CITIES AND CLIMATE CHANGE INITIATIVE

BATTICALOA, SRI LANKA:

CLIMATE CHANGE VULNERABILITY ASSESSMENT

UN-HABITAT
FOR A BETTER URBAN FUTURE

Batticaloa, Sri Lanka: Climate Change Vulnerability Assessment

Full Report on Climate Change Vulnerability in Batticaloa Municipal Council

Research, Analysis, Findings and Recommendations

December 2011

Submitted by..
Project Consultancy Unit,
Faculty of Architecture,
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UN HABITAT

Batticaloa, Sri Lanka: Climate Change Vulnerability Assessment

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1. INTRODUCTION

This vulnerability assessment follows a toolkit based on the Sorsogon City, Philippines' experience in a Participatory Climate Change Vulnerability and Adaptation Assessment. This is a participatory process of selected stakeholders, which builds the citizens' capability to address city vulnerability to climate change scenarios and to develop adaptation strategies. Some of the steps in the original methodology have been modified to suit local conditions of the Batticaloa Municipal Council (BMC) area.

The main objective of this vulnerability assessment is to estimate local area vulnerability to potential climate change impacts and provide a context for local government decision-makers to develop local climate change adaptation and mitigation plans in response to the V&AA results.

This study follows the same concept definitions adopted in the Sorsogon City Vulnerability Assessment and Adaptation (V&AA) report. Interpretations of key concepts are mentioned below for reference purposes.

Climate Change refers to any change in climate over time, whether due to natural variability or because of human activity.

Vulnerability is the degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

Adaptation is an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm of exploits beneficial opportunities (Third Assessment Report, Working Group II).

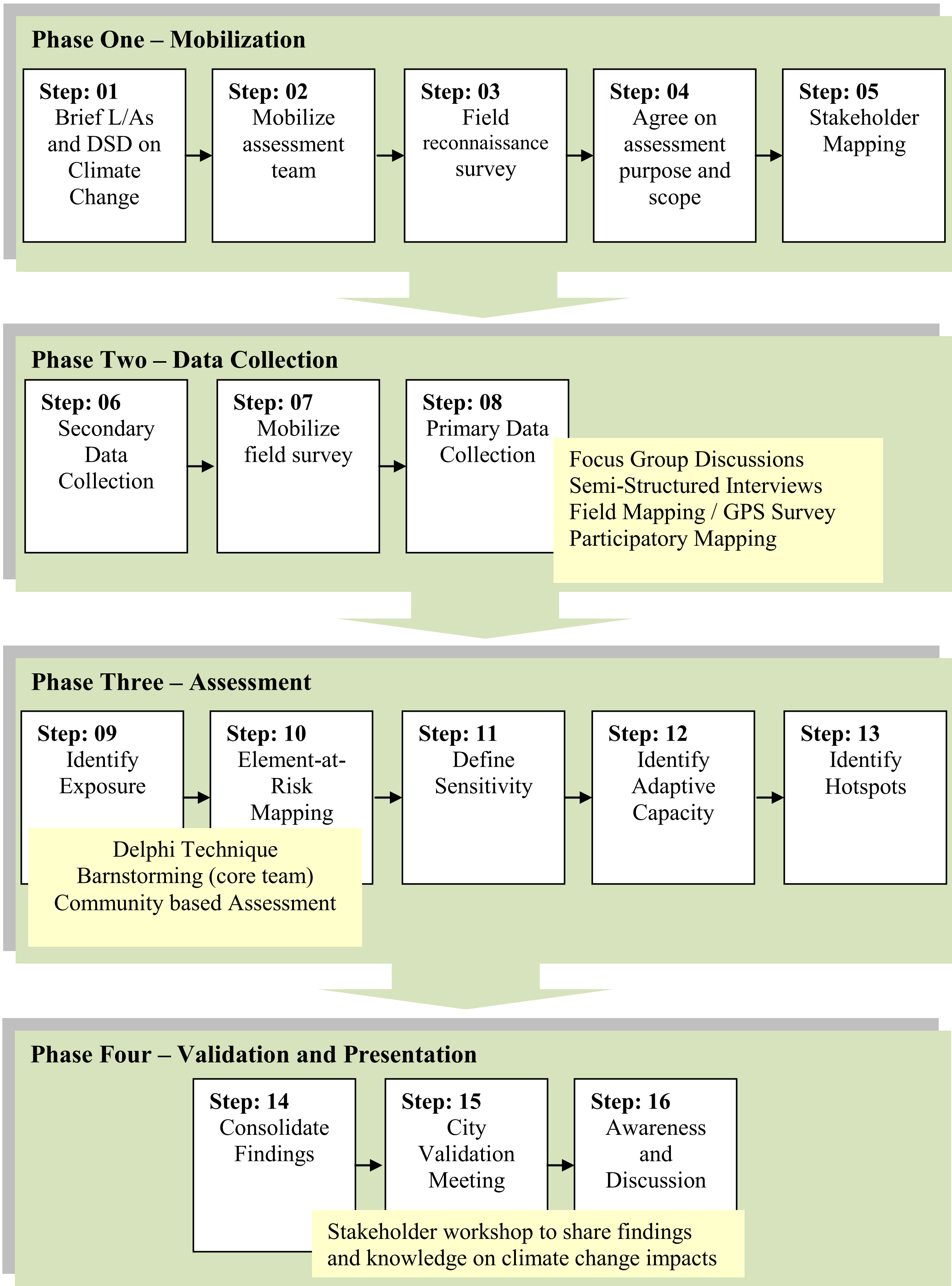
Exposure is what is at risk from climate change (e.g. population, resources, property) and the change in climate itself (e.g. sea level rise, temperature, precipitation, extreme events).

Sensitivity is the biophysical effect (e.g. flooding, strong winds, land inundation, etc) of climate change which also considers the socioeconomic context of the system being assessed.

Adaptive Capacity is the ability of a system to adjust to climate change (including climate variability and extremes) to moderate potential damages, to take advantage of opportunities, or to cope with the consequences. The IPCC Third Assessment Report outlines that it is a function of wealth, technology, institutions, information, infrastructure, and "social capital".

This report explains the overall process flow of a participatory vulnerability assessment with a description for each step and respective findings. Some of these initial steps which had briefly described in the inception report have been modified during this process.

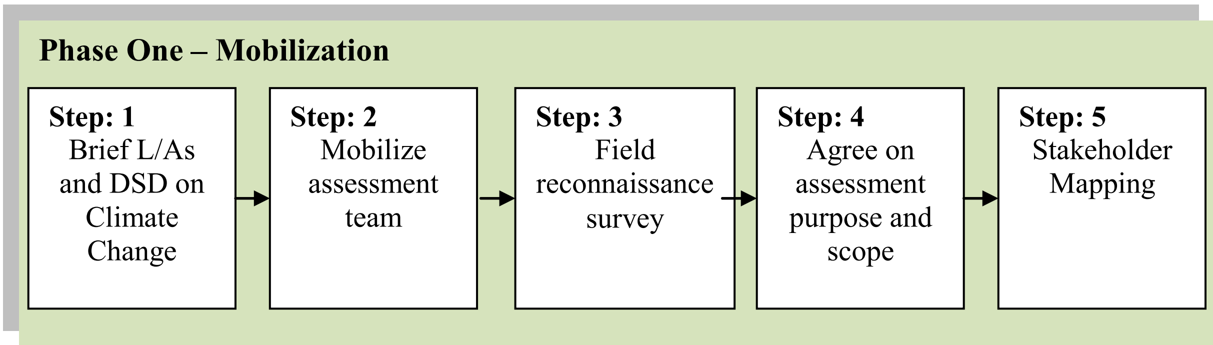
OVERALL PROCESS FLOW



Note: the pale yellow colour boxes illustrate the specific methods and techniques used for each step.

2. PHASE ONE - MOBILIZATION

This phase is the pre-assessment stage to establish the entire assessment process. The process aims to influence local stakeholders, to obtain their acceptance and willingness in developing local response actions.



There are five key steps in this phase which are described in following section.

2.1. Step: 01 Brief Local Authority (L/A) and Divisional Secretariat Division (DSD) on Climate Change

This step introduced the project to the city's key decision-makers. The main objectives of this project are:

1. To give an overview of vulnerability of cities to climate change.
2. To describe the importance of a Vulnerability Assessment in a Sustainable City Development Process.
3. To recognize the views of stakeholders regarding vulnerable groups in the local area.
4. To develop a partnership (to ensure the support and commitment of stakeholders to succeed in the above task) between stakeholders and the project team through a mutual understanding and interaction.

This was the very first opportunity for Sri Lankan local authorities to take part in conducting a city level climate change study. It required a strong foundation to reconcile the aims and objectives, nature, and expected contributions and utility of this project. Accordingly, the two key administrative bodies of the local authority: Batticaloa Municipal Council (BMC) and Manmunei-North Divisional Secretariat Division (DSD) were selected for the initial discussion.

Each key objective, and a brief explanation of each objective, is mentioned below.

a. *Climate change is a key concern of the Sri Lankan government and there have been a number of actions taken to address the impacts of climate change for the country.*

- The United Nations Framework Convention on Climate Change (UNFCCC) was adopted at the Rio summit in 1992 and the Government of Sri Lanka ratified the UNFCCC on 23 November, 1993. In order to achieve the objectives of the UNFCCC, a binding protocol was adopted at the 3rd Conference of Parties (CoP 3) by the UNFCCC held in Kyoto, Japan in 1997 and Sri Lanka acceded to the Kyoto Protocol on 3rd September 2002.

- The Ministry of Environment and Natural Resources as the national focal point for the UNFCCC, has the responsibility of implementing the provisions in the Convention and to take the initiative to pursue the decisions made at COP sessions and its subsidiary bodies. The Ministry of Environment and Natural Resources and UNFCCC have established Climate Change Secretariat and a Climate Change Coordinating & Steering Committee (CCC&SC) to undertake the abovementioned tasks.

- Sri Lanka, as a party ratifying the UNFCCC, was required to prepare a national communication report by the year 2000. Following the guidelines provided by the UNFCCC, (and partly funded by the Global Environmental Facility), the report was produced and submitted to the UNFCCC in October 2000. The report consists of information ranging from a GHG emission inventory, climate change impacts and vulnerability, mitigation options to adaptation responses. Subsequently, Sri Lanka developed policy recommendations on the basis of UNFCCC guidelines to address the need for the nation to engage in climate change mitigation and adaptation measures.

b. *Adapting to climate change may be more important for Sri Lanka than mitigation.*

- Being a small island nation, Sri Lanka falls into the UNFCCC and IPCC's category of vulnerable small island nations (Small Island Developing States) under serious threat from various climate change impacts, such as sea-level rise and severe floods and droughts (UNFCCC 1992; IPCC 2001). These threats are considered to have significant negative consequences on various sectors within Sri Lanka (Sri Lanka 2000).

- Most policy measures emphasize adaptation methods that a country needs due to its vulnerability to frequent and prolonged droughts, high intensity rainfall, increased tropical storms and sea-level rise.

c. *Cities are more vulnerable to climate change impacts than all other types of human settlements.*

- Urban settlements, with their overcrowded populations and continuous rapid urbanization are key vulnerable groups to climate change impacts. If the world continues on its present path, tropical countries in the developing world such as Sri Lanka, could possibly experience growing flood risks, sudden downpours and storms, extreme heat in summer, sea-level rise, stresses on municipal services, public health and threats to the economy of its cities.

- Climate change is already leading to an increased frequency in extreme weather events bringing floods, landslides and droughts, whilst melting glaciers threaten the drinking water supply of large cities. Sea-level rise will affect many large cities located along coastlines. Many countries see that the urban poor in every location suffer most from the impacts of climate change. Adapting to the dramatic implications of climate change is a monumental challenge facing the cities of the 21st century.

d. *Recognizing the significance of Sri Lanka, UN-HABITAT is working with the Ministry of Environment and Natural Resources in developing a national policy on climate change as a part of the CCCI programme.*

- This project is a pilot study of two pilot cities in Sri Lanka selected by UN-HABITAT in coordination with the University of Moratuwa under the programme of theCCCI programme.

- UN-HABITAT has established a global Sustainable Urban Development Network (SUD-Net) to raise awareness and to support the application of the principles of sustainable urbanization, at a global, regional, national and city level. As an initial component of UN-HABITAT's Sustainable Urban Development Network (SUD-Net), the Cities and Climate Change Initiative (CCCI seeks to enhance climate change mitigation and adaptation of cities in developing countries). The key objectives of the Cities and Climate Change Initiative (CCCI) are:

1. To promote active climate change collaboration of local governments and their associations in global, regional and national networks.
2. To enhance policy dialogue so that climate change is firmly established on the agenda.
3. To support local governments in making these changes.
4. To foster the implementation of awareness, education, and capacity building strategies supporting the implementation of climate change strategies.

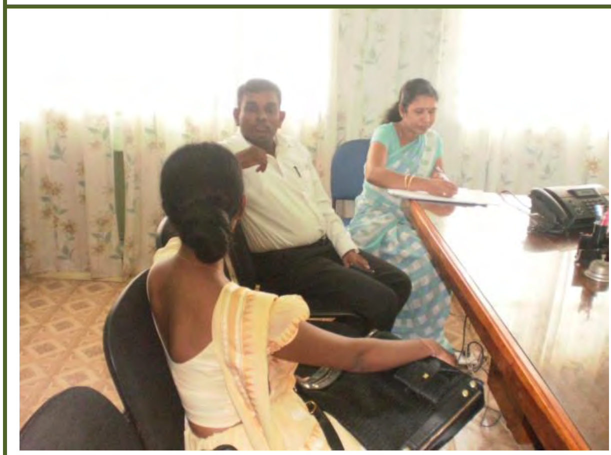
- UN HABITAT introduced the Cities and Climate Change Initiative (CCCI) programme in September 2008. Several CCCI have been implemented in nine pilot cities of the world and now further pilots are being developed in five more countries: Sri Lanka, Vietnam, China, Indonesia and Mongolia.

This step also included basic terms of climate change and its importance to a Sustainable City Development Process. Projected climate change impacts on cities and the critical role of local governments in climate change adaptation were key items during discussions. Project literature was distributed among the first stakeholders to introduce the project. .

The term 'climate change' was not new to either administrative officers or elected members of government, yet it was essential to emphasize the fact that addressing climate change is extremely important and 'local actions' are required despite climate change being a global issue. At the end of the discussions, the Mayor, the Municipal Commissioner and local government officials agreed to take part in the project whilst the Divisional Secretariat also expressed its willingness to provide fullest co-operation in future activities.

Location Batticaloa MC
Participant Mayor, Deputy Mayor and Elected Members of the MC

Location Batticaloa MC
Participant Municipal Commissioner, Officer of UN-Habitat



Location Batticaloa MC
Participant PHI and Solid Waste Project officer

Location Batticaloa DSD
Participant Divisional Secretariat

Views

"The spread of mosquito-borne diseases such as malaria and dengue is a key threat to Batticaloa Municipal Council Area. BMC has initiated a number of awareness programmes, Shramadana campaigns at school and village levels. Dengue however remains a threat which local health officers continuously attempt to address.

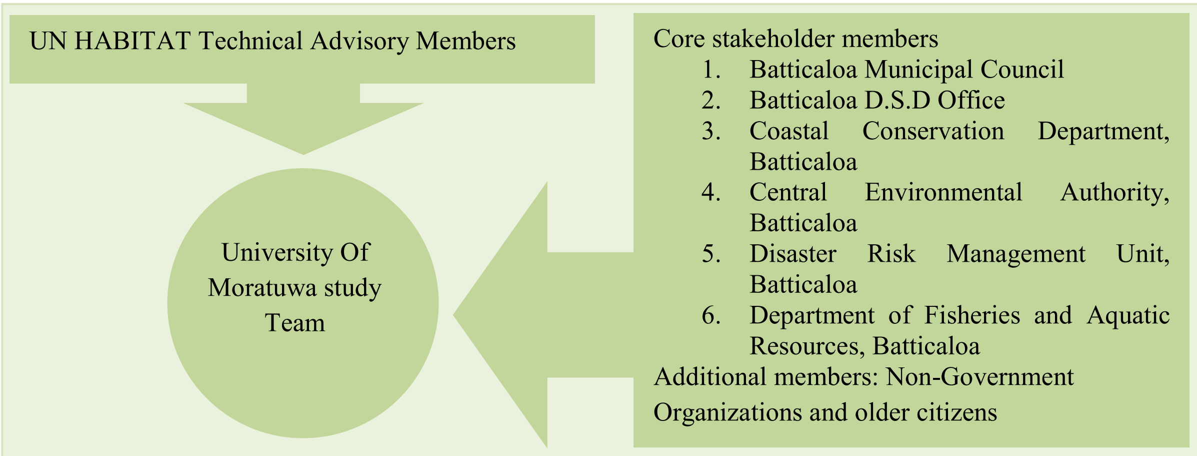
The rate of dengue infection has been increasing over the last several years. Mosquito-borne diseases have significantly increased during the higher rainfall periods."

Mrs.S. Jayanthi, Health division, BMC

2.2. Step: 02 Mobilize Assessment Team

The core assessment team comprised three parties who represent local decision makers, technical advisors and academic/research institutions. The composition of the team consists of additional members of Non-Governmental Organizations (NGOs) and older citizens who have been extensively involved in field studies.

Accordingly, an assessment team was mobilized to include academic and research members from the University of Moratuwa, technical advisory members from UN habitat and a core stakeholder member from Batticaloa urban council area.



The University of Moratuwa study team comprised university academics, graduate and under-graduate students from multi disciplinary backgrounds with special interests in the areas of urban planning and management, participatory planning, disaster management, and climate change studies. This included university students from the particular geographic area visited in order to incorporate their local knowledge.

UN-HABITAT technical advisers provided an insight into CCCI project methodologies and shared their experience, and lessons learned from previous projects implemented in Sri Lanka.

Core stakeholder groups were selected as per the suggestions of the Municipal Council and other members of the study team. All members agreed to develop a strong partnership with the project team to work together to accomplish the aims of this initiative.

The Coastal Conservation Department (CCD) was established under the Coastal Conservation Act and functions within the declared Coastal Conservation Zone of the country.

The CCD engages a spatial-decision making process through the Coastal Area Master Plan. The Central Environmental Authority (CEA) is an amalgamated body of the Ministry of Environment and Natural Resources which was established under the National Environmental Act. The CEA examines Environmental Impact Assessments (EIA) of development projects, formulate environmental regulations and guidelines as per the provisions of the National Environmental Act and thereby contributes to the city-level decision making process. The Disaster Risk Management Unit, Batticaloa is a local branch under the umbrella of the Disaster Management Centre (DMC). The DMC prepares Disaster Management Plans and enhances city-level adaptive capacities, to prevent or reduce the adverse impacts of disasters. The fisheries sector was identified as one of the most vulnerable sectors to climate change during initial discussions. Therefore, the Department of Fisheries and Aquatic Resources, Batticaloa was also selected as an additional core stakeholder team member.

Senior members of technical staff for each of the above decision-making bodies were appointed by the respective heads with an Executive Order (EO) to co-operate, support, and provide necessary inputs to the assessment team.

The core team members were selected after assessing their commitment to this assessment process, their analytical skills, communication abilities and other capabilities to enable an efficient and effective process. Furthermore, this team included representation from ethnic and gender groups. This team was selected to bridge local knowledge with scientific and technical know-how and to propose ways and means to reduce/prevent the anticipated impacts of climate change.

2.3. Step: 03 Field Reconnaissance Survey

The field reconnaissance survey was conducted in two steps: step 1 was a windscreen survey and step 2 was a detailed reconnaissance survey. The initial windscreen survey was carried out within the Municipal

Field Surveys conducted by the team

boundaries and the nearby vicinity. The aims of the survey were to:

- Identify the Municipal Council boundaries;
- Become familiarized with the main road networks of the city.

The windscreen survey was extended beyond the municipal boundaries along the coastal belt in both southerly and northerly directions. This survey was carried out in the vicinity to better understand the city status at a macro spatial level.

Detailed reconnaissance surveys were conducted within the municipal boundaries. The key aims of the surveys were to identify vulnerable groups likely to be affected by expected climate change scenarios. The geographic areas of the municipalities included in the survey are depicted in the map below.

Batticaloa Municipal Council Area

The municipality of Batticaloa has a strong economic base in the fisheries industry. Fishery activities are carried out at the lagoon, offshore as well as out in deep sea. A considerable proportion of the local population depends on fisheries and fishery related-livelihoods. According to statistics released in 2008, 3,511 families are dependent on the fishery industry, located at the lagoon. Furthermore, according to the same statistics, 3,751 persons are directly engaged in fishery sector activities..

Boat anchorages along the Lagoon

Traditional Fishery

18 fisheries co-operative societies were found in the area. There are 16 fishing centres in the Batticaloa Municipal Council area. The number of in-boat engine fishing crafts increased from 2 to 40 during the period from 2001 to 2008. Simultaneously, the number of out-boat engine fishing crafts increased from 38 to 252 during the same period. 21 farmers are engaged in prawn farming occupying 21 hectares on the outskirts of the city. 1,783 lagoon fisherman and 1,232 deep sea fisherman live in 36 villages across the city. The fishery community predominantly lives in shelters adjacent to coast and lagoon banks. They need to be considered as highly vulnerable groups for any expected climate change scenarios due to the insecurity of their current housing and livelihood options. Furthermore, those communities settled adjacent to the sea are heavily dependent on natural resources such as fisheries.

Type	Amount (kg)
Crab	87,769
Sea Fish	4,524,224
Lagoon fish	923,308
Prawn	125,395
Lobsters	2,900

Source: Fishery Department, Batticaloa

Batticaloa lagoon is the largest lagoon in Batticaloa District. It is a very large estuarine lagoon not only for Batticaloa District but also for Sri Lanka. The lagoon is situated on the East coast of Sri Lanka with a total surface area of approximately 11,500 ha. The maximum depth of the lagoon is approximately 4m (13 ft) and its length is 56km.

The long and narrow shape of the lagoon makes it a distinct geographical feature in the region.

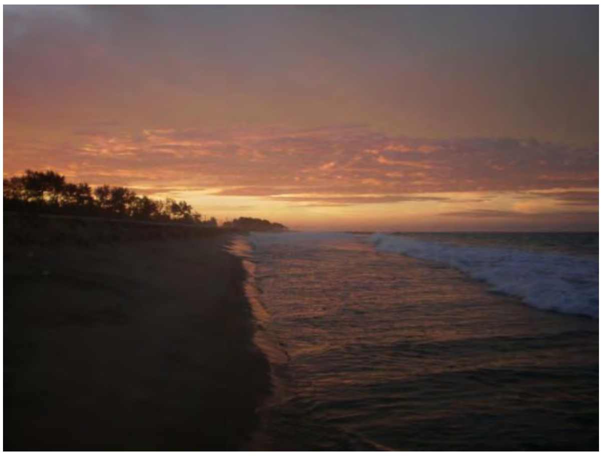
Batticaloa Lagoon

Jellyfish breeding site

There are a number of small rivers feeding fresh water into the Batticaloa lagoon. The lagoon contains aquatic species varieties such as *jellyfish* and *singing fish.* Bio-diversity is a key concern in the vulnerability assessment.

Sandy beaches extend towards neighboring localities from Batticaloa city along 4 km of shoreline. Kallady, Pasikudah and Kalkudah beaches in Batticaloa are well known attractions for local and foreign tourists. Pasikudah and Kalkudah beaches in Batticaloa have great potential to be further developed for tourism. Tourism in Batticaloa collapsed due to conflict and the 2004 Indian Ocean Tsunami. Tourism has been gaining momentum over the last two years and further developments are foreseen in the near future.

In addition, impoverished communities rely on livelihoods of farming and livestock rearing along Batticaloa coastal belts. This brief assessment helped to define the next steps of the project to and the scope of the study.



Potential Areas for Tourism: Dutch Bar and Palminmadu

2.4. Step: 04 Agree On Assessment Purpose and Scope

A common agreement among key stakeholders is necessary on the purpose and scope of the study. This is good practice and should happen before proceeding with any vulnerability assessment.

The very first consensus reached was the need to demarcate the geographic area for the study. Clearly defined boundaries avoid overlapping and exclusions of spatial units. The local authority boundary of the city was taken as the geographic area of the city. The key reasons for the selection are:

- Local authority boundaries are legally defined administrative boundaries. There are two such local level boundaries: the local authority boundary and the D.S. division boundary.)
- Local authority boundaries (municipal council boundaries) are often considered as city limits for revenue purposes.
- Local authorities have decision-making powers and political authority to make strong decisions to reduce vulnerability within city boundaries.

To determine the scope of the study, the assessment team and local government officials considered the following guiding questions outlined in the Sorsogon City V&AA toolkit.

1. What are the key development assets and issues of the city and what does the LGA want to get out of the V&AA in relation to these assets and issues?
2. Where should the focus of the assessment be? Should the assessment focus on the city as a whole, on specific population groups, on specific locations, on the economy or on specific sectors, etc
3. What resources are available to be used for the assessment?
4. How far into the future should the assessment look into? Are there available climate change models that could be used?
5. Which part of the local governance structure is critical to be assessed— the whole system or only specific groups?

> *'The most important thing to keep in mind in conducting an assessment of vulnerability and adaptation is that the assessment is meant to serve the needs of those asking questions, such as stakeholders, not the needs of the analyst. The assessment must be designed to provide information useful to stakeholders to understand vulnerability to climate change and adaptation options. The assessment therefore should begin by identifying the questions stakeholders would like to have a vulnerability and adaptation assessment answer'*.
>
> - UNFCCC Vulnerability and Adaptation Handbook Chapter 1
>
> *http://unfccc.int/resource/cd_roms/na1/v_and_a/index.htm*

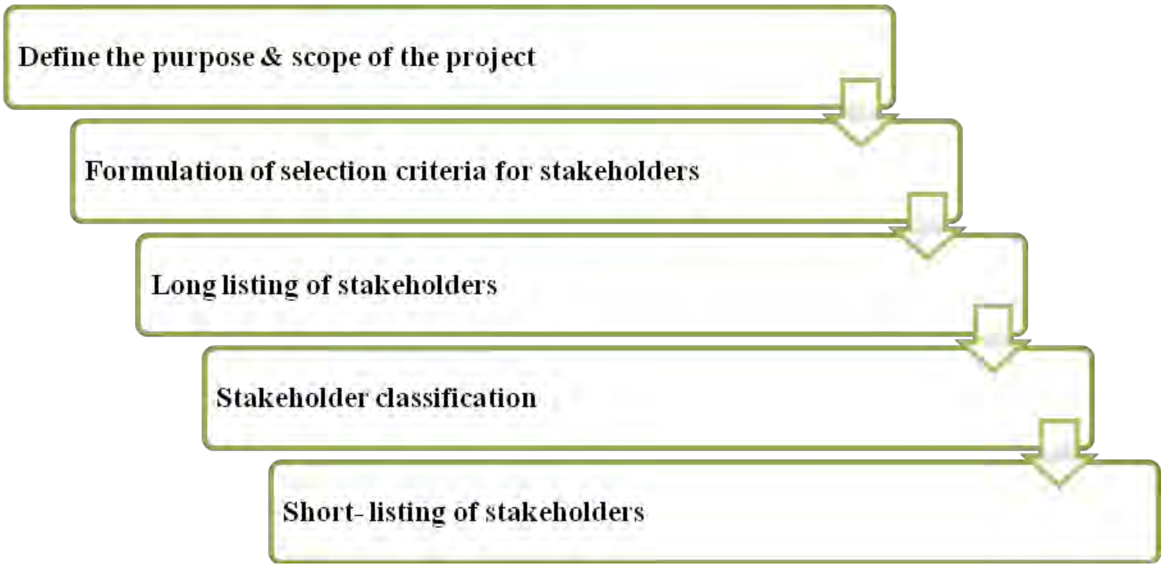
Local government officials suggested carrying out the vulnerability assessment with a key focus on concerns such as the occurrence of natural disasters, flood and cyclones, and damage to: coastal activities; resources; and settlements due to sea-level changes. In this regard, local government officials expressed their willingness to be a part of the vulnerability assessment. They also highlighted budgetary constraints and a lack of expertise/resources/personnel to proceed.

2.5. Step: 05 Stakeholder Mapping

The stakeholders of this project are the people, groups, and organizations who have significant and legitimate interests in issues related to climate change. Stakeholders play a key role in local co-operation and support critical to the success of the project. Stakeholder mobilization can ensure good governance through transparency, participation and partnership. Stakeholders provide a local link to project activities. Therefore, stakeholders should be carefully identified to include representative groups and to avoid vested interest groups.

Stakeholder mapping is a challenging task which should include all relevant stakeholders in assessing, programming, planning and implementation of any desired activities to adapt to climate change and its impacts. Climate change is an on-going phenomenon which may result in significant cumulative impacts on a wide range of stakeholders. The early involvement and commitment of all relevant stakeholders is very important.

The steps that were followed for stakeholder selection are given below.



Step 1: Define the purpose and scope of the project

The project is divided into two main tasks and stakeholders were defined on the basis of each sector.

1. Preparation of vulnerability assessment with the involvement of:
   - Vulnerable communities, Community-Based Organizations, NGOs, women, older citizens

2. Preparation of an adaptation strategy under the guidance of:
   - Planning and implementing agencies, local level officers and citizen representatives

Stakeholders have been selected based on above framework, the key considerations are mentioned in the next step.

Step 2: Criteria for selection of stakeholders

- Community groups who might be affected negatively or positively by climate change
- A core team to co-ordinate and manage the vulnerable sectors
- Planning and development decision-makers, (administrative officers, heads of institutions) and local government technical officials

- Representatives of civil society organizations and volunteers (including Community-Based Organizations, Non- Governmental Organizations)
- Institutions, private sector entrepreneurs with control over resources
- Older citizens and political leaders who act as local hosts

Step 3: Long-listing of stakeholders

The long-listing of stakeholders is based on secondary sources from websites, local authority registry records and the Divisional Secretariat office's registry.

Step 4: Stakeholder Classification

Stakeholders were classified into five groups by interest type.

Step 5: Short-listing of stakeholders

The short-listing of stakeholders was undertaken through a mapping of stakes and influences of each group on the list. This activity involved a discussion with the core- stakeholder team. The format below, (used in the Sorsogon City Vulnerability Assessment) was successfully adapted for this assessment.

	Low influence	**High Influence**
Low Stake	(Least priority)	(Useful for decision making and opinion formulation)
High Stake	(Important stakeholder groups perhaps in need of empowerment)	(Most critical stakeholder group)

Stakeholders who have a high stake and high influence are ideal partners for the project. Despite their low level of influence, the stakeholders who have a high stake were also added to the list in consideration of their need for empowerment. Stakeholders who have a low stake and low influence were given the lowest priority during the short-listing process.

All of the short-listed stakeholders were personally interviewed by the study team. Their interest to become involved in this process was ascertained and their capacity to deliver activities. Additionally, specific consideration was given to vulnerable groups to deliver climate change based on gender concerns, sensitive age groups and low-income groups. Their interest is considered a key factor and therefore their capacities were not assessed during the short-listing process.

The stakeholder assessment was conducted at the inaugural session of the project. The details of the session are outlined in the inception report. The findings of the assessment are given below.

Findings of the Stakeholder Assessment

a) Level of Awareness about institutions working on Climate Change Programmes in the Sri Lankan Context

Organization	**Level of Awareness**
Ministry of Environment and Natural Resources	90%
Climate Change Secretariat, Sri Lanka	67%

National Ozone Unit	65%
UN HABITAT	65%
UNDP	57%
United Nation Framework Convention for Climate Change (UNFCCC)	61%

b) Level of awareness about Climate Change scenarios, based on stakeholder meetings and KII's – Batticaloa

Group	Description	Level of Awareness				
		Very Low	**Low**	**Moderate**	**High**	**Very High**
Batticaloa MC	Basic knowledge of climate change			■		
	Causes of climate change			■		
	Impacts of climate change			■		
	Adaptation/mitigation measures	■				
Other administrative officers	Basic knowledge of climate change					■
	Causes of climate change				■	
	Impacts of climate change					■
	Adaptation/mitigation measures				■	
Fishery Community	Basic knowledge of climate change		■			
	Causes of climate change		■			
	Impacts of climate change			■		
	Adaptation/mitigation measures	■				
Agriculture Community	Basic knowledge of climate change		■			
	Causes of climate change		■			
	Impacts of climate change		■			
	Adaptation/mitigation measures	■				
Tourism Sector Organizations	Basic knowledge of climate change			■		
	Causes of climate change		■			
	Impacts of climate change			■		
	Adaptation/mitigation measures		■			
General Public	Basic knowledge of climate change			■		
	Causes of climate change		■			
	Impacts of climate change			■		
	Adaptation/mitigation measures		■			

The survey reveals that local administrative officials including Municipal Council officers have a better understanding of climate change scenarios when compared to the general public. On a positive note, the majority of community representatives have a basic understanding of climate change. This assessment gives us a baseline to develop a future road map of the project through a participatory process.

3. PHASE TWO - DATA COLLECTION

Phase two is the data collection phase of the project. This includes collection of data from secondary sources as local governmental departments and other local and national institutions. Information is also collected from primary sources. This is mainly due to a lack of secondary data and the availability of out-dated data sets. Field surveys for collecting primary data were organized in a systematic way.

Phase Two – Data Collection

Step: 6 Secondary Data Collection → **Step: 7** Organize field surveys → **Step: 8** Primary Data Collection

- Focal Group Discussions
- Semi Structured Interviews
- Field Mapping / GPS Survey
- Participatory Mapping

The table below presents a checklist of basic data requirements and sources to support the data collection and analysis process.

Assessment Factor	Key Data Needed	Purpose	Source/s
Climate Change Exposure (current and future)	a. Climate data (e.g. cyclones, droughts, flooding events)	Show trends, and possibly indicate how climate change is manifesting locally	- Meteorological Station, Batticaloa - Meteorological Department (head office) - Climate Change Secretariat, Sri Lanka
	b. Climate scenarios/projections (local/ national/ global	Show as adequately as possible what can be expected at a local level over the next 10, 30, 50 years or by the end of century	- Not available at either a local or national level - Global projections of IPCC
	c. Impact reports of previous disasters	Validate exposure to threats of climate change bio-physical effects	- Disaster Management Centre, Batticaloa - Disaster Risk Management Unit, Batticaloa - Social Service Division, DSD

			Batticaloa
Assessment Factor	**Key Data Needed**	**Purpose**	**Source/s**
Climate Change Sensitivities	a. Hazard map/s	Identify bio-physical effects of climate change (e.g. *drought, flooding, cyclones, etc.)*	- Disaster Management Centre, Batticaloa - Climate Change Secretariat, Sri Lanka
	b. Socio-economic profile	To show who will be affected in current and future conditions	- Resource profile, Batticaloa DSD - FGDs with communities - Community-based survey results
Adaptive Capacity	a. Socio-economic profile	Validate the thresholds of people at risk	- Resource profile, Batticaloa DSD
	b. Key physical characteristics	Validate the thresholds of people at risk - present resources and conditions	- Resource profile, Batticaloa DSD - Land cover map, Batticaloa DSD - Topography map, Survey Department
	c. Land Use Plan	To present spatial information for comparison with hazard maps and projected areas at risk	- Land Use Plan, UDA Batticaloa
	d. Local economic activities	To present the economic activities that could be at risk	- Resource profile, Batticaloa DSD - Land use map, UDA Batticaloa
	e. Local development strategy	Provide information on the relevance of at risk areas/sectors/ resources to the city priorities	- Resource profile, Batticaloa DSD - Budget Report, Batticaloa MC - FDG's KII's with relevant officers/ groups
	f. City investment program/ annual resource stream	Provide information on risk; areas/sectors/ resources to city development priorities	- Resource profile, Batticaloa DSD - Budget report, Batticaloa MC - FDG's KII's with relevant groups
	g. Copies of local disaster risk reduction plan/program	To present current actions and if possible determine existing capacity	- Disaster management Centre, Batticaloa - FDG's KII's with relevant officers/ groups

3.1. Step: 06 Secondary Data Collection

Secondary data collection was conducted to obtain data from the abovementioned sources. The data sourced from institutions of key stakeholders was collected by appointed team members. A trained team performed the data collection from the remaining institutions. These were informed about the project by the University of Moratuwa and sent formal request letters where necessary. This data was collected in both soft and hard copy formats if available.

3.2. Step: 07 Organize Field Survey

Field surveys were conducted to collect primary data, and survey teams were properly trained for this task. Team members were assigned with respective data collection tasks and each member was supplied with a set of data to be collected, methods to follow, and the format of data recording.

A field identification card was issued for each member, including a signature of the team leader and details about the team member. The local police station and the municipal council were informed about the survey. Grama Niladhari officers of each particular GN Divisions where the survey was undertaken, have pre-informed about this task. Field working team supplied with sound-recorders and cameras to report the findings.

3.3. Step: 08 Primary Data Collection

Primary Data collection has followed four types of survey methods.

1. Focus Group Discussions
2. Semi Structured Interviews
3. Field Mapping / GPS Survey
4. Participatory Mapping

Focus group discussions are qualitative research methods in which a group of people are asked about their perceptions, opinions, beliefs and attitudes towards a product, service, concept or idea. Questions are asked in an interactive group setting where participants are free to talk with other group members.

This method has discussed to collect data on specific topics related to climate change with groups of people as fishermen, tourist hotel/resource owners, and near-shore residents

A semi-structured interview is another method of research. While a structured interview is formalized, with a limited set of questions, a semi-structured interview is flexible, allowing new questions to be brought up during the interview as a result of what the interviewee says. The interviewer in a semi-structured interview generally has a framework of themes to be explored. This method was applied to Key Informant Interviews (KII's) conducted with particular officers and institutions.

Field-mapping is an integrated tool designed for computer aided field data collection. This tool is used mainly for mapping data collected during field surveys. This application works with a multi-level relational database and also provides communication with external devices such as a GPS. This is employed to map locations vulnerable to climate change impacts.

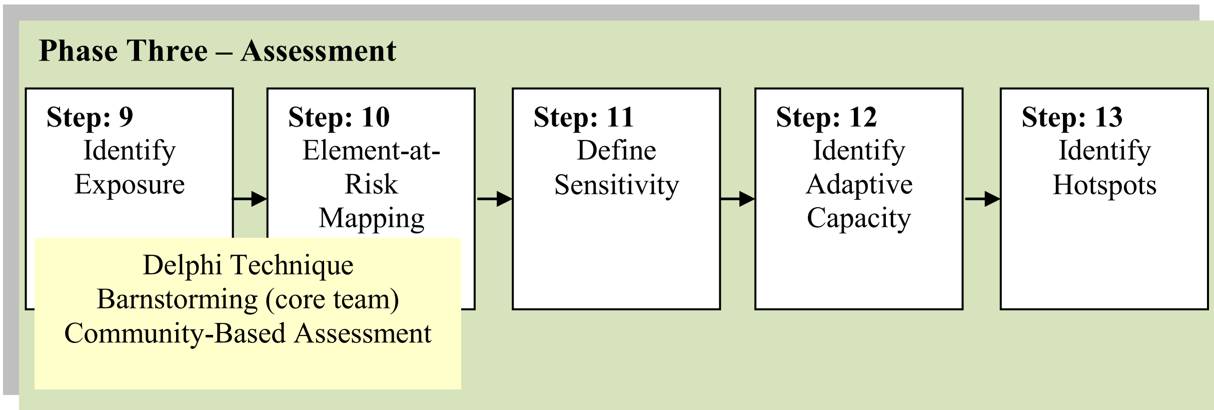
Participatory maps are those created by local or indigenous groups, usually for the purposes of defining landmarks and boundaries. This was used effectively to identify vulnerable areas though interviews. Interviewees identified disaster-exposed areas, and the team collated this information using GPS point data and satellite images.

4. PHASE THREE – ASSESSMENT

This is the main phase of the vulnerability assessment. Following the toolkit based on the Sorsogon City Vulnerability Assessment, the term 'vulnerability' is considered as a function of three factors namely: Exposure, Sensitivity, and Adaptive Capacity. Accordingly, the assessment incorporates three consecutive steps: 1, identify exposure, 2, define sensitivity and 3, identify the adaptive capacity.

Vulnerability = f (Exposure, Sensitivity, Adaptive Capacity)

The most vulnerable locations were classified as local hotspots.



The assessment examined all three factors, given that vulnerability to climate change impacts increases with exposure and sensitivity yet might be off-set by a greater adaptive capacity. For instance, even though there is a significant increase in rainfall, if the area affected has a strong adaptive capacity (i.e. a well established drainage system), then there will be lower vulnerability compared with an area of poor adaptive capacity (i.e.an obsolete drainage system).

Active stakeholder participation is a key requirement throughout the assessment. The level of understanding, local knowledge and analytical capabilities of stakeholders are the key factor of a successful assessment. The participatory nature of the assessment is expected to bring a broad-based decision-making that increases the ability of local governments to mobilize effective local actions.

Two key additions were made to the initial method, explained in the toolkit based on Sorsogon city V&AA. First, this includes the 'element at risk mapping' component, which comprehensively assesses the impact to the city overall. This is a partial extension to the participatory mapping process introduced in the toolkit. This is important for physical planners to visualize the overall impact to the city and for decision-makers to formulate spatial oriented decisions on city development. In addition to the community-based climate change scenario assessment, climate variables were assessed based on the records of observatory stations. Although this is a technical input, community members were duly impressed giving them a strong basis to emphasize the need for an adaptation plan based on the findings. The community enthusiastically compared their statements to the findings from observatory records. This in turn led to more active participation on the part of communities in later stages of the project.

4.1. Step: 09 Identify Exposure

Degrees of exposure to climate change impacts are often assessed through climate change scenarios. There are several types of climate change scenarios:

- Arbitrary climate change scenarios (scenarios that are devised arbitrarily based on the advice of experts)
- Analogue climate change scenarios (scenarios based on past climate models)
- Scenarios based on climate model outputs

Locally-specific climate models are extremely useful in the preparation of adaptation plans for cities. However, the formulation of climate change scenarios can be a costly exercise with expert inputs in climate science. Therefore, as suggested in CCCI toolkits, the scientific observations available at the global, regional and national levels as a basis for defining a city climate change exposure analysis. There is currently no scientifically established comprehensive climate change scenario at a national level for Sri Lanka. Therefore, this assessment directly follows the IPPC global predictions as key concerns for assessment. The IPCC has developed storylines to narrate qualitative aspects (e.g., political, social, cultural and educational conditions), emissions drivers, and scenarios on how future climate may change by using General Circulation Models (GCM).

The most important factor to note is to facilitate these models with an acceptable ground-truth to relate available local observations to regional/global projections. In this assessment, two alternative methods were used for this purpose by conducting FGDs with communities and stakeholder workshops as well as completing a statistical analysis of past climate records. In other words, this study attempted to relate global predictions using local accounts of historical data/previous events to emphasize the evidence of climate change impacts in the city. The global projection in the table used climate change projections of the Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report. This study then attempted to relate IPCC predictions to local (historical) accounts.

- Average surface temperature increased by 0.74°C (1960-2005)
- Global average sea level rose (due to increase in average surface temperature) at an average of 1.8mm per year over the period from 1961-2003
- Projected increases for further warming from 1.4°C to 5.8°C during the 21st century leading to a further increase in sea level rise projected to be anywhere from 18-59cm in 2010 and from 1 m to 2 m (worst case scenario) by the end of the 21st century

Secondary data collected at previous stage, was used to develop an understanding of the local situation.

Hazardous Events	Return Period	
Flood	Flash floods	Every year (Northeast Monsoon Period, Dec - April)
	Minor floods (100-150mm)	3-5 year (2004 Sep, 1997 Mar, 1994 Jan & Nov, 1993 Dec, 1989 Sep, 1987 Feb, 1986 Jan, 1980 Nov, 1971 Jan,)
	Critical floods (150-250mm)	10-20 year (2009 Dec, 1999 Dec, 1978 Dec, 1957)
Cyclone	Cyclonic storms (1967, 1931)	30 years
	Cyclones (1907, 1978)	
Sea-level Rise - Coastal Erosion	Long term	Every Day
Sea-level Rise - Salinisation	No records	No records

(Source: DMC Batticaloa, Manmunei North DSD, CCD, Batticaloa)

City exposure to climate-driven phenomena as changes in extremes (e.g. tropical cyclone/storm surge, extreme rainfall) and changes in means (e.g. temperature, precipitation, and sea-level rise) were assessed through workshop findings. In this connection, the following section explains;

4.1.1. Statistical Analysis of Changes in Means
4.1.2. Workshop findings on city-level exposure to climate change

4.1.1. Statistical Analysis of Changes in Means

The climate scenario analysis is based on climate data obtained from Batticaloa observation Station of Meteorology Department from 1970 to 2009. This analysis refers to the changes observed in rainfall and temperature levels in that particular station.

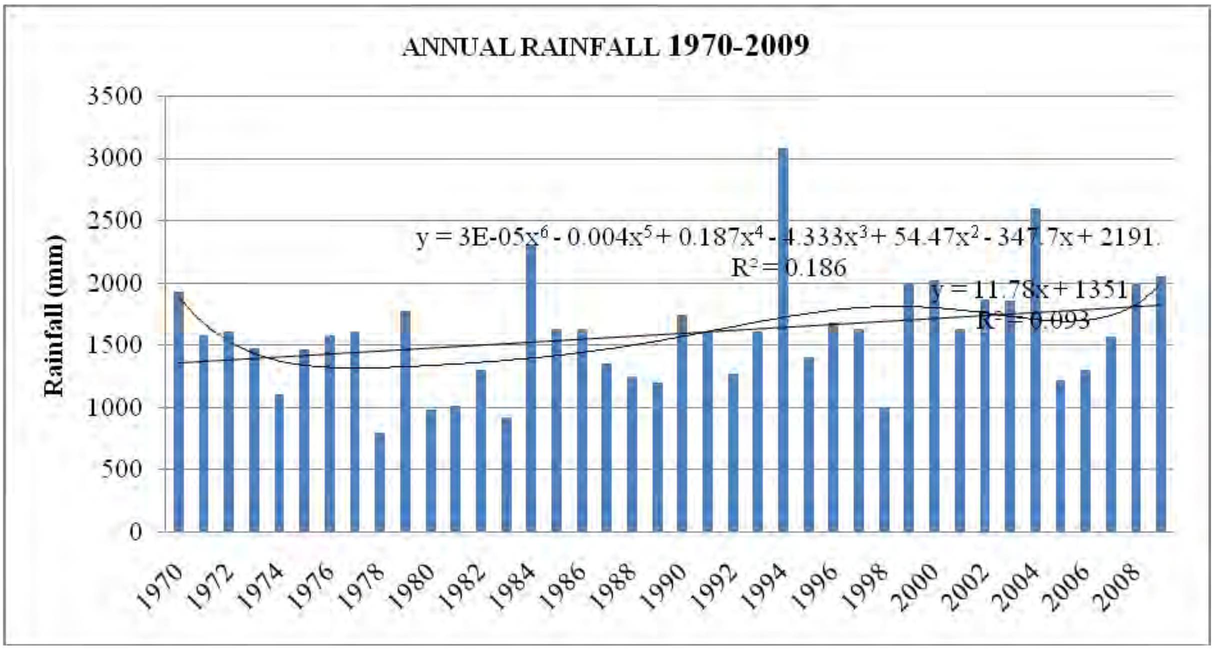
4.1.1.1. Changes in Rainfall

The average annual rainfall of Batticaloa municipality is 1,592 mm. During the last forty years the maximum annual average rainfall of 3,081 mm recorded in 1994 and the minimum average rainfall of 800mm was recorded in 1978. October, November, December, January and February are the rainy months in which average monthly rainfall exceeds 100 mm. May, June, July and August are the dry months which record an average monthly rainfall of less than 40mm.

	Min (mm)	Max (mm)	Average (mm)	Std (mm)
Annual	799.80	3080.70	1592.81	451.45
Mar	0.00	419.50	74.94	87.12
Apr	2.50	276.30	55.62	59.13
May	0.20	138.60	40.22	36.99
June	0.00	209.70	33.17	44.26
July	0.00	129.60	34.91	33.32
Aug	0.00	185.10	38.08	41.63
Sep	2.00	311.10	75.42	73.83
Oct	49.40	428.20	167.13	88.92
Nov	0.00	964.50	345.45	192.09
Dec	0.00	897.90	396.62	209.65
Jan	0.00	486.00	209.37	156.85
Feb	0.00	558.40	115.03	113.79

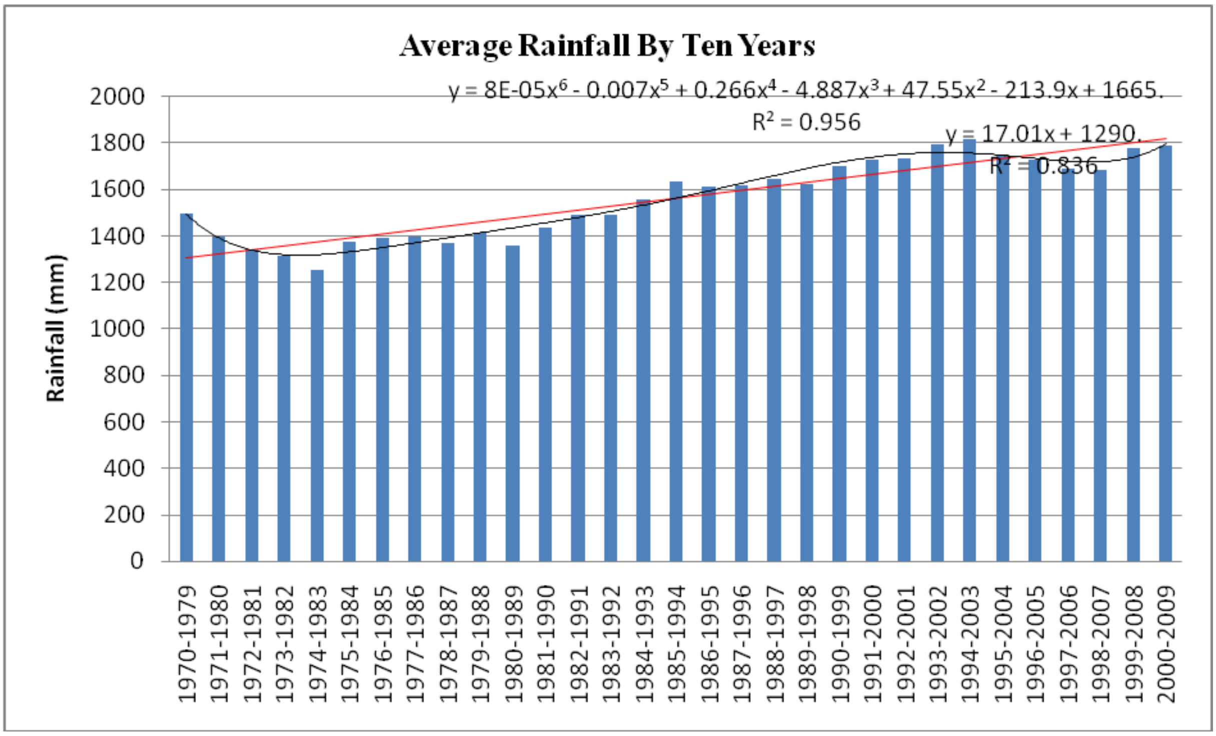
(Source: Based on Metrological Department Data)

As illustrated in the graph below, the annual average rainfall of Batticaloa has increased by an amount of 87 millimeters, about 5%, during the period 1999-2009 when compared to 1989-1999. This could be partially due to global climate change with the increase of greenhouse gases in the atmosphere.



(Source: Based on Metrological Department Data)

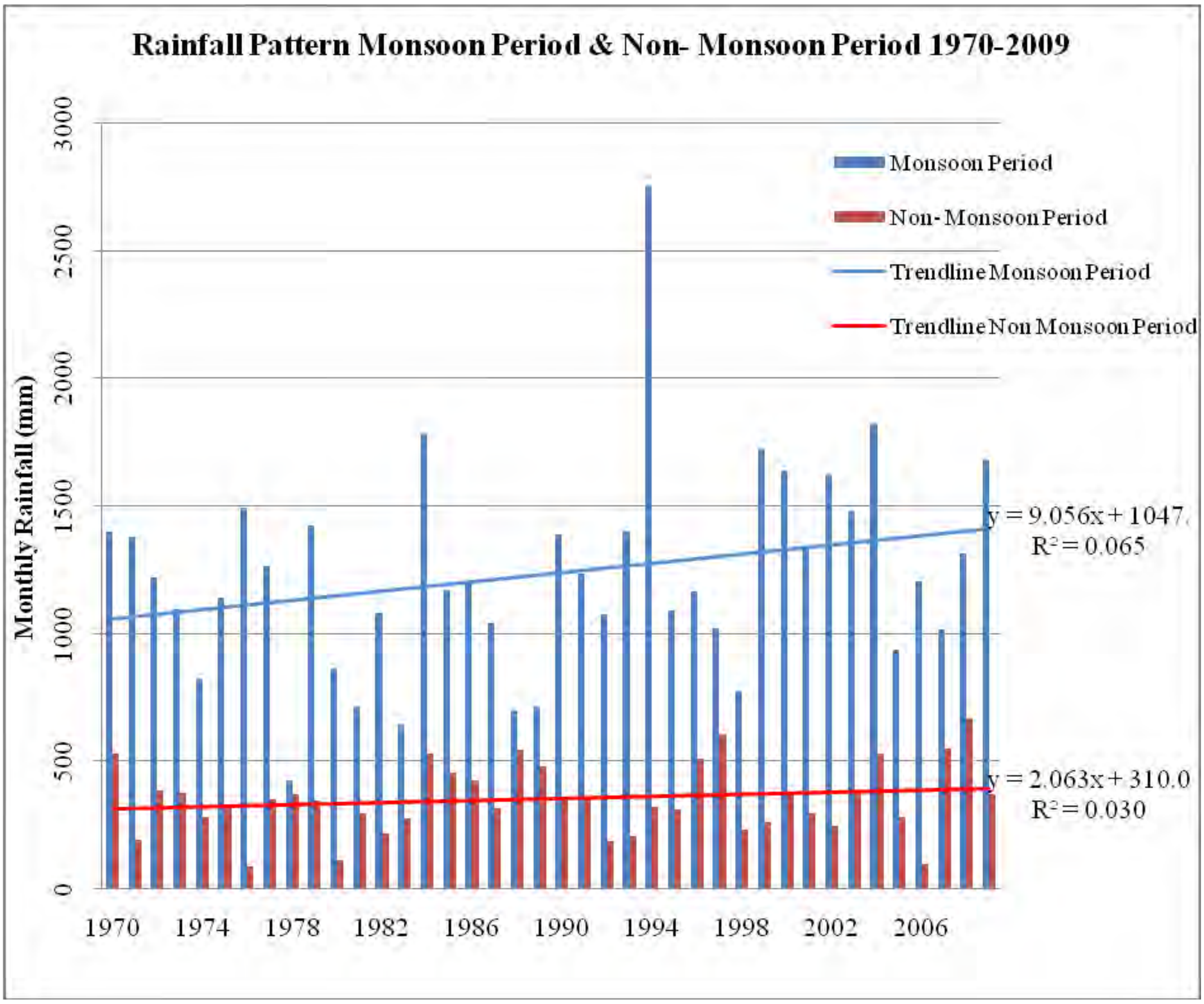
The average rainfall per decade shows a sharp increase during the decades from 1985 to 2008 compared to 1970 -1985. The following graph depicts the significant increase of rainfall in the last two decades when compared to the previous decade.



(Source: Based on Metrological Department Data)

The increase observed in annual average rainfall is visible in the breakdown taken from November to June (eight (8) consecutive months of the year) as per the records from 1970 to 2009. The average monthly rainfall of July to October (4 consecutive months of the year) reveals a decreasing trend. This trend has resulted in three key changes in monsoon rainfall as explained below:

I. Increase of average monthly rainfall during northeast monsoon months
II. Extension of monsoon season
III. Irregularities in rainfall observed during the monsoon months
IV. Decrease of rainfall in non-monsoon months



(Source: Based on Metrological Department Data)

Accordingly, the average monthly rainfall of rain from the northeast monsoon has increased by 28% during last two decades (1990-2009) compared to the previous two decades (1970-1989). This change is negligible during the non-monsoon months.

As with the change observed in rainfall intensity, there is a significant temporal variation in monsoon rainfall. The following three graphs show the daily average rainfall patterns observed during last three decades.

a) Intensive monsoon rain (more than 20 mm a day) started in the last week of October and/or first week of November during the decade from 1979 to 1989 (refer line 'A')

b) Intensive monsoon rain (more than 20 mm a day) started in the first week of October during the decade from 1999 to 2009 (refer line 'B')

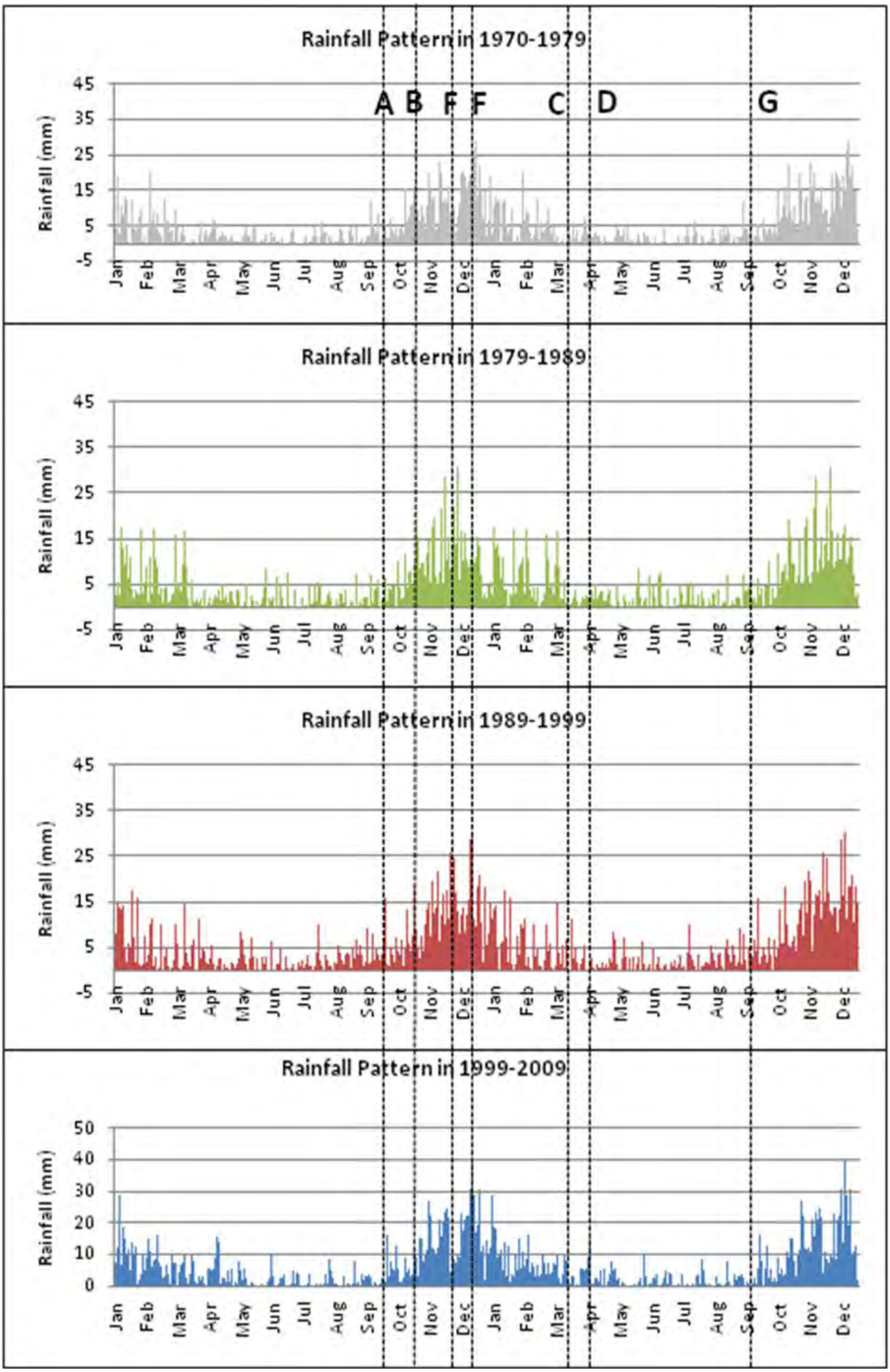
c) Intensive monsoon rain (more than 20 mm a day) stopped by about the third week of March during the decade from 1979 to 1989 (refer line 'C')

d) Intensive monsoon rain (more than 20 mm a day) continued till the second and/or third week of April during the decade from 1999 to 2009 (refer line 'D')

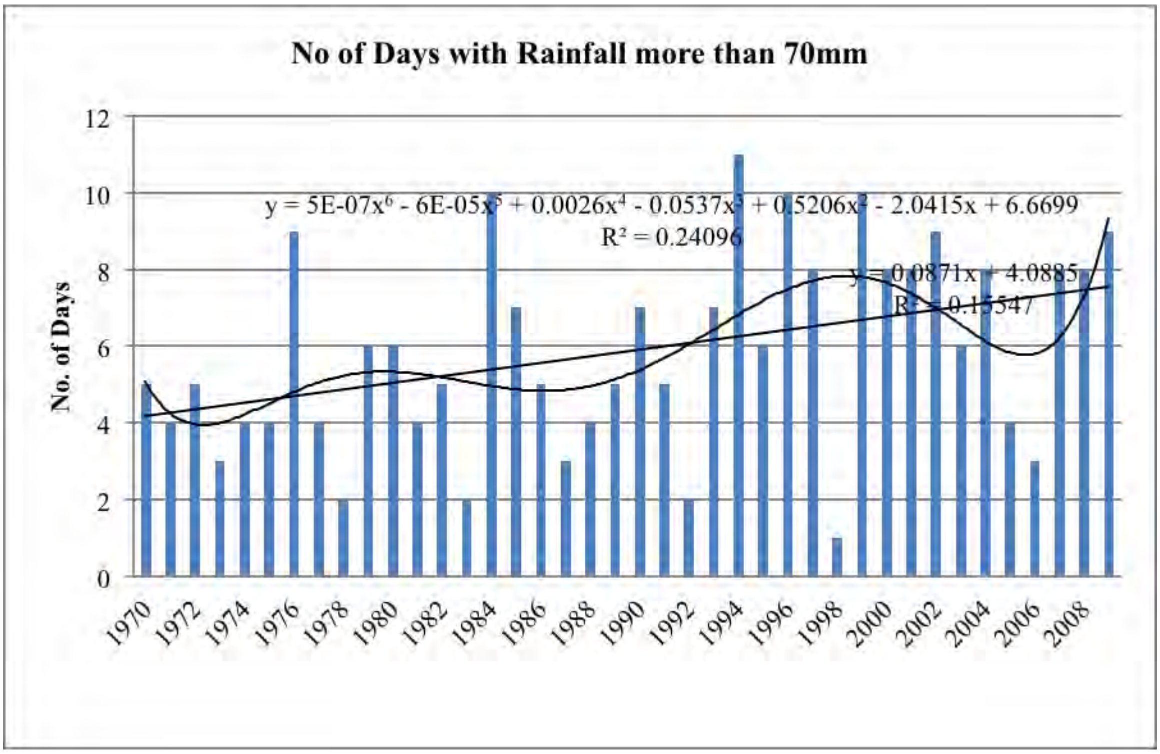
As illustrated in 'A' and 'B', there is high intensive rainfall in the monsoon rains approximately one month earlier than in previous decades. Similarly, as depicted in 'C' and 'D', high intensive rainfall was extended by approximately one month when compared to previous decades. In conclusion, the monsoon starts earlier and stops later and thereby the overall monsoon rainy season has expanded by six to eight weeks. Accordingly, the peak rainfall, which was recorded in the first week of December during 1979-1989 (refer line E), has become delayed to the third or last week of December during 1999 – 2009 (refer line F).

The above conditions lead to a situation where, there is high intensive rainfall during the monsoon season. Conversely, the non-monsoon period of the year receives less rainfall during the period of 1999 – 2009 when compared to the period from 1979 to 1989. This is reflected in the zone between Line 'D' and line 'G'. Simply, the rainy season receives high rainfall while the non-rainy seasons receive less rainfall compared to previous decades. This points to a possibility of an occurrence of extreme events during both dry and wet seasons.

These extreme events seem to be gradually losing their sequence/pattern. As depicted below 'A' to 'D' in the first graph there is a continuous but gradual rise but it is discontinuous in the second to third graphs. This situation leads to uncertainties in daily weather patterns which are extremely difficult to predict.


Rainfall Pattern in 1970-1979
Rainfall (mm)
A B F F C D G
Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Rainfall Pattern in 1979-1989
Rainfall (mm)
Rainfall Pattern in 1989-1999
Rainfall (mm)
Rainfall Pattern in 1999-2009
Rainfall (mm)

The average number of rainy days in Batticaloa is 100 days per annum. The following graph shows the number of heavy rainy days (average daily rainfall more than 70 mm) observed from 1970 to 2008. The graph depicts a significant increase in extreme events during last few years.



(Source: Based on Metrological Department Data)

Accordingly, the number of heavy rainy days during 1999 to 2008 has increased by 2.5 days (54%) compared to 1970 – 1979.

4.1.1.2. Changes in Temperature

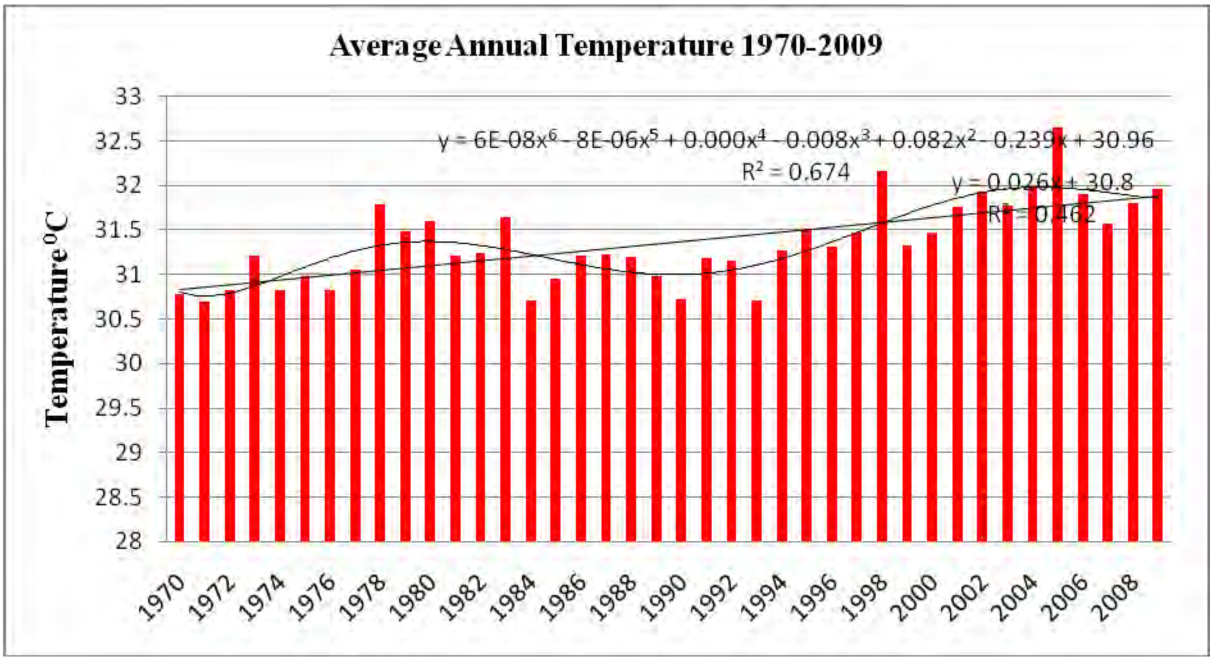
The average monthly temperature of Batticaloa municipality varies from 28 ^{0}C to 34^{0}C. During the last forty years the maximum monthly temperature of 36^{0}C was recorded in 2005 and the minimum average monthly temperature of 26^{0}C was recorded in 1976.

The months of November, December, January and February are cooler months which average monthly temperatures between 28^{0}C to 29 ^{0}C. May, June, July and August are the warmer months which record average monthly temperatures from 33 ^{0}C to 34^{0}C.

	Min (^0C)	Max (^0C)	Average (^0C)	Std (^0C)
Oct	30.14	32.93	31.36	0.62
Nov	28.62	30.79	29.51	0.49
Dec	26.81	29.59	28.31	0.62
Jan	26.63	29.27	28.08	0.57
Feb	27.72	30.84	28.98	0.69
Mar	29.34	32.53	30.38	0.67
Apr	31.11	33.50	31.94	0.57
May	32.01	34.91	33.31	0.70
June	32.23	36.13	34.26	0.80
July	32.05	35.33	33.83	0.85
Aug	32.14	34.71	33.51	0.63
Sep	30.93	34.63	32.58	0.84

(Source: Based on Metrological Department Data)

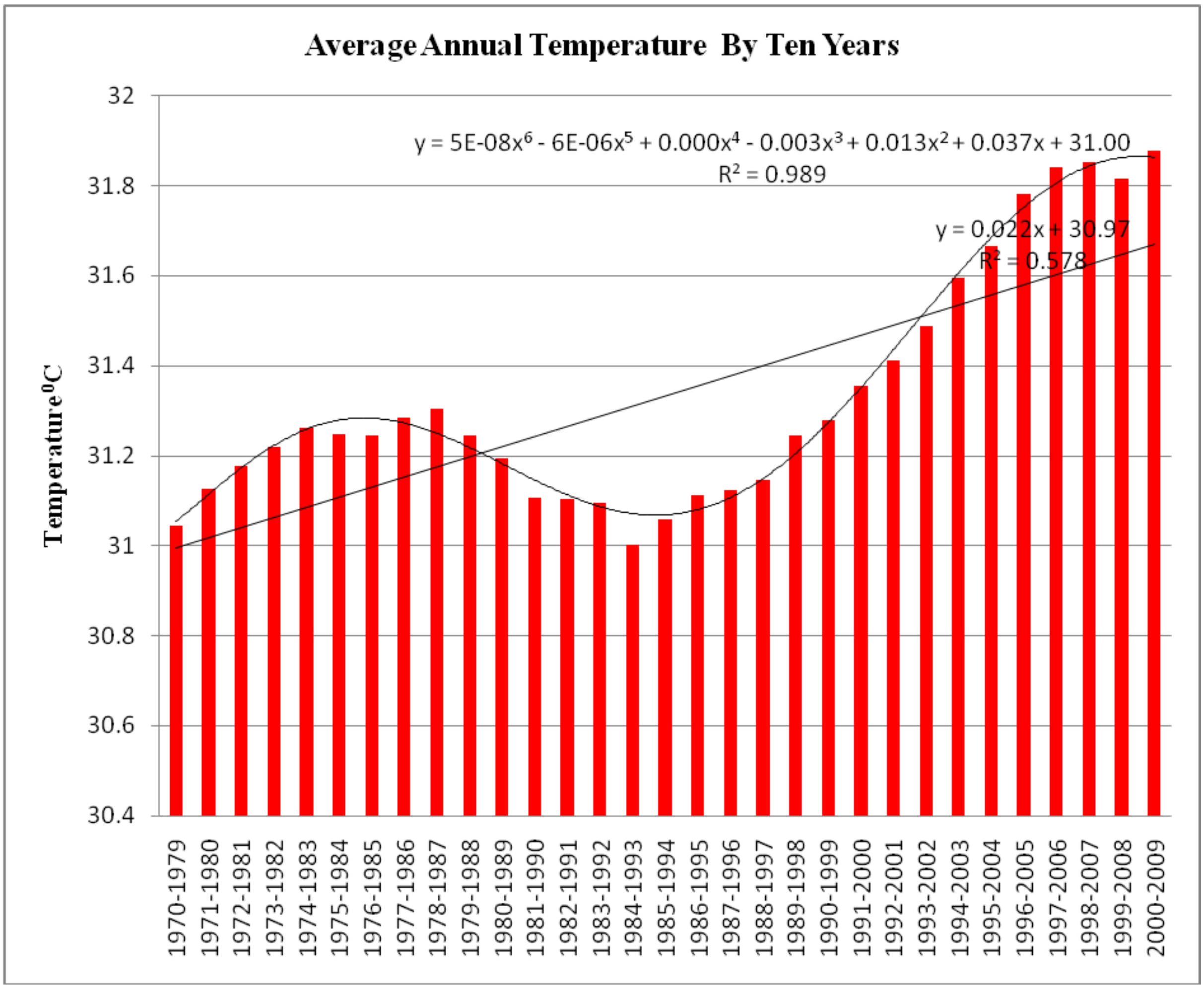
As illustrated in graph below, the annual mean air temperature of Batticaloa has increased by an amount of 0.015^0C per year during the last thirty years.



(Source: Based on Metrological Department Data)

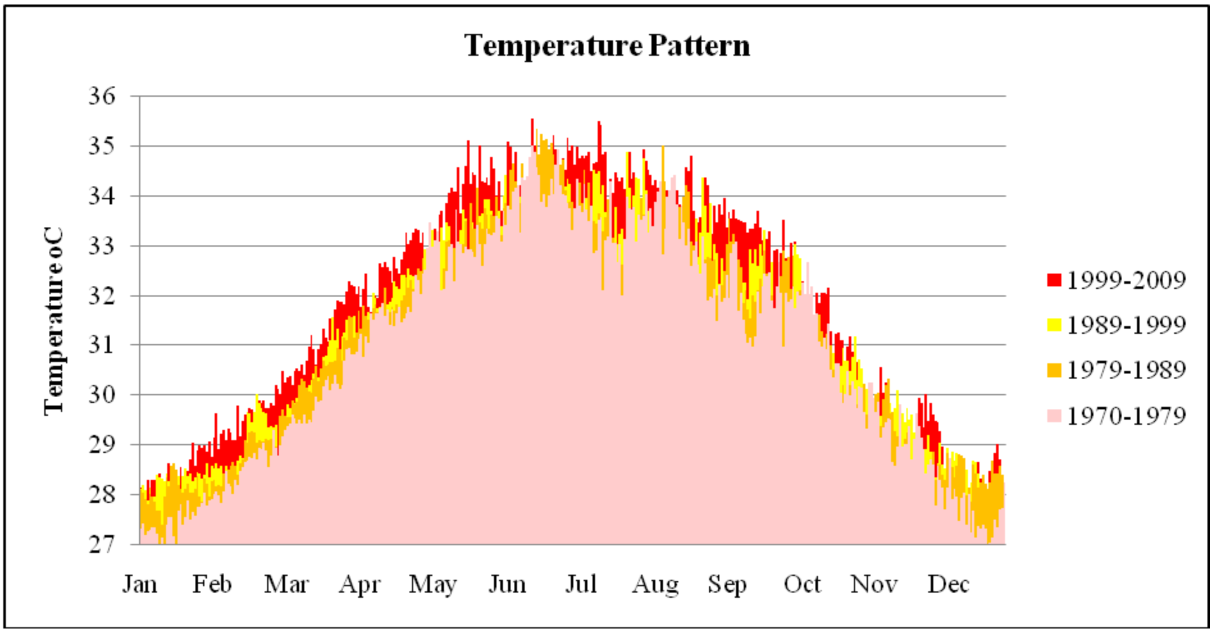
The average annual temperature which was 31.04^0C during 1970 to 1979 has increased to 31.88^0C from 2000 to 2009 by 0.84^0C. This could be partially due to global climate change with the increase of greenhouse gases in the atmosphere.

The average temperature per decade shows a sharp increase during the decades from 1990 to 2008 when compared to 1970-1990. The following graph depicts a significant increase of temperature in last two decades when compared to the previous two decades.



(Source: Base on Metrological Department Data)

The increase observed in annual average temperature is visible in the monthly breakdown. Accordingly, the average monthly temperature has increased in all months of the year during the last 40 years. However, there are minor changes recorded in the pattern as mentioned below.

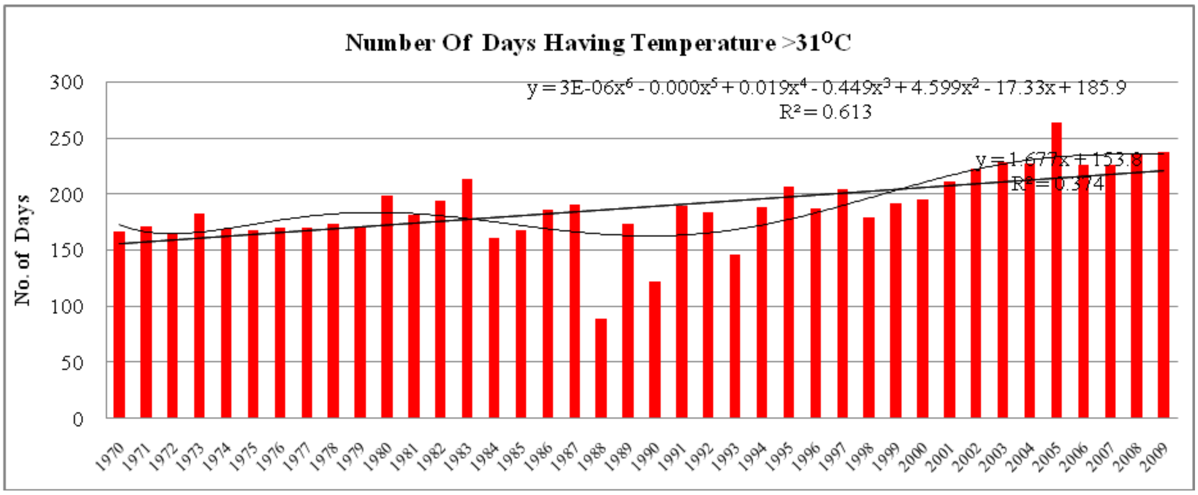


(Source: Based on Metrological Department Data)

The following changes are depicted above in a comparative diagram of the last four decades.

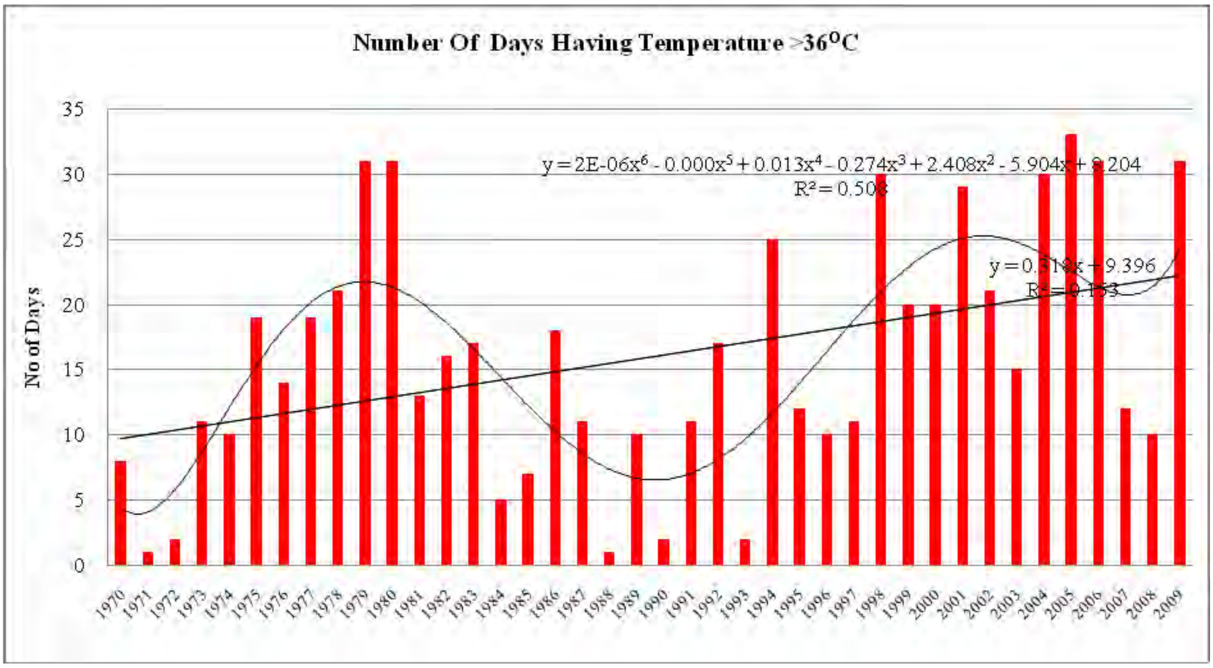
1. The daily mean air temperature recorded in some periods of the last decade (1999-2009) have decreased compared to the same periods 1970 – 1979
    a. Second and Third weeks of October by 1^0C.
    b. Second week of November by 0.5^0C.
    c. Fourth week of June by 0.6^0C.
2. The daily mean air temperature recorded in some periods of last decade (1999- 2009) have decreased compared to the same durations in 1980 – 1989.
    a. First three weeks of December by 1^0C.

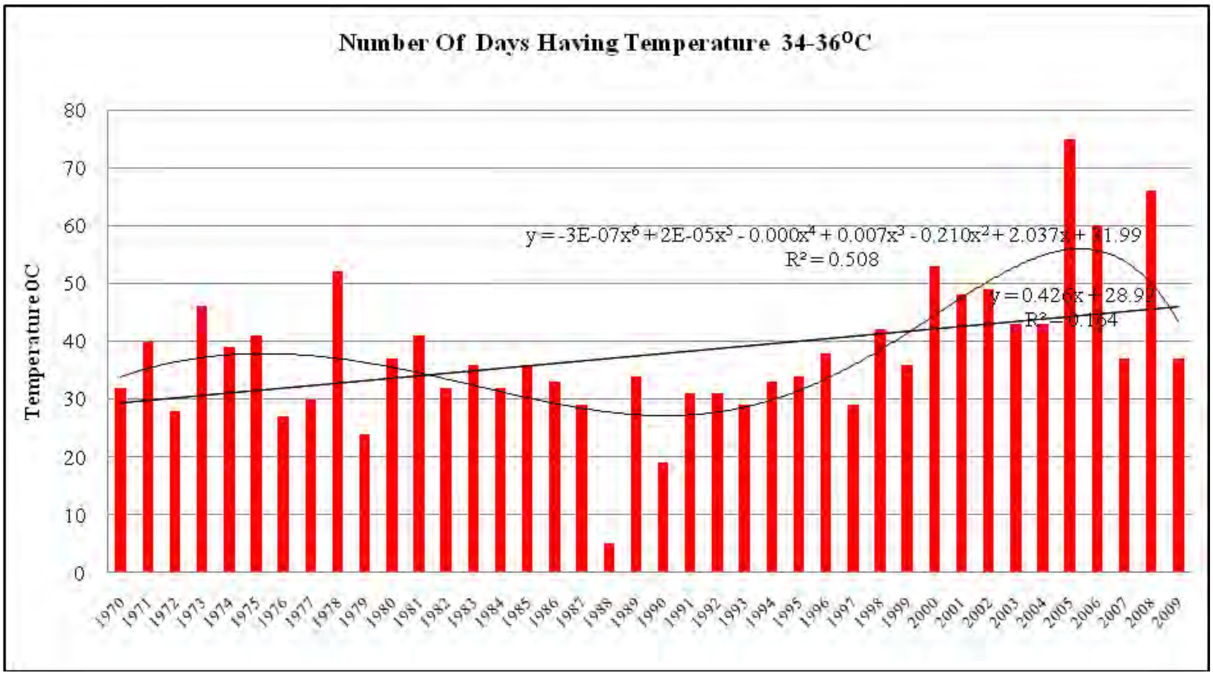
There is a significant increase in days with temperatures more than 31^0C in last few decades while days with temperatures less than 31^0C have significantly decreased.



(Source: Base on Metrological Department Data)

It is also observed that the number of days with extreme temperatures have increased in last decades.





(Source: Based on Metrological Department Data)

The highest temperature recorded during the last forty years, was recorded in 2004. The largest number of extreme events occurred during the months of July.

In conclusion, there is a significant change of climatic conditions (temperature and rainfall) as per the records observed by meteorological station, Batticaloa.

4.1.2. FDGs and KII's findings on local exposure to climate change

This stakeholder workshop collected information from people's on the ground experiences of climate changes witnessed within Batticaloa Municipality. The stakeholder workshop started with a presentation on "What is climate change, the climate change scenario, global /national / local impacts of climate change and the role of stakeholders in response to future climate change scenarios" providing the respondents with background to engage in the discussion.

Stakeholders were divided into five groups before the assessment to facilitate this exercise. The following table indicates the response of stakeholders to changes in extremes and means as per local knowledge/experience. The first row of the table details the members of the group and the number of members (within brackets). Correspondent columns depict the number of members who observed each particular change.

	Group1 BMC & DSD(08)	Group 02 & 03 Local administrative institutions(18)	Group 04 Older Citizens(07)	Group 05 CBO's & NGO's(12)	Total (35)
Changes in Extremes					
Flood	8	6	4	2	20
Cyclone	8	5	2	2	17
Storms surges	1	1	1	0	3
Dry seasons	5	6	6	8	25
Changes in Means					
Increase in Temperature	5	4	7	8	25
Increase in Rainfall	2	1	6	9	18
Sea-level rise	3	3	2	4	12

Batticaloa city has experienced extreme events such as cyclones, floods and droughts. An increase in temperature and rainfall is also observed by a number of stakeholders. Older citizens and CBOs were highly sensitive to the changes recorded in temperature and rainfall.

The following table contains the most highlighted consequences of the above changes as identified by the stakeholders.

	Changes in Means			**Changes in Extremes**		
	Increase in Temperature	Increase in Rainfall	Sea-level rise	Flood	Cyclone /Storms	Drought
Coastal erosion		Y	Y	Y	Y	
Scarcity of water	Y	Y	Y	Y		Y
Salt water intrusion			Y			Y
Poverty				Y	Y	Y
Soil erosion		Y	Y	Y		
Loss of food security				Y	Y	Y
Spreading of Epidemic diseases		Y		Y		

The occurrence of floods in Batticaloa was recognized by stakeholders as the most devastating event of climatic phenomena.

A session then followed to discuss the possible impacts of climate change for the future. This session was supported by video clips to give stakeholders visual aids. Participants were then asked to write a scenario prediction of future impacts. At the end, they marked possible impacts of climate change on their city. The identified future impacts were collated on one sheet. These items (possible impacts) were then prioritized, based on the number of stakeholders per each item. Items which were mentioned by the highest number of stakeholders were assigned as the most probable events to occur while the items listed by the lowest number of stakeholders were given to be the least probable events to occur. A summarized list of the items is given below.

High	Temperature increase	Changes in means
	Sea-level rise	Changes in means
	Scarcity of drinking water (dried-up/ salinisation)	Consequences of extremes
	Destruction to coastal habitat and houses	Consequences of extremes
	Loss of agricultural lands and productivity (dried-up/salinisation/over-rained)	Consequences of extremes
Moderate	Sudden changes to rainfall/intensive rains	Changes in means
	Floods	Changes in extremes
	Spreading of diseases	Consequences of extremes
	Loss of human lives (floods, cyclone)	Consequences of extremes
Low	Drought	Changes in extremes
	Coastal erosion	Consequences of extremes
	Losses to fisheries sector	Consequences of extremes
	Frequent cyclones / storms	Changes in extremes
	Urban heat islands	Consequences of extremes

During the activity, people were asked to mention specific areas where the affected communities/properties were located. The summary of this list is below.

Vulnerable groups	Where they stay
Fishermen	Navalady, Palameenmadu
Farmers (paddy)	Thiruparunthurai, Sathurukondan, mugathuvaram
Shop owners	Besides Trincomalee road along marshy area (near the lagoon)
Coastal community	Navalady, Dutch bar, Thiruchenthoor
People who may suffer from drinking water scarcity	Thiruparunthurai,Puthur,Mugathuvaram,Thimilanthurai,Veechikal munai,Amirtakali
Coastal communities in improvised houses	Nochimunai, Kattankudy, Manchanthoduvai, Thiraimadu
Government offices	Coastal belt
Students/schools	Manmunai south, Kallady,vipulanada vidyalaya
Farmers, Chena cultivators	Manmunai south, Paduvankarai, Karadiyanaaru
People who live in islands	Buffalo island, Puliyan thivu, Maanthivu, Bone island
Livestock	Unichi

A team of students from University of Moratuwa, and residents of Batticaloa region, marked these locations on a map. The map was explained to citizens and the locations were verified.

The post-workshop discussion highlighted how communities currently are responding to climate change phenomena and the need for involvement of the community in developing local climate change action.

4.2. Step: 10 Elements-at-Risk Mapping

The next phase of the process consisted of a participatory mapping of the identified vulnerable areas. A field mapping team visited the areas as per the map prepared at the workshop (location of vulnerable properties/people). The field mapping team was supported by the local participants while visiting these locations. KII's were conducted with vulnerable groups and these areas were marked to scale on satellite images. GPS points were taken wherever necessary to verify the ground points. The fact sheet (given below) was prepared at the end of the previous workshop and used to plan the field survey.

Hazardous Events	Return Period		Vulnerable Areas
Flood	Flash Floods	Every year (Northeast Monsoon Period, Dec - April)	▪ Thiraimadu, Saththurukondan, Amirthakali, Dutch Bar, Navalady, Manjjannthoduvai, Navatkuudahh,, Puthunagar, Thimilathivu, Veechikalmunai, Sathukam, Palameen Madu, Puliyanthivu ▪ 50-75m surrounding area of lagoon
	Minor Floods (100-150mm)	3-5 years (2004 Sep, 1997 Mar, 1994 Jan & Nov, 1993 Dec, 1989 Sep, 1987 Feb, 1986 Jan, 1980 Nov, 1971 Jan)	
	Critical Floods (150-250mm)	10-20 years (2009 Dec, 1999 Dec, 1978 Dec, 1957)	
Cyclone	Cyclonic Storms (1967, 1931)	Some agreed that this occurs once every 30 years. But, others mentioned it as non-cyclical phenomenon	▪ High impact to Coastal belt ▪ Moderate impact to entire BMC Area
	Cyclones (1907, 1978)		

Hazardous Events	Return Period	Vulnerable Areas	Hazardous Events
Sea-level Rise - Coastal Erosion	Experienced for many years	Every day a higher rate of erosion is seen during the months of December and January.	Coastal areas of Navalady, Dutch Bar, Thiruchendhoor, Nochchimunai, Palameenmad
Sea-level Rise – Salinisation	This has been significant during the past 10-12 years.	Every day, significant impact during the dry season.	Coastal areas of Dutch Bar, Thimilathivu, Veechikalmunai, Puthunagar

Field surveyed data was utilized to map vulnerable areas for flooding, cyclones and salt water intrusion. The following maps represent the maximum exposure locations for disasters.

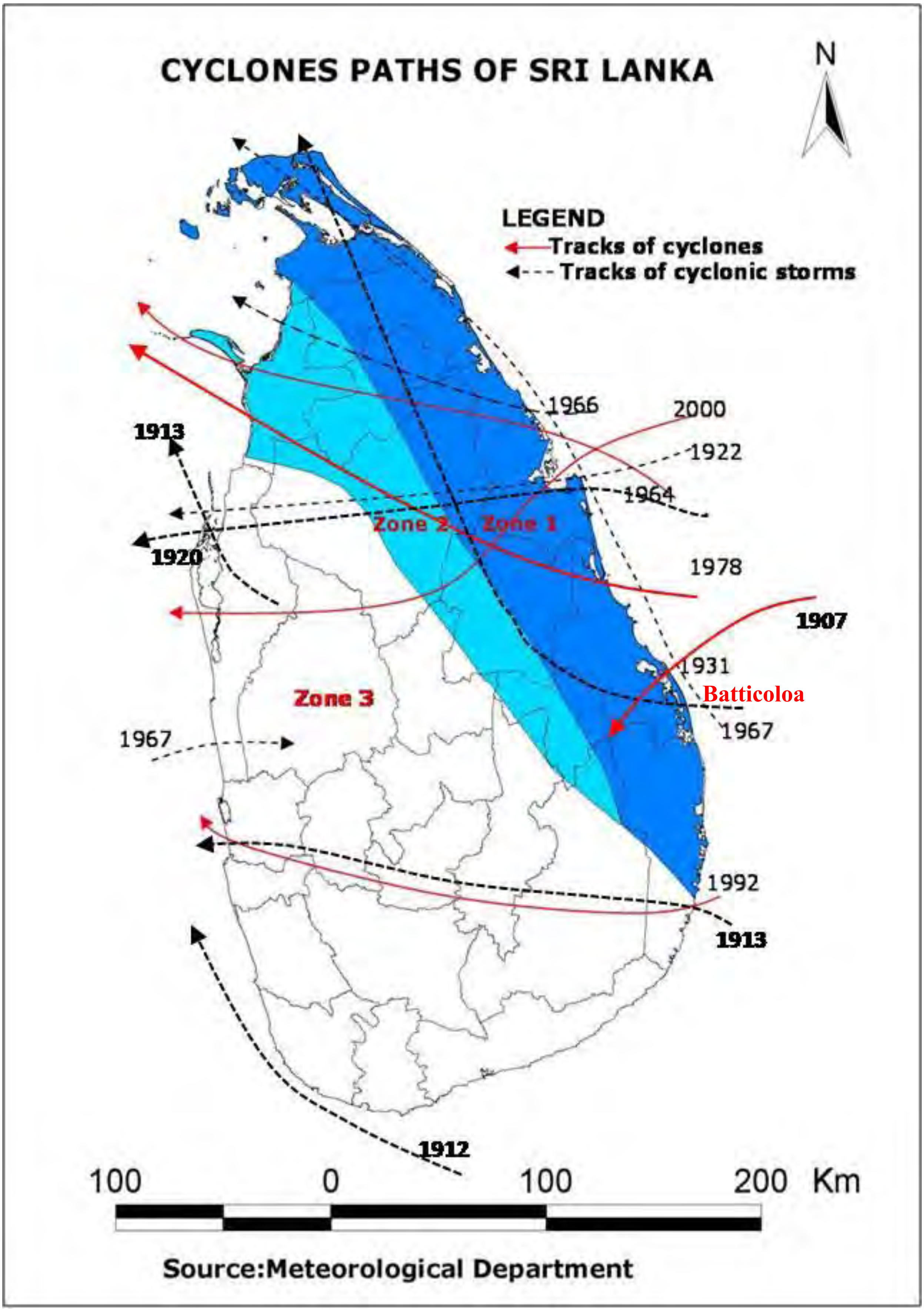
EXPOSURE TO FLOOD

Prepared by ;
PCU, Faculty of Architecture,
University of Moratuwa, Sri Lanka

1,500 750 0 1,500 Meters

Source : Based on Data from DMC, Batticaloa & Field Survey (PVA)

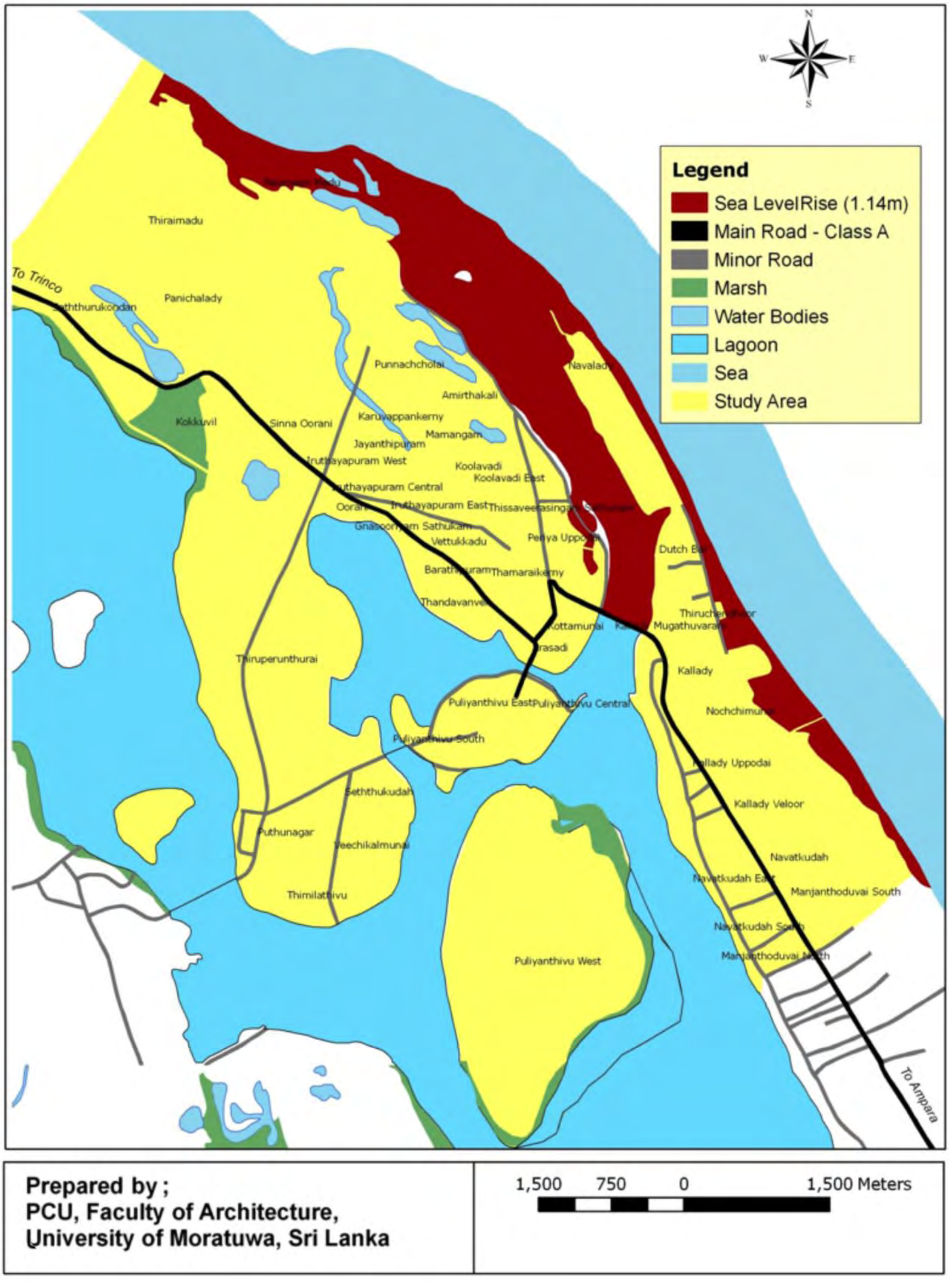
	Elements	Exposure to Flood	
		Amount	As % of Total
Areas (Ha)	Population	20,600	23
	Houses	4,580	22
	Residential Areas	382	16
	Built up areas	765	18
	Forest/Scrubs	N/A	0
	Mangrove areas	N/A	0
	Agriculture areas	70	8
	Lagoon	N/A	0
	Beach	N/A	0
	Historical/Archaeological Places	17 (locations)	43
Activities	Trading & Commercial Activities	51	-
	Lagoon Fishery	N/A	0
	Coastal Fishery	N/A	0
	Tourism	N/A	0
	Agriculture	N/A	0
Infrastructure Systems	Roads Tar Road : Gravel Road : Sand Road :	 2km 23km 16km	 10 21 22
	Transportation	▪ Batticaloa – Trinco Public Bus Route	-
	Electricity Supply	N/A	0
	Water Supply Network	N/A	0
	Domestic Water Source	▪ 2,294 Housing Units with unprotected wells Thiraimadu (220), Saththurukondan (139), Amirthakali (384), Dutch Bar (61), Navalady(110), Manjjannthoduvai North (180), Navatkuudah (238),, Puthunagar (205), Thimilathivu (181), Veechikalmunai (118), Sathukam (147), Palameen Madu (136), Puliyanthivu South (175)	12 (of HH)
	Drainage	Road Side Drainage System	-
	Sanitary Facilities Domestic Toilets	▪ 3,800 Housing Units with pit latrines Thiraimadu (614), Saththurukondan (214), Amirthakali (684), Dutch Bar (69), Navalady(105), Manjjannthoduvai North (180), Navatkuudah (262), Puthunagar (340), Thimilathivu (247), Veechikalmunai (218), Sathukam (147), Palameen Madu (271), Puliyanthivu South (449)	18 (of HH)
	Hospitals/Medical Centers	N/A	-
	Schools/Educational Institutions	2	5


CYCLONES PATHS OF SRI LANKA
N
LEGEND
Tracks of cyclones
Tracks of cyclonic storms
1966
2000
1913
1922
1964
Zone 2
Zone 1
1920
1978
1907
1931
Batticoloa
Zone 3
1967
1967
1992
1913
1912
100
0
100
200 Km
Source:Meteorological Department

	Elements	Exposure to Cyclone	
		Amount	As % of Total
Areas (Ha)	Population	Entire Population in BMC area (depending on speed, direction of cyclone)	variable
	Houses	Each housing unit is subject to some exposure to cyclones (depending on speed, direction) but housing units of the following materials have higher levels of exposure Semi-permanent houses (1,061) Improvised houses (691)	 5 3
	Residential Areas	Entire residential area in BMC area (depending on speed, direction of cyclone)	variable
	Built up areas	Entire built-up areas in BMC area (depending on speed, direction of cyclone)	variable
	Forest/Scrubs	Entire scrubs in BMC area (depending on speed, direction of cyclone)	variable
	Mangrove areas	Entire mangrove areas in BMC area (depending on speed, direction of cyclone)	variable
	Agriculture areas	Coconut cultivation 260 Ha	100
	Lagoon	N/A	0
	Beach	N/A	0
	Historical /Archaeological Places	Entire historical/Archaeological places in BMC area (depending on speed, direction of cyclone)	variable
Activities	Trade & Commercial Activities	Entire trade & commercial activities in BMC area (depending on speed, direction of cyclone)	variable
	Lagoon Fishery	Entire Lagoon fishery in BMC area (depending on speed, direction of cyclone)	variable
	Coastal Fishery	Entire coastal fishery in BMC area & it surroundings (depending on speed, direction of cyclone)	variable
	Tourism	Entire tourism in BMC area (depending on speed, direction of cyclone)	variable
	Agriculture	Coconut cultivation 230 Ha	100
Infrastructure Systems	Roads Main Road : Minor Road : Local Road :	N/A	0
	Transportation	Entire transportation network in BMC area (depending on speed, direction of cyclone)	variable
	Electricity Supply	Entire electricity supply in BMC area (depending on speed, direction of cyclone)	variable
	Water Supply Network	Elevated water tanks	variable
	Domestic Water	N/A	0

	Sources		
	Drainage	N/A	0
	Sanitary Facilities Domestic Toilets	Entire sanitary facilities in BMC area (depending on speed, direction of cyclone)	variable
	Hospitals/Medical Centers	Entire hospitals/medical centers in BMC area (depending on speed, direction of cyclone)	variable
	Schools/Educational Institutions	Entire schools/educational institutions in BMC area (depending on speed, direction of cyclone)	variable

EXPOSURE TO SEA LEVEL RISE



	Elements	Exposure to Sea-level Rise	
		Amount	As % of Total
Areas (Ha)	Population	3,151 families, 15% of total population	16%
	Houses	69	1%
	Residential Areas	Above residential areas	
	Built up areas		
	Forest/Scrubs	N/A	N/A
	Mangrove areas	N/A	N/A
	Agriculture areas	N/A	N/A
	Lagoon	Part of Lagoon	50-40%
	Beach	12.1m length belt & 60Ha	75%
	Historical /Archaeological Places	Fort	
Activities	Trading & Commercial Activities	Fishery	
	Fishery	Fishery families 16 boat anchorage locations	75%
	Tourism	Beach & coastal area 12.1m length belt & 60Ha	75%
	Agriculture	N/A	N/A
Infrastructure Systems	Roads Main Road : Minor Road : Local Road :	N/A	N/A
	Transportation	1 Bridge (Kallady)	-
	Electricity Supply	N/A	N/A
	Water Supply Network	N/A	N/A
	Domestic Water Sources	N/A	N/A
	Drainage	N/A	N/A
	Sanitary Facilities Domestic Toilets	N/A	N/A
	Hospitals/Medical Centers	N/A	N/A
	Schools/Educational Institutions	N/A	N/A

	Elements	Exposure to Coastal Erosion	
		Amount	As % of Total
Areas (Ha)	Population	N/A	N/A
	Houses	N/A	N/A
	Residential Areas	N/A	N/A
	Built up areas	N/A	N/A
	Forest/Scrubs	N/A	N/A
	Mangrove areas	N/A	N/A
	Agriculture areas	N/A	N/A
	Lagoon	N/A	N/A
	Beach	12.1m belt	100%
	Historical /Archaeological Places	N/A	N/A
Activities	Trading & Commercial Activities	N/A	N/A
	Lagoon Fishery	N/A	N/A
	Coastal Fishery	N/A	N/A
	Tourism	Beach & coastal area 12.1m belt	75%
	Agriculture	N/A	N/A
Infrastructure Systems	Roads Main Road : Minor Road : Local Road :	N/A	N/A
	Transportation	N/A	N/A
	Electricity Supply	N/A	N/A
	Water Supply Network	N/A	N/A
	Domestic Water Sources	N/A	N/A
	Drainage	N/A	N/A
	Sanitary Facilities Domestic Toilets	N/A	N/A
	Hospitals/Medical Centers	N/A	N/A
	Schools/Educational Institutions	N/A	N/A

	Elements	Exposure to Salinisation	
		Amount	As % of Total
Areas (Ha)	Population	The population living in the following areas may be exposed to the effects of salinisation in BMC area Dutch Bar (229), Thimilathivu (1,293), Veechikalmunai (786), Puthunagar (2155)	5
	Houses	N/A	N/A
	Residential Areas	N/A	N/A
	Built up areas	N/A	N/A
	Forest/Scrubs	N/A	N/A
	Mangrove areas	N/A	N/A
	Agriculture areas	N/A	N/A
	Lagoon	Entire area	100%
	Beach	N/A	N/A
	Historical /Archaeological Places	N/A	N/A
Activities	Trading & Commercial Activities	N/A	N/A
	Lagoon Fishery	N/A	N/A
	Coastal Fishery	N/A	N/A
	Tourism	N/A	N/A
	Agriculture	N/A	N/A
Infrastructure Systems	Roads Main Road : Minor Road : Local Road :	N/A	N/A
	Transportation	N/A	N/A
	Electricity Supply	N/A	N/A
	Water Supply Network	N/A	N/A
	Domestic Water Sources	The population living in the following areas & use well water for drinking may be exposed to the effects of salinisation in BMC area Dutch Bar (229), Thimilathivu (1293), Veechikalmunai (656), Puthunagar (1,005)	4
	Drainage	N/A	N/A
	Sanitary Facilities Domestic Toilets	N/A	N/A
	Hospitals/Medical Centers	N/A	N/A
	Schools/Educational Institutions	N/A	N/A

4.3. Step: 11 Define Sensitivity

This activity is designed to help reach an agreement on the quantitative and qualitative assessments of how the different impacts of climate change impact socio-economic and other development factors of the city. This was a relatively simple exercise for stakeholders because:

- Past trends of climate scenarios had already been downscaled to the city-level
- Exposure areas to extreme events have already been mapped out
- Element-at-risk within the exposed areas have already been listed out

This information was used during the decision making exercise to define sensitivity. In addition to this, global and national climate change scenarios were used in the discussions to predict future scenarios. Trendline projections made for temperature and rainfall scenarios provided as a preliminary approach to prediction.

This activity was conducted as a brainstorming session among the members of assessment team with the participation of core stakeholders. By this stage, the stakeholders' understanding of climate change and the expected outcomes has improved. The findings of the previous workshops were discussed along with the results of the participatory mapping exercise and the key items that needed to be detailed for the next stages were prioritised. The identified list of key changes in means, extremes and exposure are given below.

Climate change scenario	Possible Impact on Urban Areas
Changes in Means	Temperature
	Precipitation
	Sea-level rise
Changes in Extremes	Extreme rainfall
	Tropical cyclone/Thunderstorms/ Lightning
Changes in Exposure	Population movements
	Biological changes

Thereafter, all element-at-risk maps, exposed area maps and land use maps of the BMC were pinned on a board so all stakeholders could see them. Based on this, stakeholders were asked to list out the possible impacts of each predicted change on the urban environment of BMC.

Next, the team supplied a five scaled ranking (Insignificant, Low, Moderate, High, Severe) to mark against the exisitng level of each impact on the city. Based on the current situation, the team marked the possible future scenarios for 10 year, 25 and 50 year horizons. The final assessment list is given below.

4.3.1. Impact Identification

Change in Climate		Possible Impact on Urban Areas*	Level of Sensitivity			
			2010 (Existing)	2020 (10 year)	2035 (25 year)	2060 (50 year)
Changes in Means	Temperature	Increased energy demand for air conditioning	High Consequences	Severe Consequences	Severe Consequences	Severe Consequences
		Heat stress - Exaggerated by urban heat island effect	Insignificant	Moderate Consequences	High Consequences	Severe Consequences
		- Deaths from cardio-respiratory diseases	Insignificant	Insignificant	Low Consequences	Moderate Consequences
		- Heat related sickness	Moderate Consequences	High Consequences	Severe Consequences	Severe Consequences
		- Air pollution related mortality & morbidity (The weather affects air pollution concentration & distribution, seasonality & production of aeroallergens)	Moderate Consequences	High Consequences	Severe Consequences	Severe Consequencess
	Precipitation	Increased risk of flooding	High Consequences	Severe Consequences	Severe Consequences	Severe Consequences
	Sea-level rise	Coastal flooding - Costal Settlements - Costal wetland	Low Consequences	Moderate Consequences	High Consequences	Severe Consequences
		Coastal Erosion	Moderate Consequences	High Consequences	Severe Consequences	Severe Consequences
		Damage to fishery harbours & anchorages	Low Consequences	Moderate Consequences	High Consequences	Severe Consequences
		Damage to sea defence structure and breakwaters	Low Consequences	Moderate Consequences	High Consequences	Severe Consequences
		Damage to near shore infrastructure	Low Consequences	Moderate Consequences	High Consequences	Severe Consequences

Change in Climate		Possible Impact on Urban Areas*	Level of Sensitivity			
			2010 (Existing)	2020 (10 year)	2035 (25 year)	2060 (50 year)
Changes in Means	Sea-level rise	Flooding of historical, cultural & religious sites	Low Consequences	Moderate Consequences	High Consequences	Severe Consequences
		Reduction of income from tourism & agriculture	Low Consequences	Moderate Consequences	High Consequences	Severe Consequences
		Salt water intrusion - Low-lying agriculture - Water sources	Moderate Consequences	High Consequences	Severe Consequences	Severe Consequences
Changes in Extremes	Extreme rainfall & tropical cyclone	More intense flooding	High Consequences	Severe Consequences	Severe Consequences	Severe Consequencess
		Land degradation	Moderate Consequences	High Consequences	Severe Consequences	Severe Consequences
		Disturbance to livelihoods & city economy	Moderate Consequences	High Consequences	Severe Consequences	Severe Consequences
		Damage to homes & businesses	Moderate Consequences	High Consequences	Severe Consequences	Severe Consequences
		Damage to infrastructure (esp. transport infrastructure)	Moderate Consequences	High Consequences	Severe Consequences	Severe Consequences
		Injuries, deaths & long term physiological morbidities	Moderate Consequences	High Consequences	Severe Consequences	Severe Consequences
	Thunder storms/ Lightning	Damage to infrastructure (esp. power, telecommunication & other industrial installations)	Low Consequences	Moderate Consequences	High Consequences	Severe Consequences

<table>
<tr><th colspan="2" rowspan="2">Change in Climate</th><th rowspan="2">Possible Impact on Urban Areas*</th><th colspan="4">Level of Sensitivity</th></tr>
<tr><th>2010 (Existing)</th><th>2020 (10 year)</th><th>2035 (25 year)</th><th>2060 (50 year)</th></tr>
<tr><td rowspan="5">Changes in Exposure</td><td>Population Movements</td><td>Movement away from stressed coastal habitats</td><td>Insignificant</td><td>Low Consequences</td><td>Moderate Consequences</td><td>High Consequences</td></tr>
<tr><td rowspan="4">Biological Changes</td><td>Extended vector habitats with impact on health
- More favourable breeding grounds for pathogens
- The spread of epidemic diseases, mosquito-borne diseases, tick-borne diseases, food-borne diseases, water-borne diseases</td><td>Moderate Consequences</td><td>High Consequences</td><td>Severe Consequences</td><td>Severe Consequences</td></tr>
<tr><td>Extended vector habitats with impact on agriculture
- Crop yield
- Threats of pest</td><td>-</td><td>-</td><td>-</td><td>-</td></tr>
<tr><td>Extended vector habitats with impact on fishery</td><td>Moderate Consequences</td><td>High Consequences</td><td>Severe Consequences</td><td>Severe Consequences</td></tr>
<tr><td>Loss of biodiversity</td><td>Low Consequences</td><td>Moderate Consequences</td><td>High Consequences</td><td>Severe Consequences</td></tr>
</table>

*Source: Initial National Communication under the UNFCCC Sri Lanka (2000), Wilbanks T et al (2007), Kovats & Akhtar (2008)

As a next step, the stakeholder team agreed on common risk ratings to describe how critical these risks are and the probability of such events occurring. The discussion used the results of previous activities.

As per the toolkit, each indicator in Matrix 'A' and Matrix 'B' was discussed, however, as per the results of Matrix 'A', many impacts are viewed as insignificant at the present moment. Furthermore, many of these impacts are interrelated which results in overlapping of any future impacts. Hence, it was decided to select the most severe impacts and to identify risks on those selected projected impacts, and accordingly, we introduced a rating for the impacts as follows: '*Insignificant = 1, Low consequences = 2, Moderate consequences = 3, High consequences = 4 and Severe consequences = 5'*.

From this analysis, the most severe events that may happen were listed by the stakeholders as follows:

1. Increase in rainfall and occurrence of floods
2. Increase in the occurrence of storm surges/cyclones
3. Sea-level rise and inundation of coastal areas

The team re-wrote all effects/impacts of climate change as identified in 'Matrix A' in front of each selected CC Indicator.

A new column was inserted to the left, to list the critical socio-economic factors/elements of the city or municipality which may bear the impacts or effects of climate change. It was suggested to focus on people, places, and activity sectors rather than any other factor/element. It was considered a good suggestion to highlight the exposure to women, children, and old age groups as high risk population groups yet, the available demographic database was not complete enough to conduct a separate study. Therefore, this impact was incorporated under the general item of 'population'. Element-at-risk maps and assessment sheets, and land use maps were useful for the working team to carry out this exercise.

For the next exercise, a copy of '*Matrix B: City Exposure and Sensitivity Analysis (Who/what are at risk to CC Effects)* in the toolkit was distributed as a template**.** The assessment team was requested to identify probability or likelihood of impact and possible adverse consequence/s for current and future time horizons. To determine the risk value of each climate indicator, ratings were provided for the exposure and sensitivity of each risk effect. A set of matrices prepared under this exercise is given below.

Increase in Rainfall and occurrence of Floods

Elements	Exposure (Probability or Likelihood of Impact)				Sensitivity (Possible Adverse Consequence/s)				Risk Rating (Total score over count of risk effects)
	2010 (Existing)	2020 (10 year)	2035 (25 year)	2060 (50 year)	2010 (Existing)	2020 (10 year)	2035 (25 year)	2060 (50 year)	
People									
Population	0.75	1	1	1	0.75	1	1	1	0.89
Places									
Built up areas	0.75	1	1	1	0.75	1	1	1	0.89
Forest/Scrubs	0.5	0.75	1	1	0.5	0.75	1	1	0.70
Mangrove areas	0.25	0.5	0.75	1	0.25	0.5	0.75	1	0.47
Agriculture areas	0.5	0.75	1	1	0.5	0.75	1	1	0.70
Lagoon	0.5	0.75	1	1	0.5	0.75	1	1	0.70
Beach	0.25	0.5	0.75	1	0.25	0.5	0.75	1	0.47
Historical /Archaeological Places	0.25	0.5	0.75	1	0.5	0.75	1	1	0.56
Activities									
Trading & Commercial Activities	0.75	0.50	0.75	1.00	0.25	0.50	0.75	1.00	0.47
Fishery	0.5	0.50	0.75	1.00	0.25	0.50	0.75	1.00	0.47
Tourism	0.5	0.50	0.75	1.00	0.50	0.75	1.00	1.00	0.56
Agriculture	0.5	0.75	1.00	1.00	0.75	1.00	1.00	1.00	0.78
Roads	0.75	0.75	1.00	1.00	0.75	1.00	1.00	1.00	0.78
Transportation	0.75	1.00	1.00	1.00	0.75	1.00	1.00	1.00	0.89
Electricity Supply	0.75	1.00	1.00	1.00	0.50	0.75	1.00	1.00	0.78
Water Supply	0.75	1.00	1.00	1.00	0.75	1.00	1.00	1.00	0.89
Sanitary Facilities	0.75	1.00	1.00	1.00	0.75	1.00	1.00	1.00	0.89
Hospitals/Medical Centers	0.75	0.75	1.00	1.00	0.50	0.75	1.00	1.00	0.70
Schools/Educational Institutions	0.75	0.75	1.00	1.00	0.75	0.75	1.00	1.00	0.73
Total									**0.77**

Increase in occurrence of storm surges/cyclones

Elements	Exposure (Probability or Likelihood of Impact)				Sensitivity (Possible Adverse Consequence/s)				Risk Rating (Total score over count of risk effects)
	2010 (Existing)	2020 (10 year)	2035 (25 year)	2060 (50 year)	2010 (Existing)	2020 (10 year)	2035 (25 year)	2060 (50 year)	
People									
Population	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Places									
Built up areas	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Forest/Scrubs	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Mangrove areas	0.75	1.00	1.00	1.00	0.75	1.00	1.00	1.00	0.89
Agriculture areas	0.50	0.75	1.00	1.00	0.50	0.75	1.00	1.00	0.70
Lagoon	0.50	0.75	1.00	1.00	0.50	0.75	1.00	1.00	0.70
Beach	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Historical /Archaeological Places	0.50	0.75	1.00	1.00	0.50	0.75	1.00	1.00	0.70
Activities									
Trading & Commercial Activities	0.75	0.75	1.00	1.00	0.50	0.75	1.00	1.00	0.70
Fishery	0.75	1.00	1.00	1.00	0.75	1.00	1.00	1.00	0.89
Tourism	0.50	0.75	1.00	1.00	0.50	0.75	1.00	1.00	0.70
Agriculture	0.50	0.75	1.00	1.00	0.50	0.75	1.00	1.00	0.70
Roads	0.75	0.75	1.00	1.00	0.50	0.75	1.00	1.00	0.70
Transportation	0.75	0.75	1.00	1.00	0.50	0.75	1.00	1.00	0.70
Electricity Supply	0.75	1.00	1.00	1.00	0.75	1.00	1.00	1.00	0.89
Water Supply	0.50	0.50	0.75	1.00	0.25	0.50	0.75	1.00	0.47
Sanitary Facilities	0.50	0.50	0.75	1.00	0.25	0.50	0.75	1.00	0.47
Hospitals/Medical Centers	0.50	0.75	1.00	1.00	0.50	0.75	1.00	1.00	0.70
Schools/Educational Institutions	0.50	0.75	1.00	1.00	0.50	0.75	1.00	1.00	0.70
Total									**0.82**

Sea-level rise and inundation of coastal areas

Elements	Exposure (Probability or Likelihood of Impact)				Sensitivity (Possible Adverse Consequence/s)				Risk Rating (Total score over count of risk effects)
	2010 (Existing)	2020 (10 year)	2035 (25 year)	2060 (50 year)	2010 (Existing)	2020 (10 year)	2035 (25 year)	2060 (50 year)	
People									
Population	0	0.5	0.75	1	0	0.5	0.75	1	0.45
Places									
Built up areas	0	0.5	0.75	1	0	0.5	0.75	1	0.45
Forest/Scrubs	0	0.25	0.5	0.75	0	0.25	0.5	0.75	0.22
Mangrove areas	0	0.25	0.5	0.75	0	0.25	0.5	0.75	0.22
Agriculture areas	0	0.5	0.75	1	0	0.5	0.75	1	0.45
Lagoon	0.25	0.5	0.75	1	0.25	0.5	0.75	1	0.47
Beach	0.25	0.5	0.75	1	0.25	0.5	0.75	1	0.47
Historical /Archeological Places	0	0.25	0.5	0.75	0	0.25	0.5	0.75	0.22
Activities									
Trading & Commercial Activities	0	0.5	0.75	1	0	0.5	0.75	1	0.45
Fishery	0.25	0.5	0.75	1	0	0.5	0.75	1	0.45
Tourism	0	0.5	0.75	1	0	0.5	0.75	1	0.45
Agriculture	0	0.25	0.5	0.75	0	0.25	0.5	0.75	0.22
Roads	0	0.25	0.5	0.75	0	0.25	0.5	0.75	0.22
Transportation	0	0.25	0.5	0.75	0	0.25	0.5	0.75	0.22
Electricity Supply	0	0.25	0.5	0.75	0	0.25	0.5	0.75	0.22
Water Supply	0	0.25	0.5	0.75	0	0.25	0.5	0.75	0.22
Sanitary Facilities	0	0.25	0.5	0.75	0	0.25	0.5	0.75	0.22
Hospitals/Medical Centers	0	0.25	0.5	0.75	0	0.25	0.5	0.75	0.22
Schools/Educational Institutions	0	0.25	0.5	0.75	0	0.25	0.5	0.75	0.22
Total									**0.32**

The risk rating was generalized to present a rating for combined climate risks. Accordingly, the risk rating of *Cyclones & storm surges* (0.82) and *Increase in rainfall/floods* (0.77) were identified as the most significant impacts with the highest probability of occurrence.

Cyclones and storm surges were identified as the most devastating impact which could affect people and loss of life. Floods were also recorded as a considerable impact on population. Batticaloa lagoon and beaches were identified as the most vulnerable places for predicted future climate change impacts. Tourism and fisheries sectors were rated as the most at risk activities under threat from future climate change events. It has been highlighted that floods/increases in precipitation could make a significant impact on a range of socio-economically important sectors such as agriculture, roads & transportation, utility supply networks (water, electricity, telecommunications), health, and sanitation.

4.4. Step 12: Identify Adaptive Capacity

Adaptive capacity is determined by the allocation of resources, awareness and knowledge, technical know-how and other capabilities of each particular population group which are used to adapt to climate change scenarios. Higher adaptive capacities can reduce climate risks and offset the negative effects of climate change on sensitive socio-economic factors of a given system or area.

The Sorsogon city V&AA assessment based toolkit introduces both qualitative and quantitative methodologies to assess adaptive capacity.

> ***Quantitative analysis*** *could be done through desk assessment using available data from municipal/city profiles. The results of quantitative assessment would be useful for rating and comparing with the values derived from the exposure/sensitivity assessment.*
>
> *However, further characterization is needed through* ***qualitative assessment*** *in order to expand understanding of the coping range of the system/area and provide other critical information crucial in developing local climate change action plans. Qualitative assessments also provide wider opportunities for other stakeholders especially the communities themselves to participate in the V&A process.*
>
> *Sorsogon city V& AA*

The first method was selected given the availability of a comprehensive set of secondary data for the assessment and the stakeholder's capability in data interpretation.

4.4.1. Quantitative Analysis of CC Adaptive Capacity

From this exercise, the assessment team expected to identify relevant indicators that would enable the city to adjust its practices, processes, or structures to offset or reduce potential damages from negative impacts of climate change. To a certain extent, this exercise requires public participation as well as opinions of experts in analyzing, development planning and other relevant multi disciplinary approaches. Similarly, secondary data collected at the data collection stage of this process was useful to assess the magnitude of each factor.

The same template, given in the toolkit was used for a quantitative assessment of adaptive capacity. The four dimensions identified in Sorsogon city are: Wealth, Technology, Infrastructure, and Information. Each are equally important in the context of Batticaloa urban area. In addition to that, stakeholders suggested including institutional capacity, frameworks, policies, will & commitment as a key dimension to determine the efficacy of BMC's adaptive capacity.

Indicators used to assess many of these dimensions were not applicable in the context of Sri Lankan cities. Therefore, all indicators were modified through a focus group discussion with core-stakeholders. Assigning suitable weights for each dimensions and parameters was determined through expert opinion taking into account the local situation. Accordingly, the most critical dimensions were assigned the highest values, whilst the least critical dimensions were assigned the lowest value. Weights were assigned based on the judgment of the assessment team as to the degree of importance of the dimensions and indicators in off-setting negative climate change impacts. The most important factors highlighted for each dimension are summarised below.

Wealth	Unemployment rate 12% Number of Samurdhi receiving HH's 42% 26% of population live in semi-permanent and improvised housing structures
Technology	84% of housing units have access to electricity 100% service coverage for telecommunication, TV & radio connections
Infrastructure	Road Density 3 km per km^2 14% of housing units do not have access to sanitation. 30% of housing units do not have access to electricity supply 11% of housing units have access to pipe born water supply Teaching hospital

Information	More than 23% of the population has an education level higher than GCE O/L
Institutional	56 NGO's & 44 INGO's actively working in the BMC area As the capital of Batticaloa district, the city has branches of many government departments.

Note: there are some autonomous adaptation strategies have been taken by individuals as a response to climate change. They are well recognized as coping mechanisms but not accounted as a separate parameter due to the difficulties in identifying, consolidating, and quantifying these activities.

The following table depicts the quantitative assessment of the BMC's adaptive capacity. All values were assigned a figure in between 0-1. The results reveal that that BMC has strong technical capacities to adapt to climate change impacts but there are key constraints in terms of wealth and infrastructure facilities of the city.

Dimensions / Indicators	Rating		Score	Weighted Score	Total Score
Wealth		**0.30**			0.15
Poverty Incidence	0.25		0.58	0.15	
Employment	0.25		0.60	0.22	
Informality (Land Tenure)	0.20		0.60	0.12	
				0.42	
Technology		**0.25**			0.17
Access to Information & Telecommunications	0.40		0.80	0.36	
Access to Electricity	0.30		0.70	0.25	
Technical Knowhow	0.30		0.60	0.18	
				0.71	
Infrastructure		**0.25**			
HH with safe water access	0.25		0.30	0.08	0.14
Housing-Permanent structure	0.25		0.74	0.19	
Sea Wall	0.10		0.20	0.02	
Paved / Tar Road	0.20		0.70	0.14	
Availability of Health Facility	0.20		0.60	0.12	
				0.54	
Information		**0.20**			0.12
Education Level	0.20		0.77	0.15	
Literacy Rate	0.10		0.80	0.08	
Access to Information & Telecommunications	0.40		0.90	0.36	
				0.59	
Total		**1.00**			**0.55**

It can be concluded that from the highest possible value of 1, the city's adaptive capacity is found to be higher than the mid-point as it registers with a 0.6 rating due to its strengths in information and technologic capabilities.

4.5. Step 13: Identification of Hotspots

Climate change ‘hotspots’ were identified by overlaying all climate-related hazard maps covering sea level rise, tropical cyclone and flood occurrences, salt water intrusion etc. This section explains the case studies conducted at each hotspot and public comments on the vulnerability and local adaptations to climate change scenarios.

1. Sathurukondan

Flooding

This area is subjected to annual floods during the rainy season. (December to February). Floods last from about a week to a month. The average flood height is about 4 m besides the road and 2m in other areas. The highest floods were recorded during 1978 and 2008. During that period the entire transportation stretch of Trincomalee road was affected. In addition, paddy fields were also inundated.

Trincomalee-Batticaloa Rd *Flood Level*

Water Supply

There is evidence of poor water quality (yellow in colour) in the rainy season. On the other hand, people are suffering from water scarcity (depletion of ground water and thereby dry wells) in drought seasons.

Temperature change

An increase in temperature is inevitable throughout the year. The highest temperature records are in June and July. During this period, people have experienced unbearable heat which leads to sun burns in the past five to six years.

Wind patterns

Sudden variations in wind patterns have become a common experience during recent years. Such situations directly affect people's livelihood and causes damage to the improvised houses.

2. Thiraimadu

Flooding

This area is subjected to annual floods during the rainy season (December to April). The average flood height varies from 2m to 2.5m. The highest of the last fifty years recorded in 2009 December. After 2009, the flood frequency and flood levels decreased due to a well constructed drainage system.

Newly constructed drainage system

Elevated (1m) housing structures

Water Quality

People use wells for washing purpose and tube wells for drinking purpose. They have pipe-borne water supply network as well. There is no evidence of salt water intrusion, but water was reported to be a pale yellow colour immediately after heavy rain. People did not drink water from wells during the rainy season.

Temperature change

People experience an increase in temperature throughout the year. The highest temperature is recorded in June and July. During the last couple of years, high intensity sunlight has been experienced which causes to skin rashes on infants and small children.

Wind patterns

At present, this area experiences a stronger breeze than in previous years. Wind direction became irregular after the 2004 Indian Ocean Tsunami. There were stable wind directions at different periods of the year, but now wind blows from both regular as well as irregular directions at different times of the day.

Diseases

Dengue is a mosquito-borne disease. The rate of the spread of dengue increases with rainfall. Skin diseases commonly occur two or three days after floods (fungal infections) as well as during hot temperatures (skin burns).

3. Palameenmadu

Flooding

This area is subjected to annual floods during rainy season (December to April). The highest flood of the last thirty years was recorded during November – December 2009. The average flood height is about 3ft. floods last about 1 to 5 days per year.

Water Quality

Although they have wells, these were not used for drinking purposes due to salt water intrusion. Water from wells is only used for washing purposes. It is also not suitable for bathing, because after bathing, hair becomes sticky and a white colour powder residue appears on the skin. Families need to travel about 500m away to obtain potable water.

Temperature change

People regularly experience an increase in temperature throughout the year. The highest temperature is recorded in May and July. In recent times, the heat has become intolerable in the dry months. It is very of the day during the dry months. People prefer to engage in-door activities and avoid spending time in agriculture and fields.

Wind patterns

This area is subjected to stronger winds than previously. These winds are intermittent and less humid in nature.

Remarks

This community predominantly consists of fishery families. They have permanent housing structures as well as land tenure. The majority has completed primary and secondary education and earns a mid-range income. As a common practice, they fill sand and gravel bags on their compounds to avoid floods entering their houses. They use boats to go for lagoon fishery during the rainy season. They have constructed their fishery equipment stalls outside their houses with temporary materials. During the flood season, they shift and re-assemble these higher up in the compound to avoid encroaching flood waters.

4. Mugathuvaram

Flooding

This area is subject to floods in December each year. Floods last from1 hour to 2 days. The highest flood over the last forty years recorded in December 2008 and December 2009.

Dengue is widespread in the rainy season. The trend has been increasing during last two to three years.

Water Quality

They have wells within the premises but these are not longer being used for drinking purposes for the last ten years or so due to salt water intrusion. Water obtained from wells is used for washing and bathing purposes. They have tube wells which are used for drinking purposes throughout the year with water in plentiful supply and without contamination.

Temperature change

An increase in temperature has been noticeable for several continuous years. The highest temperatures are recorded in May and July. More recently, it has become unbearably hot during these months.

Wind patterns

Winds have become stronger than in previous years. As a result of the high winds, the roofs of the houses have been damaged at several times over the last three years.

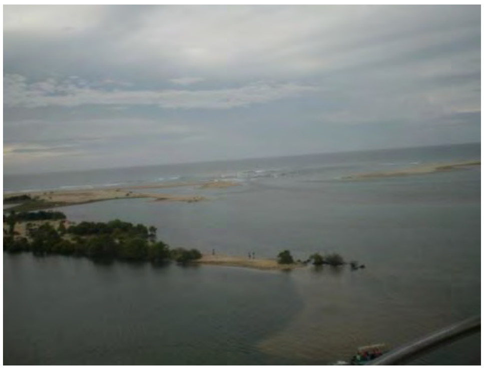
Remarks

This community belongs to a middle income class living in permanent houses with land tenure. Many of them have completed secondary education and are quite aware of coping mechanisms. They have permanent water storage tanks at their homes which are used for both dry and wet seasons. Many of them have constructed low gabion walls to prevent lagoon water from encroaching during the rainy season.

5. Amirthakali

Flooding

This area is subject to annual floods during the rainy season (December to April). The highest flood is recorded in December of each year. Floods last up to 5-7 days. The average flood height is about 3ft. There are no flash floods recorded in these areas. All flood events occur due to overflow of the lagoon. BMC has a regular practice of cutting and re-opening the lagoon mouth during this period. This allows lagoon water to discharge into the sea and water flows back gradually.



Lagoon Mouth

Water Quality

This area experiences salt water intrusion. This is a recent phenomena not experienced before 1995. After 1995, wells have become unusable for drinking water.

Temperature change

An increase in temperature occurs throughout the year. The highest temperatures are recorded in June and July. Temperature levels have increased but simultaneously, sea breeze has also increased. Sea breezes offset the heat experienced by the community living by the lagoon.

Diseases

Dengue is a quite common mosquito-borne disease which is reported immediately after the annual floods. The number of cases reported and the time period of dengue cases spreading has increased in last two to three years.

Remarks

There are gabion walls under construction on the lagoon side of the road. This may reduce extensive flooding of the area on a large scale.

There is a groundwater intake located at Palammemadu. People assume that over-extraction of ground water has led to rapid salinisation.

Gabion walls built to control flooding

6. Thiruchinthu

Flooding

This area is subject to annual floods during December. The average flood height is about 1 ft. Houses do not get flooded inside but roads get flooded for three to four days.

Sea-level rise

This area is subject to a severe rate of sea erosion. Indigenous trees which used to grow at the beach including dune-vegetation were destroyed by the 2004 Indian Ocean Tsunami. That has led to faster and more devastating coastal erosion.

Water

People find it difficult getting water from wells during the dry season. Groundwater depletion has been reported for the last seven to eight years. There is no pipe borne water available for this area. Only a single well out of all in the neighbourhood remains with water even during the dry season. Everyone in the neighborhood depends on that well for three to four weeks of the year.

Temperature change

Temperature rises continuously during the year; sea breeze makes the heat more bearable.

Wind patterns

As a result of high winds, roofs of houses were damaged several times over the past two years. Sudden variations in wind patterns have become a common experience during recent years. This directly affects the livelihoods of fishing communities.

Remarks

A casuarinas plantation programme along the coastal belt has been implemented by the Coastal Conservation Department after the 2004 Indian Ocean Tsunami. This prevents coastal erosion and stabilizes the beach. This acts as a barrier to sudden or strong storms and protects houses from severe storm exposure.

7. Nalavaladi

Flooding

This area is subject to annual floods during November and December. Flooding lasts for a period of 2 to 3 days to a week.

Sea-level rise

Coastal erosion is evident along the coastal belt and senior citizens of the locality agreed that there has been a significant rise in sea levels compared to 50 to 60 years ago. According to local fishermen, the coastal erosion rate has been increasing after the 2004 Indian Ocean Tsunami (since 2006).

Water Quality

Salt water intrusion is common in all wells of the area. Wells are not used for drinking water purposes, and during the dry season it is not even used for bathing purpose. Some people have tube wells within their properties and the rest share with them.

Temperature change

An increase in temperature seems a daily phenomenon. The highest temperatures are recorded in May to July. More recently, it has been unbearably hot and small children suffer from heat rashes and adults get sunburns due to the heat.

Diseases

Virus infections with fever have been recorded during the rainy season. This fever usually occurs with rains in December therefore, people have called a 'December fever'. Heats rashes appear during this period with the transition from dry to wet weather are commonly seen in communities.

Remarks

People who live in this area plant trees around their properties and grow climbing plants on roofs to reduce heat.

8. Dutch Bar

Flooding

This area is subject to annual floods during November and December, including flash floods. The average flood height is less than 1 ft. This is negligible in height but floods last for two to three weeks due to the topography setting of the area. When rain is frequent and intensive then the flooding lasts longer.

Water

All wells were abandoned after the 2004 Indian Ocean Tsunami. People have started to use tube wells. For the past two to three years, salt water intrusion has encroached even in the tube wells.

Wind patterns

Sudden variations of wind patterns have become a common experience in recent years. Such events directly affect fishing activities.

Remarks

Two awareness programmes have been conducted to reduce the adverse effects of flooding by the Red Cross and the Disaster Management Centre.

9. Nochchimunei

Flooding

This area is subject to annual floods since the year 2000. The years of 1957, 2000, 2004, 2007, 2009 recorded the highest flood levels over the last sixty years. Before the year 2000, the area received flooding, once or twice every ten years. Flood height is usually around 2-2.5 ft.

Temperature change

The community has regularly noted an increase in temperatures. The highest temperature of the year is recorded in May, June and July.

Remarks

Many people in this area have semi-permanent housing susceptible to flooding. Therefore, people have taken several measures to reduce the impact of flooding once this became a regular occurrence. They have increased the elevation of compounds by filling in with sand and gravel. This stops water entering into houses but roads in the area remain flooded for longer periods.

10. Manjanthoduvai

Flooding

Flooding occurs every December. Flood levels vary from 2ft to 5ft in height. This is the most affected flood prone area of BMC. This used to be a rain-fed lake 10 to 15 years ago. Later it was filled in and developed as a settlement. People living here are low-income earners. Therefore, they have far less capacity to cope with disasters.

Temperature change

An increase in temperature has been observed over the last few years. The highest temperatures are recorded in June and July.

Diseases

Vector-borne diseases such as dengue are reported to a certain extent during the flooding season. In addition to that, diarrhea is common among children during the floods.

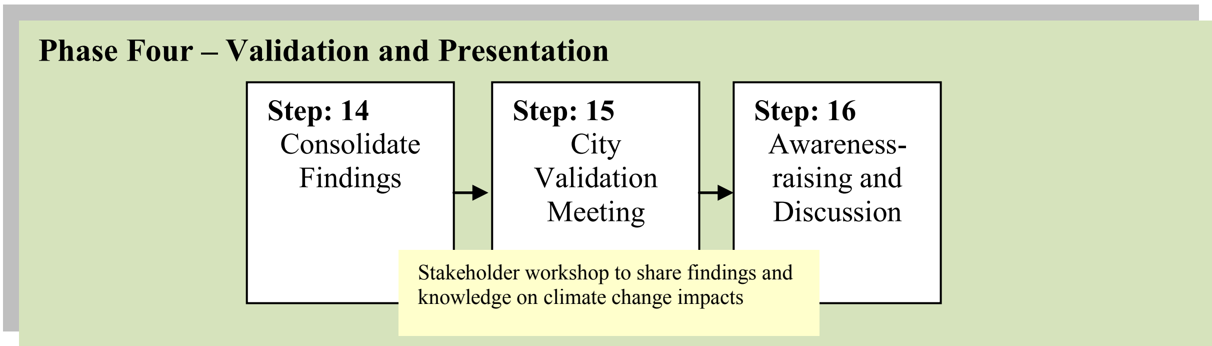
Remarks

NECDEP and the Rural Development Society have built some drains to reduce stagnant water in the area. But these drains do not have enough capacity during high intensity rainfall.

During the flood season, people usually relocate to the second floor of the school. They face enormous difficulties during this time and later when cleaning houses after floods.

5. PHASE FOUR – VALIDATION & PRESENTATION

This is the fourth and final stage of the city vulnerability assessment. This includes three steps: consolidating findings; conducting a city validation meeting; and awareness-raising and discussion.



5.1. Step: 14 Consolidate Findings

This report is the consolidated findings of a vulnerability assessment prepared for Batticaloa Municipality. It comprises steps followed and findings reached at each step.

The report defines the vulnerability defined in terms of exposure, sensitivity, and adaptive capacity. Based on this, the assessment developed a vulnerability rating/score relative to an index. The exposure and sensitivity scores have been transposed into one quantitative value which is the risk rating in Assessment Matrix B for selected socio-economic dimensions as 0.64 in 0-1 scale rating. This can be considered as a higher value to mean rating which indicates a higher sensitivity and exposure to the impacts of climate change. The city has adaptive capacity revealed as 0.55 in the same rating.

Event	Exposure X Sensitivity	Adaptive Capacity	Vulnerability = Exposure X Sensitivity /Adaptive Capacity
Floods	0.77	0.55	140%
Cyclones	0.82	0.55	149%
Sea level rise	0.32	0.55	58%
		Average City Level	**120%**

The positive difference (120%) indicates that the city does not have sufficient adaptive capacity to offset its vulnerability. This emphasizes the need to introduce and reinforce the adaptive capacity of the city to cope with expected climate change scenarios.

5.2. Step: 15 City Validation Meeting

Any vulnerability assessment needs to be validated through a stakeholder meeting before finalization. This ensures that inputs from all relevant stakeholders, especially those who were not able to participate in the assessment workshop, are considered in the final report. The primary objective of the city stakeholder validation process is to present the consolidated findings of the assessment and gather more inputs from stakeholders. The second objective of the activity is to build conformity on priority areas for adaptation based on the results. Accordingly, prior to the finalization of this report, the vulnerability assessment of Batticaloa Municipality was validated at a broad-based consultation in a city validation meeting.

Presentation of the findings of Vulnerability assessment by Prof. PKS Mahanama (Dean, Faculty of Architecture, University of Moratuwa) and the team of University of Moratuwa including local language (Tamil) translations

The main activities of the process are:

- To present the key findings of the City Vulnerability Assessment and its implications; and
- To explain the relevance of climate-related risks to city development based on the exposure and sensitivity assessment.

Distribution of Vulnerability Assessment Report

Draft copies of the vulnerability assessment were distributed to the participants for their reference. As an approach to the process, the overview of the UN-

HABITAT CCCI programme for conducting vulnerability assessments was explained to participants.

A presentation of the results of the vulnerability assessment was given including the degree of current and future climatic risks, location of vulnerable groups in the city, and the city-level adaptive capacity was presented to stakeholders.

5.3. Step: 16 Awareness and Discussion

There was an open forum conducted at the end of this session to comment and discuss the findings of vulnerability assessment. The main objective of this discussion was to develop a mutual agreement on the way forward.

Participant giving their comments on the the vulnerability assessment

Participants were actively engaged in discussions. Many stakeholders suggested developing a list of possible actions to reduce the city's vulnerability to climate change. At the end of this session, the next session started on:

- What local governance facilitative actions (practices, process, system, etc) are crucial to minimize local vulnerability
- Strengths and weakness of the city and local stakeholders in managing the risks brought about by climate change, based on the Adaptive Capacity Assessment
- What key adaptation options both at the city and hotspots level have been identified to increase the city's adaptive capacity and to manage sensitivity (adverse consequences) to climate-change exposure

This leads to a path of discussions towards a city-level climate change adaptation plan.

The Report on Climate Change Vulnerability in Batticaloa Municipal Council, Sri Lanka provides an overview of the research, analysis, findings and recommendations of work carried out in 2010 and 2011. It is part of a series of climate change vulnerability assessment reports conducted by UN-Habitat's Cities and Climate Change Initiative. These reports constitute the first step towards climate resilient human settlements. Support for this report was granted by the Government of Norway and the United Nations Development Account.

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