Chapter 10

Impact of Extreme Climate on Crop Production and Management Techniques in Batticaloa District, Sri Lanka: Review on Flood and Drought

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Abstract

Climate change is one of the most widely researched and discussed topical problems affecting many sectors specially agriculture. Sri Lanka's economy is heavily dependent on agriculture which employs a large percentage of the population. Developing countries are more vulnerable to climate change, as they will be the most affected, but have the minimum capacity to adapt to it. Climate change may be due to natural internal processes, external forcing or persistent anthropogenic changes in the composition of the atmosphere or in land use. Impacts of climate variability and change on the agricultural sector are projected to steadily manifest directly from changes in land and water regimes, the likely primary conduits of change. Climate change thus represents an additional burden that for farmers translates into production risks associated with crop yields, probabilities of extreme events, timing of field operations, and timing of investments in new technologies. Long term shifts in rainfall and temperature regimes, extreme climatic events such as droughts and flood can cause substantial damage to crops. In order to mitigate the impact of flood and drought, appropriate management measures have to be implemented. These measures can be classified into structural measures, non-structural measures and integration of structural and non-structural measures. Structural Measures include protection of the vulnerable area up to a certain level of extreme event and preferred by engineers and

local people. Non-structural measures focus on reduction of loss or damage which referred by social scientists and conservationist. Integration of structural and non-structural measures is essential for effective disaster management. This review was conducted to study the impact of climate change on crop production and the appropriate measures which uses science and technology in disaster management. Therefore, the main objective is to identify the climate change hazards and possible disaster management projects in Batticaloa and to establish the broad agreement of the Batticaloa scientific community on critical issues related to the climate change hazards.

***Keywords**: Climate change, Crop production, Disaster management, Extreme weather, Flood, Drought, Batticaloa.*

1. Introduction

Climate change has been defined as a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere in addition to natural climate variability observed over comparable time periods (Obioha, 2009). The agricultural sector of Sri Lanka, like in most developing nations, is crop based and is the primary source of employment to the rural populations (Devendra, 2002). Availability of research data on issues of climate change in Batticaloa District is limited. Lack of such information is also known to be an obstacle for strategic planning, policy development and priority setting in Sri Lanka. Therefore, the objectives of this review is to identify the climate change hazards and possible disaster management projects in Batticaloa and to establish the broad agreement of the Batticaloa scientific community on critical issues related to the climate change hazards.

2. Discussions

2.1 Impact of Climate Change on Crop Production

Agriculture, especially crop production, is highly sensitive to both short and long-term changes in climate. Temperature increases will reduce the durations of most cereal crops by hastening their phonological development (Wheeler *et al.,* 2000). Rice is highly influenced by variations in temperature and rainfall (Fernando 2000). A study by Cheng *et al*. (2009) has shown that increasing night temperatures will reduce the stimulatory effects of increasing CO_2 on rice yields. Grain development of rice is highly sensitive to temperature during its reproductive stage, with significant increases in grain sterility occurring when temperature increases beyond 34 ^{o}C even for a few hours (Horie *et al.,* 2000). In addition to the long-term shifts in rainfall and temperature regimes, extreme climatic events such as droughts and episodes of high temperature can cause substantial damage to both rice and tea crops. Such damage has serious repercussions on the national food security and foreign exchange earnings while causing substantial socio-economic damage to the large number of families that are dependent on these two crops. Similar adverse impacts are experienced by other crops (Porter and Semenov

2.2 Statistical Information on Extreme Weather and their Effects on Crop Production in Batticaloa District

Sri Lanka statistical abstract reported that analysis of air temperature and rainfall data collected by the Department of Meteorology over a period of more than 100 years have shown an increasing trend in the annual mean air temperature over the entire Island, particularly during the more recent period, 1961-1990. This increase was found to be approximately 0.16°C per decade. Batticaloa is ranked among the five districts which recorded the lowest productivity in paddy farming in the 2010/11 'Maha' season. Certainly, it may be argued that this is due in part to the severe floods experienced in this region in early 2011 (Department of Census and Statistics, 2016). The Dry and Intermediate zones are the most vulnerable to drought, with the districts of Jaffna, Killinochchi, Batticaloa, Polonnaruwa, Anuradhapura and Kurunegala having the highest probability of experiencing drought (Ministry of Environment, 2011).

Paddy irrigation requirements are predicted to increase on average across Sri Lanka by 23 per cent. The highest proportional increase is predicted to occur in Batticaloa, by 45 per cent. This increase is mainly due to the decreased rainfall during January and February months. In the recent data records, the largest downward trend of 11.16 mm/year was observed at Batticaloa. The highest decrease is predicted in Trincomalee and Batticaloa as 27 and 29 per cent, respectively creating more drought problems in these areas (Premalal 2009). Disaster Situation Report (2017) reported that 24,129 families affected due drought in Batticaloa district in 2017. Flood Situation Report (2014) reported that, 124,071 families affected due flood in Batticaloa district in 2017, 3,361 houses fully damaged and 6,736 houses partially damaged due to flood in 2014. The highest number of persons (>3,604,769 people) affected by disaster is recorded in the Batticaloa district during the period of 1974-2006. The range between 8000-90550 people affected due to drought in the Batticaloa district in the period of 1974-2006. More than 2,394,704 people affected due to flood in the Batticaloa district in the period of 1974-2006. The agricultural land area of 343 to 3530ha are affected due to drought in the Batticaloa district in the period of 1974-2006. The agricultural land area of 21,019 to 36,583ha affected due to flood in the Batticaloa district in the period of 1974-2008 (Disaster Information Management system in Sri Lanka, 2017).

Disaster Profile of Sri Lanka (2012) reported that cost of agricultural damages and losses is 15,070 LKR million in Batticaloa, Polonnaruwa, Anuradhapura, and Ampara districts due to flood in 2011.

2.3 Disaster Management Projects Implemented in Batticaloa District

Climate Resilient Action Plans of Coastal Areas of Sri Lanka (CCSL) implemented awareness programs with the school heads and teachers in Batticaloa district with the help of Batticaloa municipal council (BMC). Following themes have been discussed at the awareness program:

1. Post disaster health hazards (Mosquito borne diseases; Water borne diseases)

2. Use of trees/plants for climate change adaptation
3. Preparation for disaster (Cyclones, floods, tsunami)
4. Safe home/school for disasters
5. Save energy at home/school

Disaster Management Centre (DMC) has implemented following measures to reduce negative impact of any disaster (DMC-NDMCC, 2015)-

1. Risk awareness and assessment (hazard mapping, vulnerability assessment, capacity building).
2. Knowledge development (public education, training on community-based disaster management, information sharing)
3. Application of measures (environmental protection measures, protection of critical places of public places)
4. Early warning systems (forecasting, dissemination of warnings, preparedness measures, response capacities).

Project team of CCSL developed a project to provide recommendations to Sri Lankan cities to develop action plans to build disaster resilient cities based on the lessons learnt in the implementation of different project activities. The four Climate Resilient Adaptation Strategies and Supporting Action Plans (CRASSAPs) under this project are (CRASSAP, 2010):

1. Water resource management, especially drainage and sanitation impact from more intense rainfall events, supported by a Pre-Feasibility Study (PFS) with funding support from the SIDA (Swedish International Development Cooperation Agency) supported City Development Initiative for Asia (CDIA).
2. A multi-purpose green belt (12 km in length) was established to protect the lagoon and coastal areas, restore mangrove eco-systems and coastal bio-diversity in BMC area.
3. GIS-based Rapid Response Systems (RRS) and two Knowledge Management centers for climate exacerbated disasters were established at BMC and Negombo Municipal Council (NMC) with a training (1 month for selected 50 participants) and equipment (building, Software, 20 computers, 10 GPS, printers, scanners, broadband facilities).
4. Disaster resilient; energy efficient; low-cost shelter adaptation training, supported by local resource based- livelihood diversification options for 100 participants live in vulnerable areas.

2.3 **Recommended Disaster Management Technology**

1. ***GIS and remote sensing:*** GIS models having low cost and simple data requirement are likely to attract the local authorities in the developing countries to adopt this technology as an essential input towards a comprehensive flood management system (Saiful Islam *et al.,* 2012).

2. ***Internet:*** Launching of a well-defined website is a very cost-effective means of making an intra-national and international presence felt. It provides a new and potentially revolutionary option for the rapid, automatic and global dissemination of disaster information.
3. ***Satellite Communication:*** Satellite data can be effectively used for mapping and monitoring the flood inundated areas, flood damage assessment, flood hazard zoning and post-flood survey of rivers configuration and protection works
4. ***Flood forecasting system:*** The flood forecasting and warning system is used for alerting the likely damage centers well in advance of the actual arrival of floods, to enable the people to move and also to remove the moveable property to safer places or to raised platforms specially constructed for the purpose.

3. Conclusions and Recommendations

Adverse weather and climatic changes, capital shortages, high cost of inputs, access to credit difficulties and poor quality of output are affecting agricultural productivity and eventually impact on the incomes of the farmers in Batticaloa district. However, adequate and relevant information about impact of climate change in Batticaloa district is generally lacking. Therefore, management practices and cultivars will probably have to be adjusted to maintain agricultural crop production under a changing climate. Promoting local and international research collaborations among the researchers who worked in the same field, exchanging and implementing the knowledge generated to address the similar issues will overcome the problems mentioned above. The advancement in Information Technology in the form of Internet, GIS, Remote Sensing, Satellite communication, *etc.* can help a great deal in planning and implementation of hazards reduction. New technologies for public communication should be made available to use and natural disaster mitigation messages should be conveyed through these measures for maximum benefit. In conclusion, climate change will decrease crop yields in the long term, unless one slows climate change and/or adapts new management practices and improved cultivars.

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APPENDICES

People Affected Due to Disaster-Spatial Distribution: 1974-2006

figure 10.1a Shows spatial distribution of people affected map illustrates the geographical distribution of people affected by disaster across the districts in the country. The highest number of persons affected by disaster is recorded in the Batticaloa district (more than 3,604,769 people). *Source: www.desinventar.lk*

People Affected Due to Drought-Spatial Distribution: 1974-2006

figure 10.1b shows that spatial distribution of people affected map illustrates the geographical distribution of people affected by drought across the districts in the country. The range between 8000-90550 people affected due to drought in the Batticaloa district in period of 1974-2006. *Source: www.desinventar.lk.*

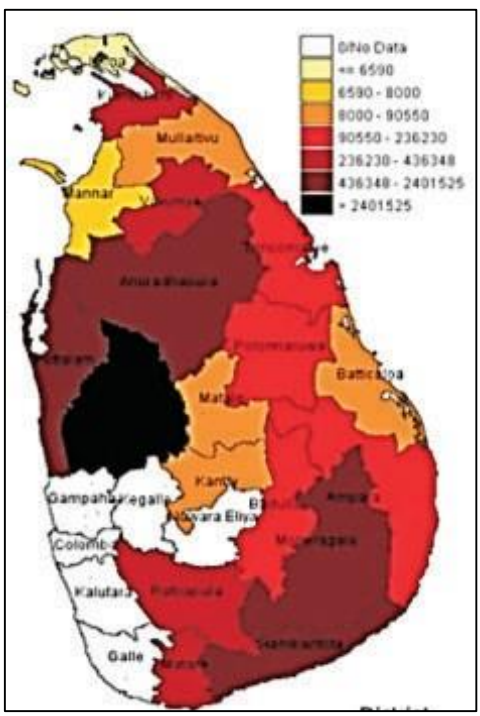

Figure 10.1a: People Affected Due to Disaster-Spatial Distribution: 1974-2006.

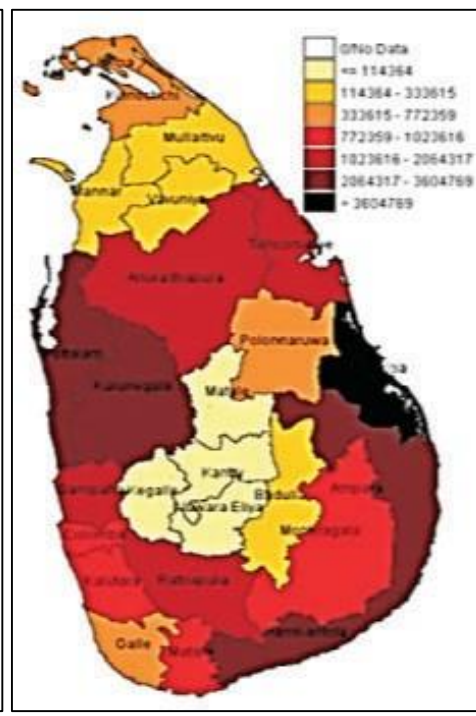

Figure 10.1b: People Affected Due to Drought-Spatial Distribution: 1974-2006.

People Affected Due to Flood-Spatial Distribution: 1974-2006

figure 10.2a shows that spatial distribution of people affected map illustrates the geographical distribution of people affected by disaster across the districts in the

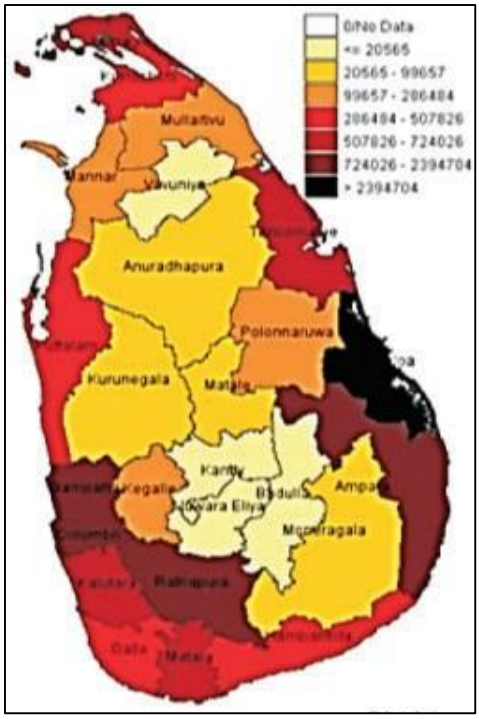

Figure 10.2a: People Affected Due to Flood-Spatial Distribution: 1974-2006.

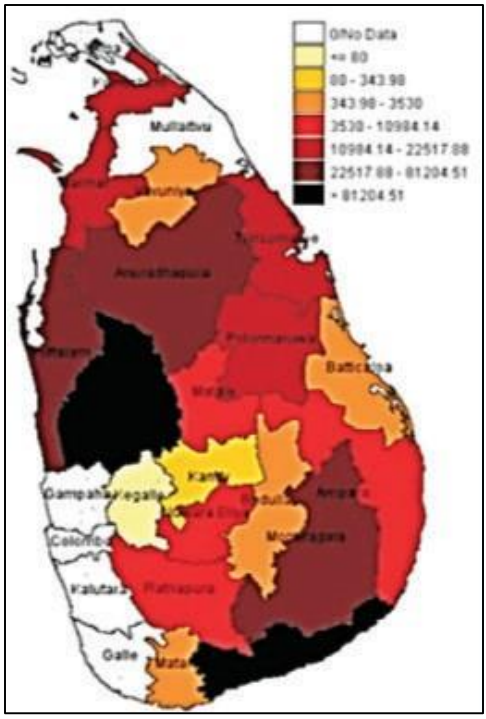

Figure 10.2b: Agricultural Losses Due to Drought (in ha) Spatial Distribution: 1974-2006.

country. More than 2,394,704 people affected due to flood in the Batticaloa district in period of 1974-2006. Source: *www.desinventar.lk.*

Agricultural Losses Due to Drought (in Hectare) Spatial Distribution: 1974-2006

figure 10.2b shows that spatial distribution of agricultural losses due to drought map illustrates the geographical distribution of people affected by disaster across the districts in the country. The range between 343–3530ha of agricultural land affected due to drought in the Batticaloa district in period of 1974-2006. *Source: www.desinventar.lk*

Agricultural Losses Due to Flood (in Hectare) Spatial Distribution: 1974-2008

figure 10.3 shows that spatial distribution of agricultural losses due to flood map illustrates the geographical distribution of people affected by disaster across the Districts in the country. The range between 21,019 – 36,583ha of agricultural land affected due to flood in the Batticaloa district in period of 1974-2008. *Source: www.desinventar.lk.*

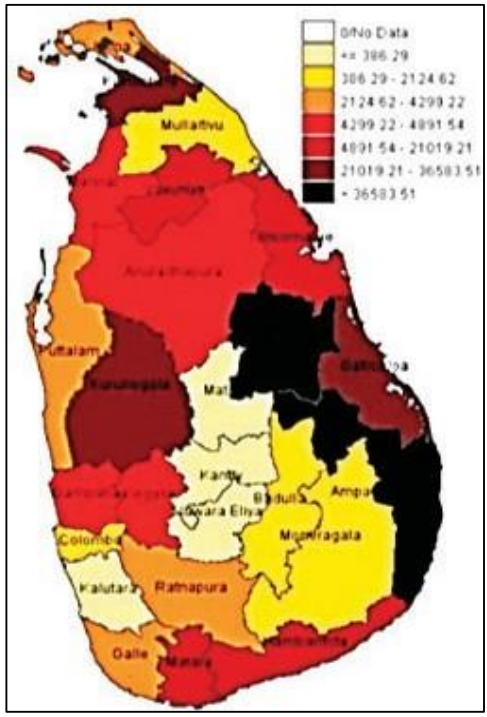

Figure 10.3: Agricultural Losses Due to Flood (in ha) Spatial Distribution: 1974-2008.

figure 10.4a shows the cumulative number of people affected by flood during 2002-12 in Batticaloa district. It shows highest number of people affected by flood. *Source: Disaster Profile of Sri Lanka*.

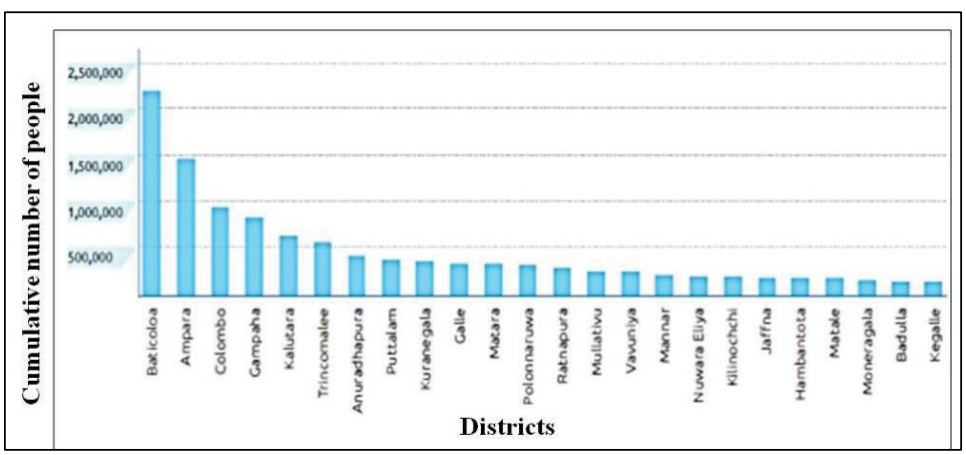

Figure 10.4a: The Cumulative Number of People Affected by Flood during 2002-12.

figure 10.4b shows the cumulative number of people affected by drought during 2002 – 2012. *Source: Disaster Profile of Sri Lanka*.

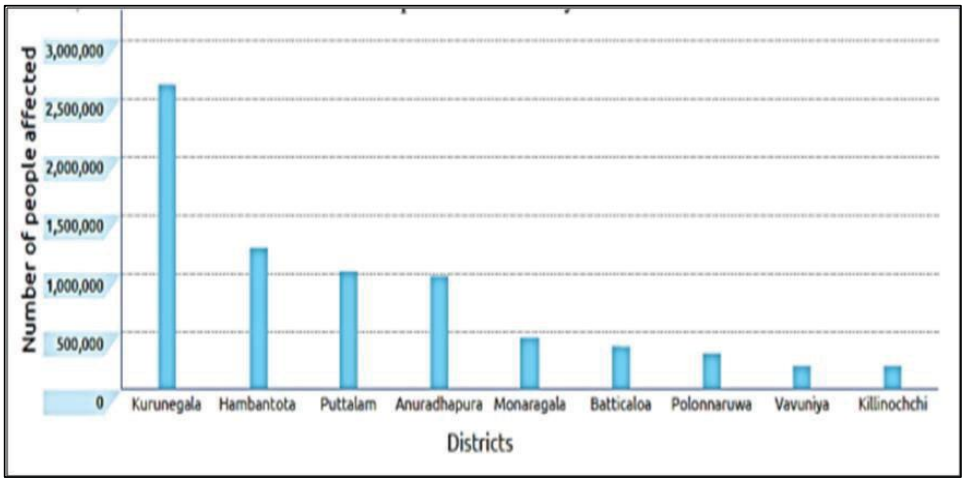

Figure 10.4b: The Cumulative Number of People Affected by Drought during 2002-12.

The losses and damages in Batticaloa, Polonnaruwa, Anuradhapura, and Ampara districts due to flood in 2011. *Source: Disaster Profile of Sri Lanka*

Table 10.1: Losses and Damages in Batticaloa, Polonnaruwa, Anuradhapura, and Ampara District Due to Flood in 2011.

Sector	*Cost of Damage and Losses (LKR million)*
Housing	7,575
Agriculture	15,070
Irrigation	3,000
Road	48,916
Livestock	1,914
Total	**77,475**

table 10.2 shows the overview of natural disasters from 1980-2010 in Sri Lanka. *Source: Disaster Profile of Sri Lanka*

Table 10.2: Overview of Natural Disasters from 1980-2010 in Sri Lanka

No of Events	**62**
No of people killed	36,982
Average killed per year	1,193
No of people affected	17,457,668
Average affected per year	563.151
Economic damage (US$ × 1,000)	1,674,364
Economic damage per year (US$ × 1,000)	54,012