

## Climate change awareness and perception among the community residing nearby areas of Batticaloa lagoon in Sri Lanka

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### Abstract

*Quality characteristics of the water can be influenced by many factors including environment, climate, management and manmade activities. These factors are responsible for the alteration of quality as well as quantity of water in every reservoir. Among those, climatic change is the key determinant of the sustainability of the ecosystems. Therefore, understanding the climatic change and its impact on Batticaloa Lagoon environment is important for its management in the future.*

*In this view, the present study was conducted during the period from 2012 to 2014 with the aim of assessing the extent of community awareness and perception on climate change and its impacts on Batticaloa Lagoon environment, Sri Lanka. A survey was conducted with 406 respondents who are residing in nearby areas of the Lagoon. Data were analysed using SPSS software and MS Excel. Results revealed that, 81.4% of them heard about or clearly known about the climatic changes. In most cases, the awareness was gained through their own experience (74%) and via the media. Nearly 84% of the respondents mentioned that the lagoon water quality degradation linked with the climate changes. However, few of them (8%) reported that the human impacts are greater than the climatic impacts on water quality degradation in lagoon environment. Around 55.6% of the respondents expressed that the amount of rainfall for the last few years has been increased and finally it led to the flooding conditions. Continuous flooding (77%) in those areas was recognised as the problematic nature which led to the pollution of lagoon water as well as groundwater. Community response and expectations on the changing pattern of rainfall and impacts of climate change on economic activities were further evaluated in this study. The collected data and results therefore will be used to develop adaptation measures against climate change and for the formulation of the Batticaloa Lagoon management plan.*

**Key words:** Adaptation, Batticaloa Lagoon, Climate change Coastal lagoon,

### Introduction

Coastal lagoons are shallow brackish or marine bodies separated from the ocean by a barrier island, spit, reef, or sand bank and connected at least intermittently to the open ocean by one or more restricted tidal inlets (Phleger 1981; Colombo 1977; Kjerfve 1994;

Gonenc and Wolflin 2004). Coastal lagoons occupy only 13% of the coastal areas worldwide, and those are present on every continent except Antarctica (Kennish and Paerl, 2010). These lagoons support the society by providing a range of high valued natural services, including fisheries

productivity, storm protection, tourism, and others (Gonenc and Wolflin 2004; Cabili and Cuevas, 2016; Lagbas, and Habito, 2016). The Batticaloa Lagoon; one of the important lagoons of Sri Lanka (Silva *et al.*, 2013) plays a major role in meeting the nutritional needs of the people and supporting their livelihood for many decades. However, quantity and quality characteristics of this water body can be threatened by many factors including environment, climate, management and manmade activities (Anthony *et al.*, 2009; Milligan *et al.*, 2009). Among those, climatic change poses greater challenge to lagoon environment due to its intense and unpredictable nature that leads to decline in productivity. Increasing temperatures and changes in rainfall pattern may alter the quantity and

quality of the lagoon. The impacts of climate change on water resources for its quality are becoming a growing concern on the management agenda (Murdoch *et al.*, 2000; Crossman *et al.*, 2012).

Therefore, understanding of the issues and challenges associated with the lagoon is very important to sustain the productivity of the Batticaloa lagoon. Further, people’s awareness on climate change and its impacts would certainly contribute to the management of the lagoon positively. In this view, the present study was conducted with the aim of assessing the extent of community awareness and understanding on climate change and its impacts on and near Batticaloa Lagoon.

## Methodology

### Description of the study area

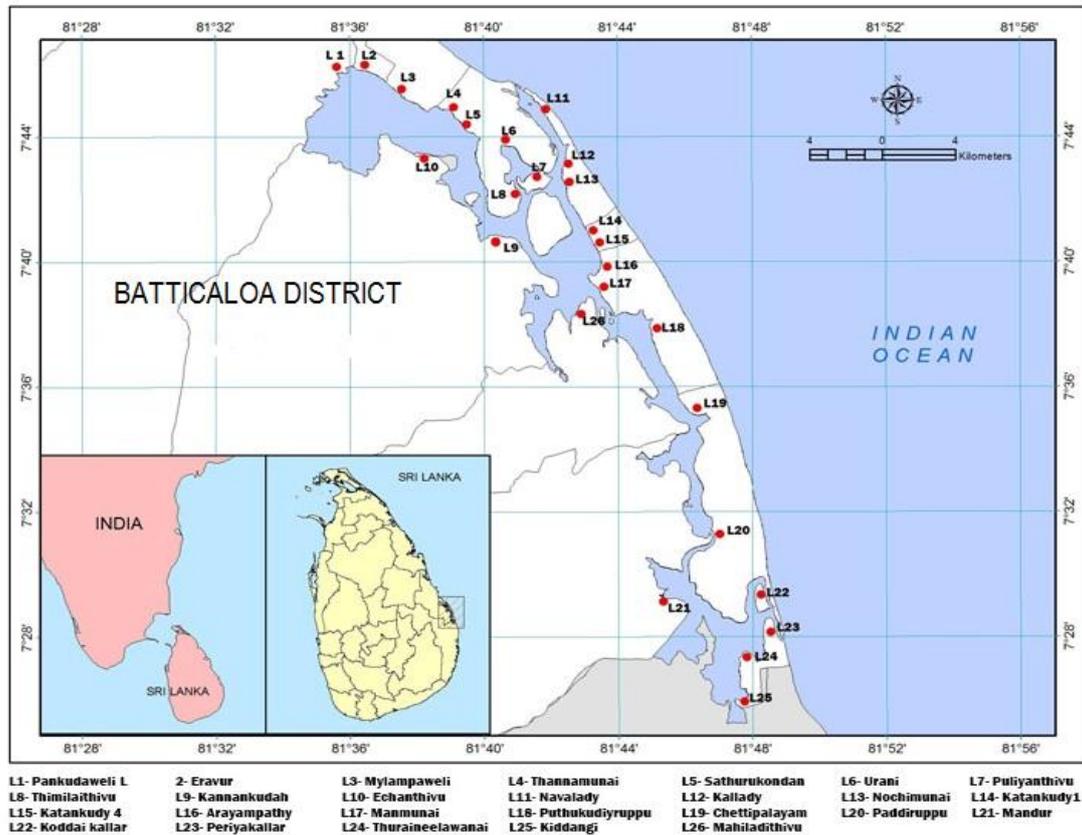


Figure 1: Location map of the study area

The Batticaloa is located within the dry zone of Sri Lanka, which has a hot and humid tropical climate. The mean annual temperature is 27.4° C, and ranges from 18° C on nights during the rainy seasons, to 38° C during the day in the dry season months.

Batticaloa receives about 1000-1700 mm of rainfall per annum, primarily (about 60%) from the Second Inter Monsoon (SIM) and Northeast Monsoons (NEM) during October to February. Batticaloa has a dry spell of five months from May to September. Winds are generally moderate, ranging from 7–15 km per hour with the evening winds being stronger.

Batticaloa district covers the area of approximately 2854 square kilometer and it has about 13,682 hectares of lagoons and associated with estuarine basins and 365 hectares of other water bodies (NECCDEP, 2010). Batticaloa district is flourished with three lagoons, namely Batticaloa lagoon, Valaichchenai Lagoon and Vakarai Lagoon. Among them, Batticaloa lagoon is the largest coastal water body in the District and it is a long (56 Km) and narrow lagoon located between 7° 24' - 7° 46'N, and 81° 35' - 81° 49'E (Figure 1) in the East coast of Sri Lanka with the total area of approximately 11,500 ha of water. The average water depth of Batticaloa Lagoon is around 1.5 m (Scot, 1989). However, study by NARA and Eastern University in 2003 (Arulananthan, 2004) stated that maximum depth of the lagoon is around 2.8 m. This lagoon opens in to the sea at two points (Green Tech Consultants, 2009).

The main land use around the lagoon is agriculture and in particular paddy and coconut cultivation. Other land uses include urban areas, road networks, fresh water bodies adjoining the Batticaloa Lagoon and associated with mangrove swamps. Due to its

elongated nature, the lagoon receives a large volume of drainage, both from rainfall and also drainage water from paddy fields. Out of 103 river basin of the country, 8 river basins bring drainage water to Batticaloa lagoon (NECCDEP, 2010).

### **Data Collection**

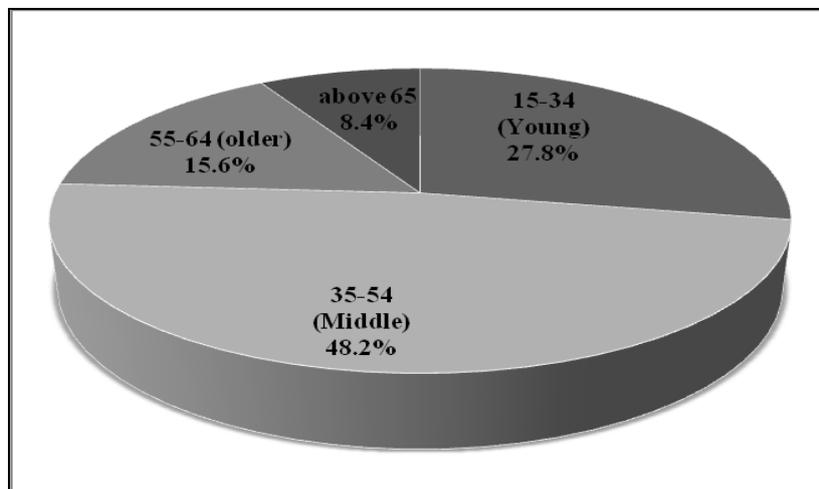
Twenty six (26) villages at 9 Divisional Secretariat (DS) divisions in Batticaloa were identified by personal interview, past experiences and direct observation in order to conduct questionnaire survey. These locations are connected with the lagoon environment and represent the flood vulnerable areas in Batticaloa districts. Stratified random sampling technique was used to select four hundred and six (406) samples for the questionnaire survey to represent households from different communities and the geographic areas. A structured questionnaire was designed and pretested among randomly selected lagoon users including fishermen. Data on socioeconomic condition of the people residing in the study area, beneficial uses of the lagoon, problems of fishing community and public near the lagoon, awareness on climate change and other public opinions relevant to climate change were collected through questionnaire survey. Secondary data about the details of fishing community, details of natural disasters and damages, maps etc., were collected from government and non-government organizations involved in water and environment sectors. The data collected in the field were entered into an Excel sheet and analysed using descriptive statistics.

## Results and discussion

### Socio-economic characteristics of the respondents

Socio - economic status is a measure of an individual's or family's economic and social position in relation to others, based on various variables responsible for that like income, education, occupation, family effluence, physical assets, social position, social participation, caste, muscle power, political influence, etc. (Shobiya *et al*, 2019). General details such as

ethnicity, gender, age, family size, education, occupational patterns and income generation were investigated in the present study. According to the results obtained from the study, about 88% of Sri Lankan Tamil and 12% of Muslim were involved in this survey and the majority of the respondents were female (55%). About 55% of the household are with family size of less than 4 and about 43% are with family size between 5 and 8 in the study area.



**Figure 2: Age category of the Respondents**

Figure 2 reveals that the majority of respondents (48.2%) belong to the age group of 35-54, while 15.6%, 27.8% and 8.4% of the respondents are with the age category of 55-64, 15-34 and above 65 respectively. Majority of the respondents (72%) had attended the primary school level education and 15% of the respondents having higher diploma and degree. Only 2% of the respondents had no schooling at the study location. Education plays an important role in creating awareness among communities hence, special attention should be given to use appropriate tools when conducting awareness or training programs to such

group. It was found that, many of the respondents (32.3%) are occupied in Government and Non-government organization while 17.9%, 15.1% and 4.9% were engaged in fishing, day wage and integrated farming respectively.

At the current study, income level of the respondents was also collected in order to understand the influence of the climatic changes on the income activities. The results revealed that, the majority of the respondent's (25.1%) income was in between Rs. 20,001 and Rs. 25,000 and also, 18.2% and 2.3% of the respondent's income

were within the range of above Rs. 40,000 and below Rs. 10000 respectively.

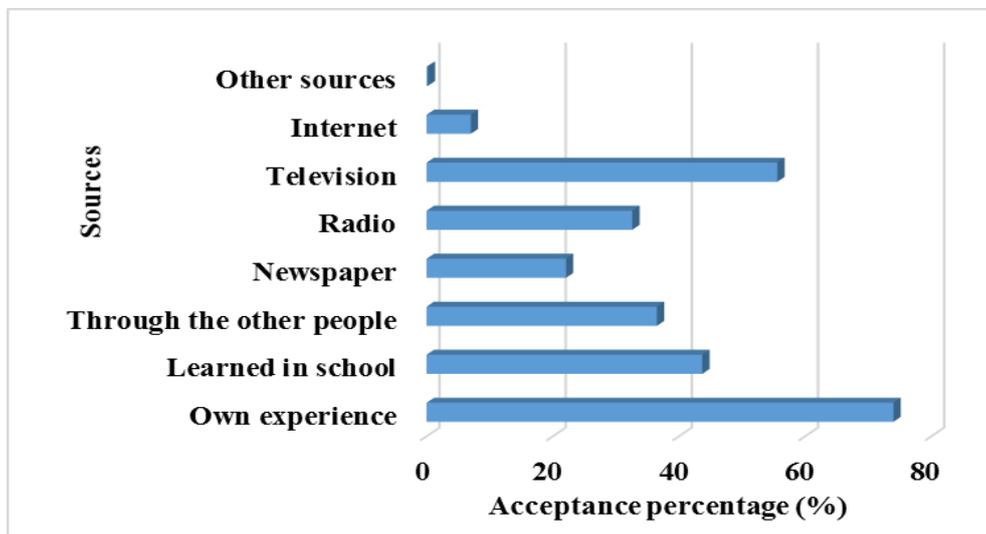
**Community awareness on climate change**

Among the total studied samples, about 81.4% of the respondents have heard about or clearly known about the climatic change. However, the perception varies among the respondents, about 25% of the respondents mentioned that climate change is cyclone/thunder storm, 73% stated that climate change means flood and drought. It appears that people interpret the term climate change according to the particular climatic event they normally face in the areas where they live. However, 18.6% of the respondents did not know anything about the climatic change. In most

cases, awareness was gained from their own experience and via the media.

**Sources of information on climate change**

In study area, information on climate change was gained through various means such as own experience (74%), learnt in school (43.7%), through the other people (36.5%), newspaper (22.1%), radio (32.6%), television (55.6%), internet (7%) and from other sources (0.2%). As far as the media are concerned, the television and radio plays major role in learning about the climate change among the community itself. Ruksana (2017) revealed that, compared to newspapers and radio, television does a good job in covering environmental issues. However, own experience of the elders contributed a lot in gathering information in the present study (Figure 3).



**Figure 3: Sources of information collection on climate change**

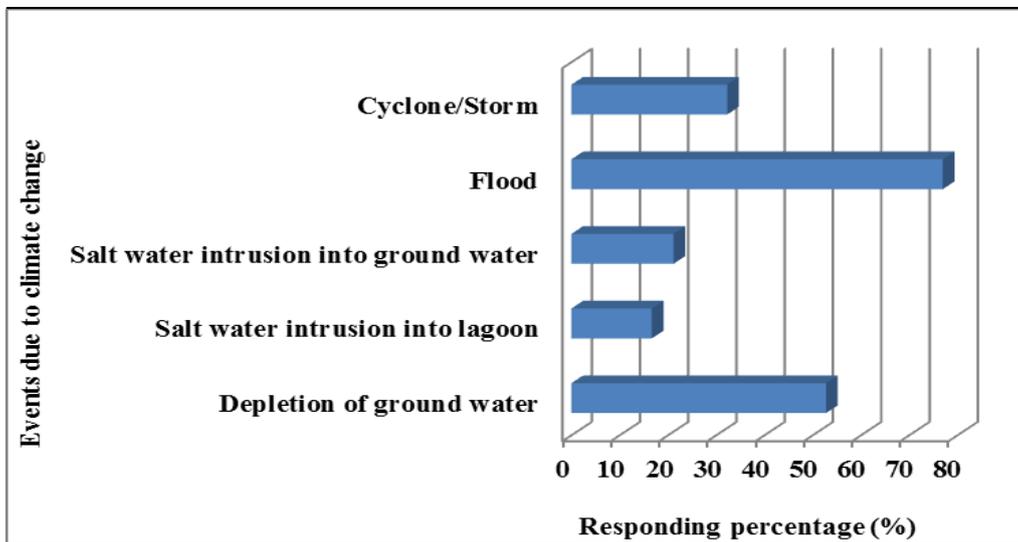
Weingart *et al.* (2000) also reported that, own experience and mass media coverage has proven to be a key contributor among number of factors in public understanding and action about the climate change.

**Community observation on climate change and their impacts**

Intensive rainfall at the latter part of every year causes flood at the bank side of the lagoon. In study area, the majority of people experienced with thunder storm (32.3%) and some of

them were victimized by this particular issue. Continuous flooding (77%) in those areas in each year was recognised as the problematic nature which led to the pollution of groundwater and surface water resources. During the flooding situation, solid particles and nutrition enriched soil particles present within the profile are carried with water and settled in low lying areas and water bodies. Some of the respondents (21.2%) complained that, some of the well water near coastal sites

contaminated with salt, which might be the proof for the salt water intrusion into groundwater. Salt water intrusion to the lagoon also occurs during the barmouth opening immediately after a flood. It was noticed by 16.7% of the respondents. Nearly 52.8% of the respondents pointed out the issue of groundwater depletion in their wells during the dry spell of the year (Figure 4) which creates pressure for the fresh water availability to the public of the Batticaloa District.



**Figure 4: General observation on the impacts of climate change**

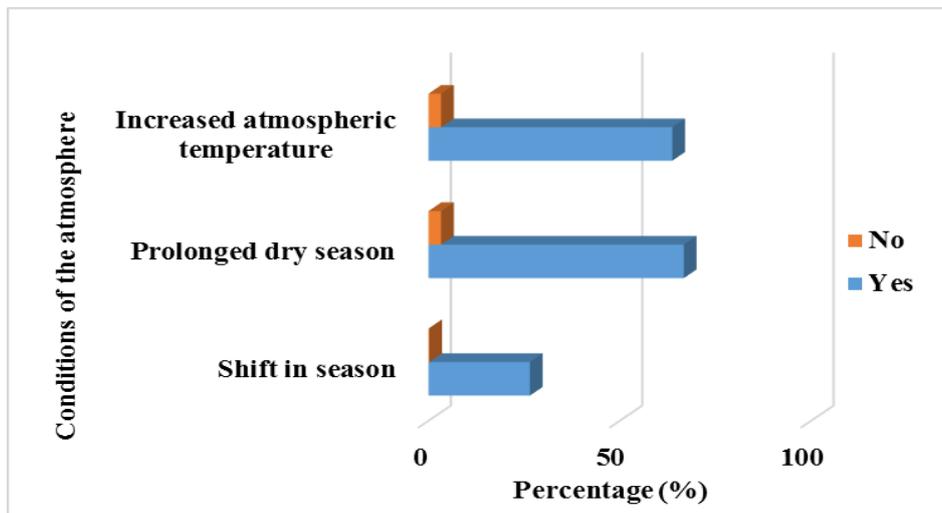
People (84%) who reside nearby the Batticaloa Lagoon stated that, due to the climatic changes water quality is degraded causing health problems and it cannot be utilized further for several activities. This was supported by Erin *et al.* (2002) reported as, concerns over the impact of anthropogenic alterations to both terrestrial and aquatic habitats, coupled with a changing global climate and explained their effect on human health. About 1.2% of the respondents have reported that they don't have much knowledge about water quality and its standard to comment on this issue. In addition, few of them (8%)

mentioned that the human impacts on water quality degradation are greater than the climatic impacts in lagoon area. The survey on water quality degradation revealed that, most of the people have awareness on climatic change but they are lack in quality aspects.

As far as the temperature is concerned, approximately, 63.7% of the respondents mentioned that the atmospheric temperature has been increased and experiencing prolonged dry season (66.7%). It is also coincide with the actual temperature data (Figure 9) and found that there was an

increasing trend with time ( $R^2=0.278$ ). Comparatively, shift in the season was not in much concern among the

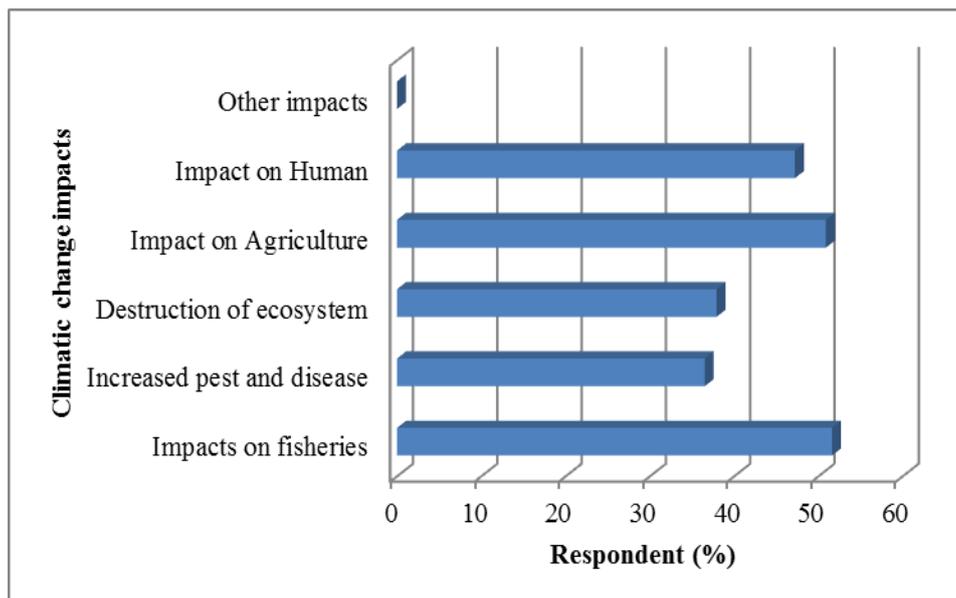
population (26.5%) who are dwelling nearby the lagoon (Figure 5).



**Figure 5: Climatic change impacts on the environment**

Batticaloa Lagoon is the major income source for many residents by providing employment opportunities. Among those employment opportunities, fishing is the most important component linked with the livelihood of the people. However, climatic changes and seasonal variation influence the peak performance of the fisheries sector. This statement was

supported by 51.6% of the community where they mentioned about the inability of harvesting fish during the high rainfall season (Figure 6). Because during heavy rainfall they are reluctant to go for fishing due to the difficulties in using canoe for fishing in the lagoon as it is deep in most places.



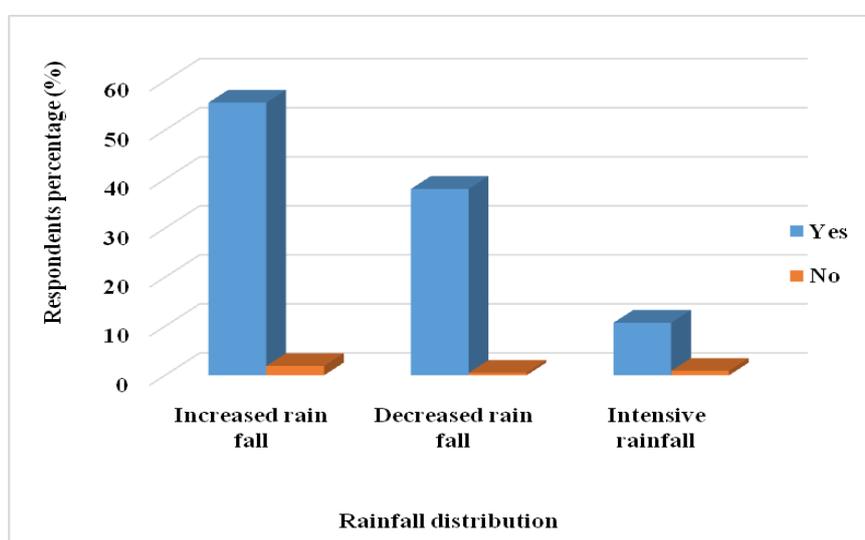
**Figure 6: Impacts of climatic change on the livelihood of the people**

Pest and disease outbreak was shared by 36.5% of the total respondents during the study period. This outbreak was directly linked with the effect of flood and disturbance on the natural ecosystems. About 37.9% of the respondents mentioned about the destruction of the ecosystem because of the climatic changes especially due to prolong dry spell. The agricultural sector and economic value of the goods and services would be definitely destroyed due to the adverse weather conditions. These were supported by

50.9% of the respondents of this survey.

Impacts of climate change on human health were another issue identified in this study. Around 47.2% of the respondents reported that they affected by the fluctuation of the meteorological factor during the past. People are concerning very much about various types of infected diseases such as malaria, dengue fever, diarrhoea, vomiting and fever. Beyond those issues, there were no specified issues shared by the people.

### Awareness on changing pattern of rainfall



**Figure 7: Rainfall distribution in Batticaloa District**

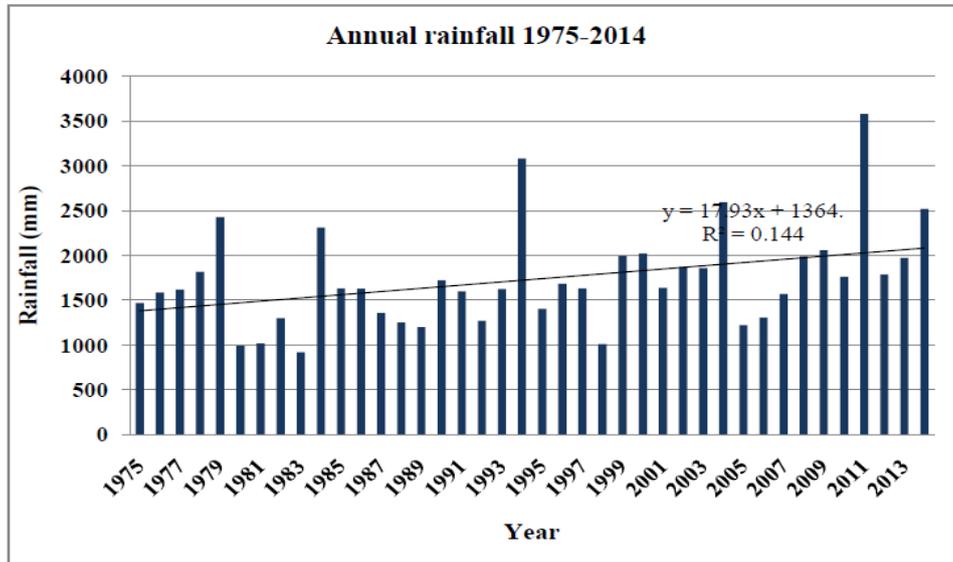
In Sri Lanka, based on the rainfall pattern, the year can be divided into four seasons, namely the two monsoons (South-West from May to September and North-East from December to February) and two inter monsoons (Suppiah, 1996; Zubair *et al.*, 2008). In the present study, feedback was gathered from the respondents regarding the pattern of monsoon rainfall (Figure 7).

Around 55.6% of the respondents expressed that the amount of rainfall for the last 5 years during monsoon period (December to January) has been increased and finally led to flooding

conditions of their surroundings. In contrast, 38% of the people mentioned that the rate of rainfall was decreased in a year and the area was experienced with prolonged dry season. However, 10.7% of the respondents mentioned that, there are no any considerable changes in the total amount of rainfall during the season but they observed the increased rainfall intensity that leads to the fast flood in Batticaloa. Sugirtharan *et al.* (2014) also reported that, the heavy rain (total amount of rainfall was 330.9 mm) occurred during 15.12.2012 to 18.12.2012, the lagoon water entered the adjacent land

upto 30-48 m from the lagoon border. At the time of this event, adjacent roads (Lady manning road, Lake Road etc) and portion of the land area of the

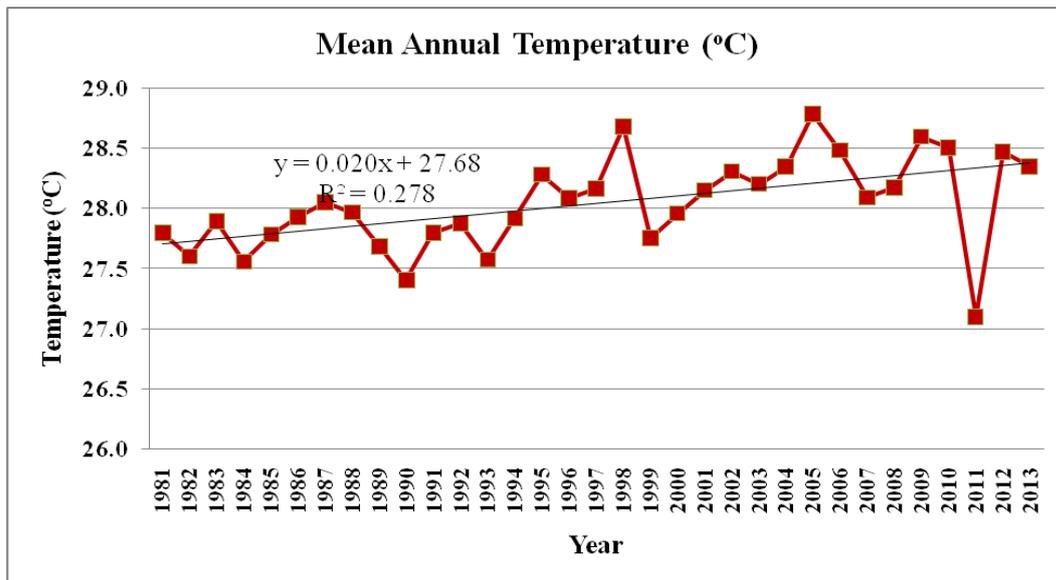
households near lagoon were flooded and disturbed the livelihood activities.



**Figure 8: Annual rainfall during the period from 1975 to 2014**

Though there are several views from the respondents in this survey, the actual meteorological data shows an

increasing trend of rainfall during the period of 1975 to 2014 (Figure 8).



**Figure 9: Mean annual temperature during 1981- 2013**

Similarly, the mean monthly temperature of the Batticaloa during the period between 1981 and 2013 (33 years) was collected and trend analysis

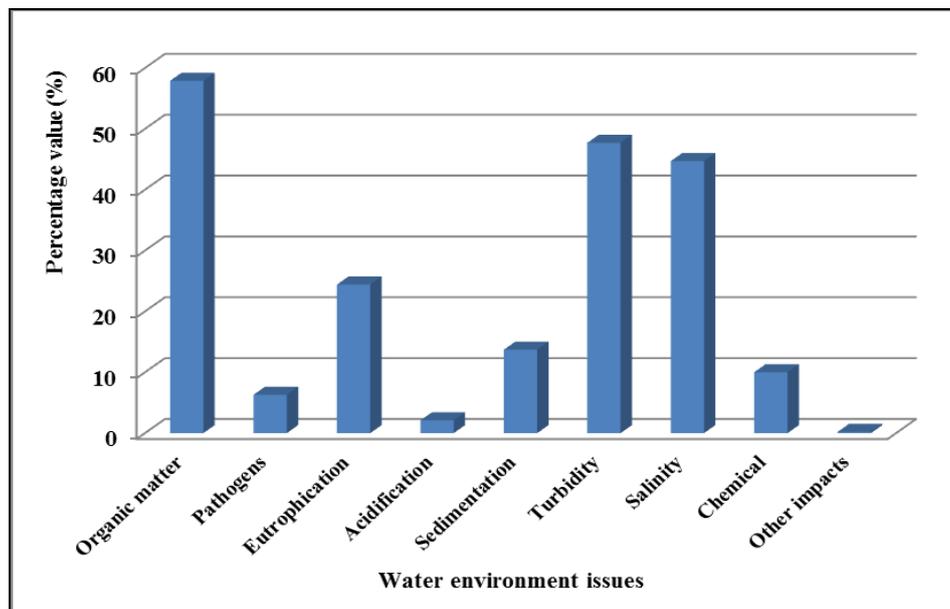
was performed where, the temperature has shown as an increasing trend ( $R^2=0.278$ ) during this period (Figure 9). There was a huge flood and the

numbers of rainy days were high in 2011, this could be the reason for the low mean annual temperature during that year.

**Community concerns on the impacts of anthropogenic activities on Batticaloa Lagoon**

By concerning the lagoon as an important resource, it should be checked frequently for its quality

aspects for future usages. People also mentioned that the lagoon may have affected by anthropogenic activities in various ways such as presence of organic particles, pathogens, eutrophication, acidification, sedimentation, turbid condition, salinity and chemical contamination (Figure 10).



**Figure 10: Expected problems at lagoon water due to climate change**

According to the Figure 10, higher percentage (57.9%) of respondents mentioned that organic matter content in lagoon is expected to be higher due to dumping of garbage near the lagoon, presence of vegetation along the banks of the lagoon, runoff water accumulation during heavy rainfall and flood. Because of the nutrient enrichment at lagoon from adjacent cultivable area leads to aquatic plant growth which facilitates the eutrophication in the lagoon. About 24.4% of the respondents identified eutrophication in some places of the lagoon. The respondents were somewhat clear with the negative impact of eutrophication to the aquatic

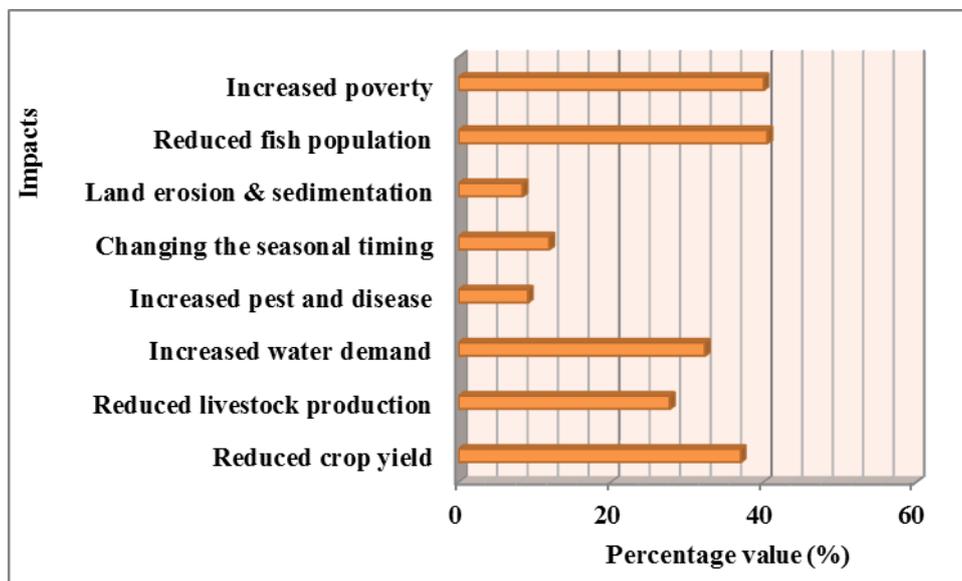
life and the livelihood activities. Due to the higher organic matter content and suspended solids, turbid nature was also observed by 47.7% of the respondents which may be the identification tool for the water pollution by the community. The above results clearly explained that the visual observation was the major determining factor on those judgements by the community.

Third major issue pointed by the public (43%) was higher salinity of the lagoon due to the salt water intrusion from sea. Sedimentation was another concern by 13.7% of the respondents. Finally, the respondents (12.3%) mentioned that the destruction of the

ecosystem, which needs to be studied and focused for the future generation. Further, majority of the respondents (52%) mentioned that the climatic changes highly influence on the income level and socio-economic activities of the population in the district while 26.5% of the respondents failed to adjoin this statement.

**Climate change impacts on various income and economic activities**

In the current study, issues which are linked with the level of income were further evaluated. Reduced crop yield, reduced livestock production, increased water demand, increased pest and disease, changing the planting time, land erosion and sedimentation, reduced fish population, increased poverty level and loss of cultivable area were some of the problems identified for the reduced level of income of the population who live nearby the lagoon.



**Figure 11: Climate change impacts on income and economic activities**

Figure 11 shows, reduced fish population contributed a lot in the income destabilisation of the society. Survey further revealed that, climatic changes lead to the low income level of the people that increased the poverty (40%) in the study area. Some people have been engaged with the crop cultivation nearby lagoon area which has also been affected (37%) by heavy rainfall, dry and salt problem during prolonged dry season.

About 8.5 % of the respondents reported that the soil erosion and sedimentation also influenced on their income activities. When the rainfall intensity is high, it accelerates the

surface runoff and causes the land erosion and transported soil particles are accumulated in the depressed areas of the lagoon and settled. These sediments are one of the reasons for the water quality degradation in Batticaloa Lagoon. In addition to that, saline condition, accumulation of organic matters and higher turbidity also cause the quality reduction of the water therefore not suitable for irrigation and drinking purposes. As the result of saline nature of the lagoon, groundwater near the lagoon area also contaminated with the saline water and cannot be utilized for drinking purpose. Therefore, demand

for the quality water (32.3%) is higher in such places and the people go for paying to get drinking water from National Water Supply and Drainage Board (NWSDB). That might indirectly influence on the economic status of the studied population.

Changing the planting date lead to the higher number of pest and disease spread among the crops cultivated, which is one of the facts stimulates the reduction in the income level by affecting the cultivation in Batticaloa District. It is also found from the study that the climatic change causes the loss of cultivable land (8.4%) mainly due to the salt accumulation by flooding and sedimentation of silt particle which cause unsuitability of the land for cultivation.

Further, the community were asked about, whether the climate change impacts on their environment, ecosystem or bio diversity. Most of the people (85.3%) mentioned that the climatic change is one of the causal agents to reduce the quality of the environment, ecosystem and bio diversity. Therefore, all the above mentioned issues should be considered further for future generations and their well beings.

### **Conclusions**

Climate change is one of the major sources for the disturbance of the Batticaloa lagoon ecosystem. Flood and prolonged dry season are considered as the major climate change impacts on lagoon and their surroundings. Most of the community are aware about the climate change and their impacts on the lagoon environment however lack of knowledge on quality aspects of the lagoon. Therefore, awareness and training on adaptation techniques against the climate change is important to sustain the lagoon based economic activities. Community understanding

of the issues and problems associated with the Batticaloa lagoon is considered as an important step for the management of the Batticaloa Lagoon.

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