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Impacts of Flood and Drought Hazards on the Economy of the Northern Region of Sri Lanka

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Abstract
During the last thirty years of the internal war, economic sector of the Northern region of Sri Lanka suffered a lot. Not only war, but natural disasters also caused massive destruction in the economic sector of the northern region. Main objective of this paper is to identify the impacts of drought and flood in the economy of the northern region of Sri Lanka. Primary and secondary data were used to conduct this study. Primary data were collected using Interviews and direct observations. Several department sources such Agriculture department and agrarian department were used as secondary sources. Drought and flood events were identified using Standardized Precipitation Index (SPI) method. Then details regarding economic losses due to drought and flood data were collected through primary and secondary data. Collected data were analyzed and mapped using separate sheet and GIS. Most of the economic losses were recorded in the low lying areas of the Northern region of Sri Lanka due to flood. Highest amount of housing damages and commercial sector losses were caused by the flood, during the North East Monsoon Season (NEMS) and Second Inter Monsoon Season (SIMS). Highest extent of agriculture losses were recorded in Mullaitivu and the lowest in Mannar districts. Highest extent of paddy and cash crop damaged during the study period were recorded in Mullaitivu, subsidiary crops damaged in Vavuniya and vegetable crops damaged in Jaffna district. Compare to drought flood caused more economic losses in the study area and the NEMS has maximum extent of the agriculture damages. New strategies have to be adopted in the study area to avoid the much impact due to drought and flood in the study area.
Keywords: Drought, Flood, Crops, Impacts, Districts

1.1. Introduction

The World Meteorological Organization observed that over 70% of natural disasters are partially or totally related to weather and climate in combination with economic, social, and political factors. (Harikishan Jayanthi et al., 2013) In rain fed agricultural systems, erratic rainfall can have comprehensive and devastating impacts on affected livelihoods and local economies. The most immediate impact of erratic rainfall on rural livelihoods is on crop production. Droughts and floods undermine farm yields and the national harvest, reducing household and national food availability, and agricultural income derived from crop sales. Poor harvests threaten food security and livelihoods from household to national level, to varying degrees according to the extent that the family or nation depends on agriculture for its food and income (Stephen Devereux, 2008).

Sri Lanka's economy faces many challenges due to the natural hazards (Weerakone, 2009). Agriculture in Sri Lanka is highly susceptible to variations in temperature, rainfall, soil moisture deficits and increases in the intensity and frequency of extreme events. Delayed monsoon rains and an increase in the frequency of droughts and floods generally affect the extent of paddy sown and harvested and yields obtained. Increase in temperature in Sri Lanka would affect the high value vegetable and potato cultivation in the central hill country. In addition the cool season potato cultivation in the Jaffna peninsula will get affected, if night time minimum temperatures continue to increase. (Shanthi de silva, 2009)

Because of the thirty years of internal war in the Northern Region of Sri Lanka, all sectors of the economy have been destroyed. Most of the economic activities have been limited during the war period. Other than the war, natural hazards also have had impact in many ways on the economic sector of the Northern Region of Sri Lanka.

This Chapter elaborates the economic impact due to the drought and flood hazards in the study area. Due to the limitation of the data availability, it is difficult to analyze the economic impact from 1972 to 2012. So, in this chapter, the economic impacts of drought and flood hazards in the Northern Region of Sri Lanka have been analyzed only for the last ten years period from 2002 to 2012. Economic impact during the years of 2008 and 2009 is also not included in the economic impact analysis, because, during the above years, people of the Vanni, were displaced from their own land and they got resettled in 2010.

When compared with drought, flood hazard have caused much greater damages in the Northern Region during the last ten years. There have not been any extreme droughts during the last ten years in the study area. Due to this, economic impact of the drought hazard is less than that of flood hazard. When compared to other types of crops damage to the paddy crop has been higher.

1.2 Objective

The objective of this study is to identify the economic impact due to the drought and flood hazards during the last ten years from 2002 to 2012 in the every district of the northern province of Sri Lanka.

1.3. Methodology

Primary data were collected using two methods such as interviews and discussions and direct observations.

According to the objectives, the primary data were to help identify the economic impacts of the climatic hazards in the Northern Region of Sri Lanka.

1.3.1 Primary Data

Primary data to a great extent helped this study particularly to identify the trends and patterns of climatic hazards such as droughts and floods, and to study the impacts of climatic hazards especially on the economy of this region. Primary data collection method helps especially to study the drought and flood occurrences and their impacts during the year 2012, in the Northern Region of Sri Lanka.

1.3.1.1 Interviews and Discussions:

Interviews and discussions regarding such matters as the identification of flood level, flood impacts, flood patterns, flood prone areas, drought impacts, drought prone areas, and also as to which sectors of economy had faced much threat from climatic hazards and the extent of impacts such climatic hazards had on the economy of the study area, were held with the people who are living and working in the Northern Region. 100 samples from each district (totally 500 in the Northern Region) were collected during the interviews and discussions were held on the basis of stratified sampling method. In the 100 samples 50 from agricultural sector, 20 from fisheries sector, 10 from small scale industries, 10 from commercial activities, and another 10 from other sectors in each district in the Northern Region (Table 1.4). During the selection of samples for the interviews, much priority was given to the most vulnerable areas of every district based on the data regarding the drought and flood hazard impacts during the year 2012. **Ten (10)** samples collected from following each location for the interviews and discussions for this study.

Table 1.1 Samples collected locations

No.	Sample Location	No.	Sample Location
1	Thirunelvely	26	Muththaiyankaddu Right
2	Kopay	27	Kanukkerny
3	Karaveddy	28	Mullaitivu
4	Chunnakam	29	Mankulam
5	Kodikamam	30	Puthukkudiyiruppu
6	Punkuduthivu	31	Nedunkerny
7	Velanai	32	Kanakarayankulam
8	Uduppiddi	33	Omanthai
9	Sandilippai	34	Thandikkulam
10	Alaveddi	35	Pavtkulam
11	Akkarayankulam	36	Puliyankulam
12	Uruththirapuram	37	Thavasikulam
13	Murasumoddai	38	Vavuniya Town
14	Kandavalai	39	Cheddikulam
15	Tharmapuram	40	Nelukkulam
16	Vaddakachchi	41	Iluppaikkadavai
17	Thiruvaiyaru	42	Murunkan
18	Paranthan	43	Andankulam
19	Poonarin	44	Madhu
20	Skanthapuram	45	Nanaddan
21	Thunukkai	46	Uyilankulam
22	Pandiyankulam	47	Mannar
23	Oddusuddan	48	Thevanpiddi
24	Udaiyarkaddu	49	Peaslai
25	Muththaiyankaddu Left	50	Musali

Unstructured questions were asked from those interviewee, based on the objectives of this study. In addition, to the identification of the economic impacts due to climatic hazards, some interviews were also held with the Government and Non Government officers who are responsible for the economic activities of each district. A maximum of ten officers were selected for such interviews from each district. Altogether 50 samples were selected from these categories. All these interviews helped to elicit the qualitative information regarding the climatic hazards and their impacts on the economy of the Northern Province of Sri Lanka.

1.3.1.2 Direct Observations

Direct observation was also one of the methods used in collecting primary data. This method helped to observe the climatic hazards occurrences and the economic impacts due to climatic hazards especially during the years 2011 and 2012. To identify the drought impact in the study area direct observations made during the months of May to September 2012 were of help. To study the flood events and their impacts, direct observations were made during the North East monsoon period of the year 2012. During those periods direct observations were

made to find out the economic impacts caused by climatic hazards in the study area. Direct observations helped to take photos and collect information. During the direct observations, interviews and discussions were also held. Direct observations helped to observe the floods and droughts and the impacts of these climatic hazards on agriculture. In fact direct observations did help to identify the real situations that prevailed during the climatic hazards in the years of 2011 and 2012 in the Northern Province of Sri Lanka.

1.3.2 Secondary Data

Secondary data also helped to identify the climatic hazards and their impacts on the economy of the Northern Province.

Statistical Abstracts of the National Statistical and Information Department:

Statistical Abstracts of this department for the period from 1970 to 2010 also served as secondary data. Information and statistics from the statistical abstracts related to the weather and climate of the five districts, in addition to agriculture, Fisheries, Industries and service sectors within the study area for thirty years were collected as secondary data.

Reports, Press Statements, Annual Symposium Proceedings and other Publications of the Disaster Management Centre: This is an important source of secondary data to identify the natural disaster profile of the country and the impacts of the natural hazards and the mitigation measures adopted by the Ministry of Disaster management

Reports and Records of the District Agricultural Department

Reports and Records of the District Agrarian Service Department

These organizations are fully responsible for the agricultural activities in the respective districts. Hence, the annual reports and records of the above two organizations in all districts of the Northern Province were used as one of the secondary data to identify the impacts of climatic hazards on agricultural activities in the study areas for 30 years.

Reports of the District Fisheries Department:

From this source secondary data related to the fishing activities and the impacts of climatic hazards on fishing activities were collected. This source was mainly used to find the impacts of climatic hazards on the fishing sector.

Statistical Hand Books and Reports of the District Secretariats and Divisional Secretariats: These sources were used to identify the data regarding the climatic hazards and its economic impacts on the respective districts and divisions.

Statistical Hand Book of the Northern Provincial Council: From this source basic information about the study area including the climate of the study area, the trends and patterns of the economic sectors of the Northern Province and impacts of the climatic hazard on the economy of the Northern Province were identified. Before 2007 Northern provincial council and the Eastern provincial councils were functioning as one unit under the name North-East Provincial Council. Hence, before 2007 this report was under the name of North -East Provincial Council Statistical Hand book.

Reports of the District Industrial Development Boards:

From this source data related to the industrial activities were collected to identify the climatic hazard impacts on the industrial sector in the study area (30 years)

Reports of the Irrigation Department:

In some districts of the Northern Province this department has been measuring the rainfall over the tanks under their maintenance. Also during floods, this department has the responsibility to monitor the water levels of the tank and the excavation of excess water. From this source details of rainfall in some stations and details of villages affected during the excavations of the excess water from particular tanks in the districts other than Jaffna were collected. This source of data was used to identify the relationship between the impacts of climatic hazard on the agricultural sector and irrigation activities (Especially during the drought and flood periods)

Reports of the Provincial Ministries of Agriculture and Livestock, Industrial Development, Fisheries and Commerce: This data source was used to identify the economic impacts due to climatic hazards in the study area for thirty years.

Reports of the Community based organizations. This data source also helped to identify the economic impacts of climatic hazards of the northern province of Sri Lanka at micro level.

Other than such Departmental sources, secondary data were collected from the following sources also.

Books related to the Natural Disasters, Economic impacts and Northern Province.

International and National Research Journals

Local and National News Papers

Reports of other government sectors, Non Governmental organizations and private organizations

Published and Unpublished Thesis related to the title.

1.3.3. Method of Data Analysis

Based on the third objective of this study, economic impacts due to climatic hazards have been identified. In the

study area, the extents of damages recorded in the agricultural have been greater than the other sectors such as fisheries and commercial activities. To identify the extent of damages in the agricultural sector, primarily the details of cultivated areas are identified. Then the details of harvested areas are identified, and finally the variations between the cultivated and harvested areas are calculated. On the basis of the difference of value between the cultivated and harvested areas, the loss of the agricultural products is considered. Then the loss of agricultural products is calculated on the basis of damages caused by floods and droughts. The above details are based on the reports of the Agricultural Department (District and Provincial), Agrarian Centre, Central Bank and the District and Divisional Secretariats. Fisheries sector losses and commercial sector losses were calculated from the primary and secondary data sources.

1.4. Results

4.2. Impacts of Drought and Flood Hazards in Kilinochchi District

In the Kilinochchi district, from the 2002 to 2012, more than 1350 houses were fully damaged and 2871 houses were partially damaged due to flood hazards. Out of these, 61% of the houses are semi permanent houses, 14% are permanent houses and the others are temporary houses.

In the Kilinochchi district, during the last ten years, totally 21179 hectare paddy crop, 4807 hectare subsidiary crop, 2785 hectare cash crop and 2281 hectare vegetables, were damaged due to drought and flood hazards during the last ten year.(Table 1.2) In the total crop damages, Paddy crops have high percentage of damages in the district (Figure 1.1)According to data available highest damage to paddy crop has been recorded during the NEMS. During the NEMS season up to 2012 more than 11021 hectares paddy was damaged due to flood hazard in the Kilinochchi district of the Northern Region of Sri Lanka. During 2010 NEMS 4345 hectare paddy was damaged due to the flood (District Agriculture Department, Kilinochchi, 2012). After that during the SIMS and FIMS very high amount of damage to the paddy crop was recorded due to the Flood and Drought Hazards. During the SWMS, damage to paddy crop was very much less. In Kilinochchi district during the SWMS, there has been very low amount of damage to Paddy due to the drought and flood hazards. During the SWMS, paddy cultivation in the Northern region is very much less.

Also, subsidiary crop cultivation activities in the Northern Region of Sri Lanka have been affected several times, due to drought and flood hazards. From 2002 to 2012 more than 4807 hectare subsidiary crop was damaged to the above hazards. During the SIMS much damage to the subsidiary crops was caused due to drought and flood hazard. During the SIMS damages to 2113 hectare subsidiary crops were recorded due to flood and drought hazards. But more of subsidiary crops were damaged during the FIMS & SIMS.

The loss of cash crops, such as Chilli, Onion, and Tobacco was also recorded due to drought and flood hazards in the Northern Region of Sri Lanka. From 2002 to 2012 more than 2787 hectare cash crops were damaged due to drought and flood hazards in Kilinochchi. Very high cash crop damage was caused by flood hazards during the FIMS. Great extent of cash crop impact was recorded in 2012 during the FIMS. Among the cash crops, onion has a high amount of damage due to these hazards, because of its characteristics.

In Kilinochchi District, from 2002 to 2012, more than 2281 hectares of vegetable crops were damaged due to the drought and flood hazards. Based on the available data about the vegetable crops, very few of them were damaged due to drought hazard. The damage to the vegetable crop was recorded to be high due to flood hazards, because, farmers use their well water to irrigate the vegetable crops during the drought. Due to it damage to the vegetable crop during the drought hazard was very less. Great extent of vegetable crops was damaged during the NEMS and SIMS due to flood hazards. In the Kilinochchi district, fruits and other crops were also damaged due to the flood and drought hazards. But the extent is very much less. If flood occurs along with high speed of wind, banana cultivation is damaged. But the extent of such damage in Kilinochchi district is very less.

In the district, the extent of damage to the fisheries due to flood and drought hazard is very less. But, dry fish activities were affected during the flood occurrences. The extent of damage is not recorded in the Kilinochchi district. According to the interviews with the fisheries related people, more than 100,000/- worth of dry fish activities are damaged due to flood hazard every year especially during the

NEMS (District Secretariat, Kilinochchi,2012). During the drought time inland water sources fishing activities also were affected in this district.

Commercial activities in the Kilinochchi district are also affected due to drought and flood hazards. There are no records of drought hazard impacts on the commercial activities. But flood hazards have made a considerable impact on commercial activities. According to the report of the District, Divisional secretariat and the DMC Small scale commercial activities face many threats due to the flood hazard in the Kilinochchi district. This extent of loss in the Kilinochchi district is 1.2 million SLRs.

It is recorded that, more than 1.7 billion SLRs worth of public properties such as electricity, telecommunications, schools, health centers, and government departments also were damaged due to flood hazards.

Table 1.2.Crop Damages of Flood and Drought in Kilinochchi District from 2002 to 2012

Year	Season	Paddy Crop(Ha)	Subsidiary Crops(Ha)	Cash Crops(Ha)	Vegetables Crops(Ha)
2002	NEMS(Flood)	3915	830	523	657
2002	SWMS(Drought)	1351	100	34	19
2012	FIMS(Flood)	1267	348	591	270
2010	NEMS(Flood)	4345	578	190	210
2010	FIMS(Drought)	1120	512	421	218
2011	NEMS(Flood)	2761	108	65	81
2007	SIMS(Flood)	489	289	40	0
2004	SIMS(Flood)	1527	1104	416	670
2010	SWMS(Drought)	569	151	90	23
2011	SWMS(Drought)	972	77	23	24
2012	SWMS(Drought)	1753	90	43	9
2011	SIMS(Flood)	680	620	351	100
Total		**20749**	**4807**	**2787**	**2281**

Source: District Agriculture, Agrarian Departments and Divisional Secretariats Divisions of the Kilinochchi District

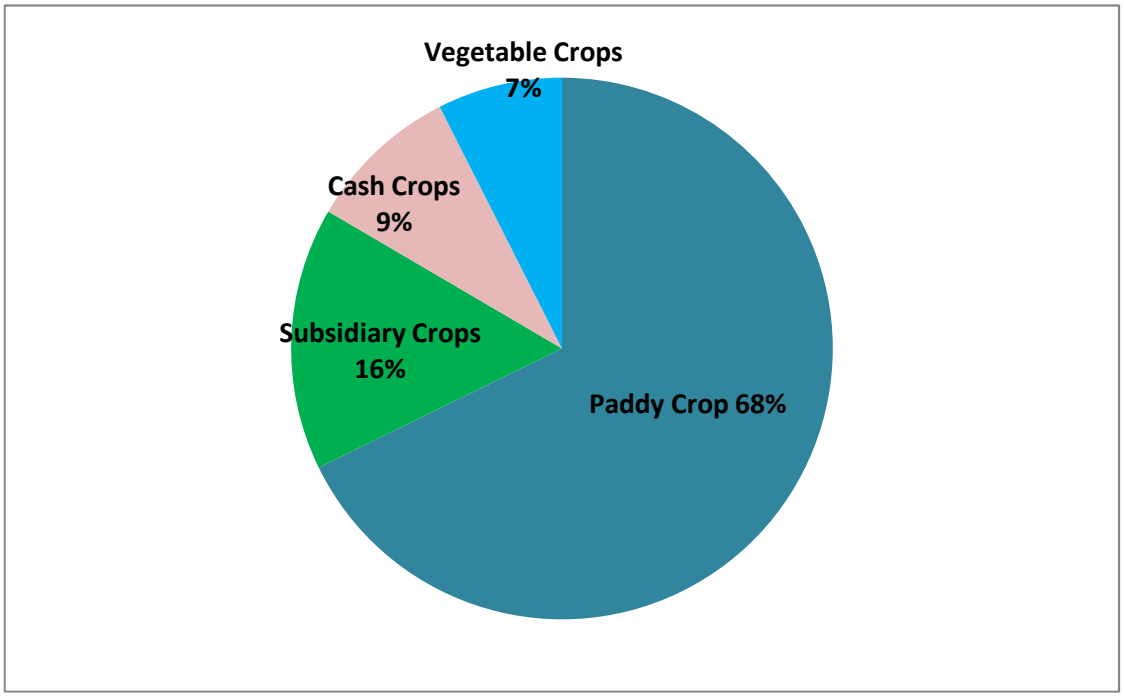

Figure: 1.1. Percentage of Crop Damage Due to Drought and Flood Hazards in the Kilinochchi District from 2002 to 2012

4.3 Impacts of Drought and Flood Hazards in Mullaitivu District

It is recorded that, in the Mullaitivu district, during the past ten year period, more than 976 were fully damaged houses and the 1310 houses were partially damaged. All these damages were due to flood. Flood and drought hazards have made serious economic impact in Mullaitivu district also. In Mullaitivu district, severe impact has been recorded in the agriculture. Varius amount of crop damages have been recorded due to these hazards in the district (Table 1.3 and Figure 1.2) Paddy crops were damaged due to drought and flood hazards. From 2002 to 2012, more than 31960 hectare of paddy damaged was recorded due to flood and drought in Mullaitivu district Large extent of paddy land damage was recorded during the NEMS, which amounts to 13054hectare. Next to that, a damage of 10761 hectare of paddy was recorded, due to drought and flood hazards during the FIMS.

During these ten years, very high extent of paddy land damage recorded during NEMS of 2011. More than 86% of the paddy land was damaged by the flood hazards. Only 4250 hectare out of 31960 was damaged due to drought in the Mullaitivu district. (District Agriculture Department, Mullaitivu, 2012) According to the interviews, 92% of the farmers of the Mullaitivu district confirm that, unexpected extreme rainfall had caused damage to the paddy crops during the NEMS and SIMS.

Subsidiary crop damage is also recorded in Mullaitivu district due to drought and flood hazards. During the ten years period from 2002 to 2012, more than 9125 hectare subsidiary crops were damaged in the Mullaitivu district. During the NEMS, high subsidiary crop damage was recorded in the district which amounts to 3231 hectares. When compared to other types of subsidiary crops, ground nut was damaged to greater extent every year.

In Mullaitivu, Cash crop damage is also recorded. In all seasons, during the ten years, about 4619 hectare cash crop damages were identified. Maximum amount of cash crop damage 7as identified in 2003 FIMS. 85% of the farmers of the Mullaitivu, expressed their view that, all their needs other than food were met with the income from the cash crop cultivation. During the flood time rainwater stagnated in the cash crop areas and affected some types of cash crop such as ground nut and onion.

Drought and flood hazards have caused considerable damage to vegetable crop in Mullaitivu district. During the ten years period of 2002 to 2012, more than 4389 hectares of vegetable crop damage has been recorded. In all four season, SIMS has much recorded more damages to vegetable crops due to flood and drought hazards. During the SIMS, 1852 hectare vegetable crop damage was recorded. Some types of vegetables such as Tomato, Ladies finger and Bitter gourd face many threats due to the drought and flood hazards.

Fisheries sector of the Mullaitivu district has been affected by flood along with high speed wind. But drought and normal flood do not make any impact on this sector. Dry fishing activities of the Mullaitivu district, have been affected by the flood, due to heavy rainfall with high speed of wind during the NEMS and SIMS and inland fishing during the drought period is also affected. According to the fishermen, dry fish industries of Mullaitivu face many threats. 47% of the fishermen consider that peak period of the NEMS is during the heavy rain with wind and they have to avoid deep sea fishing activities during this period.

Commercial activities of the Mullaitivu district are also affected due to drought and flood hazards. Extreme or severe floods have caused some extent of damage in the commercial sectors. 76% of little shop owners confirm that, they had been affected during the severe or extreme flood time due to rain water stagnating in their shops up to one feet height. Due to this, things kept on the surface were damaged due to flood hazards.

2.3 billion SLRs of public property were also damaged due to flood in the Mullaitivu district, during the last ten years from 2002 to 2012.

According to the geographical setting of the Mulliativu district, there are three D.S. Divisions such as coastal areas (Karathuraippattu), central part (Puthukkudiyiruppu and Oddusuddan) and western part (Manthai East and Thunukkai). 81% of the populations are involved with agriculture directly in the central part and western parts of the Mullaitivu district.

According to the SPI analysis, there were a number of flood and drought hazards during the last forty two years in the Mullaitivu district. These drought and floods have made their impact more on the agriculture sector than the other sectors.

Table 1.3. Crop Damage of Flood and Drought in Mullaitivu District from 2002 to 2012

Year	Season	Paddy Crops(Ha)	Subsidiary Crops(Ha)	Cash Crops(Ha)	Vegetable Crops(Ha)
2003	FIMS(Flood)	2631	487	650	420
2005	FIMS(Drought)	2178	500	378	386
2006	FIMS(Flood)	4756	813	400	491
2012	FIMS(Drought)	1196	720	482	322
2002	NEMS(Flood)	1456	864	600	104
2011	NEMS(Flood)	6960	1020	210	478
2012	NEMS(Flood)	4638	1347	96	310
2004	SIMS(Flood)	903	878	450	370
2005	SIMS(Flood)	983	1389	679	800
2011	SIMS(Flood)	634	985	510	682
2004	SIMS(Flood)	1375	35	117	12
2010	SWMS(Drought)	1767	67	20	5
2012	SWMS(Drought)	2483	20	27	9
Total		**31960**	**9125**	**4619**	**4389**

Source: Department of Agriculture, District Agrarian Service Center, Mullaitivu 2002-2012

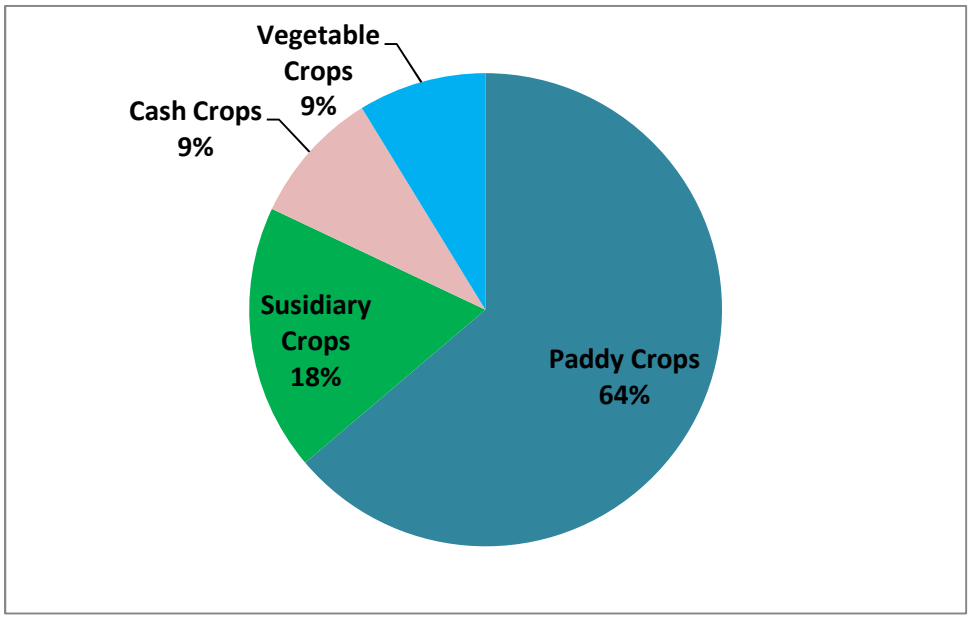

Figure: 1.2 Percentage of Crop Damages due to Drought and Flood Hazards in the Mullaitivu District from 2002 to 2012

4.4. Impacts of Drought and Flood Hazards in Jaffna District

In the Jaffna district, flood and drought impact on the economy was recorded by the Disaster Management Center of the Jaffna District. According to the records 357 houses were fully damaged and 690 houses were partially damaged in the Jaffna district due to flood during the ten years from 2002 to 2012. When compared to other districts, paddy damage is very less in Jaffna district, as the farmers of the Jaffna district give their attention more on the vegetable and cash crop cultivation. Geographical condition of the Jaffna district also is not favorable for the paddy cultivation. Therefore during the SIMS and NEMS some farmers cultivate the paddy to a small extent. Drought during the SIMS and NEMS affect paddy cultivation to small extent, because some of the farmers in the Jaffna district use their wells to irrigate water to paddy fields. Due to this, drought does not affect paddy crops much. But flood, caused paddy land damages during the NEMS and SIMS. In this way, 314 hectare of paddy damage was recorded in 2008 NEMS, 2133hectare in 2009 NEMS and 861 hectares in 2008 SIMS due to flood hazards(Table 1.4).

In the Jaffna District, compare to other crops subsidiary crop damage recorded very less, because farmers of Jaffna district are not interested in the subsidiary crop cultivation due to lack of income from the subsidiary crop cultivation. (Figure 1.3) They have expressed it during the interviews. Jaffna farmers have much interest in cash crop and Vegetable crop cultivation. Jaffna farming style is much different from other districts, in the sense that Jaffna farmers always concentrate more on cash crop farming activities to get much profit (Rajathurai, 2005). Due to this during the flood and drought times these types of crops were damaged much. Cash crops of the Jaffna district are facing threats due to the flood hazards especially in the NEMS and SIMS. In the Jaffna district, during the last ten years, more than 4301 hectares of cash crop was damaged. Much damage of cash crop was in 2008 NEMS (1113 ha) and 2008 FIMS (914 ha) cash crop damage was recorded due to flood in the Jaffna district.

In the Jaffna district, vegetable crop damage was recorded due to heavy rain. From 2002 to 2012, more than 4580.5 hectares of vegetable crops were damaged, due to drought and flood hazards. According to reports about the vegetable crops of the Jaffna district, 2008 is the bad year, because during this year NEMS, SIMS and FIMS caused flood damage to vegetables. In 2008, more than 3031 hectares of vegetables got damaged by flood. Especially in 2008 “NISHA” cyclones flood during the NEMS caused a lot of damages to the vegetable crops . After this event, prices of vegetable in the Jaffna district shot up very high and there was shortage for the vegetables in the area.

Fisheries sector of the Jaffna district is also facing some kind of threats due to flood hazards. Similar to other districts of the Northern Region, dry fish industries faced problems due to drought and flood hazards. 79% of the fishermen of the North and East coast of the Jaffna district confirm that, they don’t have problem due to the flood or drought, but flood with cyclone or storm or extreme wind makes impact on their fishing. Lagoon fishing of the Jaffna district is affected during the flood and drought periods, but very small numbers of fishermen are involved in the lagoon fishing.

Commercial activities of the Jaffna district are also affected due to the flood hazard. During the flood rain water entered into the commercial centers and damaged things. According to the interviews, some of commercial

sectors like fruits and dry things caused impacts due to flood hazard damages.
In the Jaffna district, 11 million SLRs valued public property were damaged due to flood in the Jaffna district.

Table 1.4.Crop Damages due to Drought and Flood in Jaffna District from 2002 to 2012

Year	Season	Paddy Crops (Ha)	Subsidiary Crops (Ha.)	Cash Crops (Ha.)	Vegetable Crops (Ha.)
2008	FIMS(Flood)	1421	735	748	784
2009	FIMS(Flood)	1259	621	374	700
2011	FIMS(Flood)	806	98	279	690
2008	NEMS(Flood)	2133	469	1113	733
2009	NEMS(Flood)	861	861	561	61
2008	SIMS(Flood)	314	960	914	1514
2007	SIMS(Flood)	210	490	210	40
2011	SWMS(Drought)	0	5	11	8
2010	SWMS(Drought)	0	2	19	4
2004	SWMS(Drought)	0	0	19	17
2005	SWMS(Drought)	0	0	21	9
2009	SWMS(Drought)	0	0	32	20
Total		**7004**	**4241**	**4301**	**4580**

Source: Department of Agriculture, District Agrarian Service Center, Jaffna, 2002-2012

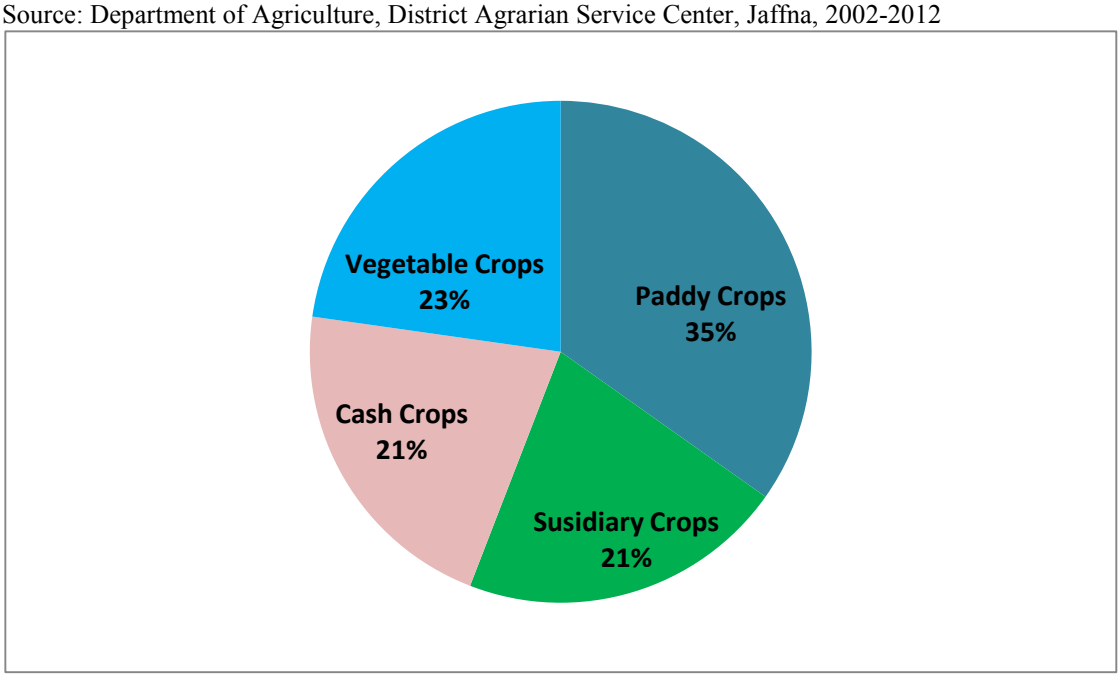

Figure: 1.3 Percentages of Crop Damages Due to Drought and Flood Hazards in the Jaffna District from 2002 to 2012.

4.5 Impacts of Drought and Flood Hazards in Vavuniya District

More than 1611 houses were fully damaged and 2651 houses were partially damaged due to flood in the Vavuniya district. Among these 59% of the houses were semi permanent structures, 26% of the houses were the semi permanent houses and others were temporary houses. Varius extent of crop damages has been recorded in Vavuniya district (Table 1.5 and Figure 1.4). In the Vavuniya district, more than 26123 hectares of paddy fields were damaged due to the drought and flood. Drought and flood have caused much impact on the paddy cultivation. During the NEMS, more than 14547 hectare of paddy was damaged due to the flood hazard. Drought also made impact on the paddy cultivation of the Vavuniya district. During the last ten years, 5304 hectares of paddy crop was damaged, due to the drought hazards in the Vavuniya district.

When compared to other districts large extent of subsidiary crops were damaged in the Vavuniya district, because farmers of the Vavuniya district are much interested in subsidiary crop cultivations. During the ten year period, 13526 hectares of subsidiary crop damage has been recorded in the study area. During the NEMS there was considerable extent of subsidiary crop damage which amounts to 6529 hectare. Vavuniya district is very famous for Ground nut, gingerly and the black gram cultivations. In the Vavuniya district, cash crop damages were recorded in 1627 hectares and vegetable crops in 3082 hectare. When compared with other districts, in Vavuniya district, the extent of cash crop cultivation is less.

In the Vavuniya district, there were some impacts on the inland fishing. Inland fishermen of the Vavuniya

district are facing difficulties due to drought in the SWMS. During the flood times, in the Vavuniya district commercial activities especially the street side shop owners were affected; because most of them have their shops in the temporary sheds on the land. In the Vavuniya district, more than 2.3 billion SLRs public property was damaged due to flood.

Table 1.5. Crop Damages of Agriculture in Vavuniya from 2002 to 2012

Year	Season	Paddy Crops (Ha.)	Subsidiary Crops(Ha)	Cash Crops (Ha.)	Vegetable Crops (Ha.)
2002	FIMS(Flood)	1921	716	271	151
2008	FIMS(Flood)	2426	1056	341	490
2010	FIMS(Flood)	286	490	146	219
2003	FIMS(Drought)	90	67	10	0
2008	NEMS(Flood)	5141	1120	64	219
2011	NEMS(Flood)	3221	1578	100	395
2012	NEMS(Flood)	6185	3831	98	404
2007	SIMS(Flood)	230	1410	169	480
2011	SIMS(Flood)	351	563	128	295
2005	SWMS(Drought)	1090	120	19	27
2011	SWMS(Drought)	1309	100	40	35
2012	SWMS(Drought)	1853	217	23	12
2003	SWMS(Drought)	676	69	39	23
2010	SWMS(Drought)	1278	1556	51	14
2010	SIMS(Flood)	21	563	128	318
2006	SIMS(Flood)	45	70	0	0
Total		**26123**	**13526**	**1627**	**3082**

Source: Department of Agriculture, District Agrarian Service Center, Vavuniya, 2002-2012

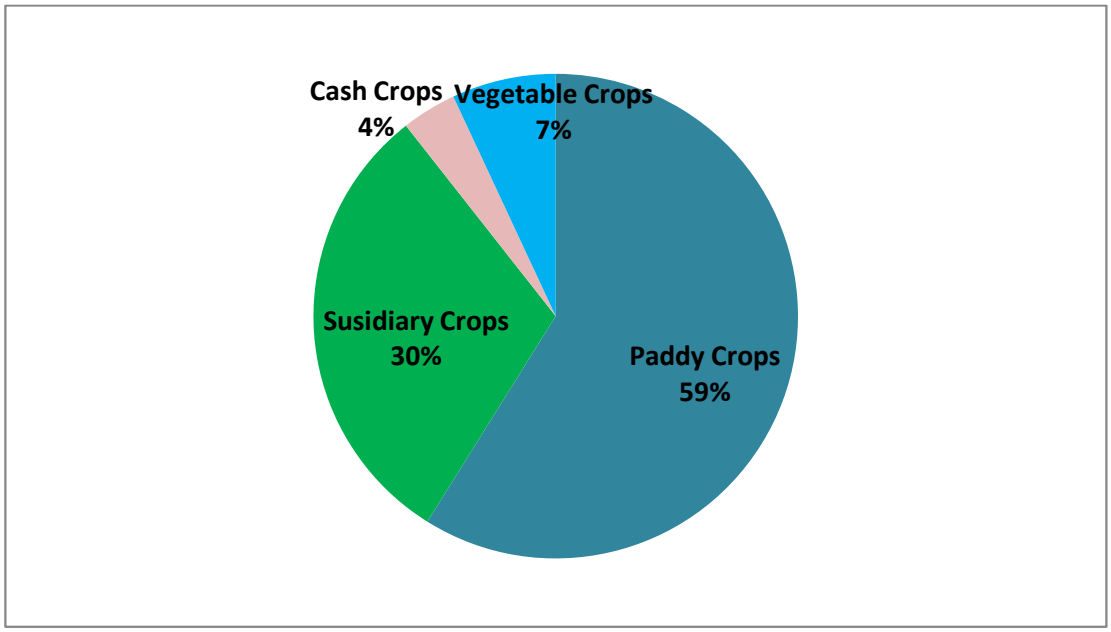

Figure: 1.4. Percentages of Crop Damages Due to Drought and Flood Hazards in the Vavuniya District from 2002 to 2012

4.6 Impacts of Drought and Flood Hazards in Mannar District

In the Mannar district during the ten years, 678 houses were fully damaged and 890 houses were partially damaged due to flood. When compared with other district, the Mannar district has less amount of agricultural damage due to the flood and drought hazards. During the last 10 years more than 16468 hectares of paddy damage was recorded due to these hazards. Also 2361 hectares of subsidiary crop damage, 1022 hectares of cash crop damage and 998 hectares of vegetable crop damages were recorded in the Mannar district during the last ten years due to drought and flood hazards (Table 1.6 and Figure 1.5). When compared with other districts agricultural activities in the Mannar district are less. Paddy cultivation during the Yala season is only under some of the tanks such as Kaddukkaraikulam, Thampanaikkulam and Pandivirichchankulam. Agriculture population of the Mannar district is 32% of the total population.

The fisheries population was affected to less extent during the flood. Inland fishing population faced problems

during the drought. Commercial activities have had less impact due to drought and flood in the Mannar district. In the Mannar district more than 19 billion SLRs worth of public property damage was recorded during the last ten years.

Table 1.6 Crop damages of flood and drought in Mannar District from 2002 to 2012

Year	Season	Paddy Crops(Ha)	Subsidiary Crops (Ha.)	Cash Crops(Ha)	Vegetable Crops (Ha.)
2003	FIMS(Flood)	328	94	110	200
2008	FIMS(Drought)	1085	310	300	369
2012	NEMS(Flood)	1678	1510	200	178
2006	SIMS(Flood)	820	230	320	220
2002	SWMS(Drought)	781	47	9	18
2006	SWMS(Drought)	662	21	12	9
2010	SWMS(Drought)	824	0	0	0
2004	SWMS(Drought)	290	19	11	4
2008	SIMS(Flood)	421	130	60	0
Total		**6889**	**2361**	**1022**	**998**

Source: Department of Agriculture, District Agrarian Service Center, Mannar, 2002-2012

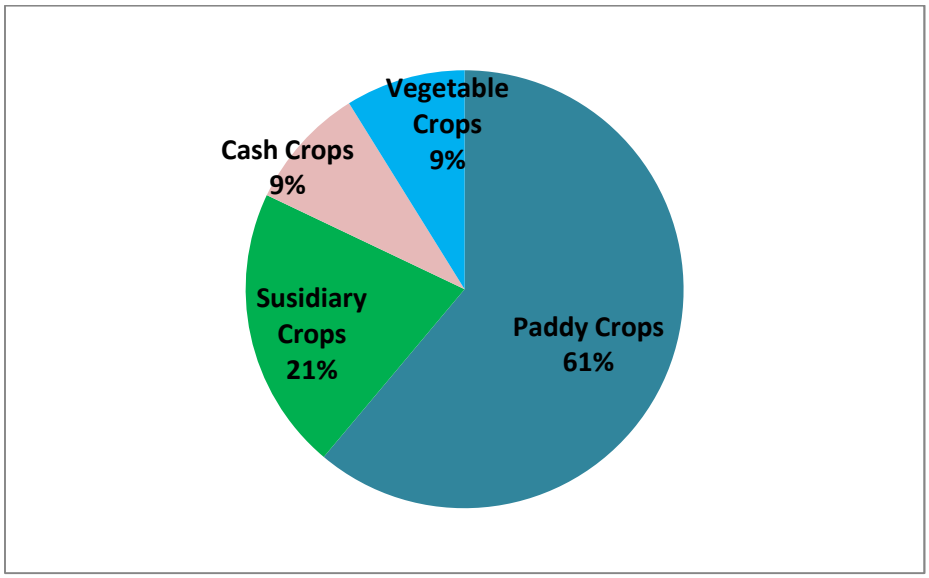

Figure: 1.5. Percentage of Crop Damages Due to Drought and Flood Hazards in the Mannar District from 2002 to 2012

Drought and flood hazards have made damage to the economic sector of the Northern Region of Sri Lanka, especially to the agriculture sector. During the ten years from 2002 to 2012, serious damage to the paddy crop was recorded in all five district of the Northern Region of Sri Lanka. Highest extent of paddy damage was recorded in Mullaitivu district which was 31960 hectares, next to it vavuniya district which was 26123 hectare, and less scale of paddy damage has been recorded in the Jaffna district which was 7004 hectares. Large extent of subsidiary crop damage has been recorded in the Vavuniya (13526ha) and less amount of subsidiary crop damage was recorded in Jaffna (424ha). Much of the cash crop damage was recorded in Mullaitivu district which amounts to 4619 hectare and less amount of cash crop damage was recorded in Mannar district which is 1022 hectares. In the study area much of the vegetable crop damage has been recorded in the Jaffna district, which was 4580.5 hectares and less amount of vegetable crop damage in Mannar district which was 998 hectares. Table 1.7 and figure 4.6 show the total crop damages of the every district of the Northern Region of Sri Lanka from 2002 to 2012 due to drought and flood hazards.

Table 1.7 Total crop damages, due to drought and flood hazards in the Northern Region of Sri Lanka, from 2002 to 2012

District	Total Agricultural Damages from 2002 to 2012 in Ha.
Mullaitivu	50095
Vavuniya	44358
Kilinochchi	30624
Mannar	20849
Jaffna	16309

Source: Provincial, District Agriculture, Agrarian and Divisional Secretariat Divisions

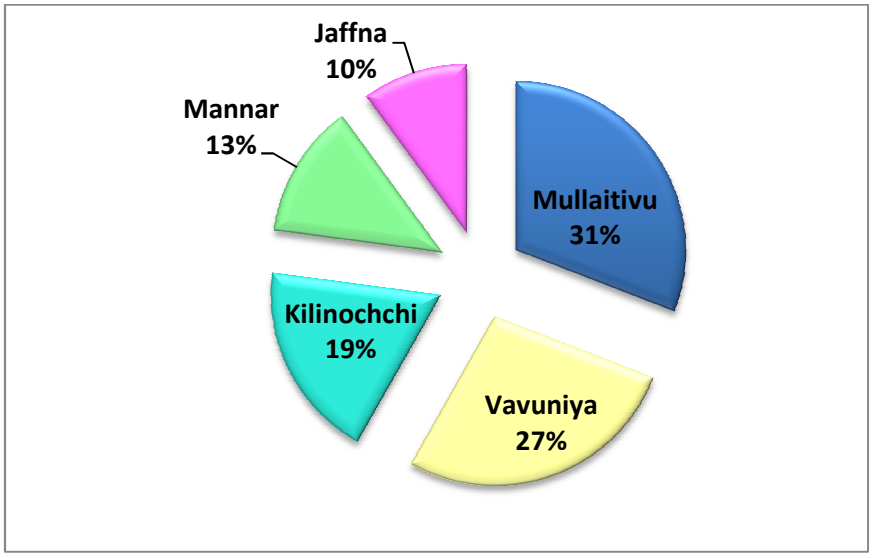

Figure: 1.6. Percentage of the Total Crop Damages of every District in the Northern Region due to Drought and Flood Hazards from 2002 to 2012

1.5. Conclusion and Recommendations

When compared to drought, flood has caused higher extent of economic losses. Some amount of economic losses have been recorded every year, which is more than Rs. 02 billion but it will increase during the flood and drought years and seasons in the Northern Region of Sri Lanka. For example, in 2012 more than 16 billion Rs of economic losses were recorded during the flood in December 2012. During the last ten year period from 2002 to 2012, more than 80 billion SLRs loss was recorded due to climatic hazards. Particularly the agricultural sector of the Northern region faced much threat due to the climatic hazards. In the Northern Region of Sri Lanka, more than 25,000mt paddy damage has been recorded due to extreme weather event. The damages of subsidiary crops, Cash crops, Vegetable crops and Fruits have also been recorded every year. Large extent of paddy damage has been recorded, during the NEMS and SIMS, because during this season (Maha season to the farmers) much extended paddy cultivation is carried out. This season belongs to Maha agricultural season and in this season most of the farmers are involved in the paddy cultivation activities. During the SWMS agriculture damage is very less, due to preventive measures such as the provision of irrigation facilities against drought impact. Due to this, drought during the SWMS does not make any impact on agriculture. When compared to other seasons, SIMS has had extensive damages to subsidiary crop due to a number of flood occurrences. Cash crops and the vegetable crops have been damaged during NEMS, SIMS and FIMS.

Maximum extent of paddy damage has been recorded due to drought and flood in, Mullaitivu,Kilinochchi and Vavuniya in the study area because in these districts paddy cultivation is high. Maximum extent of subsidiary crop damages also have been recorded in Vavuniya district during the NEMS, because most of the farmers are involved in the subsidiary crop cultivation activities. Maximum Cash crop damages in Mullaitivu and the maximum vegetable crops damages in Jaffna district are also recorded.

Most of the agricultural activities have occurred during the NEMS and SIMS (Maha season). Large numbers of the flood, severe flood and extreme flood occurrences have also been recorded during these seasons. So, agricultural damages by climatic hazards are also recorded during these seasons to a greater extent.

Other than this, many other sectors of the economy face threats due to the climatic hazards. Especially small scale commercial activities are affected several times by flood in the study area. A number of house damages partially or fully are recorded due to flood in the Northern Region of Sri Lanka.

Most of the economic damages have been recorded due to flood in the low lying areas such as Thirunavatkulam, Veppankulam, Periyarkulam, Soya road, Arasarpathi, Vannankulam, Omanthai, Thandikkulam, Nochchimoddai, Vavuniya town Puthur, Anantharpuliyankulam, Puliyankulam, Kurumankadu, Vairavarpuliyankulam in the Vavuniya district, Selvapuram, Paalinagar, Oddankulam, Katsilaimadu, Mannakandal, Muththaiyankaddu Right bank and Left bank Suthanthirapuram, Kanukkerny, Keppapilavu areas in the Mullaitivu district, Puthumurippu, Akkarayankulam, Maniyankulam, Konavil, Skanthapuram, Vaddakkachci, Thiruvaiyaru, Murasumoddai, Kandvalai, Anchadivvan, Anaivilunthan, Poonakari, Mudkompan, areas in the Kilinochci district, Nanaddan, Musali, Sinnathmpanai, in Mannar district and Palai, Mirusuvil, Ketpeli, Navatkuli, Sandilippai, Sankarththai, Vaddukkoddai, Bangs of the Valukkaiyaru, Thondaimanaru lagoon and ‘Upparu’ lagoon in the Jaffna district. During the 2012 flood, most of the agricultural damages were recorded in the low lying areas of the study areas.

According to economic damages agricultural sectors within the economy of the study area have much threat due to the drought and flood. From 2000 to 2012, Billions of SLRs economic losses have been recorded due to flood and drought hazards. Floods have made damages in all sectors of the economy of the Northern region in different scale, but droughts have made impact only on the agricultural sector.

1. Northern Region of Sri Lanka consists of oceans as their sides. In the developed countries a number of weather observation stations are located on the surface of the oceans. So at least 03 Ocean Weather Observation Center (OWOC) should be established in the Northern, Eastern and Western ocean surface of the Northern Region.
2. A separate Regional Meteorological Department should be established in the central part of the Northern Region of Sri Lanka. According to Balasundarampillai (1980) Mankulam is the central part of the Northern Region. Hence Regional Meteorological Department (RMD) should be established in Mankulam.
3. Economic data is also, equally important for such kind of research activities. Most of the Departments in the Northern Region of Sri Lanka are not seriously concerned with collecting and keeping the data related to natural hazards. 85% of the department's report that they do not have a separate file to have the data related to flood or drought damage. It is the main barrier to the researchers to carry out the researches in the Northern Region of Sri Lanka.
4. Farmers should be instructed with regard to the choice of needs to plant and cultivation system to be adopted in anticipation of flood and drought in the Northern Region of Sri Lanka. Farmers must possess knowledge about climatic features of every season and have to cultivate various types of crops and adopt various methods of farming to cope with the climatic challenges. They have to follow a system to remove the stagnant rain water during the flood and have to adopt the sprinkler, sprayer and drop irrigation systems to irrigate to their lands in the Seasons of FIMS and SWMS to save their crops from the drought impacts.
5. Government has to instruct to the people of the Northern Region of Sri Lanka, to be aware during the NEMS (December, January and February) and SIMS (October and November) to avoid the severe impacts due to flood occurrences. Because high number of flood have been occurred during above seasons in the study area
6. Building new tanks and ponds will reduce the flood damage and the drought impact in the study area. When compared to other areas, Manthai west area has very few tanks and ponds. Due to this, during every SWMS, these areas face the drought impact. The Pali Aaru River mingled with the ocean in the Manthai west and next to Vavunikkulam, there are no tanks or ponds to reserve the river water of the Pali Aru. Every year more than 2000 cubic meter of water flowed into the ocean without being used in the Northern Region of Sri Lanka (Report of NEIAP-2004). If a new tank is built in Vellankulam area, the wastage of the Pali Aru river water can be stopped and drought impact reduced in the Manthai West areas. We also need tanks to reserve the Malvaththu Oya and Aruvi Aru water in the Mannar district to reduce the drought impact in the Northern Region of Sri Lanka.
7. There are some natural and artificial drainage systems in the Northern Region of Sri Lanka. Due to thirty years of internal war most of them are silted. The unplanned construction of Walls, Roads, Deforestation and Gardening are the major cause for the damage of the natural and artificial drainage pattern in the study area. Due to the disturbance of the drainage pattern, rain water storage in the city areas, settlement areas and the farm field create flood valunarablity. New drainage and renovation of the old drainage systems should help to avoid the flood damages in the above places of the study area.
8. Disaster Management Center has to implement special projects to avoid flood and drought valunarablity in the study area. There is a need to conduct awareness programs for the people, fund the renovation of the drainage systems, to establish speedy and effective early warning systems against hazards and provide training programs to rural level disaster management committees. Fund for new researches related to disaster management will help to reduce the flood and drought impacts in the study area. Some of the above programs are conducted by the District DMC of every district of the Northern Region of Sri Lanka, but they are not regularized.
9. Identification of the drought and flood prone areas should help to assist authorities during emergency. Geographical Information Systems and Remote Sensing (GIS & RS) techniques will help to adopt measures successfully in this regard.
10. There should be an Emergency coordination between the departments which provide services to the public in the Northern Region of Sri Lanka. During flood and drought in the past there was no coordination among the departments to reduce the disaster vulnerability in the Northern Region of Sri Lanka. As per the past records officers of the district secretariat divisional secretariats and DMC commenced anti disaster operations only after the risk erupted. Other departments showed no keenness during the recovery times. Hence, there should be in such relief operations coordination among the departments which are functioning in the ground. It should be the responsibility of the government or NGO to organize such coordination.

Drought and flood hazards occur in the Northern Region of Sri Lanka and cause many types of damages. Northern Region of Sri Lanka has suffered several times due to war and natural hazards several times. It's high

time the Northern Region got developed. In this context, this study should help to predict the drought and flood hazards and create awareness of the risk to be caused by flood and drought, to plan the future activities related to such hazards and mitigate them in the Northern Region of Sri Lanka. All the departments, Non Government Organizations (NGOs), Community Based Organizations (CBOs) and people in the Northern Region of Sri Lanka should contribute collectively to implement drought and flood mitigation activities. A sense of cooperation, unity dedication and national spirit are essential virtues required in this noble commitment to fight against disasters.

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