

State of climate information products and services for agriculture and food security in Myanmar

Working Paper No. 140

CGIAR Research Program on Climate Change, Agriculture and Food Security (CCAFS)

Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES)

Ruby Rose Policarpio
Michael Sheinkman



RESEARCH PROGRAM ON
**Climate Change,
Agriculture and
Food Security**



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Abstract

The increasing variability of seasonal climate and increasing frequency and intensity of extreme weather events that are expected to accompany climate change will impact agricultural production and food security in Southeast Asia. The timely provision of climate information is one mechanism to help societies and individuals prepare for and adapt to these changes. This report assesses the state of climate information products and services in Myanmar, including how such services are disseminated and utilized by national actors. It includes recommendations to help meet the climate information needs of the agriculture and food security sector in Myanmar.

Keywords

Myanmar; Climate Services; Agriculture; Food Security.

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Acronyms

ASEAN	Association of Southeast Asian Nations
ASEANCOF	ASEAN Climate Outlook Forum
BRACED	Building Resilience and Adaptation to Climate Extremes and Disasters
CCAFS	Climate Change, Agriculture and Food Security
CGIAR	Consultative Group on International Agricultural Research
CRED	Center for Research on the Epidemiology of Disasters
DFID	United Kingdom's Department for International Development
DMH	Department of Meteorology and Hydrology
ENSO	El Nino Southern Oscillation
FAO	Food and Agriculture Organization of the United Nations
FARM	Forecast Application for Risk Management in Agriculture
FSIN	Food Security Information Network
FSU	Food Security Update
GDP	Gross Domestic Product
LPA	Low Pressure Area
MIMU	Myanmar Information Management Unit
MOAI	Ministry of Agriculture and Irrigation
MRTV	Myanmar Radio and Television
MSS	Meteorological Service Singapore
NAPA	National Adaptation Programme of Action
NMHS	National Meteorological and Hydrological Service
PRECIS	Providing Regional Climates for Impact Studies
RCOF	Regional Climate Outlook Forum
RIMES	Regional Integrated Multi-Hazard Early Warning System
UN	United Nations
UNOCHA	United Nations Office for Coordination of Humanitarian Affairs
USAID	United States Agency for International Development
WFP	World Food Programme
WMO	World Meteorological Organization

Introduction

Agriculture is vital to the Southeast Asian economy. Hosting most of the region's workforce, agriculture is a main driver of food security and development. Agriculture, however, is climate-sensitive and thus, climate variability and extremes impact on food production.

Aberrations from normal climate, especially in terms of rainfall and temperature, exacerbate risks to food production. Differential risks to agriculture and food security are likely, based on location-specific climate manifestations, agro-ecosystems, and production practices and conditions. Climate variability, weather extremes, and climate change necessitate strategies to be put in place for mitigation of anticipated adverse impacts. Hence, climate information of different timescales, to guide informed decisions, is essential.

This report is part of a series that evaluates the status of climate information products and services for agriculture and food security in six (6) countries of Southeast Asia: Cambodia, Indonesia, Lao PDR, Myanmar, Philippines and Vietnam. Each country report evaluates the mechanisms and systems used to generate, communicate, and apply climate information and services for agriculture and food security; highlights strengths and weaknesses; and provides recommendations for further development. Specifically, each country report includes:

- Country background;
- Capacities in climate information generation and application:
 - Climate information products and services for agricultural production and food security, viz.: a) weather and climate forecasts of different time scales; d) historical data analysis; and e) climate change scenarios;
 - Climate-related agricultural and food security decision-support tools including a) hazard/risk/vulnerability maps; b) monitoring and advisory system for hydro-meteorological events, pests and diseases outbreaks and other related conditions;
 - Capacity building on forecast translation for sectoral decision-makers and end-users in agriculture and food security;
 - Mechanisms and good practices in forecast information application;
 - Institutions involved in generation, interpretation, translation, communication and application of forecasts in agriculture and food security; and

- Gaps and recommendations

The report components feed into an analysis of the end-to-end forecast generation and application process which involves observation of weather/climate parameters and generation of forecasts/warning information; generation of location- and sector-specific impacts outlook and response/management strategies; implementation of management strategies; and providing feedback to National Meteorological and Hydrological Services (NMHSs) on the forecast performance and management and/or mitigation strategies that were implemented.

Gaps and potential opportunities for enhancement of the forecast generation and application system could guide institutions, working in relevant fields, in focusing resources to address country-specific concerns. In addition, institutions in the countries working in related areas could synergize their initiatives to maximize the benefits of current and planned initiatives.

The series of country reports have been prepared by RIMES as part of its collaboration with the CGIAR research program on Climate Change, Agriculture, and Food Security (CCAFS), Southeast Asia regional program.

According to the Food and Agriculture Organization of the United Nations (FAO), food security is a situation that exists when people, at all times, have physical, social and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life. This underscores that food security necessitates (a) sufficient physical availability of food supplies; (b) adequate access, of households, to the said food supplies from their own production, from the market, or other sources; and (c) appropriate utilization of food for meeting individual dietary requirements (World Food Summit, 1996).

Direct and indirect influences of climate on food security (Figure 1), include, but are not limited to (a) agro-ecological states impacting crop production and livestock rearing, (b) incidence/outbreak of pests and diseases in plants and animals, (c) demand for produce, (d) livelihoods and income distribution, and (e) human health.

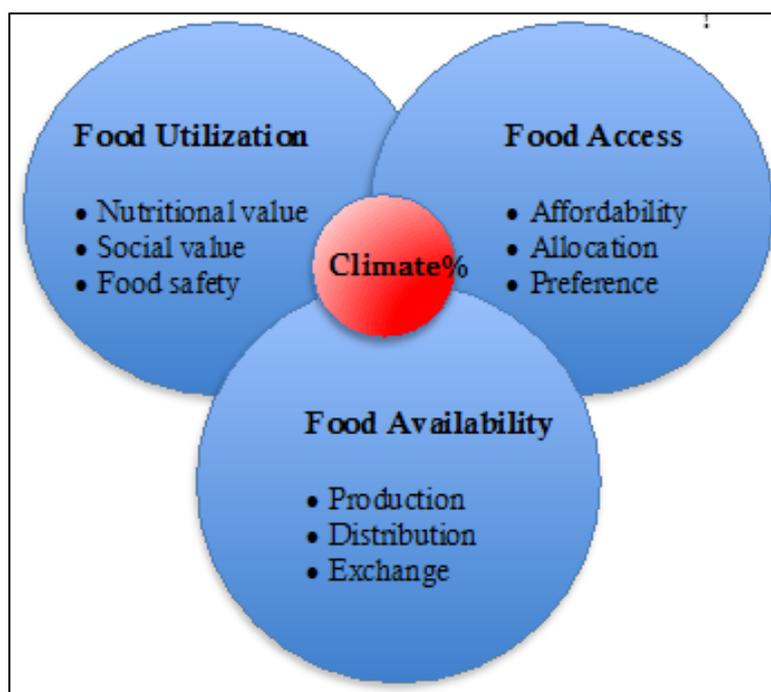


Figure 1. Climate-food security relationship. Adapted from Ericksen, 2007.

Climate impacts all three (3) key indicators of food security. However, this report focuses on the relationship between climate and food availability, specifically agricultural production.

Country Background

Geographical and socio-economic context

Myanmar, the second largest country in Southeast Asia, is situated between 9°55' and 28°15' N latitude and 92°10' and 101°10' E longitude. The land area is 677,000 square km with a coastline of approximately 2,300 km. Myanmar is home to around 57.5 million people, distributed over seven (7) states and seven (7) regions. Per the 2007 Integrated Household Living Conditions Survey in Myanmar, average household size in the country is 5.1 and 5.2 in urban and rural areas, respectively.

Agriculture and food security context

Myanmar's economy is largely dependent on the sector. Agriculture absorbs about more than half of the country's workforce. The majority of Myanmar's population lives in rural areas and depends on agriculture for their livelihood and food security.

Rice is the most important agricultural crop in Myanmar. Cultivation occurs in irrigated lowland areas, rainfed lowland areas, and rainfed upland areas. The Ayerawaddy Delta is regarded as the country's rice bowl. It contributes more than half of the country's total annual rice production. Other areas where rice is cultivated include: the Dry Zone (Figure 3), in the semi-arid central part of the country; coastal areas; and uplands in the northern part of the country.

Pulses, maize and oilseeds are the most important crops after rice. Exports of maize and pulses are important sources of foreign currency for Myanmar. Maize is predominantly grown in Monsoon season under rainfed condition. Oilseed crops are also grown in upland rainfed areas. The Dry Zone also contributes more than half of the national production of pulses. Pulses are also grown in the Ayerawaddy Delta and in Shan state.

Agriculture in Myanmar is vulnerable to extreme weather events, drought, flood, erratic rainfall, temperature fluctuations, and delayed onset / early withdrawal of the Monsoon. Other vulnerabilities include: decreasing ground water levels, intrusion of salt water in coastal and delta areas; and irrigation induced salinity in the Dry Zone.

Food systems in Myanmar are changing over time. Consumption of meat, eggs and milk are increasing. Consequently, market demand for maize continues to rise, with sown area and yield per acre increasing rapidly in the last decade. This is due primarily to the introduction of hybrid maize varieties and increased use of chemical fertilizers.

Yields for both rice and maize are considered low compared to those in neighboring countries. Rice and maize production face several agronomic and input constraints that are compounded by current climate variability and projected changes in climate. The Department of Agriculture in the Ministry of Agriculture and Irrigation (MoAI) attributes these low yields to (a) lack of post-harvest technology, (b) under-utilization of fertilizers, (c) weak socioeconomic conditions, (d) under-developed infrastructure, (e) impacts of natural disasters, and (f) man-made environmental degradation.

Freshwater and marine fisheries, and livestock are key sources of protein for Myanmar households. Fisheries and livestock raising have also been affected by climate factors, such as heat stroke suffered by livestock and poultry due prolonged high temperatures; higher

decomposition rate of aquatic plants resulting in reduced oxygen content in the water and reduced aquaculture production.

At the national level, Myanmar produces surplus food. However, food insecurity and childhood malnutrition remains endemic in some parts of the country, particularly the Central Dry Zone, Shan State, and Chin States.

Climate context

Myanmar has a tropical monsoon climate. Myanmar's climate is driven by the Southwest Monsoon from May to October and the Northeast Monsoon from December to February. Myanmar's climate has four (4) main seasons: (a) Northeast monsoon: characterized by cold and dry climate; from December to February; (b) pre-monsoon: characterized as hot and dry; from March until prior to Southwest Monsoon onset; (c) southwest monsoon: from May to October (normal onset and withdrawal dates in Figure 3) contributes to about 95% of total annual rainfall; and (d) Post-monsoon: from October to November. The Southwest monsoon is further divided into a) early monsoon period from May to June; mid-monsoon period from July to August; and late monsoon period from September until monsoon withdrawal.

The three (3) main climatic zones in the country are: (a) Coastal Areas: receiving the highest annual rainfall of about 5,000 mm, with mean temperature is around 32°C; (b) Central Dry Zone: which records the lowest annual rainfall in the country, at around 500 to 1,000 mm, due to orographic influence, with temperature ranging from 10°C during cool months to more than 40°C during hot, dry months; and (c) Northern and Hilly Areas: experiencing temperature within the range of 10°C to 40°C. Extremely low temperatures, of below freezing point, were recorded in Chin and Shan States. Normal annual rainfall, in different areas in the country, is indicated in Figure 4.

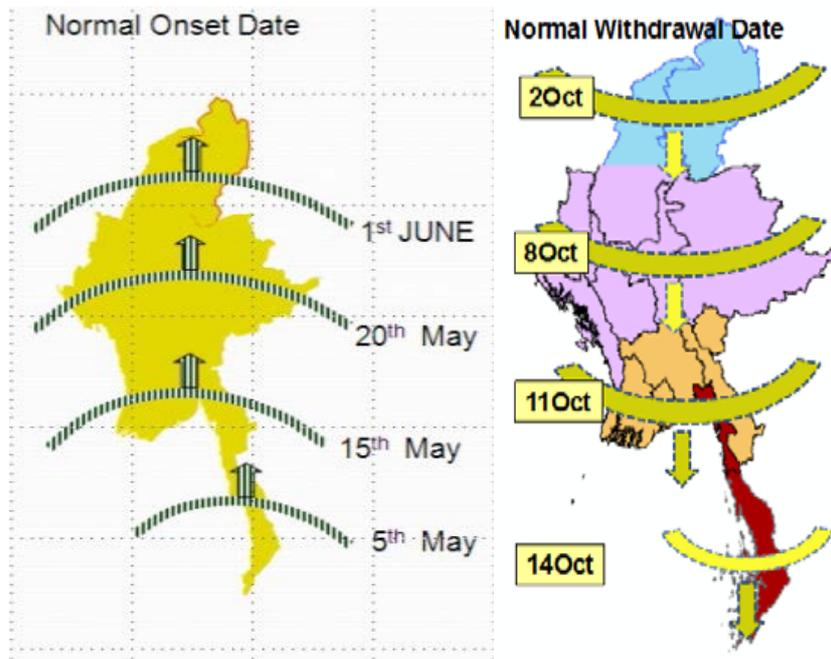


Figure 2. Left: Normal onset dates of the Southwest Monsoon over different parts of Myanmar. Right: Normal withdrawal dates of the Southwest monsoon from different areas in the country. Source: DMH.



Figure 3. Myanmar's dry zone. Source: MIMU, 2008.

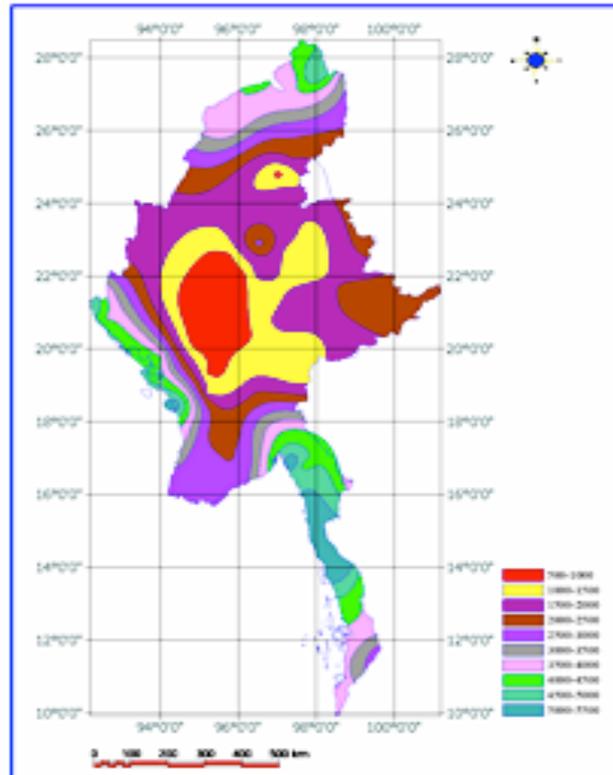


Figure 4. Normal annual rainfall range in different parts of Myanmar. Source: DMH.

In Myanmar, climate variability is attributed to El Niño Southern Oscillation (ENSO). According to the Department of Meteorology and Hydrology (DMH), El Niño years, ENSO's warm phase, have resulted in deficient rainfall and higher temperatures in the country. La Niña, the cold phase, tends to have the opposite impacts. Some of the maximum highest temperatures were recorded in 1998 (an El Niño year) over almost the entire country, except Sagaing Region, Kachin State, and Chin State. In 1999, a La Niña year, many stations registered record low minimum temperatures during the cool season, despite a trend towards rising temperatures observed over the last two decades.

Myanmar is affected by cyclonic storms occasionally. Cyclone Nargis (2008) was strongest cyclonic storm on record to strike Myanmar. Other cyclones of note were Mala (2006) and Giri (2010).

Climate influence on agriculture and food security

According to the Center for Research on the Epidemiology of Disasters (CRED, 2013), seventy percent (70%) of natural disasters affecting Myanmar are climate-related (Wealer, 2013). Of the climate-related hazards and disasters, droughts, floods, and storms have the

most significant impact on agriculture and food security. In addition, climate variability directly impacts agricultural production.

Yi, et al. (2013) reported that agriculture and food production are vulnerable to drought. The geographic area most affected by drought is the Central Dry Zone. The 2010 drought in Myanmar was considered the most severe in many decades. High temperatures and rainfall deficit caused severe water shortage in many parts of the country, especially in Ayeyarwady, Sagaing, Yangon, Mandalay and Bago Regions and in Mon, Rakhine, and Shan States.

Myanmar experiences serious floods nearly every year. The United Nations Office for Coordination of Humanitarian Affairs (UNOCHA) estimated 500,000 people were affected by floods over the period 2002-2013. One of the most severe floods in recent years was in August 2012 which affected a total of about 530,000 acres of paddy.

Cyclone Nargis was the worst natural disaster in Myanmar's history. The Tripartite Group composed of the Government of Myanmar, United Nations (UN) and the Association of Southeast Asian Nations (ASEAN, 2008) reported total damages and losses to the agriculture sector to be within 570 to 694 billion Kyats (PONJA, 2008). An FAO assessment reported substantial damage to the agriculture sector, in Ayeyarwady and Yangon Regions including:

- 63% or 783, 2220 hectares of paddy fields submerged;
- More than 700 tons of stored paddy and milled rice destroyed;
- 85% of seed stocks lost ;
- About 3,000 power tillers and thousands of tilling equipment lost;
- 37% of orchard and 70% of backyard crops lost;
- About 227,000 draught animals lost in 11 severely affected townships;
- About 68,000 pigs, 500,000 ducks, 7,000 goats and 1.25 million chickens died;
- Extensive damages to agricultural infrastructure;
- About 1,600 fishing vessels, 100,000 small boats, and nearly two-thirds of fishing gears lost;
- 37,000 acres of fish and shrimp ponds destroyed; and
- 21,000 hectares of natural and re-developed mangrove forest damaged.

The impacts of Cyclone Nargis persisted in Ayeyarwady and Yangon Regions persisted long after the event. Farmers were not able to plant for at least two (2) consecutive cropping

seasons after the cyclone, as agricultural lands became saline after having been inundated with sea water due to the storm surge.

Capacities in Climate Information Generation and Application

Climate information products and services

Historical climate data analysis: variability and trends

Spatial and temporal climate variability in Myanmar is high. The understanding of historical data can aid decision-makers in agriculture and food security sectors in putting in place better management strategies vis-à-vis seasonal, annual, decadal variability and adaptation measures relative to long-term climate change.

Climate variability and trends for Myanmar have been analyzed and included in the National Adaptation Programme of Action (NAPA), viz.:

Temperature. Analysis of temperature data from 1951 to 2007 shows that temperature in Myanmar has increased by approximately 0.08°C per decade, on the average. DMH data from 1960 to 2000 shows a decreasing trend in the number of cold days and increasing trend on the number of hot days. The highest warming was recorded in Kayin, at about 0.32°C per decade. In 50-year period (1951 to 2000), about 15 heat waves annually were registered. The strongest and most extensive was recorded in 1998, an El Niño year, which affected about 60% of the country. Despite the general trend of increasing temperature, some regions have experienced decreases. These include Magway at -0.23°C per decade and Bago at -0.16°C per decade.

Rainfall. 50-year (1955-2007) rainfall data analysis suggests that overall rainfall in Myanmar has increased by 29mm per decade on the average. The trend, though, is variable: majority of the regions recorded rainfall increase, the greatest in Upper Sagaing, with approximately 215mm on decadal basis; decrease in yearly rainfall however was recorded in six regions, with Bago registering the greatest decrease per decade of about 81mm. Variations in the Southwest monsoon season duration have also been recorded, showing a decreasing trend, from the normal 144 days, with the onset becoming later and withdrawal becoming earlier.

Drought. Drought can occur in a number of areas in the country, especially in the dry zone. DMH analysis of 50-year data (1951-2000) suggests increasing frequency and intensity of drought events in Myanmar. Significant drought years in Myanmar were 1954, 1957, 1960, 1963, 1966, 1972, 1977, 1979, 1990, 2002, 2004, 2010, 2011, 2012, and 2013. In 2010, by far the hottest year recorded in Myanmar, severe drought resulted to water stress in communities across the country and impacted agriculture heavily – production of peas, sugarcane, tomato and rice, among others, was adversely affected.

Cyclones. In 135-year period (1877-2012), a total of 87 storms and severe cyclonic storms crossed Myanmar (Table 1); most of these were in May and April. From 2002 to 2004, Myanmar coast was hit by cyclones every year; from 2006 to 2010, cyclones hit Myanmar every other year.

Table 1. Summary of storms and severe cyclonic storms which crossed Myanmar from 1877-2012. Source: Htay, DMH, 2013.

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
1877 - 1890					2						1		3
1891 - 1900				4	2					2	2		9
1901 - 1910				1	2						3		6
1911 - 1920				2	1	1				1		2	7
1921 - 1930				3	1					2	5	1	12
1931 - 1940				2								1	3
1941 - 1950				2	2					2		1	7
1951 - 1960	1	1		1	1					2		1	7
1961 - 1970					4					3		1	8
1971 - 1980	1			1	2						2		6
1981 - 1990		1		1	1					1	3	1	8
1991 - 2000				1	1					1	1		4
2001 - 2012				2	4					1			7
1877 - 2012	2	2		20	23	1				15	16	8	87

Climate change projections

Climate projections for Myanmar, generated using PRECIS (Providing Regional Climates for Impacts Studies) and included in NAPA, for time slices up to 2100, include: (a) general increase in temperature across the country, particularly from December to May, with the Central and Northern regions experiencing the greatest increases; (b) increase in clear sky days, exacerbating drought periods; (c) increase in rainfall variability during the rainy season,

including an increase in rainfall across the country from March to November (particularly in Northern Myanmar), and decrease in rainfall between December and February; (d) late monsoon onset and early withdrawal of monsoon events, increasing flood and drought risks; and (e) increase in the occurrence and intensity of extreme weather events, including cyclones/strong winds, flood/storm surge, intense rains, extreme high temperatures and drought. Table 2 provides a summary of projections per time slice, while Table 3 lists extreme events anticipated in vulnerable areas in the country.

Table 2. Climate change projections. Source: Government of Myanmar, NAPA, 2012.

2001 - 2020	2021 - 2050	2051 - 2100
Increase in temperature of about 0.4°C to 0.7°C across Myanmar, with the Yangon Deltaic region experiencing the greatest increase of approximately 0.7°C	Increase in temperature of 0.8°C to 1.4°C across Myanmar, with the Yangon Deltaic (1.4°C) and Rakhine Coastal (1.2°C) regions experiencing the greatest increases	Increase in temperature of 2.8°C to 3.5°C across Myanmar, with the highest increases in the Rakhine Coastal and Yangon Deltaic Regions of about 3.5°C
Increase in clear sky days in Northern and Central Myanmar, exacerbating drought events	Increase in rainfall across the country, with Rakhine Coastal region experiencing the greatest increase of about 661mm per annum, and the Eastern Hilly Region experiencing the smallest increase of approximately 36mm per annum	A weakened monsoon climate, supported by decreased cloud coverage
Highly variable rainfall changes throughout the country, including large increases in the Northern Hilly Region, of about 228mm per annum, as well as decreases in Rakhine Coastal, Yangon Deltaic, and Southern Coastal regions of around 58mm per annum	Period of heavier rains	Increase in drought periods across most of Myanmar
Increase in floods and droughts, resulting from variable rainfall conditions	Longer dry spells	Increase in precipitation, with highest increases in the Rakhine Coastal region of about 1582 mm per annum, and the smallest increase in the Eastern Hilly region of about 209 mm per annum

Table 3. Potential extreme events vis-à-vis vulnerable areas. Source: Government of Myanmar, NAPA, 2012.

Anticipated Extreme Events	Vulnerable Areas and Regions/States
Drought	Central Dry Zone - Sagaing, Mandalay, and Magway Regions, particularly agricultural lands in these areas
Cyclone/Strong winds	Coastal regions - Rakhine, Ayeyarwady and Yangon Regions/States
Intense Rain	Tanintharyi, Yangon, Rakhine, Ayeyarwady and Mon States/Regions. These areas have the longest exposure to the Southwest Monsoon flow. Lower Myanmar as well as North-Western areas will also be affected.
Flood/Storm Surge	All lowland and flat regions, as well as rivers and associated valleys and basins. Areas in close proximity to the Ayeyarwady, Chindwin, Sittaung and Thanlwin river systems and coastal areas are particularly at risk to storm surges, hydrological floods, flash floods, and riverbank overflow.
Extreme High Temperature	Relatively flat regions in the Central Dry Zone (e.g. Mandalay and Magway)
Sea Level Rise	Coastal zones, especially areas interspersed with tidal waterways (e.g. Ayeyarwady Delta). In certain areas, it is thought that low-lying coastal areas may face permanent inundation.

Hydro-meteorological forecasts of different timescales

In Myanmar, DMH is the mandated government institution to observe, analyze, predict, and provide warning services for weather- and climate-related hazards for protection of lives and properties, reduction of impacts of natural hazards, and sustainable resource management and development. In partnership with the World Meteorological Organization (WMO) and other UN institutions, various international and regional climate centers, and development organizations, DMH works to develop forecast products and services to better cater to user needs. Hydro-meteorological forecasts issued by DMH are summarized in Table 4.

General outlook for the Southwest monsoon season/ Seasonal climate outlook, issued on 28 April of every year, is the general outlook for the monsoon season provides guidance on the potential general condition of the Southwest monsoon. Parameters include (a) monsoon onset and withdrawal, (b) bay inference, (c) cyclone frequency, (d) monsoon intensity, (e) rainfall and temperature anomaly for different regions and states, (f) number of rainy days, and (g) number of foggy days.

Dry season outlook provides the general outlook for the winter/Northeast monsoon season, from December to February. *Monthly weather forecast*, issued every 28th of each month, provides guidance on the likelihood of development of Low Pressure Areas (LPAs) in the Bay of Bengal, likely rainfall condition, and possible number of rainy days within the period.

Table 4. DMH Forecast Products

Type of Forecast	Time of Issuance	Forecast Validity
<i>Weather and Climate Forecasts</i>		
General outlook for the monsoon season	28 April	Southwest monsoon season with updates for the Peak Monsoon (issued 28 June) and Late Monsoon (28 August)
Dry season outlook	Prior to winter/Northeast monsoon season	Winter/Northeast monsoon season
Monthly weather forecast	28 of every month	1 month
10-day weather forecast	8, 18, 28 of every month	10 days
Daily weather forecast	daily	1 day
Severe weather warnings	Issued as needed	
<i>Hydrological Forecasts</i>		
General long-range flood forecast	28 April	Southwest monsoon season
Flood forecast for early monsoon period	28 April	2 Months (May, June)
Flood forecast for mid-monsoon period	28 June	2 Months (July, August)
Flood forecast for late-monsoon period	28Aug	2 Months (Sept, Oct)
Minimum alert water level and bulletin (for low flow)	Low flow season	Depends on water level
Flood warning and bulletin	Monsoon Season	Depends on water level
Significant water level bulletin	Pre-monsoon period	Depends on water level
Monthly forecast	28 of Every month	1 Month
Dekad forecast	8, 18, 28 of Every month	10 days
Daily water level forecast	Daily	1 day

10-day forecast describes the possible condition in the Bay of Bengal, likely rainfall condition, and probable number of rainy days for the 10-day period. *Daily weather forecast* provides information on the Bay of Bengal condition, rainfall forecast for different regions and states in the country, and sea condition.

Severe weather information takes the following forms: *Storm news* is issued for storms/cyclones that are not expected to move towards Myanmar, has the potential of crossing Myanmar but not yet in Myanmar's area of responsibility, or has passed and the threat is over. *Storm warning* is issued when the storm or cyclonic storm is expected to cross Myanmar coast in the next 12 hours or is already in the country. *Flood warning* means that water level has reached one (1) meter below station-specific danger level. Areas at major rivers and the upper Ayeyarwady could have warning lead times of 1 to 3 days, while areas at the lower Ayeyarwady could have longer warning lead times of 7 to

12 days, as headwater takes longer time to reach downstream areas. *ENSO update* indicates the current state of ENSO and outlook for the subsequent months.

Tools for informed decision-making in agriculture and food security

Hazard/Risk/Vulnerability Maps

Climate- and/or agriculture and food security-related decision-support tools like hazard/risk/vulnerability maps are useful in decision-making. While various institutions developed hazard/risk/vulnerability maps in the country, these are generally not in a resolution that could sufficiently guide planning and decision-making among stakeholders, especially in terms of location-specific interventions. The usability of these tools largely depend on their spatial and temporal resolutions, hence location-specific hazard/risk/vulnerability and other maps should be generated. Event-specific hazard/risk/vulnerability maps (e.g. incoming typhoon, anticipated/potential flood) should be provided to decision-makers with ample lead time.

The Government of Myanmar's NAPA (2012) mapped areas most vulnerable to climate change, based on projected increases in intensity and severity of extreme events, socio-economic sectors, and most populated areas. The Ayeyarwady Division and the Dry Zone are among the country's most vulnerable areas in the analysis of areas and socio-economic sectors most at risk. When population was analyzed, Yangon Division has the highest vulnerability, followed by Ayeyarwady Division, the Dry Zone, and Mon State. NAPA can be accessed at: <http://unfccc.int/resource/docs/napa/mmr01.pdf>.

Generated at national scale, these available climate change vulnerability maps may have limited usability. In planning climate change adaptation initiatives, downscaled (state/region, district, and township level) vulnerability and other climate-change related maps are required.

Monitoring and advisory system on hydro-meteorological events, pests and diseases and other related conditions

DMH, as part of its seasonal forecast, provides the information on possible dates of onset and cessation of Southwest monsoon rainfall, in different parts of the country. The Monsoon Forum Brief captures the DMH seasonal forecast, including potential Southwest monsoon rainfall onset and withdrawal. Potential number of rainfall days in 1 month and 10 days forecasts, are indicated in DMH's monthly and 10-day forecasts.

WFP issues monthly Food Security Update (FSU), capturing the various situations in the country which are impacting on food security. Key events including observed weather- and climate-related hazards and pest infestation, among others, are indicated. Areas at risk to deterioration of food security situation and specific threats are underscored. The FSU includes information on actions required and/or taken. The monthly updates supplement the Food Security Monitoring Bulletins issued by the Food Security Information Network (FSIN). Additionally, WFP also provides Food Security Assessment in various areas in Myanmar prone to food insecurity, provides an analysis of food insecurity triggered by relevant events, including climate-related hazards and provide recommendations to address food insecurity concerns. These publications provide monitored conditions and do not include forecast-based potential conditions and corresponding management strategies.

Building forecast translation capacity for agriculture and food security

In Myanmar, the Monsoon Forum was introduced in 2007 to facilitate dialogue between DMH and forecast user institutions, to bridge gaps in forecast generation, interpretation, translation, communication and application. Hosting about 35-50 participants from different sectors to include the Department of Agriculture, Department of Irrigation, Department of Fisheries, and Department of Forestry, among others, DMH convened 12 Monsoon Forums, from 2007 to May 2014. The Monsoon Forum in Myanmar is facilitated by RIMES. Ideally conducted twice a year, prior to and after the Southwest monsoon, the Monsoon Forum builds capacities of user institutions in understanding and utilizing forecasts, for enhanced management of opportunities and risks and addresses the mismatch between available forecast products and information requirements by users through user-feedback that drives the evolution of sector-relevant climate services in the country.

Building on gaps highlighted by stakeholders in the Monsoon Forum, to address the disconnect between the scientific nature of forecasts and the non-scientific background of user institutions, the National Training on Forecast Translation was facilitated by RIMES and convened by DMH in September 2013. The training involved participants from hazard-sensitive sectors, including the Department of Agriculture, Department of Fisheries, and Department of Forestry. The National Training on Forecast Translation covered modules on national weather and climate context, forecast products and services, forecast interpretation,

forecast translation, and risk communication. The training is linked to the National Monsoon Forum, to sustainably address the gaps in forecast generation and application.

The National Monsoon Forum is expanded to Sub-National Monsoon Forums, as part of the development phase of the Building Resilience and Adaptation to Climate Extremes and Disasters (BRACED) Programme supported by United Kingdom's Department for International Development (DFID).

Sub-national and community level training on forecast translation was also facilitated by RIMES in select areas in the country. Targeting the Dry Zone, recorded as one of the food insecure areas in Myanmar due to rainfall deficit, the Forecast Application for Risk Management in Agriculture (FARM) School is introduced by RIMES. The training of farmers being targeted in 2014, the FARM School training curriculum was drafted in November 2013 and to be followed by the training of trainers. A computer-based agro-advisory system for farmers, will be introduced and integrated into the FARM School curriculum as a test window for forecast application. Updating of agro-ecological zone, crop-weather calendar and development of geo-spatial database, for disaster risk management are being undertaken by DMH and the Ministry of Agriculture and Irrigation (MOAI), with technical support from RIMES.

Mechanisms and good practices in forecast application

DMH communicates forecasts/warning information through multiple channels and mechanisms. Information is sent simultaneously to a) relevant ministries, which are to communicate the information to their line agencies and concerned non-government organization and development institutions; b) district/provincial DMH offices; and c) the media for dissemination. DMH, upon demand from users, also made available forecasts via social network (Facebook). These mechanisms are intended to ensure the receipt of information by various stakeholders, including communities.

The Myanmar Radio and Television (MRTV) has been in collaboration with DMH to put forward climate information/forecasts to the public. It also has a dedicated channel for farmers, called Farmers Channel where farming-related information are aired. Enhanced collaboration between DMH and MTRV is sought, to provide actionable climate-related information to farmers.

MOAI and its line departments communicate forecasts and associated information to stakeholders, through its sub-national and local level extension workers. The 9th Monsoon Forum report captured feedback from the Department of Agriculture, indicating how farmers of Labutta in Ayeyarwady Region applied DMH forecast to save reserved seeds and other assets during 2012 Southwest monsoon season.

While there are good practices in forecast application in Myanmar, feedback from other participants in the National Monsoon Forum indicate a weakness in institutional mechanisms, hence, forecast information, at times, does not reach stakeholders in various levels.

Institutions Involved in Climate Services for Agriculture and Food Security

The recent shift in the political and policy landscape in Myanmar has facilitated collaboration between DMH and international and regional institutions. A detailed list of institutions involved in the generation, interpretation, translation, communication, and application of climate forecasts for agriculture and food security, along with their specific programs, projects, and activities is provided in Annex 1.

The inaugural meeting of ASEAN Climate Outlook Forum (ASEANCOF) was convened in December 2013 by ASEAN, Meteorological Service Singapore (MSS), WMO, and the United States Agency for International Development (USAID). Like other Regional Climate Outlook Forums (RCOFs), the ASEANCOF aims to provide consensus seasonal outlook for the region to provide better guidance on the likely seasonal condition to NMHSs in the Member States.

Gaps and Recommendations

A wide range of forecast products is provided, by DMH, in Myanmar. Although there remains room for improvement in terms of enhancing forecast resolution, both spatially and temporally, the availability of climate information products of different timescales equips users the opportunity to anticipate potential climate conditions and make informed decisions.

The utilization, however, of forecast is not exploited due to the following gaps, as elevated by stakeholders during Monsoon Forums conducted in Myanmar, as well as in other discussions, assessments, and reports by various other organizations.

Absence of mechanism for sharing monitored conditions that can enhance stakeholders' anticipation of potential opportunities and/or risks relative to forecasted conditions.

Forecasts can be better utilized when it is supplemented with monitored/observed conditions. However, there is at the moment no mechanism to couple forecasts with observed conditions. In order to facilitate better decision-making among stakeholders, a summary of observed conditions, in various areas in the country for a relevant period of time, could be coupled to forecasts. This would help information users to better anticipate opportunities and risks and put in place appropriate management strategies.

Sparse observation stations that cannot adequately capture rainfall and temperature patterns in the country.

Rainfall is significant to Myanmar agriculture. However, the current distribution of observation stations is not dense enough to sufficiently capture rainfall variability, both spatially and temporally, to establish micro-climatic zones in the country. This unestablished micro-climatic zones also contribute to make forecasting, and the application thereof, more challenging. Romano (2010), in his report to FAO on Food Security, Data Management Requirement Analysis and Technical Capacity Assessment, indicated that meteorological stations in Myanmar are not adequate for agro-meteorological modeling for crop and yield forecasting. Densification of observation stations should be part of the development priority of DMH and donor institutions. Further, sharing of observed data, among government institutions in Myanmar, is generally very limited. While the Irrigation Department and other institutions also maintain observation stations, data is rarely shared. An institutional mechanism for data sharing could take advantage of available data from observation stations maintained by various institutions.

Coarse spatial and temporal forecast resolution. Forecast information users in Myanmar, based on stakeholders' feedback from the series of National Monsoon Forums in the country, indicated that the current spatial and temporal scale of forecast generated by DMH is not sufficient as a robust basis for decision-making. Location-specific forecast is advised, with enough lead-time to further encourage forecast-based analysis of impacts outlook and development, planning and implementation of relevant management strategies for

opportunities, resources and risk management. Stakeholders also convey for DMH to apply the latest technologies in research and development in forecasting, to enhance forecast reliability/accuracy. Capacity building of DMH scientists may also be required for the purpose of enhancing the forecast information products generation.

Forecasts and warnings that are not easily understood due to technical information.

Information users in Myanmar find that forecasts that are too technical are prohibitive to information application. It is therefore recommended that forecasts be presented more comprehensively and in simpler forms. Further, DMH could enhance its partnerships with relevant national sectoral institutions, development organizations and the media, to tailor the forecast language in a form that is sector-specific, and hence understandable. Capacity building of DMH agro-meteorological scientists in tailoring forecasts to the agriculture sector would contribute to enhanced uptake of climate information. Also, presentation of forecasts in geospatial (GIS-based) information may enhance the appreciation and utilization of information by users.

Inadequate mechanisms for forecast translation into potential impacts and management strategies, in relevant institutions, that could facilitate better application of information in agriculture and food security.

Twelve national and one sub-national Monsoon Forums have been convened, by DMH, in Myanmar. These dialogues provided a platform for discussion between DMH and user institutions to facilitate enhanced forecast generation, translation and application. Based on user demand, DMH and RIMES also convened national and sub-national capacity building on forecast translation which involved stakeholders in the agriculture/food security sector, among others. Residual gaps in forecast translation are addressed in the Monsoon Forum process. Institutional mechanisms for translating forecasts into potential impacts and management strategies in the agriculture and food security sector should be strengthened and sustained. Climate-related decision support tools like hazard/risk/vulnerability maps need to be refined and connected to decision-making in various levels. Finer spatial resolution may be required to encourage utilization of the said tools in agriculture and food security. High-resolution comprehensive maps could be developed integrating location-specific hazard, population, livelihoods, and capacities information, among others. Capacity building for users in utilizing decision-support tools would also support enhanced application of information. Although climate variability in Myanmar is

attributed to ENSO, the correlation is not well established. Studies to look into such relationship, as well as with other climate drivers, could be conducted to facilitate better forecast translation and application. Analysis of historical data could likewise aid forecast translation. However, the value of historical data in analysis is often overlooked and is often not accessible to stakeholders. Based on forecast and other relevant factors, risk evaluation has to be done and the risk information has to be delivered to relevant stakeholders. Historical data has to be made available for stakeholders' analysis, for better guidance in putting in place short-term and long-term interventions in agriculture and food security. Romano (2010), in his report to FAO, indicated that there should be an integration of expertise, including an agro-meteorologist, in a technical body to convert available data into relevant information for food security.

Inadequate institutional mechanism to ensure that forecasts and advisories reach end-users, including those at the district and community areas. Receipt of information, by relevant stakeholders, remains to be a gap in Myanmar. Intra-institutional mechanisms in ensuring that forecasts and associated advisories reach the last mile, in user sectors, remain weak. Inter-and intra-institutional mechanisms, for information dissemination, have to be redundant and sustained in order for information to be accessible in the sub-national and community levels. Collaboration with MRTV and mass-based organizations (e.g. Myanmar Red Cross Society) has to be harnessed to maximize information dissemination with ample lead time. Forecasts should be included in media programs relative to agriculture; DMH and MOAI could take advantage of MRTV's Farmers Channel to maximize information dissemination. Further, forecast-based advisories could be included in currently available agriculture- and food security-related regular publications.

Capacity building mechanisms for farmers to better apply forecasts in decision-making. In the aftermath of Cyclone Nargis in May 2008, international, regional and other development organizations implemented various interventions, in the sub-national and community levels, for better response to forecast information. These interventions, however, were anchored on extreme events like cyclones and did not include the integrated utilization of forecasts of different timescales. As most of these interventions focused on the utilization of short-range severe weather information, capacity building in forecast-based agricultural planning was not given emphasis. MOAI advocates the use of appropriate crop varieties in various areas in

Myanmar. The utilization of these crop varieties though have to be anchored to seasonal and other forecasts for optimum productivity. Monsoon Forum stakeholders, during the 10th Monsoon Forum, recommended a capacity building mechanism for farmers for integration of climate information of various timescales into planning and decision-making. Capacity building for water associations in monitored information and forecast-based water management should be conducted. Provision of government support, for implementation of appropriate management strategies, could also facilitate better uptake of climate information in agriculture and food security.

Mismatch between available information and user requirements. Various users need different information for application in their sectors. In Myanmar, stakeholders recommended that DMH do a thorough study of information needs of each sector at various levels. This would provide guidance in developing need/demand-based forecast/warning information.

Coarse-resolution climate change scenarios and lack of understanding of end-users of climate variability and change. For stakeholders to better understand their future climate, analysis of location-specific climate variability, trends and projections have to be made. Climate change scenarios currently available are generally having coarse resolution and high uncertainty, hence could not adequately guide adaptation initiatives. Analysis of location-specific (region-, state-, or division-wise) climate variability and development of climate change projections are required to facilitate information application. Access to historical data is necessary in order for agriculture and other relevant sectors to analyze and plan short-term and long-term management strategies.

Regular assessments of capacities and gaps in climate generation and application to guide development initiatives. Forecasting technologies, tools for application, the nature of risks, and information requirements, by different stakeholders, evolve. This dynamic system of forecast generation and application necessitates regular assessments of capacities and gaps, in an end-to-end framework, to ensure that forecast information cater to differential needs of stakeholders vis-à-vis risk management.

Absence of a rigorous drought monitoring system. DMH and MOAI do not have the capacity, at the moment, to issue drought early warning information. It is recommended that institutional capacity be built in both institutions for drought monitoring and early warning.

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Annex 1. Institutions involved in the generation, translation, communication and application of climate information for agriculture and food security

Institution	Roles and Responsibilities	Projects (Coordinating Agencies)
DMH (Department of Meteorology and Hydrology)	<p>DMH, under the aegis of the Ministry of Transport, is primarily mandated to collect hydrological, meteorological and seismological data and provide relevant forecast information, of different timescales, to stakeholders like MoAI, MoLF, MSWRR, GAD, local governments, and other institutions salient to food security. As the national institution providing early warning services, it contributes to the achievement of national goals such as protection of life and property; safeguarding the environment; and national security and sustainable development. This is through provision of information as basis for decision making for:</p> <ul style="list-style-type: none"> • agriculture development and food production • mitigation of impacts of natural hazards/disasters • accomplishment of national programmes/projects • environment and natural resources protection, sustenance, and conservation • ensuring safety of different transportation modes <p>DMH is likewise responsible for conducting research in the fields of meteorology, hydrology, and seismology and other related fields; promote public awareness; and to collaborate with international, regional and other institutions to further DMH's capacity in the generation and dissemination of warning information</p>	<ul style="list-style-type: none"> • Linking Information and Decision Making for Food Security, 2009-2012 (FAO, RIMES, DMH) • MAPDRR: Upgrading of Existing Early Warning Centers (UNDMT, ESCAP, DMH) • MAPDRR: Multi-hazard Meteorological Observation and Forecasting (DMH) • MAPDRR: Enhanced Flood Monitoring and Forecasting Capacities at Township Levels (DMH, irrigation Department) • MAPDRR: Landslide/Drought Study/Monitoring (MES, MGS, Yangon Technological University (YTU), Public Works, • GAD, MoAI, NECC (National Environment Conservation Committee), DMH) • PDRR: Cyclone Tracking and Storm Surge Forecasts (DMH) • MAPDRR: Forest Fire and Haze Monitoring System (NECC, FSD, UN, DMH) • Reducing risks of tsunamis, storm surges, large waves and other natural hazards in low elevation coastal zones (UNESCAP, RIMES, DMH)
MoAI	<p>MoAI is tasked to implement agricultural and rural development policies. With the end-in-view of increasing crop production, MoAI adapts the following flagship strategies:</p> <ul style="list-style-type: none"> • development of new agricultural land • provision of sufficient irrigation water • provision and support for agricultural mechanization • application of modern agro-technologies • development and utilization of modern varieties <p>The key departments/divisions under MoAI, among others, are:</p> <ul style="list-style-type: none"> • Department of Agricultural Research • Myanmar Agricultural Service • Myanmar Industrial Crops Development Enterprise • Irrigation Department • Agricultural Mechanization Department 	<ul style="list-style-type: none"> • Food Security through Strengthening of Institutional Capacity for Seed Production, 2011-2013 (FAO, MoAI - MAS, DAR) • Enhancing Rural Competitiveness of Rural Households in the Greater Mekong Subregion, 2007-2012 (FAO, MoAI) • Capacity Building and Technology Adoption for Sustainable Food Security in Wa Special Region, 2008-2010 (FAO, MoAI) • Support for Sustainable Agriculture and Rural Livelihoods in Northern Rakhine, 2007-2010 (FAO, MoAI) • Support for Special Rice Production Programme (SRPP) in Ayeyarwady and Yangon Divisions, 2009 (FAO, MoAI) • Empower Marginalized Landless Poor and Vulnerable Women-headed households in Northern Rakhine Through Vegetable and Poultry Production

	<ul style="list-style-type: none"> • Settlement and Land Records Department • Water Resources Utilization Department • Myanmar Agricultural Development Bank • Survey Department • Department of Agriculture • Department of Irrigation • Department of Agricultural Planning • Yezin Agricultural University 	<ul style="list-style-type: none"> • Support, 2009 (FAO, MoAI) • Food Security Information for Action Programme, 2009-2012 (FAO, MoAI) • Food Security Through the Strengthening of Institutional Capacity for Seed Production, 2009-2011 (FAO, MoAI) • Water Sector Improvement in Myanmar-Yenwe Irrigation/Drainage Scheme (FAO, MoAI) • Dry Zone Sustainable Food Security and Livelihoods Improvement Project, 2010 (FAO, MoAI) • Improving Household Food Security and Nutrition in Myanmar, 2009 (FAO, MoAI)
DAR (Department of Agricultural Research)	The DAR is the principal agency involved in agricultural research and development. Its research initiatives are centered on increasing crop production through improved seed, crop management, and crop protection techniques, and development of cropping systems most suited to different agro-ecological zones.	<ul style="list-style-type: none"> • Capacity Building and Regional Collaboration for Enhancing the Conservation and Sustainable Use of Plant Genetic Resources in Asia (FAO, University of New England (UNE)) • Increasing Food Security and Farmer Livelihoods through Enhanced Legume Cultivation in the Central Dry Zone, 2007-2010 (Australian Center for International Agricultural Research (ACIAR), ICRISAT, MAS)
DAP (Department of Agricultural Planning)	DAP, as the coordinating arm of the MoAI, facilitates discussion and negotiation, with other MoAI departments and international/regional institutions and evolve management strategies for various agricultural programs and projects. Among its main functions are: preparation of short-, medium- and long-term plans and projects for the agriculture sector; project monitoring and evaluation; data collection, archiving, analysis and reporting of agriculture statistics and publication/dissemination of agricultural information; management of technical arrangements with other institutions, in-country or international, vis-à-vis agriculture programmes; and capacity building of human resource in the agriculture sector.	<ul style="list-style-type: none"> • Sustainable Agriculture and Rural Development for Poverty Reduction Programme in the Central Dry Zone (JICA, DAP) • MAPDRR: Flood Mitigation Plan for the Agriculture Sector (MAS, DAR, Irrigation Department, FAO, Action Aid)
Irrigation Department	The Irrigation Department is responsible for the organization and management of irrigation works, construction of new projects to enhance irrigation services, and investigation, design, and implementation of programmes/projects and initiatives relevant to the utility of surface water	<ul style="list-style-type: none"> • Sustainable development in the Dry Zone for the Mitigation of Drought Impacts (DoF, MES, Fire Services Department (FSD), DMH, MGS, Irrigation Department) • Construction of Various Irrigation Facilities (Irrigation Department)
MAS (Myanmar Agricultural Services)	The key responsibilities of MAS are as follows: Increased production of major crops Improvement of production technology through proper researches on management of soil crop and pest control Development of suitable high-yielding crop varieties Transfer of appropriate crop production technology through agricultural extension programmes Distribution of certified seeds through seed programmes Provision of agricultural inputs Classification of soils and provision of advisory on soil conservation techniques Exploration of export markets for agricultural produce	<ul style="list-style-type: none"> • Special Rice Production Programme (SRPP) in Ayeyarwady and Yangon Divisions (FAO, IRRI, MAS) • Support to Dry Season Crop Production for Small Scale Farmers in Ayeyarwady (EC, MAS) • MAPDRR: Flood Mitigation Plan for Agricultural Sector (MoAI, MAS) • MAPDRR: Promoting Sustainable Development in the Mountain Areas (DAP, Social Welfare Department, MAS)

WRUD (Water Resources Utilization Department)	<p>The WRUD is mandated to perform the following functions:</p> <p>Supply irrigation water by pumping water from rivers and streams and explore the utilization of underground water to enhance crop production</p> <p>Promote socio-economic conditions of rural population through supply of potable water from tube wells and piped water supply reticulation systems</p> <p>Supply water for crop and for human consumption from spring sources</p> <p>Disseminate knowledge and practice of efficient usage of drip irrigation</p>	<ul style="list-style-type: none"> • River Pump Irrigation, 1999-2010 (Irrigation Department, WRUD) • Tube Wells for Irrigation, 1995 (Irrigation Department, WRUD) • Groundwater Irrigation, 2008(Irrigation Department, WRUD)
SLRD (Settlement and Land Records Department)	<p>The key responsibility of SLRD include:</p> <p>Settlement work</p> <p>Collection of agricultural statistics</p> <p>Annual assessment of land revenue and land rent</p> <p>Registration of deeds</p> <p>Agricultural land administration</p>	<ul style="list-style-type: none"> • Preservation of Farming Areas for Urgent Rehabilitation of Agricultural Production and Rural Life in Areas Affected by Cyclone Nargis, 2009-2011 (DAP, Irrigation Department, MAS, SLRD, AMD, Myanmar Agriculture Development Bank (MADP))
AMD (Agriculture Mechanization Department)	<p>The main function of AMD are:</p> <p>To provide tractor hire service to farmers</p> <p>To reclaim lands for cultivation</p> <p>To produce small farm machineries and equipment</p> <p>To import power tillers and farm implements for resale to farmers</p> <p>To research, develop and utilize small farm machineries applicable to the prevailing general conditions of the agricultural sector of the country</p> <p>To propagate the use and technical know-how of small farm machineries among the farmers</p>	<ul style="list-style-type: none"> • Preservation of Farming Areas for Urgent Rehabilitation of Agricultural Production and Rural Life in Areas Affected by Cyclone Nargis, 2009-2011 (DAP, Irrigation Department, MAS, SLRD, AMD, Myanmar Agriculture Development Bank (MADP))
(MPCE) Myanmar Perennial Crops Enterprise	<p>The Myanmar Perennial Crops Enterprise (MPCE), previously the Plantation Crops Division was transfer to, initially formed as one of the major divisions under the Myanma Agriculture Service (MAS), then Agriculture corporation. The plantation crops Division was separated from the Myanma Farms Enterprise and upgraded as the Myanma Perennial Crops Enterprise a new commercial organization. Main functions are:</p> <ul style="list-style-type: none"> • Planning of perennial Crops development planning • Establishment and management of Plantation/Estate • Processing of rubber, palm oil • Extension services and supplies of plating material and other inputs for the development of crops in private sector • Research and training • Marketing 	<ul style="list-style-type: none"> • Development/Productivity of Perennial Crops (MPCE)
(YAU) Yezin Agricultural University	<p>YAU, administered by the MoAI, is the leading institution for higher education in agriculture in Myanmar. The institution's thrust is to provide quality agricultural science training and education to students, and increase the pool of quality agriculturists in Myanmar. Research activities to foster agriculture is among the key activities of the institution.</p>	<ul style="list-style-type: none"> • Linking Information and Decision-Making to Improve Food Security, 2009-2012 (FAO, MoAI, YAU) • Research and development for agricultural enhancement (YAU)
MoF (Ministry of Forestry)	<p>All concerns pertaining forest utilization, regulation, and conservation are under the jurisdiction of the MoF.</p>	<ul style="list-style-type: none"> • All initiatives salient to forestry (MoF)
DoF (Department of	<p>The DOF is responsible for the protection, and conservation of wildlife and sustainable</p>	<ul style="list-style-type: none"> • Sustainable Development in the Dry

Forestry)	management forest resources of the country.	Zone for Mitigation of Drought Impacts (DMH, Irrigation Department, MED, MGS, DZGD, DoF)
DZGD (Dry Zone Greening Department)	Established in 1997, the DZGD, one of the key departments under the MoF, is to undertake environmental conservation and greening activities in the Central Dry Zone of Myanmar. Its objectives include: Greening of the arid region Maintenance of the arid region's ecosystem Fulfill basic requirements for forest produce of the rural population Contribute to socio-economic development of the rural population Raise awareness, among local citizens, of the value and salience of forest and trees Enhance public knowledge on conservation and promotion of natural environment, and facilitate public participation Contribute to climatic balance to support cultivation Prevent desertification	<ul style="list-style-type: none"> Environmentally sustainable food security and micro-income opportunities in the dry zone (FAO, UNDP, DoF, DZGD) Environmentally sustainable food security and micro income opportunities in critical watersheds of Shan State (FAO, UNDP, DoF, DZGD) Environmentally sustainable food security and micro income opportunity in the Ayeyarwady (mangrove) delta (FAO, UNDP, DoF, DZGD) Greening the Dry Zone (ESCAP, DZGD) Sustainable Development in the Dry Zone for the Mitigation of Drought Impacts (DAP, Irrigation Department, DoF)
NECC	Formerly the National Commission for Environmental Affairs (NCEA), NECC is the key coordinating body for environmental protection, conservation, and sustainable development in the country	<ul style="list-style-type: none"> MAPDRR: Promoting Sustainable Development in the Mountain Areas (MAS, DoF, Planning Department, Social Welfare Department)
MSWRR	The MSWRR's key roles include: <ul style="list-style-type: none"> Assist vulnerable groups to reintegrate into society through social work methodologies Resettle and rehabilitate victims of disasters Facilitate resilience vis-à-vis hazards Encourage non-government organizations to participate in national movement for social development Train and form fire services personnel and volunteers to become reserve forces for safeguarding peace and stability of the state 	<ul style="list-style-type: none"> MAPDRR: Development of National Disaster Management Law (ASEAN, ADPC, MSWRR)
RRD	RRD, under the MSWRR, provides emergency relief to those affected by hazards/disasters. It provides assistance to hazard/disaster-prone communities to facilitate mitigation of impacts of hazards/disasters. During hazard/disaster events, the RRD coordinates with UN institutions and other organizations for foreign assistance.	<ul style="list-style-type: none"> Hazard Profile of Myanmar (DMH, DoF) MAPDRR: Implementation of Standing Order (Irrigation Department, FSD, MES, MGS, MIMU, ADPC, UNDP)
MoLF) Ministry of Livestock and Fisheries	The MoLF's main goals include the conservation of resources for fish/shrimp and other marine components; providing assistance to farmers in the livestock development through the provision of breeding stocks, animal feeds, medicines, etc; prevention and treatment of diseases in livestock; and promotion of bee-keeping industry, among others.	<ul style="list-style-type: none"> All initiatives, projects and programmes relative to the livestock and fishery sectors are under the jurisdiction of the MoLF (MoLF)
GAD (General Administration Department)	GAD, under the Ministry of Foreign Affairs, has the responsibility of supervising local governments, maintaining law and order, overseeing maintenance of peace and order in local levels including communities, regional development and upholding of public interest.	<ul style="list-style-type: none"> MAPDRR: Micro-Finance Schemes: Alternative Livelihood Options (UNDP, FAO, OXFAM, PACT Myanmar)
ACF (Action Against Hunger)	Recognized as one of the key institutions in addressing malnutrition issues, ACF's work is centered at saving the lives of malnourished children and providing communities with access to safe water and sustainable ways to	<ul style="list-style-type: none"> Food Security in Kayah State (Switzerland, ACF) Empowering communities and improving their living conditions and health status through increased access to safe water,

	address hunger. ACF works in emergency situations of conflict, natural disaster, and chronic food security.	<p>sanitation and hygiene facilities within vulnerable and marginalized communities in Kayah State, 2010 (ECHO, ACF-France)</p> <ul style="list-style-type: none"> • Integrated Approach to malnutrition through nutrition, health, care practices, 2010-xxxx (ECHO, ACF-France) • Integrated Wash and Food Security Project for Uprooted Communities in Kayah State (EU, ACF)
ACMECS	It is a cooperation framework amongst Cambodia, Lao PDR, Myanmar, Thailand, and Vietnam to promote balanced development in the sub-region. Among its flagships are enhancing productivity and resilience of the agriculture sector	<ul style="list-style-type: none"> • Strengthening Human Resource Capacities for Agricultural Competitiveness (ACMECS) • Strengthening Agricultural Market Information Service (ACMECS)
ADRA (Adventist Development and Relief Agency)	ADRA, an independent, humanitarian agency established by the Seventh Day Adventist Church, works in the field of individual and community development and disaster response in Myanmar.	<ul style="list-style-type: none"> • Food Insecurity Reduction in Myanmar (ADRA UK, EC, ADRA) • Enhanced Food Security Initiative (ADRA NZ, WFP, ADRA) • Social Assistance, Infrastructure and Livelihood Project • Enhance Food Security Initiative (UNOCHA, ADRA, WFP, ADRA) • Livelihood Enhancement to Reduce Poverty (LIFT, ADRA) • Livelihood Replacement Project (ASB, ADRA)
AVSI Foundation (International Volunteers Service Association)	AVSI is a member of the Food Security Working Group in Myanmar. It is geared to support human development in developing countries, particularly in education and promotion of human dignity. Among its program areas are education, child development and family support; agriculture, food security and water; economic strengthening and employment; and emergency and post-conflict assistance, among others.	<ul style="list-style-type: none"> • Improvement of Food Security and Sustainable Agriculture Development: Support to Crop Production Programme in Ayeyarwady, 2010-2012 (Government of Italy, AVSI) • Food Security and Water Availability in Mandalay Division, 2011-2012 (AVSI, MOAI/MAS) • Support to special rice production, 2010-2011 (FAO, AVASI) • Protracted Relief and Recovery Operation, Southern Shan, 2008-2010 (WFP, KMSS-Phe Kone, AVSI)
CARE International	<p>The activities of CARE International are anchored on its mission is to serve individuals and families in the poorest communities. Its strategies include:</p> <ul style="list-style-type: none"> • enhancing capacity for self-help • providing economic opportunity • delivering relief in emergency • influencing policy decisions • addressing discrimination 	<ul style="list-style-type: none"> • Critical Water, Sanitation, and Hygiene Needs, Provide Emergency Shelter and Promote Food Security for Vulnerable Households in Northern Rakhine (Australia, CARE International) • Livelihood Rehabilitation for ex-poppy farmers in Kokang (Switzerland, CARE International)
Caritas Switzerland	Caritas Switzerland provides emergency disaster relief and cooperates with other partners in the implementation of reconstruction projects and promote sustainable development. It provides special services for peace building, micro-credit and institutional development. Caritas' focal activities are on peace and reconciliation, emergencies, economic justice, climate change, HIV and AIDS, women and migration.	<ul style="list-style-type: none"> • DRR, Capacity Building, Agriculture, Education, Humanitarian Support (Switzerland, Caritas Switzerland) • Farmer Field Schools (Switzerland, Caritas Switzerland)
Deutsche Welthungerhilfe e.V.	Deutsche Welthungerhilfe e.V. is a relief organization engaged in food security, rural development and natural resources preservation initiatives.	<ul style="list-style-type: none"> • Improvement of Livelihoods and Reinforcement of Participatory Development Processes in Resettled Villages in Northern Shan, Wa Special Region, Wein Kao District, and Naung Kit, 2008-2012 (EU,

<p>ECHO (European Community Humanitarian Office)</p>	<p>ECHO, the humanitarian arm of the European Union, has flagships in humanitarian aid and civil protection.</p>	<ul style="list-style-type: none"> • Deutsche Welthungerhilfe Ev) • Empowering communities and improving their living conditions and health status through increased access to safe water, sanitation and hygiene facilities within vulnerable and marginalized communities in Kayah State, 2010 (ECHO, ACF-France) • Reduced vulnerability of the Myanmar population living in coastal areas most affected by recurrent natural hazards, 2010 (ECHO, Malteser International) • Integrated Approach to malnutrition through nutrition, health, care practices, 2010-xxxx (ECHO, ACF-France) <p><i>Other projects are indicated in preceding and later part of this document.</i></p>
<p>FAO</p>	<p>FAO, an arm of the United Nations, undertakes initiatives to attain food security: raise nutrition levels, improve productivity in agriculture, improve standard of living of the rural population, and contribute to the economic growth.</p> <p>FAO, being a knowledge organization, facilitates and shares salient information about food, agriculture and natural resources to various stakeholders.</p>	<ul style="list-style-type: none"> • Capacity building to improve market access for fish and fishery products, xxxx-2014 (FAO) • Enhancing Food and Nutritional Security Through Crop Production in Northern Rakhine, Myanmar, xxxx-2012 (FAO) • Prevention and Control of Human and Human Influenza in Myanmar, xxxx - 2012 (FAO) • Immediate Technical Assistance to Strengthen Emergency Preparedness for Highly Pathogenic Avian Influenza, xxxx, 2012 (FAO) • Sustainable Small-scale Fisheries and Aquaculture Livelihoods in Coastal Mangrove Ecosystems, xxxx-2012 (FAO) • Support to Special Rice Production, xxxx-2012 (FAO) • Immediate Rehabilitation of Farming, Coastal Fisheries and Aquaculture Livelihoods in the Cyclone Nargis Affected Areas, xxxx-2012 (FAO) • Oil Crops Development Project, xxxx-2012 (FAO) • Enhancing Income through Layer Duck Rearing for Nargis Affected Farmers in Bogalay Township, xxxx-2013 (FAO) • Support for Improvement of Crops, Small Livestock and Fish Production for Small Farmers and Landless Households, xxxx-2013 (FAO) • Enhancing Milk Consumption and Livelihoods Through School Milk Programmes Linked To Smallholder Dairy Operations, xxxx-2012 (FAO) • Capacity Development to Reduce Post-Harvest Losses in Horticultural Chains, xxxx-2013 (FAO) • Capacity Building for the Spread Prevention and Management of Cassava Pink Mealybug in the Greater Mekong Subregion, xxxx-2012 (FAO) • Bioenergy and Food Security in ASEAN, xxxx-2014 (FAO) • Sustainable Management of the Bay of Bengal Large Marine Ecosystem, xxxx-2014 (FAO) • Production of Certified Fruit and Vegetables for Export through Integrated Supply Chain Management,

		<p>xxxx-2013 (FAO)</p> <ul style="list-style-type: none"> • Smallholder Dairy Development: Improving the Bargaining Power and Sustainable Livelihood Smallholder Dairy Farmers through the Enhancement of Productivity and Market Access in Dairy, xxxx-2015 (FAO) • Intra-African Training and Dissemination of Technical Know-How for Sustainable Agriculture and Rural Development with Africa-ASEAN Country Cooperation within the Framework of South-South Cooperation, xxxx-2013 (FAO) • Enhancing Agricultural Competitiveness of Rural Households in the Greater Mekong Sub-Region, xxxx-2012 (FAO) • Capacity Building and Regional Collaboration for Enhancing the Conservation and Sustainable Use of Plant Genetic Resources, xxxx-2012 (FAO) • Linking Information and Decision-Making to Improve Food Security, 2009-2012 (FAO) • Medium-Term Cooperation Programme with Farmers' Organizations in Asia and the Pacific, xxxx-2012 (FAO) • Capacity Building and Implementation of International Food Safety Standards, xxxx-2016 (FAO) • Enhanced Food Security and Livelihoods in Northern Rakhine, 2010-xxxx (CERF, FAO) • Emergency support to restore food security in Cyclone Nargis-affected areas through the provision of agriculture inputs and technical assistance, 2006-2008 (CERF, FAO) • Emergency Support to the Restoration of Food Security in Areas of Southern Myanmar Affected by Cyclone Nargis, 2003-2009 (UK, FAO) • Emergency Assistance to support the rehabilitation of the Livelihoods of Cyclone-Affected Families in Ayeyarwady and Yangon Divisions, 2006-2009 (FAO) • Coordination of Cyclone Nargis Agricultural Emergency and Rehabilitation Interventions, 2007-2009 (UK, FAO) • Emergency Supply of Fishing Gear Boat Repair Tools and Fish Processing Implements, and Aquaculture Supplies to Immediately Restore Food Security for Vulnerable Fishermen and Fish Farmers Affected by Cyclone Nargis, 2007-2009 (SWEDEN, FAO) • Emergency support to restore food security and livelihoods for the most Cyclone Nargis-affected Farmers through Distribution of Draught Animals for Cultivation in Ayeyarwaddy and Yangon, 2008-2009 (Price Water Coopers Charitable Foundation, FAO) • Emergency Support to Restore Food Security for Cyclone Nargis-Affected Farmers through the Provision of Agriculture Inputs and Technical Assistance, 2009 (Italy, FAO)
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IFRC	<p>Founded in 1919, and having a membership of 187 National Societies of Red Cross and Red Crescent, IFRC implements operations to assist victims of disasters, and combines this with development work to strengthen the capacities of its member National Societies. Its work is focused on four (4) core areas: promoting humanitarian values, disaster response, disaster preparedness, and health and community care.</p>	<ul style="list-style-type: none"> • Support to Livelihoods Programme for Vulnerable Households in Nargis-Affected Areas (Taiwan Red Cross Society, IFRC)
IMC (Indo-Myanmar Conservation)	<p>The mission of IMC include the prevention of extinction of threatened wildlife by facilitating the design and implementation of community-based conservation projects and to contribute to the active participation of civil society in biodiversity conservation. IMC provides technical and financial assistance to communities, particularly in strengthening the capacity of communities in participating in wildlife protection for sustainable livelihood and development.</p>	<ul style="list-style-type: none"> • Supporting Sustainable Fisheries in Indawgi Lake, Kachin State, 2011-2014 (EU, IMC)
JICA (Japan International Cooperation Agency)	<p>JICA interventions in Myanmar are guided by the following mission: addressing global agenda reducing poverty through equitable growth improving governance achieving human security</p>	<ul style="list-style-type: none"> • Development Study on Sustainable Agriculture and Rural Development for Poverty Reduction Programme in the Central Dry Zone, 2005 (JICA, MoAI) • Improving food security, nutrition, and livelihoods of vulnerable population (JICA, WFP)
Malteser International	<p>Malteser International's work is centered on:</p> <ul style="list-style-type: none"> • Provision of relief to major emergencies and implement reconstruction and 	<ul style="list-style-type: none"> • Improved Water and Sanitation for Conflict-Affected Vulnerable Population in Northern Shan, 2010 (ECHO, Malteser)

	<p>rehabilitation initiatives with a community focus</p> <ul style="list-style-type: none"> • Establish and promote primary health care services and contribute to better health through nutrition programmes • Contribute to better health and better living conditions through the provision of access to drinking water, sanitation and hygiene (WASH) facilities • Implement livelihood and social initiatives to ensure people's income security and reduce their vulnerability and poverty • Establish and promote disaster risk reduction activities particularly in the community level 	<p>International)</p> <ul style="list-style-type: none"> • Reduced vulnerability of the Myanmar population living in coastal areas most affected by recurrent natural hazards, 2010- (ECHO, Malteser International) • Support for Malnourished Children and Their Families in Northern Rakhine State (Malteser International) • Water and Sanitation in the Slums of Dawbon Township (Malteser International)
MSF (Medecins Sans Frontieres)-Netherlands	MSF-Netherlands delivers emergency aid to people affected by armed conflict, epidemics, natural disasters and exclusion from healthcare.	<ul style="list-style-type: none"> • Basic health care programme with special focus on malaria and nutrition (ECHO, MSF-Netherlands)
NRC (Norwegian Refugee Council)	<p>Working in Myanmar since 2008, NRC provides protection and humanitarian assistance to refugees and internally displaced persons. Programme activities are centered on the following core activities:</p> <ul style="list-style-type: none"> • building of homes and schools • distribution of food and non-food relief items • information, counseling and legal assistance • camp management • education 	<ul style="list-style-type: none"> • Joint Initiative for Livelihoods and Shelter Recovery in Laputta, 2010 (UK, NRC)
RIMES	<p>RIMES addresses differential needs of member and collaborating States in end-to-end multi-hazard early warning through capacity building in:</p> <ul style="list-style-type: none"> • hazard monitoring, detection analysis, prediction and forecasting • risk assessment • potential impact analysis • generation of tailored risk information of different time scales • risk communication • application of tailored risk information in decision-making 	<ul style="list-style-type: none"> • RIMES Master Plan 2010-2014 (RIMES, DMH) • Linking Information and Decision-Making to Improve Food Security, 2009-2012 (EC, FAO, RIMES) • Capacity Building of DMH in the Generation of Forecasts of Different Timescales (RIMES, DMH) • Reducing Risks of Tsunamis, Storm Surges, Large Waves and Other Natural Hazards in Low Elevation Coastal Zones (NESCAP, RIMES, DMH)
UNDP	<p>UNDP's initiatives are targeted at helping countries build and share solutions for poverty reduction and the achievement of the Millennium Development Goals, Democratic Governance, Crisis Prevention and Recovery, Environment and Energy for Sustainable Development. UNDP helps developing countries attract and use aid effectively and encourages the protection of human rights, capacity development and the empowerment of women.</p>	<ul style="list-style-type: none"> • Strengthening disaster risk reduction practice through research and enhanced inter-agency coordination, 2010 (ECHO, UNDP) • Support to Income Generation Activities in Flood Affected Communities (Australia, UNDP) • Improving critical access to safe drinking water supply and facilities in Rathedaung, 2010 (CERF, UNDP) • Promoting food security of the most vulnerable households through increased food production and off-farm income, 2010 (CERF, UNDP)
UNHCR	<p>The UNHCR is mandated to lead and coordinate interactional action to protect refugees and resolve refugee problems. Its primary purpose is to safeguard the rights and well-being of refugees. It strives to ensure that everyone can exercise the right to seek asylum and find safe refuge in another state, with the option to return home voluntarily,</p>	<ul style="list-style-type: none"> • Provision of safe drinking water and sanitary facilities in Northern Rakhine, 2010 (CERF, UNHCR) • Treatment of severe acute malnutrition among children under five in Northern Rakhine, 2010 (CERF, UNHCR)

	integrate locally or resettle in a third country. It also has the mandate to help stateless people.	
UNICEF	UNICEF is an advocate of children's rights, works to address children's basic needs, and facilitating opportunities for children to achieve their full potential.	<ul style="list-style-type: none"> Prevention and treatment of acute malnutrition and micronutrient deficiencies among children and pregnant and lactating women in Northern Rakhine, 2010 (CERF, UNICEF)
UNODC (United Nations Office on Drugs and Crime)	<p>UNODC's focus is the fight against drugs, crime and terrorism. UNODC's work pillars are:</p> <ul style="list-style-type: none"> enhance the capacity of Members States to counteract drugs, crime and terrorism increase knowledge and understanding of drugs and crime issues and expand the evidence base for policy and operational decisions assistance in the ratification and implementation of relevant international treaties, development of domestic legislation against drugs, crime and terrorism, and the provision of secretariat and substantive support to treaty-based and governing bodies 	<ul style="list-style-type: none"> Food Security Programme in Four (4) Village Tracts in Pinlaung Township, Southern Shan, 2009-2013 (EU, UNODC)
WFP	<p>WFP is the food aid arm of the United Nations. WFP's key policies and strategies are:</p> <ul style="list-style-type: none"> save lives in refugee and other emergency situations improve nutrition and quality of life of the most vulnerable people at critical times in their lives help build assets and promote the self-reliance of the poor particularly through labour-intensive work programmes <p>WFP's priorities are support to disaster prevention, preparedness and mitigation and post-disaster rehabilitation activities.</p>	<ul style="list-style-type: none"> Food Aid, xxxx-2011 (WFP) Food Assistance, xxxx-2013 (CIDA, WFP) Provision of Food Assistance for vulnerable households in Northern Rakhine, 2010 (ECHO, WFP) Improving food security, nutrition status and livelihoods of vulnerable populations, 2010 (CERF, WFP) Food assistance to the most vulnerable people and their family in Northern Rakhine, Kokang, Special Region I, and Wa Special Region II, Northern Shan, 2010 (ECHO, WFP) Support to livelihood activities for food-insecure people in Northern Rakhine and Kokang, 2010 (ECHO, WFP) Food Aid, 2010 (Germany, WFP) Improving food security, nutrition, and livelihoods of vulnerable population (JICA, WFP)
WV (World Vision)	<p>WV plays a key role in emergency relief and reconstruction. Its core competencies include:</p> <ul style="list-style-type: none"> Food security and agricultural recovery Commodities and logistics Health and nutrition Displaced persons resettlement programming 	<ul style="list-style-type: none"> Livelihood Recovery WASH Child Protection Disaster Risk reduction <p>(WV Hong Kong, WV New Zealand, WV Australia, WV Singapore, WV USA, WV Canada, AusAid, Disaster Emergency Committee Grant)</p>



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