local people, pigs and dogs are non-existent on the islands. As per the Livestock census 2002, livestock population has been increased from 28,920 to 50,539 in 2002 at annual growth rate 15%. The annual growth rate was about 5% for cattle and 16% in the case of goats. Poultry population was 1,30,651 and registered growth rate of 13% over the year. Nearly 90 percent of the total households are rearing two to three goats for meat purposes and also meet their daily requirement of milk to some extent.

Figure 1.2.11 Animal Husbandry in Lakshadweep

1.2.4.5 Industry

The UTL has been declared as a "No Industry District" of the country in view of the fragile ecology of the islands. The inherent constraints of the area, especially being isolated and geographically scattered do not permit it to take up any major Industrial ventures. Locational disadvantages, non-availability of fresh water and power hinder development of even medium type of industries. An Industries Department however exists in Lakshadweep which aims to develop small industries and entrepreneurship among local population. Industries which do not require much land, large quantity of water, power and which do not pollute the lagoons and soil, can only be considered in these tiny islands. Industrial activity in Lakshadweep centres on coir and fish. The ecological and environment considerations prevent the setting up of large-scale industrial units in these islands as is done for the mainland states. There are 41 registered industrial units in the government sector and 504 in the private sector (2001-02). All the units in the private sector are small and medium scale dealing with coir, fish and various support activities. In the government sector, there are five coir fibre factories (units produce coir fibre, coir yarn, curled fibre and corridor mattings), five production demonstration centres, seven fibre curling units, a printing press, a hosiery factory, a tuna-canning factory and two boat building yards. Further information on the Industry Sector is available in Annexure X.

Figure 1.2.12 Coir Fibre Production

1.2.4.6 Tourism[36,37]

The UTL administration has declared tourism as an industry. Lakshadweep is home to many rare species of marine life and is one of the biggest natural underwater zoos in the world. The Administration aims to promote quality tourism that is sensitive to the ecology of the islands, that provide physical, economic and social security for the islanders and quality services to the visitors. The tourism sector has high potential for not only creating employment opportunities but also earning valuable foreign exchange thus indicating a potential growth for the island economy. The tourist season in the islands mainly runs from October to April i.e. outside the monsoon months. The tourist accommodation available is extremely limited and largely in the Government sector with very limited private accommodation. Bangaram Island has been developed as a tourist resort and operated by a hotel group from the

[36] UTL, 2011. http://lakshadweeptourism.nic.in/, Accessed on 3 March 2012
[37] *Op.Cit.*, Planning Commission, 2007

mainland. In 2002 the Government of India launched its National Tourism Policy while for its part; the Lakshadweep administration had not yet framed a policy for tourism. Tourism growth in the Lakshadweep was 2-3 percent until 2004, lower than the projected 7 to 9 percent due to insufficient infrastructure. The launch of the Star Cruise ship in 2006-2007 resulted in the influx of 25083 tourists in Lakshadweep, whose carrying capacity was a mere 8,000-10,000 tourists per year (Table 1.2.9). Further information on the Tourism sector can be found in Annexure X.

Table 1.2.9 Tourist Arrivals in Lakshadweep and Revenue from Tourism

Year	No. of Tourists			Revenue (in Crore)
	Indian	Foreign	Total	
1999-2000	1379	741	2120	1.27
2000-2001	2992	871	3863	2.98
2001-2002	3259	539	3798	3.41
2002-2003	4151	580	4731	3.75
2003-2004	4045	656	4701	2.61
2004-2005	2430	158	2588	2.13
2005-2006	12875	1418	14293	6.1
2006-2007	22941	2142	25083	7.3
2007-2008	10263	2852	13115	15
2008-2009	5871	1172	7043	15

1.2.4.7 Transport and Infrastructure

1.2.4.7.1 Shipping

There is no agricultural activity in the islands other than coconut cultivation and hence, all food articles including rice, wheat, sugar, pulses, potato, onions, etc. are transported from the mainland. Similarly, there is no major industrial activity in the islands other than some small or cottage industry. Thus, all commodities such as building materials, fuel, clothing, all daily essentials, etc. are also transported from the mainland. Since there are no major hospitals, schools and colleges in most of the islands, the people have to travel to the mainland or from one island to the other for receiving medical treatment or for education. Shipping services are the primary means of transportation of men and material between the islands and the mainland as well as in the inter-island sectors. With the growth of population and increase in the propensity to travel among the islanders for various developmental activities, the transportation requirements of the islanders are constantly on the rise. Till 1962, there was no ship or any mechanized vessel operating between the islands and mainland to carry even local passengers. The first passenger ship with 12 seats was introduced in 1962.

Restricted Navigability: The islands are surrounded by lagoons which are fenced by coral reefs all round. These reefs provide a natural shelter from rough seas, besides adding beauty to the islands. However, at the same time, these reefs restrict the navigability of the islands owing to shallow depth of water over the reefs. The environmental conditions, such as shore site topography and the tide profile in the lagoons along with the steep slopes of the coral reefs militate against the construction of large boats. The beaches in the reef ridges are very shallow. The islands are navigated by small and low draught vessels through some limited navigable entry points of these reefs where the navigable depth of water over the reef is available. Thus, the main problem is that vessels with drafts more than two metres/large boats cannot enter the lagoons and island shores. The depth of the lagoons as well as the entrance into them, thus, effectively restrict the size of the boats and along with the tidal range limit the mobility within the lagoons and therefore can create difficulties in launching internally built boats into navigable water. In some places however, the administration has widened and deepened them for building jetties. Hence, embarkation and disembarkation of passengers and cargo at most of the islands are carried out in open sea and then brought to the islands and *vice versa* by small launches or country boats. This makes the whole exercise of embarkation and disembarkation very risky; expensive and time consuming. Large vessels cannot be built on the beaches nor navigated in shallow lagoons owing to a prolonged monsoon season and high waves and rough water. Minicoy alone provides deep lagoons for such purposes but even there the underwater topography near the shore is not suited for building large sized vessels on the beach and pushing them into deep waters. The size of the cargo from different islands is also a factor determining the size of boat construction. This explains why minimum size sea-going vessels were jointly owned by persons from different islands. This shows how the local ecology and economy limit the development of the ship-building technology in the two categories of islands.

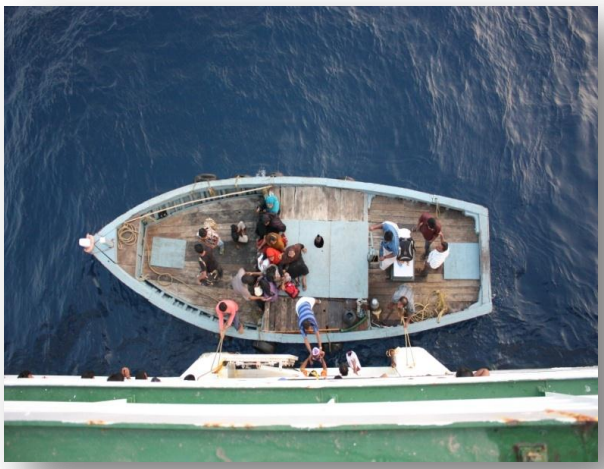
Figure 1.2.13 Ship Service in the UTL

1.2.4.7.2 Inter and Intra Island Transport

The UTL has a distinct system for 'inter and intra island transport'. Passenger shipping is provided by the administration that includes passenger ships as well as passenger-cum-cargo ships. The mainland–Island passenger-cum-cargo service fleet comprises of 17 vessels with a capacity for 1,671 persons. Besides, there are 5 barges for cargo transport and also there are two tugs. Some of the ships are ageing and are in the process of replacement, besides addition of new ships. Two fast ferry aluminium hull (catamaran type) vessels with 100 passengers capacity have also been operating since 1991 for the inter-island traffic and these handle about 30 per cent of the inter- island passenger traffic.

The embarkation and disembarkation of the passengers and cargo is usually carried out in the open sea and serviced to the island jetties by small boats or country crafts. In five islands, there are 5 lagoon jetties, and in 4 bigger islands, 2 jetties each are available, and in Androtт there is one jetty and one Breakwater for berthing smaller vessels. Four new jetties, constructed on the eastern side, are not currently operational. The repair and maintenance costs of the existing vessels are also rather high, which could be due to dependence on a single ship repair yard. Currently, the administration is heavily dependent on the Shipping Corporation of India Ltd. for ship management. The territory needs dry-dock facilities for ship repairs and maintenance. However, scarcity of land prevents setting of this infrastructure in any of the constituent islands. Such facilities can be set up in the lagoons, subject, however, to environmental sustainability. It was also reported that while the mainland-islands traffic is going up, the inter-island traffic is declining. This indicates an increasing dependence of the islanders on the mainland rather than on the islands[38].

Figure 1.2.14 Ship Embarkation



1.2.4.7.3 Civil Aviation

The administration has 2 Helicopters stationed at Kavaratti for inter-island movement and evacuation of patients. One more helicopter is being added to this fleet. Twelve helipads are available in the ten inhabited and two uninhabited islands. At present, air services are provided to the UTL by Air India which connects Agatti to Kochi and Bangalore. The Lakshadweep administration operates helicopter services (two Pawan Hans Helicopters) for inter-island connectivity as well as for providing commutation, particularly for emergency evacuation, to the mainland. The frequency of the air services is low and the costs to the passengers, high. Availability of faster means of communication through frequent and affordable air services is necessary for the effective economic integration of the islands with the rest of the country. While the journey on the passenger ships operated by the administration is heavily subsidised, the air journey to and from Lakshadweep has remained prohibitively costly. Agatti airport, the only airport in Lakshadweep, can facilitate landing of aircraft with carrying capacity of less than 70 passengers. This is totally inadequate. There is urgent need to extend the runway to facilitate landing of bigger aircraft such as Air Bus/Boeing 737 which would be useful not only for tourism and other civilian requirements but also for the defence forces. Larger aircraft will enable the

Figure 1.2.15 Airport at Agatti

[38] *Op.Cit.*, Planning Commission, 2007

carrier airlines to reduce the fares too. This will possibly require connecting the adjoining island of Kalpitti by way of a bridge and extending the runway from the existing length of 1350 metres by another 700 metres.

1.2.4.7.4 Roads[39]

All the inhabited islands of Lakshadweep are serviced by all-weather cement concrete roads (main road and branch routes), providing at least the main connectivity within each island. Each island is serviced by a main road and branch routes. Road construction and maintenance is handled by the administration as well as by the district panchayat. The islands being small in expanse do not necessarily require four wheelers for commutation and, therefore, two wheelers have remained popular. More than three-fourths of the registered vehicles are motor cycles. The total length of roads in 10 islands is 180 km. Nearly 10 km of road length added every year. Land is allotted to Coast Guard for new Airstrip at Minicoy. Land is also made available at Androth for a new Greenfield Airport for Airport Authority of India. There are approximately 4,897 vehicles registered in the UTL under the category of two wheelers, three wheelers, four wheelers, heavy transport (Buses), tractors etc. and touch screen kiosks have been installed at Kavaratti to educate the people about the vehicle driving practices.

1.2.4.8 Energy

UTL has achieved 100% electrification of households in all the inhabited islands. There are 16,610 domestic, 3351 commercial and 281 industrial consumers. Nearly 1.07 Cr. litres of diesel is used every year to create power. UTL administration requires 130 Lakh Litre HSD Oil every year for various departments - Electricity – 107.50 Lakh Litres, Fisheries– 10.50 Lakh Litres and Shipping – 12.00 Lakh Litres. Currently, the energy requirements in in the islands are being fulfilled by diesel run generators (16MW power is produced using 9 lakh litres of diesel every month), for which the diesel is imported in containers from the mainland and transported from island to island through boats.

Figure 1.2.16 Transportation of Diesel Oil in 200 L Barrels from Mainland

This is prohibitively expensive and tedious and adds to the overall vulnerability of the islands. There are 11 Diesel Generator Power Houses in the 10 inhabited and one uninhabited island. Since electricity is generated through diesel generators in all the islands it is transported in 200/210 litre capacity barrels from Calicut in Kerala to the individual islands and stored there. Lakshadweep Electricity Department also maintains an oil depot at Calicut, where oil is loaded into 200/210 ltrs. Capacity barrels and the barrels are then transported by barges, owned by UTL

[39] *Op.Cit.*, Planning Commission, 2007

administration, to the off- shore of the reef. The barrels are again unloaded on small open barge for transportation to the jetties at the islands. On land they are transported by small trucks from Jetty to the island stockyard and stored there. The whole process of transportation is tedious, cumbersome and costly. The cost per KWh generation comes to Rs.10.56; however, it is provided to the consumers at the subsidized rate of Rs.4.27 (average) per kWh. To overcome the difficulties and to avoid unnecessary expenditure, it is proposed to construct bulk oil storage facilities in all islands in a phased manner.[40] The details of maximum energy demand in kilowatt are given in Table 1.2.10.

Table 1.2.10 Maximum Energy Demand (kW)

Islands	2002 -03	2003-04	2004-05	2005 –06	2006-07
Minicoy	999	982	1126	1150	1210
Kavaratti	995	985	1200	1285	1320
Amini	575	590	663	680	695
Andrott	875	880	880	867	890
Kalpeni	425	425	490	500	510
Agatti	545	495	629	642	650
Kadmat	470	490	540	565	580
Kiltan	306	349	350	369	393
Chetlat	260	268	265	275	299
Bitra	30	32	35	35	43
Bangaram	24	24	26	45	49
Total	**5504**	**5520**	**6204**	**6413**	**6639**

Solar energy has a lot of potential in Lakshadweep islands. The use of solar energy will also contribute to reduced emission of Green House Gases. Geographical location, ecological considerations and energy demand pattern of Lakshadweep make solar energy, through the solar photovoltaic (SPV) generation, one of the most appropriate options to meet the energy demand of the island. The average solar radiation over the islands is 4.932 kWh/sq.m/day, which indicates a vast potential for harnessing solar energy.

To supplement diesel power generation, there are 11 Solar Power Voltaic (SPV) plants established with capacity of one megawatt. Smokeless stoves developed by Indian Institute of Science, have been distributed to all the 10,000 households for using the coconut residues as fuel for cooking. Solar lanterns, solar torches and solar fans are also being distributed. Solar water heaters are being introduced and battery operated vehicles have become popular with more than 800 have been sold during the last one year. The UT Administration is setting up 100 KWP diesel grid interactive SPV power plants in nine inhabited islands except Bitra with the financial assistance from the Ministry of Non-Conventional Energy Sources. In addition, the Ministry of New and Renewable energy has sanctioned a Rs.40 crore project for enhancing solar power capacity by 1 MW in 4 islands together with renovation and

[40] *Op Cit.*, Planning Commission, SDR, 2007

maintenance of all the 12 existing solar plants in the islands during the year 2010-11. At present the SPV power plants are producing 1065 KWP energy in islands. The energy produced from these power plants of 1 MW capacity is expected to save diesel fuel equivalent to approximately 5.6 lakh litres per annum. The time series data on installed capacity, generation and actual consumption of power during year 1999 to 2009 are given in Table 1.2.20.[41] It provides the details of the installed capacity, generation and consumption. Further information on the Energy Sector is provided in Annexure X.

Table 1.2.11 Installed Capacity, Generation and Consumption

YEAR	Installed Capacity In KW.		Generation (000kWh)		Consumption (000 kWh)
	Diesel	Solar	Diesel	Solar	
1999-2000	9972	Nil	19397.9	Nil	17122
2000-2001	9922	Nil	19819.6	Nil	17387
2001-2002	9837	Nil	19855.8	Nil	17386
2002-2003	9887	685	20379.0	508	18228
2003-2004	9878	685	21352.0	526	18965
2004-2005	9878	775	22054.0	559	19977
2005-2006	9924	850	25275.0	498	22542
2006-2007	9924	850	27704.6	446	24165
2007-2008	12174	850	28420.0	447	24248
2008-2009	14350	1050	30385.0	559	23492

The highly fragile ecology of Lakshadweep faces serious adverse consequences of air, water or noise pollution, which are inevitably associated with power generation through diesel sets. The storage of diesel oil for long periods in 200 litres drums not only results in wastage of the diesel oil through leakage but also affects the ecological condition of these Islands. Moreover, as the soil in these islands is highly porous, the seepage of oil from diesel generators as well as during transportation at various places such as loading and unloading locations, jetty, powerhouse, etc. and supply/storage in damaged leaky barrels pollute the water and the soil.

The presence, accumulation and increasing concentration of oil and grease will have adverse effects on coral reproduction, growth rate, photosynthesis, cell structure, colonisation capacities, feeding and behavioural responses in the long-term. Diesel generation causes water, air and noise pollution. The smoke/fume from the generating sets adversely impacts on the ambient air quality; Lakshadweep soils being highly porous the seepage of oil from generating sets as well as storage pollute the water. Moreover, diesel generation of power is a big drain on a non-renewable source. It may also be stated that despite the emphasis proposed for alternative sources, the conventional diesel oil based power generation will have to continue to be a significant source for power for the coming years, at least till the alternatives stabilise on a commercially viable scale.

[41] *Basic Statistics 2009*, Directorate of Planning and Statistics, Secretariat, Lakshadweep-Kavaratti

1.3 CLIMATE CHANGE SCENARIOS

Small island states constitute many characteristics (e.g., physical size, proneness to natural disasters and climate extremes, extreme openness of their economies, low adaptive capacity) that enhance their vulnerability and reduce their resilience to climate variability and change. In most cases they have low adaptive capacity, and adaptation costs are high relative to gross domestic product.[42] In addition to climate change and sea-level rise, other factors such as socio-economic conditions, natural resource and space limitations, susceptibility to natural hazards such as tsunami and storms are also contributors to the extreme vulnerability of small islands.

As of today, UTL has a tropical warm, humid and generally pleasant climate with little variation in the diurnal or seasonal temperature range. Lying well within the tropics and extending to the equatorial belt, it becomes more equatorial in the southern islands of the territory. The humid tropical monsoon climate is governed by cyclonic depressions which occur in south Arabian Sea and Bay of Bengal. Islands such as Androth, Kalpeni and Minicoy lie in a cyclone belt. The mean monthly temperature ranges from 25-30^{o}C (Table 1.3.1)[43]. The eastern sides are replete with rocky relicts consisting of fossiliferous, dayey conglomerates of sandstone and are subjected to heavy action of waves and wind. Infrastructure and economic activities being located near the coast of the islands are vulnerable to storms and sea erosion.

Table 1.3.1 Lakshadweep Weather Averages

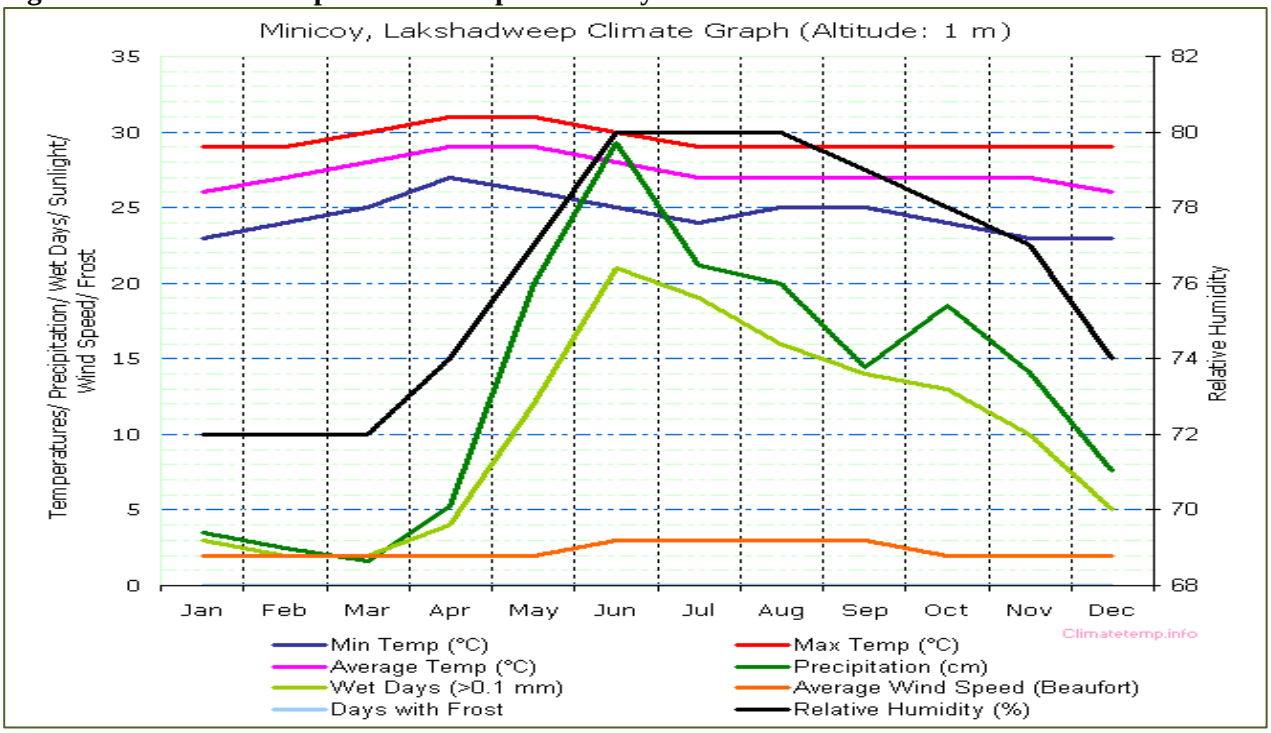
Months	Average Temperatures			Average Precipitation	Wet Days	Relative Humidity	Average Wind Speed
	Minimum (°C)	Maximum (°C)	Mean (°C)	Rainfall (mm)	(>0.1 mm)	(%)	(Beaufort)
January	23	29	26	35	3	72	2
February	24	29	27	25	2	72	2
March	25	30	28	16	2	72.0	2
April	27	31	29	52	4	74	2
May	26	31	29	200	12	77	2
June	25	30	28	293	21	80	3
July	24	29	27	212	19	80	3
August	25	29	27	200	16	80	3
September	25	29	27	144	14	79	3
October	24	29	27	185	13	78	2
November	23	29	27	141	10	77	2
December	23	29	26	76	5	74	2

Source: http://www.climatetemp.info/lakshadweep/

[42]Mimura, N., L. Nurse, R.F. McLean, J. Agard, L. Briguglio, P. Lefale, R. Payet and G. Sem, 2007: Small islands. *Climate Change 2007:Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the IntergovernmentalPanel on Climate Change,* M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 687-716.

[43] Op.Cit., Planning Commission, 2007

Figure 1.3.1 Lakshadweep Climate Graph - Minicoy



Source: http://www.climatetemp.info/lakshadweep/

With regard to precipitation, there is no significant change in rainfall and temperature data for last 30 years recorded in UTL (Figure 1.3.1). Since Indian summer monsoon (ISM) is a manifestation of complex interactions between land, ocean and atmosphere, the simulations of ISM's mean pattern as well as variability on inter annual and intra seasonal scales has been a challenging ongoing problem. Owing to paucity of data and scientific evidences from the UTL, future climate change scenarios adapted globally with relevant information for UTL sea territory is analysed and discussed herein.

Some simulations by IITM, Pune have indicated that summer monsoon intensity may increase beginning from 2040 and by 10% by 2100 under A2 scenario of IPCC. According to IPCC, while there appears a strong probability of lesser number of rainy days in a year in the future for the entire selected small islands, an increase in the daily intensity of precipitation is possible over the small islands of the Pacific Ocean and the Indian Ocean[44] (Table 1.3.2.and Table 1.3.4)

[44]Lal, M., H. Harasawa and K. Takahashi, 2002: Future climate change and its impacts over small island states. *Climate Res.*, **19**, 179-192.

Table 1.3.2 Projected Change in Precipitation (%) by Region, Relative to the 1961–1990 Period

Region	2010–2039	2040–2069	2040–2069
Mediterranean	−35.6 to +55.1	−52.6 to +38.3	−61.0 to +6.2
Caribbean	−14.2 to +13.7	−36.3 to +34.2	−49.3 to +28.9
Indian Ocean	−5.4 to +6.0	−6.9 to +12.4	−9.8 to +14.7
Northern Pacific	−6.3 to +9.1	−19.2 to +21.3	−2.7 to +25.8
Southern Pacific	−3. 9 to +3.4	−8.23 to +6.7	−14.0 to +14.6

Source: AR4, IPCC, 2007[45]

Table 1.3.3 Projected increase in air temperature (°C) by region, relative to the 1961–1990 period

Region	2010–2039	2040–2069	2040–2069
Mediterranean	0.60 to 2.19	0.81 to 3.85	1.20 to 7.07
Caribbean	0.48 to 1.06	0.79 to 2.45	0.94 to 4.18
Indian Ocean	0.51 to 0.98	0.84 to 2.10	1.05 to 3.77
Northern Pacific	0.49 to 1.13	0.81 to 2.48	1.00 to 4.17
Southern Pacific	0.45 to 0.82	0.80 to 1.79	0.99 to 3.11

Source: AR4, IPCC, 2007

Further information on climate scenario is provided in Annexure XI

1.3.1 Sea Level Rise

It has long been recognized that islands on coral atolls are especially vulnerable to a combination of impacts, and it is argued that the risk from climate-induced factors constitutes a dangerous level of climatic change to atoll countries.[46] The future of atoll island geomorphology has been predicted using both geological analogues and simulation modelling approaches. Using a modified shoreline translation model, it was found that, with sea-level rise, ocean shores will be eroded and sediment re-deposited further lagoon ward, assuming that the volume of island sediment remains constant.[47] Simulations also show that changes in sediment supply can cause physical alteration of atoll islands by an equivalent or greater amount than by sea-level rise alone.

[45] Source: http://www.climatetemp.info/lakshadweep/
[46] Barnett, J.and W.N. Adger, 2003: Climate dangers and atoll countries. *Climatic Change*, **61**, 321-337.
[47] Kench, P.S. and Cowell, P.J. 2001. The Morphological Response of Atoll Islands to Sea-Level Rise. Part 2: Application of the Modified Shoreline Translation Model (STM).Challenges for the 21st Century in Coastal Sciences, Engineering and Environment,*Journal of Coastal Research*, Special Issue, 34: 645-656.

Researchers have warned that the region most vulnerable to inundation from accelerated sea level rise is the UTL archipelago. [48] The impact of accelerated sea level rise on coastal regions and islands and the ability to adapt to environmental changes of a particular shoreline depend on local topographic characteristics. The UTL islands off the south-west coast of India, with a maximum height of 4 m above present mean sea level, may be particularly vulnerable to the consequences of sea level rise due to the greenhouse effect. Available data on the topography of Kiltan, Kavaratti, Kadmat, Kalpeni-Cheriyam and Agatti-Bangaram islands suggest that the predicted sea level rise scenario value of 1 m may be responsible for 19, 11, 19, 21 and 18% (respectively) land loss in these islands.[49]

Using the records of coastal tide gauges in the north Indian Ocean for more than 40 years, it has been estimated, that sea level rise was between 1.06-1.75 mm per year. These rates are consistent with 1-2 mm per year global sea level rise estimates of IPCC.[50] While some spatial variation within and among regions is expected, it is reported (IPCC, AR4) that sea level is projected to rise at an average rate of about 5.0 mm/yr over the 21st century, and concluded that sea-level change of this magnitude would pose great challenges and high risk, especially to low-lying islands that might not be able to adapt[51]. The IPCC Report (2007)[52] predicts a global sea level rise of at least 40 cm by 2100 that shall inundate vast areas on the coast, and up to 88 per cent of the coral reefs, termed the "rainforests of the ocean", may be lost. Globally, sea level rose at an average rate of 1.8 mm per year over 1961 to 2003. The rate was faster over 1993 to 2003, at about 3.1 mm per year.

There is high confidence that the rate of observed sea-level rise increased from the 19th to the 20th century. The total 20th-century rise is estimated to be 0.17 m. It is also projected that the sea level may rise further than what it is today and with warming of the oceans, the intensity and frequency of cyclonic activities and storm surges may increase leading to large-scale inundation of the low-lying areas along the coastline. A mean Sea Level Rise (SLR) of 15-38 cm is projected along India's coast by the mid-21st century and of 46-59 cm by 2100.

[49]Pathak, M.C, and K. L Kotnala. 1990. Consequences of predicted sea level rise for the Lakshadweep islands. Current Science, Vol. 59 (3).

[50]Unnikrishnan, A.S., and Shankar, D., 2007. Area sea level trends along the north Indian Ocean coasts consistent with global estimates. Global and Planetary Change, 57, 301, pp 15.

[51] Nurse, L., G. Sem, J.E. Hay,A.G. Suarez, P.P.Wong, L. Briguglio and S. Ragoonaden, 2001: Small island states. *Climate Change 2001: Impacts, Adaptation, andVulnerability. Contribution of Working Group II to the Third Assessment Reportof the Intergovernmental Panel on Climate Change*, J.J.McCarthy,O.F. Canziani,N.A. Leary, D.J. Dokken and K.S. White, Eds., Cambridge University Press,Cambridge, 842-975.

[52]IPCC, 2007. Climate Change, Synthesis Report (Fourth Assessment).

1.4 Assessment of Climate Change Impacts and Vulnerability

1.4.1 Lakshadweep: Assessment of Impact and Vulnerability

Climate change will impact the social and economic fabric of life in small islands, affecting key sectors such as tourism and agriculture, and placing critical infrastructure at risk. It has been reported that the impacts of climate change have the potential to make atoll islands such as Kiribati, Tuvalu and the Maldives uninhabitable owing to changes in precipitation which would lead to droughts that affect the supplies of drinking water and food security in general[53]. The economy is reliant on a limited resource base and is subjected to a high degree of mainland dependence. Assessment of vulnerability of Lakshadweep Islands to both the natural and man-made hazards becomes multi-fold mainly due to their insularity, remoteness and geographical isolation from the mainland.

Three main considerations when assessing vulnerability risk for UTL:

1. **Economic vulnerability:** to sea level rise and consequences of storm surges;
2. **Social vulnerability**: incidence of extreme events w.r.t. mortality or social disruption etc.
3. **Ecological vulnerability**: disturbance of coastal systems, terrestrial ecosystems or coral reefs.

In contrast to the main land, natural disasters can lead to a complete breakdown of economic processes, extensive environmental damage and substantial and extensive disruptions in social fabric of the islands. The UTL will focus the efforts on enhancing their resilience and implement appropriate adaptation measures as urgent priorities. Thus, integration of risk reduction strategies into key sectoral activities (e.g., sectoral planning, disaster management, integrated coastal management and health care planning etc.) will be pursued as part of the adaptation planning process for climate change. The vulnerability of Lakshadweep islands to climate change has been assessed (Table 1.4.1). The vulnerability maps of India to Wind & Cyclone, earthquake and flood are given in Annexure V, Annexure VI and Annexure VII respectively.

[53] *Op.Cit.*,UN-OHRLLS, 2009

Table 1.4.1 Assessment of Vulnerability of Lakshadweep Islands

Climate Change	Exposure	Who or What Affected
Sea level rise and salt water intrusion	Salinization of water lenses Less fresh water available	Human consumption and health Water suppliers Plant nurseries and parks Biodiversity, protected areas
Reduced average rainfall	Less fresh water available Drought	Aquifer recharge rates Cisterns and reservoirs Biodiversity
Increased rainfall intensity	Runoff and soil erosion	Reduction in crop production Crop quality reduced Post-harvest losses Sedimentation of water bodies Blocked storm water wells
Increased evaporation rates	Soil erosion	Farming community; crop yields Biodiversity
Decreased temperature	Reduced minimum temperature Microclimate affected	Soil biodiversity affected Reduced crop yield Crop quality reduced

Source: Adapted and Modified from Hurlston, 2004

1.4.2 Natural Disasters: Impact and Vulnerability

There has been an overall increasing trend in severe storm incidence along the coast at the rate of 0.011 events per year. In the Indian Ocean, tropical storm activity (May to December) in the northern Indian Ocean has been near normal in recent years. For the southern Indian Ocean, the tropical cyclone season is normally active from December to April. A lack of historical record-keeping severely hinders trend analysis.[54]

Storms and cyclones are the main natural hazards occurring in UTL. Effective adaptive and disaster mitigation efforts are of prime importance considering predictions on global climate change and rising sea levels. A glimpse into the recorded history of disasters in Lakshadweep shows that some islands like Androtт and Kalpeni have been frequented by cyclones causing considerable damage. Infrastructure and economic activities being located near the coast, they become highly vulnerable to cyclones and sea-level fluctuations. Low-lying islands are at greater risk from sea-level rise. Androtт, Kalpeni and Minicoy lie in a cyclone belt. The remaining islands are subject to the fury of the Southwest and Northeast monsoons causing heavy damages to coconut crops, seashore land, sheds and dwelling houses that are not able to withstand cyclonic winds or in areas subject to flooding. Were the December 26, 2004 tsunami that hit East Asia including the Andaman and Nicobar Islands and the eastern coast of India to hit Lakshadweep with the same severity, it would almost annihilate the islands, as the land surface is hardly1-3 metres above sea level.

[54] Ibid

1.4.2.1 Cyclonic Storms and other risks

The UTL islands are surrounded by the vast ocean, which are open to storms and cyclones. Some of the areas in island are low-lying and due to heavy rain, the people residing in such part of the island have to flee for safety and stay in places where water does not reach. The storms and cyclones hit some of the islands in the year 1847, 1891, 1922, 1963, 1977, and during May, 2004. The main problem is that due to the hitting of waves during such occasions, sea erosion takes place. The devastation by the cyclone in many areas in the island resulted in uprooting and twisting of coconut trees, loss of vegetation, blowing away of roof tiles, damages to the buildings, and loss of domestic animals. The houses are also prone to damage caused due to the high-speed wind and falling of coconut trees on it. A few of the cyclonic depressions and storms, which form in the south Arabian Sea during April and May, affect the weather over the territory (Table 1.4.2 and Table 1.4.3).

During the post monsoon months of October to December also, a few of such systems originating in the Bay of Bengal and traveling westwards emerge into the south Arabian sea, and occasionally affect these islands. In association with these, strong winds are caused and heavy rains occur. The table gives the number of storms and depressions which affected the region in the above mentioned months during last 115 years ending 2004. These events also lead to losses to physical and social infrastructure that retards the pace of development. Increasing occurrence of extreme weather events, one of the established manifestations of climate change, increases the vulnerability of the UTL.

Table 1.4.2 Special Weather Phenomena in Lakshadweep

Mean No. of days with	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Minicoy													
Thunder	1.3	0.9	1.8	4	6	3	1.7	0.5	0.5	1.4	2	0.9	24
Hail	0	0	0	0.2	0	0	0	0	0	0	0	0	0.2
Dust - storm	0	0	0	0	0.6	0	0	0	0	0	0	0	0.6
Squall	0	0	0.1	0.2	0.5	0.7	0.3	0	0.5	0	0.1	0	2
Fog	0	0	0	0	0	0	0	0	0	0	0	0	0
Amini													
Thunder	0.5	0.1	0.7	1.3	3	3	0.7	0.2	0.8	3	3	0.7	17
Hail	0	0.1	0	0	0	0	0	0	0	0	0	0	0.1
Dust-storm	0	0	0	0	0	0	0	0	0	0	0	0	0
Squall	0.2	0	0	0.1	0.9	3	4	1.5	1.6	0.8	1.0	0.1	13
Fog	0	0	0	0	0	0	0	0	0	0	0	0	0

Earthquakes: Lakshadweep islands are situated in the Arabian Sea and have moderate seismicity. It is classified as Seismic Zone III as per IS: 1893-2002, which is, referred as Moderate Damage Risk Zone of MSK VII in the Vulnerability Atlas of India, 1997. Although there is very little observed seismicity, the faults running parallel to the west coast of the mainland of India have the potential of generating M6.5 earthquakes, hence causing MSK VII shaking in the islands. [55]

Tsunamis: West coast is generally less prone as compared to east coast since the tsunamigenic earthquakes generally occur in the Java trench in the Andaman coast. Historically west coast has recorded tsunami due to earthquake in Makran coast. There is no record on the tsunami affecting the UTL coast. Though effect of the recent Tsunami was not adversely felt in and around UTL except for some minor effects in Minicoy and Andrott, yet the smallness of the size of these islands and their geographical segregation makes them very vulnerable to any kind of Tsunami threat. The recent Tsunami with a wave direction propagating east from Sumatra had little or no effect on the UTL islands (Figures available in Annexure XII)[56].

Table 1.4.3 Number of Storms and Depressions in Lakshadweep Islands during last 115 years ending 2004

Months	No. of Storms and Depressions in Arabian Sea
April	4
May	2
October	8
November	10
December	3
Total	**27**

Source: Framework of Disaster Management Plan in Lakshadweep, 2004 prepared by Lakshadweep Administration

[55] Taskforce Report
[56] *Op.Cit*., GoI, 2005

1.4.3 Coastal Zone Vulnerability

1.4.3.1 Coastal Zone Erosion and Accretion

Coastal erosion is a serious problem faced by the Lakshadweep islands. Maximum erosion observed over a period of 35-40 years were in the range 28 to 44 m. With a tiny landmass of 32 sq.km and lying at below a maximum of 6 m from MSL, erosion of every inch of land is a serious loss. Erosion takes place on account of natural causes like wave action as well as due to destruction of coral reefs. Similarly, the high-speed wind and huge waves hitting the seashore lead to sea erosion resulting into reduction of the size of the islands. Even otherwise, during southwest monsoon season, sea erosion takes place and many low-lying foreshore regions of the islands are washed out[57].

Risks of inundation of sea water

This can occur due to:

- Anticipated sea level rise
- Storm surges that may occur sometimes in these islands
- Tsunami waves.

The projected rise in sea level may further aggravate the scenario. The UTL has witnessed an unprecedented flooding and erosion of some of the islands during the 2004 cyclonic storms. Studies on collection of baseline data on erosion and the accretion cycle in Lakshadweep Islands and to design and implement proper coastal protection measures and beach monitoring over a long term period were carried out by the Center of Earth Science Studies (CESS), Thiruvananthapuram, in four islands viz. Kavaratti, Agatti, Amini and Bangaram during 1990-1993. The studies revealed a net accretion of 21.43-m^3/ m in Kadmat and 11.05 m^3/m in Chetlat islands during the study period. The Kiltan Island showed net accretion as well as seasonal erosion at certain stretches. Major part of Kiltan Island has been undergoing erosion on the east coast. Good correlation between high diffraction zones and erosion was observed. Similarly, erosion was noticed at Bitra Island (the smallest island in the UTL) mostly on the south and south-eastern sectors. Long-term shoreline changes have been estimated for these islands. The Chetlat Island exhibited maximum recession of shoreline on southeast and northeast corner whereas in the case of a baseline data on the erosion aggression cycle has indicated that the erosion pattern in the islands is controlled by the wave diffraction. Wave diffraction plays a significant role in the distribution of wave energy along the Coasts of the islands, which affects the stability of the coast. The diffraction coefficients along the boundary of the islands vary from 0.71 to 1.45. Higher diffraction is observed at the SW and SE coasts where critical erosion is observed. At the NE portion of the islands where there is no net erosion the diffraction coefficient is less.

[57] *Op.Cit.*, GoI, 2005

Table 1.4.4 Shoreline Changes

Island	Perimeter (km)	Length of shoreline in km		
		Erosion (%)	Accretion (%)	No Change (%)
1. Kavaratti	11.45	4.15 (36)	7.12 (61)	0.18 (1.5)
2. Agatti	16.14	9.01(56)	6.34 (39)	0.79 (4.8)
3. Amini	6.67	2.45(36)	3.85(57)	0.37(5.3)
4. Androtт	10.59	4.47(42)	0.92(8.6)	5.2(49)
5. Bangaram	3.51	2.17(61)	1.34(38)	-
6. Kalpeni	11.85	2.53 (21)	2.01 (17)	7.31 (61)
7. Minicoy	23.07	9.98 (43)	3.58 (15)	9.51 (41)
8. Kiltan	7.81	3.64(46)	3.18 (40)	0.99 (12)
9. Chetlat	5.82	2.14(36)	3.2(55)	0.48(8)
10. Kadamat	18.37	5.55(30)	9.82(53)	3.01(16)

Source: CESS

1.4.3.2 Flood Prone Areas of Lakshadweep Islands

In order to identify the flood prone areas on various Islands of Lakshadweep, the data on land elevation collected by Centre for Earth Science Studies (CESS) under a project " Preparation of Integrated Coastal Zone Management Plan for Lakshadweep Islands" sponsored by Government of India, Ministry of Environment and Forests was used. Some of the observation on Amini, Kavaratti and Kiltan Islands are summarized below.

Flood Prone Areas of Lakshadweep

Kavaratti Island

- Major part of the island has an elevation of 3 to 4 m above MSL.
- High sand bumps of > 5 m: Patches near Ujra Palli and further south.
- Low-lying areas: Bordering northeast coast from south of Ottavayil palli (south of Reference Station CSK-5) up to CSK-8 near the Administrator bungalow in the north; Patches near fisheries jetty, south of Purath Palli and south of Chicken neck.

Amini Island

- High sand dunes of >5 m: North-western part
- Low-lying areas: Central part of island (from Thiruvath palli in the north to Helar Palli in the south).
- Gradual slope: From eastern part to the coast.

Kiltan Island

- Major part of the island has an elevation of m above MSL.
- Low-lying regions: Kulikkara Palli, Kunni Palli, and North West of EliPalli.
- In the eastern coast starting from Naranga Palli towards north the stretches has an elevation 0 to 2.5 m above the MSL.

1.4.4 Assessment of Key Sectoral Impacts and Vulnerabilities

1.4.4.1 Crop and Animal Husbandry

The main livelihood operations for the people of Lakshadweep are coconut cultivation and fishing. Both these activities at the time of calamities get disrupted. The uprooting of coconut trees and loss of standing coconut crops sets back the economy of Lakshadweep immediately for a minimum period of two years. Arable land for crop agriculture is increasingly in short supply and the likely prospect of land loss and salinization due to climate change and sea-level rise will threaten the sustainability of both subsistence and commercial agriculture. The impacts on agriculture arise not only from direct loss of arable land to inundation, but also to the increased potential for erosion and increased coastal flooding. Differing interests may cause conflict and dispute over property rights and responsibilities. Farmers losing land to sea-level rise can get land only from others to compensate for their loss. Since vacant agricultural land is scarce, the result could be ruin for farmers hit by the effects of land loss. [58]

Evidences of Climate Change Impacts on Crops and Livestock

- **Estimated loss** in crop production: 10-40% by 2100
- **High sensitivity** of food production in India to climate changes events: variability in monsoon rainfall and temperature changes within a season.
- **Pathogens and insect population dynamics**: Strongly dependent upon temperature and humidity
- **High projection of economic losses** resulting from the negative effects of climate change on agriculture in low lying islands (WB, 2000)
    - Case study: Tarawa, Kiribati: Cost of US $8-16 million/year by 2050(in the absence of adaptation).
    - Cost represents 17-18 % of Kiribati's GDP (2002).
- **Coconut: Optimum temperature** ~27°C. Monthly minimum temperature below 23°C, over a period of 4 months (18 months before harvest), significantly influences the fruit set. There also exists significant +ve correlation between annual yield and mean annual temperature period (18 month period); Ohler , J.G.(1999)

[58] FAO, 2007. Adaptation to climate change in agriculture, forestry and fisheries: Perspective, framework and priorities.
NAPCC, 2008. National action plan on Climate change, Government of India.
World Bank (2000). *Cities, Seas, and Storms: Managing Change in Pacific Island Economies.* Volume I: Summary Report (draft). Papua New Guinea and Pacific Islands Country Unit: The World Bank. Washington, D.C.
Ohler, J.G. (editor) (1999) Modern Coconut Management. Intermediate Technology Publications Ltd., published for the Food and Agriculture Organization of the United Nations in collaboration with Leiden University in The Netherlands.

1.4.4.2 Fishery

Tuna is the main fishery in Lakshadweep islands. The fisheries sector is highly vulnerable to climate change as tuna is highly attuned to the biophysical conditions of the pelagic environment, particularly ENSO and associated changes in SST[64]. During the 1997/1998 El Nino the Indian Ocean purse seine fishery was shifted to the east, unlike other years owing to the elevated depth of the 20^0C isotherm[65]. Climate induced changes and fishery overexploitation occurring elsewhere may have local repercussions in islands like Lakshadweep and Maldives, as tuna fishery of is part of the wider Indian Ocean tuna fisheries.[66] The most recent assessments of the tuna stock in Indian Ocean revealed that the big eye tuna is overexploited and that yellow fin tuna stock is considered to have reached maximum sustainable levels[67]. Tuna movement and abundance in the Indian Ocean is closely linked to the monsoon driven ocean productivity[68]. The Somali Basin and the north Arabian Sea is particularly productive during the southwest monsoon which is becoming stronger causing over 300% increase in phytoplankton biomass in the area[69]. These in turn is expected to have profound implications of tuna distribution and abundance in the Indian Ocean[70]. In contrast to agriculture, the mobility of fish makes it difficult to estimate future changes in marine fish resources.

Evidences of Climate Change Impacts on Fishery

- **Tuna distribution and abundance in Indian Ocean linked to:**
  - Monsoon driven ocean productivity[59]
  - Changes in migration patterns
  - Depth of fish stocks
  - Southwest monsoon becoming stronger causing 300% increase in phytoplankton biomass in the area[60]; may cause migratory shifts in tuna aggregations to other locations. [61]
  - Other factors include ciguatera fish poisoning (caused by pollution, reef degradation and warmer sea temperatures during El Niño events[62])
- These variations in tuna catches are especially significant during **El Niño and La Niña years** (1972/1973, 1976, 1982/1983, 1987, and 1992/1994). Fluctuations in skipjack catches and yellow fin found.[63]

[59]Ibid
[60]Ibid, Goes et.al.
[61]McLean, R.F., A. Tsyban, V. Burkett, J.O. Codignotto, D.L. Forbes, N. Mimura, R.J. Beamish and V. Ittekkot, 2001: Coastal zones and marine ecosystems. Climate Change 2001: Impacts, Adaptation, and Vulnerability. Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, J.J. McCarthy, O.F. Canziani, N.A. Leary, D.J. Dokken and K.S. White, Eds., Cambridge University Press, Cambridge, 343-379.
[62]Hales, S., P.Weinstein and A.Woodward, 1999: Ciguatera (fish poisoning), El Niño, and sea surface temperature. *Ecosyst. Health*, **5**, 20-25.
[63]MOHA(Ministry of Home Affairs, Maldives), 2001: *First National Communication of the Republic of Maldives to the United Nations Framework Convention on Climate Change*. Ministry of Home Affairs, Housing and Environment, Malé, Republic of Maldives, 134 pp
[64]National Adaptation Plan of Action (NAPA), 2006. Republic of Maldives.
[65]Marsac F. et J-L Le Blanc, 1998 : Dynamics of ENSO events in the Indian Ocean: To what extent would recruitment and catchability be affected. IOTC 7th Expert Consultation on Indian Ocean Tunas. Victoria, Seychelles ; 9-14 Novembre 1998.
[66]Adam, M. S. (2006). Climate Change Vulnerability and Adaptation Assessment of The Fisheries Sector of Maldives. Maldives Climate Change Policy Research Working Papers. Male', Ministry of Environment, Energy And Water
[67]IOTC (2005).Report of the Eight Session of the Scientific Committee. Victoria, Seychelles
[68]Ibid., Adam, 2006
[69]Goes J, I., Thoppil P.G., et al. (2005). "Warming of the Eurasian landmass is making the Arabian Sea more productive. Science 308: 545-547.
[70]Ibid, Adam, 2006

Furthermore, since the life cycles of many species of commercially exploited fisheries range from freshwater to ocean water, land-based and coastal activities will also be likely to affect the populations of those species. Coral reefs and other coastal ecosystems which may be severely affected by climate change will also have an impact on fisheries.[71]

1.4.4.3 Biodiversity

Oceanic islands often have a unique biodiversity through high endemism (i.e., with regionally restricted distribution) caused by ecological isolation. Moreover, human well-being on most small islands is heavily reliant on ecosystem services such as amenity value and fisheries.[72] Small islands, globally, are home to a significant part of the world's biodiversity. Their relative physical isolation has led to the formation of many geographically unique species. Any sea-level rise will allow waves to over-top the reefs, increasing coastal vulnerability to erosion and storms, at least until reef growth can catch up with sea-level. The more rapid the rate of sea-level rise, the longer the period of vulnerability, and the greater the possibility that present reefs will be unable to catch up and that they will drown. Coral mining for building materials, and land reclamation on coral reef flats increase the risk of damage. Some scientists have suggested that increased growth rate of coral reefs and more efficient sedimentation processes may offset some of the sea-level rise effects for atolls, at least for the next 50-100 years[73].

Figure 1.4.1 Coral Bleaching

The rise in sea surface temperature due to El-Nino phenomenon during 1998 caused extensive coral reef bleaching impacting over 40 to 90% of live coral cover. Live coral cover was no more than 10% at Kadmat Island after the bleaching had happened. The hard corals of Porites species, found in abundance in the lagoons of the Lakshadweep islands, are facing a threat to their existence. Severe coral bleaching occurred during 1998[74], with mortality rates as high as 87% in some parts of Maldives and Lakshadweep Islands.

[71] Graham,N.A.J., S.K.Wilson, S. Jennings,N.V.C. Polunin, J.P. Bijoux and J. Robinson, 2006: Dynamic fragility of oceanic coral reef ecosystems. *P. Natl. Acad. Sci.USA*, **103**, 8425-8429.

[72] Wong, P.P., E.Marone, P. Lana, J.Agard,M. Fortes,D.Moro and L.Vicente, 2005: Island systems. *Ecosystems and Human Well-being: Millennium Ecosystem Assessment*, H.A.Mooney andA. Cropper, Eds., Island Press.Washington, District of Columbia / Covelo, London, 663-680.

[73] W.J. McG. Tegart, G.W. Sheldon and D.C. Griffiths, 1990. (eds.).Climate Change: The IPCC Impacts Assessment. Report prepared for Intergovernmental Panel on Climate Change by Working Group II.Australian Government Publishing Service, Camberra, Australia 294 pp.

[74] It is reported that 1998 was the warmest year on record and the 1990s was the warmest decade in the UTL since temperature recording began about 150 years ago. Additionally, 1998 also saw the strongest El Nino ever recorded; the consequences of these were felt strongly in the tropical Indian Ocean, often with temperatures of 3-5o C above normal.

Minor coral bleaching was observed in South Asia in March - April 2003 and 2004; the same months as massive bleaching occurred in 1998. This time coincides with the warm weather prior to the southwest monsoon. Coral bleaching was observed in India on some islands of the Gulf of Mannar, with 10 - 20% of massive corals bleached, but the majority recovered in the second half of the year. Some bleaching primarily of Porites colonies was also recorded in 1998.

It is expected that 32 per cent of the reefs may be lost in the next 30 years if the threats are not reduced. Loss of healthy coral reefs will lead to elimination of primary sources of food, income and employment for millions of people around the world, as well as the extinction of many fascinating and beautiful marine species. Concerning the 1998 bleaching event, the overall economic cost to tourism, shoreline protection and fisheries in the Indian Ocean has been estimated to be between US$608 and 8026 million.[75] Some live corals are getting affected by crown of thorns (*Acanthaster planci*) infection. The live coral cover of the Lakshadweep Islands ranged between 17.5% and 44.3% during the 2009. The lowest percentage of live coral cover was recorded at Suheli Island and the highest percentage at Bitra Island. The status of coral reefs in Lakshadweep Islands is shown in Table 1.4.5.

Table 1.4.5 Status of Coral reefs in Lakshadweep Islands

Name	Area (sq.km)	Lagoon Area (sq.km)	Average Live Coral by Latest Survey (%)	Survey Year	Effect of Bleaching	Recovery	Natural Resources
Agatti	2.71	17.5	40%	2002	Less Affected	Good	
Amini	2.59	1.5	5.50%	2002	Much Affected	Slow	
Androth	4.84	NIL	12%	2002	Much Affected	Good	Less reef fishes
Bangaram	0.58	46.25	13%	2001	Heavy	Good	
Bitra	0.1	45.61	32.50%	2001	Minimum	-	Good live coral cover in pristine condition
Chetlat	1.04	1.6	14%	2001	Minimum	-	Turtles Noticed
Kadamat	3.12	37.5	7%	2000	Maximum	Slow	
Kalpeni	2.28	25.6	10%	2002			High coral Diversity
Kavaratti	3.63	4.96	23%	2002	Maximum		
Kiltan	1.63	1.76	15%	2001			
Minicoy	4.37	30.6	12%	2002	Much Affected		
Suheli			21%	2002	Much Affected	Good	Rich in reef fishes; Turtle Nesting Site

[75] Cesar et al, 2002).Cesar, H, Pet-Soede, L, Westmacott, S, Mangi, S and Aish, A. (2002) 'Economic analysis of coral bleaching in theIndian Ocean – Phase II' in Linden, O, Souter, D, Wilhelmsson, D and Obura, D. (eds.) Coral Reef Degradation in the Indian Ocean: Status Report 2002. CORDIO and University of Kalmar: Kalmar (Sweden), 251-262.

Increased bleaching coupled with reduced calcification will affect coral growth and reef integrity and, reduce the ability of the reef to keep up with sea level rise. Furthermore, mass spawning of corals which are the building blocks of a coral reef and its sustainability make them particularly vulnerable to climate change. A miss in a major spawning event can be disastrous to coral recruitment and the replenishment and recovery of coral reef.[82]

Evidences of Climate Change Impacts on Corals

- **Decrease in the growth rate (calcification rate)** of two hard corals by around 25 per cent observed between 1993 and 2003 along the lagoon of Kavaratti Island[76].
- **Bleaching Events:** In the past 20 years, a sea surface temperature (SST) rise of approximately 1ºC above the normal maximum summer temperature has led to bleaching events. Some studies have predicted that, in the next 30 to 50 years, bleaching events could occur annually in most tropical oceans[77].
- Another threat to coral reefs is that of **rising CO_2 concentration levels** in the oceans – related to rising atmospheric CO_2. Based on projected CO_2 levels, it has been suggested that the calcification rate of corals could decrease by about 14 percent to 30 percent by 2050.[78]
- **Coral diseases:** There is also a detectable influence on marine and terrestrial pathogens, such as coral diseases and oyster pathogens, linked to ENSO events.[79] These changes are in addition to coral bleaching, which could become an annual or biannual event in the next 30 to 50 years or sooner without an increase in thermal tolerance of 0.2 to 1.0°C[80,81].

With damage to coral reef and associated habitat loss, reef fish species which are specialists requiring specific types of habitats within a reef or specific type of food from a reef could be adversely affected[83].Improved management could increase the resilience and resistance of the coral reefs by helping to facilitate recovery from the 1998 event, and improve the chances of withstanding another similar event; which appears inevitable based on current predictions.

[76] Studies conducted by scientists of the National Geophysical Research Institute (NGRI) Hyderabad.

[77] S. Masood A, V.M. Padmakumari, Waseem R, K. Venkatesham, G. Suseela, Netramani S, Ashutosh C, R. Soundar Rajan. 2011. High-resolution carbon and oxygen isotope records from a scleractinian (Porites)coral of Lakshadweep Archipelago. Quaternary International 238.:107–114

[78] Nurse, L., et al, 2001, Small island states, In *Climate Change 2001: Impacts, Adaptation, and Vulnerability*, J.J.McCarthy et al (eds.), Contribution of Working Group II to the Third Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, pp. 842-975.

[79] Harvell, C.D., C.E. Mitchell, J.R.Ward, S.Altizer,A.P. Dobson, R.S. Ostfeld and M.D. Samuel, 2002: Climate warming and disease risks for terrestrial and marine biota. Science, 296, 2158-2162.

[80] Sheppard, C.R.C., 2003: Predicted recurrences of mass coral mortality in the Indian Ocean. Nature 425, 294-297.

[81] Donner, S.D., W.J. Skirving, C.M. Little, M. Oppenheimer and O. Hoegh-Guldberg, 2005:Global assessment of coral bleaching and required rates of adaptation under climate change. Glob. Change Biol., 11, 2251-2265.

[82] Naseer, A. (2006). Vulnerability and Adaptation Assessment of the Coral Reefs of Maldives. Technical Papers to Maldives National Adaptation Plan of Action for Climate Change. Male, Ministry of Environment, Energy and Water.

83 Op.Cit., Adam 2006

Apart from harbouring significant biological diversity and acting as the breeding grounds for fishery stock, coral reefs also act as the 'natural defence mechanism' against sea-surges and storms in the UTL. However, the health and integrity of the corals in the UTL have taken a beating. Other threats to coral reef include marine pollution due to oil slicks, disposal of untreated sewage and dumping of non-biodegradable solid waste into the marine ecosystems.

Man Made Threats to Coral in Lakshadweep

- **Heavy Metal Pollutants**: High level of heavy metal pollutants presence in reef corals is likely to have an adverse effect on corals that will ultimately affect many other reef organisms, which rely on these healthy communities either directly or indirectly. High concentration of trace metal concentrations in ramrose and branching type corals.[84]
- **Human Activities:** Dredging of the reef to create wider entry points for navigation, collection of corals and shingles from the reef for construction activities, overexploitation of certain resources for example, movement of human beings in the reef for gleaning, dragging fishing nets and the drop in the number of live-bait fishes.
- **Pollution:** Oil spills, sewage, presence of synthetic products such as rubber, plastics, cements and metals impact corals. These seem to impede coral growth and lead to crumbling of the coral colony.

The sea grass species prevalent in UTL (*Cymodocea isoetifolia, Syringodium isoetifolium, Thalassia hemprichii*) are affected with warming ocean temperatures, which is likely to result in distribution shifts, changes in patterns of sexual reproduction, altered growth rates, metabolism, and changes in their carbon balance[85]. High temperatures (above their ambient temperatures have caused large scale diebacks of *Amphibolis Antarctica* and *Zostera* spp. in southern Australia[86]. In addition, species of sea turtles (Leather backs *Dermochelys coriacea, Green Turtle Chelonia mydas, Hawksbill Eretmochelys imbricata, Olive ridley)* which are found in UTL are also likely to face the impacts of climate change. The uninhabited islands of Lakshadweep are the second largest nesting grounds for green and hawksbill turtles[87]. Some scientists are now suggesting that global climate change has the potential to eliminate the production of male turtle offspring if mean global temperatures increase 4°C, (7.2°F) and increases of less than 2°C (3.6°F) may dramatically skew the male-female sex ratios. The sex of sea turtle hatchlings is temperature dependent, with warmer temperatures increasing the number of female sea turtles at the expense of males. Various studies have shown that rises in sea level (0.5-0.9m) is projected to cause a decrease in turtle nesting habitat (35-51%)[88,89,90]. Future climate change could also alter the intra-annual timing of nesting, such that warmer water temperatures may contribute to an earlier onset of nesting (by 12 to 18 d 1°C–1 for loggerhead turtles, a decrease in the inter nesting interval.

[84] Anu, G, N. C. Kumar, K. V. Jayalakshmi, S. M. Nair, 2007. Environ Monit Assess 128:195–208
[85] Short and Neckles 1999
[86] Seddon et al.2000
[87] Reef Resilience, 2011. Tool Kit for Reef Resilience.http://www.reefresilience.org/Toolkit_Coral/C8_India.html.
[88] Baker et al. 2006, Fish et al. 2008,
[89] Fish, M.R., I.M. Cote, J.A. Gill, A.P. Jones, S. Renshoff and A.Watkinson, 2005:Predicting the impact of sea level rise on Caribbean sea turtle nesting habitat.*Conserv. Biol.*, **19**, 482-491.
[90] Lucy A. Hawkes, Annette C. Broderick, Matthew H. Godfrey, Brendan J. Godley. 2009. Climate change and marine turtles. Endangered Species Research. Vol. 7: 137–154.http://www.int-res.com/articles/esr2009/7/n007p137.pdf

1.4.4.4 Water Resources

Fresh ground water occurs in the UTL as 'thin lenses' that float on sea water as a hydraulic continuum. In the past, when the population was scarce, the ground water was adequate to meet the requirement of people. However, with 3-4 fold increase in the population in the last two decades, the change in life style and various development processes have placed a heavy strain on the ground water availability to the extent that in several islands intrusion of saline water into the ground water lens in summer is a regular phenomenon. In addition, the over usage of ground water with pumps and tanks, concretization that reduces the area available for percolation of rainwater, wastage of water and mixing of the sewage with fresh water, etc. worsen the situation. The dependency on rainfall increases the vulnerability of small islands to future changes and variations in rainfall distributions. Low rainfall can lead to a reduction in the amount of water that can be physically harvested and a slower rate of recharge of the freshwater lenses, which can result in prolonged droughts.

Table 1.4.6 Adaptive Capacity of Water Resources in Lakshadweep to Climate Change, Extreme Events and Disasters[91]

Capacity	Status
Drinking Water	• The Lakshadweep islands being coralline in their nature have a high porosity leading to salinity ingress and accordingly have limited source of drinking water required for the population. • The major source of drinking water is through rainwater, which is collected through Rain Harvesting system and stored in tanks and distributed through a network of pipes • The local community has laid community taps at regular intervals for use. 920 such tanks with 10,000 litre capacity each have been constructed on different islands through the grants received from the India-Canada Environment Facility (ICEF) and have been operational on various islands. • Desalination plants that have been set up, with a capacity of 1 Lakh lt. per day is expected to augment the drinking water supply to Kavaratti • It is proposed that each of the island should be provided with a Desalination Plant with a suitable capacity so as to fulfil the needs of the community at all the times and during disasters in particular
Groundwater Availability	• The fresh Ground Water Resource of the tiny coral atolls of Lakshadweep, by and large, occurs as lenses floating in hydraulic continuity in seawater. • Rainfall, averaging about 1600mm annually, is the sole source of groundwater recharge in these islands. • Cases of increased extraction from these fragile lenses and resulting salinization were reported from many islands where pumping activity has been on the increase, specially, during last two decades. • This necessitates a detailed study in all the inhabited islands of Lakshadweep, to delineate the geometry of the fresh ground water lenses, to evaluate their storage potential, and to assess the sustainable rate of production in order to suggest appropriate, futuristic groundwater development and management

[91] Source: Task Force Report, 2007

Capacity	Status
	options for the island territory. • Hydro-geological and geophysical methods using innovative procedures are adopted for direct mapping of fresh groundwater lens, for hydraulically characterizing the aquifer and for assessing the sustainable long-term production capability of the fresh groundwater lens system. • The static and dynamic storage potential of the inhabited islands of Lakshadweep is determined based on the geometry and specific yields of the fresh groundwater portion of the aquifers. • It generally indicates that the dynamic storage of inhabited islands is adequate to serve the needs, provided the development of the resource does not tell upon the sustainable yield. • The salinity Index of the island groundwater system indicates that no fresh groundwater without saline contamination is available in any island of Lakshadweep. However, the contamination is marginal except at a few spots at Kavaratti and Minicoy. • It is also observed that the quality of water deteriorates with longer duration of content. Therefore it can be said that extraction deteriorates the quality of fresh groundwater in these islands. • Thus, the prime consideration for the development and management of the groundwater resources in the islands of Lakshadweep is the maintenance of a minimum thickness of lens as a critical factor for the upkeep of island groundwater system. It implies that the fresh groundwater extraction from island lenses has to be limited to the sustainable level. • Ground water resource estimation with emphasis on budgeting needs to be carried out for the islands. This should address the issue of input, extraction, quality etc.

The scarcity of fresh water is often a limiting factor for social and economic development in small islands. Poor water quality affects human health and the incidence of water-borne diseases. Many small islands already experience water stress. Also, with the rapid growth of tourism and service industries in many small islands, there is a need for both an augmentation of the existing water resources and a more efficient system of management for those resources that already exist[92]. The observations and the projections in terms of precipitation are associated with very high degree of uncertainty. Any decrease or increase of annual precipitation amount would influence the recharge of the groundwater resources. Meantime, an increase of the evaporation because of higher temperature would also reduce the overall quantity of water resources (although any changes might be limited). These effects would be further enhanced during dry spells. The loss of land due to sea level rise may also reduce the quantity of water collected on the Islands. However, no quantitative estimations are available at this stage.

[92] Burns,W.C.G., 2002: Pacific island developing countrywater resources and climate change. The World's Water, 3rd edn, P. Gleick, Ed., Island Press, Washington, District of Columbia, 113-132.

Climate Change Impact on Fresh Water Lenses: Case Studies from Small Islands

- **El Nino Events:** Strong El Niño occurrences between 1998 and 2000 were responsible for acute water shortages in many islands in the Indian and Pacific oceans.The wet and dry cycles associated with El Niño episodes can have serious impacts on water supplies in small islands.
- **Reduction in average rainfall:** Model projections suggest that a 10% reduction in average rainfall by 2050 is likely to correspond to a 20% reduction in the size of the freshwater lens on Tarawa Atoll, Kiribati
- **Rise in Sea Level:** Less rainfall coupled with accelerated sea-level rise would compound this threat. Studies conducted on Bonriki Island in Tarawa, Kiribati, showed that a 50 cm rise in sea level accompanied by a reduction in rainfall of 25% would reduce the freshwater lens by 65%[93]. Increases in sea level may also shift water tables close to or above the surface, resulting in increased evapo-transpiration, thus diminishing the resource.[94]
- **Saline intrusions:** The projected sea level rise and potential inundation during storm surge events might induce saline intrusions. Generally, heavy precipitations follow such events and "wash" the lenses. However, if no precipitation occurs straight after the event, the situation can get worse. For example on Puka-Puka in the Pacific Ocean, when no rainfall occurred for 5 months after the cyclone Pierce in 2005, the effects of the event on water lenses were still noticeable after 12 months and only marginal after 24 months.
- **Over-pumping** and **increasing pollution** are all threats that will continue to increase in the future. Groundwater resources are especially at risk from pollution in many small islands[95] and in countries such as the Comoros, the polluted waters are linked to outbreaks of yellow fever and cholera.[96]

1.4.4.5 Health

A changing climate will have adverse impact on the health of human populations in small islands[97]. High-density populations in low-lying coastal regions experience a high health burden from weather disasters. Increases in temperature will increase incidents of heat stress whilst projections for reduced rainfall, for instance, will reduce the amount of available freshwater for human use and consumption, leading to the increased risk of disease. Flooding associated with increased rainfall and high sea levels coupled with increased surface air temperature is likely to cause higher incidences of vector- and water-borne diseases[98]. Climate change is affecting the seasonality of some allergenic species as well as the seasonal activity and distribution of some disease vectors. Climate plays an important role in the seasonal pattern or temporal distribution of major vector borne diseases such as malaria, filarial, dengue,

[93] *Op.Cit*., World Bank,2000
[94] *Op.Cit*., Burns, 2000
[95] UNEP (UnitedNations Environment Programme), 2000:*Overview on Land-Based Pollutant Sources and Activities Affecting the Marine, Coastal, and Freshwater Environment in the Pacific Islands Region*. Regional Seas Reports and Studies No.174, 48 pp.
[96] *Op.Cit*.,Hay et al., 2003.
[97] *Op.Cit*., UNOHRLLS, 2008
[98] *Op.Cit*., IPCC 2001

chikungunya, and other diseases such as tick-borne diseases, cholera and some other diarrheal diseases. Heat waves and flooding can have severe and long-lasting effects.

Table 1.4.7 Adaptive Capacity of Health Sector in UTL to Climate Change, Extreme Events and Disasters[99]

Capacity	Status
Sanitation	• Lakshadweep islands have a total population of 65,000. The individual houses with an average population of five people have not been provided with sanitary facilities. • Attempts to provide Bio-toilets as well as community toilets and the sewage treatment systems have failed in the past because of incompatible technologies or traditional faith of the local population. • As such, the untreated sewage directly enters into the sea affecting the Coral-reef ecosystem. • This also leads to common water-borne diseases as well as epidemics particularly during the time of disaster. An urgent need of sanitary facilities with suitable technologies is recommended for all the islands.
Health	• The population of Lakshadweep Island is prone to various water borne diseases such as Diarrhoea, Cholera, Gastroenteritis, Dysentery, Infective Hepatitis, Poliomyelitis, Malaria/Filaria and some of the skin diseases. • The administration has a provision of Medical Officer attached to a community health center on each of the inhabited island and a First-aid center at Bitra Island. Even though a special quota of 10 students in the medicine is allocated for Lakshadweep islands, there is dearth of specialists on most of these islands due to the existing recruitment policies of the government. This leads to inadequacy of the medical staff and the specialists leading to poor medical aid during the time of disaster. • Special efforts to recruit doctors with a mandatory time frame to work on islands are urgently required so as to address these gaps. Arrangement for extra manpower, doctors, paramedic's as well as storage and distribution of medicines and facilities for mobile hospitals, which can be installed on a ship/ vessel, can be considered. • The islands are linked to main land through ISRO telemedicine network.
Solid Waste Disposal	• Lakshadweep administration has banned the use of plastics and non-biodegradable materials on islands. In the event of an accidental use of such materials, they are collected and incinerated on the islands. The mechanism for disposal of other biodegradable materials is being developed in a phased manner.

[99] Source: Task Force Report, 2007

Climate Change Impacts on Health: Evidences[100]

- **Climate-sensitive health outcomes** of concern in small island states include malaria, dengue, diarrhoeal diseases, heat stress, skin diseases, acute respiratory infections and asthma (WHO, 2004).
- **Increased rate of diseases:** Populations with poor sanitation infrastructure and high burdens of infectious disease often experience increased rates of diarrhoeal diseases[101], cholera[102], cryptosporidiosis[103] and typhoid fever[104] after flood events.
- High-density populations in low-lying coastal regions experience a **high health burden from weather disasters.**
- Harmful algal blooms (HABs) produce toxins that can cause human diseases, mainly via consumption of contaminated shellfish. Warmer seas may thus contribute to **increased cases of human shellfish and reeffish poisoning** (ciguatera) and poleward expansions of these disease distributions[105]

Emerging evidence of climate change effects on human health shows that climate change has altered the distribution of some infectious disease vectors, altered the seasonal distribution of some allergenic pollen species and increased heat wave-related deaths.[106] Projected trends in climate-change-related exposures of importance to human health will increase malnutrition and consequent disorders, including those relating to child growth and development, increase the number of people suffering from death, disease and injury from heat waves, floods, storms, fires and droughts, continue to change the range of some infectious disease vectors, have mixed effects on malaria; in some places the geographical range will contract, elsewhere the geographical range will expand and the transmission season may be changed, increase the burden of diarrheal diseases, increase cardio-respiratory morbidity and mortality associated with ground-level ozone, increase the number of people at risk of dengue, bring some benefits to health, including fewer deaths from cold, although it is expected that these will be outweighed by the negative effects of rising temperatures worldwide, especially in developing countries.[107]

1.4.4.6 Tourism

Tourism is an important source of income for the islands population, and UTL is becoming increasing popular with both domestic and foreign tourist. However, their numbers and activities need to be carefully monitored and controlled as they cause a threat to the ecology of the island. Since their

[100] Murari Lal,, Hideo Harasawa, Kiyoshi Takahashi. 2002. Future climate change and its impacts over small island states. Climate Research. Vol. 19: 179–192. http://www.int-res.com/articles/cr2002/19/c019p179.pdf
[101] Mondal et al., 2001
[102] Sur et al., 2000; Gabastou et al., 2002
[103] Katsumata et al., 1998
[104] Vollaard et al., 2004
[105] Kohler and Kohler, 1992; Lehane and Lewis, 2000; Hall et al., 2002; Hunter, 2003; Korenberg, 2004
[106] Confalonieri, U., B. Menne, R. Akhtar, K.L. Ebi, M. Hauengue, R.S. Kovats, B. Revich and A. Woodward, 2007: Human health. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 391-431.
[107] IPCC, 2007. Intergovernmental Panel on Climate Change (IPCC), Climate change 2007: The physical science basis.

economies depend so highly on tourism, the impacts of climate change on tourism resources in small islands will have significant effects[108], both direct and indirect[109].

Increases in the frequency or magnitude of certain weather and climate extremes, which are likely as a result of projected climate change will affect the tourism industry through increased infrastructure damage, additional emergency preparedness requirements, and higher operating expenses (e.g., insurance, backup water and power systems, and evacuations).[113] Changes in water availability, biodiversity loss, reduced landscape aesthetic, altered agricultural production, increased natural hazards, coastal erosion and inundation, damage to infrastructure and the increasing incidence of vector-borne diseases will all impact tourism to varying degrees. Sea-level rise and increased sea water temperatures are projected to accelerate beach erosion, cause degradation of natural coastal defences such as mangroves and coral reefs, and result in the loss of cultural heritage on coasts affected by inundation and flooding. These impacts will in turn reduce attractions for coastal tourism. Tourism in small island states is also vulnerable to climate change through extreme events and sea-level rise leading to transport and communication interruption. Shortage of water and increased danger of vector-borne diseases may also steer tourists away from small islands, and warmer climate in the northern countries could reduce the number of tourists who visit small islands in the tropical and subtropical regions.

Climate Change Impacts on Tourism

- **Detrimental environmental conditions**: Rise in infectious disease, wildfires, insect or waterborne pests (e.g., jellyfish, algae blooms), and extreme events such as tropical cyclones may deter tourists.[110]
- **Low level of awareness on climate change**: among tourism operators, policmakers and practitioners; no long term strategic planning[111].
- **Sustainability of island tourism resorts to be compromised**[112]: by rising sea level, beach erosion and saline contamination of groundwater, which may steer away tourists

[108] Viner, D., 2006: Tourism and its interactions with climate change. *Journal of Sustainable Tourism*, **14**, 317-322.

[109] Bigano,A., J.M. Hamilton and R.S.J. Tol, 2005: The impact of climate change on domestic and international tourism: a simulation study.Working Paper FNU-58, HamburgUniversity and Centre forMarine andAtmospheric Science,Hamburg. Accessed 25 April 2012: http://www.uni-hamburg.de/Wiss/FB/15/Sustainability/htm12wp.pdf.

[110] Scott, D. et al. 2007. Climate Change and Tourism: Responding to Global Challenges. Report commissioned to an international team of experts by the World Tourism Organization (UNWTO), the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO).

[111] (e.g.; Elsasser & Bürki 2002; Scott et al 2002; Raksakulthai 2003; Becken 2004; Scott & Jones 2005; Scott et al 2005; Sievanen et al 2005; Wolfsegger et al 2008; Simpson 2008b, UNWTO 2008 & AIACC 2008, Institute for Development Studies 2006

[113] Simpson, M.C., Gössling, S., Scott, D., Hall, C.M. and Gladin, E. (2008) *Climate Change Adaptation and Mitigation in the Tourism Sector: Frameworks, Tools and Practices***.**UNEP, University of Oxford, UNWTO, WMO:Paris, France.

1.4.4.7 Infrastructure and Transportation

Like settlements and industry, the infrastructural base that supports the vital socio-economic sectors of island economies tends to occupy coastal locations. Several challenges have been identified that will confront the transportation sector as a result of climate variability and change[114]. These include closure of roads, airports and bridges due to flooding and landslides, and damage to port facilities. The resulting disruption would not be confined to the transportation sector alone, but would impact other key dependent sectors and services including tourism, agriculture, health care delivery, clean water, food security and market supplies.

Climate Change Impacts on Infrastructure: Examples

- It has been shown, for instance, that port facilities at Suva, Fiji, and Apia, Samoa, would experience overtopping, damage to wharves, and flooding of the hinterland if there were a 0.5 m rise in sea level combined with waves associated with a 1-in-50 year cyclone.
- In the Caribbean, the damage to coastal infrastructure from storm surge alone has been severe. In November 1999, surge damage in St. Lucia associated with Hurricane Lenny was in excess of US$6 million, even though the storm was centred many kilometres offshore.
- The devastation of Grenada following the passage of Hurricane Ivan on 7 September 2004 is a powerful illustration of the reality of small-island vulnerability. In less than eight hours, the country's vital socio-economic infrastructure, including housing, utilities, tourism-related facilities and subsistence and commercial agricultural production, suffered incalculable damage.

The main infrastructure of the islands consists of houses, roads, buildings, ports and harbours, airports and helipads, boats, crafts and catamarans, automobiles and vehicles, communication facilities etc. Taking into consideration the remoteness of these islands and the nature and magnitude of the vulnerabilities, the infrastructural facilities are limited making the islands more vulnerable during the period of calamity. Any significant rise in the sea level shall lead to the progressive submergence of proximate coastal parts of the islands (starting with the beaches), where most of the infrastructure is concentrated. Communication systems will breakdown in the islands, which lie separated away from each other results in them becoming isolated pockets of calamities. The ship and ferry service, which is chief mode of transportation also, gets disrupted. Almost without exception airports which are sited on or within a few kilometres of the coast, and on tiny coral islands will severely be damaged. Likewise, since the main (and often only) road network runs along the coast, it will add to the vulnerability.[115] These impacts will be felt in a differential manner across the scattered islands.

[114] *Op.Cit*., Hay et al. (2003)

[115] Walker, I.J. and J.V. Barrie, 2006: Geomorphology and sea level rise on one of Canada's most 'sensitive' coasts: northeast Graham Island, British Columbia. *J.Coastal Res.*, SI 39, 220-226.

Table 1.4.8 Adaptive Capacity of Infrastructure Sector in UTL to Climate Change, Extreme Events and Disasters[116]

Capacity	Status
Residential and Office Buildings	• The criteria for safe construction including the construction materials have not been followed while constructing these buildings. • The large majority (67.36%) of the total 17169 housing units in the Lakshadweep Territory as per the 1991 census consist of stone walls. • Such buildings are placed in Category A of MSK Intensity Classification type. Building is this category could have medium to large cracks in walls and some partial collapses too, incase earthquake intensity MSK VII takes place. • Though loss of life may be small, property loss could be considerable. This calls for precautionary measures in building constructions as per the codes and guidelines

Sequential extreme events may mean that recovery is never complete, resulting in long-term deteriorations in affected systems, e.g., declines in agricultural output because soils never recover from salinisation; urban water systems and housing infrastructure deteriorating because damage cannot be repaired before the next extreme event.

1.4.4.8 Energy

Currently, electricity generation in the UTL is done largely by diesel-run generators for which the diesel is imported in containers from the mainland and transported from island to island through boats. This is prohibitively expensive, cumbersome and adds to the overall vulnerability of the islands including the possibility of any mishap during transportation/ storage. No standards procedures and norms are followed in the transport and storage of diesel, which may result, into a disaster itself in case of any accident. Even though solar panels are being used for limited purposes, the use of non-conventional energy sources is not widespread. Increasing usage of renewable energy sources must be encouraged. Given Lakshadweep's high dependency on oil for electricity generation, any significant disruption to the transportation infrastructure has serious implications for energy service reliability. Some islands have

Climate Change Impacts on Energy Sector

- Extreme weather events caused by climate change have a **strong impact on the production and distribution** of energy resources such as petroleum, gas and electricity. The energy infrastructure is very vulnerable to these extreme climatic events. For example, under strong winds with speeds over 100km/hr, electric wires and other electricity distribution components can easily collapse[117]. In the future, climate change may create a situation where more intense and/or more frequent extreme events may mean there is less time in which to recover.

[116] Source: Task Force Report, 2007

[117] Contreras-Lisperguer, R. and de Cuba, K.2008. The Potential Impact of Climate Change on the Energy Sector in the Caribbean Region. Sustainable Energy and Climate Change Division Department of Sustainable Development Organization of American States.

already begun to become 'renewable energy islands'; La Desirade (Caribbean), Fiji, Samsoe (Denmark), Pellworm (Germany) and La Réunion (Indian Ocean) are cited as presently generating more than 50% of their electricity from renewable energy sources.[118]

The proposed non renewable energy sources (once implemented) viz., wave, tidal, or ocean thermal energy in the UTL is also prone to climate change impacts. These can be affected by climate change due to changes in average water temperature, temperature gradients, salinity, sea level and wind patterns affecting wave production, and intensity and frequency of extreme weather events. With conventional and renewable technologies inherently reliant on climate, changes will result among other things in[119]:

- Altering availability of natural energy resources;
- Changes in the quantity and timing of renewable resource extraction potential;
- Changes in operational performance of energy production systems.

Table 1.4.9 Adaptive Capacity of Energy Sector in UTL to Climate Change, Extreme Events and Disasters[120]

Capacity	Status
Energy Requirements	• The energy requirements of the local population are being fulfilled by the diesel run gensets for which the diesel is imported in containers from the mainland and transported from island to island through boats. • No standards procedures and norms are followed in the transport and storage of diesel, which may result, into a disaster itself in case of any accident. • Even though solar panels are being used for street lighting, the use of non-conventional energy sources is strongly recommended. The requirement of fuel is fulfilled through use of coconut husk

Renewable energy facilities are generally designed and emplaced based on historical climate data or to suit prevailing climate conditions, without the consideration of future climate change in feasibility studies. If key energy stakeholders are not aware of climate change implications to the productivity, or even the viability, of energy production systems, the ability to supply reliable and affordable energy to meet demand may be at serious risk.

1.4.5 Vulnerable Groups: Assessment of Impact and Vulnerability

1.4.5.1 Livelihood Vulnerability and Vulnerable Groups

Socio-economic contributors to the island vulnerability include external pressures such as terms of trade, impacts of globalisation (both positive and negative), financial crises, resource conflicts, and internal

[118] Jensen, T.J., 1999: Renewable energy on small islands. Tiempo, **32**, 11-14.
[119] Op.Cit., Contreras, 2008
[120] Source: Task Force Report, 2007

local conditions such as rapid population growth, rising incidence of poverty, political instability, unemployment, reduced social cohesion, and a widening gap between poor and rich, together with the interactions between them.[121] Heavy dependence on coastal resources for subsistence is also a major feature of UTL. High concentrations of people create various social, economic and political stresses, and make people more vulnerable to short-term physical and biological hazards such as tropical cyclones and diseases. It also increases their vulnerability to the impacts of climate change and sea-level rise.[122] If any natural calamity takes place, then the whole development of these islands will come to a standstill and thereby high vulnerability can be expected.

Coconut plantations are the first and the most affected causality of any cyclone surge. The loss of ripe coconuts and the uprooting of trees put an immediate pressure on the basic source of livelihood of the majority of the population. Traditionally it is said that the loss of crop in one season leads to poor harvest in the next season also. So, the farmers are basically affected for two consecutive years due to loss of coconut harvest. Uprooting of coconut trees, loss of standing coconut crops, limited tourism operations and fishery activity will slow down the economy and loss of livelihoods options for people. In the longer run, losses to physical and social infrastructure further hamper development. 80 percent of the total geographical area is under cultivable land. The climatic change in addition to the limited potable water, poor calcareous soils, fragmented holdings of land etc. heavily deprived the economic status of the farmers and climbers community which in terms heavily affect the social and economic status of the society. The UTL has limited scope for industrial development on account of ecological and economic reasons. Hence, the prospects for economic growth will have to focus mainly on agriculture, fisheries and allied activities. Tourism and small scale and industries provide supplementary livelihoods. These sectors are extremely climate sensitive and get affected significantly during extreme weather events.

The number of fishermen engaged in fisheries sector constitutes about 25% of the total working population. The projected climate change will have impacts on fisheries. Its impacts such as degeneration of coral reefs and lagoon ecosystem, changes in the seasonality and abundance of fish species, etc. can reduce the catch type, size and income for local fishermen. Tourism will be another sector that will find difficult to thrive through climatically harsh times. As has been felt in other similar places, fisher folk, farmers and womenfolk will have to bear the brunt of such escalated and heightened vulnerabilities because of their dependence on climate sensitive sectors. Fisheries contribute significantly to GDP on many islands; consequently the socio-economic implications of the impact of climate change on fisheries are likely to be important and would exacerbate other anthropogenic stresses such as over-fishing. In many small islands, fisheries contribute up to 10 percent of the GDP.

The socioeconomic implications of climate change effects on fisheries will therefore be significant. In the Maldives, it is argued that sea-level rise would so seriously damage the fishing and tourism

[121] ADB, 2004: *Environmental Pacific Regional Strategy, 2005-2009*. Asian Development Bank,Manila, 105 pp.
[122] Connell, J., 1999: Environmental change, economic development, and emigration in Tuvalu. *Pacific Studies*, **22**, 1-20.

industries that GDP would be reduced by more than 40%.[123]Major fishing methods employed are pole and line fishing, trolling, hand lining and gill netting. The impact of climate change certainly affect the know availability of live baits required for pole and line fishing. It also degenerates lagoon ecosystem, seasonality in the recruitment pattern of migrants species in an around coral reefs which heavily havoc the income and gross domestic product of the fishermen community. Indiscriminate exploitation and anthropogenic pressure can disturb the balance in the association of different organism leading to loss of bio diversity and environmental degradation.

The scope for industrial development has severe limitations in view of the ecological and cost related factors. The prospects for economic activities focus mainly on agriculture and allied activities, fisheries and tourism and the supplementary activities in the sectors of animal husbandry and small scale and cottage industries. Internal processes that create vulnerability include rapid population growth, attempts to increase economic growth through exploitation of natural resources such as forests, fisheries and beaches, weak infrastructure, increasing income inequality, unemployment, rapid urbanisation, political instability, a growing gap between demand for and provision of health care and education services, weakening social capital, and economic stagnation. These internal processes interact in complex ways with various external factors to heighten the vulnerability of island social and ecological systems to climate change. In many coastal communities of the world, local knowledge has accumulated through centuries of reef dependency and is demonstrated by both the men and women who exploit the reef. An example of the level of local or indigenous knowledge is revealed in local naming systems, or folk taxa. The Lakshadweep islanders have knowledge of numerous different types of fish and where they can be found according to the tide or lunar cycle.[124]

1.4.5.2 Human Settlements and Well-being

It was noted that most of the residential and office buildings are constructed using porous concrete bricks made up of the coralline sand mixed up with the concrete material. These houses are provided with the roofs covered with Mangalore tiles or the galvanized iron sheets. Most of these houses have been constructed at the using low plinth level and are prone to inundation. The criteria for safe construction including the construction materials have not been followed while constructing these buildings. The large majority (67.36%) of the total housing units in the Lakshadweep Territory consist of stone walls. Such buildings are placed in Category A of MSK Intensity Classification type. Building is this category could have medium to large cracks in walls and some partial collapses too, in case earthquake intensity MSK VII takes place. Though loss of life may be small, property loss could be considerable. This calls for precautionary measures in building constructions as per the codes and guidelines. An important consideration in relation to settlements is housing. In many parts of the Pacific islands, traditional housing styles, techniques and materials were resistant to damage and/or could be repaired quickly. Moves away from traditional housing have increased vulnerability to thermal stress

[123]Majeed, A. and A. Abdulla, 2004: Economic and environmental vulnerabilities of the Maldives and graduation from LDC status. *Economic Vulnerability and Resilience of Small States*, L. Briguglio and E. Kisanga, Eds., Commonwealth Secretariat and the University of Malta, 243-255.

[124]*Op.Cit.*, Hoon, 2003

and slowed housing reconstruction after storms and flooding. As a result, human wellbeing in several major settlements on islands in the Pacific and Indian Oceans has changed over the past two or three decades.[125]

1.4.6 Adaptation

The risks posed to small islands by climate change are dependent on: the magnitude and severity of a given climate hazard, the likelihood of the hazard happening, and the sensitivity of the stakes involved. Sensitivity refers to the degree to which an island is affected either adversely or beneficially by climate change. The factors influencing sensitivity to climate change include; culture, tradition, gender, social networks, equity and governance. These can be broadly grouped into social, economic and geo-physical factors and they determine who is affected, how they are affected and the degree to which they are affected. With climate change, there is little that small island communities can do to change the magnitude of a hazard, nor can they change the probability of the hazard occurring. However, island communities can invest in reducing risk – or the expected damage or loss due to the combination of vulnerability and hazards.[126]

1.4.6.1 Adaptation: Practices, Options and Constraints

Adaptation to climate change cannot be addressed in isolation but needs to be incorporated into developmental activities. Enhancing adaptive capacity will only be successful when it is integrated with other policies such as disaster preparedness, land-use planning, environmental conservation, coastal planning, and national plans for sustainable development.[127]Current government expenditure in India on adaptation to climate variability exceeds 2.6% of the GDP, with agriculture, water resources, health and sanitation, forests, coastal-zone infrastructure and extreme weather events, being specific areas of concern.

While it is clear that implementing anticipatory adaptation strategies early on is desirable, there are obstacles associated with the uncertainty of the climate change projections. Inhabitants of small islands, individuals, communities and governments, have adapted to inter annual variability in climate and sea conditions, as well as to extreme events, over a long period of time. There is no doubt that this experience will be of value in dealing with inter-annual variability and extremes in climate and sea conditions that are likely to accompany the longer-term mean changes in climate and sea level. However, it is also true that in many islands traditional mechanisms for coping with environmental hazards are being, or have been, lost, although paradoxically the value of such mechanisms is being

[125] *Op.Cit*., Hay et al., 2003
[126] http://www.regional.gov.au/territories/publications/files/Indian+Ocean+Territory+Climate+Change+Risk+Assessment.pdf
[127] Sutherland, K., B. Smit, V. Wulf and T. Nakalevu, 2005: Vulnerability to climate change and adaptive capacity in Samoa: the case of Saoluafata village. *Tiempo*, **54**, 11-15.

increasingly recognised in the context of adaptation to climate change.[128,129] Further information on the type of adaptation strategies, adaptation best practices, and adaptive capacities are given in Annexure XIII.

1.4.6.2 Disaster Risk Management Initiatives

1.4.6.2.1 Disaster Preparedness

According to the State Development Report, to avoid chaotic sets of actions alerted during a disaster response, the suggested model for disaster management in Lakshadweep is the expand-contract model wherein prevention, preparedness, relief and rehabilitation are carried out as a continuous process in a parallel series of activities although with varying degrees of emphasis with respect to the time of disaster occurrence. Specific budgetary provisions should be earmarked every year for disaster mitigation efforts and disaster response. Disaster mitigation efforts should be seen as cost-effective over disaster management. It is emphasised that disaster mitigation activities be built into the overall developmental scheme of Lakshadweep rather than being seen as isolated activities. There is currently no Disaster Management Act for this Territory. However, the administration has formulated a framework of Disaster Management Plan for Lakshadweep during 2004. The framework servesas the basic guidelines document towards cyclone preparedness and response mechanism.

1.4.6.2.2 The Lakshadweep Disaster Management Authority

The UTL comes directly under the administrative control of Ministry of Home Affairs. To avoid chaotic sets of actions altered during a disaster response, the Union Territory of Lakshadweep has set up a high state level steering Committee under the Chairmanship of Collector Cum Development Commissioner for relief and rehabilitation measure, if any natural calamity occurs in the islands. Also a local level Disaster management committee was set up under the concerned Sub Divisional officer/ Deputy Collector in each island to monitor the occurrence of calamity. The Lakshadweep Disaster Management Authority was constituted in the year 2003 and is headed by the Collector cum Development Commissioner who is also the Relief Commissioner for the UTL. The Member of Parliament, President cum Chief Counsellor and Vice President cum Counsellor of District Panchayat and the major department heads are members of Lakshadweep Disaster Management Authority. Disaster relief cum evacuation centers are being created in 7 islands under the Prime Minister's Relief Fund to handle any emergencies that may arise on account of rise in sea level in the islands.

1.4.6.2.3 Disaster Forecasting, Early Warning and Dissemination

Disaster forecasting, the immediate percolation of early warning disaster signals to the people, and preparedness of the people are critical in disaster reduction. Provision of mobile communication sets to panchayats for use by fishermen can help in rescue and warning efforts. Mapping vulnerable areas based

[128]MESD, 1999. Ministry of Environment and Social Development (MESD) (1999). Kiribati Government Initial Communication under the United Nations Convention on Climate Change. Retrieved from http://unfccc.int/essential_background/library/items/3599.php?rec=j&priref=2437#beg

[129]Fox, S., 2003: *When the Weather is Changing: Inuit Observations of Environmental Change*. Cooperative Institute for Research in Environmental Sciences, Boulder, Colorado: University of Colorado.

on surveys and demographic census is prerequisites for effective disaster response. The relationship between economic status of communities and their vulnerabilities are increasingly being recognised. Disaster forecasting is important for a rapid disaster response. The organisations involved in disaster warning in India are: (i) the Indian Meteorological Department which looks at drought, rainfall, cyclone and crop position; (ii) the Department of Space which deals with satellite monitoring of drought and floods; and (iii) the Ministry of Water Resources which studies riparian floods. The Meteorological Department has a coastal network of 10 cyclone detection radars, but the main instrument is the INSAT-IB that enables satellite imageries and remote sensing for cyclone forecasting.

Cyclone warning to Lakshadweep is provided from the *Area Cyclone Warning Centres* at Chennai and Thiruvananthapuram. A monitoring cell functions at the Collectorate Headquarter at Kavaratti, which immediately transmits such messages to all islands. The TV network also plays a vital role. The communication network of BSNL, Naval detachment, Interstate Police Wireless, Lakshadweep Police Wireless, India Reserve Battalion Wireless, NIC, etc. can be fully utilised for warning and for communication. Provision of mobile communication sets to panchayats for use by fishermen can help in rescue and warning efforts.

1.4.6.2.4 Cyclone Shelters

Cyclone shelters should be identified or built outside the High Risk Areas. Kavaratti, Minicoy, Kadmat, Agatti and Bitra have been identified as less prone to inundation by sea. The local people should be made aware regarding where and when to take refuge. Concrete steps have been proposed for disaster preparedness and management. Schools in the inhabited islands have been identified as shelters in case of any emergency. However, these schools have inadequate drinking water, sanitary facilities as well as facilities for storage of civil supplies during emergency. Most of the schools have also been located on the same elevation, and is prone to inundation during heavy rains as well as cyclonic conditions. Currently, these schools are not in a position to accommodate more than 50% of the population in the event of disasters, and the construction standards do not always meet the requisite design criteria meant for disaster management.

Cyclone Early Warning Systems

Cyclones can be managed by adopting preventive, cautionary and curative measures. Iridium India Telicom limited has provided Govt. relief organizations four free Iridium hand-sets and free air time for use in earthquake devastated regions of UP in march 1999 ,and during ONGC earlier this year. Iridium is a global wireless communication system that combines worldwide coverage of a network of 66 low-earth orbiting satellites .It provides reliable 2-way communication during disaster relief. The role of these instruments (Iridium handsets i.e. phones and pagers) in disaster Management are reputed to be extremely durable, handy in bad weather and on rough terrains .It will caution the people in face of ensuing danger to shift to safer place. The track and intensity of cyclone can be predicted well in advance, based on satellite and radar data and by using data interpretation & Mathematical models.

1.4.6.3 Integrated Coastal Zone Management Plan (ICZMP)[130]

The CRZ area is defined as coastal stretches of seas, bays, estuaries, creeks, rivers and backwaters which are influenced by tidal action (in the landward side). As per the notification 500 metres on the landward side from the High Tide Line (HTL) and the land area between the Low Tide Line (LTL) and HTL including 500 metres along the tidal influenced water bodies subject to a minimum of 100 m on the width of the water body, whichever is less is declared as CRZ area. Based on the ecological sensitivity, geomorphological feature and demographic distribution, the CRZ area is classified into four categories namely, CRZ-I (sensitive and inter tidal), CRZ- II (urban or developed), CRZ-III (rural or undeveloped), CRZ-IV (Andaman & Nicobar and Lakshadweep Islands)[131]. Integrated coastal management plans prepared for the islands are presented in (Figure 1.4.2 and Figure 1.4.3):

1.4.6.3.1 ICZMP Objectives

The main objectives are

- Preserving the functional integrity of the islands ecosystem
- Reduce the resource based conflicts
- Minimise damages to the coral ecosystem
- Regain the beneficial uses of the beach and lagoon waters
- Enhance the socio - economic status of island community

1.4.6.3.2 Prioritisation of Problems and Issues

- Issues requiring immediate management intervention:
- Coastal erosion and Shore protection
- Fresh water management
- Conservation of Coral reefs/mangroves
- Fishery resource exploitation & Catch enhancement
- Sewage and Solid waste management
- Tourism
- Infrastructure development
- Environmental education

1.4.6.3.3 Other important issues to be addressed are:

- Implementation of CRZ rules
- Environmental quality enhancement
- Alternate employment generation

[130] Prepared by CESS, 2007 Thiruvananthapuram

[131] Karl Kübel Institute, 2006.Disaster Preparedness and Response Lessons From Tsunami. Report of the National Consultation 14–16 February , Germany.

Figure 1.4.2 Integrated Coastal Zone Management Plan Kavaratti

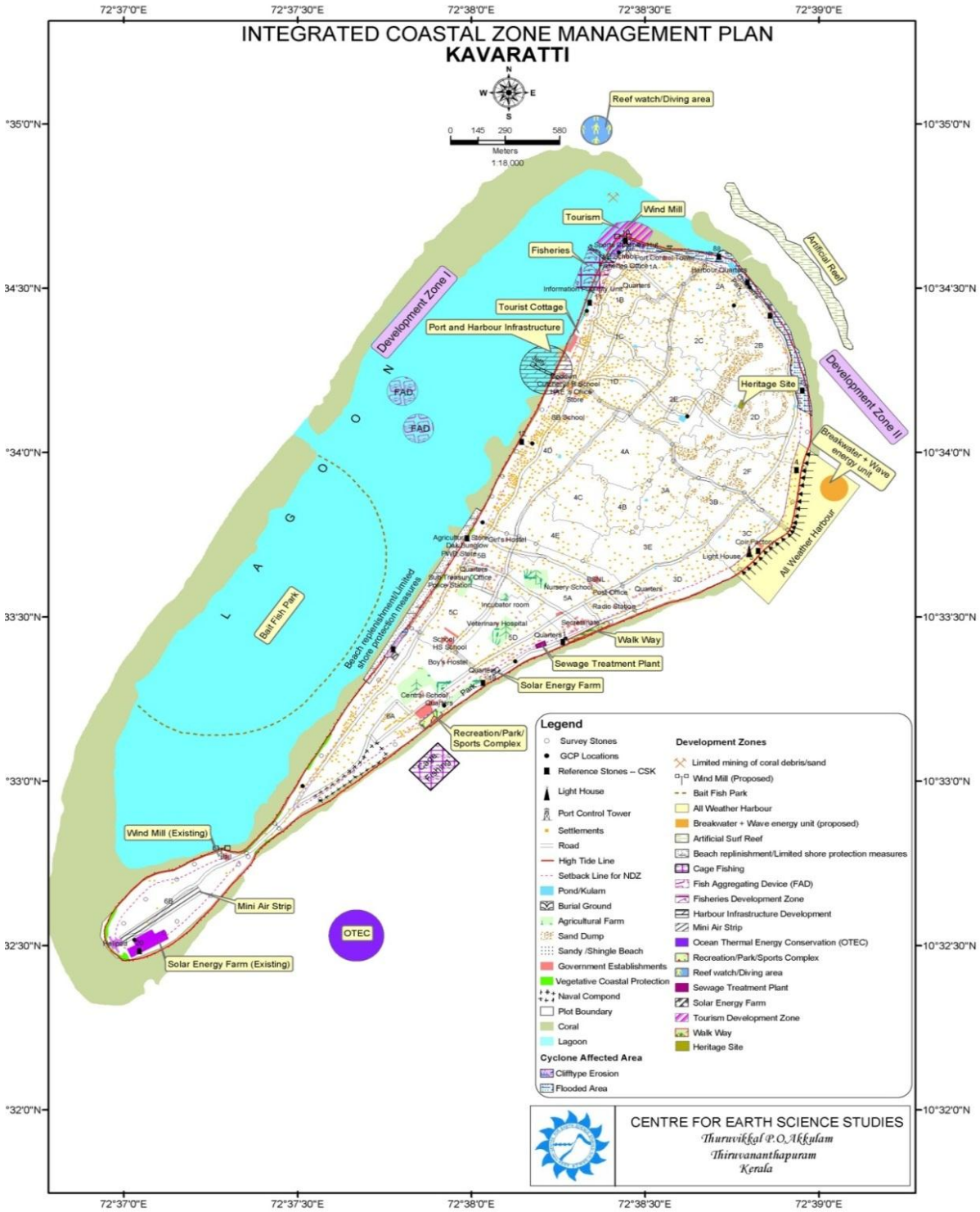


Figure 1.4.3 Integrated Coastal Zone Management Plan – Androth, CESS, 2006

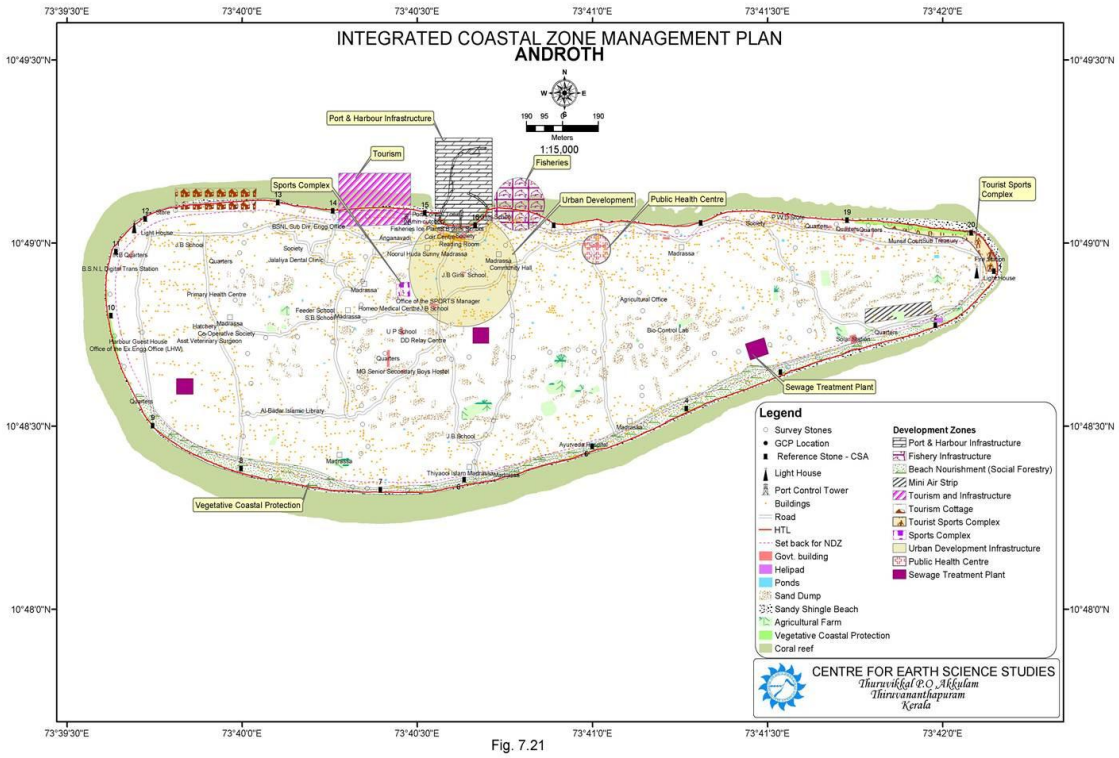


Fig. 7.21

1.4.6.4 Adaptive Capacity: Institutions, Policies and Governance

There are several constraints to adaptation that are inherent in the very nature of many small islands, including small size, limited natural resources, and relative isolation. The main determinants of a country's adaptive capacity to climate change are: economic wealth, technology, information and skills, infrastructure, institutions and equity.[132] The adaptive capacity of small island states will need to be built up in several important areas including human resource development, institutional strengthening, technology and infrastructure, and public awareness and education. Efforts to enhance island resilience must be mainstreamed into general development policy formulation, and that adaptations should not be seen as separate or confined to engineering or land use planning-based realms.[133] The enhancement of resilience at various levels of society, through capacity building, efficient resource allocation and the mainstreaming of climate risk management into development policies at the national and local scale, could constitute a key element of the adaptation strategy. The status of infrastructure development and physical factors contributing to the vulnerability of Lakshadweep Islands to natural hazards is given in Table 1.4.10.

[132](WHO, 2003b).
[133](Pelling and Uitto, 2001).

Table 1.4.10: Adaptive Capacity of Lakshadweep Islands to Climate Change, Extreme Events and Disasters

Capacity	Status
Disaster Mitigation Capability	• Limited hazard forecasting ability, complacency and little insurance cover
Demographic Factors	• Limited human resource base, small population, rapid population changes, single urban centre, population concentrated on coastal zone, dis-economies of scale leading to high per capita cost for infrastructure and services
Economic Factors	• Small economies, dependence on external finance, small internal market, dependence on natural resources
Economic Losses	• The uprooting of coconut trees and loss of standing coconut crops during calamities sets back the economy of Lakshadweep immediately for a minimum period of two years. • Since fishing is not possible during such times, the people suffer immediate losses to their day to day livelihood options. • In the longer run losses to physical and social infrastructure sets back the pace of development
Cyclone Shelters	• Each of the inhabited islands has a junior, senior basic schools as well as nursery schools and Madrasas. • Most of these schools have been identified as shelters in case of an emergency. • These schools have limited drinking water, sanitary facilities as well as facilities for storage of civil supplies during an emergency. • Most of these schools have been located on the same elevation as the island, which is prone to inundation during heavy rains as well as cyclonic conditions. • These schools cannot accommodate more than 50% of the population during the time of disaster and the constructions are not in tune with the design criteria.

Source: Task Force Report, 2007

Further information on current initiatives being undertaken in UTL can be found in Annexure XIV.

1.5 KNOWLEDGE GAPS

There is no mechanism to record data on temperature and rainfall except Amini and Minicoy Island. The scientific data on wind, humidity, water currents etc. are not available in Lakshadweep. There is no permanent station for recording the data related with earth quakes/ tsunamis in the Island. Bio-markers for climate change in UTL are to be identified. Responses of sea grass, coral reef to the rising temperature have to be studied. The greenhouse gas emission from transport vehicles has to be analysed. The zoological past of the island is not known till date.

After Independence, scientists from CMFRI, NIO, CESS and other University Departments have been carrying out various studies on biological, physical and chemical properties and fisheries yield. Though each of these studies addressed a specific question, they were not designed to provide any continuity of observation. The negative impact of such a lacuna was felt most acutely in 1998 when the massive "bleaching episode" occurred worldwide. During the summer of that year, the sea surface temperature in the tropics rose by 1-2º C above the seasonal maximum. As the corals are quite sensitive to temperature changes, they could not survive, leading to 'bleaching' (loss of pigmentation) and eventual death. The extent of mortality varied between different reef regions in India but was the severest in the Lakshadweep. This estimate was only in a qualitative sense, since there was no quantitative measurements of the actual live coral cover prior to the bleaching episode.

There are several data gaps to be addressed in order to develop strategies for adapting to climate change. Lack of scientific knowledge can result in devising mal-adaptive strategies, under the climate change realm, which in turn can impact the fragile ecosystem.

Also, while evaluating the various policy alternatives for island development, incomplete, inadequate and poor quality information will lead to incorrect actions. This will prevent the stakeholders from making informed choices for sustainable actions. The small land area and often low elevation of small island states make them particularly vulnerable to rising sea levels and impacts such as inundation, shoreline change, and saltwater intrusion into underground aquifers. Short record lengths and the inadequate resolution of current climate models to represent small island states limit the assessment of changes in extremes. There is insufficient evidence to assess observed trends and future projections in rainfall across the small island regions considered here.

Although future projections of mean air temperature are rather consistent among climate models, projections for changes in precipitation, tropical cyclones and wind direction and strength, which are critical concerns for small islands, remain uncertain. Projections based on outputs at finer resolution are needed to inform the development of reliable climate change scenarios for small islands. Regional Climate Models (RCMs) and statistical downscaling techniques may prove to be useful tools in this regard, as the outputs are more applicable to countries at the scale of small islands. These approaches could lead to improved vulnerability assessments and the identification of more appropriate adaptation options.

In contrast to the other regions, there is also an absence of demographic and socio-economic scenarios and projections for small islands. Nor have future changes in socio-economic conditions on small islands been well presented in existing assessments (e.g., IPCC, 2001; Millennium Ecosystem Assessment, 2003). Developing more appropriate scenarios for assessing the impacts of climate change on the human systems of small islands remains a challenge.

Evaluation of adaptation in small islands suggests that the understanding of adaptive capacity and adaptation options is still at an early stage of development. Although several potential constraints on, as well as opportunities for, adaptation were identified, two features became apparent. First, the application of some adaptation measures commonly used in continental situations poses particular challenges in a small island setting. Examples include insurance, where there is a small population pool although the propensity for natural disasters is high and where local resilience may be undermined by economic liberalisation. Second, some adaptation measures appear to be advocated particularly for small islands and not elsewhere. Examples include emigration and resettlement, the use of traditional knowledge, and responses to short-term extreme events as a model for adaptation to climate change.

Ongoing observation is required to monitor the rate and magnitude of changes and impacts, over different spatial and temporal scales. The projections have not been fully utilised in small islands because of the greater uncertainty attached to them, as opposed to global projections.

Local capacity should be strengthened in the areas of environmental assessment and management, modelling, economic and social development planning related to climate change, and adaptation and mitigation in small islands. This objective should be pursued through the application of participatory approaches to capacity building and institutional change.

1.6 GHG Emission and Energy Needs Inventory: Data Gaps

There is no specific scientific data available on quantity of greenhouse gas emissions and energy needs inventory in the islands. The major greenhouse gas emission sectors in islands are domestic cooking sector, diesel generator for the production of electricity and transport sector. Almost all stakeholders in the island consist of middle class family and 95% of the total population using firewood for cooking their meal. This is considered as the highest GHG emission sector in the islands. The coconut waste such as husk, coconut nuts and coconut leaf sticks are the main fuel wood used in this sector.

At present seven passenger ships, four cargo barges and nine ferry vessels are operating from mainland to islands and between the islands. In addition to that a number of private vessels (Manjus) are operating between islands and mainland. There are 2861 fishing boats/OBM fitted crafts registered in fisheries

department during the year 2006-07. Two Pawan Hans helicopters and one more helicopter being added as soon as the hanger facilities are ready. All these vehicles are utilizing fossil fuel for generating energy and have led to GHG emission in large quantities which in turn pollutes the near surrounding at large. While considering the land, 4897 numbers of vehicles are already registered in regional transport office Kavaratti. The greenhouse gas emission from these vehicles both in land and water are considered to be the second largest green gas emission sector in island.

Diesel generators installed in all inhabited islands for the production of electricity are the third largest greenhouse gas emission source in Lakshadweep. A total of 9924kW capacity diesel generators are installed in island for the generation of electricity. In which it generates 27705kW of energy during the year 2006-07. The fossil fuel which runs the diesel generator is a main source of greenhouse gas emission in this sector. There is no scientific data on greenhouse gas emission or clean development mechanism available in islands. However the administration takes necessary steps to reduce greenhouse gas emission in the following ways.

a) Adequate solar power plant stations are installed in most of the island to harness the solar power from the tropical humid climate available in island.
b) The administration is encouraging the use of Liquid Petroleum Gas (LPG) cylinders and smokeless Chulhas instead of firewood as practiced in islands.
c) The Union Territory administration is giving 30% subsidy to the battery operated vehicles in islands to discourage fuel based vehicles already for use in islands.

Part B: Climate Change Strategy

2 Climate Change Strategy for Lakshadweep

2.1 Approach for Climate Change Strategy

Lakshadweep possesses certain unique features which are quite relevant in the context of climate change: small surface area, high population density, inadequacy of infrastructure, over reliance on a few fragile natural resources, diminishing stock of fresh water resources, etc. These along with prevailing economic and developmental challenges make the islands increasingly vulnerable to the existing and emerging risks of climate change. As mentioned before, therefore, the broad climate change strategies for islands may have to start with a 'precautionary adaptation approach'; one that is embedded largely as a sub-set of overall "sustainable" development. Even in the absence of climate change, such strategies will contribute to sustainable development, overall reduction in vulnerability, improved resilience of natural resources and communities. More specifically, the UTL has to identify climate response measures that include sustainable management of fresh water resources, prevention of coastal erosion and salt water intrusion, climate proofing of fisheries and agriculture based livelihoods, promoting alternate livelihoods, putting in place a robust disaster management system, effective sewage disposal mechanisms, energy efficiency, use of non-renewable energy sources, etc. As vulnerability is a function of the communities' capacity to adapt to changing conditions, and is often manifested in the form of poverty, the strategies must be articulated around policies and actions (in the short, medium and longer term), related to the overall growth and poverty reduction strategy.

2.1.1 Overarching Climate Change Strategic Framework

The LAPCC would identify appropriate actions for expanding and broadening the range of coping strategies adopted by local communities such that they become resilient against the adverse impacts of climate change and are in a position to achieve the Millennium Development Goals. It is therefore necessary to draw up an action plan for the next five years highlighting the fruitful action to be taken up to meet the well-defined goals set up in the NAPCC based on the proposed Vision and Goal for the islands.

2.1.1.1 Vision and Goal

The Vision and Goal are largely conceived based on the existing knowledge base and wisdom that will definitely get improved over time. The specific sub-sectoral actions/ strategies and the time frame are detailed in Part C of the report. This section explains the various broad strategies undertaken and proposed under the UTL's developmental programmes that can be dovetailed with the climate adaptation programmes.

Vision: UTL are adequately capacitated to adapt to the risks and impacts of climate change.

Goal: UTL develop their capacity to cope with the risks and impacts of climate change through appropriate adaptation actions; while contributing to voluntary mitigation of greenhouse gas emissions; improving governance and decision making; broadening the knowledge of climate change and its effects; building capacities and awareness; and developing and strengthening partnership while pursuing overall sustainable development objectives and for achieving Millennium Development Goals.

2.1.1.2 Key Elements and Strategies

An overarching framework for addressing climate change in Lakshadweep, expected outcomes and broad strategies are narrated below.

2.1.1.2.1 Element 1: Contributing to Reduction in Greenhouse Gas Emissions

Outcomes

- Energy efficiency technologies and actions promoted and implemented.
- Renewable and alternate energy technologies and options explored, promoted and implemented

Broad Strategies

Energy Sector

- Estimate the potential of the 'state of the art' renewable energy resources (solar, wind, tidal, biomass etc.) and identify energy efficiency opportunities and standards including setting up of 'hybrid' energy systems.
- Develop an energy policy for the UTL to ensure effective utilization of feasible renewable energy and energy efficiency technologies.
- Promote the use of energy efficient equipment's and their installations

- Conduct capacity development programmes on the use of renewable energy and energy efficient equipment's.
- Review the technical and financial sustainability of existing and future renewable energy and energy efficiency installations and provide technical assistance to improve their performance and disseminate good practices and lessons learnt.
- Provide technical support to update national Greenhouse Gas Inventories.

Forestry Sector

- Promote carbon sequestration by afforestation and greening programmes.

2.1.1.2.2 Element 2: Contributing to Reduction in Greenhouse Gas Emissions: Developing and Implementing Appropriate Adaptation Measures for Vulnerability Reduction

Outcomes

- Priority vulnerable areas/ sectors identified through baseline assessments.
- Appropriate adaptation measures to the adverse impacts of climate change developed and effectively implemented at all levels; thereby improving the coping capacity of communities, sectors and ecosystems.
- Adaptation measures integrated into the overall sustainable development strategy and budgeting process in Lakshadweep.
- Institutional mechanisms for the long-term monitoring of key climate change related parameters established.
- Periodic assessments of the efficacy of adaptation measures undertaken and reviewed.

Broad strategies

Flood Control/ Anti Erosion

- Preparation/ Revision of Integrated Coastal Zone Management Plan to increase the resilience of coastal ecosystems and communities and compliance with Coastal Regulation Zone regulations.
- Adopt natural adaptation solutions over engineering adaptation solutions as they are cost effective, affordable and provide ecosystem benefits.

Ecology and Environment

- Develop detailed profile of geological, ecological and climate change related attributes and detailed vulnerability mapping in the context of climate change.

Fishery

- Promote sustainable harvesting of fisheries (by adopting an ecosystem based approach) and improve fishing techniques.

Disaster Management

- Develop contingency plans for disaster risk reduction and management.

- Integrate climate change adaptation measures into sectoral plans and budgetary processes.

Water Supply and Sanitation

- Rationalize the use and management of freshwater resources and adopt improved water conservation practices.

Agriculture

- Promote improved agronomic/ agro-forestry practices and product diversification for coconut; diversification of crops for ensuring nutritional security and generating additional economic opportunities.

2.1.1.2.3 Element 3: Improving Governance Mechanisms and Institutional Decision Making

Outcomes

- Climate change considerations integrated into sustainable development strategies and growth plans.
- Institutional decision-making mechanisms and processes (including the monitoring & evaluation) strengthened to ensure cross-sectoral coordination of actions related to climate change.
- Regulatory and incentive based approaches developed and adopted to encourage appropriate adaptation and mitigation measures.
- Climate change adaptation and mitigation policies, strategies, programmes and management instruments developed, implemented, monitored and evaluated.
- Institutional capacity developed for disaster risk reduction and management.

Broad strategies

Cross-Sectoral

- Integrate and mainstream climate change adaptation (including disaster risk reduction and management) into economic planning, policies, regulations and programs and explicitly prioritize and allocate resources that reflects considerations of risk and effects of climate change.
- Periodically assess and identify integrated response measures to climate change impacts through cross-sectoral and multidisciplinary approach and in active consultation with communities and experts.
- Strengthen the knowledge base on climate change by promoting research and developing close linkages between National Disaster Management Units, Meteorology and Climate Change Experts.
- Identify and integrate traditional and customary knowledge into overall response strategies.

- Carry out cost benefit analysis to help the choice of policies, strategies, projects and management instruments.
- Dovetail climate change risk assessment as part of Environmental Impact Assessment for all major infrastructure and economic development projects.
- Develop protocols for climate change risk appraisal for community vulnerability assessments with focus on local livelihoods.
- Promote community facilitated capacity development programmes.

2.1.1.2.4 Element 4: Improving the Knowledge Base and Understanding Climate Change

Outcomes

- Institutional capacity (meteorological, hydrological, and oceanographic) for climate change monitoring and prediction developed or strengthened.
- Climate change related information (including traditional knowledge) integrated into relevant social and economic contexts and used for decision making, development planning, forecasting climate variability & events and used in early warning system.

Broad strategies

Cross-Sectoral

- Develop and strengthen institutional capacity for meteorological, hydrological and oceanographic monitoring including using satellite data and other relevant technology.
- Develop a comprehensive knowledge management system on climate change related issues in the UTL, which is user friendly and easily retrievable.
- Improve telecommunications facilities and faster dissemination of climate change related information to communities.
- Climate proofing existing and future developmental programmes and actions by undertaking climate risk assessment.
- Establish a Climate Change Monitoring Centre in the UTL.
- Undertake long and short term monitoring of sea level rise, ecosystem dynamics and other associated impacts of climate change.

2.1.1.2.5 Element 5: Capacity Development, Education & Awareness

Outcomes

- Capacity to understand, monitor and assess environmental, social and economic risks and impacts of climate change developed/ strengthened.
- Capacity to identify and implement cost-effective climate change response measures developed/ strengthened.
- A pool of technical experts conversant with practical strategies/tools/ methods of adaptation and mitigation created.
- Capacity to identify and integrate scientific and traditional knowledge into adaptation and mitigation practices strengthened.
- Capacity to integrate climate change considerations into developmental planning strengthened.

Broad strategies

Cross-Sectoral

- Undertake needs assessment of resources and trainings required on building capacities on climate change and disaster risk management.
- Undertake capacity building programmes to monitor and predict seasonal, inter-annual, decadal, and longer climate variability and impacts of climate change.
- Conduct training of staff and local communities in understanding and observing climate change, in devising/ up-scaling appropriate response measures including disaster risk reduction and management.
- Prepare a compendium of good practices on climate change response measures relevant in the context of the UTL.
- Disseminate information and tools about climate change impacts and issues related to economic and social implications to policy makers and general public.
- Undertake public awareness programmes on health, conservation of natural resources, sustainable utilization of water resources, waste management, energy efficiency, etc.
- Incorporate climate change as a subject into the syllabus of schools and colleges.
- Undertake training programmes and exposure visits on climate change, for scientific, technical and managerial personnel.
- Create a network of regional & national organizations and individuals, working in the field of climate change.

2.2 SECTORAL POLICIES AND IDENTIFIED STRATEGIES

In line with the broad outcomes and strategies identified in the previous section, the LAPCC has looked into sectoral policies existent for the UTL and has identified sectoral specific strategies, in line with the vision and goal of the UTL. This section will list out the various sectoral strategies that will be carried out within the climate change programme.

2.2.1 Fisheries

Fisheries sector is the prime engine of economic growth and subsistence activity in the UTL. By and large, considering the potential, the fishery resources are under-exploited. Adopting better practices can augment the fish catch. Of particular mention in this context would be the adoption of Ecosystem Based Approach (EAF) framework developed by Food and Agricultural Organization (FAO) for promoting sustainable fishing operations. Supply of modern technology and improved fishing gear are other important areas that will improve the fishery operations. To tap the vast fish wealth, a Mother Vessel is being planned along with long liners so that large scale fishing can increase the fish catch substantially. This will be the first Mother Vessel in India.

Sustainable development of fisheries is therefore considered of paramount importance for achieving the goals of food for all, economic growth and employment generation in the UTL. The Marine Fishing Policy 2004 of the Government of India aimed at augmenting the marine fish production in a responsible manner to boost the export of seafood, socio-economic security of the artisanal fishermen and sustainable development of marine fisheries, specially emphasizes the development of fisheries in the Union Territory of Lakshadweep.

For the islands, the "Integrated Perspective Plan for Fisheries Development of Lakshadweep", developed by The Indian Council of Agricultural Research (ICAR) New Delhi, as requested by the administration of the UTL and the Ministry of Agriculture, Government of India, has been accepted and its recommendations have been included as agenda points for discussions in the Island Development Authority (IDA) of the Planning Commission.

The Perspective Plan covers aspects of coastal and oceanic fisheries, fishing technology, post-harvest handling and processing and open sea mariculture for the next ten years for implementation in three phases. The approach to the plan is by considering different scenarios such as increasing production, employment and income with the existing infrastructure facilities and by upgrading the facilities at different levels. The major approach

of the Perspective Plan for increasing the production and income are through sustainable capture fisheries, open sea mariculture, improved processing and value addition, and by ensuring marketing and value realization.

The XI Five Year Plan proposals, evolved by suitably blending the successful programmes of the Department of Fisheries, U.T of Lakshadweep in the previous Five Year Plans with the recommendations of the Integrated Perspective Plan for the Development of Fisheries in Lakshadweep prepared by the Indian Council of Agricultural Research, New Delhi, gives due thrust for increasing the fish landing by upgrading the existing fishing crafts, introducing new and improved fishing crafts including mother vessels, introducing diversified fishing methods to tap virgin resources, improvement of quality of the fishery products produced in the islands by improving shore based infrastructural facilities, production of multiple fishery products, open sea mariculture, ecotourism and human resources development etc. whereby employment generation and high value realization leading to the socio economic upliftment of ethnic Scheduled Tribe population of Lakshadweep. Further information on activities listed out in XI Five Year Plan is listed out in Annexure XV.

Based on the sectoral profiles and policies, strategies for Fisheries and its allied sectors have been identified below:

Key Strategies in Fisheries and Allied Sectors

1. Assess and estimate sustainable yield projections for fisheries in the UTL
2. Adopt Ecosystem Based Approach (EAF) framework developed by Food and Agricultural Organization (FAO) for promoting sustainable fishing operations.
3. Expand the reach of modern technologies like Doppler Radar Systems and satellite data that would enhance and improve fishing operations.
4. Expand the reach and supply of improved fishing gear and equipment's to fishermen.
5. Installation of proper storage facilities, improved marketing of fishery products and product diversification.
6. Complete the procurement of mother vessel for fishery operations.
7. Explore the potential of promoting ornamental fishing including marketing and its impacts on marine biodiversity.
8. Ensure uninterrupted supply of diesel, oil, etc. to fisher-folk.
9. Integration of traditional fishing operations into modern systems
10. Stricter compliance of Marine and Fisheries laws and strengthened enforcement against violations and illegal fishing operations
11. Undertake periodic extension activities and capacity building.

2.2.2 Crop and Animal Husbandry

Agriculture in the UTL is dominated by coconut. Though the productivity of coconut is among the highest in the country, there is still room for maximizing its production in the UTL. Factors against maximizing coconut production include: a) closer spacing and non-systematic planting of saplings, b) Occurrence of diseases and rat menace, c) limited crop improvement, etc. An important opportunity for coconut based livelihoods in the UTL is the potential for product diversification and value addition. Annexure XV shows the 11th Five Year Plan outlay for agriculture at a glance and various schemes.

The entire strategy for development of agriculture in the UTL during the 11th Five Year Plan period is on Coconut Husbandry based Organic Farming with farm level processing and product diversification. The administration has established 15 model organic farms in different islands to propagate the message of organic farming. Livelihood support programs for the ST small and marginal farmers of the UTL (under the Tribal Sub Plan) for viable and feasible crop cultivation cum agri-business ventures are proposed therefore to ensure that the resources released to them are ploughed back into livelihood agriculture in a more productive manner. Pumping of water for crop irrigation has been stopped since 1995. And therefore the only alternate strategy would be for rain-fed farming with possible rain water harvesting. Out of 178 km coastal area, 26 km are severely eroded. Due to the unique soil features and fertility status particularly highly deficient nitrogen and potash, a judicious integrated nutrient management strategy with organic and bio degradable waste recycling is called for.

In the Animal Husbandry, during 11th Five Year Plan period, the department proposes to expand and streamline dairy units in order to augment milk production in the islands to meet demands of the locals (Annexure XV). Besides it is also proposes to expand existing veterinary facilities consequent on the recent outbreak of various dread diseases like bird flu, anthrax in the country. Under Poultry sector it is proposed to introduce solar hatchery in the islands to reduce current consumption. Thus the Department visualized for programmes to bring more employment opportunities and to achieve self-sufficiency in the production of meat, milk and egg. It is the only place in India, which is rabies free. Ultimate aim is to make this territory as disease free zone.

Thus, various entry points for climate change strategies exist within the sectoral policies identified in the 11th Annual Five Year Plan. Realising that the sectoral focus primarily lies in increasing coconut plantations production and attaining self-reliance, the climate change sectoral strategies for Agriculture and its allied sectors have been listed out below:

Key Strategies in Agriculture and Allied Sector

1. Promote good package of practices for the cultivation of coconut including adoption of proper spacing, use of bio-fertilizers, etc.
2. Identification and promotion of genetically superior coconut trees from the local species and supply of quality seedlings.
3. Promotion of diversification of coconut products and adoption of better marketing strategy including organic certification and premium marketing.
4. Revitalization and integration of traditional cropping methods with modern production practices.
5. Promotion of intercropping and home-stead agro-forestry, wherever feasible, for income augmentation, subsistence and nutritional security.
6. Promotion of high yielding varieties of livestock and diversification of products.
7. Promotion of agricultural extension services and conducting capacity building programmes
8. Effectively implement and widen the reach of crop and livestock insurance against calamities.

2.2.3 Water Supply and Sanitation

Water supply scheme has been introduced in all the islands in Lakshadweep, but the supply is partial in quantity. There is no village/ island in the group of Lakshadweep islands in the category of Not Covered (NC). There is no surface water available in the territory. The only natural source of water is ground water (sub soil water) which is being replenished by rain mainly during the south west monsoon. Even this sub soil water is not available in one of the islands, namely Bitra. In this particular island water supply is being managed through rain water harvesting system. In the other islands, full requirement of water cannot be met with from the ground water/ sub soil water. Therefore it has to be supplemented with desalination plants and rain water harvesting system. Hence, supply of water in the islands is a combination of all these three sources.

The main emphasis is given to rain water harvesting system, which is a more environment friendly activity and which practically involves no maintenance cost. A substantial number of rain water tanks have been constructed. An additional 150 tanks are proposed to be constructed in this plan period. Now the administration is in the process of setting up of Low Temperature Thermal Desalination Plant (LTTD) in 6 islands. An amount of 26.6 Crore required for the setting up of 6 LTTD plant has already been deposited with National Institute of Ocean Technology, Chennai and it is proposed to install 3 desalination plants in the remaining islands viz. Kalpeni, Kadmat and Bitra during XI Five Year Plan. different items of work specified under the programme for water supply and sanitation have been given in Annexure XV.

A limited quantity of water is available as ground water for the utilization of the local population. Because of the peculiarities associated with the location, formation hydrogeology and rainfall availability (1500 mm per year), the availability of fresh water is very limited. Additionally, due to high permeability and limited sub terrain storage space above the mean sea level, a substantial portion of the in-filtered water percolates in to the sea. In the absence of adequate rainfall the contribution from rainwater harvesting has also become insignificant and the ground water has become scarce and saline. The maintenance of a minimum thickness of lens is therefore, also one of the prime considerations for the upkeep of island groundwater system. It implies that the fresh groundwater extraction from island lenses has to be adjusted to sustainable level. In Kavaratti, it was observed that when pumping rate exceeded 13,000 litre/ day, the water started showing signs of deterioration.[134]

As on today there is no centralized sewage treatment plant in this Territory. The conventional types of sewage treatment plants are not suitable to this territory considering its geographical and geological condition[135]. There is no arrangement for disposal of solid/liquid wastes either, which at present get discharged into the open sea/lagoon directly/indirectly. . The quantity of wastes is also increasing with increase in population. Since the area of the islands is very small and land mass very porous the septic tanks set up in the past have not proved very useful. It is, therefore, imperative to establish sewage disposal systems in all the islands and ensure that all solid/liquid wastes are disposed off only in an eco-friendly manner.

Thus, the sectoral strategy identified for water and sanitation focus on sustainable utilisation and harvesting of all the three sources available:

Key Strategies for Water Sector

1. Undertake detailed study of all inhabited islands of the UTL to delineate the geometry of fresh ground water lenses, assess storage potential, recharge dynamics, and sustainable yield potential, etc. in order to suggest appropriate, futuristic groundwater development and management options.
2. Complete and commission desalinization plants in the remaining inhabited islands.
3. Augment the capacity of rainwater harvesting systems in the UTL.
4. Develop a fresh water use policy and water budgeting
5. Undertake public awareness programmes for promoting rational use of water and water budgeting.

[134] Pallavi Banerjee and Singh V.S, 2010. Ground water quality monitoring for sustainable management of island aquifer using artificial neural network.

[135] The Centre for Earth Science Studies, Trivandrum has conducted a study for setting up of Sewage System and the pilot project near IR Battalion Campus is in progress. If this project is found successful, it shall be implemented in other islands.

2.2.4 Ecology and Environment Sector

The ecosystem of these islands has stabilized over the centuries and do not pose any danger to human life. Population growth increases the environmental load irrespective of the rate of economic growth. Rapid economic growth can intensify environmental degradation. Therefore all the developmental activities must be in consonance with the delicate ecological balance. The solution does not lie in slowing growth since slow growth also leads to its own form of environmental deterioration. With rapid growth, the UTL can have the recourses to prevent and deal with environmental problems, but it must also be ensured that rapid growth is environmentally benign. This can be achieved through greater awareness, starting with school children, youths, planners and appropriate policies. Scheme-wise financial outlay is given in Annexure XV, where thrust is given for protection and conservation.

Disposal of solid and liquid waste and public health continues to be serious environmental and developmental challenges in the UTL. However, over the years, several initiatives have been undertaken by the administration to address these issues. UTL administration is using a DRDO developed technology of bio-toilets where the activation of decomposition of the human waste, results in minimum amount of sludge. This has been successfully tried and is now being replicated in all the 10,000 households in the islands. The UTL administration has banned the use of plastics and non-biodegradable materials on islands and also installed incinerators to dispose them. The mechanism for disposal of other biodegradable materials is being developed in a phased manner.

Some of the species listed in the Wildlife (Protection) Act, 1972, are available in the seas around the islands. It is therefore necessary to have all these species protected. Moreover all corals with many of its associated animals are classified under Schedule I of the Wildlife (Protection) Act. The coral reefs exhibit extra ordinary biodiversity. A proper management plan has to adopt the sustainable use of this natural resource which can restore the deteriorated parts. Cleaning campaigns of the islands were undertaken with the help of NGOs and Panchayats. Regular lagoon cleaning is being carried out for keeping intact considering the biodiversity of the lagoons. This department declared Pitti Island as bird sanctuary. The provisions of the Wildlife (Protection) Act, 1972, The Environment Protection Act, 1986, etc. are also enforced in the islands for the protection of the environment. The key strategies, therefore, have been identified for the islands:

Key Strategies for Ecology and Environment Sector

1. Undertake periodic monitoring of the extent and health of coral reef system in the UTL by setting up a multi-disciplinary Coral Monitoring Team comprising of experts and staff from various department like Environment & Forests, Fisheries, Agriculture, scientific institutions, etc.
2. Stricter enforcement of laws for the protection of coral reef and lagoon.
3. Conduct regular awareness programmes on the conservation of coral reef including incorporation into school and college curriculum.
4. Discourage the use of corals for construction works and provide alternatives.
5. Restoration of degraded lagoons and corals including through coral transplanting in heavily degraded areas.
6. Prevent disposal of wastes (both liquid and solid) into coral reef system and carry out periodic cleaning/ waste removal operations with active participation of local communities.
7. Prevent discharge of pollutants from barges and ships into the lagoon and seas.

2.2.5 Forestry

Owing chiefly to the delicate and vulnerable ecology of the islands, adequate thrust is necessary on social and agro forestry aimed at rejuvenation of littoral and mangrove vegetation, raising of marine green belt with massive tree plantation and other social forestry activities. A comprehensive plan for the protection of mangroves in Minicoy Island is under consideration.

The scheme on social and agro forestry, so far as this Union Territory is concerned, is of very vital importance to perpetuate and fulfil nature harnessing requirement especially of the vulnerable sea shore area which in all respect is the lifeline zone of Islands. It is also important keep wetlands healthy by reclamation, regeneration & maintenance of these wetlands. XI Five Year Plan proposals envisaged coverage of vulnerable seashore area with 3-4 rows of littoral, mangrove tree belt vegetation (Annexure XV). This scheme is formulated for the protection of marine wildlife around the islands and to create a thick green belt and wind breaker for the protection of seashore from the erosion.

Regularly GIA is provided to District panchayat for social forestry activities. The Department is undertaking seashore plantation by promoting indigenous species like Kanni (*Scaevola koenigii*), Kaitha (*Pandanus Odoratissimus*), Cheruthalam (*Pemphis acidula*), Chonum (*Suriana maritime*), Chabook (*Casurina equisetifolia*), etc to combat soil erosion. The various components are Social Forestry, Reclamation and regeneration of vegetation in and around lakes and ponds and Assistance to Lakshadweep Medicinal Plant Board for raising and maintenance of medicinal plants. Accordingly, the sectoral strategies for forestry have been identified:

Key Strategies for Forestry

- Envisage coverage of vulnerable seashore area with 3-4 rows of littoral, mangrove tree belt vegetation
- Social Forestry: Social forestry aimed at rejuvenation of littoral vegetation, raising of marine green belt with tree plantation and other social forestry activities.
- Reclamation and regeneration of vegetation in and around lakes and ponds: The natural lakes and natural ponds (wetlands) in various islands especially in Minicoy & Bangaram islands should be maintained. The mangrove vegetation *(Ceriops tagal, Bruguiera parvifolra)* around and other littoral associated trees are to be protected and conserved.
- Assistance to Lakshadweep Medicinal plant Board for rising and maintenance of medicinal plants: The protection and preservation of medicinal plants in the island required to check the extinction of the endangered species. The traditional use of these herbals in the traditional medicines and make awareness and keeping demonstration plots in various islands.

2.2.6 Medical and Public Health

The Lakshadweep Medical & Health department functions under the Lakshadweep administration and head quarter is located at Kavaratti. Administrator is the State head assisted by Secretary (Health) and Director of Medical & Health Services for implementing the health programme in the Union Territory. The Medical and Health Services plays a vital role in the efforts to enable the people of Lakshadweep lead a healthy life by promoting programmes covering preventive, promotive and curative health care. Through successful implementation of plan schemes and other National Health programmes, the birth rate, death rate, infant mortality rate and maternal mortality rate etc. have been brought down much below the national average.

At present, 2 Hospitals, 3 Community Health Centres, 4 Primary Health Centres, two First Aid Centres and 14 Sub Centres are functioning in Lakshadweep. In addition to these, two Ayurvedic Dispensaries, one Homeopathic Dispensary and Four Dental Units are also functioning in the Islands of Lakshadweep. To a good extent, the coverage and quality of health care has also improved. The physical targets laid down in the earlier Plan periods could not be achieved fully due to minor administrative and technical reasons. The total financial outlay for the sector is given in Annexure XV. Appropriate climate change sectoral strategies for medical and public health have been identified below:

Key Strategies for Medical and Public Health

1. Sustained awareness among local communities on waste disposal, sanitation, public health, etc.
2. Augment the facilities for the safe disposal and management of bio-medical wastes.
3. Special efforts to recruit doctors with a mandatory time frame to work on islands.
4. Arrange for extra manpower, doctors, paramedic's as well as storage and distribution of medicines and facilities for mobile hospitals, which can be installed on a ship/ vessel.

2.2.7 Protection from Coastal Erosion and Stabilizing the Shoreline

The degree and intensity of coastal erosion varies from island to island and also within an island. The major reasons attributed for coastal erosion in the UTL are a) destruction of natural vegetation along the coast, b) Anthropogenic activities c) increasing wave action and storm surges, etc. The presence of huge boulders and rocky outcrops in the lagoon and the deposition of thick layer of coralline rock on the eastern side prevented the waves from breaking roughly on the shore. The blasting and removal of these for construction activities in the past contributed significantly to the increased erosion of the coastal sands. Similarly the loss of vegetal cover (woods, shrubs and creepers) that acted as natural soil binders have also contributed to the weakening of shoreline against invading waves.

In view of these, any strategy for coastal erosion control should involve both preventive and remedial measures. These will comprise of stricter protection of corals and lagoons that are critical as the 'first line of defence' against wave action. Central Water Commission under the Ministry of Water Resources will take up the task of collecting data required for formulation of schemes to provide long term solutions for sea erosion problems in Lakshadweep. Similarly, restocking/ establishing green cover, adopting appropriate physical methods (wherever feasible and with caution) are other strategies that need to be considered. It is also important that the existing practices (both engineering and natural) are reviewed and a judicious mix of engineering and natural methods adopted.

Lakshadweep Public Work Department is the construction agency for the administration and for the other Central Government Organizations functioning in Lakshadweep. Apart from the construction of the buildings for various departments, the PWD is also dealing directly with various sectors such as Water Supply, Flood Control, Road & Bridges, and Housing and Urban Development. In view of the severe erosion in the island and high cost of shore protection measures; administration requested Ministry of Water Resources to suggest low

cost schemes to prevent sea erosion. Accordingly the Union Ministry of Water Resources constituted a team of experts under the leadership of Central Water and Power Research Station (CWPRS), Pune in 1986. Based on their observations four pilot schemes were suggested for the most affected areas of the islands. Shore protection works adopting these pilot schemes were executed and the performance of these pilot schemes against wave action was also watched. The experts found that these schemes were satisfactory in general and observed that these measures have withstood the wave action[136].

Lakshadweep has got total shore length 132 km. A total coastal length of 59 km has been protected till 2006. This has however led to creation of a concrete jungle totally covering the beaches and the sight is certainly not pleasant. It has therefore been proposed to review the whole scheme, in order to ensure re-emergence of beaches. It is also proposed to adopt the 'Maldivian Model' of shore protection as a pilot scheme. During the XI Five Year Plan it was proposed to cover 32.00 km by adopting the pilot schemes suggested by the expert committee with a financial allocation of Rs.5650.25 Lakhs (Annexure XV).

The main component under the scheme is Anti Sea Erosion works along the shore. Anti-Sea Erosion works in Lakshadweep is carried out based on the study conducted by CWPRS to protect the shore of these coral island. Shore protection work adopting the pilot schemes were executed at shore. The main objective is to carry out Anti Sea Erosion works along the reef instead of placing the protective measures along Shore. Another component is the Construction of fish landing at Cheriya panium. Cheriya panium has a broad reef and it is a fishing island with no sand banks. The fisherman camp in the fishing season and process the fishes. Therefore, it is necessary to construct a Platform covering the Anti-Sea Erosion Works for the benefit of local fisherman. The climate change strategies identified in addition to the schemes have also been listed below:

[136] XI FYP, Annual Plan 2011-2012

Strategies for Anti Erosion Programmes

1. Undertake long term and systematic monitoring of coastal erosion in various islands.
2. Undertake thorough review of the existing systems of coastal protection including the methods of placement of tetra pods and spatial planting of woody, herbaceous vegetation and creepers.
3. Stricter enforcement of rules and laws regarding the protection of corals reef including augmenting the current enforcement capacity (technical knowhow and manpower).
4. As suggested by CWC construction of a ring bund around the Islands may be considered as and when really required.
5. Establish a fool proof coastal green wall using preferably indigenous species and species found to be effective against coastal erosion.
6. Promote the growth of coastal creepers like *Ipomea*, etc. that act as a strong soil binder.
7. Adopt natural solutions over engineering solutions as these are cost effective, affordable and provide multiple ecosystem benefits.
8. Revitalize the local traditions for coastal protection – e.g., retting of coconut husks along the banks.
9. Preparation/ revision of Integrated Coastal Zone Management Plan as envisaged in the Coastal Regulation Zone Act, 2011that promotes the conservation of sand dunes, mangroves, lagoons, beaches, etc. and regulate indiscriminate and ecologically non-sensitive interventions on coastal habitats.
10. Ensure close coordination between the Departments (Environment & Forests, Public Works, Fisheries, Science and Technology, etc.) on coastal erosion control activities.
11. Adopt a judicious combination of natural and physical methods for coastal erosion control.
12. Awareness and capacity development among local staff, local communities and children on coastal and shoreline protection.

2.2.8 Energy Sector

The National Institute of Ocean Technology has already installed one lakh litre per day capacity sea water based low thermal desalination plant at Kavaratti on experimental basis. On seeing the success and acceptance of desalinated water by the local people the administration has decided to increase the capacity to 6 lakhs litre per day. Similar plants of capacities ranging from 1.5 lakh to 3 lakh litre are also proposed to install in the remaining islands. Power requirement of the plants have been taken into consideration while framing the plan schemes. The major thrust therefore would be to replace the old diesel generating sets with new ones of appropriate capacity to meet the additional load and qualitative improvement of power supply. The scheme wise details of major programmes taken up during 2010-2011 Annual Plan Period are given in Annexure XV.

The Government of India, Ministry of New and Renewable Energy has evolved certain schemes utilising new and renewable energy to bridge the gap between the conventional energy and the national economy (Annexure XV). Under the Popularization of Solar Energy

Devices and Appliances, it is proposed to distribute (a) Solar Lanterns, (b) Solar Cookers, (c) Solar Water Heaters and (d) Solar Copra Drier/ Fish Driers etc. in the islands. The key sectoral strategies for energy, thus takes into account of the existent policies and are listed below:

Key Strategies for Energy Sector

1. Estimate the potential of the 'state of the art' renewable energy resources and identify energy efficiency opportunities and standards including setting up 'hybrid' energy systems.
2. Promote the use of non-conventional energy sources .
3. Develop an energy policy for the UT to ensure effective utilization of feasible renewable energy and energy efficient technologies.
4. Explore the potential of state of the art biomass based (coconut residues) gasifier for energy generation.
5. Provide adequate and safe storage facilities (including Oil Depot) for fuel in the UTL.
6. Promote the use of energy saving appliances (LED, solar heater, solar drier, lanterns, street lights, etc.), smokeless and fuel efficient stoves.
7. Establish integrated hybrid systems for power generation
8. Conduct capacity development programmes on the use of renewable energy and energy efficient equipments.
9. Review the technical and financial sustainability of existing and future renewable energy and energy efficiency installations and provide technical assistance to improve their performance and disseminate good practices and lessons learnt.
10. Provide technical support to update national Greenhouse Gas Inventories.

2.2.9 Industry and Minerals

The Government of India is giving special emphasis on development of economic activities in Lakshadweep. Promotion of Industries in the Islands requires special consideration in view of its peculiar geographical condition and resource constraints etc. Specific studies were conducted by the Planning Commission in pursuance of the decision taken by the Standing Committee of the Island Development Authority. The financial outlay for the schemes under the sector is given in Annexure XV.

The main components of the sectoral strategies are; building up of entrepreneurship in the islands, development of SSI sector, development of coir sector in the islands, development of handicraft sector, and development of khadi and village industries

Strategy for Future Developmental Planning Under Coir Sector

- Expansion of Fibre Factories/ Curling unit and DCP (coir) unit is main target
- Introduction of bristle fibre: Bristle fibre is a value added product comparative to the existing mixed fibre.
- Mat Matting: Produce door mat and matting like carpet in the islands.
- White fibre: White fibre produced from green husk. It is the value added product. Coir yarn from white fibre also high in the market value. Green husk is available only in seasonally. Therefore white fibre cannot be produced always.
- Sea Water: - Sweet water in the island is very less and precious. Therefore dept. proposes to use sea water for soaking husks in all islands.

2.2.10 Transport Sector

Port Light Houses and Shipping: The administration has planned to add one high speed vessel of 400 PAX with 40 Knot capacity per hour for faster connectivity between the mainland and the 10 islands, and 1000 MT oil barge (Bulk) for transportation to its fleet. It is further proposed to set up floating storage tanks of adequate storage capacity in all islands to overcome the problem of storage of HSD fuel oil. Construction of mini airstrips at five islands and a dedicated berth at Kochi for Lakshadweep ships are also proposed during the XI Five Year Plan period (Annexure XV). Due to the increase in number of vessels operating in Lakshadweep, the passenger and cargo operations are on a regular basis at the Kavaratti. Hence it is proposed to declare Kavaratti as a major port.

The administration has 2 Helicopters stationed at Kavaratti for inter-island movement and evacuation of patients. One more helicopter is being added to this fleet which is likely to be stationed in Kalpitti Island. Twelve Helipads are available in the ten inhabited and two uninhabited islands. At present, air services are provided to the UTL by Indian Airlines and King Fisher which connects Agatti to Kochi and Bangalore. Agatti Airport is being extended by about 250 meters in such a manner that neither the lagoon nor the nearby uninhabited island of Kalpitti is affected. A new green field airport is also being planned at Andrott Island as an alternative airport. There are proposals to introduce sea planes for inter-island transportation.

Roads and Bridges

The traffic is nominal as compared to mainland but for facilitating the movement of vehicles including transportation of materials, construction of cement concrete roads in all inhabited island have been taken up. Tourism is one of the sectors in Lakshadweep with great potential for the development and various infrastructures are created in various locations in the island. Hence for the effective implementation of road transport the construction of new roads is

required. Because of the extended heavy monsoon season, tar roads are not found to be very useful and the cement roads have stood the test of time in the islands.

Approximately 100 km road still remain to be constructed in these islands, out of this 30 km is the target during the XI Five Year Plan period with a financial allocation of Rs.2060.40 Lakhs including an establish component with an amount of Rs.0.40 Lakhs. It is proposed to construct the cement concrete link Roads in all islands to connect various locations and the Widening/ resurfacing of CC roads in all islands. As a strategy to better implementation of Motor Vehicle Acts and Rules and providing better service to the general publics, the department proposes to start a separate Joint Regional Transport Office in Kavaratti and start 3 new regional offices in the major Islands viz.; Minicoy, Andrott and Amini. One of the main components is promoting eco vehicles – Battery Operated Vehicles in Lakshadweep with the aim to control the total pollution and petrol scarcity by providing necessary financial assistance to the customers in tune of tax exemption and subsidy.

Strategies for Transport Sector

1. Periodically review and improve the connectivity of islands (Inter-island and with the main land) through air and sea route.
2. Introduce sea planes for inter-island connectivity.
3. Complete the upgradation of Agatti airport and complete the construction of new airport at Andrott.
4. Rationalize the use of petroleum vehicles and promote eco-friendly mode of transport.
5. Promote the use of bicycles for intra island mobility

2.2.11 Tourism

UTL administration has realized the importance of Tourism and declared tourism as an industry in 1988. Water Sports activities and scuba diving which is high yielding and environment friendly will be promoted vigorously. Scuba Diving Centers will be setup in various islands. Uninhabited coral islands have a place of its own in tourism industry. Uninhabited islands of Thinnakara and Cheriyam will be developed as island resorts of international standard. If more uninhabited islands are opened for International Tourists, the income from tourism can be increased; much more employment avenues can be generated for the local unemployed educated youths. The Tourists Resorts are to be well connected.

In view of the stringent environmental measures proposed by the Central Government and its relevance to Lakshadweep, conventional methods of tourism development will not suit to Lakshadweep. Therefore a study will be conducted to develop these islands as cruise line tourists' destinations which are ideal for eco sensitive islands and a Master plan will be

drawn to develop tourism on alternative lines. With these in mind following 6 schemes have been drawn for 11th Five year plan (Annexure XV) and improving transport facility is given priority. Administration has taken steps to monitor the carrying capacity of each island and the tourism infrastructure is kept restricted accordingly so that tourism activities do not result in the over exploitation and degradation of fragile island environment.

Key Strategies for Tourism

1. Promote 'low volume high value tourism' in the UTL as they are less demanding on local ecology and bring in increased revenue per tourist.
2. Scale up the branding of the UTL as an ideal destination and develop more tourism products and activities.
3. Periodically monitor and assess the ecological and cultural impacts of tourism in the UTL.
4. Promote community based nature based tourism.
5. Adoption of better marketing and branding of tourism operations.
6. Estimate the carrying capacity of tourism operations.

2.2.12 Disaster Management

As part of the response strategy to disasters, the UTL administration has set up a high state level steering Committee under the Chairmanship of Collector Cum Development Commissioner for relief and rehabilitation measure. Also local level Disaster management committees have been set up under the concerned Sub Divisional officer/ Deputy Collector in each island to monitor the occurrence of disasters. Disaster relief cum evacuation centers are being created in 7 islands under the Prime Minister's Relief Fund to handle any emergencies that may arise on account of rise in sea level in the islands. The State level steering Committee conducted awareness creation programmes in seven islands with the help of National Disaster Management Authority (NDMA), New Delhi.

Key Strategies for Disaster Management

1. Develop contingency plan for disaster risk reduction and management
2. Complete the construction of cyclone shelters.
3. Install early warning systems in all islands
4. Capacity development of staff and citizens

Part C: Climate Change Action Plan

3 Climate Change Action Plan

Lakshadweep Climate Change Action Plan needs to identify and implement specific climate change response measures within the broad strategies and the sectoral strategies identified, as well as climate proofing the current programmes and policies. Further, it will also implement strategies within the measures given in India's National Action Plan on Climate Change to achieve sustainable development with co-benefits in terms of climate change. The UTL has several ongoing programmes and schemes that are highly relevant in the context of climate change as discussed in Part B of the report. However, based on the assessment of vulnerability narrated in Part A, and also based on the broad strategies and sectoral strategies identified, in the following section, it is attempted to develop and identify sub-sectoral strategies relevant under the proposed Missions of the NAPCC.

3.1 Process of Preparation, Coordination and Implementation of LAPCC

3.1.1 Identification of Main Stakeholders: Primary and Secondary

The main stakeholders of the climate change and development programmes in the UTL are identified and grouped into two main categories

a) Primary Stakeholders
b) Secondary Stakeholders

The stakeholder categories are listed in Table 3.2.1.

Table 3.1.1 Key Stakeholder Groups Identified

Stakeholder Groups
Primary Stakeholders
Central Government Agencies
All Government Departments, Institutions, Centres, Cells and Agencies responsible for and involved in Climate Change and UT Island Planning Programmes, Coral Monitoring Networks, Marine Biodiversity Conservation Networks, Defence and Security
UT and Local Government
District Panchayats
Science &Technology
Planning & Statistics
Water and Sanitation
Agriculture
Animal Husbandry
Fisheries
Biodiversity, Environment and Forests
Pollution Control Board
Tourism
Education
PWD
Rural Development
Medical & Health Services
Transport (Roads,Port Shipping & Aviation)
Energy
Industries
Women and Child Development
Information and Public Relations
Relief and Disaster Management
Lakshadweep Marine Research Centre, Kavaratti
Lakshadweep State Social Welfare Board, Kavaratti
Information, Communication and Technology (ICT)
Defence and Security
Island Community Stakeholders
Fishermen
Boat/ Manju owners
Farmers
Coconut Climbers
Malmi/ Seamen
Government/ Semi-Government Servants
Academia
Religious Councils
Local Businessmen/Traders

Cooperative Societies
NGOs
Self Help Groups
Youth Clubs
Labourers
House Wives
Children
Secondary Stakeholders
Tourists
Mainland Traders

3.1.2 Stakeholder Consultations

The LAPCC was prepared and was coordinated by the Department of Environment and Forest, which acts as the nodal Department. The nodal department works in coordination with all the line departments at all stages during the LAPCC preparation. The LAPCC focuses on climate change adaptation, considering the small island status of the UTL and the magnitude of climate vulnerability. The baseline information and adaptive strategies were compiled in consultation with the stakeholders in a participatory mode. Series of sectoral meetings and stakeholder consultations were organized with technical backstopping from the UNDP. The LAPCC was formulated by adopting a Multilevel Consultative Approach. Several rounds of consultations were held with the respective stakeholders in the islands. The list of stakeholder groups participated in the consultations is given below.

The consultations generated relevant observations on the rainfall and temperature variability over a period of time along with information on unpredictability of the weather and its impacts on the various sectors. Also, people's perceptions on the various vulnerabilities were recorded and included in the document supported with scientific evidences. Expert opinion was gathered during consultations and also through multiple interactions and deliberations.

Consultation levels	Stakeholder Group	Representatives
First consultation level	Local Government UNDP	Directors of line departments UNDP Officials
Second	Panchayat Bodies	All representatives of the local panchayats
Third	Island wise consultations	Representatives of different local community groups
Fourth	UTL administration, UNDP	UTL administration including local bodies, UNDP, representative stakeholders from island communities

Multilevel Consultation Participants	
UT and Local Government Representatives from Departments/ Agencies	
District Panchayats	Rural Development
Science &Technology	Medical & Health Services
Planning & Statistics	Transport (Roads,Port Shipping & Aviation)
Water and Sanitation	Energy
Agriculture	Industries
Animal Husbandry	PWD
Fisheries	Information and Public Relations
Biodiversity, Environment and Forests	Relief and Disaster Management
Pollution Control Board	Education
Tourism	Information, Communication and Technology (ICT)
Lakshadweep Marine Research Centre, Kavaratti	Lakshadweep State Social Welfare Board, Kavaratti
Women and Child Development	UNDP
Island Community Stakeholders	
Fishermen	Local Businessmen/Traders
Boat/ Manju owners	Cooperative Societies
Farmers	NGOs
Coconut Climbers	Self Help Groups
Malmi/ Seamen	Youth Clubs
Academia	Labourers

3.1.3 Institutional Framework

As envisaged in the frame work for preparation of the State Level Action Plan on Climate Change and in accordance with the strategy outlined in the National Action Plan on Climate Change, the Hon. Administrator, U.T of Lakshadweep constituted a State Steering Committee (SSC) and a State Advisory Board (SAB) on 30th March 2012 for providing overall guidance, supervision, and also coordinating the whole process of preparation of Lakshadweep State Level Action Plan on Climate Change and its subsequent implementation. The details of the Committee members of SSC and SAB are given below (Table 3.1.2). Under the overall direction of SSC, the State Advisory Board shall be responsible for directly monitoring and supervising the preparation of Lakshadweep Action Plan on Climate Change by the Key Agency, United Nations Development Programme (UNDP) New Delhi. SAG would also review the technical quality of data, robustness of analysis and feasibility of recommendations or strategies for the development of State Level Climate Change Strategy and Action Plan (SCCSAP).

Table 3.1.2 Institutional Arrangement for Climate Change Action Plan

S.No.	A. State Steering Committee	Capacity
1	Administrator	Chairman
2	Secretary (Environment & Forests)	Member
3	Conservator of Forests	Member
4	Director, Science &Technology	Member
5	Director of Panchayat	Member
6.	Chief Executive Officer, District Panchayat	Member
7.	Superintending Engineer, PWD	Member
8.	Director, Planning & Statistics	Member
9.	Director, Agriculture	Member
10.	Director, Animal Husbandry	Member
11.	Director, Fisheries	Member
12.	Director, Tourism	Member
13.	Director, Education	Member
14.	Accounts Officer, Secretariat	Member
15.	Director, Rural Development	Member
16.	Director, Printing & Stationary	Member
17.	Director, Port Shipping & Aviation Member	Member
18	Director, Medical & Health Services	Member
19.	Executive Engineer, Electrical	Member
20.	Director, Industries	Member
21.	Director of Women and Child Development	Member
22	Director Information and Public Relations	Member
24.	Director, Relief and Disaster Management	Member
25.	Chairman, Lakshadweep Marine Research Centre, Kavaratti	Member
26.	Chairperson, Lakshadweep State Social Welfare Board,	Member

	Kavaratti	
27.	Deputy Conservator of Forests	Member Secretary
B. State Advisory Group		
1	Secretary, Environment & Forests	
2	Conservator of Forests	
3	Director Science & Technology	
4	Director, Planning & Statistics	
5	Deputy Conservator of Forests	

3.2 MONITORING AND EVALUATION FRAMEWORK

3.2.1 Design of Monitoring and Evaluation Framework

Adaptation strategies proposed for Lakshadweep islands cut across multiple sectors and are to implemented at different scales (from regional to household level), over different timescales, and take a broad range of approaches (from hard structural adaptation measures to soft policy measures). Hence, measuring the efficiency, effectiveness and impacts of adaptation programmes, projects, and policies are very important for assessing whether the adaptive interventions have been successful in e*nhancing resilience*, *reducing vulnerability* and *improving adaptive capacity* of the UTL. This necessitates the setting up of an effective and transparent monitoring and evaluation system (M&E) in the LAPCC framework. Targets and indicators will be established within the Action Plan linked to the M&E Framework and set at the appropriate levels. The framework will be subjected to periodic reviews to determine the overall progress, at different levels. Monitoring and evaluation are distinct tasks which should complement one another. Monitoring gives information on where a project is at any given time (over time) relative to respective targets and outcomes, and is largely a descriptive task. On the other hand, evaluation gives evidence of why targets and outcomes have or have not been achieved.

Monitoring tracks progress toward a set of benchmarks and measure progress towards outcomes, while evaluation validates results and makes overall judgements about what and to what extent intended and unintended results are achieved (Table 3.2.1). The M&E promotes learning, feedback, and knowledge sharing on results and lessons learned as a basis for decision-making on policies, strategies, program management, and projects, and to improve knowledge and performance.

Table 3.2.1 Monitoring and Evaluation Criteria

Monitoring	Evaluation
Links activities and their resources to outputs and outcomes	Analyses why intended results were or were not achieved
Translates objectives into performance indicators and set targets	Assess specific casual contributions of activities to results
Routinely collects data on indicators; compares actual with targets	Examines the implementation process
Reports progress to the climate adaptation team to check for inconsistencies	Explores unintended results
	Provides lessons, highlights significant accomplishment or program potential, and offers recommendations for improvement

3.2.1.1 Monitoring and Evaluation Indicators

3.2.1.1.1 Indicators of Process

The programmes, projects and policies should have a good balance of indicators of process, *outputs, outcomes and impact*; as well as indicators that cover the evaluative criteria of *coverage, effectiveness, sustainability and replication*[137]. The results are the changes in a state or condition which derive from a cause-and- effect relationship. There are three types of such changes which can be set in motion by a development intervention- its output, outcome and impact. Indicators for Evaluative Criteria of Climate Adaptation Programmes are given in Table 3.3.2.

- **Outputs:** The products and services which result from the completion of activities within a development intervention.
- **Impact:** Positive and negative long-term effects on identifiable population groups produced by a development intervention. These effects can be economic, socio-cultural, institutional, environmental, technological or of other types.
- **Outcome:** The intended or achieved short-term and medium-term effects of an intervention's outputs, usually requiring the collective effort of partners. Outcomes represent changes in development conditions which occur between the completion of outputs and the achievement of impact.

Table 3.2.2 Indicators for Evaluative Criteria of Climate Adaptation Programmes

Coverage

- Number of policies, plans or programmes introduced or adjusted to incorporate climate change risks.
- Number of stakeholders (e.g. communities, households, agencies, decision makers) engaged in capacity building activities for vulnerability reduction or improved adaptive capacity.
- Number of stakeholders served by new or expanded climate information management systems (e.g. early warning systems, forecasting, etc.)
- Number of investment decisions revised or made to incorporate climate change risks).
- Number of risk-reducing practices/measures implemented to support adaptation of livelihoods and/or resource management

[137]UNDP, 2010. Monitoring Framework for Climate Change Adaptation. UNDP-GEF Adaptation

Effectiveness

- Percent change in stakeholders' behaviours utilising adjusted processes, practices or methods for managing climate change risks, assessed through evidences (relevant across processes
- Percent change in stakeholders' capacities to manage climate change (e.g. communicate climate change risks, disseminate information, or make decisions based on high quality information)
- Percent change in use of/performance of information management systems, for example, early warning response times.
- Percent change in stakeholder perceptions of vulnerability to (or capacity to adapt to) a recurrence of primary climate change-related threat(s),
- Narrative description of the role of project interventions in reducing vulnerability (or improving capacity to adapt to climate change-related threat(s))
- Improvement in the relevant quantitative development outcome (food security, water resources, health outcomes, etc.) as a supplemental indicator

Sustainability

- Number of project beneficiaries involved in capacity building for implementation of specific adaptation measures or decision-support tools.
- Availability of skills and resources necessary to continue adaptation after conclusion of project (at relevant scale)
- Stakeholder perceptions of adaptation sustainability

Replicability

- Number of 'lessons learned' codified
- Number of relevant networks or communities with which lessons learned are disseminated

Source: Brooks and Frankel Reed, (2008), UNDP[138]

3.2.1.2 Major Criteria for M&E for Projects

- **Relevance**: The extent to which the activity is suited to local and national development priorities and organizational policies, including changes over time.
- **Effectiveness**: The extent to which an objective has been achieved or how likely it is to be achieved.
- **Efficiency**: The extent to which results have been delivered with the least costly resources possible; also called cost effectiveness or efficacy.
- **Results**: The positive and negative, and foreseen and unforeseen, changes to and effects produced by a development intervention. Results include direct project outputs, short to medium-term outcomes, and longer-term impact including global environmental benefits, replication effects, and other local effects.

[138]Brooks. N and J. Frankel-Reed (2008) Proposed framework for monitoring and evaluating adaptation to climate change. GEF International Workshop on Evaluating ClimateChange and Development. UNDP.

- **Sustainability**: The likely ability of an intervention to continue to deliver benefits for an extended period of time after completion. Projects need to be environmentally as well as financially and socially sustainable.[139]

3.2.1.3 Sample Adaptation Indicators[140]

3.2.1.3.1 Infrastructure

- Housing building codes adopted and enforced
- Climate-proof standards applied to all public infrastructure

3.2.1.3.2 Water

- Percentage change in economic impact of floods (or droughts) in real terms
- Percentage decline in unaccounted-for water in reticulation systems

3.2.1.3.3 Agriculture

- Change in yields
- Changes in fish catch
- Change in loss value of output
- Changes in availability of local food during scarcity months

3.2.1.3.4 Coastal

- Change in property values in vulnerable coastal areas (in real terms)
- Change in percentage of coastline mapped and rated for different classes of hazards (e.g. erosion)
- Change in number of people settled in areas with high hazard ratings

3.2.1.3.5 Health

- Change in epidemic potential of vector-borne diseases (e.g. malaria, dengue fever)

3.2.1.4 M&E Implementation Arrangements

The M&E system for climate change adaptation will be coordinated by the State Advisory Committee under the overall direction of the State Steering Committee constituted by the UTL administration for preparing the Lakshadweep Climate Change Action Plan and the implementation of the plan thereafter. The details of the institutional arrangements in the UTL for addressing the climate change concerns are detailed in the preceding section.

[139] GEF, 2006
[140] World Bank, 2010

3.3 INTEGRATING LAPCC STRATEGIES WITHIN NAPCC MISSIONS

As discussed in climate change adaptation section, efforts to enhance island resilience must be mainstreamed into general development policy formulation. Also adaptations should not be seen as separate or confined only to engineering or land use planning based realms. In view of the above, the strategy for addressing climate change in the UTL needs to be integrated into the overall development planning process with basic elements built on multi-focal interventions in the areas of economic development, environmental protection, disaster risk reduction and management and poverty alleviation. Further, the strategy has to be developed in consonance with national and regional developmental objectives and contexts, based on sound scientific information and by following a participatory approach including consultation with local stakeholders and communities.

This has necessitated integrating the agenda for climate change into the policy framework of Lakshadweep's development in the future. Consequently, it is attempted to link the Lakshadweep Action Plan on Climate Change (LAPCC) with the National Action Plan for Climate Change (NAPCC) so that the UTL's climate change strategies are in tandem with the national strategy. The eight missions under NAPCC are presented in the box below. Out of the eight missions, barring Himalayan ecosystem all other seven missions have a direct impact on Lakshadweep islands.

3.3.1 NAPCC: Missions and Targets

National Action Plan on Climate Change (NAPCC): Targets

1. **National Solar Mission** seeks to deploy 20,000 MW of solar electricity capacity in the country by 2020. The first phase (2010-12) is currently underway during which 1,000 MW are planned to be installed
2. **National Mission for Enhanced Energy Efficiency** creates new institutional mechanisms to enable the development and strengthening of energy efficiency markets. Various programmes have been initiated, including the Perform, Achieve and Trade (PAT) mechanism to promote efficiency in large industries, and the Super-Efficient Equipment Programme (SEEP) to accelerate the introduction of deployment of super-efficient appliances.
3. **National Mission on Sustainable Habitat** promotes the introduction of sustainable transport, energy-efficient buildings, and sustainable waste management in cities
4. **National Water Mission** promotes the integrated management of water resources and increase water use efficiency by 20 per cent
5. **National Mission for Sustaining the Himalayan Ecosystem** establishes an observational and monitoring network for the Himalayan environment so as to assess

climate impacts on the Himalayan glacier and promote community-based management of these ecosystems

6. **National Mission for a Green India** seeks to afforest an additional 10 million hectare of forest lands, waste lands and community lands.
7. **National Mission for Sustainable Agriculture** focuses on enhancing productivity and resilience of agriculture so as to reduce vulnerability to extremes of weather, long dry spells, flooding, and variable moisture availability.
8. **National Mission on Strategic Knowledge for Climate Change** identifies challenges arising from climate change, promotes the development and diffusion of knowledge on responses to these challenges in the areas of health, demography, migration and livelihood of coastal communities.

It is attempted to identify the priorities in different missions that are relevant to LAPCC. Details of LAPCC activities planned under each of the NAPCC Missions including the timelines and budget are presented in the ensuing section.

3.3.2 Climate Change Adaptive Strategies, Targets, Financial Outlay and Time Frame

3.3.2.1 LAPCC and National Solar Mission

Solar based power technologies are an extremely clean form of generation with practically no form of emissions at the point of generation. They would lead to energy security through displacement of coal and petroleum. T&D losses are very low in decentralized systems. Deployment can be done independently of the national grid and integrated with the national grid when needed. The following are the various programmes that may be taken up under the National Action Plan.

- Solar Thermal Power Generation
- Solar Photovoltaic Generation
- R&D Collaboration, Technology Transfer and Capacity Building

Table 3.3.1Integrating Action Plan with National Solar Mission

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs in Crore)	Departments	Time Frame
Energy							
Promote the use of energy saving appliances (LED, solar heater, solar drier, lanterns, street lights, etc.) smokeless and fuel efficient stoves							
Solar Power Plant in the islands	Completed	All to be renovated and upgraded	Continues	One megawatt solar power plant is developed in addition to the existing capacity/year that shall reduce the use of diesel for power generation and reduction in greenhouse gas emissions	25	Dept. of Electricity	Medium Term
Distribution of solar lanterns to BPL families free of cost	1700	4000	-	100 %BPL households in the UTL provided with solar energy.	1.25	Dept. of Electricity & Dept. of Finance	Short Term

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs in Crore)	Departments	Time Frame
Distribution of Solar lanterns to other stake holders @ Rs.489/-	6755	12000 Nos.		To reduce dependence on diesel for power generation and popularization of solar energy in the island.	0.60	Dept. of Electricity & Dept. of Finance	Short Term
Providing Solar Water heaters to Hospital	13	20		To reduce the consumption of diesel for power generation and enhance the use of non-conventional energy	0.10	Directorate of Medical & Health & Dept. of Finance	
Use of solar water heaters in the island	None	1600		To enhance the use of 'cleaner' non-conventional energy for power generation.	0.10	Dept. of Electricity, Dept. of Finance & Dept. of IP&T	
Establishing Solar Fish Driers	None	10		To enhance the use of non-conventional energy sources.	0.25	Dept. of Electricity, Dept. of Fisheries and Dept. of Finance	
Establishing Solar Street Lights	50	100%		To reduce diesel power generation and promote the use of non-conventional energy.	1.00	Dept.of Electricity, Dept.of Finance & Dept. of Planning	
Promote the use of non-conventional energy sources in the UTL							
Promote the use of non-conventional energy and sustainable use	*Nil*	*10*		*Awareness creation Involving VDP's, dignitaries, students, locals, officials etc.*		*Dept. of Electricity and Dept. of Information & Tourism*	

3.3.2.2 LAPCC and National Mission for Enhanced Energy Efficiency

- GHG Mitigation Options in the Industry Sector
- Potential for Emissions Reduction
- Co-Benefits
- Technology Transfer
- Financing
- Capacity-Building Needs
- Policy and Regulatory Options
- Delivery Options

The activities can be integrated with the National mission as given in Table 3.3.2.

Table 3.3.2 Integrating Action Plan with National Mission on Enhanced Energy Efficiency

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs in crores)	Departments	Time Frame
Energy							
Promote the use of energy saving appliances (LED, solar heater, solar drier, lanterns, street lights, etc.) smokeless and fuel efficient stoves							
Spread of LED in the islands	None	15000	Continues	Through awareness among stake holders	-	Dept. of Electricity & Dept. of Environment & Forest	Medium Term
Subsidy Battery Operated Vehicles	300	1500	Continues	To make reduce pollution, and reduction in emission of GHGs.	1.00	Dept. of Road Transport & Dept. of Finance	Short Term
Supply of fuel efficient	1000	10000	Continues	To reduce dependency on	0.25	Department of Electricity, IIS	Short Term

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs in crores)	Departments	Time Frame
Smokeless Stove				petroleum products and promote the use locally available coconut material.		Bangalore/ Department of Finance	
Installation and commissioning of SPV Power plants in islands							Long Term
Popularization of Energy Saving Devises (Solar lantern and other equipment's)							
Explore the potential of state of the art biomass based (coconut residues) gasifier for energy generation							
Installation of Biomass Gasifier							Short/Medium Term
Review the technical and financial sustainability of existing and future renewable energy and energy efficiencies installations....							
Tapping of Ocean Energy							
Fuel cell							
Conduct Capacity Building Programmes on the use of renewable energy and energy efficient equipment's							
Others…							
Installation of Wind electric Generators							

3.3.2.3 LAPCC and National Mission on Sustainable Habitat

The Mission comprises three components out of which two have been identified for identification of sub sectoral strategies, i.e. promoting energy efficiency in the residential and commercial sector, and management of municipal solid waste (Table 3.3.3).

Table 3.3.3 Integrating Action Pan with National Mission on Sustainable Habitat

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs in crores)	Departments	Time Frame
Water Supply and Sanitation							
Sewage Disposal & Control of Water Pollution							
Bio Waste Management Cell							
Ecology and Environment							
Town Plan/ Landscape plan for the UTL	2	10	Continues	Sustainable use of water/air/land achieved only by proper panning/execution	11.00	Dept. of PWD & Dept. of Finance	
Incinerators for waste disposal	7	11	Continues	For the safe disposal of bio-medical waste in Hospitals	2.05	Dept. of Science & Technology & Dept. of Finance	
Bio-toilets	22	10000	Continues	To ensure proper disposal of human waste and reduce contamination of fresh water.	0.60	Dept. of Science & Technology and & LPCC	
Supply of waste bin for collection of	3200	6500	Continues	To ensure systematic and	0.75	Dept. of Environment and Forest,	

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs in crores)	Departments	Time Frame
non-biodegradable waste				segregated collection and management of Municipal waste		Dept. of Finance &Dept. of Planning	
Creation of compost pits	105	10000	Continues	For the safe disposal of bio-degradable waste and production of manure and compost	3.00	Dept. of Environment and Forest, Dept. of Agriculture & Dept. of Planning	
Awareness creation	1	5	Continues	An interstate tour for students to understand the pollution related issues and mitigation measures	0.15	Dept. of Environment and Forest, Dept. of Finance & Dept. of Planning	
Land for Incinerator installation	2	11	Continues	To burn the municipal solid waste in an efficient manner.	13.50	Dept. of Science & Technology and Dept. of planning	
Strengthening of Science clubs	1	6	Continues	To spread environmental awareness.	0.50	Dept. of Science & Technology Dept. of Planning and Dept. of Finance	
To promote cracker free festival among children	Nil	100%	Continues	Through effective campaign in Lakshadweep	0.50	Dept. of Education & Dept. of Information Publicity and Dept. of Planning	

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs in crores)	Departments	Time Frame
Production of Paper bags	1	10	Continues	To produce biodegradable paper bags to eliminate the plastic	1.00	Khadi & Village Industries, Dept. of Environment & Forest and Dept. of Science & Technology	
Transport							
Issue of Pollution Control Certificate	1	9	Continues	Create infrastructure in all islands to issue Pollution Control Certificate	9.00	Dept. of Road Transport & Dept. of Finance	
Distribution of Bicycles to Girl students	122	9000	Continues	To spread awareness on pollution free transport and intra island mobility	3.00	Dept. of Social Welfare & Dept. of Finance	
Green Field Airport	Nil	1	Continues	Construction of Airport at Androth for smooth flow of Air Traffic	10	Dept. of Port Shipping and Aviation & Dept. of Planning	
LED screens in the jetty for ship traffic information	Nil	10	Continues	LEDs placed near jetty to inform public about ship schedule and ticket availability in all islands	1.00	Dept. of Port Shipping and Aviation & Dept. of Planning	
Augmentation of ship to shore transport facilities Procurement of ships for Lakshadweep							

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs in crores)	Departments	Time Frame
service							
Awareness Programme on Road Safety and Traffic Rules							
Complete the upgradation of Agatti airport and complete the construction of new airport at Androtт							
Augmentation of dedicated berths at mainland ports							
Extension/Construction of airstrips and operation of daily flight by airlines							
Introduce planes for inter-island connectivity							
Energy							
LPG for domestic consumption	600/kavaratti, minicoy/ month	1000/islands/month	Continues	To improve fuel availability.	1.00	Dept. of Civil Supplies & Dept. of Planning	
Augmentation of Diesel Generating Capacity and Distribution System in all the Islands							

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs in crores)	Departments	Time Frame
Acquisition of land for setting up of infrastructure for procurement of Petroleum products							
Enhance Fuel quality for reducing air pollution	Nil	100%	Continues	Request oil companies to supply low sulphur diesel /Petrol through dedicated refineries and mandate cleaner fuel to reduce the amount of exhaust/tail pipe emissions substantially.	Nil	Dept. of Civil Supplies, Dept. of Planning and Dept. of Environment	
Tourism							
High quality, low volume tourist promotion	4	10	Continues	To promote sustainable and responsible tourism	10.00	Dept. of Tourism and Dept. of Planning	
Eco-friendly cottages	Nil	100	Continues	To upgrade tourist infrastructure.	o.90	Dept of Tourism/ Dept. of PWD/ Dept. of planning	
Public Private Participation in Tourism							
Strengthening of Tourist Transport							

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs in crores)	Departments	Time Frame
Opening of more islands for Tourism							
Medical and Public Health							
Elimination of Filariasis	Under Progress	100 %	Continues	Mass administration of medicines to eliminate *filariasis*.	0.50	Dept. of Medical and Health Services/ Dept. of Planning	
Expansion and modification of Hospital/ Community Health Centers/							
Setting up of Public Health Laboratory/Drug Analyzing Lab							
Strengthening of ISM & Homeopathy							
Providing of Multi-Purpose High Speed Ambulance Boat							
Tele medicine facilities in the Island	5	10	Continues	Tele medicine facility extended with the help of ISRO	3.00	Directorate of Health and Service/ Dept. of Planning	
Establishment of Ayush centres	Nil	10	Continues	To create and spread awareness about Indian system of medicines	10.00	Directorate of Medical and Health Services/ Dept. of Planning	

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs in crores)	Departments	Time Frame
Establishment of Day Care Centre for Disabled Children	Nil	1	Continues	Day Care Centre for disabled children at Kavaratti.	1.00	Directorate of Medical and Health Services/ Dept. of Planning	
Disaster Management							
Disaster Relief/ Evacuation Centers	7	11	Continues	Disaster Relief/Cum Evacuation Centre to handle disaster and emergencies	7.00	Collect orate/Sub-Divisional Offices/Dept. of Planning	
Others…							
SWAN Project	Under Progress	10	Continues	To reduce paper work and stream line island administration	0,50	Dept. of Information Technology/ Dept. of Planning	
Online Ship Ticket Reservation	Nil	100 %	Continues	Online reservation of ship tickets to reduce paper work/movement of men and material.	0.50	Dept. of Information Technology/ Dept. of Planning	
Organizing Entrepreneur Development Programme for Promotion of SSI units in Islands							
Incentives/ financial support to ST/ local entrepreneurs in Lakshadweep							

3.3.2.4 LAPCC and National Water Mission

The relevant components for the UTL identified in the National Water Mission are discussed below.

3.3.2.4.1 Studies on Management of Surface Water Resources

- Developing digital elevation models of flood-prone areas for forecasting floods
- Mapping areas likely to experience floods and developing schemes to manage floods
- Establishment of a wider network of automatic weather status and automated rain gauge stations
- Customizing climate change models for regional water basins

3.3.2.4.2 Management and Regulation of Groundwater Resources

- Mandating water harvesting and artificial recharge in relevant urban areas
- Mandatory water assessments and audits; ensuring proper industrial waste disposal

3.3.2.4.3 Upgrading Storage Structures for Fresh Water and Drainage Systems for Wastewater

- Developing models of urban storm water flows and estimating drainage capacities for storm-water and for sewers based on the simulations
- Strengthen links with afforestation programmes and wetland conservation
- Restoration of old water tanks

3.3.2.4.4 Conservation of Wetlands

- Environmental appraisal and impact assessment of developmental projects on wetlands
- Developing an inventory of wetlands, especially those with unique features
- Mapping of catchments and surveying and assessing land use patterns with emphasis on drainage, vegetation cover, silting, encroachment, conversion of mangrove areas, human settlements, and human activities and their impact on catchments and water bodies.
- Creating awareness among people on importance of wetland ecosystems
- Formulating and implementing a regulatory regime to ensure wise use of wetlands at the national, the state, and district levels

3.3.2.4.5 Development of Desalination Technologies

- Seawater desalination using Reverse Osmosis and multistage flash distillation to take advantage of low-grade heat energy e.g. from power plants located in the coastal regions or by using renewable energy such as solar
- Brackish water desalination
- Water recycle and reuse
- Water purification technologies

The activities that can be integrated with the National Mission are given in Table 3.3.4.

Table 3.3.4 Integrating Action Plan with National Water Mission

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs in crore)	Departments	Time Frame
Water Supply and Sanitation							
Augment the capacity of rainwater harvesting systems							
Rain Water Harvesting Tank	3500	10000	Continues	Construction of RWHTs in domestic sector for water conservation and recharge	20.00	Dept. of Science & Technology, LIWAMP and Dept. of Finance	
Rain Water recharge system	Nil	500	Continues	All Hospitals, schools and public offices adopt rain water recharge system to supplement the ground water	0.50	Dept. of Science & Technology and LIWAMP, Dept. of PWD and Dept. of Finance	
Complete and commission desalinisation plants in the remaining inhabited islands							
Desalination for drinking water	1	8	Continues	For ensuring the supply of safe drinking water to stake holders	20.00	Dept. of PWD & NIOT	

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs in crore)	Departments	Time Frame
Augmentation/ Networking of distribution system to LTTD Plant in the islands							
Other strategies…							
Effluent Water Treatment Facility	Nil	10	Continues	To purify the effluent water and utilized for enhanced greenery	3.00	Dept. of PWD, Dept. of Agriculture, Dept. of Environment & Forest & Dept. of Finance	
Water recharging by restoring water bodies	123	100%	Continues	All water bodies to be restored	0.50	Dept. of Science & Technology, MGNREGS and LIWAMP	
Water regulation under Water prevention and control Act, 1974	Nil	1	Continues	To control the use of Ground water systematically	0.01	Law cell in Secretariat/ Dept. of Environment & Forest	
Up-gradation of Water Quality Testing Lab Kvt to State Level Lab							
Flood Control/ Anti Erosion							
Establish a full proof coastal green wall using preferably indigenous species and species found to be effective against coastal erosion.							
Coastal shelter belt plantation							
Adopt a judicious combination of natural and physical methods for coastal erosion control							
Anti-Sea Erosion works in							

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs in crore)	Departments	Time Frame
Lakshadweep along the shore							
Anti-Sea Erosion works in Lakshadweep along the reef							

3.3.2.5 LAPCC and National Mission for a Green India

The proposed national programme will focus on two objectives, namely increasing the forest cover and density as a whole of the country and conserving biodiversity. The key components are discussed in Table 3.3.5.

3.3.2.5.1 Increase in Forest Cover and Density

- Training on silvicultural practices for fast growing and climate hardy tree species
- Implementation of the Greening India Plan

3.3.2.5.2 Conserving Biodiversity

Conservation of wildlife and biodiversity in natural heritage sites including sacred groves, protected areas, and other biodiversity 'hotspots' is crucial for maintaining the resilience of ecosystems. Specific actions in this programme include:

- In-situ and ex-situ conservation of genetic resources, especially of threatened flora and fauna
- Creation of biodiversity registers (at national, district, and local levels) for documenting genetic diversity and the associated traditional knowledge
- Effective implementation of the Protected Area System under the Wildlife Conservation Act
- Effective implementation of the National Biodiversity Conservation Act, 2001

Table 3.3.5 Integrating Action Plan with National Mission for a Green India

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs in crore)	Departments	Time Frame
Ecology and Environment							
Corals, Wild Life and Lagoon Conservation							
Environment Awareness Programme							
Scientific Management of Bio-degradable and Non Bio-degradable wastes							
Forestry							
Social Forestry							
Reclamation and regeneration of vegetation in and around lakes and ponds							
Establishing Medicinal Plant Plot & Herbal Garden	5	10	Continues	To increase green cover and increase awareness about indigenous medicinal plant species	1.00	Dept. of Environment & Forest, Dept. of Agriculture & Dept. of Planning	
Establishment of Botanical Garden	2	9	Continues	To increase greenery, aesthetic value, etc	0.10	Dept. of Environment & Forest, Dept. of Agriculture & Dept. of Planning	
Mangrove restoration and regeneration	1	2	Continues	Protect, conserve and reintroduce Mangrove species in Minicoy and Kalpeni	0.02	Dept. of Environment & Forest and Dept. of Planning	

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs in crore)	Departments	Time Frame
Establishment of Nursery	Nil	5	Continues	Production of locally available soil binding species	0.05	Dept. of Environment & Forest and Dept. of Planning	
Habitat restoration of wet lands and lagoon	Nil	12	Continues	Cleaning and protection of lagoon, seashore and wetlands from Non-biodegradable waste, oil pollution, over fishing etc.	1.00	Dept. of Environment & Forest, Dept. of Fisheries and Dept. of Planning	
Establishing Children's Park	5	11	Continues	To facilitate recreation centre to children's and enhance green cover	3.00	Dept. of Women & Child welfare and Dept. of Planning	
Coastal Plantation	Nil	5 lakhs	Continues	Distribution and planting of casuarinas trees to protect seashore	0.50	Dept. of Environment & Forest/ Environment & Planning	
Distribution of Fruit Plants	1 Lakh	3 Lakh	Continues	Enhance the availability of fruit species and food security.	0.30	Dept. of Agriculture & Dept. of Environment & Forest	

3.3.2.6 LAPCC and National Mission for Sustainable Agriculture

The proposed national mission will focus on four areas crucial to agriculture in adapting to climate change, namely dryland agriculture, risk management, access to information, and use of biotechnology.

3.3.2.6.1 Dryland Agriculture

- Development of drought- and pest-resistant crop varieties
- Improving methods to conserve soil and water
- Stakeholder consultations, training workshops and demonstration exercises for farming communities, for agro-climatic information sharing and dissemination
- Financial support to enable farmers to invest in and adopt relevant technologies to overcome climate related stresses

3.3.2.6.2 Risk Management

The agricultural sector may face risks due to extreme climatic events. Priority areas for UTL are as follows:

- Strengthening of current agricultural and weather insurance mechanisms
- Development and validation of weather derivative models (by insurance providers ensuring their access to archival and current weather data)
- Creation of web-enabled, regional language based services for facilitation of weather-based insurance
- Development of GIS and remote-sensing methodologies for detailed soil resource mapping and land use planning at the level of a watershed or a river basin
- Mapping vulnerable eco-regions and pest and disease hotspots
- Developing and implementing region-specific contingency plans based on vulnerability and risk scenarios

3.3.2.6.3 Access to Information

Although many information channels are available to farmers, none of them offers need-based information in an interactive mode. Supplying customized information can boost farm productivity and farm incomes, and the following areas deserve priority:

- Development of regional databases of soil, weather, genotypes, land-use patterns and water resources
- Providing information on off-season crops, aromatic and medicinal plants, greenhouse crops, pasture development, agro-forestry, livestock and agro-processing.
- Collation and dissemination of block-level data on agro-climatic variables, land-use, and socio-economic features and preparation of state-level agro-climatic atlases

3.3.2.6.4 Use of Biotechnology

Biotechnology applications in agriculture relate to several themes, including drought proofing, taking advantage of elevated CO_2 concentrations, increased yields and increased resistance to disease and pests.

- Development of crops with better water and nitrogen use efficiency which may result in reduced emissions of greenhouse gases or greater tolerance to drought or submergence or salinity
- Development of nutritional strategies for managing heat stress in dairy animals to prevent nutrient deficiencies leading to low milk yield and productivity

Table 3.3.6 shows how the action plan can be integrated with the national mission.

Table 3.3.6 Integrating Action Plan with National Mission for Sustainable Agriculture

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs. in crore)	Departments	Time Frame
Crop and Animal Husbandry							
Promote good package of practices for the cultivation of coconut including adoption of proper spacing, use of bio-fertilizers, etc.							
Organic Certification	Nil	100%	Continues	Organic certification for agriculture products	0.20	Dept. of Agriculture	
Coconut Demonstration Plots							
Green manure cropping							
Vermiculture/coir pith plus compost making							
Integrated Soil Nutrient Management							
Integrated Pest and Disease Management							
Identification and promotion of genetically superior coconut trees from the local species and supply of quality seedlings							
Organic coconut Farms; Kitchen Garden/School Garden	Nil	15	Continues	To promote coconut cultivation and nursery in Islands	0.70	Dept of Agriculture and Department of Planning	
Coconut Nurseries							
Promotion of diversification of coconut products and adoption of better marketing strategy including organic certification and premium marketing							
Processing and Product Diversification							
Market development and							

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs. in crore)	Departments	Time Frame
Promotion							
Neera Tapping and Processing							
Husk Retting and Coir Spinning							
Virgin coconut oil making							
Coconut wood furniture/handicrafts units							
Revitalisation and integration of traditional cropping methods with modern production practices.							
e-Commerce and e-Business							
Promotion of intercropping and home-stead agro-forestry, wherever feasible, for income augmentation, subsistence and nutritional security							
Distribution of Fruit Plants	1 Lakh	3 Lakh		Enhance sustainability and Greenery and reduce pollution		Dept.of Agriculture & Dept.of Environment & Forest	
Productivity enhancement							
Floriculture/orchids							
Banana/papaya/sweet potato/betel vine/ gardens							
Mushroom Cultivation							
Vegetable Cultivation							
Tuber cultivation							
Spices cultivation							
Pulse cultivation							
Poly film Greenhouses							
Effectively implement and widen the reach of crop and livestock insurance against calamities							
Coconut Crop Insurance							
Insuring Coconut Climbers							
Introduction insurance							

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs. in crore)	Departments	Time Frame
coverage of birds and Welfare measure for Livestock Farmers.							
Animal Husbandry							
Promotion of high yielding varieties of livestock and diversification of products.							
Provision for Fish waste & Feed mixing equipment's							
Introduction of Quail pickle Unit, Chicken pickle Unit and Egg pickle units							
Provision for Solar Hatcheries							
Genetic improvement of the existing goat population by way of intense cross breeding programme							
Establishment of two Goat Breeding Farms							
To building up an elite stock of high yielding cows through the introduction of calf distribution scheme							
Expansion of veterinary facilities in all islands							
Educate and provide services to the livestock farmers by way of imparting / conducting training and extension education about the latest technical know-how in livestock and poultry							

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs. in crore)	Departments	Time Frame
management and disease control.							
Fishery							
Expand the reach of modern technologies like Doppler Radar Systems and satellite date that would enhance and improve fishing operations							
Computerization of the Fisheries Field Units in all the islands and providing V-sat facilities for strengthening of statistical database							
Complete the procurement of mother vessel for fishery operations							
Procurement of Mother Vessel	Under work	1	Continues	Mother vessel for fisheries to increase the fish catch substantially	0.55	Dept. of Fisheries and Dept. of Planning	
Fish Aggregation Devices (FAD) in coastal Water	10	20	Continues	For improved fish production.	0.10	Dept. of Fisheries, Dept. of Finance & NIOT	
Stricter compliance of Marine and Fisheries laws and strengthened enforcement against violations and illegal fishing operations							
Marine Monitoring station in Islands	Nil	3	Continues	To monitor the movement of marine vessels and pollution	3.00	Dept. of Fisheries, Dept. of Environment & Forest & LPCC	
Installation of proper storage facilities, improved marketing of fishery products and product diversification							
Construction of Fish Market/Meat market	9	11	Continues	Modernize using adequate infrastructure with effluent treatment plant and other amenities	2.00	Dept. of Fisheries, Dept. of Social Welfare, VDP's in islands and	

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs. in crore)	Departments	Time Frame
						Dept. of Planning	
Establishment Ice Plants in the islands							
Establishment of cold storages-cum-walk in freezers in the islands and mainland							
Establishment of an integrated fish processing unit at Kavaratti							
Production of value added fishery products and fish waste utilization							
Establishment, running and maintenance of community Masmin making units for production of High Quality Masmin							
Supply of Insulated Fish Boxes / Ice Boxes							
Integration of traditional fishing operations into modern systems							
Supply of mechanized fishing boats and introduction of modern fishing vessels							
Explore the potential of promoting ornamental fishing including marketing and impacts on marine biodiversity							
Establishment of a small scale hatchery-cum-laboratory at Kadmath island for pearl oyster spat production and nucleus							

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs. in crore)	Departments	Time Frame
implantation							
Mariculture of Pearl Oysters and production of cultured pearls							
Undertake periodic extension activities and capacity building							
To conduct seminar / workshops on various topics for educating the public / voluntary organizations / Self Help Groups / Panchayat functionaries and the fishermen on resource utilisation, development, conservation, entrepreneurship development							

3.3.2.7 LAPCC and National Mission on Strategic Knowledge for Climate Change

This national mission envisages a broad-based effort that would include the following key themes. Table 3.3.7 shows how the action plan can be integrated with the national mission:

Table 3.3.7 Integrating Action Plan with National Mission for Strategic Knowledge

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs. in crore)	Departments	Time Frame
Set up Climate Change Monitoring Station	Nil	1	Continues	To understand the early warning signals of climate change	1.00	Ministry of Earth Science & Dept. of Science & Technology	
Create Data base on Coral reefs	2	5	Continues	Hold one International convention on coral reefs/year to create a data base	0.25	LCRMN, Dept. of Science & Technology and Dept. of Environment & Forest	
Transplantation of Coral Reef	1	10	Continues	Regeneration of Corals	0.10	LCRMN, Dept. of Science & Technology and Dept. of Environment & Forest	
Education & Training	Nil	10	Continues	Involving civil society in conservation	0.10	Dept. of Information & Publicity, Dept. of Environment & Forest, Dept. of Science & Technology and Dept. of Planning	
Reduce the use of fossil fuel in transportation	Nil	10	Continues	Involving user group from vehicle owners, boat owners, country	0.10	Dept. of Road Transport, Dept. of Fisheries and Dept. of Information & publicity	

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs. in crore)	Departments	Time Frame
				craft etc.			
Library on Climate change	Nil	1	Continues	Set ting up a climate change library with adequate reference, scientific papers, Journals, periodicals etc. for up to date information	0.50	Dept. of Environment & Forest and Dept. of Planning	
Awareness generation and education	Nil	10	Continues	Through Science Club & Eco-club in Educational Institutions on climate change issues.	0.50	Dept. of Education and Dept. of Planning	
Medical Waste	Nil	10		Collection, Handling and Disposal of Medical Waste		Directorate of Medical & Health, DP, VDP, Dept. of Environment & Forest and Reputed agencies.	
Conversion of Coconut pith to Bio – manure	Nil	100%		The waste from industries utilized as bio-manure for development of greenery in Island		Dept. of Industries, Dept. of science & Technology & Dept.of Finance	
Production of Paper bags	1	10		To produce biodegradable paper bags to eliminate the plastic cover and		Khadi & Village Industries, Dept. of Environment & Forest and Dept. of Science & Technology	

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs. in crore)	Departments	Time Frame
				anthropogenic stress in coral reef			
Electricity from Ocean Current	Nil	1		To minimize oil pollution generating electricity and pollution free electric generation		DOD, IIT, Dept. of Electricity & Dept. of Planning	
Energy Save Buildings	Nil	1		Study and set up a system for regulatory and Energy Bench marking for Government and other buildings		Dept. of PWD, Dept. of Electricity, Educational Institution etc.	
Restrict the use of fossil fuel in transportation	Nil	10		Involving user group from vehicle owners, boat owners, Country craft etc.		Dept. of Road Transport, Dept. of Fisheries and Dept. of Information & publicity	
Non-conventional energy promotion and Sustainable use	Nil	10		Awareness creation Involving VDP's, dignitaries, students, locals, officials etc.		Dept. of Electricity and Dept. of Information & Tourism	
High quality, low volume tourist	Nil	10		To protect national heritage, national integration and		Dept. of Tourism and Dept. of Planning	

Sub sector	Target 2012	Target 2016	Target 2025	Objective and strategy to be adopted	Cost (Rs. in crore)	Departments	Time Frame
promotion				preserve a sustainable environment giving adequate job opportunity to local stake holders			
Web Design on Island Climate Change	Nil	1		Exclusively make a web page in internet to publish the update data and success stories in Climate Change adaptation & mitigation		Dept. of Information Technology & Dept. of Environment & Forest	
Reclamation of land	Nil	10		The dredging sand utilized for reclamation of erosion area and new construction that help coral reef from destruction		Dept. of Harbour/ Dept. of Environment & Forest	

3.3.3 NAPCC-Other Relevant Areas of Significance for Lakshadweep

3.3.3.1 Disaster Management Response to Extreme Climate Events

With projected increases in the frequency and intensity of extreme events including cyclones, droughts, and floods attributable to climate change, disaster management needs greater attention. In the 11th Plan, the approach towards disaster management has moved from relief to prevention, mitigation, and preparedness. Two main planks of the new approach are mainstreaming disaster risk reduction into infra-structural project design and strengthening communication networks and disaster management facilities at all levels.

3.3.3.1.1 Reducing Risk to Infrastructure through Better Design

As a planned adaptation strategy, reducing risks from natural disasters needs to be a part of infra-structure project design, especially in areas vulnerable to extreme events. It is generally much cheaper to incorporate appropriate features in the initial design and construction of infrastructure projects, including siting, than to undertake retrofits later. The various elements of this Programme may include:

- Disaster-specific vulnerability assessments and sectoral impacts assessments at the state and district level for preparing contingency plans
- Maintenance of critical facilities such as health care services and water supplies
- Collaboration with insurance providers to insure infrastructure, mainstreaming disaster risk reduction into Sarva Shiksha Abhiyan, Jawaharlal Nehru National Urban Renewal Mission and Indira Awas Yojana
- Capacity building among design engineers, project planners and financial institutions on incorporating elements of disaster management
- Development of prefabricated structures instead of cast-in-place construction in vulnerable areas
- Enforcement of building codes; better urban planning and zoning of vulnerable areas

3.3.3.1.2 Strengthening Communication Networks and Disaster Management Facilities

Ensuring that communication channels are not severed during disasters can protect lives and expedite relief and rehabilitation operations. Furthermore, it is essential to have a regular monitoring programme in place to provide early warning of imminent disasters to facilitate a

planned response, including evacuation from vulnerable areas to minimize the impact of disasters. Specific action areas will include:

- Upgrading forecasting, tracking and early warning system for cyclones, floods, storms and tsunami
- Generation of regional scenarios based on single or multi-hazard mapping
- Disaster response training at the community level to build infrastructure and human resources for medical preparedness and emergency medical response to manage mass casualties during extreme events

3.3.3.2 Protection of Coastal Areas

The coastal areas are an important and critical region for India not only because of the vast 7500-km coast line but also because of the density of population and livelihoods dependant on coastal resources. Coastal zones are particularly vulnerable and sensitive to such impacts of climate change as rise in the sea level, rise in the high-tide level, and cyclones and storms, which are projected to become more frequent and intense. The programme will focus on two elements, namely (1) coastal protection and (2) early warning systems. Priority areas on coastal zones include:

- Development of a regional ocean modelling system especially in the Bay of Bengal and the Arabian Sea
- High-resolution coupled ocean–atmosphere variability studies in tropical oceans, in particular the Indian Ocean
- Development of a high-resolution storm surge model for coastal regions
- Development of salinity-tolerant crop cultivars
- Community awareness on coastal disasters and necessary action; plantation and regeneration of mangroves
- Timely forecasting, cyclone and flood warning systems
- Enhanced plantation and regeneration of mangroves and coastal forests

3.3.3.3 Health Sector

The proposed programme comprises two main components, namely provision of enhanced public health care services and assessment of increased burden of disease due to climate change. Areas that can contribute to enhanced health care services include the following:

- Providing high-resolution weather and climate data to study the regional pattern of disease
- Development of a high-resolution health impact model at the state level
- GIS mapping of access routes to health facilities in areas prone to climatic extremes
- Prioritization of geographic areas based on epidemiological data and the extent of vulnerability to adverse impacts of climate change
- Ecological study of air pollutants and pollen (as the triggers of asthma and respiratory diseases) and how they are affected by climate change
- Studies on the response of disease vectors to climate change
- Enhanced provision of primary, secondary, and tertiary health care facilities and implementation of public health measures, including vector control, sanitation, and clean drinking water supply

3.3.3.4 Creating Appropriate Capacity at Different Levels of Government

In view of several new initiatives that would be required, both in respect of adaptation and mitigation, creation of knowledge and suitable capacity at each level of Government to facilitate implementation of appropriate measures assumes great importance. At the level of the central government, there would be a need to carry out the following:

- There should be support to relevant policy research to ensure that adaptation and mitigation takes place in a manner that enhances human wellbeing, while at the same time minimizing societal costs. This should lead to the design of suitable legal, fiscal and regulatory measures.
- Appropriate capacity for implementing R&D activities and promoting large-scale public awareness and information dissemination on various aspects of climate change is required. For adequate R&D activities a proactive approach favouring partnerships between research organizations and industry would be efficient and productive.

At the level of state governments, several agencies would need to enlarge and redefine their goals and areas of operation.

- For instance, State Electricity Regulatory Commissions would need to concern themselves with regulatory decisions that ensure higher energy efficiency, greater use of renewable energy, and other low carbon activities that would ensure energy security, reduced local pollution, and increased access to energy in areas where distributed and decentralized forms of energy production would be economically superior to conven-

tional methods. State governments may also employ instruments to promote appropriate options and measures.

- Local bodies would need to create capacity on regulatory measures, particularly for ensuring energy efficiency in new buildings as well as through a programme of retrofits. In respect of adaptation measures, local capacity and the involvement of communities in actions to adapt to the impacts of climate change would be crucial.

Public awareness on climate change would have to be spearheaded and driven by government at all levels. Emphasis on schools and colleges is essential. In some cases legislation may be required at the central and state levels to arrive at appropriate delegation of responsibility and authority for meeting some of the goals mentioned above.

3.3.4 LAPCC and MGNREGA

MGNREGA aims at regenerating the environment through creation of productive assets such as water tanks, ponds, bunds, check dams and through afforestation programmes. The activities like afforestation (which also serves as a carbon sink), water conservation efforts including water and sanitation programmes, land and agriculture development, rural connectivity, flood control, and anti-erosion works (also including other relevant works) of NREGA will have a significant effect on food, water and livelihood security. This is expected to reduce climate change vulnerability of the UTL. Possibilities of integrating adaptive interventions identified in LAPCC in MGNREGA and other developmental programmes will be explored at the implementation stage.

Table 3.3.8 MGNREGA Interventions in Lakshadweep

Sector	Works under MGNREGA	Total Estimated Cost for Kavaratti (2010-2015)
Water Conservation	Digging of Pond Percolation of Well Rain Water Harvesting Tank Well Recharge Pit Chakirikkulam Husk Burial	549.32
Renovation of Traditional Water Bodies	Well Renovation Pond Renovation	106.50
Rural Connectivity	Link Road (km) Ring Road (km) Road Maintenance (km)	555.60

Sector	Works under MGNREGA	Total Estimated Cost for Kavaratti (2010-2015)
Flood Control	Anti-Sea Erosion Work (km) Maintenance of Anti sea erosion work (km) Sea Shore Plantation (ha) Sea Mouth Cleaning (meter)	44.26
Land Development	Coconut Seedling Coconut Pathy Centri Pital Terracing Coconut Compost Pit Coconut Trench Compost Pit Waste Pit Coir Pit Compost Fish Waste Compost Horticulture (ha) Bio Fencing (m) Land Development and Island Cleaning (ha) Road side Plantation (ha) Clearing Bushed (ha) Soil Up Filling (ha) Land Levelling Work in Schools (ha) Tree Plantation (ha) Vegetable Garden (ha)	167.81
Other Works	Septic Tank Public Toilet and Urinal Coconut Climbing Mosquito Control (days) Param Maintenance Compound Wall (School and public place) (km) Cycle Shed - School Kitchen Repair and New Kitchen Auditorium , New Hall and Buildings & Repair La	211.68

3.3.5 Summary of Sectoral Targets and Budgetary Requirement under LAPCC

Table 3.3.9 Summary of Sectoral Targets and Budgetary Requirement under LAPCC (2012-2025)

Sector	Target Period	Annual Budgetary Outlay (Rs. in lakhs)	Adaptation Cost (Annual) (Rs. in lakhs)
Fisheries		1125	
Crop and Animal Husbandry		1680	
Science, Technology Environment (Scientific Research, IT, Ecology and Environment, Forestry and Wildlife		4570	
Water Supply and Sanitation		2290	
Health		1430	
Energy			
• Power		2360	
• Non-Conventional Source of Energy		566	
Transport and Infrastructure		16662	
Coastal Zone Management Anti Erosion Works			
• Flood control/management		400	
• Shoreline protection			
Tourism		500	
Rural Development		120	
Industry (SSI)		300	

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Annexures

Annexure I Laws and Regulations for Conserving Natural Resources in Lakshadweep

- Laccadive Islands and Minicoy Regulation Act (1959)
- The Laccadive, Minicoy and Amindivi Islands Land Revenue and Tenancy Regulation (1965)
- The Laccadive, Minicoy and Amindivi Islands Land Revenue and Tenancy Rules (1969)
- The Wildlife (Protection) Act, 1972
- The Wildlife (Transactions and Taxidermy) and Lakshadweep Wildlife (Stock Declaration) Rules (1973)
- Survey and Boundary Regulations Supplementary Rules (1979)
- Environment Protection Act (EPA) Act, 1986
- The Coastal Zone Regulation Rules (1991)
- Notification of Administrator Preventing Extraction of Sea Cucumbers (1994)
- Notification from Minicoy Information and Publicity Unit Preventing Killing of Migrant Birds (1994-95)
- The Coastal Zone Management Plan for the U.T. of Lakshadweep (1996)
- Notification Preventing Killing of Dolphins and Whales
- The Lakshadweep Protection of Corals, Bye Laws (1998)
- The Lakshadweep Protection of Corals (Amendments) Bye Laws (1998)
- The Lakshadweep Sanitation Conservancy Bye Laws (1998)
- The Lakshadweep Marine Fishing Regulation (2000)
- The Lakshadweep Marine Fishing Regulation and Rules (2001)
- Notification (Amendment) to Wildlife (Protection) Act 1972 (2001)
- Coastal Regulation Zone (CRZ) Notification 2011
- Indian Fisheries Act 1897,
- Indian Ports Act 1902,
- Merchant Shipping Act 1974,
- Wildlife (Protection) Act (WPA) 1972,
- Water (Prevention and Control of Pollution) Act 1974
- Air (Prevention and Control of Pollution) Act 1981,
- Indian Coast Guards Act 1974,
- Maritime Zones of India (Regulation of Fishing by Foreign Vessels) Act 1981,
- National Environment Tribunal Act 1995,
- Hazardous Wastes (Management and Handling) Rules 1989

Annexure II Special Laws and Regulations in Lakshadweep Islands

TWO SPECIAL LAWS EXIST SPECIALLY FOR LAKSHADWEEP

1. The Lakshadweep Prohibition Regulation 1979
2. LM&A islands (Restriction on Entry and Residence) Rules, 1967

THE LAKSHADWEEP PROHIBITION REGULATION 1979

1. Lakshadweep Prohibition Regulation 1979 extends to whole of the Union Territory. As per the Section 3 of the Regulation import, export, transportation, possession and manufacture of liquor or any intoxicating drugs is prohibited in all the islands. Being an international Tourist center, Bangaram is exempted.
2. All the offence under the Regulation are cognizable and the provisions of the Code of Criminal Procedure, 1973, with respect to cognizable offences shall apply to them.
3. Violation of the provisions of the Regulation shall be punishable with imprisonment for a term, which may extent to one year or with fine, which may extent two thousand rupees, or with both.

LM&A ISLANDS (RESTRICTION ON ENTRY AND RESIDENCE) RULES, 1967

1. As per the Rules no person who is not a native of the island shall enter or reside in or attempt to enter or reside in the island except under and in accordance with a permit issued by a competent authority.
2. Provided that no such a permit shall be necessary in the case of the following classes of persons namely:-

(a) Persons who had taken up permanent residence in the islands at any time before the commencement of these rules and members of the families of such persons.
(b) Members of Armed Forces of the Indian Union entering the islands on duty.
(c) Persons serving in connection with the administration of the islands proceeding to the islands on official duty and members of their families.

3) Every permit issued on an application under Rule 5 may be renewed or endorsed on an application made in the prescribed form and submitted through the nearest registration officer at least 15 days in advance of the date on which the permit is due to expire, or the date with effect from which such endorsement required. An application for renewal or endorsement of a permit shall be accompanied by the permit in respect of which the application is made.

4) The holder of a permit shall not enter or leave an island otherwise than at such a port as may be specified therein.

5) A permit shall be valid only for the island or islands endorsed thereon and the holders thereof shall not enter or attempt to enter any other islands or islands without getting the permit endorsed for such other island or islands.

6) The holder of a permit shall, as soon as possible and in any case within 24 hours after his arrival in any island, report with his permit to the nearest Registration Officer (Station House Officer) who shall enter in the permit the date and time of arrival of the holder in the island.

7) Whenever during the period of validity of a permit the holder thereof leaves the island, he shall present his permit to the nearest Registration Officer who shall make an entry therein regarding the date and time of departure of the holder and return the permit to the holder.

8) Separate form is prescribed for Indian Tourist intending to visit the islands. They should obtain a permit exemption order. Foreign Tourists are also issued with entry permit Rules after approval by the Ministry of Home Affairs, Government of India.

Source: http://lakshadweep.nic.in/depts/police/Statutory%20Provisions.htm

Annexure III Profile of Class Structure- Lakshadweep

Koyas

The Koyas were the chief land owning class of the society. Formerly they were known as Tarawadis or the Karnavar class. Originally, the class consisted of the Principal families of Tarwads known as Karnavans who sat as jurors in the community Panchayats. They regarded themselves superior to others and hated alliance with others. In earlier days, the Karnavans were the real masters of the land.

Malmis

The Malmis are the sailors. The word Malmi is connected with the signs of ways. In the past the Malmis were the tenants of the Koyas and they served as sailors under them and exported their produce in the odam. Piloting of vessels is not the only privilege of this class and anybody who acquired mastery over the nautical table is as competent as a successful Malmi.

Melacheris

The Melacheris were the original labour class of the islands and formed the major part of the population of Amini of the Laccadive Group of islands. The people of Kadmat, Kiltan, Chetlat and Bitra are all Melacheris who have migrated from Amini and from the coast. Their traditional occupation is to collect coconut tree nuts and tap neerah, the sweet toddy. It appears that the name has its origin in their traditional place of residence on the western side of the island. Mala means West, Cheri denotes a village.

Among the class system of Minicoy, the Manikfans are considered to be of the highest class. They alone owned private property and were the leisured class. The Thakrufans were the sailors who mainly piloted sailing vessels. Takrus worked in the boats during voyages while the Raveris were the Labourers. Women of the four classes are known as Manikka, Beefan, Beebee and Kambilo respectively. In between Thakrufan and Thakru , there is a sub-caste known as Bebe.

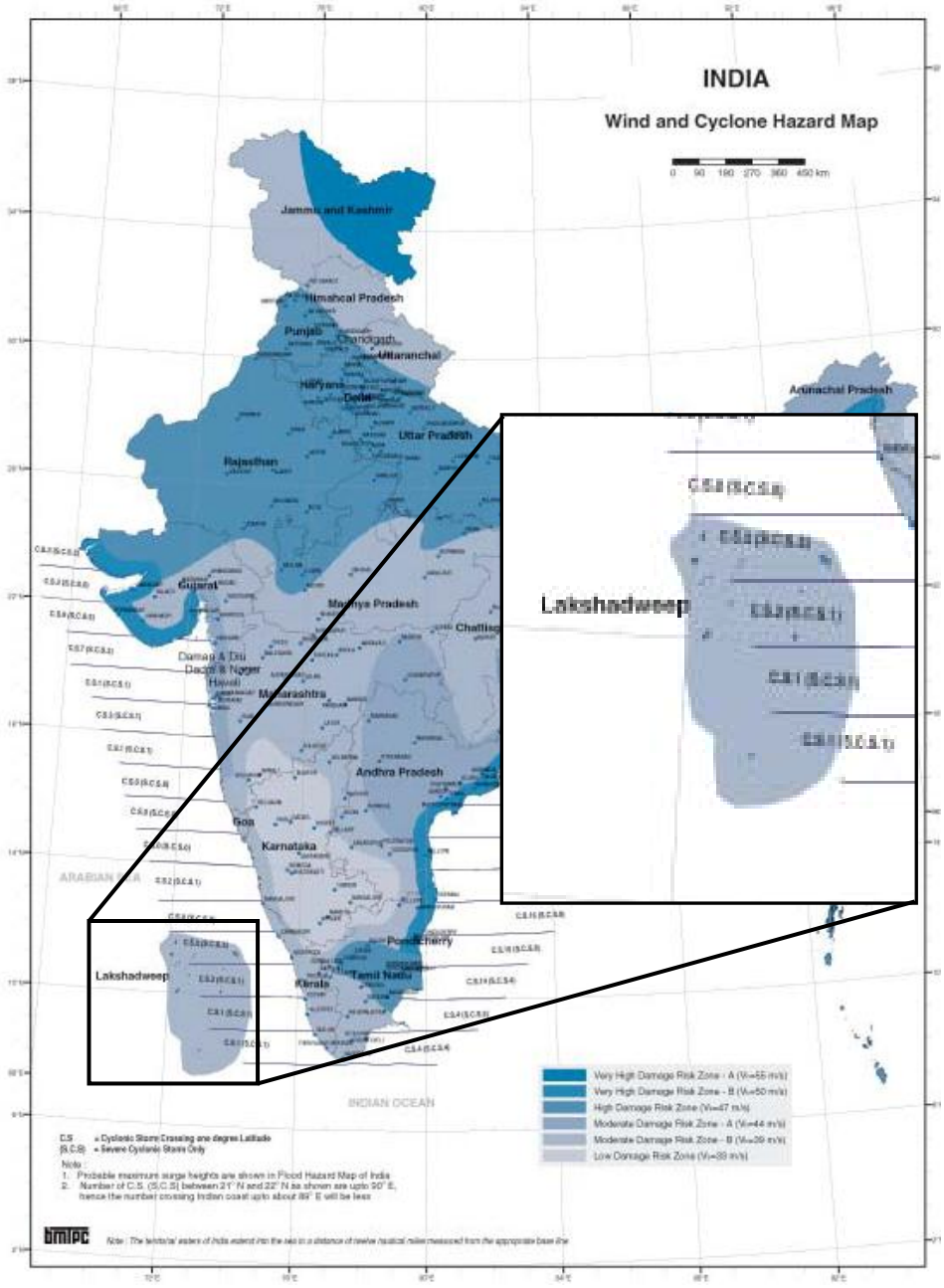
In Amini, the class groupism appears to have been based on property. The tarwad class comprised a few families which alone had tenants in the days of early settlement. The Tanakampranavar were those possessing property of their own but with no tenants under them. The Kudiyatis were the tenant class. The Melacheris were originally the landless Labourers.

Annexure IV Basic Amenities and Infrastructure in Lakshadweep

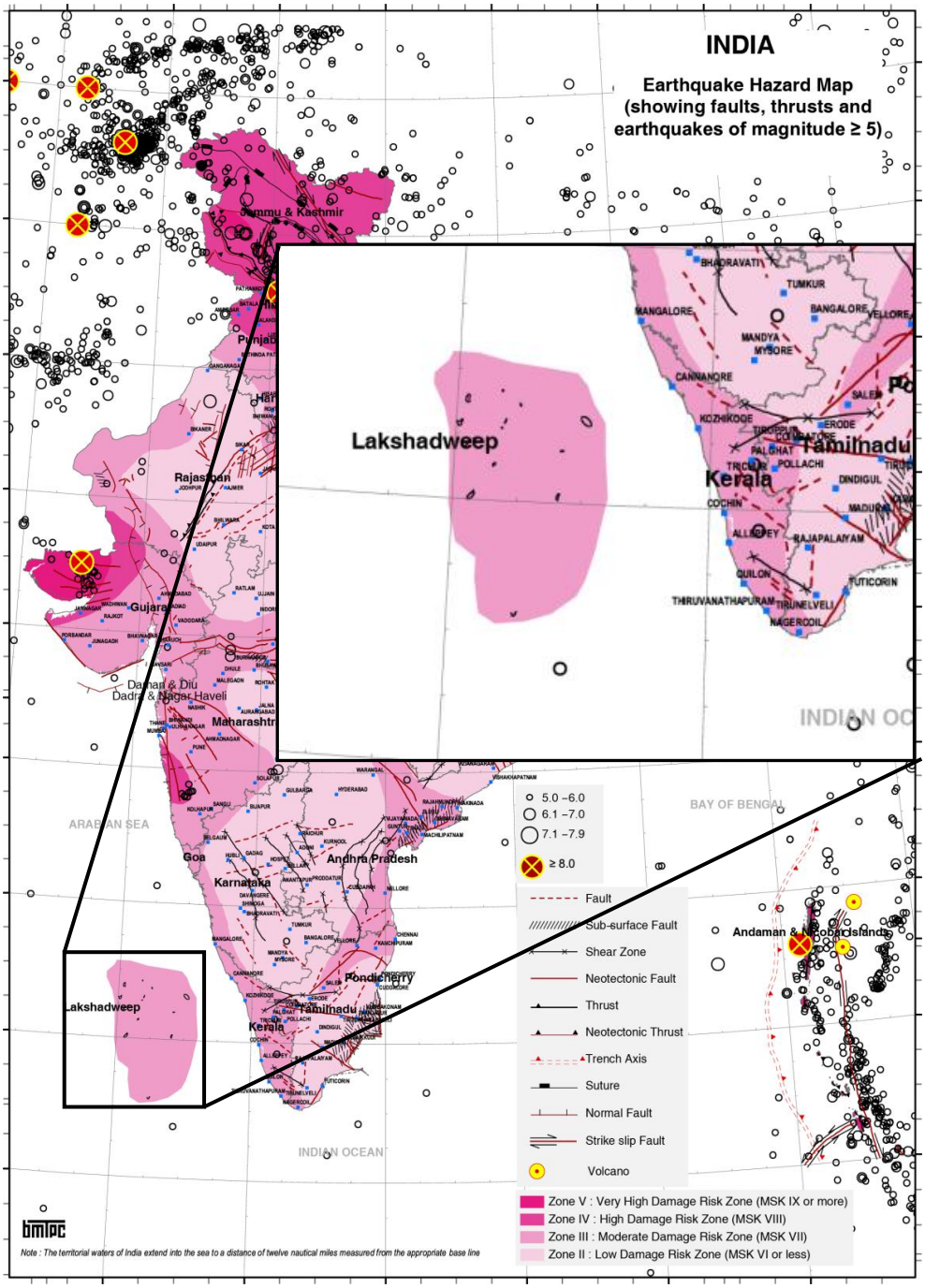
Amenities / Infrastructure	Unit	Kavaratti	Andrott	Amini	Kiltan	Minicoy	Total
Pond (2009)	Number	340 (31.86%)	340 (31.86%)	173 (16.21%)	160 (15%)	54 (5.07%)	1067 (100%)
Well (2009)	Number	2973 (26.61%)	3557 (31.84%)	2521 (22.56%)	1372 (12.28%)	750 (6.71%)	11173 (100%)
PWD Road (2009) - Km	Kilometer	36.36 (22.61%)	45.02 (27.99%)	41.80 (25.99%)	11.49 (7.15%)	26.15 (16.26%)	160.82 (100%)
Lower Primary School (2009)	Number	3 (23.08%)	3 (23.08%)	3 (23.08%)	3 (23.08%)	1 (7.68%)	13 (100%)
Upper Primary School (2009)	Number	3 (25%)	3 (25%)	3 (25%)	2 (16.67%)	1 (8.33%)	12 (100%)
High School	Number	1 (16.67%)	4 (66.67%)	1 (16.66%)	0 (0%)	0 (0%)	6 (100%)
Higher Secondary School (2009)	Number	3 (30%)	2 (20%)	2 (20%)	2 (20%)	1 (10%)	10 (100%)
Anganwadi (2009)	Number	24 (27.59%)	21 (24.14%)	18 (20.69%)	10 (11.49%)	14 (16.09%)	87 (100%)
Krishi Bhawan (2009)	Number	2 (22.22%)	2 (22.22%)	2 (22.22%)	2 (22.22%)	1 (11.12%)	9 (100%)
Veterinary Hospital (2009)	Number	2 (22.22%)	2 (22.22%)	2 (22.22%)	2 (22.22%)	1 (11.12%)	9 (100%)
Primary Health Centre (2009)	Number	2 (22.22%)	2 (22.22%)	2 (22.22%)	2 (22.22%0	1 (11.12%)	9 (100%)
Sub Centre (2009)	Number	1 (12.5%)	2 (25%)	3 (37.5%)	1 (12.5%)	1 (12.5%)	8 (100%)
First Aid Centre (2009)	Number	0(0%)	0(0%)	0(0%)	1 (100%)	0(0%)	1 (100%)
Library (2009)	Number	2 (20%)	2 (20%)	2 (20%)	3 (30%)	1 (10%)	10 (100%)
Rain Water Harvesting Tank (2009)	Number	355 (39.05%)	61 (6.72%)	103 (`11.33%)	160 (17.60%)	230 (25.30%)	909 (100%)
Post Office (2002)	Number	2 (20%)	2 (20%)	2 (20%)	3 (30%)	1 (10%)	10 (100%)
Power Generation (2006-07)	Kwh	9326.55 (33.34%)	6010.32 (21.49%)	4973.8 (17.78%)	2140.1 (7.65%)	5521.68 (19.74%)	27972.43 (100%)
Power Consumption - Domestic (2006-07)	Kwh	4617.82 (27.06%)	4136.31 (24.24%)	2955.9 (17.32%)	1413.2 (8.29%)	3941.01 (23.09%)	17064.24 (100%)
Power Consumption – Commercial (2006-07)	Kwh	2424.88 (46.44%)	889.4 (17.03%)	713.79 (13.67%)	429.13 (8.23%)	764.01 (14.63%)	5221.21 (100%)
Power Consumption – Industrial (2006-07)	Kwh	104.43 (26.72%)	61.03 (15.61%)	70.97 (18.16%)	17.97 (4.60%)	136.46 (34.91%)	390.86 (100%)
Power Connections – Domestic (2006-07)	Number	4968 (29.91%)	4083 (24.59%)	3538 (21.30%)	2027 (12.20%)	1991 (12%)	16607 (100%)
Power Connections – Commercial (2006-07)	Number	1008 (30.17%)	869 (26.01%)	606 (18.14%)	438 (13.11%)	420 (12.57%)	3341 (100%)
Power Connections – Industrial (2006-07)	Number	70 (24.82%)	78 (27.66%)	68 (24.11%)	29 (10.29%)	37 (13.12%)	282 (100%)
Telephone Connections (2007)	Number	2622 (30.24%)	2178 (25.12%)	1617 (18.65%)	918 (10.59%)	1336 (15.40%)	8671 (100%)

Vulnerability Maps

Annexure V Vulnerability Map: Wind and Cyclone

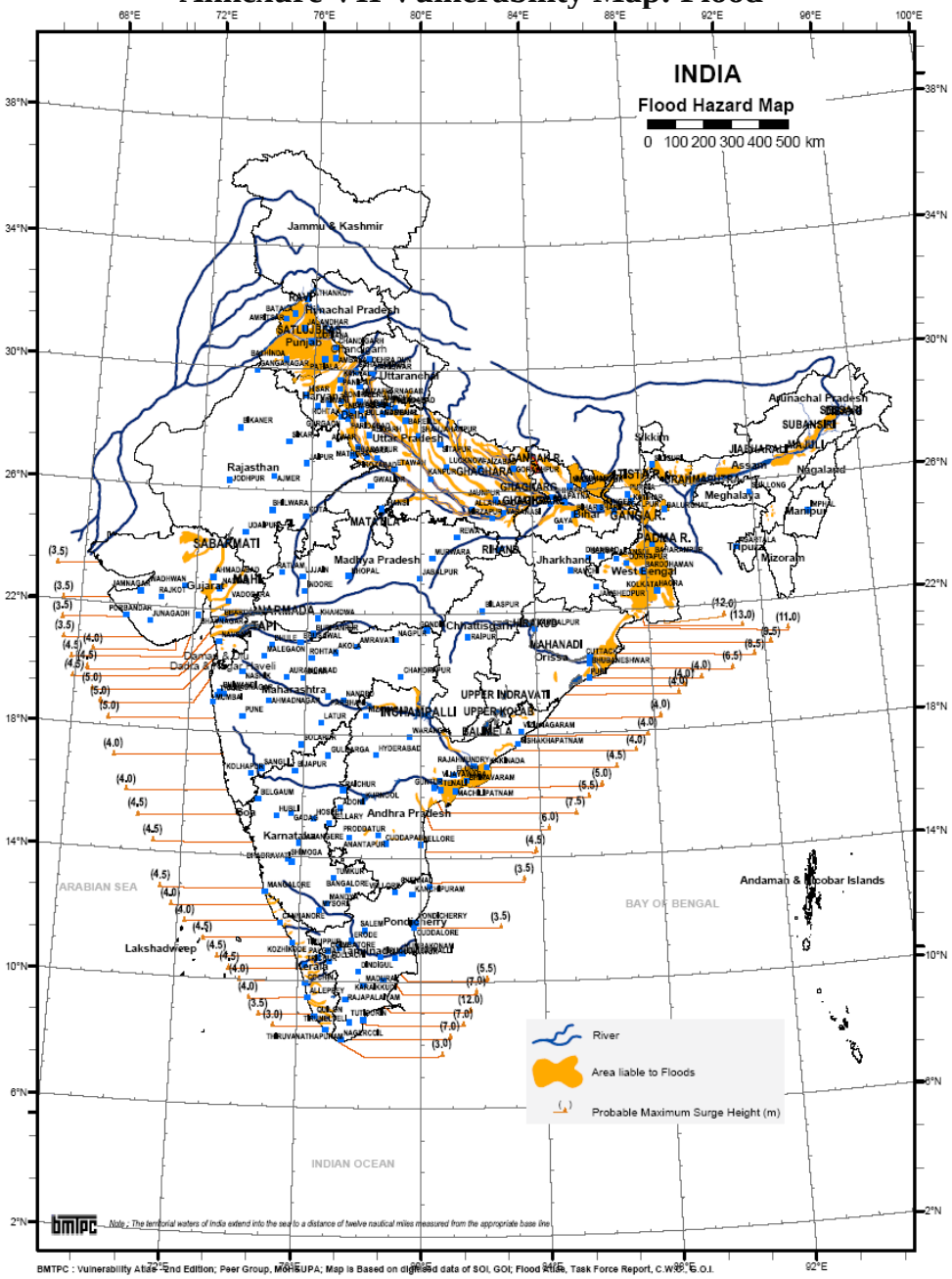


Annexure VI Vulnerability Map: Earthquake



Source: BMTPC

Annexure VII Vulnerability Map: Flood



Source: BMTPC

Annexure VIII Details of Centrally Sponsored/Central Sector Schemes

DETAILS OF CENTRALLY SPONSORED/ CENTRAL SECTOR SCHEMES WITH IMPLEMENTING DEPARTMENTS				
				(Rs. in Lakhs)
S. No.	Name of the Scheme	2007-08 Outlay	2008-09 Outlay	2009-10 Outlay
I. Agriculture				
1	Coconut Development Board	20.57	25.25	
2	Macro Management	15.00	6.00	31.00
3	National Horticulture Mission	29.90		
4	RashtriyaKrishiVigasYojana		47.00	132.00
5	Agricultural Census	10.60	12.75	17.50
	Sector Total	**76.07**	**91.00**	**180.50**
II. Animal Husbandry				
1	Integrated Sample Survey for Estimation of Production of Major Livestock Products	6.69	9.24	27.60
2	Conducting of 18th Livestock Census	6.00	1.00	
3	Assistance to States for Control of Animal Disease (ASCAD)	8.00	5.00	
4	Foot and Mouth Disease Control Programme (FMD)	1.00	1.00	
5	National Project on Reinterprets Eradication (NPRE)	1.00		
6	Assistance for States Poultry/ Duck Farm			
7	Rashtriya Krishi Vigas Yojana			300.00
	Sector Total	**22.69**	**16.24**	**327.60**
III. Fisheries				
1	Development of Marine Fisheries, Infrastructure and Post-Harvest Operations - Development of Marine Fisheries - (a) Motorization of traditional crafts	17.60		12.60
2	(b) Safety of Fishermen at sea			74.70
3	(c) Fishermen Development Rebate on HSD Oil	20.25		23.06

4	Group Accident Insurance for Active Fishermen			
5	Rashtriya Krishi Vigas Yojana			400.00
Sector Total		**37.85**	**0.00**	**510.36**
IV. Cooperation				
1	RashtriyaKrishiVigasYojana			200.00
Sector Total		**0.00**	**0.00**	**200.00**
V. Panchayat				
1	Rastriya Gram Swaraj Yojana			
2	Panchayat Empowerment Incentive Scheme			
Sector Total		**0.00**	**0.00**	**0.00**
VI. Rural Development				
1	SGSY	38.06	24.03	
2	SGRY	82.73		
3	NREGA		491.50	1531.30
4	IAY	34.73	51.52	
5	NSAP (a) NOAPs	1.20	1.72	
6	NSAP (b) NFBS	1.59	2.19	
Sector Total		**158.31**	**570.96**	**1531.30**
VII. Lakshadweep PWD				
Nil				
VIII. Electricity				
NIL				
IX. New & Renewable Energy				
1	Installation of Solar Fish Drier		4.32	1.08
2	Distribution of Solar Lanterns		11.33	11.33
3	Observance of Rajiv Gandhi Akshay Ujra Diwas	1.70	0.70	
Sector Total		**1.70**	**16.35**	**12.41**

X. Industries				
1	Prime Minister's Employment Generation Programme			
	Sector Total	**0.00**	**0.00**	**0.00**
XI.Port, Shipping & Aviation				
XII. Road Transport				
	NIL			
XIII. Science & Technology				
1	Conservation and Management of Coral Reef in Lakshadweep funding by MoEF		10.00	
	Sector Total	**0.00**	**10.00**	**0.00**
XIV. Information Technology				
1	Capacity Building		182.00	
2	State Data Centre		472.00	
3	State Wide Area Network			
4	State Portal and State Service Delivery Gateway			
5	Common Service Centre			
	Sector Total	**0.00**	**654.00**	**0.00**
XV. Environment &Forest				
1	Central Sponsored Scheme on Medicinal Plants	10.36	9.91	10.00
	Sector Total	**10.36**	**9.91**	**10.00**
XVI. Planning & Statistics				
1	Urban Statistics for HR to Assessments (USHA) Centre Sector		10.00	
2	Study/ Survey of NPI (Plan Scheme)		2.34	
3	Basic Statistics for Local Level Development (BSLLD)		0.50	
4	Arrangement of Retail Data Price Collection for CPI (Urban)		1.10	
5	PMGSY			
6	MPLADS	441.54	698.61	

	Sector Total	**441.54**	**712.55**	**0.00**
XVII. Tourism Development				
1	Augmentation of Tourist Infrastructure	782.73		
	Sector Total	**782.73**	**0.00**	**0.00**
XVIII. Food & Civil Supplies				
	NIL			
XIX. Legal Metrology				
	NIL			
XX. Education				
1	DIET Education	19.03	0.00	97.00
2	Surva Shiksha Abiyan (SSA)	235.17	347.27	344.52
3	Mid-Day Meals Scheme		39.13	44.98
4	CIC VV Project		8.56	7.20
	Sector Total	**254.20**	**394.96**	**493.70**
XXI. Sports & Youth Services				
	Nil			
XXII. Art & Culture				
	NIL			
XXIII. Medical & Health Services				
1	RCH Flexible pool	46.80	52.61	149.71
2	Additionality under NRHM	109.47	123.16	164.25
3	Strengthening of Routine Immunization	2.94	3.19	6.20
4	National Programme for Control of Blindness(NPCB)	12.00	6.65	18.64
5	National Leprosy Eradication Programme(NLEP)	0.00	0.00	29.85
6	Family Welfare Programme(2211)	54.00	64.35	87.02
7	National Iodine Deficiency Disorders	0.00	9.92	35.00
8	Lakshadweep AIDS Control Society	48.07	34.86	35.49
9	National Vector Borne Diseases Control Programme	2.80	0.00	25.00
10	Integrated Diseases Control Programme	0.00	0.00	16.00

11	RNTCP	18.45	11.60	24.83
	Sector Total	**294.53**	**306.34**	**591.99**
XXIV. Information & Public Relations				
	NIL			
XXV. Employment & Training				
	NIL			
XXVI. Social Welfare & Tribal Affairs				
1	National Programme for Persons with Disability (NPRPD)			
2	NSAP - Grant-in-aid to DRCS and DRDA	2.50	4.50	4.50
	Sector Total	**2.50**	**4.50**	**4.50**
XXVII. Women & Child Development				
1	ICDS (General)	65.58	84.36	379.92
2	SNP	16.66	32.98	12.45
3	Kishari Shakti Yojana		1.10	1.10
	Sector Total	**82.24**	**118.44**	**393.47**
XXVIII. Printing & Stationery				
	NIL			
XXIX. Police				
1	Police Modernization Scheme	3.30	3.30	3.28
2	Costal Security Scheme	0.61	0.75	0.00
	Sector Total	**3.91**	**4.05**	**3.28**
XXX. Lakshadweep Development Corporation Limited				
1	Assistance to States for Developing Export Infrastructure and other Allied Activities (ASIDE)			
	Sector Total	**0.00**	**0.00**	**0.00**
	Grand Total	**2168.63**	**2909.30**	**4259.11**

Additional Information

Annexure IX Baseline Scenario of Lakshadweep

Geophysical Profile

Islands Clusters: Geographic Location and Lagoon Area

The islands in Lakshadweep are considered to be geologically young. The Lakshadweep archipelago is formed by two main groups of islands, one to the north and the other to the south of the 10^0 N parallel; the two groups are separated by the 9 Degree Channel, which was a well-known route between the west coast of India and the Arabic peninsula.[141] There are eleven inhabited islands; these are Kavaratti, Agatti, Amini, Androth, Kiltan, Kalpeni, Kadmat, Chetlat, Bitra, Minicoy and Bangaram. Administratively, it is a single district with Kavaratti as the capital. The biggest of the islands is about 5 sq.km in extent (Androtti) and the smallest is less than one sq.km (Bitra). Bitra is also the northern most atolls. Minicoy atoll is the southernmost, separated from the northern group of islands, by the 9 Degree channel, about 180 km in width, and from the neighbouring Maldives in the south by an 8 Degree Channel of about 120 km. Other islands are small and exist as satellites of the inhabited islands. There are 17 uninhabited islands located in the close vicinity of the inhabited islands. They are namely: Pitti (Birds Island), Viringili, Cheriyam, Kodithala, Tilakkam (i), Thilakkam (ii), Thilakkam (iii), Pitti (i), Pitti (ii), Bangaram, Thinnakara, Parali(i), Parali (ii), Parali (iii), Kalpitti, Suheli Valiya Kara, Suheli Cheriya Kara. Among the uninhabited islands, Suheli is a coconut growing and fishing centre. Pitti or the Bird Island is small reef with sand bank covering an area of 1.2 hectare lying northwest of Kavaratti where terns in thousands visit for nesting and is designated as a bird sanctuary.[142]The details of geographical locations and lagoon area of the various islands are presented in Table 3.3.3. The aerial views of the islands are presented in Figure 3.3.1.

[141]Luiz Drude de Lacerda. 2002. *Mangrove ecosystems: function and management*. Springer. p.292

[142]CMFRI, Kochi (2006) LAKFISHIntegrated perspective plan for fisheries development of Lakshadweep. Technical Report. Central Marine Fisheries Research Institute, Kochi.

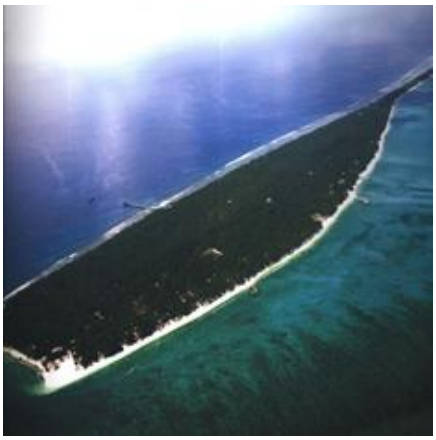
Table 0.1 The Geographic Locations and Lagoon Area of the Inhabited Islands in the UTL

S. No	Name of Island	Area sq.km	Lagoon area sq.km	Geographic Location	Length and Width (km)	Distance to Mainland
1.	Agatti	3.84	17.50	Lat.10°51' N; Long.72°11' E	Maximum length of 10 km and width of 1 km. It has a north-east, south-west trend with a long tail on the south.	459 km (248 nautical miles) from Kochi and is located at the west of Kavaratti Island
2.	Amini	2.60	1.50	Lat.11°07' N; Long.72°44' E	A width of 1.20 km at the broadest point and a length of 2.70 km. This island has an oval/oblong shape.	407 km (220 nautical miles) from Kochi and located between Kavaratti Island in the south and Kadmat Island in the north.
3.	Androth	4.90	-	Lat.10°49' N; Long.73°41' E	Largest island with a length of 4.66 km and a maximum width of 1.43 km. It is the nearest island to the mainland and has an east-west orientation unlike other islands lying in the north-south direction.	It is 119 km (64 nautical miles) away from Kavaratti and 293 km (158 nautical miles) away from Kochi. This is the only island that is having a very small lagoon area.
4.	Bitra	0.10	45.61	Lat.11°36' N; Long.72°10' E	Smallest inhabited island in the territory having a land area of 0.105 sq. km. It has a length of 0.57 km and a width of 0.28 km at the broadest point.	This is at a distance of 483 km (261 nautical miles) from Kochi.
5.	Chetlat	1.40	1.60	Lat.11°41' N; Long.72°43' E		56 km on the north of the Amini and 432 km (233 nautical miles) away from Kochi.
6.	Kadmat	3.20	37.50	Lat.11°13' N; Long.73°39' E	Long and narrow island. It is only 0.57 km wide at the broadest point having maximum length of 11 km.	This island is at a distance of 407 km (220 nautical mil from Kochi and located between Amini Island in the south and Chetlat Island in the north.
7.	Kalpeni	2.79	25.60	Lat.10°05' N;	It has a very large lagoon measuring about 2.8 km at the point of maximum	The Island is located at a distance of 287 km (155 nautical miles) from Kochi

				Long.72°11' E	width. The Island is aligned in the north-south direction.	and located south-east of Kavaratti Island and midway between Androtт and Minicoy.
8.	Kavaratti	4.22	4.96	Lat.10°33' N; Long.72°38' E	Maximum length of the island is 5.8 km and width is 1.6 km	This island is at a distance of 404 km (218 nautical miles) from Kochi and is located between Agatti Island on the west and Androtт Island on the east.
9.	Kiltan	2.20	1.76	Lat.11°29' N; Long.73°04' E	It has 3.4 km length and 0.6 km width at the broadest point. It lies 51 km north-east of Amini on the international trade route between the Persian Gulf and Sri Lanka. On the northern and southern ends of the island, there are high storm beaches.	This island is 394 km (213 nautical miles) away from Kochi.
10.	Minicoy	4.80	30.60	Lat.8°17' N; Long.73°04' E	Second largest island which is about 2 m above the mean sea level on the western side and about 3 to 4 m on the eastern side, and is 11 km long This island lies near the 9 Degree Channel, which is one of the busiest shipping routes and is about 130 km from the northern-most island of Maldives.	Southern-most island of Lakshadweep, situated at a distance of 398 km (215 nautical miles) south-west of Kochi.
11.	Bangaram	0.58	60	Lat.10°56'N Long.72°17' E		Located 459 kms, from Cochin

Source: CMFRI, 2006, http://lakshadweep.nic.in

Agatti Island



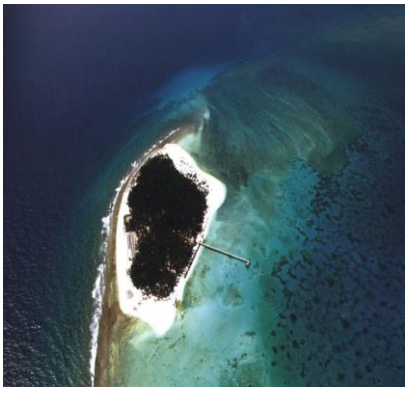
Kavaratti Island

Andrott Island

Kadmath Island

Kalpeni Island

Bitra Island

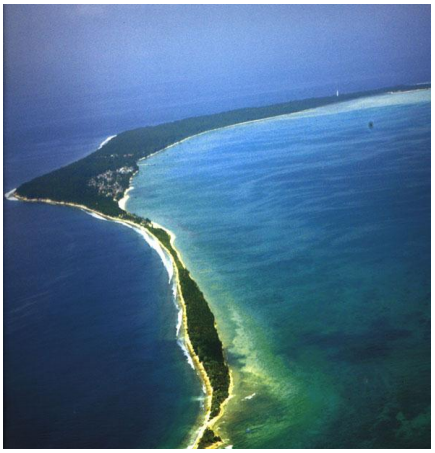


Kiltan Island

Chetlat Island

Amini Island

Minicoy Island



Bangaram Island

PItty Island

Figure 0.1 Aerial View of the Major Islands

Natural Wetlands

Coral reefs

Corals are the most dominating of the three wetland types and accounts for 55179 ha of area that amounts to 69 % of wetland area in Lakshadweep. In every coral-growing area and in particularly in oceanic coral reefs two diametrically opposed processes are continuously in operation. One is constructive depending on the growth of coral and associated plants such as Nullipore. Other is the geological formation of conglomerate rocks and sandstones from the coral or other calcareous debris, which is destructive to the activities of animals that feed upon coral or animals and plants that bore into coral and so render it less solid and more liable for destruction due to erosion by waves and currents, and change in temperature and salinity etc.[143]. Coral reefs are of three types namely; fringing reefs, barrier reef and atolls. The coral reefs of the Lakshadweep islands are mainly atolls except one platform reef of Androth. The Lakshadweep atoll coral reefs are mainly oceanic and without association with land. The UTL is the only atoll coral island chain in India and the Lakshadweep archipelago comprises of the most extensive coral reef and atoll system in the Indian Ocean as well as the largest atoll system in the world. Atolls consist of ribbons of reef that may not always be circular but whose broad configuration is a closed shape up to dozens of kilometres across, enclosing a lagoon that may be approximately 50 m (160 feet) deep or more[144], as shown in Figure 0.2. Each island is fringed by coral sands, and is marked by huge, shallow, calm lagoon on the western side that separates it from incoming swells of the outer sea by the wall of a reef made up of massive coral boulders and live corals. Estimated total coral reef area in these islands is 276 km^2 including the reef flat area of 136.5 km^2.[145] As coral reefs tend to be positioned perpendicularly to the mean direction of wind generated swell currents flowing over the reefs, they can weaken the incoming waves, thereby minimising erosion and costal hazards behind the reefs.

[143]Sewell, R. and Seymour, B. 1935. Geographical and oceanographic research in Indian waters. Daya Publishing House, New Delhi.

[144]http://www.britannica.com/EBchecked/topic/41543/ accessed on 4March 2012

[145]Bahuguna, A and Nayak S.1998.Remote sensingapplications for monitoring coralreefs. Proceedings ofthe symposium on status and protection of coral reefs,March 11 – 13, Kadmat Island, U.T. of Lakshadweep.Pp. 17–19

Figure 0.2 Coral Atoll (Agatti Island)
Source: Google images

Lagoons[146]

Lagoons may be formed by estuary outlets and delta channels completely blocked by sandbars, sand spits or sand dunes which limit access to sea. Nevertheless, as a rule, lagoon will have mixing of freshwater brought by rivers and saltwater due to its access to sea. These results in complex environment wherein diversity of organisms range from freshwater type to marine through another group of organisms those show adaptability to both. However, in Lakshadweep the lagoons are very different from the mainland in the sense that they are actually coral reef lagoons wherein the water body gets enclosed in an atoll or within a barrier reef. The depth of the lagoon is appreciable and available literature indicates that the floor of these lagoons mainly contain the coral debris and calcareous sand[147,148]. The smaller lagoons of Chetlat, Kiltan, Amini and Kadmat are substantially filled with sediments and show an average depth of 1 – 2.5 m while the larger ones like Bangaram, Suheli Par and Minicoy are devoid of sediments and show greater depth ranging from 10-16 m. Lagoon stands next to coral comprising 23674 ha of area. It

[146] Op.Cit, NWIA, 2011
[147] Gazetter of India-Union territory of Lakshadweep. 1997. N.S. Manndiar (Ed.), Administration of Union Territory of Lakshadweep.
[148] Anon. 1987. Land use pattern in Lakshadweep. Report of Expert Group constituted by Chairman of the Steering Committee of Island Development Authority.

accounts for 30 % of wetland area followed by Sand/Beach (733 ha). The lagoons are the only category considered for open water spread in pre-monsoon and post-monsoon. The open water spread (23674 ha) of lagoons remained unchanged in both the seasons owing to their contact with the sea, which allows movement water perpetually. The qualitative turbidity remained low in both seasons indicating the tranquillity of lagoons on these islands. Further, the absence of aquatic vegetation adds to the clarity of water.

Sand/Beach

Sand/Beach accounts for one percent of wetland area comprising 733 ha out of 79587 ha. The Sand/Beach shows the presence of terrestrial vegetation. This category under Sand/Beach is essentially a sandy beach. In Lakshadweep these sandy beaches are characteristically located on windward side. On the other sides the sandy beaches experience the vagaries of monsoon. These beaches comprise vegetation mainly *Ipomea batatas*, *Ipomea pescaprae*, *Cochorus aestuans*, *Eragrostis tenella*, *Digitaria adscandes*, *Dactyloctenium aegyptium* and *Casurina equselifolia*.

Edaphic Conditions

The formation of Lakshadweep soil is from fragmentation of coral lime stones and sedimentary rocks. It is formed by sediments deposited by water and wind which are consolidated into rocks by weight of the overlying deposits. Later by fragmentation of the lime stones and sedimentary rocks fine soil is accumulated. The soil in the interior tract of the island generally is ash coloured for the reason that from the remnants of the plants and animals, inorganic and organic acids are formed which in turn bring about profound influence on rapid weathering and changes the white colour of the soil. The coral atolls have two important mineral deposits— the phosphate deposits (guano) in the islands and the calcium carbonate in the lagoons. The soils are geologically very young and rich in calcium carbonates of aquatic origin and poor in silica and sesquioxides. The coral atolls are very rich in phosphate deposit of low grade (13.4 per cent P_2O_5). The phosphate reserve is estimated as 0.12 million tonnes and it is also reported that a large deposit of calcium carbonate exists in the surrounding lagoons.[149,150,151] Out of the total flat land area of 2494 ha, 2107 ha (i.e., 85 per cent) is classified as excessively drained, while the remaining is imperfectly drained. Soil depth is limited by the presence of a hard pan or shallow ground water.

[149] http://lakshadweep.nic.in/depts/agriculture/Files/Soil.htm accessed on 25 February 2012
[150] Sinha, B.N. 1994.Geoeconomic Survey of Lakshadweep, Concept Publishing Company, New Delhi, p. 256.
[151] Op.Cit.Gazatter of India, Lakshadweep, p.122, 1977

Hydrogeology[152]

Fresh Water Lenses

The islands are so small that water run-off, if any, cannot attain critical concentration to render even a small stream. It is all in situ infiltration of rain water into the ground. Thus recharging potential is extremely good. Infiltrated rain water being of good quality, floats on the relatively denser saline water in the aquifer. However, the fresh water zone is of limited thickness. Ground water occurs under phreatic conditions in these islands occurring as a thin lens floating over the seawater and is tapped by open wells. About 2500 rainwater harvesting structures had been created so far. This water is limited in quantity and its salinity level increases as a function of time during withdrawal in the dry periods. Majority of the wells included under participatory monitoring[153] tap coral sands and in almost all the wells hard coral limestone is exposed near the bottom. The depths to water level in these islands vary from a few centimetres to 5 m below ground level and depths of the wells vary from less than a meter to about 6 m. The depth to water level is highly influenced by the tides. The water level fluctuation in these islands is significantly controlled by tides when compared to the groundwater recharge and draft. The diurnal fluctuation of water level due to tides is in the range of negligible to 80 cm. It was estimated that about 500 mm of rainfall reaches the groundwater body, annually, as recharge. Irrespective of this, it was found that the water table rise, upon incidence of rainfall, diminishes in a couple of days.[154] Hence the magnitude of seasonal fluctuation in water level due to ground water recharge is not so significant when compared to tidal fluctuations. The islands do not have any rivers or creeks but some brackish water ponds occur at Bangaram and Minicoy. At Bangaram the pond has been formed during the process of growth of the Islands where the outlet of the bay has been blocked by sand. At Minicoy, a similar pond was being formed at the southern edge but a bund has been constructed and this has created an artificial brackish water pond.

The static and dynamic storage potential of the inhabited islands of Lakshadweep, determined based on the geometry and specific yield of the fresh groundwater portion of the aquifer is given in Table. In general, it indicates that the dynamic storage of inhabited islands is adequate to serve the needs provided the development of the resource does not tell upon the sustainable yield, worked out to be about 10% of the average annual recharge (AAR). Contrary to this, the estimated draft of fresh groundwater at Kavaratti was about 0.17 MCM as against the AAR, It

[152]CGWB, 2010. Approach Paper on Ground Water Quality Issues In Islands (Andaman & Nicobar And Lakshadweep) Central Ground Water Board, Ministry of Water Resources, Government of India Island Report

[153]Op.Cit. NWIA, 2011

[154]CESS, 1997, Identification of airstrip corridors based on environmental impact assessment (EIA) in Kavaratti, Andrott, Kadmat, Kiltan and Minicoy Islands of Lakshadweep, Report (Volume I & II) submitted to the Administration, Union Territory of Lakshadweep, Kavaratti, Centre For Earth Science Studies (CESS), Trivandrum.

suggested that either an overdraft takes place or a part of the groundwater draft (about 25%) re-enters the ground, which is logical in the island situation.

Table 0.2 Static Storage, Annual Recharge and Projected Dynamic Storage of Groundwater

Name of Islands	Area of fresh GW zone km^2	Sp. Yield %	Volume of fresh GW portion of the aquifer MCM	Static storage potential of fresh GW MCM	Annual water surplus mm	Recharge area km^2	Dynamic storage potential MCM	Sustainable Yield MCM/Yr.
Agatti	1.070	21	2.344	0.4922	193	1.284	0.2478	0.025
Androtт	4.077	11	63.633	6.9996	414	4.077	1.6879	0.036
Amini	1.563	17	6.463	1.0987	193	1.876	0.3621	0.169
Chetlat	0.514	22	2.381	0.5238	414	0.514	0.2128	0.021
Kadmat	2.200	17	15.424	2.6221	414	2.200	0.9108	0.091
Kalpeni	1.180	25	14.990	3.7475	414	1.180	0.4885	0.049
Kavaratti	1.930	18	6.450	1.1614	474	1.930	0.9140	0.130
Kiltan	1.172	26	10.667	2.7734	414	1.172	0.4852	0.049
Minicoy	1.226	25	7.325	1.8313	459	1.226	0.5627	0.056

Source: CESS, 1997

The maintenance of a minimum thickness of lens is a critical factor for the upkeep of island groundwater system. The fresh groundwater extraction from island lenses has to be limited to the sustainable yield. Studies by CESS recommended stoppage of indiscriminate pumping and advocates the use of infiltration galleries and low capacity pumps (about 60 Ipm), if pumping is needed. The study also suggested limiting pumping locations to zones where the thickness of lens is greater[155]. The bulk of the ground water draft is utilized in the domestic sector. Irrigation draft is minimum and industrial draft is negligible. However, due to the large population and the limited resource some areas are not able to cater even to the domestic requirements. The growing use of pump sets for domestic requirements has accelerated the ground water draft in the islands. The ground water resource of Lakshadweep is presented in

Table 0.3. The stage of ground water development ranges from 44 to 86 %. The overall stage of development of the islands as a whole stands at 63 %. Detailed hydrogeological and geophysical studies are required for proper understanding of the saline-fresh water interface behaviour and management of the ground water resource.

[155]CESS, 1997, Identification of airstrip corridors based on environmental impact assessment (EIA) in Kavaratti, Androtт, Kadmat, Kiltan and Minicoy Islands of Lakshadweep, *Report (Volume I & II) submitted to the Administration, Union Territory of Lakshadweep, Kavaratti,* Centre For Earth Science Studies (CESS), Trivandrum.

Table 0.3 Estimated Ground Water Resources in Lakshadweep

S.No.	Particulars	mcm
1	Total Ground Water Recharge	12.08
2	Natural Discharge during non-monsoon	8.58
3	Net Ground Water Availability	3.50
4	Draft for domestic uses	2.20
5	Stage of development	63 %

Source: CGWB, 2010

Groundwater Quality

The quality is highly variable and reversible. It is also observed that the quality improves with rainfall. Other factors affecting the quality are tides, ground water recharge and draft. There is a vertical variation of quality due to the zone of interface and underlying sea water. Perforation created due to drilling or otherwise also affects the quality as it acts as a conduit for flow of sea water. Wells manually operated retain more or less the same quality of ground water over longer time periods as compared to mechanized wells where, quality deterioration is observed in the form of increasing EC. Brackish water is present along topographic lows and in places where coarse pebbles and corals are present. The quality of ground water has also changed in the recent years. The UTL is one of the lowest lying groups of islands in the world. As a result, the islands face the risks of 1) Inundation of low lying areas due to storm surges and 2) Intrusion of seawater into fresh water. Saline water intrusion has serious ramifications in the UTL. The salinity index of the island groundwater system indicates that no fresh groundwater without saline contamination is available in any island of Lakshadweep. However, the contamination fortunately is very marginal except at a few spots at Kavaratti and Minicoy. Another major threat to ground water in the islands is the pollution. The human and livestock wastes, oil spills and fertilizers are the main polluting agents with sewerage and other biological wastes contributing most. Since, construction of septic tanks has become a norm in most of the houses, percolation of the waste through the porous soil and contamination of ground water frequently occurs. Most of the sites from where ground water is drawn, the microbiological contamination levels are found to be exceptionally high. The use of detergents and soaps in the last decade has also negatively impacted the quality of potable water to a large extent. It is also observed that the quality of water deteriorated with longer duration of pumping. Studies have shown early signals of deterioration in ground water quality in Kavarati, when pumping rate exceeds 13,000

litre/day.[156]In the past, when the population was scarce, the ground water was adequate to meet the requirement of people. However, with 3-4 fold increase in the population in the last two decades, the change in life style and various development processes have placed a heavy strain on the ground water availability to the extent that in several islands intrusion of saline water into the ground water lens in summer is a regular phenomenon. In addition, the over usage of ground water with pumps and tanks, concretization that reduces the area available for percolation of rainwater, wastage of water and mixing of the sewage with fresh water, etc. worsen the situation.

Ecological Profile

Flora

Forestry and Afforestation

The vegetation of Lakshadweep is conspicuous by the absence of forests of any kind and the overall pattern of vegetation is almost uniform with a few exceptions in the cases of Andrott and Minicoy. The plant diversity is not large. Forest Survey of India has categorized 82.75% of the islands under moderate forest. The Department of Environment & Forests under the 20 point programme is establishing 'coastal green belt' to protect sea shore against erosion and other natural disasters. Similarly, a seashore plantation drive (with planting of casuarinas and littoral species) was taken up by the Agriculture Department during the year 2009-10 with planting of one lakh seedlings.

Medicinal Plants

Olden days the flora of Lakshadweep was blessed with varieties of medicinal plants. Due to cultural operations and increased peoples intervention on the surrounding have resulted the loss of many valuable plants from these fragile ecosystem. The plants proposed to be introduced are 1. Karimkurinji, 2. Nagdhandi, 3. Ramachan (Vettiver), and 4. Chittaratha (Plumpago indika). Based on the report of the Task Force on Conservation and Sustainable Use of Medicinal Plants, the Planning Commission, Government of India, has listed about 25 plant species, which are most commonly used in India which are to be evaluated for their suitability to the islands. Other nodal agencies such as CDRI, Lucknow, CIMAF, NMPB, FLHRHT, NOVOD, etc. also actively promote the use and cultivation of medicinal plants.

[156] Pallavi Banerjee and Singh V.S, 2010. Ground water quality monitoring for sustainable management of island aquifer using artificialneuraal network.

Mangrove[157,158]

Indian mangrove vegetation covers about 6,749 km^2 along the 7516.6 km long coast line, including Island territories. The entire mangrove habitats are situated in three zones: (1) East Coast, about 4700 km2, (2) West Coast, about 850 km2, and (3) Andaman & Nicobar Islands about 1190 km^2, with Lakshadweep Atoll. Studies on the relative mangrove diversity (RMD) showed that the Sundarbans recorded the maximum RMD (90%) and Lakshadweep Atoll the minimum (9.4%). Small and sparse mangroves with stunted growth are reported from the islands.[159,160]Mangroves are noticed only at Minicoy Island in Lakshadweep and occur in two patches each of about one hectare in area. The two mangrove ecosystems are found in south and south east areas of Minicoy Island. *Ceriops candolleana* is reported from the south and *Bruguiera cylindrica* from the southeast.[161] Besides these two patches, no mangroves exist in any of the islands of Lakshadweep. Lakshadweep Atoll (AL) has 8 species distributed in 5 genera and 3 families. Mangrove samples from Lakshadweep Island yielded 32 species of higher fungi.[162]Unlike the mangroves of the mainland, the mangroves of Minicoy are in the formative stage and free from serious human pressure. Majority of mangrove species grow best in low to moderate salinities (25 ppt).

Fauna[163]

Marine fishes

The fishes that occur in the coralline niches of the lagoon exhibit the characteristic variety of colours and mainly consist of perches, gar-fishes, half-beaks, scarids, goat-fishes, carangids, grey mullets, antherinids, spyraenids, polynemids, balistids, blennids and globe-fishes[164,165]. Jones and Kumaran (1980) recorded 603 species of fish were recorded from the Laccadive archipelago.[166] The offshore fishery is constituted by fishes viz. seer fish, sharks, sail fish, tunnies, flying fish,

[157]A.K.V. Nasser, V.A. Kunhikoya and P.M. Aboobaker. 1999.Mangrove Ecosystems Of Minicoy Island, Lakshadweep. CMFRI. Report.159.

[158]Mandal, R.N. and K.R. Naskar. 2008. Diversity and classification of Indian mangroves: a review. Tropical Ecology 49(2): 131-146.

[159]Newberri, D.M.C. & M.G. Hill. 1981. Numericalclassification of "Mixed Scrub" vegetation, AldabraAtoll. Atoll Research Bulletin no. 246.

[160]Spicer, R.A. & D. Newberri. 1979. The TerrestrialVegetation of an Indian Ocean Coral Island,Willingili, Addu Atoll, Maldives Islands, I. TransectAnalysis of Vegetation. Atoll Research Bulletin No231.

[161]Radhakrishnan, K., A.G.P & Urangan, S.Rajasekharan & P. Pushpangadan.,1998. Ecofloristic studies of Lakshadweep Islands, India. *J. Eco. Tax. Bot.* Vol. 22. No.1, pp. 37-48.

[162]Chinnaraj, S. (1992). Higher marine fungi of Lakshadweep Islands and a note on *Quintaria lignatilis*. *Cryptogamie Mycologie* **13** (4), 313-319.

[163]http://lakshadweep.nic.in/depts/laktech/fauna_of_lakshadweep.htmaccessed on 5 April 2012.

[164]Balan, V 1958: Notes on a visit to certain islands of the Laccadive Archipelago, with special reference to fisheries, *J. Bombay nat. Hisl. Soc.*, 55 (2): 297-306.

[165]Kumaran M., P.P. Pillai, R.S. Lal Mohan, V.S.R. Murty and G. Gopakumar.,1989. Live-bait resources and development. Bull. Cent. Mar. Fish. Res. Inst. **43:**39-45.

[166]Jones, S. and Kumaran, M., 1980. Fishes of the Laccadive Archipelago.Nature Conservation and Aquatic Sciences Service, Trivandrum, 760 pp.

carangids and ribbon fish. Moreover, rays and skates are also common in the Lakshadweep water. Fishes such as *Crenimugil crenilabis, Polynemus sexfilis, Naso tuberosus, Naso unicornis, Gomphousus varius, Novacutichthys taeniurus and Anampses diadematus* are common in the offshore waters of Lakshadweep[167].The fishery resources of the islands comprising the oceanic resources such as the tunas, billfishes pelagic sharks etc., and the other groups of food fishes, live baits and ornamental fishes inhabiting the reefs and numerous lagoons play a vital role in the economy of the islands. The fishery activities in Lakshadweep are concentrated in all the 11 inhabited islands and in the uninhabited island - Suheli. The main resource exploited is tuna and tuna-like fishes. Overexploitation of the fishery resources in the adjoining reaches and poaching by the foreign vessels add to these problems. The developmental activities such as dredging of channel by harbour department and fishing practices using gillnet and other modern means greatly deprive the fishery and coral habitat in Lakshadweep. Moreover, foreign fishing boats form Kerala and other coastal areas are largely harvesting fisheries resources from Lakshadweep territorial waters that would not only lead to depletion of the resources but also pose to the conflict between stake holders in this region. A recent survey conducted by the CMFRI indicated that, 20 of the 35 families are common and are represented by 252 species). Among these, 165 species constitute the major ornamental fishes and have great demand in the ornamental fish trade.

Corals

More than 400 species of coral diversity have been recorded, including hermatypic and ahermatypic corals. So far, 220 species under 58 genera, and 209 species under 62 genera, have been reported respectively from Chagos[168] and Maldives[169]. About 148 species of corals have been recorded from Lakshadweep. The coral diversity of the UTL is second only to that of Andaman & Nicobar Islands. All corals are classified under schedule 1 of the Wild Life (Protection) Act, 1972. Nearly 4,000 sq. km of lagoon area houses most of these species. Experts observe that many more species can be recorded which are globally significant in terms of their diversity. Researchers presume that, in comparison, the biodiversity of corals in Lakshadweep is likely to be twice higher than what is known now[170]. Around eight species of coral have been reported only from Lakshadweep. Coral genera like *Montipora, Pavaona, Porites, Favia, Favites, Goniastrea, Platygyra, Hydnophora* and *Symphillia* are common. Some sub-genera like *Psammocora (Plesioseris)* and *Psammorora* (*Stephanaria*) are found only in the UTL. On

[167]James, P.S.B.R., C.S.G. Pill Ai, P.A. Thomas, D.B.James and Saidkoy A 1989. Environmental damage and consequences. Cent. Mar. Fish.Res. Inst., Bul1. No. 43:212-227.

[168] Sheppard C.R.C , 2000. The Chagos Archipelago. InCoral Reefs of the Indian Ocean: Their Ecology andConservation. (eds. McClanahan.R., Sheppard C.R.C.,and Obura, D.O). Oxford University Press, New York.Pp. 445 – 468

[169] Clark S.,1995. Recommendations for establishing acoral collection within the Marine Research Station,Male. Pp. 1 – 19

[170]Jeyabaskaran, R.,2006. *Human impacts on Lakshadweep Atolls, India.* In: Proceedings of the 10th International Coral Reef Symposium, 2006, Kinawa, Japan.

lagoon shoals and the windward and leeward sides of the reefs, genera like *Pocillopora, Acropora, Porites, Goniastrea* among the *Scleractinians* and the blue coral *Heliopora* are found. In some of the lagoon reefs and shoals (Minicoy and Chetlet), atleast, 80 % of the reef surface and lagoon floor is occupied by blue coral, which makes large hemispherical colonies. The lagoons of Minicoy show species found in Maldives like *Lobophyllia* and *Diploastria*. A total of 78 species of *Scleractinian*corals divided among 31 genera are reported from the islands. Of these, 27 genera with a toral of 69 species are hermatypes and the rest 4 genera with 89 species are ahermatypes[171]. Coral reefs are the most productive marine ecosystems, with annual gross production rates in the range of 2000 to 5000 g cm^2.[172] Reefs provides up to 25% of the total fish catch in India and up to 75% of the animal protein consumed.

Turtles

There are four species of marine turtles that occur and nest in the islands of Lakshadweep (Bhaskar, 1978). The green turtle (*Chelonia mydas*) is the common species that nests in inhabited islands whereas hawksbills (*Eretmochelys imbricata*) and leatherbacks nest more frequently in the uninhabited islands. The olive ridley (*Lepidochelys olivacea*) nests from January to March whereas the former two species nest in the monsoon.[173] All the species are declining rapidly and the leatherback is listed in the IUCN Red Data book. The first survey of sea turtles in Lakshadweep was conducted during 1976[174]. Extensive work on green turtle nesting in Suheli Valiakara, a seasonally inhabited island, during the monsoon,[175] , the information available from other islands on sea turtle nesting is very limited and no detailed work has yet been done in any of the islands of Lakshadweep. Green turtle *mirugom (Chelonia mydas), Hawkbill, Ama (Eretmochelys imbricata)* and leathery turtle, lisarmulla *(Dermochelys coracea)* are plentiful in Lakshadweep waters. Turtle hunting had been a sport in the islands until recently for its oil for embalming the country crafts.

Threats to Sea Turtles

Carapaces of green turtle were found in uninhabited/seasonally inhabited islands *viz.* Tinnakara, Parali I & II, Suheli Valiakara and Cheriyam Island. According to fishermen, green turtles are generally caught during nesting and slaughtered for extraction of oil, which is used for painting country boats as this works as an excellent waterproofing agent. Many people differentiate green and olive ridley turtles by the quality and quantity of oil and the former is preferred because of

[171]Ramachandran, K.K. and Ajaykumar Varma.1997. A Review of the Contribution of Centre for Earth Science Studies (CESS) Towards Understanding the totality of Environment of Lakshadweep, India in, Vineeta Hoon (1997) Proceedings of the Regional Workshop on the Conservation and Sustainable Management of Coral Reefs. Proceedings No.22, CRSARD, Madras

[172]Mann, K.H. 1982. Ecology of coastal waters: A systems approach. Stud.Ecol., 8: 160-182.

[173]Tripathy, B, B.C. Choudhury & K.Shanker ,2002. Sea turtles and their nestingbeaches in Lakshadweep Islands, India – A Status Survey. Wildlife Institute of India, Dehradun.

[174]Bhaskar,S. 1978a. Sea turtles in the Arabianislands of Lakshadweep. In *Tiger Paper,* F.A.O,Bangkok.

[175]Bhaskar, S. 1978b., Turtles and other marine life in Lakshadweep. *Hornbill* (April-June) pp. 21 – 26.

its oil content. There is no consumption of turtle meat and eggs due to Islamic religious taboo. However, the stuffing of juvenile hawksbill turtles is still in practice in many islands. The stuffed specimens fetch about Rs. 500/- to Rs. 1500/- and are sold to tourists or in the mainland at Mangalore, Calicut or Cochin. All species of sea turtles occurring in Indian waters are listed as endangered and are included in Schedule I of the Indian Wild Life (Protection) Act, 1972. It was reported that the increase in the number of turtles in the lagoon has caused a depletion of sea-grasses, which in turn has affected the live-bait fish population.[176]

Dolphins and Whales

In the seas around India, there are 24 species of cetaceans frequenting the coastal waters, mostly for feeding and breeding, but no detailed scientific investigation has been carried out so far on the species diversity of dolphins in different coastal regions of India[177]. The occurrence of Cuvier's beaked whale (*Ziphius cavirostris*) was reported from Minicoy Island of Lakshadweep[178]. The common species of dolphin that are caught as bycatch are the Spinner dolphin (*Stenella longirostris*), Indo-pacific humpback dolphin (*Sousa chinensis*), Bottlenose dolphin (*Tursiops truncatus aduncus*) and Cape dolphin (*Delphinus delphis*).[179]Dolphins are frequently sighted close to the island coast between October and April. To the fishermen, this animal serves as an indicator of tuna shoals in the offshore waters of Lakshadweep. There are unconfirmed reports of the collection of ambergris by islanders, when washed ashore. This indicates that sperm whales may also occur in the offshore waters of Lakshadweep[180].

Sea Grass

The lagoon of most of the islands show an extensive bed of sea grass adjacent to the beaches. Seagrass meadows occur in long stretches along the shores and are confined to depth of up to 3 m. The total seagrass cover in the Lakshadweep regions was estimated to be 1.12 km^2 of which Minicoy (the southernmost island) has a maximum of 0.4 km^2, followed by Kavaratti (0.34 km^2) and Agatti (0.19 km^2)[181]. *Cymodocea isoetifolia, Syringodium isoetifolium, Thalassia hemprichii* are the three species of sea grasses reported from the islands. These plants act as a protection to the beaches preventing erosion and movement of the beach sediment. Wherever these plants are not grown erosion has been observed to take place to a certain extent. Besides, *Thalassia*

[176]Rohan Arthur and Kartik Shanker, Olive and Green: Shades of Conflict Between Turtles &Fishers in India. Current conservation. P 29-35

[177]James P. S. B. R. and R. S. Lai Mohan, 1987. The Marine mammals of India. Mar.Fish, infor. Ser. T & E. Ser. No. 71;1-13.

[178]Pillai, G.S. (1981). On a new record of Cuviers beaked Whale Ziphius carvirostris in Indian waters. *J. Mar. Biol. Ass. India*, 23; (1&2) 218-221

[179]Lal Mohan, R S and James, D B and Kalimuthu, S (1989) Mariculture potentials. CMFRI Bulletin Marine living resources of the union territory of Lakshadweep An Indicative Survey With Suggestions For Development, 43 . pp. 243-247..

[180]*Basudev Tripathy, 2000. Marine Biodiversity of Lakshadweep: An overview, Wildlife Institute of India.*

[181]Sea Grass watch, 2011. Lakshadweep Islands. http://www.seagrasswatch.org/India.html

hemprichii is found to be a major food for the adult turtles and hence the common name *'turtle grass'*. The sea grass community of the lagoon contributes to the benthic plant biomass of islands. The major threats to seagrasses are natural processes like sea erosion, siltation, construction, mechanised fishing, dredging for cargo transport and oil pollution. The Lakshadweep group of atolls is situated along the main off-tanker route in the Indian Ocean, which is polluted with petroleum hydrocarbons. There has been sand mining in some lagoons which is likely to have impacted areas of reef.

Sea Weed and Economic Importance

Shallow reefs are dominated by algal elements and sea weeds. The predominant seaweeds observed are *Enteromorpha, Ulva, Codium, Laminaria, Turbinaria, Sargassum, Padina, Gelidium, Gracilaria, Hypena* and *Ceramium.* There are potentially useful seaweeds. Agatti and Kadmat islands have more agarophytes. *Caulerpa, Dictyota* and *Laurencia* can be used as food in different forms. Seaweed also grows on the coral reef. Blue-green algae like the *Lyngbyamajuscula, Anabaena* and *Oscillatoria* species were observed in the lagoon in many islands associated with sea-grasses. The branching coral beds support seaweed growth to a large extent. The lagoon and atolls of Lakshadweep also abound in a variety of marine *macrophyte* or algae. They belong to *Chlorophyta* (Green Algae), *Phaeophyta* (Brown algae) and *Rhodophyta*(Red algae).Resource assessment surveys in the Laccadive Archipelago carried out by the Central Marine Fisheries Research Institute, Kochi and the Central Salt and Marine Chemicals Research Institute, Bhavnagar indicate nearly 10000-19,000 tonnes (wet biomass) of standing crop of seaweed comprising 114 species belonging to 62 genera.Twenty five per cent of the standing crop comprises seaweeds such as *Gelidiella acerosa and Gracilaria edulis* that can be exploited for the production of commercially important polysacccharides like agar-agar and *Turbinaria* and *Sargassum spp*. for alginic acid. The rest include edible and carageenan yielding species. Species identified for mariculture include the carrageenan yielding red seaweed, *Kappaphycuss triatus* and *Eucheuma cattani.* These resources can be tapped for industrial purposes by regulated harvest as well as mariculture in lagoons. The results of the preliminary survey on the economically important algae present in the lagoons and their commercial uses are presented in Table 0.4.

Table 0.4 Economically Important Algae

Genus	Food stuff	Material for Agar	Material for Algin	Medicinal uses	Fertilizer	Cattle & Poultry feed
Ulva	+			+		+
Enteromorpha	+			+		+
Codium	+					+
Laminaria	+		+	+	+	+
Turbinaria	+		+			

Sargassum	+		+	
Padina	+		+	
Gelidium	+	+		+
Gracilaria	+	+		
Hypnea	+	+		
Ceramium		+		

Source: http://lakshadweep.nic.in/depts/laktech/flora.htm

Common Terrestrial Fauna

Among reptiles the most common are the wall lizards, *Palli (Gecko* sp.) garden lizards, *onthu (Calotes versicolar* and *Calotes liocephalus*) and skinds, *Arana (Mabuya carinata). Lycodon travancoricus* ("Beddomes" wolf snake *chera)* has been reported at Androth. Otherwise snakes are very uncommon in these islands although coral snakes are occasionally seen in the reef area during low tide. Among vertebrates the cattle and poultry birds are common in the inhabited islands. The only representative of the family Carnivora is the common domesticated cat. Perhaps, the only wild mammal observed belongs to the genus Mus. At least two species are identified and they are common house mice, *Mus rattus* and *Mus refescens.* Presence of the common frog Thavala (Rana tigrina) has been reported at Minicoy island[182]. Insects of common occurrence are the Cockroach viz., Cockroach/*Koora (Periplanata americana* and *Periplanata orientalis).* The Rhinoceros beetle, *chellu (Oryctus rhinoceros)* is a pest on the coconut palm and does a lot of damage.

Birds

Coral reefs offer a verity of feeding and breeding grounds for birds and more than 101 species of birds had been recorded form these Islands. There are many species of birds which are exclusively depending on coral reefs ecosystem. Common Sea birds are Tarataihi (Sterna fuscata) and Karifetu (Anous folidus); the former being the state bird. Most of the birds nest on an Island called Pitty - a bird Sanctuary. Among birds the Indian crow is not uniformly found in the islands. While they are commonly seen in Amini & Minicoy they are absent in Kavaratti. Some of the oceanic birds which are commonly seen are thrrathasi (Sooty Tern; Sterna fuscata), Katalkakka (Sterna bergiivelox), Karifetu (Noddy Tern; Anous stolidus piletus), (tharathasi) (Brown winged Tern; Sterna anethetus). Some of the migratory birds are Chullu (Pluvialis dominical) Koluvayam (Nuemenius phaeopus), Arenaria interpries. The common pond heron Annal (Ardeola grayii) and the reef heron valia Nhara (Egretta sp). are also seen in the islands.

[182] Laidlaw, F.F. 1903. The marine Turbellaria, with an account of the anatomy of some of the species, in: Gardiner, J.S. (Ed.) (1903). The fauna and geography of the Maldive and Laccadive Archipelagoes, being the account of the work carried on and of the collections made by an expedition during the years 1899 and 1900. Volume I. pp. 282-312, plates XIV-XV

Pitti-Bird Sanctuary

About 24 km. north west of Kavaratti is Pitti island consisting of a reef and a sand bank at the southern end. The island is devoid of any vegetation. Several thousands of birds belonging to two types are observed in this island. They are *Thararhasi (Sterna fuscata)* and *Karifetu (Anous Stolidus piletus).* This island has been declared a bird sanctuary by the Lakshadweep administration. Pitti Island has been declared as a bird sanctuary because of the nesting and breeding grounds of the pelagic birds and congregation of nesting sea birds. The buffer zone around the Pitti Bird Sanctuary comprised of submerged coral reef is also being declared as a Pitti Conservation Reserve with an area of nearly 324 sq.km. The sand is highly rich with guano phosphate. Observing the flocks of these birds hovering in the air the fishermen are able to locate tuna shoals, because these birds and tuna shoals feed on small fishes. The island has been known, from the early nineteenth century, to harbour many varieties of terns and numbers have known to cross 20,000. Though some migratory waders are seen on Pitti, terns are the only breeding birds on the island. The tern species that nest in and feed around Pitti are Sooty Tern *Sterna fuscata*, Brown Noddy *Anous stodilus*, Large Crested Tern *Sterna bergii*, *and* Bridled Tern *Sterna anaethetus*. Waders reported from Pitti include Ruddy Turnstone *Arenaria intepres*, Eurasian Curlew *Numenius arquata*, and Lesser Sand Plover *Charadrius mongolus*.[183]The beach erosion is severe and most of the rocky substratum in eastern & northern side is in fully exposed condition. Non-biodegradable garbage is observed all along the seashore which is cleared by the concerned department in the UT.[184]Heavy rains take their toll on the chicks, as evidenced by the high rate of mortality. Predation by crabs is another natural threat to the eggs. Introduction of vegetation has been suggested on Pitti Island but this would be disastrous to the nesting colony of terns[185].The main threats to Pitti bird sanctuary are human disturbance, natural events and unsustainable exploitation (of eggs). Although the island is uninhabited, fishermen from other islands in Lakshadweep visit Pitti for fishing, collecting shells and tern eggs. This poses a severe threat to the colony throughout the year, except during the monsoons when the island becomes inaccessible to human beings.

[183] Anonymous (1991) Pitti Island Lakshadweep an ornithological study. Madras Naturalist Society, Madras.
[184] Lakshadweep Administration, 2011
[185] Op.Cit.,Anon.1991

Annexure X: Economic Profile of Lakshadweep

Livelihood Pattern

Fisheries[186]

The fishery resources of the islands comprising the oceanic resources such as the tunas, billfishes pelagic sharks etc., and the other groups of food fishes, live baits and ornamental fishes inhabiting the reefs and numerous lagoons play a vital role in the economy of the islands. Fishing is the primary occupation here, and is dominated by a pole-and-line fishery for the pelagic skipjack tuna. Fishing on reefs and lagoons is, by contrast, fairly artisanal, and limited to local consumption, supplying the evening meal. During the monsoons, the lagoon and reefs take on an added significance, since tuna fishing stops, and these more protected habitats become the primary sources of fish for the island communities[187]. The Department of Fisheries and the Lakshadweep Development Corporation Ltd are the two agencies responsible for the development of fisheries in the UT. The functions of these agencies include: construction and supply of mechanized boats to fishermen; management of boat building yards; management of canning factory; management of fishermen training center; supply of fishery gears, diesel, oil, etc.; collection and analysis of fish landing data; diversification of fishing methods, etc. The fishery activities in Lakshadweep are concentrated in all the 11 inhabited islands and in the uninhabited island - Suheli. The main resource exploited is tuna and tuna-like fishes. It is estimated that the annual catchable potential yield of tunas is about 50,000 tonnes of tunas and an equal quantity of other fishes are available. The annual total landing is about 10,000 tonnes, which is only about 10% of the estimated fishable potential.

The communities' reliance on the reef fishery and gleaning for protein and income is high. 20% of the households on Agatti report reef fishery and gleaning as their main occupation, 90% of the protein intake of poor households comes from reef fishing and gleaning[188].Gear use around the island is largely determined by hydrography and how the gear is operated, as well as by habitat and availability of target species. Overall catch per unit effort (CPUE) was 1.66±0.07 kg per person per day based on data from 3030 fishing events[189]. The total annual catch was estimated

[186] *Op.Cit.*CMFRI, 2006

[187] http://www.indiaenvironmentportal.org.in/files/file/turtles.pdf

[188] Hoon, V., 2003: A case study on Lakshadweep islands in Whittingham, E., Townsley P. and Campbell, J. eds. Poverty and Reefs: Vol 2. published by IOC/UNESCO

[189] Tamelander J and Hoon V. 2008. The artisanal Reef Fishery on Agatti Island, Union Territory of Lakshadweep, India. In: Obura, D.O., Tamelander,J., & Linden, O. (Eds) (2008) Ten years after bleaching – facing the consequences of climate change in the Indian Ocean. CORDIOStatus Report 2008. CORDIO (Coastal Oceans Research and Development, Indian Ocean)/Sida-SAREC. Mombasa. http//:www.cordioea.org. 400 pp.

at over 61 metric tons, harvested from a lagoon area of 12 km^2. Almost half of the total catch is obtained from only 2% of the catches, i.e. catches larger than 20kg. Most large catches are from more indiscriminate gears such as large-scale dragnets.

Critical Challenges in Fisheries Sector: The critical factors impacting fisheries sector are 1)Access to market, 2) Poor connectivity to mainland, 3)Inadequate processing capacity, 4)Lack of value addition, 5)Limitations of fishing crafts, 6)Diesel subsidy, 7) Conflicts between users of water bodies and 8) Inadequate power, water, credit, and communications.

Present Status of Capture Fisheries

Fish landings by year and Island are given in Table 0.5 and Table 0.6 respectively. The major fish landings are at Agatti, Suheli, Minicoy, Bitra and Androth.

Table 0.5 Fish landings in Lakshadweep during1995-2008 (in tonnes)

Year	Shark	Tuna	Miscellaneous	Total
1995	261	8250	717	9887
1996	119	8798	802	10250
1997	221	8072	1119	10412
1998	980	12308	899	14615
1999	139	7624	4188	13081
2000	145	7071	1604	10082
2001	75	9343	2382	12800
2002	185	7304	1660	9149
2003	205	8063	706	8974
2004	213	8363	805	9381
2005	123	8782	2030	10935
2006	80	8661	3010	11751
2007	69	8874	2457	11400
2008	47	9228	2452	11727
Average	204	8624	1774	11032

Source: Lakfish, 2009

Table 0.6 Island-wise fish landing during 2000-2009 (in tonnes)

Islands	Landing in tonnes										Decadal average
	2000	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	
Kavaratti	1320	1664	889	1006	1009	1085	1120	1155	1194	1306	1175
Agatti	2107	2675	1711	2157	2345	2420	2560	2052	2086	2281	2239
Amini	353	461	237	237	240	267	278	352	416	470	331
Kadmat	383	487	231	196	195	202	230	212	252	287	268
Kiltan	696	883	512	737	762	754	812	912	791	806	767
Chetlat	403	512	289	254	265	270	290	397	487	527	369
Bitra	444	563	304	350	374	403	470	367	426	461	416
Andrott	1311	1664	797	1064	1130	1212	1280	2121	2028	2032	1464
Kalpeni	393	499	166	648	712	765	809	709	933	1012	665
Minicoy	1462	1856	1141	2400	2390	2410	2450	1863	1899	1912	1978
Suheli	1210	1536	1027	981	1090	1247	1452	1260	1215	1190	1221
Total	**10082**	**12800**	**7304**	**10030**	**10512**	**11035**	**11751**	**11400**	**11727**	**12284**	**10893**

Source: Lakfish, 2009

Tuna Fishery

During the period 1995 to 2008, annual tuna landings in the Lakshadweep islands ranged between 7071t (2000) and 12308t (1998) with an average of 8624t against a projected annual potential varying between 50,000 and 90,000t (Table 0.7). The major contribution to the tuna landings comes from Agatti (31%), Suheli (14%), Minicoy (17%), Kavarati and Androth (8%). Compared to the tuna catch of neighbouring island nations such as Maldives (1,48,500t) and Sri Lanka (27,000 t), the catches from Lakshadweep are very low.

Table 0.7 Island-wise tuna landings during -2000-2009 (average) (tonnes)

Island	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	Average
Agatti	1886	2408	1711	1940	1966	1629	1667	1714	1753	1973	1865
Amini	257	337	237	173	242	193	153	172	223	267	225
Androth	878	1115	797	713	916	1612	1601	1520	1404	1465	1202

Bitra	334	422	304	263	349	895	235	233	285	342	366
Chetlat	518	405	289	201	333	238	249	304	382	414	333
Kadmat	254	321	231	131	266	79	89	121	149	176	182
Kalpeni	183	235	166	305	191	534	633	668	667	805	439
Kavaratti	986	1248	889	754	1021	771	911	984	1070	1189	982
Kiltan	564	715	512	597	588	549	569	586	658	673	601
Minicoy	1257	1596	1141	2064	1311	1480	1679	1699	1761	1776	1576
Suheli	1131	1444	1027	922	1180	802	875	873	876	897	1003
Total	8248	10246	7304	8063	8363	8782	8661	8874	9228	9977	8775

Potential resources of tunas in the seas around Lakshadweep have been estimated to be 50,000 tonnes[190] and 90,000 tonnes.[191] But the average production for the last ten years is only about 6,000 tonnes. Many earlier workers have proposed strategies for development and management of tuna fishery to increase the production. The major tuna species landed (1980-2001 average) was *K. pelamis* (86%) followed by *T. albacares* (12%) and the rest was *E. affinis.* Pole & lines account for 97% of the total tuna landings followed by troll lines. About 300 boats are annually in operation for pole and line tuna fishing during the last 15 years. Pole & line-fishing boats (OAL of 25-36') mostly conduct single day fishing trips and often operate 2 trips during the peak season. The difficulty in maneuvering larger sized boats within the lagoon is perceived as bottleneck in introducing larger boats with higher fish hold capacity. Though there have been wide annual fluctuations in catch and catch per unit effort, catch per unit effort and the mean length in the fishery have not undergone any significant change. At Lakshadweep over 85% of the total landings constitute tunas of which about 50% of the total tuna landings is used for *'Masmin*' production and the remaining 50% consumed fresh.

Live bait resources: Live bait fishes are used for chumming and attracting tuna shoals and are essential for tuna pole line fishing. The live baits are caught from the coral reef and lagoon of different islands. There are about 21 species of live baits available in Lakshadweep waters. Over a dozen species is used in the fishing. The most common species in the order of abundance are *Spratelloides delicatulus, S. japonicus, Apogon sangiensis, A. savayensis* and *Chromis ternatensis*. Fishermen do report scarcity of live baits occasionally.

[190] George, P.C., B.I. Antony Raja and K.C. George 1977: Fishery resources of the Indian Economic Zone. Silver Jubilee Souvenir, IFF: 70-116.

[191] Chidambaram, K (1987) Management of Potential Fishery Resources. CMFRI Special Publication , 30 . pp. 109-125.

Artificial Baits: Artificial baits (plastic strips suspended on two or three rows on which water is splashed to create an impression of live baits) were tried on an experimental scale during 2002 off Minicoy but had limited success compared to live-baits.

Fisheries Communication Network

At present the pole and line-fishing boats spend considerable time in scouting and searching for tuna shoals. This seriously affects the profitability of the boats, besides resulting in waste of valuable energy in terms of diesel and manpower. It is well known that the biting frenzy of tuna shoals are at a peak during early morning and evening hours, and therefore, for increased efficiency of the P & L units, it is necessary that the boats arrive at the grounds during this time. Shoals located at other times do not display the same feeding frenzy and are not of same magnitude. The Islands already have a marine communication network (VHF) for ship to ship and ship to land communications. This facility is available in all the inhabited islands and is under the control of the port department and is locally known as control towers. The quick dissemination of the information gathered on the shoal movements from different grounds can yield higher catch rates and would reduce the scouting time and fuel consumption. Furthermore, the existing information on PFZ provided by the NRSA can also be communicated using this network.

Fish Aggregating Device

Introduction/deployment of FADs is helpful in the augmentation of fish catch particularly of the migratory pelagic fishes like tunas. There is no evidence to suggest that the FADs increase the overall number of tunas in a given area. Rather, they attract and gather fishes from a larger area to a smaller one and make them easier to locate and catch. As a result the catches and catch rates tend to be higher. Also, the FADs help to reduce the scouting time and fuel consumption. However, the negative aspect of FADs is that the young ones of tunas, especially of the yellowfin are attracted more, resulting in higher catch of juveniles in the FAD sites (18-20%) than in the non-FAD sites (4-5 %) This may affect the stocks and the future catches if not managed properly. Fish Aggregating Devices (FADs) were introduced in Lakshadweep waters in 2002 in the open sea as well as in the lagoons to aggregate fishes by the CMFRI under a World Bank Programme. At present, two National Institute of Ocean Technology (NIOT) data buoys off Minicoy and Pitti are acting as FADs. Lakshadweep administration is being deployed 30 FADs with the help of NIOT, Chennai. Data buoys for Arabian Sea Monsoon Experiments-Phase-II deployed by the National Institute of Ocean Technology (NIOT), 16-26 nautical miles off Minicoy and Kavaratti are functioning as FADs aggregating tunas as well as other fishes. It is observed that young tunas aggregate in large numbers than the adults. However, assured catches from the FAD sites made the fishermen to venture to these distant fishing grounds with GPS. There is good scope for improving the troll line fishing techniques by adding booms and having additional lines attached to the booms. These can also be operated while steaming from the island to the fishing ground and back as well as in the regions where FADs are installed.

Crop Production

History of the islands indicates that human settlement started in 6th century. The Lakshadweep islands were once fringed by a thick growth of Tamara *(Ternfortia boraginacea)*,Kanni (*Scaevola koenigii*), Chonam *(Pemphis acidula)*, Cheruthalam *(Pemphis stronga*), while inside large trees of Punna *(Calophyllum inophyllum)*,Cheerani *(Thespecia populnea)*, wild Almond and Banyan trees were found. The ground flora was thick and almost knee deep in certain places. The earliest settlers, who came from the Malabar cost, brought with them the Coconut tree, their *Kalpavriksha (*the beneficent tree of heaven). The earliest settlers who came from Malabar Coast, brought with them coconut and started cultivation. Islands were covered with various types of perennial shrubs and trees and thick coverage of ground with various species of grasses. Earlier settlers were nomadic type and they started coconut cultivation in certain patches. Interior part of the island was excavated to create water-logged condition to cultivate rice, other cereals like jower, sorgum, ragi, sweet potato and banana. Wild colacasia and cowpea were also cultivated. Modern Agricultural activities were commenced in the islands in the year 1955 by posting an Agricultural Demonstrator with his head quarter at Agatti island. During fiftees, sugar cane was cultivated at Agatti and sugar candy were produced. During 1958, Agricultural Demonstration units were established in all inhabited islands and a separate department for Agriculture has come to existence under U T administration. The main activities of Agricultural Department were production of good quality coconut seedlings, demonstration of the improved cultural and manurial aspects of coconut cultivation, control of pests and diseases, establishment of vegetable gardens. While agriculture remains the predominant land based economic activity for the island population and agriculture itself very largely means coconut cultivation. Cultivation is by and large rain fed with unique mixed farming practices. The yield in terms of nuts per tree and per hectare is very high, more than double the all-India average. Yet, coconut alone is unable to provide optimal returns from the land. The delicate ecology of these islands discourages large-scale use of chemical fertilisers. The uses of chemical fertilizers are practically banned in the islands, on ecological consideration.

Operational Holdings

As per the Agricultural Census data of 2005-06, Lakshadweep had a total operated area of 2,780 hectares, consisting of 10,242 operational holdings, of which nearly 87.35 per cent have an area of less than 0.5 hectare each, while another 8.16 per cent are in the size-class of 0.5 to 1.0 hectare group. The operational holdings in the size-class of up to 0.5 hectare, being 87.35 per cent of the total holding, possess only 46.23 per cent of the total operated area.
At the other end of the spectrum of holdings, lie the larger holders. About 1.33 per cent of the total number of holdings was in the range of 2 hectares and above and these comprised around 19.82 per cent of the total operated area. The inequality regarding distribution of operational

holdings is more significant in the case of total holdings (Table 0.8).Land Utilization Statistics of Lakshadweep from 1997 to 2007 show that the total cropped area accounts for 72% of the total geographical area.

Table 0.8 Number and Area of Operational Holdings

Sl.No.	Size of Holding(in ha.)	Individual Holdings		Joint Holdings		Total holdings	
		Number	Area	Number	Area	Number	Area
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	Below 0.5	8128	1119	120	29	8248	1148
2	0.5 - 1.0	708	479	14	11	722	490
3	1.0 - 2.0	241	324	2	4	243	328
4	2.0 - 3.0	87	194	4	10	91	204
5	3.0 - 4.0	17	60	1	4	18	63
6	4.0 - 5.0	7	31	0	0	7	31
7	5.0 - 7.5	4	23	0	0	4	23
8	7.5 - 10.0	8	67	0	0	8	67
9	10.0 - 20.0	1	10	0	0	1	10
10	20.0 & ABOVE	0	0	0	0	0	0
11	ALL CLASSES	9201	2305	141	58	9342	2363

Source: Agriculture Census 2005-2006: http://agcensus.dacnet.nic.in/StateT1table1.aspx

Cropping Pattern and Productivity

The cropping pattern of Lakshadweep islands economy did not have any cereal cultivation which explains the absence generally of landless labourers. Coconut palms were leased out on tenancy arrangements and, in any case, did not require the degree of labour input as cereals do and, therefore, did not need a separate class exclusively to tend them. The soil, too, did not require much care. However, labour was required seasonally for collecting nuts, processing them into copra, vinegar, jaggery and coif on a small scale. The major labour demand came from operating the sailing boats during the limited period when trading activity with the mainland was to be carried out. The coconut production of 52.8 million nuts in the beginning of the 10th Five Year Plan (FYP) was enhanced to 58.0 million nuts by the end of the FYP significantly enhancing the productivity to 22310 nuts per hectare, the highest in the Indian Union. The production of coconuts in 2001-02 was 531.00 lakh nuts which increased to 645.31 lakh nuts in 2009-10 and 698.94 lakh nuts in 2010-11. The average yield per palm is 81 nuts per year. Total Copra production is 3,500 Tonnes. Andrott is the highest producer among the islands. The number of palms per hectare, which stands on an average at 241 and goes much higher in some of the islands, needs to be brought down to 180-200 as the existing high density reduces the availability of sunlight for the coconut palms as well as land for intercropping. *Laccadive Ordinary* and *Laccadive Micro* are the two time tested eco-types of the UT with high quality copra, higher oil

content and other superior attributes besides true organic[192]. Owing to the rapid subdivision and fragmentation of holdings, the farmers practice very close planting and plant more seedlings on the boundaries or corners to mark their fields, thus creating overcrowding of palms in all the islands. An average of 400-500 coconut palms of all ages is available in one hectare of land as against 170-200 normally recommended for optimum yield. This has resulted in a very low yield even in the absence of any major diseases.

More than half of the local demand for vegetables and fruits is met by importing from mainland. Almost 20% of the demand is met out of the production of Departmental Demonstration Farms and local farmers. A major chunk of family budget is spent on purchasing fruits and vegetables imported from the mainland. Crops such as banana, papaya, bread fruit, drum stick, sweet potato, water melon, sapota and vegetable crops are becoming popular, often as inter crop with coconut. On the lines of agricultural garden in Kadmat, similar vegetable gardens are planned in all the islands so that vegetables need not be transported all the way from the mainland.

Agro-development: Challenges

While there are many favourable factors for coconut cultivation in the islands there are many constraints as well. The most important being the very limited fresh water aquifer available in the islands, which is hardly sufficient for drinking purposes of its inhabitants thereby the entire farming essentially turned rain fed. Practically none could be grown irrigated. Secondly, there is no possibility of further expansion in the area of coconut or for any crop in that matter confining the entire crop cultivation within the limited area available. The geological farness of these small atolls from the mainland India also did contribute much to its backwardness in use of high tech agronomic interventions and market development. One of the constraints for the expansion of production and diversification lies in the potential threat to the environment. For example, in the agricultural sector, banana cultivation initiated some time back had to be discontinued owing to the heavy evapo-transpiration rate and lack of sweet water for nurturing it; and livestock rearing for milk or meat is difficult because of non-availability of grass, fodder and water. The adverse environmental impact of livestock activities has also been affirmed by studies carried out by the Island Development Authority. Even poultry development is riddled with problems of waste disposal besides involving more serious ones relating to marketing support, development infrastructure, laboratory for certification of health of birds and products and cost and availability of feed. However, to meet the balanced essential dietary needs of the local populace stall-fed small units of cows and goats and poultry should be promoted by the government.

[192] *Op. Cit*. UTL, 2007, FYP 2007-12

Industry

The UTL has been declared as a "No Industry District" of the country in view of the fragile ecology of the islands. The inherent constraints of the area, especially being isolated and geographically scattered do not permit it to take up any major Industrial ventures. Locational disadvantages, non-availability of fresh water and power hinder development of even medium type of Industries. An Industries Department however exists in Lakshadweep which aims to develop small industries and entrepreneurship among local population. Industries which do not require much land, large quantity of water, power and which do not pollute the lagoons and soil, can only be considered in these tiny islands.Industrial activity in Lakshadweep centres on coir and fish. The ecological and environment considerations prevent the setting up of large-scale industrial units in these islands as is done for the mainland states. There are 41 registered industrial units in the government sector and 504 in the privatesector (2001-02). All the units in the private sector are small and medium scale dealing with coir, fish and various support activities. In the government sector, there are five coir fibre factories (units produce coir fibre, coir yarn, curled fibre and corridor mattings), five production demonstration centres, seven fibre curling units, a printing press, a hosiery factory, a tuna-canning factory and two boat building yards.

Lakshadweep Development Corporation

Lakshadweep Development Corporation, a registered organisation under Companies Act 1956, has been set up under the auspices of the Island Development Authority for developing the economic and commercial activities of the islands. This has taken over the Tuna Canning Factory at Minicoy and augumented its installed capacity which is 3 lakh canns per annum. A Desiccated Coconut Powder unit has been started at Kadmat and Commercial production started from 1.4.93. The average annual production of Desiccated Coconut is 60 tonnes. The Corporation is also diversifying this unit to produce Coconut Oil also. Marketing of Coir products produced by the Department of Industries has been taken over by the Corporation and is now able to fetch better prices than earlier. Jaggery, Vinegar and Coconut nursery unit had been set up at Kalpeni and Androtт respectively. A Masmin and fish meal unit was established at Agatti to produce masmin and utilise the bye-product as fish meal for poultry consumption. The annual installed capacity is 100 tonnes of masmin and 30 tonnes of fish meal. The annual turnover is estimated to be Rs. 90.00 lakhs from Tuna Canning Factory, Rs. 93.00 lakhs from masmin and fish meal unit at Agatti and Rs.24.00 lakhs from Desiccated Coconut Powder unit at Kadmat.

Cooperative Sector

The Co-operative movement has established very strong roots in the territory since the late sixties and has succeeded in knocking out the middleman. Public distribution of every article is

solely maintained through the cooperative societies in different islands. These cater to the needs of the entire population. More than half of the total population are members of Cooperative Societies while all households have been covered by membership. Cooperative societies play a crucial role in the administration of Lakshadweep. Under Lacadive and Amini Island, Co-operative Societies Regulation 1962, there are 55 societies registered. Each inhabited island has its own Marketing and Supply Society. An apex society, the Lakshadweep Co-operative Marketing Federation (LCMF) is responsible for procurement and supplies all materials through Island Marketing and Supply Societies to its members. Majority of the natives are members of their respective island society, and these cooperative societies, are in turn, members of the LCMF. The LCMF functions at the mainland, Cochin, Calicut and Mangalore, and supplies materials to all island societies according to their need. The secretaries of these societies are government officials appointed by the Registrar of Cooperative Societies, Lakshadweep. The societies receive grants and transport subsidies from Lakshadweep administration, and also act as Public Distribution Retail outlets of essential commodities to the poor people of Lakshadweep. Apart from the above-mentioned societies, Lakshadweep has many other societies registered with the Registrar of Co-operative Societies, Lakshadweep under the National Government Act, the Society Registration Act 1860. 22 Godowns exist in the 10 islands with the storage capacity of 6400 MT. Food Corporation of India (FCI) is setting up a Godown of 2,500 Tonnes capacity at Androth Island.

Tourism[193,194]

Economic Significance

The UTL administration has declared tourism as an industry. Lakshadweep is home to many rare species of marine life and is one of the biggest natural underwater zoos in the world. The administration aims to promote quality tourism that is sensitive to the ecology of the islands, that provide physical, economic and social security for the islanders and quality services to the visitors. The tourism sector has high potential for not only creating employment opportunities but also earning valuable foreign exchange thus indicating a potential growth for the island economy. The tourist season in the islands mainly runs from October to April i.e. outside the monsoon months. The tourist accommodation available is extremely limited and largely in the Government sector with very limited private accommodation. Bangaram Island has been developed as a tourist resort and operated by a hotel group from the mainland. In 2002 the Government of India launched its National Tourism Policy while for its part; the Lakshadweep administration had not yet framed a policy for tourism. Tourism growth in the Lakshadweep was 2-3 percent until 2004, lower than the projected 7 to 9 percent due to insufficient infrastructure.

[193] UTL, 2011. http://lakshadweeptourism.nic.in/, Accessed on 3 March 2012
[194] *Op.Cit.*, Planning Commission, 2007

The launch of the Star Cruise ship in 2006-2007 resulted in the influx of 25083 tourists in Lakshadweep, whose carrying capacity was a mere 8,000-10,000 tourists per year (Table 1.2.9).

Table 0.9 Tourist Arrivals in Lakshadweep and Revenue from Tourism

Year	No. of Tourists			Revenue (in Crore)
	Indian	Foreign	Total	
1999-2000	1379	741	2120	1.27
2000-2001	2992	871	3863	2.98
2001-2002	3259	539	3798	3.41
2002-2003	4151	580	4731	3.75
2003-2004	4045	656	4701	2.61
2004-2005	2430	158	2588	2.13
2005-2006	12875	1418	14293	6.1
2006-2007	22941	2142	25083	7.3
2007-2008	10263	2852	13115	15
2008-2009	5871	1172	7043	15

Tourism Infrastructure

The promotion of tourism in Lakshadweep has been entrusted to the Society for Promotion of Recreation &Nature Tourism (SPORTS). It is a registered society managed by senior officers of the administration and prominent citizens of Lakshadweep. Under the Lakshadweep administration, SPORTS, a society fully funded by the DOT, was set up to act as a flexible nodal agency for tourism operations in Lakshadweep. Tourism officers are tasked to serve as its Deputy General Managers (DGMs). Six members of the Board of Directors of SPORTS are heads of the following departments: Tourism, Industries, Public Works, Ports, Collector and Registrar of Co-operative Societies. The Administrator acts as Chairman, while the Secretary of the DOT acts as its Managing Director. Four tourism officers and three water sports instructors of DOT work with SPORTS, to which DOT has transferred tourism infrastructure on rent or lease. SPORTS has, in turn, leased tourism infrastructure to private tourist operators who provide and manage tourism facilities at par with international standards. The society has been acting as the hospitality wing of the administration. Since 2003, SPORTS has been managing the State Guest House, Kavaratti. SPORTS undertakes all tourism related packages, and runs the Govt. owned resorts and Dive Centres.

3.3.5.1.1.1 Tourism Policy

The policy of the administration for the promotion of Tourism in the islands is designed on the basis of the recommendation of Island Development Authority. Since the carrying capacity of these tiny islands has to be kept in mind, any activities related with Tourism have to be carried out with utmost care. This has stressed the necessity of preventing environmental imbalance

arising out Tourism and has recommended sea based Tourism so as to ensure that land resources are not over taxed. Therefore the domestic tourists are brought by ship and the night halt of tourists are arranged in such way that they are boarded from the islands before night taking in to account carrying capacity of the islands and shortage of essential items including drinking water. The experiment of day tourism has been found quite successful. International tourists to Bangaram are brought by flight from Kochi to Agatti, the nearest Island to Bangaram which is having an Airport. The restrictions imposed on the entry of visitors (the Laccadive Minicoy and Aminidive Islands (Restriction on Entry and Residence) Rules, 1967) and the remoteness ofthe islands from the mainland coupled with inadequate means of commutation, have led to only a modest level of tourism related activities for the economy of the territory. A study[195] on tourism in Lakshadweep observed that the four major constraints to development are the weak institutional set-up, low returns on resource utilization and lack of backward/forward linkages, inadequate infrastructure development in all islands, and threats to the ecosystem. These four constraints have caused the low growth of tourism that has in turn resulted to the slow growth of the economy of Lakshadweep.

Transport and Infrastructure

As the islands lie scattered in the Arabian Sea, and whenever a natural calamity occurs, the lifelines of these islands viz. communication and transportation are disrupted and the link between mainland and islands becomes non-functional. Maximum possible speed of ships available now with UTL is approximately 15 knots taking 18 hours to cover journey from mainland. UTL requires one additional 400 pax all-weather high speed ship, which can operate at a speed of 40 knots per hour, and reach any island in 6 hours from mainland. Since ship is the only mode of transportation for the local people it cannot ply between the islands during the period of disaster and the local people get stranded at their respective places. Mid-sea embarkation and disembarkation of passengers and cargo is very risky, especially in Monsoon period (high sea, high speed wind) and therefore Landing Barges are urgently required. The houses and other physical infrastructure (houses, roads, buildings, ports and harbours, airports and helipads, boats, crafts and catamarans, automobiles and vehicles, communication facilities) are also prone to damage caused by high-speed wind and uprooting of coconut trees.

[195] Meena, R., 2008. A Srategy for the Sustainable development of Tourism in the Lakshadweep Islands in India. Masters Thesis, Asian Institute of Management p.145

Energy

Power

The electrification of Lakshadweep islands was first taken up in 1962. Minicoy was the 1st island electrified in 1962. The 2nd island Kavaratti was electrified in 1963-64. Amini and Androtт electrified in 1965 and 1966 respectively. The remaining islands Kalpeni, Agatti, Kadmat, Kiltan, Chetlat, Bitra and Bangaram were electrified subsequently and now all the Islands are fully electrified. The source of generation is mainly through Diesel fired combustion engines. Till 1982, six hours power supply was provided in the islands. 24 hours power supply provided with effect from 1983 in all islands except Bitra. 24 hours electricity restored at Bitra from 1988 onwards with the introduction of solar photo-voltaic power plant of 5 kWp capacity.

Diesel Generators

Nearly 1.07 Cr. litres of diesel is used every year to create power. Lakshadweep administration requires 130 Lakh Litre HSD Oil every year for various departments - Electricity – 107.50 Lakh Litres, Fisheries– 10.50 Lakh Litres and Shipping – 12.00 Lakh Litres. Currently, the energy requirements in in the islands are being fulfilled by diesel run generators (16MW power is produced using 9 lakh litres of diesel every month), for which the diesel is imported in containers from the mainland and transported from island to island through boats. This is prohibitively expensive and tedious and adds to the overall vulnerability of the Islands. Since electricity is generated through diesel generators in all the Islands it is transported in 200/210 litre capacity barrels from Calicut in Kerala to the individual Islands and stored there. Lakshadweep Electricity Department also maintains an oil depot at Calicut, where oil is loaded into 200/210 ltrs. Capacity barrels and the barrels are then transported by barges, owned by Lakshadweep administration, to the off- shore of the reef. The barrels are again unloaded on small open barge for transportation to the jetties at the islands. On land they are transported by small trucks from Jetty to the island stockyard and stored there. The whole process of transportation is tedious, cumbersome and costly. The cost per KWh generation comes to Rs.10.56; however, it is provided to the consumers at the subsidized rate of Rs.4.27 (average) per kWh. To overcome the difficulties and to avoid unnecessary expenditure, it is proposed to construct bulk oil storage facilities in all islands in a phased manner.[196] The details of maximum energy demand in kilowatt are given in Table 1.2.10.

Table 0.10 Maximum Energy Demand (kW)

Islands	2002 -03	2003-04	2004-05	2005 –06	2006-07
Minicoy	999	982	1126	1150	1210
Kavaratti	995	985	1200	1285	1320

[196] *Op Cit.*, Planning Commission, SDR, 2007

Amini	575	590	663	680	695
Androtт	875	880	880	867	890
Kalpeni	425	425	490	500	510
Agatti	545	495	629	642	650
Kadmat	470	490	540	565	580
Kiltan	306	349	350	369	393
Chetlat	260	268	265	275	299
Bitra	30	32	35	35	43
Bangaram	24	24	26	45	49
Total	5504	5520	6204	6413	6639

Table 0.11 Diesel Generating Capacity of Various Islands (kW)

Name of Island	Existing capacity	To be added	To be scrapped	Total
Minicoy	2800 kW	1000 kW	800 kW	3000 kW
Kavaratti	3800 kW	1000 kW	800 kW	4000 kW
Amini	1900 kW	1500 kW	400 kW	3000 kW
Androtт	2750 kW	1500 kW	500 kW	3750 kW
Kalpeni	1250 kW	1200 kW	750 kW	1700 kW
Agatti	1700 kW	1200 kW	900 kW	2000 kW
Kadmat	1000 kW	1200 kW	750 kW	1450 kW
Kiltan	1000 kW	400 kW	200 kW	1200 kW
Chetlat	700 kW	400 kW	200 kW	900 kW
Bitra	80 kW	120 kW	Nil	200 kW
Bangaram	120 kW	120 kW	Nil	240 kW
Total	**17100 kW**	**9640 kW**	**5300 kW**	21440 kW

Problems with the Current System: Electricity generation is mainly through diesel generators. There are 11 Diesel Generator Power Houses in the 10 inhabited and one uninhabited island. Diesel comes from the mainland making it expensive and the process of transportation cumbersome. In addition, there are 11 Solar Power Voltaic (SPV) plants established with capacity of one megawatt. The time series data on installed capacity, generation and actual

consumption of power during year 1999 to 2009 are given in Table 1.2.20.[197] It provides the details of the installed capacity, generation and consumption.

Table 0.12 Installed Capacity, Generation and Consumption

YEAR	Installed Capacity In KW.		Generation (000kWh)		Consumption (000 kWh)
	Diesel	Solar	Diesel	Solar	
1999-2000	9972	Nil	19397.9	Nil	17122
2000-2001	9922	Nil	19819.6	Nil	17387
2001-2002	9837	Nil	19855.8	Nil	17386
2002-2003	9887	685	20379.0	508	18228
2003-2004	9878	685	21352.0	526	18965
2004-2005	9878	775	22054.0	559	19977
2005-2006	9924	850	25275.0	498	22542
2006-2007	9924	850	27704.6	446	24165
2007-2008	12174	850	28420.0	447	24248
2008-2009	14350	1050	30385.0	559	23492

Electricity generation by diesel generating sets is not only an expensive proposition but also a cause of concern because of its adverse impact on the ecology and environment. The highly fragile ecology of Lakshadweep faces serious adverse consequences of air, water or noise pollution, which are inevitably associated with power generation through diesel sets. The transportation of high speed diesel oil to the islands is difficult and expensive. In order to meet monsoon requirements of the DG sets diesel oil is stored well in advance. The storage of diesel oil for long periods in 200 litres drums not only results in wastage of the diesel oil through leakage but also affects the ecological condition of these Islands. Moreover, as the soil in these islands is highly porous, the seepage of oil from diesel generators as well as during transportation at various places such as loading and unloading locations, jetty, powerhouse, etc. and supply/storage in damaged leaky barrels pollute the water and the soil.

The presence, accumulation and increasing concentration of oil and grease will have adverse effects on coral reproduction, growth rate, photosynthesis, cell structure, colonisation capacities, feeding and behavioural responses in the long-term. For humans, consumption of water containing fuel oils or their derivatives is reported to be carcinogenic on a long-term basis. The coral Islands of Lakshadweep is highly fragile ecologically and hence no pollution, either air, water or noise, is the key for preserving and conserving the Islands. However, diesel generation causes water, air and noise pollution. The smoke/fume from the generating sets adversely impacts on the ambient air quality; Lakshadweep soils being highly porous the seepage of oil

[197] *Basic Statistics 2009*, Directorate of Planning and Statistics, Secretariat, Lakshadweep-Kavaratti

from generating sets as well as storage pollute the water. Moreover, diesel generation of power is a big drain on a non-renewable source. Another problem is that due to the high density of coconut trees and high velocity of wind, trapping of overhead lines and the snapping of conductors are frequent. Further, the saline atmosphere causes corrosion of joints of metal parts, leading to disruptions in the power supply. These also contribute to heavy distribution losses in the islands. It may also be stated that despite the emphasis proposed for alternative sources, the conventional diesel oil based power generation will have to continue to be a significant source for power for the coming years, at least till the alternatives stabilise on a commercially viable scale.

Non-Conventional Sources of Energy (NCSE)

The environment and ecology related problems accruing to the existing diesel based power generation system in the island can to some extent be addressed by increasing usage of new renewable alternative sources of energy such as solar, wind and biomass. Such schemes for alternative and renewable energy sources will lead to saving of precious fossil fuel and therefore have a significant beneficial impact. Another option, of wave energy, also exists but the technology is still not developed for its adoption on a commercial scale. In view of these problems the Union Territory of Lakshadweep has embarked up on the plan for solar power generation. While the capital investment for solar power plant is large compared to other means of generation but operation and maintenance cost is comparatively negligible. If the negative externalities associated with diesel generation are kept in view along with high cost of generation, meeting a part of need by solar power would appear to be a viable proposition. *The Lakshadweep administration has now decided to extend the use of renewables in the islands, so that at least 20% of the total power demand is met by these alternate energy sources initially and then progress to 100% electrification through renewable energy*[198].

Solar Energy

Solar energy has a lot of potential in Lakshadweep islands. The use of solar energy will also contribute to reduced emission of greenhouse gases. Geographical location, ecological considerations and energy demand pattern of Lakshadweep make solar energy, through the solar photovoltaic (SPV) generation, one of the most appropriate options to meet the energy demand of the island. The average solar radiation over the islands is 4.932 kWh/sq.m/day, which indicates a vast potential for harnessing solar energy Table 0.13. Among the inhabited islands, Minicoy, Kavaratti, Andrott and Kadmat are having high potential for harnessing solar energy.

[198]UTL, 2011., http://lakshadweep.nic.in/depts/electricity/renewable.htm, Accessed on 26 February 2012

Table 0.13 Annual Solar Energy Potential in Different Islands

Sl.No.	Island	Annual Electricity Generation Potential (in
1	Minicoy	1239.5
2	Kavaratti	1239.3
3	Amini	929.5
4	Andrott	1239.3
5	Kalpeni	929.5
6	Agatti	929.5
7	Kadmat	1239.3
8	Kiltan	433.7
9	Chetlat	309.8
10	Bitra	62
11	Bangaram	124
	Total	8675.4

Source: Ministry of Non-Conventional Energy Sources

Using the monthly radiation data and taking into account the 11 per cent efficiency of the solar panels and effective number of sunshine hours, dust, cloud cover, etc. the generation of about 8.4 million units of electricity per annum has been estimated from 0.139 sq.km area (about 4.6 per cent of the total islands area) assumed to be available for SPV power plants.

To supplement diesel power generation, solar power plants have been set up in all the islands in a small way to create 1 MW of power and are in existence for the last 10 years. Smokeless stoves developed by Indian Institute of Science, have been distributed to all the 10,000 households for using the coconut residues as fuel for cooking. Solar lanterns, solar torches and solar fans are also being distributed. Solar water heaters are being introduced and battery operated vehicles have become popular with more than 800 have been sold. The UT administration is setting up 100 KWP diesel grid interactive SPV power plants in nine inhabited islands except Bitra with the financial assistance from the Ministry of Non-Conventional Energy Sources. In addition, the Ministry of New and Renewable energy has sanctioned a Rs.40 crore project for enhancing solar power capacity by 1 MW in 4 islands together with renovation and maintenance of all the 12 existing solar plants in the islands during the year 2010-11. At present the SPV power plants are producing 1065 KWP energy in islands. The energy produced from these power plants of 1 MW capacity is expected to save diesel fuel equivalent to approximately 5.6 lakh litres per annum. The existing 10 kWp & 25 kWp stand-alone plants at Bitra & Bangaram islands have been

augmented to 50 kWp. The plant at Bangaram is a Solar – Diesel hybrid system, which is first of its kind in India.

Solar Lanterns

The administration is providing 8,455 nos. of solar lantern to the islanders, of which 17,00 are given to Below Poverty Line (BPL) families free of cost and the remaining ones at a subsidized rate of Rs.485/-. The adoption of solar water heaters, Solar Fish Drier and Solar Street Lights are other options that will be explored and adopted in near future. Through these integrated approaches, the UTL will be able to ensure energy security by meeting the growing energy demands in a much 'cleaner' and environmentally friendly manner(reduced oil spillage, land and water pollution, impact on ambient air quality, etc.) while also emitting less greenhouse gases.

Solar Based Technology: Limitations

The main limitation for the application of solar-based technology in these islands is the large land area requirement for setting up the solar photovoltaic power plants. Almost the entire territory is covered under dense coconut plantation, which is the main crop for income generation. This limits the availability of free land in these islands very severely. Whatever land is available, as also the rooftops, face lack of sunlight owing to the dense coconut tree cover. Owing to these reasons, stand-alone solar home lighting systems are also not feasible for lighting in these islands. As the large-scale solar energy based power generation systems require large uncovered areas, such plants can be set up in the lagoons.

Biomass Utilisation: Biomass Gasifier

Biomass power for generation of grid quality power, based on available biomass resources in the islands, appears to be another important renewable energy source. *Copra* is produced from the coconut and the dried husk is used for fibre extraction. There is, however, a very large quantity of unused biomass such as dried husk, leaves or cadjins, shells and sawmill biomass. The unused biomass in the islands is a major environmental problem, which may be tackled by utilising it for power generation through biomass gasifiers. It is estimated that the biomass requirement is only 2,100 tonnes (43.5 per cent of total availability of biomass) for 250 kW capacity biomass gasifier for 6000 hours operation (250 days per year). The Electricity Department is, however, facing a lot of difficulty in successfully running the gasifier due to technical problems. Servicing of equipment is likely to be an impediment for successful implementation of biomass gasification in the islands. As initiated and funded by the Ministry of Renewable Energy, the Institute for Energy Studies, Anna University, Chennai has conducted Biomass Resource Assessment Study in 6 Islands in Lakshadweep. Island wise residue generation details are furnished in Table 0.14. The Amini Island contributes the maximum biomass residue generation.

Table 0.14 Island wise Generation of Biomass Residues

Sl. No.	Island	Residues Tons per Year
1.	Androtт	9940
2.	Kalpeni	7130
3.	Kavaratti	8800
4.	Amini	15000
5.	Kadmat	3970
6.	Kiltan	2830

Source: Ministry of Non-Conventional Energy Sources

Biomass Gasifiers: Limitations

Though the pollution potential of biomass gasifiers is relatively low, it does produce airborne emission such as SO_2, NO and CO_2, though at a reduced level compared to coal or hydrocarbons. The land requirement for storage of biomass and plant is also relatively high. The biomass and water requirement are very high for most popular biomass gasifiers (Direct fixed system). As the land and water resources are both critical to the island system, any stress on these is considered undesirable. Yet another concern is that the enhanced levels of biomass requirements for biomass gasifiers may result in stress on biomass. However, on the whole, the concept of biomass based power generation seems to have considerable merit and deserves serious consideration.

Biomass based Cooking

80% of the islanders are using coconut by-products for cooking which produce the highest level of Green Gas in island. The high population density per sq.km in Lakshadweep and non-availability of enough LPG cylinders for cooking purpose magnifies the situation worse. The administration under Agriculture sector had purchased and distributed 1000 Nos. smokeless stoves to BPL families at free of cost during the year 2009-10. The work is also under progress to purchase 11000 more for the remaining BPL families in islands. Moreover Ministry of petroleum has agreed to the administration's request and allocated 1000 LPG cylinders per island every month. These all effective development measures would definitely help to reduce the greenhouse gas emission in islands.

Wind Energy

Wind resource assessment had been undertaken by the Ministry of Non-conventional Energy Sources in association wIth the local Electricity Department at two locations namely Agatti and Minicoy Islands. The wind resource survey analysis indicated that between May and November, only the months of June, July and August have the highest wind speeds of about 8 to 9 m/s. The remaining months have hourly wind speeds greater than 2.8 m/s and there is no significant variation in the hourly wind speeds in a typical month. Wind energy has, therefore, the potential for energy generation in Lakshadweep. One of the favourable point for wind electric generators is that they cause relatively small adverse impact owing to marginal land requirement and

removal of vegetation. The beneficial impacts of these systems depend, to a large extent, on the height and location of the tower and wind pattern. Based on the available data for the island, a rough estimate of the electricity generation potential through wind energy for each island is given in Table 0.15. There are a few limitations in promoting wind energy for electricity generation in these islands, which include inadequate shipping and unloading facilities in the islands for the equipment and machinery heavier than two tonnes. In view of this, wind electric generators up to 100 kW capacities seem to be feasible for installation in these islands. Another limitation is the mast height of the generator, which needs to be higher than that of the coconut trees so that theavailable wind speed is fully utilised. The minimum clear area around the wind generators and the strong foundation requirements could also be a limitation.The feasibility for installation of an offshore wind farm may also be considered for greater levels of power generation, as this could possibly offset the capital cost and would also not pose any additional stress on the already scarce land resources. This, however, can be a technical challenge.

Table 0.15 Estimated Potential for Electricity generation through Wind Energy

Sl.No.	Island	Annual Electricity Generation Potential (in 000' kWh)
1	Minicoy	1239.5
2	Kavaratti	1239.3
3	Amini	929.5
4	Andrott	1239.3
5	Kalpeni	929.5
6	Agatti	929.5
7	Kadmat	1239.3
8	Kiltan	433.7
9	Chetlat	309.8
10	Bitra	62.00
11	Bangaram	124.00
	Total	8675.4

Source: Ministry of Non-Conventional Energy Sources

Wave and Tidal Energy

Ocean will supply enormous amount of energy in the form of wave energy, tidal energy and energy from the thermal gradient between the layers of the ocean waters from surface to few meters below. Tapping of this energy need interventions of scientific organizations like NIOT, NIO etc. Prototype plants can be developed as pilot projects (With the help of MNRE) for generating electricity in these far flung islands at their own cost as done in the case of Low Temperature Thermal Desalination Plant installed and commissioned by the National Institute of Ocean Technology, Chennai. Wave power cannot be economical as a stand-alone facility at the present level of development. To make it viable it has to be developed as a multipurpose scheme. Harbour protection, coastal erosion control, mariculture, desalination, seafood processing,

coastal waterways, tourism, etc. can be coupled with wave power schemes. However, the situation in the Lakshadweep islands is favourable for wave power generation, even as a stand-alone system considering the non-availability of other sources and high cost of diesel power generation. The Centre for Earth Sciences Studies, Thiruvanthapuram had undertaken a study sponsored by the Department of Ocean Development and prepared a project report for tapping wave power in Lakshadweep Island in the year 1992. As per this study, wave based power generation may be appropriate during the rainy season when intense wave conditions prevail. The recorded wave data had shown that the wave power potential is higher at the Lakshadweep location than that at Vizhinjam, Thiruvananthapuram, Kerala (India's first pilot wave power plant was established in the sea off Vizhinjam at Thiruvananthapuram and the 150 kW capacity Oscillating Wave Column (OWC) device deployed at 12 m depth is connected to the main breakwater of the Vizhinjam fishing harbour). Further detailed studies for assessing the potential and possibilities of wave power generation need to be conducted.

Energy from Waste

Various organic biodegradable wastes and effluents such as sewage, night soil, fish wastes, slaughterhouse wastes, etc. are being generated in the islands, which are leading to acute problems of ground water/environmental pollution, endangering the health of the inhabitants. All such wastes/effluents may be gainfully utilised in Anaerobic Digestion plants for generation of biogas, which can be used as fuel for direct thermal applications (cooking, water heating, etc.) or even for power generation, with the attendant benefit of abatement of environmental pollution.

Annexure XI Climate Change Scenarios: Past and Future

Rainfall

Rains are the most important fresh water resource for crop/biomass production, livestock rearing, aquaculture, domestic consumption and environmental services. Annual rainfall of Lakshadweep islands generally decrease from south to north; but southwest monsoon rainfall (during June to September) increase from south to north. The rainfall data of various islands in Lakshadweep are collected at two stations of Indian Meteorological Department located at Minicoy and Amini (Table 0.16) and the actual rainfall data does not show much variation in recent years, except for Amini in 2004. Amini Divi recorded 1168 mm rainfall on May 6, 2004 and created a record for the north Indian Ocean. It was associated with a passage of a tropical cyclone. It is worthwhile to mention that this station recorded 1840mm rainfall during just three days viz. May 5-7, 2004[199], whereas the heavy downpour that wreaked havoc in Mumbai on 27 July 2005 was only 944 mm.[200] The average annual rainfall recorded in Lakshadweep is 1600 mm. The mean annual rainfall ranges from 1715 (Amini) to 1934 mm (Androtт) of which 75-80 per cent is distributed from May to November/December. The main advantage is that there is some rainfall in the remaining months of the year to provide proper moisture for maintaining growth throughout the year of a typical humid tropical climate. Southwest monsoon period is the main rainy season which spans from late May to early October. As in the case of rainfall, the number of rainy days during the southwest monsoon season is also greater in the north than in the south. Annual rainfall generally decreases whereas the southwest monsoon increases from south to north.[201] The length of the dry period ranges between five and six months (November to April).

Table 0.16 Normal and Actual Rainfall in Lakshadweep

Year	Rainfall (mm)			
	Actual		**Normal**	
	Minicoy	**Amini**	**Minicoy**	**Amini**
1980	1410	1448	1660	1519
1981	1583	1553	1660	1519
1982	1713	1072	1660	1519
1983	1476	1627	1660	1519
1984	1425	1194	1660	1519
1985	1574	1353	1660	1519
1986	1312	1236	1660	1519

[199] Khladkar, R.M., P.M. Mahajan and J.RKulkarni. 2009. *Alarming Rise in the Number and Intensity of Extreme Point Rainfall Events over the Indian Region Under Climate Change Scenario*, RR no. 123. Indian Institute of Tropical Meteorology.

[200] Sud,S. 2005.Overall Rainfall 2% Above Normal, Monsoon Watch http://www.business-standard.com/india/news/overall-rainfall-2-above-normal/219667/

[201] UTL, 2011. h1997ttp://lakshadweep.nic.in/documents/Presentation/Depts/6.pdf, Accessed on 26 Febraury 2012

1987	1312	1385	1660	1519
1988	1512	1385	1660	1519
1989	1886	1553	1660	1519
1990	1206	1307	1660	1519
1991	1666	1660	1660	1519
1992	1737	1688	1660	1519
1993	1813	1091	1660	1519
1994	1834	1493	1660	1519
1995	1682	1610	1660	1519
1996	1583	1627	1660	1519
1997	N.A	NA	NA	NA
1998	1582	1627	1660	1519
1999	1857	1841	1660	1519
2000	1620	1101	1660	1519
2001	1505	1252	1660	1519
2002	945	1051	1660	1519
2003	1620	1497	1660	1519
2004	1550	3089	1660	1519
2005	1400	1388	1660	1519
2006	1804	1645	1660	1519
2007	1474	2211	1660	1519
2008	1928	1839	1660	1519

Source: Basic Statistics, 2009, Lakshadweep administration

Rainfall in the southern islands is more uniformly distributed as compared to the northern islands. June to September rainfall is 70 per cent of the annual in the north and only 56 per cent in the south islands. The southern island receives 20 per cent and northern 15per cent of the annual rainfall during October and November. June is the rainiest month contributing 25 per cent in the north and less than 20 per cent of annual rain in the south. Rainfall decreases progressively after June in the north whereas the south experiences a secondary maximum in October (bi-modal) owing to the influence of the northeast monsoon. Yearly variation in rainfall also increases from south to north. On an average the number of rainy days (72.5 mm rainfall) in a year was 80 at Amini (north) and 94 in Minicoy (south). The air is humid throughout the year, the relative humidity being always over 70 to 75 per cent. Such a climatic pattern, coupled with other natural and ecological factors such as the Eddie oceanic currents are believed to be the main factors behind the origin and development of these coral islands.

Temperature

The economy of most small islands is intrinsically linked with the subsistence agricultural production, aquaculture, fisheries and tourism.[202] The heat stress due to a rise in surface air temperature stands a good chance of disrupting the terrestrial, marine and agro-ecosystems in such islands.[203] The temperature in Lakshadweep Islands remains moderate all through the year, ranging between about 24 and 32 degrees Celsius and the relative humidity (RH) varies between 70-75 percent. April and May are the hottest months in the year. Throughout the year, the air is humid (Figure 0.3). 1998 was the warmest year on record and 1990s were the warmest decade recorded. At the India level, increase of 0.4°C has been observed in surface air temperatures over the past century. In India, the projections for the coastal region represent the climate projections for the western coast and the eastern coast together[204]. In the western coastal region, annual temperatures are likely to increase to 26.8°C–27.5°C in the 2030s. In the eastern coastal region, the annual air temperature is likely to rise from 28.7±0.6oC to 29.3±0.7°C. The rise in temperature with respect to the 1970s is around 1.6°C to 2.1°C. The rise in temperature with respect to the 1970s will be between 1.7°C and 1.8°C[205].

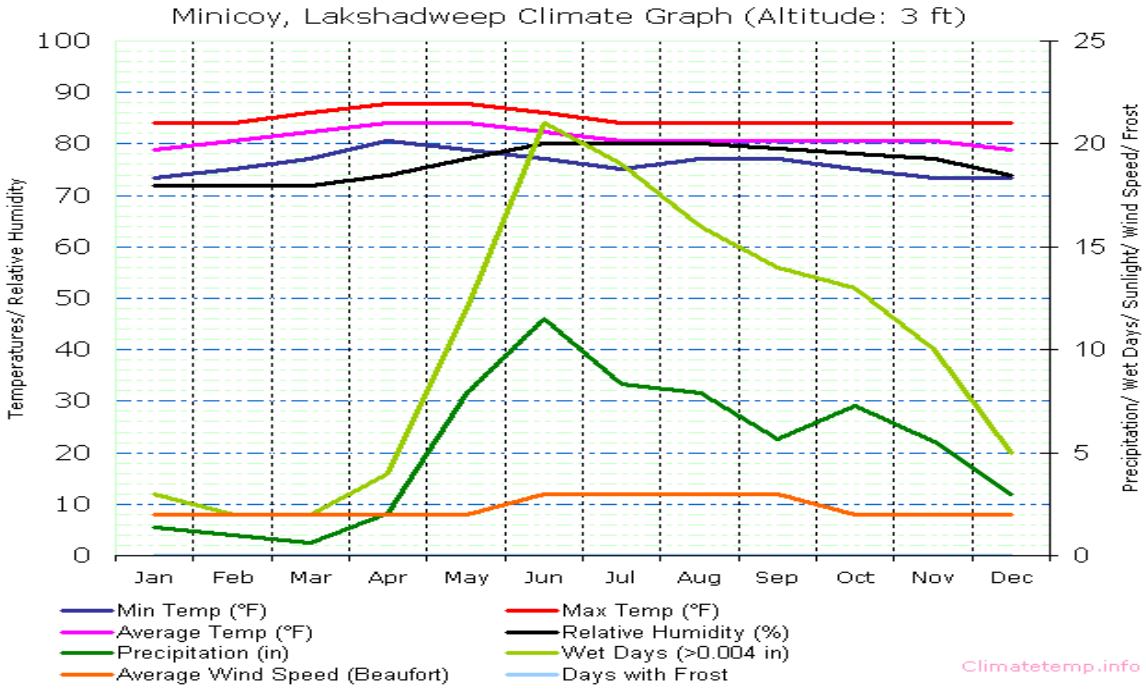


Figure 0.3 Lakshadweep Climate Graph: Temperature and Humidity

[202] Hess A (1990) Sustainable development and environmental management of small islands—an overview. In: Beller W,D'ayala P, Hein P (eds) Sustainable development and environmental management of small islands. UNESCO, Paris, p 3–14

[203] Benioff, R., S. Guill and J. Lee, 1996: *Vulnerability and Adaptation Assessments: An International Handbook.* Kluwer Academic Publishers, Dordrecht.

[204] MoEF, 2010, Climate Change and India: A 4X4 assessment – A sectoral and regional analysis for 2030s.

[205] *Op.Cit*, MoEF, 2010

Sea Surface Temperature

A gradual warming of Sea Surface Temperature (SST) and a general warming trend in surface air temperature in all small-island regions and seasons are predicted.[206] It has been reported that climate change is affecting the development process in Small Island territories across the world. Observational records have shown that sea surface temperatures have been increasing by 0.1ºC per decade in the oceans where most small islands are located.[207] Studies have also shown that annual and seasonal ocean surface and island air temperatures have increased from 0.6°C to 1.0°C since 1910 throughout a large part of the South Pacific.[208] However, it must be cautioned that, because of scaling problems, these projections for the most part apply to open ocean surfaces and not to land surfaces. Consequently the temperature changes may well be higher than current projections. Projected changes in seasonal surface air temperature and precipitation for the three 30-year periods (2010 to 2039, 2040 to 2069 and 2070 to 2099) relative to the baseline period 1961 to 1990, have been prepared for all the sub-continental scale regions of the world, including small islands.[209] Researchers used seven coupled atmosphere ocean general circulation models (AOGCMs), the greenhouse gas and aerosol forcing being inferred from the IPCC Special Report on Emissions Scenarios (SRES) A1FI, A2, B1 and B2 emissions scenarios.[210] All seven models project increased surface air temperature for all regions of the small islands. For the Caribbean, Indian Ocean and Mediterranean regions, analyses show warming trends ranging from 0°C to 0.5°C per decade for the 1971 to 2004 period[211]. The numbers of tropical cyclones in small island regions are dominated by El Niño Southern Oscillation and decadal variability which result in a redistribution of tropical storms and a disruption of the paths taken by these storms. The surface water temperature varies between 28 – 31^{o} C while its salinity ranges from 34 to 37 ppt (salinity in Arabian sea is 39.8 ppt and ranges between 39-40 ppt)[212].

Intensity and spatio-temporal variability of the Indian Ocean warm pool depends largely on the seasonally reversing monsoon.[213]These strong winds force the ocean locally, and they excite propagating signals (Kelvin and Rossby waves) that travelling distances to affect the ocean remotely. A study reported that remote forcing plays a major role in the development of high

[206]Lal, M., H. Harasawa and K. Takahashi, 2002: Future climate change and its impactsover small island states. *Climate Res.*, **19**, 179-192.

[207]Nurse, L., et al, 2001, Small island states, In *Climate Change 2001: Impacts, Adaptation, and Vulnerability*, J.J.McCarthy et al (eds.), Contribution of Working Group II to the Th ird Assessment Report of the IntergovernmentalPanel on Climate Change, Cambridge University Press, Cambridge, pp. 842-975.

[208]Folland, C.K., J.A. Renwick, M.J. Salinger, N. Jiang and N.A. Rayner, 2003: Trends and variations in South Pacifi c islands and ocean surface temperatures. *J. Climate*, **16**, 2859-2874.

[209]Ruosteenoja,K., T.R. Carter, K. Jylhä and H. Tuomenvirta, 2003: Future climate inworld regions: an intercomparison of model-based projections for the new IPCCemissions scenarios. The Finnish Environment 644, Finnish Environment Institute,Helsinki, 83 pp.

[210]Nakićenović, N. and R. Swart, Eds., 2000: *IPCC Special Report on EmissionsScenarios*, Cambridge University Press, Cambridge, 599 pp.

[211] Ibid

[212] Planning Commission, Vist to Lakshadweep, 2008

[213]Vinayachandran and Shetye 1991. quoted in Neema, C.P, P. V. Hareeshkumar, C. A. Babu. Characteristics of Arabian Sea mini warm pool and Indian summer monsoon. Clim Dyn.

SST in the Lakshadweep region, which is favourable for the genesis of the monsoon on set vortex.[214] One of the studies reported that the sea level changes in the Lakshadweep Sea exhibits an annual cycle, with a low(high) appearing during July (January).[215,216] In view of the large dynamic variability of this region, under the aegis of the Indian climate research program, the Arabian Sea Monsoon Experiment field program was conceived, planned and executed in the Lakshadweep Seas to understand the coupling between the summer monsoon and the upper ocean[217].The Lakshadweep Sea, in the south-eastern Arabian Sea (SEAS),is of prime climatic importance, being situated in the Indian Ocean warm pool. It is also an area of marked oceanic dynamical activity. Several hydrographic cruises carried out during different seasons revealed striking contrasts between summer monsoon and winter monsoon seasons.[218] The advent of altimetry in the early 1990s allowed documentation of a clear seasonal cycle in the SEAS, with positive sea-level anomaly (SLA) during winter and negative SLA during summer. This feature was termed the Lakshadweep High and Low (LH/LL). The LS presents the highest SST of the world ocean during the pre-summer monsoon period, with values exceeding 30 ^{0}C in climatological conditions during April–May.[219]

214 Shenoi et al. 1999., quoted in Neema, C.P, Clim Dyn.

[215]Shankar, D. and S. R. Shetye (1997): On the dynamics of theLakshadweep high and low in the southeastern Arabian Sea.*J. Geophys. Res*., **102**, 12551–12562.

[216]Alvarinho J. Lui, and Hiroshi Kawamura. 2004. Air-Sea Interaction, Coastal Circulation and Primary Production in the Eastern Arabian Sea: A Review. Journal of Oceanography, Vol. 60, pp. 205 to 218.

[217]Gopalakrishna, V.V, F.Durand, K.Nisha , M.Lengaigne, T.P.Boyer, J.Costa, R.R.Rao, M. Ravichandran, S.Amrithash, L.John, K.Girish, C.Ravichandran, V.Suneel,2011. Observed intra-seasonaltointerannualvariabilityoftheupperoceanthermalstructure inthesoutheasternArabianSeaduring2002–2008

[218]Shetye et al.,1990,1991; Shankar and Shetye, 1997; Bruce etal.,1998; quoted in Gopalakrishna, V.V, F.Durand, K.Nisha , M.Lengaigne, T.P.Boyer, J.Costa, R.R.Rao, M. Ravichandran, S.Amrithash, L.John, K.Girish, C.Ravichandran, V.Suneel, 2010.Observed intra-seasonaltointerannualvariabilityoftheupperoceanthermalstructure inthesoutheasternArabianSeaduring2002–2008.Deep-Sea Research I 57:739–754

[219]Shenoi, S. S. C., D. Shankar and S. R. Shetye (1999): On thesea surface temperature high in theLakshadweep Sea beforethe onset of the southwest monsoon. *J. Geophys. Res*., 104, 15703–15712.

Annexure XII: Tsunami Inundation Maps for 1945 and 2004 Tsunamis

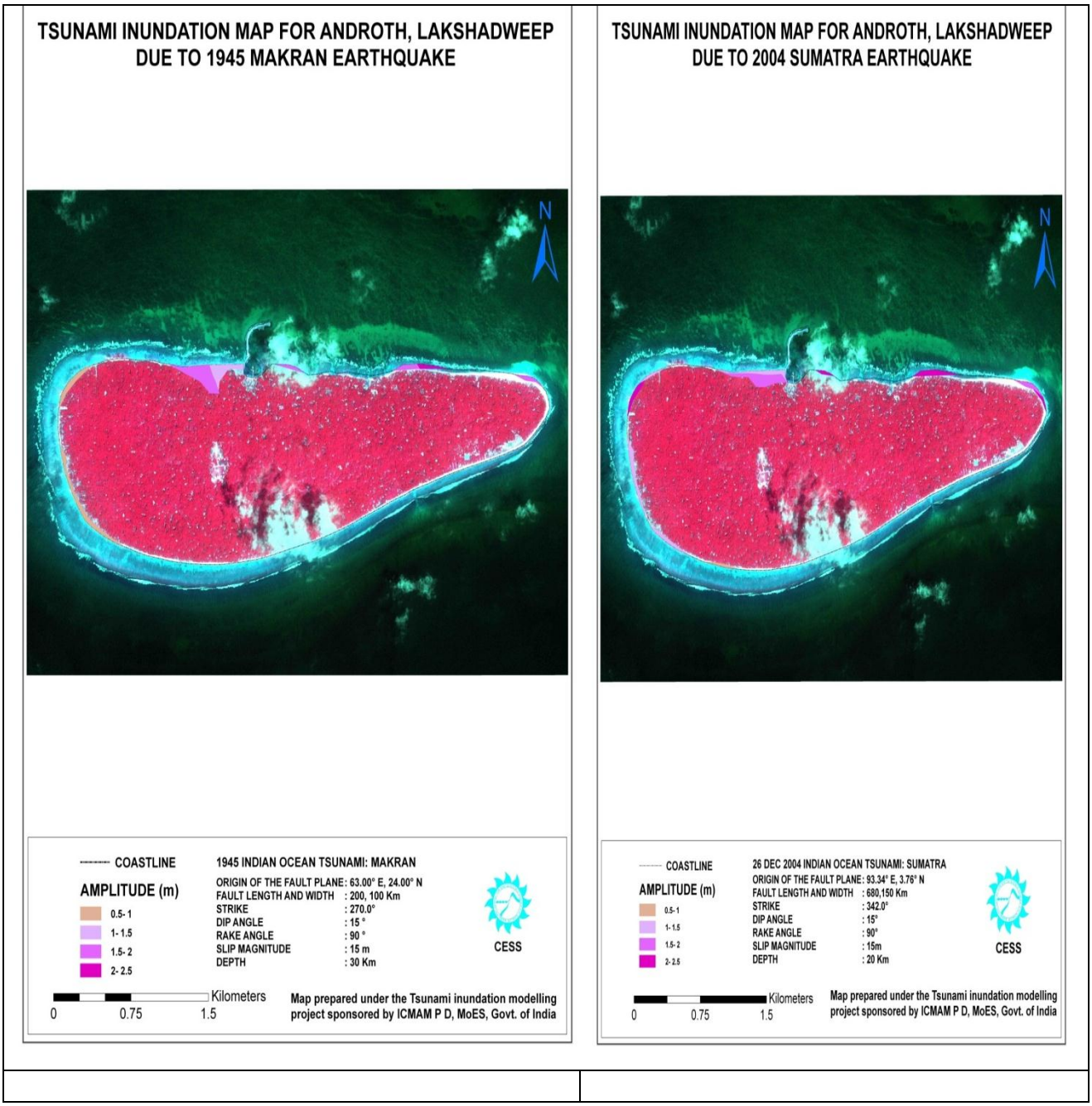


Figure 0.4 Tsunami Inundation Map of Islands- Androth

Source: CESS

Figure 0.5 Tsunami Inundation Map of Islands- Kadamat

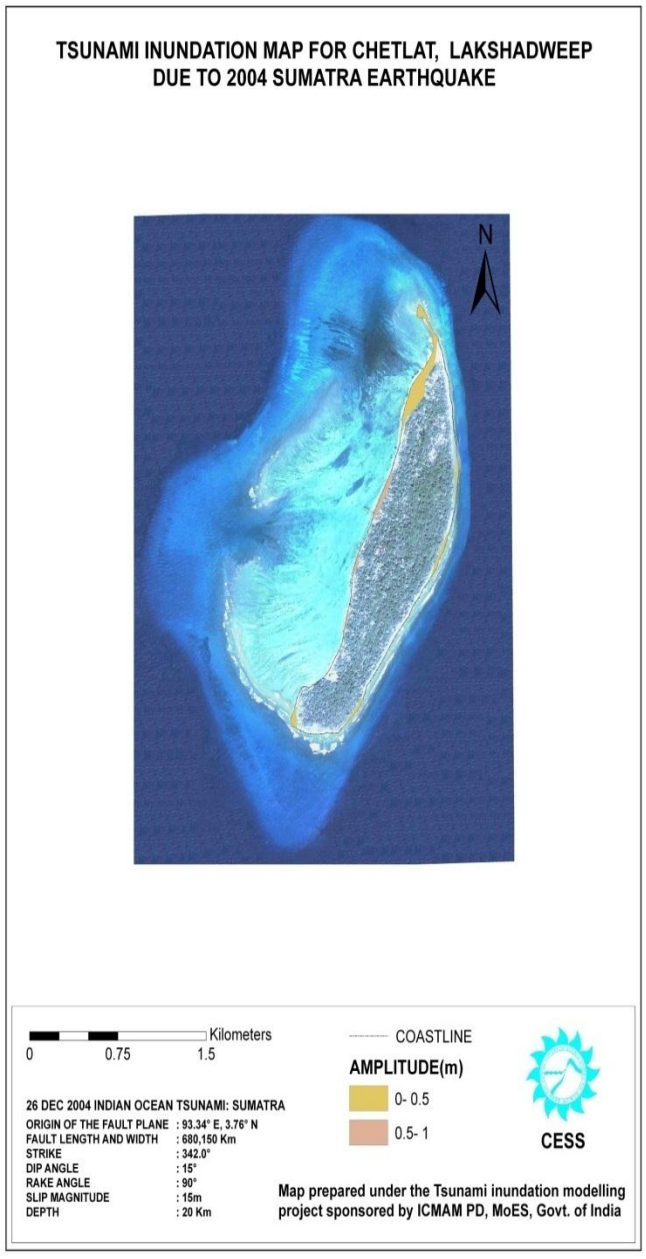


Figure 0.6 Tsunami Inundation Map of Islands - Chetlat

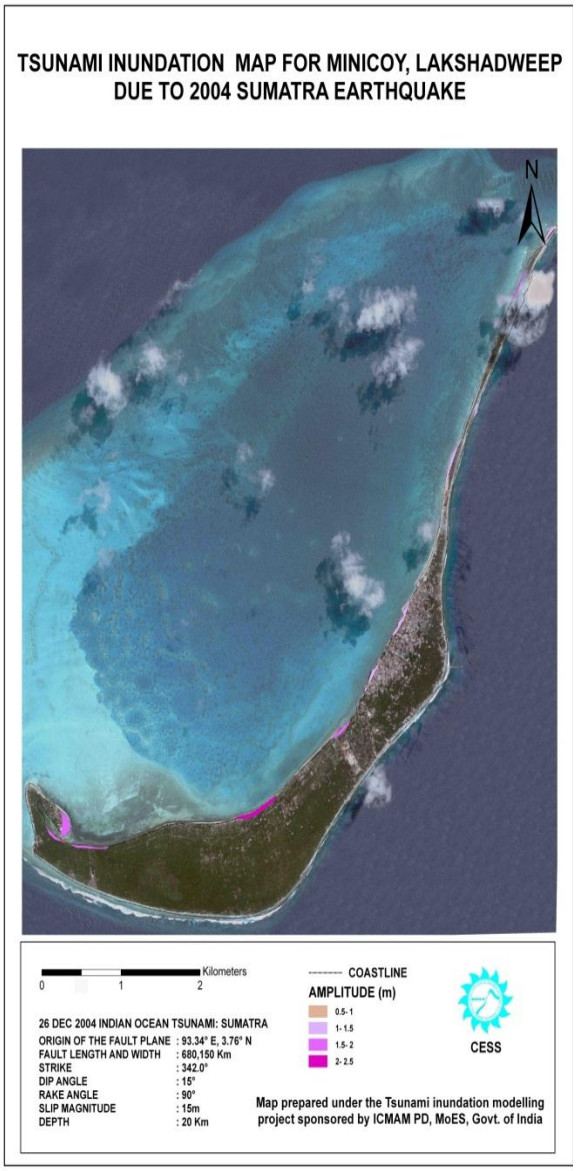


Figure 0.7 Tsunami Inundation Map of Islands- Minicoy

Annexure XIII Adaptation and Adaptive Capacity

Adaptation, in the context of climate change, comprises the measures taken to minimize the adverse impacts of climate change, e.g. relocating the communities living close to the sea shore, for instance, to cope with the rising sea level or switching to crops that can withstand higher temperatures[220]. Adaptation to climate change cannot be addressed in isolation but needs to be incorporated into developmental activities. Enhancing adaptive capacity will only be successful when it is integrated with other policies such as disaster preparedness, land-use planning, environmental conservation, coastal planning, and national plans for sustainable development.[221]Current government expenditure in India on adaptation to climate variability exceeds 2.6% of the GDP, with agriculture, water resources, health and sanitation, forests, coastal-zone infrastructure and extreme weather events, being specific areas of concern.

Box 0.1 System Characteristics that are Relevant for Adaptation

System Characteristics that are Relevant for Adaptation

- *Sensitivity*: degree to which a system is affected by, or responsive to, climate stimuli
- *Vulnerability*: degree to which a system is susceptible to injury, damage or harm
- *Impact potential*: degree to which a system is susceptible to climate stimuli
- *Resilience*: degree to which a system rebounds, recoups or recovers from a stimulus
- *Responsiveness*: degree to which a system reacts to stimulus
- *Adaptive capacity*: the potential or capability of a system to adapt to (to alter to better suit) climatic stimuli

While it is clear that implementing anticipatory adaptation strategies early on is desirable, there are obstacles associated with the uncertainty of the climate change projections. To overcome this uncertainty, it has been suggested that a better strategy for small islands is to enhance the resilience of whole-island socio-ecological systems, rather than concentrating on sectoral adaptation[222]. Inhabitants of small islands, individuals, communities and governments, have adapted to inter annual variability in climate and sea conditions, as well as to extreme events, over a long period of time. There is no doubt that this experience will be of value in dealing with inter-annual variability and extremes in climate and sea conditions that are likely to accompany the longer-term mean changes in climate and sea level. However, it is also true that in many islands traditional mechanisms for coping with environmental hazards are being, or have been, lost, although paradoxically the value of such mechanisms is being increasingly recognised in the

[220] Op.Cit., NAPCC, 2008

[221]Sutherland, K., B. Smit, V. Wulf and T. Nakalevu, 2005: Vulnerability to climate change and adaptive capacityin Samoa: the case of Saoluafata village. *Tiempo*, **54**, 11-15.

[222]Barnett, J., 2001:Adapting to climate change in Pacific Island countries: the problem of uncertainty. *World Dev.*, **29**, 977-993.

context of adaptation to climate change.[223,224]. Past studies of adaptation options for small islands have largely focused on adjustments to sea-level rise and storm surges associated with tropical cyclones. Vulnerability studies conducted for selected small islands show that the costs of overall infrastructure and settlement protection are a significant proportion of GDP, and well beyond the financial means of most autonomous/non autonomous small islands.[225] According to Wells (2000) the priority ingredients for successful (adaptation) programme are: Involving local communities in decision-making and management; Ensuring appropriate livelihoods for those immediately dependent on reefs for their income; Developing integrated coastal management frameworks for coral reef management; Involving the tourism and dive industries; Identifying mechanisms for sustainable financing; Promoting training and capacity building; Establishing long-term monitoring programmes

Mal-adaptation

Adaptation can also occur through the prevention and removal of maladaptive practices. Maladaptation has been defined by the IPCC as "any changes in natural or human systems that inadvertently increase vulnerability to climatic stimuli." An alternate definition for maladaptation is: "an adaptation that does not succeed in reducing vulnerability but increases it instead." Examples of laws and practices that can inadvertently increase vulnerability include: policies that lead to the destruction of mangroves; the relaxation of coastal setback regulations; absence of comprehensive coastal zone management and planning. Individuals can carry out maladaptive practices by deliberately ignoring the risks posed by climate change (such as repeatedly rebuilding property in a vulnerable zone). Maladaptation can occur because of underestimating, overestimating or mis-estimating the climate impact (adapted from Tompkins et al):

- Underestimating: money is wasted as the action is inadequate, for example building sea defences with an expected life of 50 years that are over-topped within 5 years;
- Overestimating: money is wasted as the action is overzealous, for example building sea defences that undermine natural beach processes and that are unnecessary during their 50 year life;

[223]MESD, 1999. Ministry of Environment and Social Development (MESD) (1999). Kiribati Government Initial Communication under the United Nations Convention on Climate Change. Retrieved from http://unfccc.int/essential_background/library/items/3599.php?rec=j&priref=2437#beg

[224]Fox, S., 2003: *When the Weather is Changing: Inuit Observations of Environmental Change*. Cooperative Institute for Research in Environmental Sciences, Boulder, Colorado: University of Colorado.

[225]*Op.Cit*., Nurse, et al., 2001

- Mis-estimating: for example sea defences are built but the most critical impacts from climate change manifest themselves as more intense rainfall events, so that inland flooding rather than coastal flooding is the problem.

In tiny islands where physical space is already very scarce, adaptation measures such as retreat to higher ground, raising of the land (which requires sand and other aggregates which may be unavailable) and the use of building setbacks would appear to have little practical utility[226].More recent studies have identified major areas of adaptation, including water resources and watershed management, reef conservation, agricultural and forest management, conservation of biodiversity, energy security, increased development of renewable energy, and optimised energy consumption. Proposed adaptation strategies have also focused on reducing vulnerability and increasing resilience of systems and sectors to climate variability and extremes through mainstreaming adaptation.[227,228,229,230] Risk-reduction strategies, together with other sectoral policy initiatives, in areas such as sustainable development planning, disaster prevention and management, integrated coastal zone management, and health care planning could be usefully employed[231]. In the longer term, studies indicate that increasing food security risks under climate change will require higher agricultural productivity, reduced production variability, and agricultural systems that are more resilient to disruptive events.[232]

Adaptation Best Practices

One of the studies suggested that mass coral mortality over the past decade at some sites in the Seychelles has resulted in a reduction in the level of the fringing reef surface, a consequent rise in wave energy over the reef, and increased coastal erosion. Further declines in reef health are expected to accelerate this trend. The most recent study found coastal protection to be the least-cost strategy to combat sea-level rise in Singapore, under three scenarios . The study noted that the annual cost of shoreline protection would increase as sea-level rises, and would range from US$0.3–5.7 million by 2050 to US$0.9–16.8 million by 2100. It was concluded that it would be more costly to the country to allow the coast to become inundated than to defend it. Studies have estimated the cost of protecting the coasts of Jamaica from a sea-level rise of one metre at US$462 million78. Adaptation costs have been estimated at US$71 million in Antigua and US$50 million in St Kitts and Nevis. Evidences project that that with a 1 m sea level rise, as

[226]Bird, E.C.F., 1993: Submerging Coasts: The Effects of Rising Sea-Level on Coastal Environments. John Wiley and Sons, Chichester, UK, 184 pp.
[227] Op.Cit., Shea, et al., 2001.
[228] Op.Cit., Hay, et al., 2003.
[229]*Op Cit* .ADB, 2004
[230]UNDP (United Nations Development Programme), 2005: Adaptation PolicyFramework for Climate Change: Developing Strategies, Policies and Measures.Cambridge University Press, Cambridge and New York, 258 pp.
[231] Nurse et al., 2001
[232] Cline, 2007; Stern, 2007; Halsnaes and Traerup, 2009; FAO, 2010

many as 1190 tiny islands that constitute the Republic of Maldives may be submerged. In low-lying atolls of Marshall Islands land loss is estimated to be nearly 60 ha of dry land (8.6% of the total land area). In Trinidad and Tobago (South Caribbean), beach erosion rates of 2 to 4 m yr–1 have already been reported in recent years.

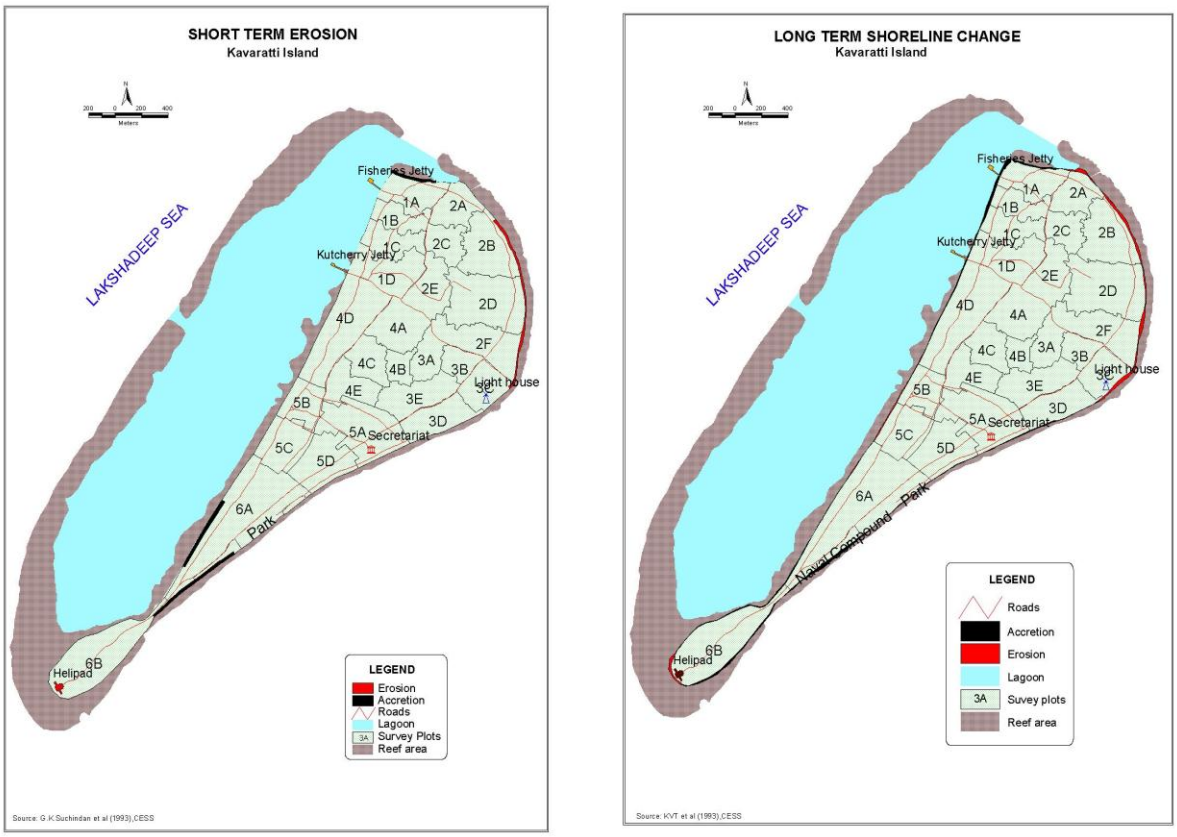


Figure 0.8 Long Term Shoreline Changes in Kavaratti

Source: CESS, 2006

Box 0.2 Climate Change Adaptation Best Practices

Climate Change Adaptation Best Practices

- Adaptation costs for small island states are more than $1 billion a year, or about 3 percent of the total estimated cost of adaptation. In relative terms, the adaptation costs are higher still, averaging 1 percent of GDP in small island states over 2010–50 compared with 0.03–0.1 percent for other developing countries.
- In the Maldives, degradation of protective coral reefs necessitated the construction of artificial breakwaters at a cost of US$ 10 million per kilometer (SCBD, 2009)[233].
- In Vietnam, the Red Cross began planting mangroves in 1994 with the result that, by 2002, some 12,000 hectares of mangroves had cost US$1.1 million for planting but saved annual levee

[233] IPCC, 2012.

maintenance costs of US$ 7.3 million, shielded inland areas from a significant typhoon in 2000, and restored livelihoods in planting and harvesting shellfish (Reid and Huq, 2005; SCBD, 2009).[234]

- Bangladesh, has implemented simple modifications to improve the cyclone resistance of (non-masonry) kutcha or temporary houses, with costs that amounted to only 5% of the construction costs (Lewis and Chisholm, 1996; Rossetto, 2007). Bangladesh is also developing national policies requiring that houses built following disasters include a small section of the replacement house that meets 'climate proofing' standards and acts as a household shelter in the next disaster.
- Improving water supply-demand management is an adaptation option or water sector. For instance, many small islands are resorting to alternative sources of water viz., rainwater harvesting, desalination etc.
- In many countries, climate-proofing guidelines and standards are applied to structures that are used as emergency shelters and for structures that form the economic and social lifeline of a society, such as its communications links, hospitals, and transportation networks (Rossetto, 2007).
- Using traditional knowledge is key in many Small Islands for enhancing resilience and finding strategies to cope with the changing climate. For example, on Timor Island, farmers have developed their own varieties of major staple crops to adapt to erratic rainfall and cyclones and to ensure food security. The implementation of traditional marine social institutions, as exemplified in the Ra'ui in Rarotonga, Cook Islands, is an effective conservation management tool, and is improving coral reef health[235].
- Many Small islands have already started to implement adaptation strategies on a local scale, often in an ad hoc manner. For example, placing concrete blocks on the top of zinc roofs to prevent the roofs from being blown away during hurricanes has become common practice in Jamaica since Hurricane Ivan.
- More ambitious, costly and technical projects include an ecosystem restoration programme in the Seychelles, which aims ultimately to translocate globally threatened coastal birds as well as rehabilitating native coastal woodlands on eleven islands in the country.[236]
- Risk-sharing and insurance***:*** Insurance is another way of reducing vulnerability and is increasingly being discussed in the context of small islands and climate change. However, there are several constraints to transferring or sharing risk in small islands. These include the limited size of the risk pool, and the lack of availability of financial instruments and services for risk management.
- Scotland has established a world center for ocean energy innovation and prototype testing facilities in the Orkney Islands, further demonstrating that islands can be important incubators for technology development and create significant opportunities for foreign direct investment, R&D, training, and employment.
- Small islands are exceptionally rich in ocean resources and endemic biodiversity, making them potential candidates for mineral/oil exploration and bioprospecting. (Bioprospecting is the search for wild species useful for the development of new products and processes such as crops and pharmaceuticals.)
- The Sustainable Livelihoods Approach or Framework has been used internationally for rural and coastal development to holistically describe the variables that impact livelihoods locally and to define the capacity, assets (both natural and social), and policies required for sustainable living, poverty reduction, and recovery from disasters (Brocklesby and Fisher, 2003; Yamin et al., 2005).

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[234] Ibid, p.

[235] Hoffmann, T.G., 2002: The reimplementation of the *Ra'ui*: coral reef management in Rarotonga, Cook Islands. *Coast. Manage.*, **30**, 401-418.

[236] Henri et al., 2004). Henri, K., G. Milne and N. Shah, 2004: Costs of ecosystem restoration on islands in Seychelles*Ocean Coast. Manage.*, **47**, 409-428.

- Possible measures to address impacts on infrastructure and settlements include: providing for the scientific and engineering services required to assess vulnerabilities and define priorities, then retrofitting buildings; integrating adaptation into population and resettlement programs; improving the planning and permitting processes to guide coastal zone activities, including regulatory adjustments, awareness raising and enforcement; producing design and construction guidelines and applying them in pilot investments.
- Ecosystem-based adaptation, which integrates the use of biodiversity and ecosystem services into an overall adaptation strategy, can be a costeffective strategy for responding to the effects of weather and climate extremes (SCBD, 2009).
- Mangrove replanting has been used as a buffer against cyclones and storm surges, with reports of a 70 to 90% reduction in energy from wind-generated waves in coastal areas (UNEP, 2006) and reduction in the number of deaths from cyclones (Das and Vincent, 2009), depending on the health and extent of the mangroves.
- Climate-based early warning systems for heatwaves and malaria outbreaks have been implemented at national and local levels to alert the population and relevant authorities that a disease outbreak can be expected based on climatic and environmental forecasts (Abeku et al., 2004; Teklehaimanot et al., 2004; Thomson et al., 2005; Kovats and Ebi, 2006).

Box 0.3 Adaptive measures in the Maldives: Case Study

Adaptive measures in the Maldives: Source: MOHA (2001)

Adaptation options in low-lying atoll islands which have been identified as especially vulnerable are limited, and response measures to climate change or its adverse impacts are potentially very costly. In the Maldives adaptation covers two main types of activities. First, there are adaptive measures involving activities targeted at specific sectors where climate change impacts have been identified. Second, there are adaptive measures aimed at enhancing the capacity of the Maldives to effectively implement adaptations to climate change and sea-level rise. Within these two activities the Maldivian Ministry of Home Affairs, Housing and Environment has identified several vulnerable areas and adaptive measures that could be implemented to reduce climate change impacts.

Vulnerable Area	Adaptation Response
Land loss and beach erosion	• Coastal protection • Population consolidation i.e., reduction in number of inhabited islands • Ban on coral mining
Infrastructure and settlement damage	• Protection of international airport • Upgrading existing airports • Increase elevation in the future
Damage to coral reefs	• Reduction of human impacts on coral reefs • Assigning protection status for more reefs
Damage to tourism industry	• Coastal protection of resort islands • Reduce dependency on diving as a primary resort focus • Economy diversification

Agriculture and food security	• Explore alternate methods of growing fruits, vegetables and other foods • Crop production using hydroponic systems
Water resources	• Protection of groundwater • Increasing rainwater harvesting and storage capacity • Use of solar distillation • Management of storm water • Allocation of groundwater recharge areas in the islands
Lack of capacity to adapt (both financial and technical)	• Human resource development • Institutional strengthening • Research and systematic observation • Public awareness and education

Box 0.4 Social Protection Measures for Climate Change Adaptation

Preferred social protection interventions include both protective measures (safety nets, cash transfers) and productive measures (livelihoods, asset protection, attention to natural resources and agriculture). Safety net programs, when designed to address climate hazards, should include investments in risk preparedness and response systems, with attention to gender issues in disaster mitigation. And they should include investments in the construction of community-level physical assets, such as water storage and land management systems. Harmonization and coordination among actors involved in disaster risk management, social protection, and longer term development are considered important. Both the Productive Safety Net Program (Ethiopia) and National Rural Employment Guarantee Act (NREGA) in India, for example, have elements that can be adapted to address climate risks. NREGA, in particular, has been shown to reduce distress migration by half in drought-affected sample villages.[237]

[237] World Bank, 2010. The Costs to Developing Countriesof Adapting to Climate Change*New Methods and Estimates*The Global Report of the Economics ofAdaptation to Climate Change Study. Consultation Draft. http://siteresources.worldbank.org/EXTCC/Resources/EACC-june2010.pdf

Annexure XIV Current Initiatives in building Adaptive Capacity through Institutions, Policies and Governance

Shoreline Protection

Tetrapods

The Public Works Department (PWD) has undertaken shore protection measures by placing large boulders or specially designed wave breaking concrete tetra pods, besides hollow blocks and coir bags. It has been pointed out that the engineering measures adopted for shore protection restrict access to and enjoyment of the beaches and coastlines for normal life apart from the development of tourism. These blocks are very expensive and optimisation of their utility is uppermost. The option of placing shore protection devices such as tetrapods on the reefs instead of on the shores may be explored, as this would enable unhindered access to the shores. The coastline of the UTL is subjected to erosion and accretion on account of natural phenomena as well as due to human interventions. Protection of the coast 'in principle' is governed under the provisions of the Coastal Regulation Zone (CRZ) Act, 2011. However, implementation of the provisions of the CRZ is constrained by practical difficulties in view of the limited geographical area and quest for development. Therefore, civil construction has continued in the islands well within the 500m regulated zone from the high tide mark.

Bio-shields

Eco-friendly techniques for shore protection such as growth of sea-grass also need to be explored. Coastal erosion by the sea waves is quite prevalent. Depending upon the orientation of the islands, direction of monsoon storms and the waves, erosion in one part and soil accretion or deposition on other parts of the same island appear quite common. The lagoon structure associated with an island is also important in guiding soil erosion or deposition (accretion) of weathered material. Unfortunately coastal or wetland vegetation like that of mangroves elsewhere, which offers a very effective wave breaking system, is generally absent in these islands. Some coastal vegetation has been observed in Bangaram and Minicoy (Keorha) but most other islands are devoid of such vegetative protection. Developing vegetative lining of the coast would facilitate wave breaking and thus help in protecting the shore. It has been suggested that solid block concrete rings or squares may be used and appropriate vegetation such as bamboo, casuarinas/others or rapidly spreading or crawling type vegetation observed in Bangaram may be planted within these concrete rings or squares. Such vegetation will provide better anchorage of concrete rings or squares and also provide a canopy to absorb waves. This will also provide additional energy (carbon) source for aquatic fauna and will enhance biodiversity, besides giving a pleasing appearance. Another solution recommended is cultivation of eco-friendly sea grass, afforestation measures like coastal forestry, agroforestry, farm forestry, and home gardens. The traditional approach of planting *Casuarina* plantations on the shores needs to be reviewed as

there are concerns that these plantations inhibit turtle nesting and breeding and other natural phenomena, besides causing restrictions for fishermen to access the shores and the sea. There have been community opposition on casuarina planting and hence alternative indigenous species have to be explored and considered.

Coral Reef Management

Management of Coral Reef and Lagoon

Due to high biodiversity and economic value, coral reefs are facing an unlimited and very high stress of disturbance viz., pollution, over fishing, walking over reefs, local site seeing, tourism, scuba diving, cowry pickers, octopus hunters etc besides the natural threats. The main cause of damage to reef and island are removal of coral blocks and collection of shingles. The Union Territory of Lakshadweep has banned the collection or removal of dead and live corals. Only in cases where a landowner specifically requests quarrying of limestones in his land, is he granted a permission to do, that too only up to a maximum of 100 m^3. After the corals have been brought under Schedule I of the Wildlife Act, even this practice has been discontinued. Cleaning campaigns of the islands were undertaken with the help of NGOs and Panchayats. Regular lagoon cleaning is being carried out for keeping intact considering the biodiversity of the lagoons. Lakshadweep has many untouched and not disturbed virgin reefs like Suheli par with 78.96 sq.km of lagoon area, Baliyapani par with 57.46 sq.km of lagoon area, Cheiyapani par with 172.59 sq.km of lagoon area and Perumulpar with 83.02 sq.km of lagoon area are available. It is envisaged to declare any one of these virgin reef to a Marine National Park to protect for the interest of Nation and as well as to preserve the real biodiversity for the future generation.

Coral Transportation

The National Institute of Oceonography (NIO) and UTL has taken initiatives for the restoration of the reef by coral transplants, at Lakshadweep. The aim is to survey the reefs, create manpower and restore the reefs by coral transplantation. Coral reefs in India have been under stress for quite some time. Lakshadweep reefs bore the brunt of coral mining, souvenir coral collection, ground water pollution and mechanical damages owing to activities like dredging. While efforts led by scientists could identify these issues and suggest remedies, NIO realized that the conservation of coral reefs at Lakshadweep could be only successful if the local populations are involved in the project. As corals are distributed below water surface, at a depth of 50 m, assessment of their well-being and management requires competence in SCUBA diving and observation skills. In order to achieve these two objectives, NIO created dive centres in Lakshadweep, acquired diving kits, trained a broad spectrum of stakeholders ranging from officers, wardens, scientific staff to unemployed local youth from all 10 islands of Lakshadweep.

Marine Protected Areas for Lakshadweep

It is necessary to strengthen the institutional systems for the protection of biodiversity of the region. This calls for augmenting the monitoring mechanisms and periodic updating of the

database relating to the ecology of the region. Involvement of local people in these efforts through awareness building, marine area Biosphere programme and by empowering the local bodies is also crucial. As per the existing norms of the Coastal Regulation Zone (CRZ) Notification, 1991 as amended from time to time; the Lakshadweep Islands are classified as Coastal Regulation Zone (CRZ) IV. Since these Islands are covered by Coral Reefs which are fragile ecosystems or ecologically sensitive areas and accordingly have further been classified as Coastal Regulation Zone (CRZ) I. As per the CRZ norms no developmental activities are permitted in the CRZ I area. The *in situ* conservation strategy for marine living resources remains restricted to 3 major protected areas notified by the Govt. of India, in accordance with the provisions of the Wildlife Protection Act, 1972 [See 35(1) and 35(6)], constitution of India [Art. 48 A and 51A (g)] and CRZ Notification, 1991 [CRZ I, 6(2) and CRZ IV].

Considering the status, exploitation level and conservation needs, the Indian Wild Life (Protection) Act, 1972 made amendments in schedule I, III and IV of the act and in which it was recommended to insert sharks, sea horse and giant groupers in part II (A), all corals and sea fans in IV (B), 9 species of molluscs in IV (C), while sea cucumbers and calcareous sponges are included in the schedule II which also included 15 species of other mollusks.[238] Continuous monitoring of the reefs is necessary if the recovery is to be assessed (and assisted if possible) and the changes in the reef quality and the biodiversity composition are to be maintained. Accordingly, the Department of Science and Technology, Union Territory of Lakshadweep, released an initial funding of Rs 5 lakhs in January 1999. Subsequently, this financial support was augmented by grants from the Ministry of Environment and Forests (MoEF) every year since then, through its Management Action Plans (MAPs) for coral reef areas in India. The MAP design adopted for Lakshadweep by the MoEF has a five-pronged approach viz., Biophysical surveys, Infrastructure creation, Capacity building, Awareness creation, and Protection measures.

The Lakshadweep Marine Fishing Regulation 2000 (MFR 2000)

MFR 2000 aims at sustainable development of fisheries for achieving the goals of food for all, economic growth and employment generation in the islands. Various steps/measures can be adopted for this and the most important and immediate step should be to market the produces and enhance their welfare and standard of living. Suheli is to be made as an Exclusive Fisheries Island. The MFR 2000 aims at sustainable development of fisheries for achieving the goals of food for all, economic growth and employment generation in the islands. Various steps/measures can be adopted for achieving this; creation of an Exclusive Zone would be a right step towards this. Suheli with two islands,(Valiyakara and Chariyakara)very vast lagoon and highly productive open sea is the most ideal zone for the purpose. The energy requirement may be met

[238]Gazetter of India-Union territory of Lakshadweep. 2001. Administration of Union Territory of Lakshadweep.

from the windmills and solar energy and rainwater may be harvested in addition to the new NIOT model desalination plant for freshwater

Waste Management

To tackle the solid waste problem in Lakshadweep, the Department of Environment & Forests has every year been providing blue coloured waste bins to collect non-biodegradable wastes all over the islands. All the residents are asked to deposit the non-biodegradable wastes in these bins. The waste materials normally includes plastics, broken glasses, bottle containers, tetra packs etc. The collections of these materials are entrusted to Local bodies of Village (Dweep) Panchayat and regularly monitored by the officials from Department of Environment & Forest of the concerned island. The collected wastes are carried to the Central Garbage Depositories (CGD) and suitably disposed in the incinerators. The administration has also banned the use of pick up bags in entire U.T. of Lakshadweep under the Sanitation and Conservancy Bye Law of Panchayat Regulation Act, 2005[239]. Further all shop keepers are instructed not to use plastic bags for packing as carry bags except packed commodities, so as to reduce in flow of plastic materials in the islands. In Kiltan island, papers bags were distributed free of cost to shopkeepers with a view to discourage them from using plastics. The corollary benefits of this were the promotion of employment opportunities (for manufacture of paper bags) in the islands as well as a cleaner environment.

Lakshadweep Pollution Control Committee

The Lakshadweep Pollution Control Committee (LPCC) which was formed during in the year 2001 is the Nodal Agency to implement the following Acts and Rules.

- Environment (Protection) Act, 1986 and Rules
- Water (Prevention and Control of Pollution) act, 1974 and Rules
- Air (Prevention and Control of Pollution) Act, 1981 and Rules.

The Major Functions of the Committee are stated below:-

- To implement the provisions of Bio Medical Wastes (Management & Handling) Rules, 1988
- To plan comprehensive Programme for the prevention, control and abatement of pollution
- To advise the UT administration on any matter relating to pollution
- To encourage, conduct and participate in pollution control programmes and disseminate the information available with us on the above subject.

[239]Polythene bag bye law of the Lakshadweep Administration

Traditional Knowledge for Resource Management

For awareness creation a book on Traditional knowledge of navigation in the islands, titled 'Marijan' was published. One of the recommendations of STAPCOR 98, leading to current Management Actions, was that traditional knowledge should be documented for posterity. Accordingly, a search among the islanders having such experience as sailors was done and their wisdom was shared. Until two decades back, navigation between the islands was made by following the position of stars, interpreting atmospheric and weather features intuitively. This skilled knowledge base was handed down through generations. Such a knowledge base comprises of distribution of reefs, banks and shoals, fisheries around the islands, water movement and currents and sensitivity to some biodiversity components in the reef. With the advent of modern navigation techniques, this knowledge base is getting eroded: at the moment, it is limited to a handful of seasoned sailors, numbering less than a dozen.

Annexure XV: Schemes initiated in XI Five Year Plan

FISHERIES: Opportunities, Entry Points and Schemes – 11th Plan

The major programmes for the XI Plan are Supply of Mechanised fishing boats including modern vessels like Long liner cum-Gill netters, Maldivian type pole and line vessels and supply of inboard engines, out board motors on subsidy under Hire Purchase System, navigational aids at full cost under HP System. For exploration of the deep sea resources in the territorial waters of Lakshadweep, the programmes such as deployment and monitoring of Fish Aggregation Devices (FADs), supply of fishing gear materials on subsidy, operation and maintenance of Departmental fishing vessels for demonstration of advanced fishing methods, monitoring fish aggregation devices, monitoring control and surveillance (MCS) in the territorial waters of Lakshadweep etc. are proposed (Table 0.17). Infrastructural facilities like cold storages, ice plants, freezing plants etc. for developing an efficient cold chain in Lakshadweep and mainland in the entire supply chain is proposed for improving the quality of the fish and fishery produces of Lakshadweep to the levels of domestic, fish processing and export markets. Financial assistance is proposed to be extended to the Self Help Groups for production of value added fishery products which would boost the utilisation of low value fishes for the production of high value yielding products; diversify the fishery produces and employment generation etc. For the quality improvement of *masmin*, the Community *Masmin* making units are proposed to be introduced.

Establishment of an Integrated Fish Processing Plant is proposed for value addition of fish and production of export quality fishery products, employment generation and for earning foreign exchange. It is proposed to set up more fishermen cooperative societies in addition to strengthening of the existing societies during the plan period. Mariculture of economically important seaweeds and pearl oysters with establishment of one hatchery cum laboratory for spat production and pearl implantation is in the proposal. Capacity building programmes in various areas of fisheries such as advanced fishing methods, post-harvest fish handling and fish processing, production of value added fishery products, fishing gear making, mariculture etc. are proposed under the scheme Human Resources Development and Fisheries Extension. The Scheme Introduction of Mother Vessel for enhancement of the fish production and high value realization of fish caught by the fishermen of Lakshadweep is continued in the 11thPlan as recommended by the Perspective Plan and the Feasibility Report by the Indian Institute of Management, Kozhikode and it accounts for 57% of the total budget outlay for the sector. The XIth Plan initiates action for the total revamping of the Department of Fisheries, U.T of Lakshadweep with increased funds, manpower and autonomy for facilitating a quantum jump in the fish production and utilisation for boosting the dwindling Agricultural Gross Domestic Product (GDP) of the Country and for ensuring food for all.

Table 0.17 Financial Outlay for Fisheries Sector (2007-2012; Rs.in Lakhs)

Sl. No	Name of the Schemes	Proposed outlay (2007-12)					
		2007-08	2008-09	2009-10	2010-11	2011-12	Total
1	Supply of mechanized fishing boats, introduction of modern fishing vessels on subsidy under hire purchase system and issue of in board Engine, Out board Motors and navigational equipment's under Hire purchase system	89.0	139.0	291.0	291.0	291.0	1101
2	Development of Deep Sea Fisheries	345.0	85.0	75.0	90.0	90.0	685
3	Development of Shore based infrastructural facilities	27.9	200.4	476.3	107.7	54.7	867
4	Mariculture of commercially important marine organisms	12.9	31.6	18.5	19.0	19.0	101
5	Extension & Training and Strengthening of Statistical Database in Fisheries Sector	43.6	37.7	37.4	41.2	39.1	199
6	Setting up of Fisherman Cooperative Societies	61.0	118.0	145.0	146.0	135.0	605
7	Civil work	122.0	150.0	110.0	95.0	30.0	507
8	Introduction of mother vessel/ Collector vessel	2000.0	2500.0	620	130	150	5400
	Total	2701.4	3261.7	1773.2	919.9	808.8	9465

Major Schemes in Fisheries Sector are;

Scheme I: Supply of mechanized fishing boats, introduction of modern fishing vessels on subsidy under hire purchase system and issue of in board Engine, out board Motors and navigational equipment's under Hire purchase system

This component is the foremost and major programme in the sector aiming enhanced fish production, increased income out of fishing and socio-economic development of the poor fishermen of Lakshadweep. The scheme envisages programmes that would create employment, sustainable exploitation of the untapped resources, safe and economic fishing operations etc. The major programmes proposed are;

- Construction and supply of 30-34 footer mechanized tuna pole and line fishing boats on subsidy under Hire Purchase System

- Introduction of Gill netter-cum-long liner Vessels on subsidy under Hire Purchase System is suggested by the Indian Council of Agriculture Research (ICAR) for increasing the fish landing and employment generation in Lakshadweep
- Introduction of Maldivian Type pole and line Fishing Vessels on subsidy under Hire Purchase System is another component
- Supply of inboard and outboard engine on subsidy under Hire Purchase System:
- Issue of Navigational and communication equipment's like GPS, VHF etc. on hire purchase system is proposed.

Scheme II: Development of Deep Sea Fisheries

The scheme is to diversify the fishing in Lakshadweep from pole and line fishing for inshore tunas only to gill netting, long lining etc. for oceanic tunas and tuna like fishes, sharks and rays etc. by operating medium size multi-purpose fishing vessels such as Gill net-cum Long line fishing vessels etc. with refrigerated storage facilities to operate monofilament logline fishing gears and gillnets for the exploitation of deep sea verities of tunas like yellow fin tuna, Big Eye tuna and other tuna like fishes such as sail fishes, marlines, seer fishes etc. and sharks and rays. Demonstration of these diversified fishing methods and training the local fishermen in these operations by the departmental fishing vessels is proposed under the scheme. The various components are;

- Fish Aggregation Devices (FADs)
- Operation and maintenance of departmental 38 and 55 footer Boats /modification of these boats for operation of modern fishing gears
- Operation and maintenance of Self Propelled Barge for aiding fishing in the distant fishing grounds in the EEZ of Lakshadweep
- Supply of Fishing Gear materials on subsidy for fabrication of long lines and gill nets

Scheme III: Development of Shore Based Infrastructural Facilities

This scheme mainly focuses on establishment of cold chain facilities such as ice plants, cold storages and freezers in all the islands, running and maintenance of these facilities, supply of insulated fish boxes and deep freezers to fishermen and fish vendors, extension of financial assistance to the Self Help Groups for production of value added fishery products, establishment of community *masmin* making units for quality improvement of masmin the main commercial fishery product of Lakshadweep etc. The main components under the scheme are as follows.

- Establishment Ice Plants in the islands
- Establishment of cold storages-cum-walk in freezers in the islands and mainland
- Establishment of an integrated fish processing unit at Kavaratti

- Extension of financial assistance to self-help groups (SHGs), other voluntary organizations including Panchayat for production of value added fishery products and fish waste utilization at 30% subsidy
- Establishment, running and maintenance of community Masmin making units for production of High Quality masmin at Agatti
- Running and maintenance of cold chain infrastructures in the islands and mainland
- Establishment and maintenance of fish markets
- Financial assistance to the Fishermen Co-operative Societies in Lakshadweep
- Supply of Insulated Fish Boxes / Ice Boxes on Subsidy to the Fishermen

Scheme IV: Mariculture of Commercially Important Marine Organisms:

It is recognized that a number of marine species of global interest found exclusively in the islands are endangered and have been recently placed in the Schedule I and IV of the Indian Wild Life (Protection) Act and in this context conservation mariculture of these species are also of relevance. The Integrated Perspective Plan for the development of fisheries sector of Lakshadweep strongly recommends for mariculture of commercially important species like the marine fin fishes, ornamental fishes, lobsters, molluscs, pearl oysters, giant clams, octopus, sea cucumbers, seaweed, etc. The candidate species for the mariculture in the 11th Plan include the sea weed and pearl oyster for which perfected technologies are available in the country. Chemical derivatives such as algin and agar from seaweeds have immense industrial applications ranging from the food and beverages industries to the cosmetic and pharmaceutical industries. Agarophytes such as *Gracilaria*, *Gelidiella*, carrageenophytes such as *Hypnia*, *Kappaphycus* and alginophytes such as *Turbinaria* etc are potential species for seaweed mariculture. The components under the scheme are given below.

- Demonstration mariculture of economically important seaweeds
- Financial and technical assistance to the, Self Help Groups, other voluntary organizations and Village (Dweep) Panchayat etc. for the seaweed culture, processing and marketing
- Mariculture of Pearl Oysters and production of cultured pearls
- Establishment of a small scale hatchery-cum-laboratory at Kadmath island for pearl oyster spat production and nucleus implantation

Scheme V: Extension & Training and Strengthening of Statistical Database in Fisheries Sector:

A strong statistical database is essential for planning the development in any sector. Any fisheries development plan should essentially depend upon the yield and the potential yield to decide whether and to what extent the expansion of the fishery is required or to initiate conservatory measures if the stock is over exploited etc., estimates on the yield and potential

yield estimates are essential. Therefore strengthening of the statistical database in fisheries sector of Lakshadweep is essential.

Scheme VI: Setting up of Fisherman Cooperative Societies:
Realizing the importance of the co-operative sub-sector in developing the vast fisheries sector of Lakshadweep for the socio-economic uplifting potential is recommended by the Integrated Perspective Plan for income generation and quality employment.

Scheme VIII: Introduction of Mother Vessel/ Collector Vessel:
Mother vessel type fishing is an ideal concept in a place like Lakshadweep which has geographical disadvantage of scattered islands and isolation island to island from any mainland port. The proposal is to introduce multipurpose vessels used for fishing as well as collection of fish from smaller fishing crafts and store on board after initial preservation and processing. A mother vessel would take a good number of smaller boats to distant fishing grounds where there is no land to halt for fishing for about 10-15 days. The mother vessel will fish during this period with smaller boats and the smaller boats will conduct fishing and deliver the catch to the mother vessel for processing and storage. The accompanying smaller boats can receive provisions like diesel, fresh water etc from the mother vessel there by the operational cost of the smaller boats will also drastically come down as the frequent return to the base island for fuel and provisions is delineated. The mother vessel would carry the fish collected to the mainland for domestic as well as export marketing. This would enhance the exploitation of distant fishing grounds such as Cheriyapani, Valiyapani, Perumulpar and Ezhikalpeni etc. and boost the fish landing in Lakshadweep while providing economic fishing operation to the fishermen.

Potential Production Scenario[240]

Building of infrastructure facilities for handling, storage, processing and marketing

Annual fish production in Lakshadweep Islands is about 10,000 tonnes; 90% of which is contributed by tunas. Local consumption as fresh fish and raw material for *masmin* production accounts for about 99% of the landing while a small quantity, less than 1% is utilized for canned tuna production. The development program for Lakshadweep Islands is planned to increase the fish production to 11,000 tonnes in the 1st phase, 67,765 tonnes in the 2nd phase and 58,576 tonnes in the 3rd phase respectively. Out of this tuna fishes form 9,900 tonnes, 60,990 tonnes and 53,250 tonnes respectively while other fishes form 1100 tonnes, 6,775 tonnes and 5,326 tonnes respectively during this period. The tuna available for commercial processing will be 7,920 tonnes, 48,792 tonnes and 42,600 tonnes in the 1st, 2nd, and 3rd phases respectively (Table 0.18)

[240] Op.Cit., CMFRI, 2006. Lakfish

Table 0.18 Expected Tuna Resource Availability for Commercial Processing

Phase	Expected Resource Availability			Total (tonnes)
	Tuna for local consumption (tonnes)	Tuna for Processing (tonnes)	Others (tonnes)	
2011-2012	1980	7920	1100	11000
2012-2017	12198	48792	6775	67765
2017-2020	10650	42600	5326	58576

Source: Lakfish, CMFRI, 2006

Other varieties of fish that contribute to the landings in Lakshadweep Islands comprise the fish viz., Sharks, Carangids, Flying fish, Belonids & Hemirampus, Baracudas, Red mullets, Cephalopods, Seer fish, Perches & Sail fish. Based on the resource availability about 17 commercially important products have been identified and their production targets are presented in Table 0.19.

Table 0.19Marine Products Identified and Production Targets (MT)

Sl. no	Products	1st phase (MT)	2nd phase (MT)	3rd phase (MT)
1.	Sashimi Grade (Yellow fin tuna)	300	1500	900
2.	Chilled and frozen tuna loins(yellow fin tuna)	400	2000	1500
3.	Fresh tuna in chilled form for distribution in mainland	300	1950	1800
4.	High quality *masmin (skip jack tuna)*	300	1500	900
5.	Value added tuna product*(skip jack et al)	10	225	450
6.	Frozen whole fish for export(skip jack and yellowfin)	400	2000	1200
7.	Battered and breaded products for export*	40	200	120
8.	Salted and cured shark meat	75	375	225
9.	Shark cartilage	22.5	112.5	67.5
10.	Shark fin	7.5	37.5	22.5
11.	Shark skin leather	1.25	6.25	3.75
12	Canned tuna (in oil and curry)*	4.5 lakhs (300 tonnes)	22.5 lakhs (1500 tonnes)	13.5 lakhs (900 tonnes)
13.	Fish waste utilization & production of fish feed	2200	11000	6600
14.	Masmin flakes and powder	160	800	480
15.	Tuna Kure	12	60	36
16.	Smoked tuna in oil	90	450	270
17.	Gelatine	15	75	45

The items marked (*) indicate only a general classification while it includes a number of products in that category.

There exists very good market for shark products both in the export market as well as mainland. The important products are shark cartilage, shark fin, shark liver oil, shark skin leather etc. Cleaned shark cartilage fetches 2-3 US $ /kg while shark fin gets Rs. 2000/- to 5000/- per kg depending on the size of fins. Shark liver oil is a by-product which has got good demand in the mainland. The price of the oil increases depending on purity and vitamin potency.

Crop and Animal Husbandry: Opportunities, Entry Points and Schemes – 11th Plan

The Table 0.20 shows the plan outlay for agriculture at a glance and the scheme for livelihood supports has been allocated the maximum amount.

Table 0.20Agriculture and Natural Resource Management: Plan outlay at a Glance (Rs. in lakhs)

Name of Schemes	Outlays (Rs in lakh)					Total
	2007-08	2008-09	2009-10	2010-11	2011-12	
Coconut Development Program	50.92	70.92	115.17	139.42	149.42	525.85
Organic Farming Program	36.02	36.02	43.02	50.02	50.02	215.10
Livelihood Support Services	63.82	223.07	538.42	405.02	526.32	1756.65
Horticulture Development Program	100.41	99.16	143.42	187.07	182.49	712.55
Natural Resource Management	48.52	53.52	159.02	260.52	263.52	785.10
Integrated Pest Management	140.27	140.27	185.27	230.27	230.27	926.35
Human Resource Development	19.02	22.02	29.02	36.02	39.02	145.10
Information Communication	11.02	20.02	34.02	47.02	51.02	163.10

Technology						
Civil Works	30.00	35.00	63.00	91.00	91.00	310.00
Total	500.00	700.00	1310.36	1446.36	1583.08	5539.80

Scheme I: Coconut Development Programme: Agriculture in the UTL is dominated by coconut. Though the productivity of coconut is among the highest in the country, there is still room for maximizing its production. Factors against maximizing coconut production include: a) closer spacing and non-systematic planting of saplings, b) Occurrence of diseases and rat menace, c) limited crop improvement, etc. An important opportunity for coconut based livelihoods in the UTL is the potential for product diversification and value addition. Currently, coconut is converted to copra by local people that is then procured and marketed through Lakshadweep Marketing Federation and also by direct selling in Kerala and Karnataka. There are some limited efforts made for product diversification in coconut. Coconut oil, coconut powder, coir and mats are made in small scale industrial units. Considering that coconut production is largely organic, it can fetch a much higher premium price in the national/ international market, if proper marketing methods are adopted. Similarly, the scope of making handicrafts out of coconut could also be explored. Viable packages are proposed for individual agro climatic zones/islands putting together knowledge of what is likely to work best in each zone/island. The key components are Organic farming, Productivity enhancement, Processing and product diversification, Market development and promotion, and Capacity building and technology updation.

Scheme II: Organic Farming Programme: The administration has established 15 model organic farms in different islands to propagate the message of organic farming. The entire strategy for development of agriculture in the UT during the XI FYP period is on Coconut Husbandry based Organic Farming with farm level processing and product diversification.

Scheme III: **Livelihood Support Services:** Livelihood support programs for the ST small and marginal farmers of the UT (under the Tribal Sub Plan) for viable and feasible crop cultivation cum agri-business ventures are proposed therefore to ensure that the resources released to them are ploughed back into livelihood agriculture in a more productive manner. The components are; Coconut Demonstration Plot, Coconut Nurseries, Neera Tapping and Processing, Husk Retting and Coir Spinning, Virgin coconut oil making, Vermiculture/coir pith plus compost making, Banana/papaya/sweet potato/betel vine/ gardens, Floriculture/orchids, Coconut wood furniture/handicrafts units, and Mushroom Cultivation.

Scheme IV: Horticulture Development Program: Due to the geographical farness of these islands from mainland India, regular availability of fresh fruits and vegetables for the day to day use of its inhabitants are very remote. And that small quantity transported from mainland during the fair season are very costly and unaffordable to the poor inhabitants, besides highly inorganic and pesticide contaminated. Under the circumstances, inter cultivation in the coconut gardens with fruits and vegetables is a nutritional necessity to feed and foster the inhabitants besides as a technological intervention to improve the soil condition. The various components are; Vegetable Cultivation, Fruit cultivation, Tuber cultivation, Spices cultivation and Pulse cultivation.

Scheme V: Natural Resource Management: As the available fresh water aquifer is very scarce, even insufficient for drinking purposes of the inhabitants, irrigation to crops particularly to coconut is not viable. Pumping of water for crop irrigation has been stopped since 1995. And therefore the only alternate strategy would be for rain-fed farming with possible rain water harvesting. Out of 178 km coastal area, 26 km are severely eroded. Due to the unique soil features and fertility status particularly highly deficient nitrogen and potash, a judicious integrated nutrient management strategy with organic and bio degradable waste recycling is called for. The various components are; Rainwater harvesting in Agriculture and cultivation; Land Reclamation and Development including Coastal shelter belt plantation, Integrated nutrient management, Soil, water and Biodiversity Conservation , Strengthening of soil testing lab and Poly film greenhouses.

Scheme VI: **Integrated Pest and Disease Management:** Rodent pest management and Mandari Control program are the two major pest management programs envisaged during the XI Five Year Plan. 10-30% coconut damage loss is sustained from rodent damages while 25-40% loss is from Mandari. Inorganic pesticides have been banned since 1995 and the UT is under absolute organic farming now. The various components are; Rodent pest management, Mandari/Eriophyid mite control programme, Bio control programme, Mechanical control, Organic and bio-pesticides and Strengthening of Bio control lab.

Scheme VII: **Information Communication Technology:** The scheme is to mandate to enhance organisational efficiency of the Department, operationalise an accountable agriculture information technology and knowledge centre in every inhabited island, introduce globally competitive IT enabled organic farming for high value self-employment as well as for job employment and above all provide effective, transparent and accountable citizen centred e-Governance. The components are e-Infrastructure, e-Commerce and e-Business, e-Net work with broad band connectivity, IT enabled organic farming and e-Services.

During XI Five Year Plan period, department proposes to be expand and streamline dairy units in order to augment milk production in the islands to meet demands of the locals Table 0.21

Table 0.21 Outlay for Animal Husbandry at a Glance (Rs. in lakhs)

Name of Schemes	XI th Plan	2007-08	2008-09	2009-10	2010-11	2011-12
1. Poultry Development Programme	**1507.97**	247.00	271.70	298.87	328.76	361.64
2. Goat Development Programme	**274.74**	45.00	49.50	54.45	59.90	65.89
3. Cattle Development Programme	**335.77**	55.00	60.50	66.55	73.20	80.52
4. Veterinary Service & Animal Health Control Programme	**390.72**	64.00	70.40	77.44	85.18	93.70
5. Training and Technical Assistance Programme.	**59.81**	10.35	11.12	11.94	12.83	13.57
6. Civil Works	**305.82**	52.00	56.60	57.66	70.23	69.33
Total	**2874.83**	**473.35**	**519.82**	**566.91**	**630.10**	**684.65**

Scheme I: *Poultry Development Programme*: The Poultry development is the major thrust area in the overall activities of Animal Husbandry Department and plays a vital role for the welfare of this backward area and its people. The objective of poultry development is to meet the egg and chicken meat needs in the islands and to provide self-employment to the educated youth as well as women folk. Huge quantities of fish wastes are available in the islands mainly Agatti and Minicoy and it is proposed to start feed mixing unit along with fish meal units for utilizing the large quantities of tuna and other fish waste available in plenty to be converted in to fish meal in order to add in the preparation of poultry feed.

Scheme II: Goat Development Programme: Nearly 90 % of total households are rearing two to three goats for meat purposes and also to meet their daily requirement of milk to some extent. Chevon is the popular meat in Lakshadweep and people use it at all occasions especially marriages and religious functions. In spite of large number of households rearing the goats, the availability of goat milk and meat is meagre. The islanders are not prepared to give up goat rearing because of social and economic reasons. The existing schemes envisage distribution of high quality breeding goats to the farmers and providing assistance for feed and goat shed etc.

Scheme III: Cattle Development Programme: Due to scarcity of gracing lands, organized dairy farming is not encouraged. But household farming is being encouraged by distributing quality cross breeds of Holstein Friesian, Jersey and brown Swiss for maintaining present level of milk production and to generate income. Breeding of animals is carried out with the help of Artificial Insemination utilizing frozen semen from Kerala and also by maintaining the bulls for natural service in islands/ areas where it is difficult to provide liquid nitrogen in time. The cattle development scheme envisages assistants high yielding milch animals, cattle feed, insurance and cattle shed. The Animals required for milk and meat purpose are being procured from the

mainland and transported through mainly Mangalore port. This animal is required to hold for some days to observe for symptoms of the diseases in order to prevent the clandestine entry of the diseases to islands. In So far, department have no breeding farm as such to evolve the suitable breeds for the island.

Scheme IV: Veterinary Services & Disease Control Programme: Animal health places the significant role in controlling production losses as well as protecting the voluble animals/ birds. The overall aim is the animal health scheme is to keep Lakshadweep free from the threat of any other break of contagious and infectious diseases and provide pre veterinary services at the farmers' door.

Water Supply and Sanitation: Opportunities, Entry Points and Schemes – 11th Plan

During the XI Five Year Plan, different items of work specified under the programme for water supply and sanitation with a provision of Rs.4428.30 lakhs which includes an establishment component to the extent of 3% (Table 0.22).

Table 0.22 Schemes and Expenditure: Water supply and Sanitation(Rs. in Lakhs)

Sl. No.	Name of the Scheme	XIth Plan 2007-12	Annual Plan 2011-12		
			Proposed Outlay	ACA, if any	Total
1	Providing protected Water Supply in Lakshadweep	4278.30	2260.00	0.00	2260.00
2	Sewage Disposal & Control of Water Pollution in Lakshadweep Islands	150.00	30.00	0.00	30.00
Total		4428.30	2290.00	0.00	2290.00

Scheme I: Providing protected water supply in Lakshadweep

There is no surface water available in the territory. A limited quantity of water is available as ground water for the utilization of the local population. The total requirement of water is around 25 lakhs litres per day @40 litres per capita per day. Because of the peculiarities associated with the location, formation hydrogeology and rainfall availability (1500 mm per year) the availability of fresh water is very limited. There are no surface water sources like streams and rivers in the islands. Due to high permeability and limited sub terrain storage space above the mean sea level, a substantial portion of the in-filtered water percolates in to the sea. The outflow coupled with evapotranspiration losses leaves only a small fraction of the total infiltrated water as an effective re-charge to the shallow aquifer. The demand for water at present is being met from the ground water resources, rain water harvesting and contribution from Desalination Plants. In the absence of adequate rainfall the contribution from rainwater harvesting has also become insignificant and the ground water has become scarce and saline. The solution to the problem of potable water

therefore lies in the setting up of desalination plants. One of the prime considerations for the development and management of the groundwater resources in the islands of Lakshadweep is the maintenance of a minimum thickness of lens as a critical factor for the upkeep of island groundwater system. It implies that the fresh groundwater extraction from island lenses has to be adjusted to sustainable level. In Kavarati, it was observed that when pumping rate exceeded 13,000 litre/day, the water started signs of deterioration.[241]

Augmentation of water supply scheme in islands: Water Supply scheme has been introduced in all the islands in Lakshadweep, but the supply is not sufficient in quantity. Water is supplied through stand pipes on the streets. It is proposed to provide house hold tap connection to all the households in a phased manner and to begin with it is proposed to provide house hold connections to all houses at Kavaratti during the year. Construction of additional tanks, wells, extension /replacement of pipelines etc. are to be carried out in all the islands.

Installation seawater Desalination Plants (LTTD) in all Islands: The total requirement of water is around 25 lakh litres per day but availability of ground water is very limited. Increase in population has put additional load on ground water extraction which is causing salinity, intrusion of sea water in fresh water lens, there by ground water has become scarce and saline. It is not possible to harvest rain water to meet the balance requirement as the islands are very small and covered green area is more than 80%. Desalination is not only an attractive and practical option but also a safe method where water to the extent of several lakh litres per day (depending on the plant capacity) can be produced. Now the administration is in the process of setting up of Low Temperature Thermal Desalination Plant in 6 islands and it is proposed to install 2 desalination plants during this year. An amount of 26.6 Crore required for the setting up of 6 no, LTTD plant has already been deposited with National Institute of Ocean Technology Chennai and it is proposed to install 3 desalination plants in the remaining islands viz. Kalpeni, Kadmath and Bitra during XI five year plan. The National Institute of Ocean Technology (NIOT) has developed a desalination plant in Kavaratti (at a cost of Rs.10 crores), with a capacity of 1 lakh litres of water every day. Similar plants are being established in Agatti and Minicoy and are expected to be completed by March-April, 2011. There are plans to create similar desalinization plants in the islands of Kalpeni, Andrott, Amini, Kadmat, Kiltan & Chetlat by 2013. For smaller islands like Bitra, Bangaram and Suhali, it is proposed to install a 10,000 litre per day capacity Solar Thermal Desalination Plant using the Multi Effect Humidification Technology in collaboration with M/s GIZ of Germany. This is expected to address the issue of drinking water problem in the UTL.

Augmentation/ Networking of distribution system to LTTD Plant in the islands: In the capital island Kavaratti; NIOT Chennai has installed one lakh litre capacity per day desalination

[241] Pallavi Banerjee and Singh V.S, 2010. Ground water quality monitoring for sustainable management of island aquifer using artificialneuraal network.

plant and the installation work is in progress at Agatti, Androtti, and Minicoy. The administration proposed to install similar plants in the remaining islands also to meet the urgent requirements in a phased manner. To meet the full requirement of potable water the capacity of plant has to be increased to 3 lakhs litres per day.

Community/ Individual rain water harvesting structure: The only natural source of water is ground water which is being replenished by rain mainly during the south west monsoon. Even this sub soil water is not available in one of the islands, namely Bitra and water supply is provided by harvesting rain water. It is not possible to harvest rain water to meet the full requirement because the islands are very small and covered green area is more than 80%. Substantial number of Rain Water Tanks has been constructed and it is proposed to construct 100 numbers tanks during year. The UTL has also introduced Rain Harvesting system through tanks and distributed through a network of pipes and community taps set up at regular intervals. Around 920 such tanks with a capacity of 10,000 litres each have been created on different islands through the grants received from the India-Canada Environment Facility (ICEF) and have been operational on various islands. Of late, community institutions and individual houses have also started constructing rain water harvesting systems. It is not possible to harvest rain water to meet the full requirement because the islands are very small and covered green area is more than 80%. Land area being scarce, it would not be in larger interest to construct surface structures for harvesting rain water such as percolation tanks and ponds. Of late, community institutions and individual houses have also started constructing rain water harvesting systems. Roof top rain water harvesting can provide reliable fresh water during major part of the year. Sloping roofs of GI sheets are common throughout the islands. The rain fall on the roof top can be channelized and stored in tanks for use. The advantage is that the tanks would get filled and re-filled a number of times during the rainy season.

Scheme II: Solid Waste Management and Construction of Scientific Sewage System

Sewage disposal & control of water pollution in Lakshadweep Island: There is no arrangement for disposal of solid/liquid wastes which at present get discharged into the open sea/lagoon directly/indirectly. The quantity of wastes is also increasing with increase in population. Since the area of the islands is very small and land mass very porous the septic tanks set up in the past have not proved very useful. There are more than 600 septic tanks and leach pits in an area of 3.63 sq.km in Kavaratti. The septic tanks, leach pits and water wells are located within a distance of 5 m to 25 m. which leads to mixing of waste water from the septic tanks with fresh water which if not checked could lead to serious consequences. Such a situation is also going to severely damage the marine life in the long run thereby affecting the ecology of the island. It is, therefore, imperative to establish sewage disposal systems in all the islands and ensure that all solid/liquid wastes are disposed off only in an eco-friendly manner.

Ecology and Environment: Opportunities, Entry Points and Schemes – 11th Plan

Scheme-wise financial outlay is given in Table 0.23 and thrust is given for protection and conservation.

Table 0.23 Schemes and Expenditure Details for Ecology and Environmental Sector (Rs. in Lakhs)

Sl. No.	Name of the Scheme	Outlays (Rs in lakh)					Total
		2007-08	2008-09	2009-10	2010-11	2011-12	
1	Environment Protection & Awareness	30.00	40.00	65.00	67.45	64.26	266.71
2	Scientific Management of Biodegradable & Non-biodegradable waste	20.00	25.00	45.00	48.00	54.25	192.25
3	Corals, Wild Life & Lagoon Conservation.	25.00	35.00	75.00	82.00	63.25	280.25
4	Civil Work	---	100.00	40.00	35.00	25.00	200.00
5	Social Forestry	18.00	22.00	23.00	25.00	26.50	114.50
Total		93.00	222.00	248.00	257.45	233.26	1053.71

Scheme I: Environment Protection & Awareness

The various components are Environment Month, Sea shore Plantation, Environment Education, Environment Awareness Programme, Books & Literature, Wildlife Week, Ozone Day, Posters & Pamphlets, World Environment Day, Wild Life Tour

Scheme II: Scientific Management of Bio-degradable and Non Bio-degradable wastes

Because of the porous nature of the soil and also due to the higher water level there is ample chance of ground water pollution on account of accumulation of large quantities of non-bio degradable wastes. Therefore it is envisaged to have a comprehensive Waste Management System. This scheme is formulated for the total eradication of the hazardous non-biodegradable wastes like polythene, plastic, pick up bags etc. Waste generation being one of the crucial consequences of human life, requires special attention in these islands. The use of thin plastic bags to pack and to carry various materials including house hold articles has become a common practice all over in Lakshadweep. However the disposal of the waste plastic bags in large quantities has been a problem and is of great concern particularly in such a fragile ecology. The mixing up of these waste plastic bags with other bio-degradable organic waste materials in the garbage has been the main cause of the problem. It is more appropriate to segregate wastes at home into recyclable products and sort out organic and inorganic waste and dispose of organic waste in local compost or vermiculture pits. Therefore attempts should be made to educate all

islanders for segregation of waste at point of origin, maximizing recycling and safe disposal of the rest. The prohibition of the use of the thin plastic bags and pickup bags for packing and other common use should be enforced, so as to control this "undesirable waste material" from getting mixed up with the other organic garbage. In case it is possible to find useful application for the waste plastic bags, there will be substantial scrap value for this waste product and therefore they will be collected and sold by interested persons, instead of being littered or thrown out in the dust bins or into the central depository. Another major issue of solid waste is the absence of systematic sewerage system; most households have constructed soak pits for disposal of latrine waste. Owing to acute pressure on the land, the soak pits have been constructed very close to the open wells. The soil being sandy and porous and the soak pits had been constructed rather unscientifically, faecal matter from the soak pits finds its way into the water in the open wells. This makes the available water supply unsafe and has been generally accepted to the main reason behind the high rate of waterborne diseases including acute diarrhoea prevalent in the islands. The scarcity of pure drinking water is the major crisis that the inhabitants of the Lakshadweep Islands are facing. Therefore it is envisaged that all the Islands should have proper facility to purify the contaminated water from soak pits.

Disposal of solid and liquid waste and public health continues to be serious environmental and developmental challenges in the UTL. However, over the years, several initiatives have been undertaken by the administration to address these issues. UT administration is using a DRDO developed technology of bio-toilets where the activation of decomposition of the human waste, results in minimum amount of sludge. This has been successfully tried and is now being replicated in all the 10000 households in the islands. The UTL administration has banned the use of plastics and non-biodegradable materials on islands and also installed incinerators to dispose them. The mechanism for disposal of other biodegradable materials is being developed in a phased manner. The main components under the scheme are: Collection, Storage & Disposal of Non-bio degradable waste, Procurement/ Replacement of waste Bins, Operation of power tiller, and Procurement of Tempo Van.

Scheme III: Corals Wild Life and Lagoon Conservation

Some of the species listed in the Wildlife (Protection) Act, 1972, are available in the seas around the islands. It is therefore necessary to have all these species protected. The scheme is therefore proposed for the protection and conservation of corals, lagoons and marine flora and fauna. Schemes under XI FYP proposed for the protection and conservation of corals, lagoons and marine flora and fauna. The scheme is formulated for the protection and conservation of fragile and pristine ecosystem of Lakshadweep. Coral reefs are ecologically sensitive area and categorized them as CRZ-1 which implies that these areas are afforded protection of the highest order. Moreover all corals with many of its associated animals are classified under Schedule I of the Wildlife (Protection) Act. The coral reefs exhibit extra ordinary biodiversity. Due to these high biodiversity and economic value, coral reefs are facing an unlimited & very high stress of

disturbance, pollutions, over fishing, walking over reefs, local site seeing, tourism, scuba diving, cowry pickers, octopus hunters etc. besides the natural threats. All these unsustainable practices have already leaded to the loss of biodiversities from the reefs. A proper management plan has to adopt the sustainable use of this natural resource which can restore the deteriorated parts. Cleaning campaigns of the islands were undertaken with the help of NGOs and Panchayats. Regular lagoon cleaning is being carried out for keeping intact considering the biodiversity of the lagoons. This department declared Pitti Island as bird Sanctuary. The provisions of the Wildlife (Protection) Act, 1972, The Environment Protection Act, 1986, etc. are also enforced in the islands for the protection of the environment.

Forestry and Wildlife: Opportunities, Entry Points and Schemes – 11th Plan

XI Five Year Plan proposals envisaged coverage of vulnerable seashore area with 3-4 rows of littoral, mangrove tree belt vegetation (Table 3.3.26)

Table 0.24 Forestry and Wildlife: Financial Outlay 2011-2012 (Rs. in Lakhs)

Sl. No.	Item/ Component	Unit	Phy. Target	Financial Target			Amount		
				Major Head	Minor Head	Object Head	Rev	Cap	Total
1	Social Forestry 1.Fencing materials 2.Regeneration of vegetation 3.Marine greenbelt 4.Labour strength	10	20 ha with 13000 seedlings	2406	01198	010031	80.00		80.00
2	Reclamation and regeneration of vegetation in and around the natural lakes of Bangaram, Minicoy & other islands	3	3	2406	01198	010031	3.00		3.00

3	Assistance to Lakshadweep Medicinal plant Board for rising and maintenance of medicinal plants	5	5	2406	01198	010031	17.00		17.00
Total							100.00	0.00	100.00

Medical and Public Health: Opportunities, Entry Points and Schemes – 11th Plan

The total financial outlay for the sector is given in Table 0.25 and expansion and modernization of Hospitals is allotted the highest amount

Table 0.25 Financial Outlay at a Glance: Medical and Public Health(Rs. in lakhs)

Sl No	Name of the Schemes	Proposed Outlay					
		2007-08	2008-09	2009-10	2010-11	2011-12	**Total**
1	Expansion of Primary Health facilities	63.00	91.60	92.10	81.10	84.60	**412.40**
2	Expansion and Modernization of Hospitals/CHCs	177.10	329.60	360.20	360.30	376.00	**1603.20**
3	Strengthening of Public health activities	4.25	9.85	10.10	10.70	11.70	**46.60**
4	Procurement & Supply of medicines and equipment to PHCs/CHCs/Hospitals.	100.06	110.60	111.60	118.10	119.10	**559.46**
5.	Training and Continuing Education.	1.10	2.00	2.00	2.00	2.00	**9.10**
6.	Financial assistance to the poor Psychiatric patients of Lakshadweep.	0.60	6.00	6.00	6.00	6.00	**24.60**
7.	Financial Assistance to evacuated patients for specialized treatment	Nil	62.00	64.00	73.00	83.00	**282.00**

	at mainland.						
8.	Setting up of Public Health Laboratory	Nil	10.90	10.90	10.90	10.90	**43.60**
9	Providing of Multi-Purpose High Speed Ambulance Boat	Nil	122.40	122.40	122.40	122.40	**489.60**
10	Bio Waste Management Unit	Nil	36.20	15.20	8.20	8.20	**67.80**
11	IGH converted in to Super Speciality Hospital	Nil	24.50	24.50	29.50	34.50	**113.00**
12	Strengthening of ISM&H	52.50	86.00	101.00	101.30	111.30	**452.10**
	TOTAL	**398.61**	**891.65**	**920.00**	**923.50**	**969.70**	**4103.46**

Protection from Coastal Erosion: Opportunities, Entry Points and Schemes – 11th Plan

During the XI Five Year Plan it was proposed to cover 32.00 km by adopting the pilot schemes suggested by the expert committee with a financial allocation of Rs.5650.25 Lakhs (Table 0.26). The main component under the scheme is Anti Sea Erosion works along the shore. Anti-Sea Erosion works in Lakshadweep is carried out based on the study conducted by CWPRS to protect the shore of these coral island. Shore protection work adopting the pilot schemes were executed at shore. The main objective is to carry out Anti Sea Erosion works along the reef instead of placing the protective measures along Shore. Another component is the Construction of fish landing at Cheriya panium. Cheriya panium has a broad reef and it is a fishing island with no sand banks. The fisherman camp in the fishing season and process the fishes. Therefore, it is necessary to construct a Platform covering the Anti-Sea Erosion Works for the benefit of local fisherman.

Table 0.26 Details of Expenditure for Anti Sea Erosion Works (Rs. in lakhs)

Sl. No	Item/component	Unit	2007-08	2008-09	2009-10	2010-11	2011-12	Total
A. RECURRING								
	Salary of staff Post created and filled . Nil Post created but not filled. New Post proposed							Nil Nil
1	EE/ Surveyor of works	1 Post	0.01	0.01	0.01	0.01	0.01	0.05

	(10000-15500)							
2	Assistant Engineer (6500-10500)	1 Post	0.01	0.01	0.01	0.01	0.01	0.05
3	Junior Engineer (5000-8000)	3 Post	0.03	0.03	0.03	0.03	0.03	0.15
	TOTAL - A		0.05	0.05	0.05	0.05	0.05	0.25
B. NON RECURRING								
1	Anti-Sea Erosion works in Lakshadweep along the shore	KM	300	400	600.05	700.05	800	2800.10
2	Anti-Sea Erosion works in Lakshadweep along the reef	K.M	150	249.95	600	700	1000	2699.95
3	Construction of Platform by strengthening the reef at Cheriyapani.		49.95	50	50			149.95
	TOTAL - B		499.95	699.95	1250.05	1400.05	1800.00	5650
	TOTAL A+B		500.00	700.00	1250.10	1400.10	1800.05	5650.25

Energy: Opportunities, Entry Points and Schemes – 11th Plan

The XI Five Year Plan 2007-2012 has been formulated on the basis of the demand projections made by 17th Electric Power Survey of India. The scheme wise details of major programmes taken up during 2010-2011 Annual Plan period are given in Table 3.3.29.

Table 0.27 Planned Outlay for Energy Sector (Rs. in Lakhs)

Sl. No.	Name of the Scheme	XIth Plan 2007-12	Annual Plan 2011-12		
			Proposed Outlay	ACA, if any	Total
1	Augmentation of Diesel Generating Capacity and Distribution System at Minicoy Island	1598.77	300.00	0.00	300.00
2	----- do ------ Kavaratti	2204.75	100.00	0.00	100.00
3	----- do ------ Amini	1764.52	300.00	0.00	300.00
4	----- do ------ Andrott	2267.63	300.00	0.00	300.00
5	----- do ------ Kalpeni	1671.02	175.00	0.00	175.00
6	----- do ------ Agatti	1687.36	380.00	0.00	380.00
7	----- do ------ Kadamt	1753.07	250.00	0.00	250.00

8	----- do ------ Kiltan	1329.22	125.00	0.00	125.00
9	----- do ------ Chetlat	1118.17	120.00	0.00	120.00
10	----- do ------ Bitra	269.30	10.00	0.00	10.00
11	----- do ------ Bangaram	66.25	25.00	0.00	25.00
12	Construction of transit accommodation at Suheli Island	0.00	25.00	0.00	25.00
13	Acquisition of land for setting up of infrastructure for procurement of Petroleum products and other items including civil works at Beypore	0.00	250.00	0.00	250.00
Total		15730.06	2360.00	0.00	2360.00

Non-Conventional Sources of Energy (NCSE)

The Government of India, Ministry of New and Renewable Energy has evolved certain schemes utilising new and renewable energy to bridge the gap between the conventional energy and the national economy (Table 0.28). The scheme was first introduced in Lakshadweep during the year 1985-86. The scheme wise details of major programmes proposed during the X and XI five-year plan (2002-2007; 2007-2012) were as follows:

Installation and commissioning of SPV Power plants in islands

1. Installation of Biomass Gasifier
2. Installation of Wind electric Generators
3. Popularization of Energy Saving Devises (Solar lantern and other equipment's)
4. Tapping of Ocean Energy
5. Fuel cell

Table 0.28 Details of schemes and expenditure for promoting non-conventional energy sources (Rs. In lakhs)

Sl. No.	Name of the Scheme	XIth Plan 2007-12	Annual Plan 2011-12		
			Proposed Outlay	ACA, if any	Total
1	Installation of SPV Power plants	3151.60	200.00	0.00	200.00
2	Installation of Biomass Gasifier.	106.00	50.00	0.00	50.00
3	Wind Electric Generators		150.00	0.00	150.00
4	Popularization of Energy saving devices and appliances	295.75	166.00	0.00	166.00
5	Tapping of Ocean Energy	360.00	0.00	0.00	0.00
Total			566.00	0.00	566.00

Industry and Minerals: Opportunities, Entry Points and Schemes – 11th Plan

The financial outlay for the schemes under the sector is given in Table 0.29.

Table 0.29 Details of Various Schemes and Expenditure: Industry (Rs. in Lakhs)

Sl. No.	Name of the Scheme	XIth Plan 2007-12	Annual Plan 2011-12		
			Proposed Outlay	ACA, if any	Total
1	Incentives/ financial support to ST/ local entrepreneurs in Lakshadweep.	97.00	23.00	0.00	23.00
2	Modernization of existing mechanized Coir Fibre Factories/DCP/CPC in Islands.	378.00	135.00	0.00	135.00
3	Promotion of Handicrafts In Lakshadweep (Tra.DP)	99.00	13.00	0.00	13.00
4	Organizing Entrepreneur Development Programme for Promotion of SSI units in Islands (Tra.DP)	55.00	7.00	0.00	7.00
5	Assistance to LKVI Board (Tra.DP)	170.00	75.00	0.00	75.00
6	Providing Transport Subsidy to SSI units/ Human Resources Development Programme for Lakshadweep (Tra.DP)	110.00	12.00	0.00	12.00
7	Civil Work	175.00	35.00	0.00	35.00
Total		1084.00	300.00	0.00	300.00

Transport: Opportunities, Entry Points and Schemes – 11th Plan

Table 0.30 Schemes and Expenditure Details: Transport (Rs. in Lakhs)

Sl. No	Name of the Scheme	Outlays(Rs. in lakh)					
		2007-08	2008-09	2009-10	2010-11	2011-12	Total
1	Augmentation of ship to shore transport facilities	1999.00	1999.00	1999.00	1999.00	1999.00	**9995.00**
2	Procurement of ships for Lakshadweep service	12265.17	11134.17	3588.17	8750.17	10250.17	**45987.85**
3	Development of Marine Workshop and repair facilities	14264.17.12	13133.17.12	5587.17.12	10749.17.12	12249.17.12	**55982.85.60**
4	Development of harbour facilities	442.74	387.05	282.05	347.05	247.05	**1705.94**

5	Pre-sea training in rating	50.00	50.00	50.00	50.00	50.00	**250.00**
6	Providing of navigational aids for private Motor Sailing vessels	40.00	40.00	40.00	40.00	40.00	**200.00**
7	Augmentation of dedicated berths at mainland ports	2750.00	5.00	5.00	10.00	20.00	**2790.00**
8	Extension/Construction of airstrips and operation of daily flight by airlines	985.65	3613.74	5948.23	1100.16	150.16	**11797.94**
9	Civil Works	25.00	25.00	15.00	15.00	15.00	**95.00**
10	Constitution of Port Management Board	52.32	52.32	52.32	52.32	52.32	**261.60**
	Total	**32874.17.00**	**30439.570**	**17567.06**	**23112.99**	**25072.99**	**129066.78**

Tourism: Opportunities, Entry Points and Schemes – 11th Plan

The 11th Five year plan will strive to provide staff component for ongoing, proposed and complete Central Sector schemes. 6 schemes have been drawn with a proposed outlay of Rs-607.08 lakhs for 11th Five year plan (Table 0.31) and improving transport facility is given priority.

Table 0.31 Schemes and Expenditure Details for Tourism (Rs. in Lakhs)

Sl. No.	Name of the Scheme	XIth Plan 2007-12	Annual Plan 2011-12		
			Proposed Outlay	ACA, if any	Total
1	Infrastructure & Human Resource Development	585.80	50.00	0.00	50.00
2	Tourism Marketing & Promotion	613.20	50.00	0.00	50.00
3	Opening of more islands for Tourism	618.30	250.00	0.00	250.00
4	Public Private Participation in Tourism	588.20	24.00	0.00	24.00
5	Strengthening of Tourist Transport	61652.19	00.00	0.00	00.00
6	Civil Works	11341.28	126.00	0.00	126.00
Total		75398.97	500.00	0.00	500.00

LAKSHADWEEP ACTION PLAN ON CLIMATE CHANGE

(LAPCC)

Lakshadweep possesses certain unique features which are quite relevant in the context of climate change: small surface area, high population density, inadequacy of infrastructure, over reliance on a few fragile natural resources, diminishing stock of fresh water resources, etc. These along with prevailing economic and developmental challenges make the Islands increasingly vulnerable to the existing and emerging risks of climate change. Therefore, the climate change strategy for the Islands may have to start with a 'precautionary adaptation approach'; one that is embedded largely as a sub-set of overall "sustainable" development. Even in the absence of climate change, such a strategy will lead to 'no regret' investments that will in turn contribute to sustainable development, overall reduction in vulnerability, and improved resilience of natural resources and communities.