

Leaflet No. 20/2019

**The Republic of the Union of Myanmar
Ministry of Natural Resources and Environmental Conservation
Forest Department**



**The Socio-economic impacts of Climate Change:
Case Study on the Dry Zone of Myanmar**



Wutyi Mon, Staff Officer
Environmental Conservation Department

December, 2019

Contents

	စာတမ်းအကျဉ်း	i
	Abstract	ii
1.	Introduction	
2.	Objectives	
3.	Materials and Methods	
4.	Results	
	4.1. Current Climatic Conditions in Dry Zone	
	4.1.1 Droughts	
	4.1.2 Dry spells	
	4.1.3 Flooding	
	4.2. Climate Change Projections	
	4.2.1 Temperature rise	
	4.2.2. Precipitation	
	4.2.3. Future risks	
	4.3. Uncertainty in Projection of Climate Change	
	4.4 Socio-Economic Impacts of Climate Change in Dry Zone	
	4.4.1 Low crop production	
	4.4.2 Food and water scarcity	
	4.4.3 Health related issues	
	4.4.4 Poverty and out-migration	
5.	Discussion and Recommendations	
	5.1 Low Crop Production	
	5.2 Food and Water Scarcity	
	5.2.1 Food	
	5.2.2 Water	
	5.3 Health Related Issues	
	5.4. Poverty and Out-migration	
6.	Conclusion	
	References	

ရာသီဥတုပြောင်းလဲမှုကြောင့်အပူပိုင်းဒေသရှိ ဒေသခံများအပေါ်သက်ရောက်သည့်
လူမှုစီးပွားရေးအခြေအနေများကို လေ့လာခြင်း

ဝတ်ရည်မွန် (ဦးစီးအရာရှိ၊ ပတ်ဝန်းကျင်ထိန်းသိမ်းရေးဦးစီးဌာန)

စာတမ်းအကျဉ်း

နိုင်ငံဖွံ့ဖြိုးတိုးတက်ရေးအတွက် စိုက်ပျိုးရေးကဏ္ဍအပေါ် များစွာမှီခိုအားထားရသည့် မြန်မာနိုင်ငံအနေဖြင့် ရာသီဥတုပြောင်းလဲမှု၏ အကျိုးသက်ရောက်မှုများကြောင့် စိုက်ပျိုးရေး ကဏ္ဍ၏ဝင်ငွေရရှိမှုသည် ပိုမိုမလုံခြုံမှုဖြစ်ပေါ်လာပါသည်။ အထူးသဖြင့် လွန်ခဲ့သော ဆယ်စု နှစ် နှစ်ခု၊ သုံးခုအတွင်းကစပြီး အပူပိုင်းဒေသ၏ ရာသီဥတုအခြေအနေများ ပြောင်းလဲမှု ဖြစ် ပေါ်ခဲ့ပြီး သုတေသနတွေ့ရှိချက်များအရ အဆိုပါဖြစ်ရပ်များသည် ဒေသတွင်းရှိ စိုက်ပျိုးရေး ကဏ္ဍအပေါ်စိန်ခေါ်မှုများကြုံတွေ့ရပြီး သီးနှံထုတ်လုပ်မှုအပေါ် သက်ရောက်ခြင်းနှင့် ဝင်ငွေ လျော့နည်းမှုကို ပြသခဲ့သည်။ ထို့အပြင် ရာသီဥတုပြောင်းလဲခြင်းနှင့် ပြင်းထန်သော သဘာဝ ဘေးအန္တရာယ်ဖြစ်ရပ်များသည် ကျေးလက်ဒေသမှ မြို့ကြီးများသို့ ဒေသခံများ ပြောင်းရွှေ့ ခြင်း၏ အကြောင်းအရင်းသစ်ဖြစ်လာသည်။ အပူပိုင်းဒေသအပေါ် လေ့လာသည့် အစီရင်ခံ စာများနှင့် လေ့လာချက်များအရ ဒေသခံများအတွက် ရေရရှိနိုင်မှုသည် မိုးခေါင်ခြင်းကြောင့် အခက်အခဲတွေ့ရပြီး အိမ်ထောင်စုများ၏ လေးပုံတစ်ပုံသည် အခြေခံရေ လိုအပ်ချက်များကို မရရှိကြပါ။ စားနပ်ရိက္ခာရရှိရန် ခက်ခဲမှုနှင့် အာဟာရချို့တဲ့မှုတို့သည်လည်း အပူပိုင်းဒေသ အတွက် ဖိအားများဖြစ်သည်။ သုတေသနတွေ့ရှိချက်များအရ အပူပိုင်းဒေသတွင် ရာသီဥတု ပြောင်းလဲခြင်း၏အကျိုးသက်ရောက်မှုကြောင့် စိုက်ပျိုးရေးနှင့် ဒေသတွင်းမွေးမြူရေး ကဲ့သို့ သော အဓိကစီးပွားရေးကဏ္ဍများတွင် သိသိသာသာ ထိခိုက်မှုရှိကြောင်း တွေ့ရသည်။ ရာသီ ဥတုပြောင်းလဲမှုဆိုင်ရာ ခန့်မှန်းချက်များအရလည်း မုတ်သုံရရှိမှုပြောင်းလဲခြင်း၊ အပူချိန် မြင့် တက်ခြင်းတို့ ပိုမိုဖြစ်ပေါ်လာနိုင်ပြီး သက်ရောက်မှုများ ဆက်လက်ကြုံတွေ့မည်ဖြစ်သည်။ အဆိုပါအချက်များသည် လူမှုစီးပွားရေးပြဿနာများ၏ အဓိကရင်းမြစ်များဖြစ်ပြီး ဒေသတွင်း ဖွံ့ဖြိုးတိုးတက်မှုအဆင့်ကို နိမ့်ကျစေပါသည်။ သို့ဖြစ်၍ ဒေသတွင်းရာသီဥတုပြောင်းလဲမှု ဒဏ်ခံနိုင်ရည်ရှိမှုအတွက် အဆိုပါပြဿနာများကို ရင်ဆိုင်ဖြေရှင်းနိုင်မည့် ၎င်းတို့နှင့် လိုက် လျောညီထွေမှုရှိသည့် အစီအမံများကို အရေးတကြီးထည့်သွင်းစဉ်းစားသွားရန် လိုအပ်ကြောင်း တွေ့ရှိရပါသည်။

The Socio-economic impacts of Climate Change: Case Study on the Dry Zone of Myanmar

Wutyi Mon, Staff Officer
Environmental Conservation Department

Abstract

Myanmar which relies heavily on the agricultural sector for the nation's growth is more insecure to the impacts of climate change. Especially, the climatic conditions of dry zone area have changed over the past 2 or 3 decades and these climatic events have the potential to risk crop production seriously and the findings from the research highlighted the challenges posed to agriculture sector in the region and showed the low-income pressures of agriculture sector due to climate risks. Furthermore, changing in climate and extreme disaster events are the new cause of migration from the rural to big cities. The reports and studies in the dry zone show that accessing water is also the risk for the communities due to the drought events and a quarter of the household does not receive basic water needs. Food uncertainty and undernourishment are also pressure for the Dry Zone Communities. Through research studies, it can be determined that the effects of climate change in Dry Zone are already notable in different sectors like agriculture, livestock which are the main economic sectors of the region. These impacts can also be expected to rise as climate patterns projected that temperature increased which will threat crop productivity and impact human health by extreme heat wave and hot days and monsoon patterns changing that will negatively result agricultural sectors of the region. Those are the main sources of socio-economic issues of the region which can lead to the under development status of the region so that the adaptation programs in order to tackle these issues urgently need to be consider for the climate change resilience of the region.

Keywords: Dry zone, Myanmar, Climate change, Socio-economic

The Socio-economic impacts of Climate Change: Case Study on the Dry Zone of Myanmar

1. Introduction

During past years, climate change has become the major environmental threat to all human beings in the globe. According to the Intergovernmental Panel on Climate Change -IPCC report of 2007, the significant changes in rainfall patterns and temperature, the intensity and frequency of floods and droughts and sea level rise have been detected. The impacts of climate change not only risk to the environment but also to the sustainable development of the nations. Further, it affects the people by putting the risks to the sustenance of life; food, health and drink. For the developing countries like Myanmar, Climate Change is the additional affliction for country's growth and development as the other problems are already putting pressures on the nation's growth. The impacts of climate change in Myanmar are already significant across the country; high temperature, flooding, drought, rainfall patterns changing, storms and also due to the low technology, poor infrastructure and high poverty especially in the rural area, putting the country to become one of the most vulnerable countries in the world to the Climate Change.

Among the regions in Myanmar, the Dry Zone is subjected to extreme of climate including high temperatures, droughts and floods. The major population of the dry zone heavily relies on the agriculture sector as livelihood for the region and the significant climatic events have the potential impacts on the crop production seriously which showed the low-income pressures of agricultural based economy of the region. The available source of water for the agriculture purpose, scarce rainfall and drought caused the low production of crops in the region and also lead to the shortage of food for the community. These unusual changes in climate affect the community in the dry zone and their ability to cope with these extreme events are limited so that these impacts lead to further socio-economic problems in the region.

In consequence, the socio-economic impacts of climatic changes in the area of Myanmar's dry zone are needed to be dispatched for the development of the region. In this paper, the socio-economic impacts of climate change in the dry zone of Myanmar will be analyzed for integrating the ways to address climate change impacts into the policies and socio-economic development programs of the country.

2. Objectives

The main purpose of the paper is to examine the socio-economic related issues in the region of dry zone of Myanmar due to extreme climate change events in order to suggest relevant policy recommendations for these issues and also will consider the key findings of this paper into the development process and program of the region. The paper mainly focuses on the following issues;

- i. Low crop production
- ii. Food and Water scarcity
- iii. Health related issues
- iv. Poverty and out-migration exacerbated by climate change

This paper shows how climate change and extreme climatic events disrupted the socio-economic development of dry zone through the changes in temperature, rainfall, drought and flood. These enormous effects impacted the socio-economic conditions of the region in the main economic

sectors such as agriculture and livestock which mainly rely on climatic events. The key findings from the paper can provide some information for the decision makers and key stakeholders in order to consider and tackle these socio-economic impacts in the decision making process, policy planning and implementation of the development program.

3. Materials and Methods

This paper used the existing documents and reports from the government, INGO/ NGOs and development partners who are working under the climate change sector of dry zone, Myanmar. The paper also relies on secondary data and statistics from the reliable sources.

4. Results

4.1. Current Climatic Conditions in Dry Zone

At present, Myanmar has a tropical-monsoon climate with mainly 3 seasons of Summer season (March-May), Raining season (June-October) and Winter Season (November-February). Myanmar composed with eight major geographical regions and I will mainly focus the climatic conditions in Dry Zone in this study. There are differences in climate that depend on the regional condition and the Dry Zone is a large inland part of the nation which is vulnerable to extreme heat waves and droughts (WWF, 2017). Yearly average precipitation of the dry region reaches from 500 to 1000 mm. The range is low when contrast with the country range (2000-5000 mm) as shown in the Figure 7.

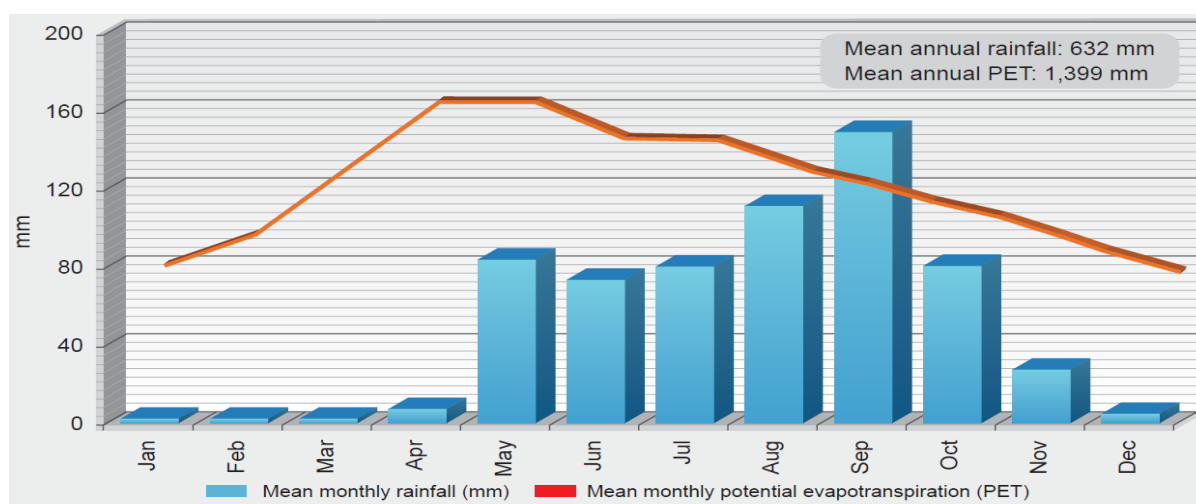


Figure 1. Mean monthly rainfall and potential evapotranspiration (Dry Zone)

(Source: FAO LocClim; Local Climate Estimator)

In Dry Zone, the temperature normally reaches 40 °C in the hot season. The Dry Zone is defined by irregular precipitation and the forms vary broadly between areas and every once in a while. Over the last 20 years, there was an observation that the period of the raining season has declined when precipitation has turned into less but more extreme (IWMI, 2013). According to IWMI's analysis report, there were the high spacial and ephemeral irregular precipitation patterns in the Dry Zone. Summer season is quite moist in the dry zone and that problem found because the raining season in dry zone is less and the lighter precipitation happens during the beginning and the end of the

season. It is too uncertainty for the agrarians to use this precipitation for cultivation of yields because it contains light precipitation patterns scattered with longer dryness season. The wet season starting time is much more varied than the end date and it is the challenge for the agriculture sector that rely on precipitation for water. The period with no rain during the season is especially prolonged in the region. The combination between the very high unevenness in the starting time of the raining season and its quiet fewer periods has raised the chances of drought at the beginning of the rain fed yield circle. The conditions of relatively low and uneven rainfall patterns are one of the major constraints for crop production and affect to the agricultural sector income and other socio-economic sectors indirectly. Most affected climatic events of the Dry Zone are as follow;

4.1.1 Droughts

In Dry zone, 21% of the towns were impacted by drought annually (Saw, 1990). Moreover, the chance of drought happening in any region is once every 5 years (Kyi, 2012). Based on the features of droughts applying the set of precipitation, the worst drought of the regions was between 1979 and 1980, the next worst one happened between 1982 and 1983 and the third one struck the entire area of dry zone between 1993 and 1994 (Kahil et al., 2015). Apart from the period among the second and the third worst droughts of decades, the repetition of droughts in the dry zone region likely to be occurrence at the less periods around three years (Hein, 2012). The most serious drought happened in 2010 and also extreme temperature increased up to 47.2 °C in the same year of 2010 (Boori et al, 2017). In year 2010, the heat was higher than the past years and also the raining season came late, it caused water shortage in many parts of the region and plenty of yield production declined as a result of the drought year (Kyi, 2012). Droughts commonly happen in the early monsoon period and it can lead to the shortage of soil moisture that has negative affect in crop production, which leads to the food insecurity both for human and livestock (DMH, 2015).

4.1.2 Dry spells

In Dry zone, the most common climatic event noticed by agrarians was the dry spell which generally happens during July (early monsoon period). They normally happened during the monsoon period however if they last for elongated periods, this can raise the problems for agriculture sector (IWMI, 2013). During dry spells period, in conditions where public water sources are restrained to raindrop storage or ponds, even getting water for household can be impacted. Water for household and livestock became seriously limited and also many animals died due to water shortage. Cultivation process for agriculture crops had to delay and some farms are losses as water lacking after sowing.

4.1.3 Flooding

Even the Dry zone has long suffered from drought, unusual climatic events (like flooding) have happened yearly. Floods usually impacted to the farmers' monsoon crops. If flooding is adequately severe, not only paddy but also dry land crops can be destroyed. Due to this consequence, food shortage in the region occurred and low-income problems for the family also rose. It mostly affected to the farmers with limited access of land and they even had to migrate to another region for their household income and the socio-economic impact found indirectly. In 2011, the landslides and floods events occurred in some parts of the regions due to the tropical storm. Frequently, the cyclones in the Dry zone resulted heavy rains which can cause flash floods. The tropical storm of 2011 affected mostly to agricultural sector, other sectors and even killed many people. Among the seven townships, more than 26,000 people became homeless and approximately USD 271,000 lost (Boori et al., (2017).)

4.2. Climate Change Projections

In Myanmar, the precipitation, temperature, sea level and extreme weather events are assumed to vary dramatically for the next years that can result the impacts on Myanmar's environment and ecosystem, which contributes to the livelihoods of community, agriculture, business, food and water , infrastructure and health and others socio-economic sectors. Previous data on Myanmar's climate over the last 60 years showed that temperatures have increased, on mean, by 0.8°C per 10 years period. Based on regional climate modeling, the country is most likely to face with warmer climate in coming future with long hot period, more drought and extreme weather events (Han Swe, 2014).

4.2.1 Temperature rise

The temperature in the Dry zone is projected to increase over the coming years according to the annual range data. The annual average temperatures are expected to increase by 0.7-1.1°C during (2011-2040) and by 1.2-2.7°C during (2041-70) as per NASA Earth Exchange Global Daily Downscaled Projections (NASA NEX-GDDP) dataset (Table 1 and 2). Projected change in mean temperature from 2011-2070 compared with the 1980-2005 average for the nation of Myanmar as a whole and in eight major regions.

Table 1: Projected change in mean temperature (+°C) in 2011-2040 compared to the 1980-2005 (based year)

(Source: NASA NEX-GDDP-2015)

Region	Annual		Hot Season (MARCH TO MAY)		Wet Season (JUNE TO OCTOBER)		Cool Season (NOVEMBER TO FEBRUARY)	
	Low Estimate	High Estimate	Low Estimate	High Estimate	Low Estimate	High Estimate	Low Estimate	High Estimate
Myanmar (All Regions)	+0.7°C	+1.1°C	+0.8°C	+1.2°C	+0.6°C	+1.1°C	+0.7°C	+1.2°C
Ayeyarwady Delta	+0.5°C	+0.9°C	+0.6°C	+0.9°C	+0.5°C	+0.8°C	+0.5°C	+1.0°C
Central Dry Zone	+0.7°C	+1.1°C	+0.9°C	+1.2°C	+0.6°C	+1.0°C	+0.7°C	+1.2°C
Northern Hilly	+0.7°C	+1.2°C	+0.8°C	+1.3°C	+0.6°C	+1.2°C	+0.7°C	+1.2°C
Rakhine Coastal	+0.7°C	+0.9°C	+0.7°C	+1.0°C	+0.6°C	+0.9°C	+0.7°C	+1.1°C
Eastern Hilly	+0.7°C	+1.2°C	+0.9°C	+1.4°C	+0.6°C	+1.2°C	+0.7°C	+1.3°C
Southern Coastal	+0.6°C	+1.0°C	+0.6°C	+1.1°C	+0.6°C	+0.9°C	+0.6°C	+1.0°C
Yangon Deltaic	+0.6°C	+1.0°C	+0.7°C	+1.1°C	+0.6°C	+1.0°C	+0.6°C	+1.1°C
Southern Interior	+0.7°C	+1.1°C	+0.8°C	+1.2°C	+0.6°C	+1.1°C	+0.7°C	+1.1°C

Table 2. Projected change in mean temperature (+°C) in 2041-2070 compared to the 1980-2005(based year)

(Source: NASA NEX-GDDP-2015)

Region	Annual		Hot Season (MARCH TO MAY)		Wet Season (JUNE TO OCTOBER)		Cool Season (NOVEMBER TO FEBRUARY)	
	Low Estimate	High Estimate	Low Estimate	High Estimate	Low Estimate	High Estimate	Low Estimate	High Estimate
Myanmar (All Regions)	+1.3°C	+2.7°C	+1.4°C	+2.9°C	+1.1°C	+2.4°C	+1.3°C	+2.8°C
Ayeyarwaddy Delta	+1.1°C	+2.1°C	+1.2°C	+2.4°C	+1.0°C	+2.0°C	+1.1°C	+2.4°C
Central Dry Zone	+1.2°C	+2.7°C	+1.5°C	+2.9°C	+1.1°C	+2.3°C	+1.3°C	+2.9°C
Northern Hilly	+1.4°C	+2.8°C	+1.5°C	+2.9°C	+1.2°C	+2.7°C	+1.4°C	+2.9°C
Rakhine Coastal	+1.2°C	+2.4°C	+1.3°C	+2.7°C	+1.1°C	+2.1°C	+1.2°C	+2.6°C
Eastern Hilly	+1.4°C	+2.8°C	+1.6°C	+3.1°C	+1.2°C	+2.5°C	+1.5°C	+2.8°C
Southern Coastal	+1.1°C	+2.4°C	+1.2°C	+2.6°C	+1.0°C	+2.2°C	+1.1°C	+2.5°C
Yangon Deltaic	+1.2°C	+2.4°C	+1.2°C	+2.7°C	+1.1°C	+2.2°C	+1.2°C	+2.7°C
Southern Interior	+1.3°C	+2.6°C	+1.4°C	+2.9°C	+1.1°C	+2.3°C	+1.3°C	+2.7°C

This kind of projection can support the policy makers to integrate these risks into long-term plans which can give additional information for better resilience community.

4.2.2. Precipitation

The following Table 3 and 4 show the annual change in mean precipitation (%) of the Dry zone and it is projected from 2-11 % during (2011-2040) and from 9-26 % during (2041-2070) based on the dataset from NASA Earth Exchange Global Daily Downscaled Projections (NASA NEX-GDDP). However this differs by season and shows more likely to decline than increase in the cold season.

Table 3. Projected change in mean precipitation (%) in 2011-2040 compared to the 1980-2005(based year)

(Source: NASA NEX-GDDP-2015)

Town/city	Annual		Hot Season (MARCH TO MAY)		Wet Season (JUNE TO OCTOBER)		Cool Season (NOVEMBER TO FEBRUARY)	
	Low Estimate	High Estimate	Low Estimate	High Estimate	Low Estimate	High Estimate	Low Estimate	High Estimate
Myanmar (All Regions)	+1%	+11%	-11%	+12%	+2%	+12%	-23%	+11%
Ayeyarwaddy Delta	-1%	+11%	-13%	+18%	0%	+10%	-27%	+13%
Central Dry Zone	+2%	+11%	-14%	+13%	+3%	+12%	-32%	+9%
Northern Hilly	+2%	+13%	-10%	+14%	+3%	+16%	-19%	+8%
Rakhine Coastal	0%	+9%	-17%	+14%	+2%	+10%	-30%	+8%
Eastern Hilly	0%	+10%	-11%	+11%	+2%	+12%	-25%	+9%
Southern Coastal	-1%	+8%	-10%	+8%	-2%	+9%	-11%	+18%
Yangon Deltaic	0%	+12%	-12%	+19%	+1%	+11%	-29%	+14%
Southern Interior	+1%	+11%	-11%	+11%	+1%	+13%	-28%	+14%

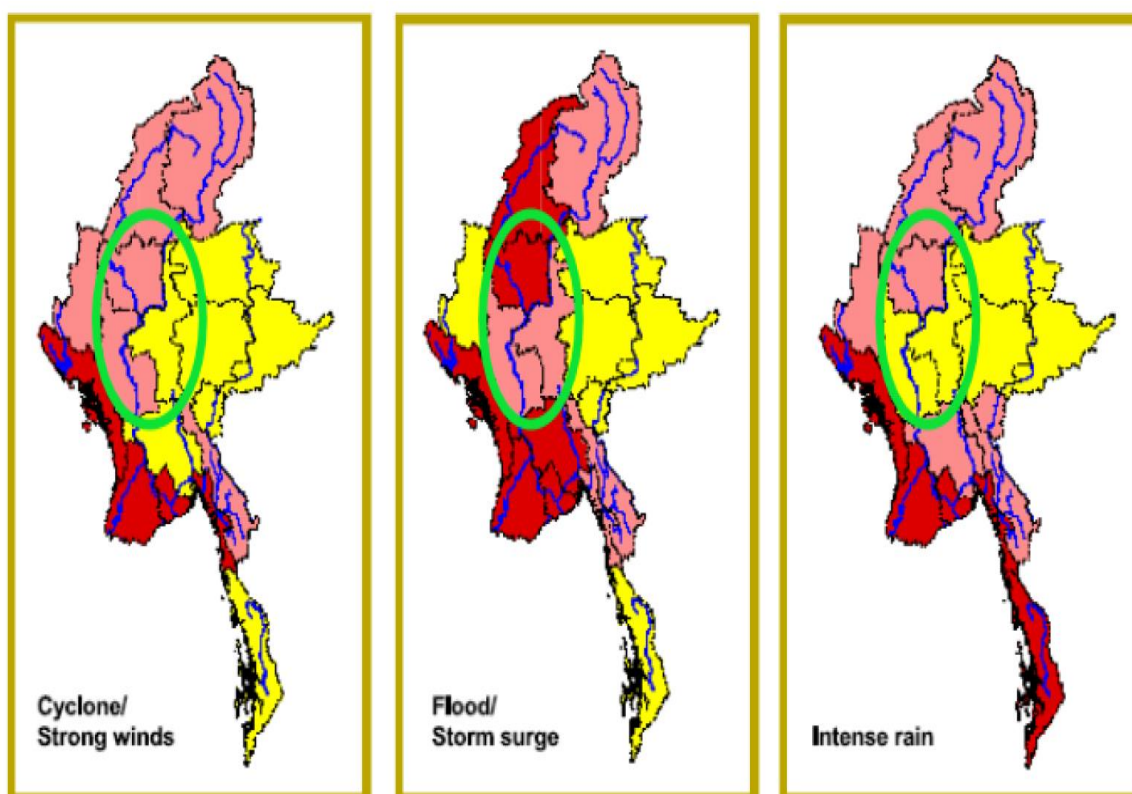
Table 4. Projected change in mean precipitation (%) in 2041-2070 compared to the 1980-2005(based year)

(Source: NASA NEX-GDDP-2015)

Town/city	Annual		Hot Season (MARCH TO MAY)		Wet Season (JUNE TO OCTOBER)		Cool Season (NOVEMBER TO FEBRUARY)	
	Low Estimate ¹	High Estimate ²	Low Estimate	High Estimate	Low Estimate	High Estimate	Low Estimate	High Estimate
Myanmar (All Regions)	+6%	+23%	-7%	+19%	+6%	+27%	-12%	+11%
Ayeyarwady Delta	+3%	+23%	-7%	+19%	+3%	+25%	-9%	+15%
Central Dry Zone	+8%	+22%	-12%	+14%	+9%	+26%	-19%	+6%
Northern Hilly	+7%	+27%	-4%	+33%	+7%	+30%	-14%	+10%
Rakhine Coastal	+5%	+20%	-17%	+12%	+6%	+23%	-20%	+2%
Eastern Hilly	+7%	+24%	-8%	+14%	+7%	+30%	-15%	+7%
Southern Coastal	+3%	+16%	-2%	+13%	+1%	+18%	-1%	+29%
Yangon Deltaic	+5%	+24%	-4%	+17%	+5%	+26%	-5%	+15%
Southern Interior	+7%	+25%	-5%	+11%	+7%	+29%	-6%	+15%

4.2.3. Future risks

According to the Department of Meteorology and Hydrology (DMH), it is also estimated that the threats faced in the Dry zone regarding extreme high temperature and droughts will potentially higher than other weather events. These projections predicted that the agriculture sector, the main livelihood sector of the Dry Zone will be the most vulnerable sectors of the region and it can also lead to other socio-economic issues directly or indirectly. The risk levels for various climate change related events in Myanmar, in reference to the projection of time-series data from DMH are presented as follow in Figure 8 and the Dry zone is circled in green color;



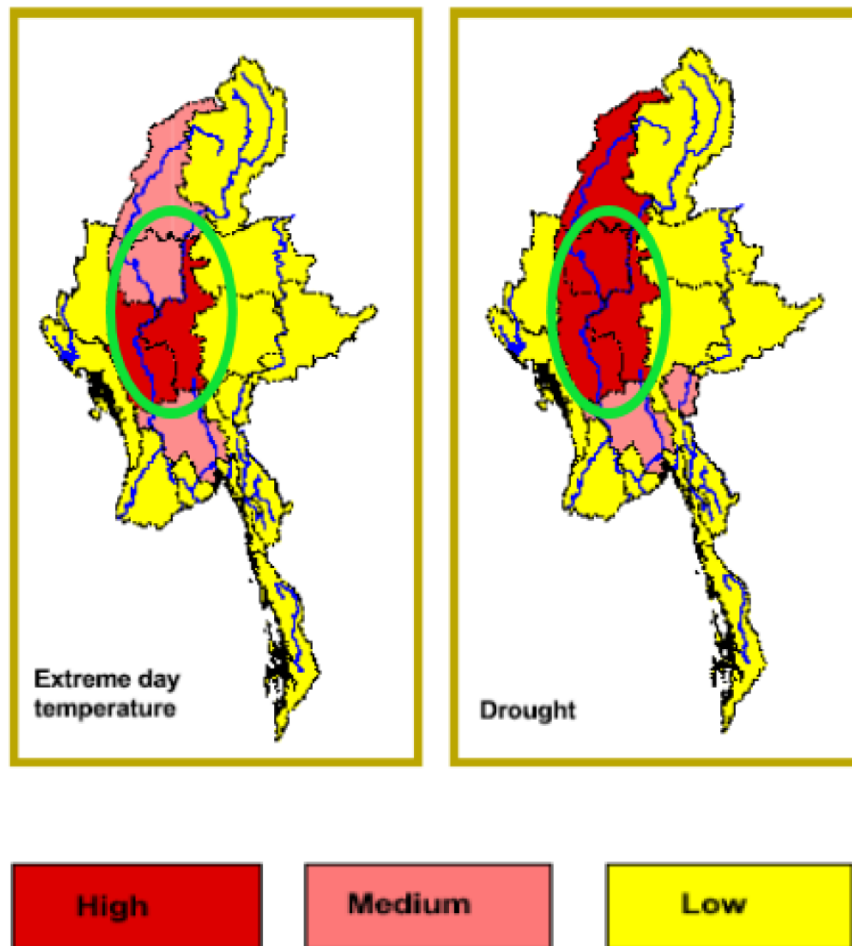


Figure 2. Risk levels for various climate change related events in Myanmar

(Source: Department of Meteorology and Hydrology-DMH)

Based on the research and technical reports, the followings are the future climate change projections for the Dry Zone,

- The temperature is projected to increase in coming decades
- More warming in hot and cold season
- Extreme heat days is expected to increase (frequently of 4-17 days per month)
- Expansion in floods and droughts due to variable rainfall conditions
- Increase the occurrence of severe climatic conditions such as foods, droughts, and heat waves

4.3. Uncertainty in Projection of Climate Change

Due to previous research and papers findings, we found significant climate changes, extreme weather events in the Dry Zone of Myanmar. Therefore, the national and regional policy makers need

to be conscious of the changes that will directly or indirectly impacted to the Dry zone community. By understanding regional risks to the climate change or predicting based on the future conditions, activities to tackle and address these issues can be taken immediately in order to prevent the risky impacts of climate change. However, there is a certain amount of uncertainty in association with forecasting future climate conditions because they have yet to occur (Horton et al, 2015) .

The cause of uncertainty for the future climate change is that natural unevenness of the climate pattern is largely unpredictable (Horton et al, 2017). This contains irregularity in ocean movements, storm events, solar system and the patterns changes in atmospheric that change in unpredictable manner over time. The second reason of uncertainty is human manners and contributions. The efficiency of International Climate Change Protocols and Agreements to reduce GHG emissions, the innovation and development of new technologies and systems will control the trajectory of GHG emissions through the years and determine the range and rate of climate change. The final reason of uncertainty relies on the global climate models that predict future climate patterns. Each of them simulates the climate system, how that system will act to large amount of GHG emissions and feedback loops from the interrelated systems that control weather and climate. These climate models integrate these various situations in slightly diverse ways, resulting in various outcomes for sea level rise, temperatures precipitation and other variables.

However, the concern of uncertainty should not be a reason for lack of action or for not using these projections in the decision making process.

4.4 Socio-Economic Impacts of Climate Change in Dry Zone

4.4.1 Low crop production

In Myanmar, the agriculture sector is highly exposed to climate change. As per (Oo, 2018), the crop production in the Dry zone is highly affected by the climate change especially during the growing season. According to the Department of Agricultural Planning, there was low crop production in the some areas of Dry zone due to the low rainfall during the growing season as in Figure 9.

Item	Unit	Nyaung U (n=70)	Meiktila (n=70)
Farmers having crop loss due to low rainfall	%	81.43	94.29
Number of years facing crop loss during last 10 years	years	4	3

Figure 3. Crop loss due to low rainfall and years faced by farm households in selected areas of Dry zone

(Source: Department of Agricultural Planning)

The high temperature reduces the crop yield and also changes in rainfall patterns increase short-term crop collapse as well as long-term production declines. Highly variable in precipitation patterns stressed the farming in the Dry zone, especially the cropping and cultivation lands which are subjected to face the shocks such as flooding and droughts. As a consequence, the farmers are extremely vulnerable to climatic instability, especially the beginning and end of the season. Figure 10 also shows the crop damaging in the Dry zone due to extreme weather events (Cyclone Nargis).

	Affected	Damaged	Re-sown
Flood	462,495	96,732	903
Drought	129,811	2,844	-
Pests & Diseases	1,814	129	-
Others	207,149	196,787	347
Total:	801,269	296,492	1,250

Figure 4. Crop areas (in acre) damaged

(Source: Department of Agricultural Planning)

These low crop productions due to climate change leads to huge damages and financial burden to the farmers. For example, rapid-onset extreme weather events can damage the irrigation system, limit access to the markets and destroy harvests, while slow-onset hazards can decline overall farm productivity and the quality of crop yields. Thus, the government needs to provide adaptation options for the agriculture community in order to cope with the climate change conditions.

4.4.2 Food and water scarcity

Climate change could deteriorate the prevalence of craving by the direct adverse impacts on production and indirect effects on purchasing powers of food. Shifts in temperature, rainfall, and climatic extreme events will add the pressure on agricultural sector mostly and diminish the land areas' quality for agricultural production. The effects of climate change in the dry zone such as changes of rainfall patterns, high temperature and increasing frequency of extreme climatic events, causes the risks for food safety by declining agricultural productivity and also increasing the commodity prices of food. Food insecurity is closely related to the regional dry spells and droughts issues and leads to the underdevelopment of the region. According to World Food Programme (WFP), 18.5 % of the Dry zone households faced food insecurity and 12.3 % of children under five found to be intensely malnourished. Households with less land for farming and poor access to the markets are likely to face with food insecurity. Farming family groups are more subjected to be food-secure but food security is even risky for these households. According to the data, the food safety of 41% of farming families was harshly impacted by dry spells.

Water scarcity poses the problem not only for the agriculture sector but also for the household and has been recognized as one of the constraint to the regional development, an obstacle to livelihoods and the community in the dry zone. According to the Water Resource Utilization Department, the regions in the Dry zone (around 6.65 million people) access household water use from over 13,700 wells, drinking water from wells and for the livestock from the lakes in the raining

season and surface wells in the summer season (IWMI, 2013). Water shortage for domestic use happens especially during the monsoon season when dry spells occurred. If the dry spells remain for long periods, this can happen the problems for the local community. Water shortage for agriculture mostly happens in the early monsoon season as the consequence of the droughts. Based on the report from Department of Metrology and Hydrology (DMH), droughts happen during the early and peak monsoon period (significantly in 2010) and have mainly impacted to the agriculture land, farmers and also for drinking water. The shortage of water also lead to the health problems including maternal health and surprising also can contribute to the migration. Decreasing water access for agriculture lead to reduce the income of farmers and likely to increase the rate of migration (Fee, 2017). When greater amount of men migrate to other regions for their household income, most of the female have to lead the household.

4.4.3 Health related issues

The possible health risks for the climate change involve, expand of waterborne and vector-borne diseases, high temperature related illnesses and increased malnutrition. The poor households, women, children and the elderly person are most likely to be vulnerable the health related problems. Moreover, most of the Climate Change related health problems happened due to the limited access of water and food insecurity, High temperatures and erratic rainfall patterns also create the situations which can easily spread the infectious diseases. Moreover, heat exhaustion and dehydration are also the related health problem for the dry zone community who work under the high temperature. For all areas in Dry zone, the spread of wasting is 13.9 % and stunting is 30.8 % (WFP, 2013). Long term poor access of diverse foods (some factors of climate change) and poor healthy environment for both mothers and child lead to stunting.

4.4.4 Poverty and out-migration

The communities in the Dry Zone mainly rely on the agriculture sector as their livelihood and most of the family members are working as household labor for agriculture sector. Although, due to the impacts of climate change in the agriculture sector, mostly the youth from the family have to go outside for other income opportunities as the lower income from these sector have put at risk for their livelihood. Another problem is poverty track of farmers due to climate change impacts. Most of the farmers lend money in order to invest in their agriculture land but due to unexpected climatic conditions, the crop production is very low and they cannot afford to pay back their loan to the lender. These loans have to lend with high interest rate and if they cannot pay it on time, the amount of interest will rise higher and higher and leads to the poor family being affected with debt and tracked in the poverty. On the other hand, the local government cannot wholly support sufficient facilities suchlike in-kind contribution, cash and some technology to adapt this situation so that most of the community interested in migration to other big cities or even to abroad (Kyi, 2012).

According to the World Food Program, in Magway region in the Dry zone, there are more than one labor migrants in five households. Climate change and environmental pressures are the major drivers of migration in the Dry zone as a kind of coping strategy for the low income pressure of the household and the family.

5. Discussion and Recommendations

According to the above mentioned climate change projections from the research and data, the Dry zone is likely to face with various climate stressors in the coming years as a consequence of high

temperature, rainfall patterns changes and increased the risk of floods and the occurrence of extreme climatic events such as droughts, intense rains and cyclones. These climate change impacts will significantly affect to the Dry zone community and the Government needs strategic plans in order to address and cope with these changes for the future sustainable development of the region. The government also needs to get ready and perform immediately if anything to do right now or future climate change adaptation and mitigation is to be accomplished. The followings are the recommendation plans and strategies for the specific issues in order to cope with the current and future climate change risks of the Dry zone region and community;

5.1 Low Crop Production

As agriculture is the main livelihood for the Dry zone community, the climate change impacts on the agriculture sector negatively contributes to many socio-economic issues such as low crop production, food insecurity and low income of the household. In order to tackle this issue, the Government needs to consider and adopt the following systems and plans;

- Adoption of ***climate smart agriculture system*** for the affected community with the cooperation of the Central Government, Local Government and other NGOs and INGOs
- Provide ***information and knowledge*** about climate change to the farmers' community for climate adaptive agricultural practices.
- ***Research*** activities need to support the community in implementing proper changes to the traditional farming systems in the course of the constraints that they have to face.
- Reinforcing ***communication and public awareness*** on climate change.

5.2 Food and Water Scarcity

5.2.1 Food

Agriculture is a significant factor for improving food security in the Dry zone where over 60 percent of the community has land for farming. The data proven that climate change has significant negative impacts on the crop production and will put a huge pressure on the Dry zone's communities and food accessibility of the people in the region. Thus, the local government and the stakeholders should eagerly seek, adopt and force for adaptation strategies and plans which can not only alleviate further food scarcity but also lessen that which had already happened by implementing the following recommendations;

- For the future water programs in the dry zone, the better ***irrigation infrastructure*** need to invest for agriculture's community as accessing to irrigation is an important factor for contributing to food security by providing adequate amount of water for agriculture purpose.
- Implementing “ ***School Feeding Program***” for Children at Local school
- Improving ***market mechanism for agricultural products*** so that food prices can control under the system.
- Implement ***Food distributions and feeding programs*** for the pregnant women and the children under five in order to prevent under nutrition problems.

5.2.2 Water

The findings of this paper have shown that, in the Dry zone, water scarcity problem has been recognized as one of the major constraints to the regional development by impacting the agricultural land, farm's communities and also health status of the community. According to the projections regarding climate change in Myanmar indicate that, overall, the temperature will rise and the rainfall patterns will also vary over the coming years across the states and regions. Particularly in the Dry zone, the increasing temperature and the changes in the period and intensity of drought throughout the hot season can be intended by the coming years. This means that the water scarcity problem in the Dry zone can be worsened in the future and the multi-stakeholder groups such as Government (Central and Local), NGOs and INGOs should consider and set up adaptation plan for this issue. The followings are the suggested plans and strategies in order to address water scarcity problem of the Dry zone;

- Establish better ***water management system*** in order to reduce the risk of crop failure and access water for daily life especially during hot season and dry spell period.
- Providing ***rainwater collecting*** system and storage in small multi-functional reservoirs.
- Ensure ***long-term preservation of the reservoirs*** through technical and communal approaches.

5.3 Health Related Issues

Under the projection of high temperature and various rainfall patterns in the Dry zone, the Local government and the related stakeholder need to prepare for preventing climate related health problems for the community by implementing and adopting the following strategies and plans;

- Improving access to ***public health services***, hygiene and sanitation and ensuring the risk communities of climate change have access to public health care system
- Strengthening ***local health officers capacities*** in order to respond current and coming risks of climate-related health problems
- Establishing ***preparedness and response plans*** to deal with increasing heat stresses and other climate change events that pose risks to the human health
- Reducing climate-induced and water related health risks by increasing access to ***safety drinking water and improving sanitation***
- Raising ***public awareness*** about climate change related health impacts

5.4. Poverty and Out-migration

Most of household's incomes are based on agriculture sector which enlarges the vulnerability to the climate change. These stresses result the poverty and out-migration issues of the region so that appropriate adaptation plans, strategies and social protection mechanisms should be considered for the farm community as follow;

- Possible ***adaptation strategy*** in order to fight poverty for farmers is to alter livelihood patterns (as off-farm employment) because not all the sources of family income are impacted so much by climate change.

- Improving access to ***loan or trust fund*** on favorable conditions, for example through respective saving groups of the villages and/or through the Government banks.
- Government needs to encourage the community for ***the established of new off-farm business*** and also needs to provide relevant skill, technology and information for the new market
- Developing ***financial mechanism*** in order to invest in climate change risks resilience activities.
- Establish ***heath care funds*** within the villages could be one solution for reduction heath related debt of the households.

6. Conclusion

The Dry zone region is naturally high-risk and hampers to get natural resources like water, soil, forest resource and also spreads with dry and hot climate situation, which naturally prevents the availability of adequate resources or good climate conditions unlike other regions of Myanmar. So those, the community in the Dry zone are risky and hazardous under the erratic climatic impacts which contribute to socio-economic issues of the region and now they also face with these socio-economic impacts of climate change in the region as mentioned above. Moreover, there are projections of climate change in the Dry zone such as increasing temperature that will risk to agriculture productivity and also impact to human health, changing precipitation patterns which will risk to agriculture sector and other extreme weather events. Thus, the policy makers need to have the plans, strategies and financial mechanism for both rapid-onset climatic events such as floods and cyclones as well as slow-onset changes like extreme temperature, droughts and water scarcity. As we presented above, the climate change impact on the Dry zone lead to the socio-economic issues of the regions such as low crop production, increased food prices and shortage of food for poor households, water scarcity, health related issues, low income due to low crop productivity. These impacts have the potential to interrupt the sustainable development of the region and intensify the poverty track of the region also.

Therefore, it is necessary that the central Government, regional Government, civil society, private sector and community itself need to work corporately in order to address and adapt the current and future risks of climate change impacts.

References

- Boori, M. S., Chondhary, K., Evers, , & M., & Kupriyanov, A. ((2017).). *Environmental Dynamics for Central Dry Zone Area of Myanmar*. International Journal of Geoinformatics, 13(3), 1–12.
- Fee, L., Gibert, M., R., B., & Capizzi, P. H. (2017). *Climate Change Vulnerability Assessment of Pakokku Township, Magway Region, Myanmar, 2016 - 2050*, . UN-Habitat Myanmar.
- Giron, E. J. ((2010).). *ADAPT - towards an integrated decision tool for adaptation measures. Case study: Floods. Bruxelles, Belgium: Belgian Federal Science Policy. .*
- Horton, R., Little, , C., Gornitz, V., , & Bader, D. and Oppenh. (Chapter 2: Sea Level Rise and Coastal Storms. New York City Panel on Climate Change 2015 Report.). 2015. Ann. N.Y. Acad. Sci.
- Horton, R. D. (2017). *Assessing Climate Risk in Myanmar: Summary for Policymakers and Planners* . New York: Center for Climate Systems Research at Columbia University, WWF-US and WWF-Myanmar, UNHabitat Myanmar.
- Horton, R. D., & Capizzi, P., Martin, S. and Rosenzweig, C. (2017). *Assessing Climate Risk in Myanmar: Technical Report* . New York, NY, USA: Center for Climate Systems Research at Columbia University, WWF-US and WWF-Myanmar.
- Horton, R., Little, C., , Gornitz, V., Bader, , & D. and Oppenheimer. ((2015a).). *Chapter 2: Sea Level Rise and Coastal Storms. New York City Panel on Climate Change 2015 Report*. Ann. N.Y.
- Institute, I. W. (2015.). *Improving water management in Myanmar's dry zone for food security, livelihoods and health*. Colombo, Sri Lanka: International Water Management Institute (IWMI).
- IPCC. 2007b. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.
- MoNREC, M. o. (2012). *Myanmar's National Adaptation Programme of Action(NAPA) to Climate Change*. Nay Pyi Taw: MoNREC.
- Oo, A. T. (2018). *COMMUNITY PERCEPTIONS OF THE IMPACTS OF CLIMATE CHANGE ON AGRICULTURE IN MYANMAR'S CENTRAL DRY ZONE* . Michigan: Department of Agricultural, Food, and Resource Economics, Michigan State University.
- Population, D. o. (2015). *The 2014 Myanmar Population and Housing Census: Union Report. Census Report Volume 2* . Ministry of Immigration and Population, Nay Pyi Taw, Myanmar.
- Programme, W. F. (2011). *Food security assessment in the Dry Zone*. Myanmar. Yangon, Myanmar. .
- Saw Myint Tin, U. (1990). *Climate of the Dry Zone of Myanmar', Master Thesis: Department of Geography, University of Mandalay*. , . Thomson Reuters: FACTBOX- Key facts about cyclone Nargis.
- Stern, N. (2007.). *The Economics of Climate Change: The Stern Review*. . Cambridge University Press, Cambridge, UK.
- Swe., H. (2014.). *Mapping-out Myanmar's climate smart agriculture strategy focused on rice-based farming systems*. . CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS) .
- WFP. ((2014).). *Food Security Update - April 2014: Early Warning and Situation Reports*. . Food Security Information Network. Livelihoods and Food Security Trust Fund.