COUNTRY REPORT
CLIMATE RISK MANAGEMENT IN INDONESIA

A report of ongoing and potential climate risk management strategies and options to address current and future climate risks in Indonesia

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

January, 2013

United Nations Development Programme

CRISIS PREVENTION AND RECOVERY

Supported by
United Nations Development Programme (UNDP)
Bureau for Crisis Prevention & Recovery (BCPR)-Bureau for Development Policy (BDP)
Under the
Climate Risk Management - Technical Assistance Support Project (CRM-TASP)

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Cite as: United Nations Development Programme (UNDP), Bureau for Crisis Prevention and Recovery (BCPR). 2013. *Climate Risk Management for Agriculture Sector in Indonesia*. New York, NY: UNDP BCPR

Published by:
United Nations Development Programme (UNDP), Bureau for Crisis Prevention and Recovery (BCPR), One UN Plaza, New York-10017

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CONTENTS

LIST OF ABBREVIATIONS AND ACRONYMS

ACIAR	Australian Centre for International Agricultural Research
BAPEDDA	Regional development planning agency
BAPENNAS	National development planning agency
BCPR	Bureau for Crisis Prevention and Recovery
BDP/EEG	Bureau for Development Policy Energy and Environment Group
BIPP	District center for information and extension
BKP	Agricultural extension office
BMKG	Meteorological, Climatological, and Geophysical Agency
BNPB	National disaster management agency
BPBD	Local disaster management agency
BPS	National statistics agency
BULOG	National Food Logistics Agency
CCA	Climate Change Adaptation
CFS	Climate Field School
CRM TASP	Climate Risk Management Technical Assistance Support Project
CRM	Climate risk management
DITLIN	Directorate for Crop Protection
DRR	Disaster Risk Reduction
ENSO	El Niño-Southern Oscillation
GDP	Gross Domestic Product
GNI	Gross National Income
ICCSR	Indonesia Climate Change Sectoral Roadmap
ICZM	Integrated coastal zone management
IFM	Integrated Forestry Management
IITM	Indian Institute of Tropical Meteorology
IMR	Infant Mortality Rate
IPB	Bogor Agricultural University
IPCC	Intergovernmental Panel on Climate Change
IWM	Integrated water management
KLH	Ministry of Environment
LAPAN	National institute of aeronautics and space
MJO	Madden-Julian Oscillation
MMR	Maternal Mortality Ratio
NAD	Nanggroe Aceh Darussalam
NAP	National Action Plan
NGOs	Non Governmental Organizations
NTB	Nusa Tenggara Barat
NTT	Nusa Tenggara Timur
NWRDP	National Water Resources Development Plan

PDO	Pacific Decadal Oscillation
RAN/PRB	Rencana Aksi Pengurangan Risiko Bencana (National Action Plan on Disaster Risk Reduction)
RKP	Rencana Kerja Pemerintah (Annual Government Workplan)
RPJM	Medium-term development plan
RPJMN	Rencana Pembangunan Jangka Menengah Nasional (National Medium Term Development Plan)
RPJPN	National Long Term Development Plan
SRES	Special Report on Emissions Scenarios
SST	Sea Surface Temperature
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USAID/OFDA	United States Agency for International Development/ Office of Foreign Disaster Assistance

FOREWORD

Climate change has the potential to exacerbate conflict, cause humanitarian crises, displace people, destroy livelihoods and set-back development and the fight against poverty for millions of people across the globe.

For example, it is estimated that over 20 million people in the Mekong Delta and 20 million in Bangladesh could be forced to move as their homes are affected by saltwater incursion from rising sea levels. Entire populations of some low lying island states, such as Nauru or the Maldives may have to be relocated. In countries like Honduras, where more than half the population relies on agriculture, climate induced risks, such as hurricane Mitch in 1998, which caused over USD 2 billion in agricultural losses, will continue to pose a staggering potential for damage. Similarly, climate risk assessments in Nicaragua show that changes in rainfall patterns, floods and drought could put human health at risk by increasing the prevalence of respiratory and water borne diseases and malnutrition.

Long-term incremental changes will mean that people everywhere must learn to adapt to weather or rainfall patterns changing, or to shifts in ecosystems that humans depend upon for food. Perhaps more worrying however, is that climate variability and change will also bring unpredictable weather patterns that will in turn result in more extreme weather events. Heat waves, droughts, floods, and violent storms could be much more common in the decades to come. Climate change is "loading the dice" and making extreme weather events more likely. These disasters will undermine the sustainability of development and render some practices, such as certain types of agriculture, unsustainable; some places uninhabitable; and some lives unliveable.

As climate change creates new risks, better analysis is needed to understand a new level of uncertainty. In order to plan for disasters, we need to understand how climate change will impact on economies, livelihoods and development. We need to understand how likely changes in temperature, precipitation, as well as the frequency and magnitude of future extreme weather will affect any sector, including agriculture, water-use, human and animal health and the biodiversity of wetlands.

This report is a product of the *Climate Risk Management – Technical Assistance Support Project*, which is supported by UNDP's Bureau for Crisis Prevention and Recovery, and Bureau for Development Policy. This is one in a series of reports that examine high-risk countries and focus on a specific socio-economic sector in each country. The series illustrates how people in different communities and across a range of socio-economic sectors may have to make adaptations to the way they generate income and cultivate livelihoods in the face of a changing climate. These reports present an evidence base for understanding how climatic risks are likely to unfold. They will help governments, development agencies and even the communities themselves to identify underlying risks, including inappropriately designed policies and plans and crucial capacity gaps.

This series is part of a growing body of climate change adaptation resources being developed by UNDP. The Climate Risk Management – Technical Assistance Support Project has formulated a range of climate risk management assessments and strategies that bring together disaster risk reduction and climate change adaptation practices. The project is designing a common framework to assist countries in developing the necessary capacity to manage climate-induced risks to respond to this emerging threat. The climate risk assessments discussed in this report and others in the series will feed into a set of country-level projects and regional initiatives that will inform the practice of climate risk management for decades to come.

Addressing climate change is one of UNDP's strategic priorities. There is strong demand for more information. People at all levels, including small communities want to understand the potential impact of climate change and learn how they can develop strategies to reduce their own vulnerability. UNDP is addressing this demand and enabling communities and nations to devise informed risk management solutions. UNDP recognises that climate change is a crucial challenge to sustainable development and the goal of building resilient nations.

As the full effect of climate change becomes apparent, it is assessments such as these that will become the lynchpin of national responses and adaptation strategies for many years to come. Like the threat from many disasters, there is still time to prepare for the worst impacts of climate change in developing countries if we expand our understanding now.

This knowledge must be combined with real preparedness and action at all levels. Only then will we be able to stave off the worst impacts of climate change in the most vulnerable and high risk countries of our world.

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ACKNOWLEDGEMENTS

The Report *Climate Risk Management for Agriculture Sector in Indonesia* was commissioned under the Climate Risk Management – Technical Assistance Support Project (CRM-TASP), a joint initiative by the Bureau for Crisis Prevention and Recovery (BCPR) and the Bureau for Development Policy (BDP), UNDP and implemented by Regional Integrated Multi-Hazard Early Warning System for Africa and Asia (RIMES) through a contract administered by Asian Disaster Preparedness Center.

The Project, its methodology and analytical framework was conceptualized by Maxx Dilley, Disaster Partnerships Advisor and Alain Lambert, Policy Advisor, Disaster Risk Reduction and Recovery Team (DRRT), BCPR with key inputs from Kamal Kishore, Programme Advisor, DRRT, BCPR and Ms. Bo Lim, Special CC Advisor, Environment and Energy Group (EEG), BDP.

Within BCPR, the Project implementation process has been supervised by Alain Lambert and Rajeev Issar who provided regular inputs to ensure in-depth climate risk assessments and identification of tangible risk reduction and adaptation options. From BDP, Ms. Mihoko Kumamoto and Ms. Jennifer Baumwoll provided their inputs to refine the assessment and recommendations. The climate risk assessment has also benefitted immensely from the strategic guidance provided by Jo Scheuer, Global Coordinator, DRRT, BCPR and by Ms. Veerle Vandeweerd, Director, EEG, BDP.

The Project team would like to acknowledge and give special thanks to the main authors of the Report from RIMES.

For their valuable contribution to the project implementation and climate risk assessment process, the Project team and lead authors would like to gratefully acknowledge the unstinted support provided by colleagues from UNDP Indonesia Country Office who provided regular inputs and anchored the process at the country level, officers from the national/sub-national nodal department/ agency, their officers and other stakeholders.

The climate risk assessments under the CRM-TASP project have been undertaken with the funding support of the Government of Sweden.

EXECUTIVE SUMMARY

Indonesia is an archipelagic country comprising of over 17,000 islands of which 6,000 are inhabited spread across a vast geographical area from 7ºN and 11ºS and 94ºE and 141ºW. It is a lower middle income country with a per capita income of US $2,500. Indonesia has been growing at an average of 6 per cent, with the industrial and services sector as drivers of its growth.

The contribution of agriculture sector to total GDP is less than 15 percent. However, 40 percent of livelihoods are dependent on agriculture. 70 percent of farm households are marginalised and average land holding is 0.7 ha. In underdeveloped regions such as NTT, proportion of rural households dependent on agriculture is more than 80 per cent and food security related concerns such as malnutrition is very high in these poor regions. Government of Indonesia prioritised agriculture sector and reducing regional imbalances as one of its major development goals in the recent years, considering that agricultural growth is the key to reducing poverty and ensuring food security.

The development goals of Government of Indonesia are disrupted due to periodic climate shocks that impacts agriculture sector and thus aggravating food security and poverty situations. On an annual basis, 300,000 ha of crop lands are rendered unproductive due to deficient years even in so-called 'normal years'. Periodic El Niño could amplify the area to 1 million ha translating to 5 million tonnes of food grains. Indonesia's food security situation is delicately balanced with a demand and supply gap of 1.5 to 2 million tonnes, however the climate related shocks such as El Nino could further widen the food deficit thus forcing the Government of Indonesia to import several million tonnes of food grains.

There is a possibility to utilise climate information to guide crop diversification, horticulture development and livestock and fisheries management. In addition, climate forecast information could be applied for adjusting crop calendars and bringing lands including unused (swamp) lands to increase production and reduce dependence on imports. Despite these possibilities, experience of the past decade of applying climate forecast information shows that it is not fully realised due to several constraints.

Effective generation and application of climate information for resource management is contingent upon availability of functional irrigation, research and development mechanisms and extension support. Inadequacy of these pre-requisites rendered the potential climate risk information application for Indonesia ineffective.

Due to lack of science-based climate decision-support tools the food management decisions are taken subjectively. Food management is a serious political issue within Indonesia considering influential stakeholder's and traders' political interests. This results in over-estimating import needs resulting in depressed prices causing enormous losses to the farmers and the economy.

Further, an analysis of government priorities reflected in agriculture sector budget reveals that that there is a trend of decreasing allocation for irrigation, research and development and extension support and increasing allocation to subsidies. This non-productive allocation in the form of fertilisers, seeds, undertaking market operations for stabilising prices, accounts for almost 40 per cent of the total agricultural spending. Currently more than 50 per cent of irrigation systems are dysfunctional and research and development systems are not able to draw lessons from the experience of applying climate information for resource management.

As adequate investment is not available for enhancing agricultural production, agriculture sector has been stagnant in the last decade with an average growth rate of 3 per cent that does not meet the domestic demands nor provide enough income to its workforce. This situation forces Government of Indonesia to depend on social safety net programmes to the tune of 60 trillion Rupiah devoted to support 19.1 million poor households by providing subsidised rice (at 70 per cent price subsidy at the rate of 15 kg/ month/ household), direct cash of 100,000 Rupiah month/ per household, free health care and subsidised education for primary, secondary schools.

Hence there is a need to revisit policy priorities to reverse the priorities from subsidies and safety net programmes to support agriculture production infrastructure, to enable it to realise potential benefits of climate risk information, and encourage research to develop decision-support tools to better manage food security decisions.

In addition to national concerns on food security discussed above, there is a need to focus attention on climate stressed regions such as NTT. Such regions require a concerted effort to apply climate knowledge to guide development as well as apply climate forecast information for resource management from season to season. Climate risk assessment in NTT reveals that application of climate risk information could effectively reduce its dependency on national support through better management of crop systems by application of climate forecast information. Climate knowledge could provide a basis for agriculture livestock based system, agro-forestry and insulating income-generating activities from climate risk.

Due to decentralisation of powers to local government there is an enabling environment now available at the provincial and local levels to integrate climate information application for resource- and risk-management. The climate change concerns have been duly recognised in Indonesia and there are several initiatives to provide institutional and policy support for climate change adaptation measures.

However, the interventions are still guided by three distinct domains- disaster risk management, development planning and climate change adaptation frameworks. Risk assessment, risk prioritization and climate risk reduction processes are still under development and enormous capacity building of institutions are required to undertake these functions in a systematic, coherent and user-focussed manner.

Appreciating that the high predictability of El Niño has enormous potential for reducing climate risks in Indonesia, the MOE through CRM TASP started evolving an action plan with the participation of all stakeholders to adopt CRM approach to address constraints identified in realising the CRM options both in NTT and the national level starting with food security sector. The key climate risk management strategies recommended include (i) delineation of risk zones for food production by using climate risk assessment results (ii) application of seasonal forecasts to enhance food production (iii) integration of CRM decision-support tools for food logistics management and (iv) reforming the Climate Field School (CFS) program.

INTRODUCTION

BACKGROUND

Climate risk management (CRM) is an inter-disciplinary, multi-stakeholder process that involves analysis of climate-related risks leading to consensus-based identification and prioritization of risk management actions to anticipate and manage both extant and emerging climate risks.

Climate Change can further alter the observed climate mean or cause changes in nature of extremes (severity, frequency, spread, duration and timing) as well as possible surprises. The resultant climate risks could resemble current climate variability patterns, but with higher amplitude variations. Hence, the CRM suggests that pattern of risks could be anticipated and the experiences of present systems in dealing with these risks could be drawn upon towards building resilience to long-term climate change. For climate "surprises," while past climate patterns may not provide any clue as to how they would unfold and manifest, human experiences in dealing with extreme climate events may provide guidance for dealing with uncertainties associated with climate change-related risks. Thus from a policy point of view, building the capacities of institutions and systems around managing current climate extremes and thereby a resilient development, could also assist to take care of "surprises."

Climate risk management framework has been adopted to assist countries to develop capacity to manage risks associated with climate variability and change, developed by the United Nations Development Programme (UNDP), through its Bureau for Crisis Prevention and Recovery (BCPR), responsible for assisting countries to develop capacity to better manage disaster risks, and Bureau for Development Policy Energy and Environment Group (BDP/EEG), responsible to assist countries to develop capacity to adapt to climate change. Climate Risk Management Technical Assistance Support Project (CRM TASP) has been evolved to operationalize the CRM framework by integrating CCA and DRR. The Regional Integrated Multi-hazard Early Warning System for Africa and Asia (RIMES) in collaboration with Asian Disaster Preparedness Center has been tasked with implementing the CRM TASP framework in assessing risk management priorities and capacity needs into development planning in six countries in Asia, including Indonesia.

APPROACH AND METHODS

The CRM TASP was initiated through a regional inception meeting organized for the UNDP focal points and key government representatives from the four countries (Armenia, Ecuador, Indonesia and Mozambique [1]) at Bangkok, Thailand from 29 September to 01 October 2008. In Indonesia a national workshop and stakeholder consultation was also held in Jakarta on 01 April 2009 in collaboration with UNDP and Meteorological, Climatological, and Geophysical Agency (BMKG), that reviewed approaches to a background country paper on climate change adaptation in Indonesia, discussed methodologies for conducting district-level climate change impacts assessments, presented a sample application of district-level climate change impacts assessment methodologies in Belu District, Nusa Tenggara Timur (NTT), identified and prioritized climate change adaptation projects for Belu District and discussed application of district-level climate change impacts assessments in Nanggroe Aceh Darussalam (NAD). 65 participants from government agencies, donor agencies, nongovernmental organizations, private companies, and representatives from NTT and NAD participated in the workshop.

1 Mozambique was unable to participate and an inception mission to Maputo was undertaken instead.

The project implementation in Indonesia involved the United Nations Development Programme's Crisis Prevention and Recovery team, the Ministry of Environment and GRM International (as local consultant) as well as the Indian Institute of Tropical Meteorology (IITM) through the implementation process outlined below (see table 1).

TABLE 1. PROJECT STEPS AND METHODS

PROJECT STEP & PURPOSE		SPECIFIC STEPS APPLIED IN INDONESIA
1. Initiation	• Introduce CRM TASP	• Inception Meeting and discussions with key stakeholders
2. Climate risk assessment	• Participatory risk assessment involving stakeholders	• District level studies conducted in collaboration with UNDP in NTT • Participatory analysis of climate data initiated in collaboration with BMKG and IITM for NTT and Aceh to derive extreme weather and climate indices
3. Development of CRM programme	• Identify stakeholder needs to integrate CRM into agriculture and food security	• Assessment of needs of departments and existing gaps in applying CRM approach, and ways to address the gaps
4. Institutionalisation of climate risk management	• Integrate CRM into agriculture and food security planning processes	• Sharing CRM Risk assessment options with stakeholders through Ministry of Environment
5. Evolution of action plan for capacity building	• To build capacities for CRM among stakeholders	• Consensus-based evolution of action plan starting with food security
6. Documentation & Report writing	• Documentation and finalisation of CRM TASP report	• Stakeholder's meeting held in collaboration with Ministry of Environment and UNDP to review the draft report at Bogor on 19-20 October 2011

A regional workshop on analysis of extremes, in which two BMKG forecasters participated, was conducted jointly in collaboration with the Indian Institute for Tropical Meteorology (IITM) for all four CRM-TASP countries in Pune, India in March 2009. The available datasets for NTT and Aceh were analyzed using a methodology for understanding the behaviour of (past) extreme climate parameters, such as high temperature and extreme rainfall episodes to identify indices and indicators of climate change and variability, with particular emphasis on the creation of indices of daily to seasonal extremes at national level using standardized software packages. Initial assessment conducted under the project focussed on several sectors- agriculture, forestry, fisheries, water resources and infrastructure. This has since been narrowed down to one critical sector- agriculture, based on the significant impacts of climate risks as well as its importance in providing sustenance to majority of the Indonesia's population.

UNDP's Disaster Risk Reduction Unit was actively engaged and involved in conducting the district level assessment in NTT to assess current levels of risks in various climate sensitive sectors and identified entry-points to address them through focussed interventions, which form the base for the recommendations.

REPORT STRUCTURE

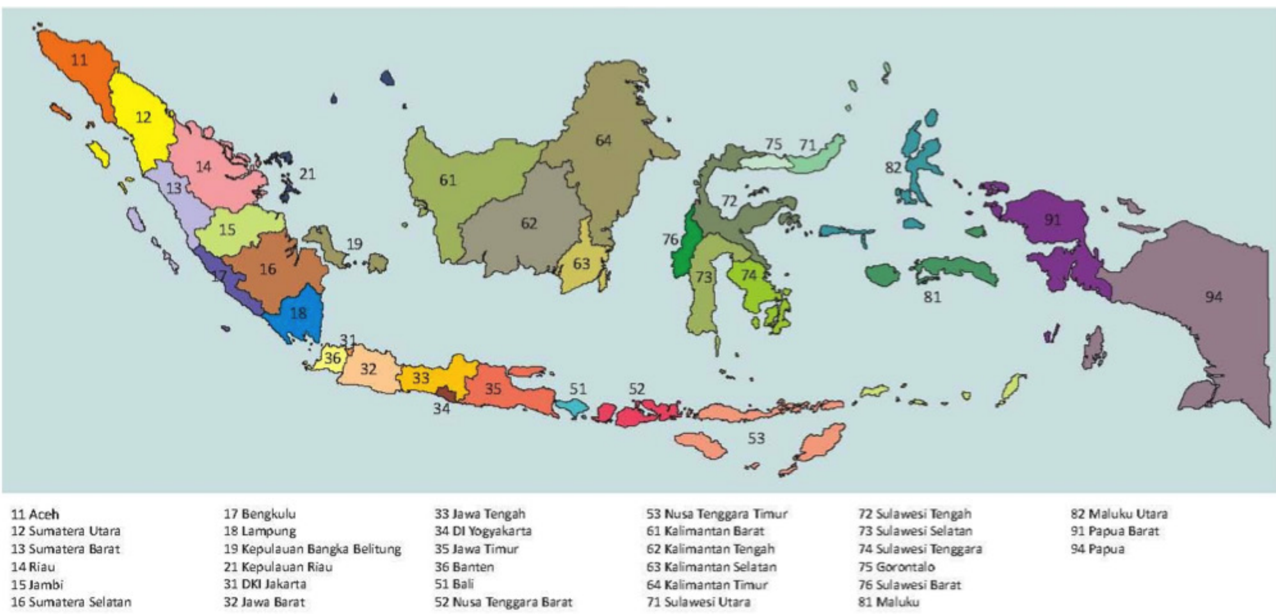
Chapter 1 captures the process steps and methods adopted. Chapter 2 focuses on development context and trends in Indonesia and the rationale for prioritization of a climate sensitive sector. Chapter 3 focuses on geo-physical environment and climate risk features of Indonesia- past, current and future. Assessment of climate threats to development in the context of past climate risks and anticipated climate change projections are covered in Chapter 4. Current Climate Risk Management processes, policy and institutional systems to address the threats identified earlier are discussed in Chapter 5, while Chapter 6 focuses on ownership of CRM within the government, assessment of capacity needs, and recommendations for future actions.

DEVELOPMENT PROFILE

Vulnerability and exposure of a society to climate risks can be largely explained by the current status of its development as well as its future trends. This chapter examines the key development conditions prevalent in Indonesia, the trends observed over the past decades, and the future as seen through the vision and strategies outlined in the National Planning documents. Focus is also narrowed down to the 'most significant' sector seen from perspective of climate sensitivity as well as extent of sustenance provided by the sector.

CURRENT DEVELOPMENT CONDITIONS, TRENDS AND CHALLENGES

Indonesia is an archipelagic country comprising of over 18,000 islands spread over a huge area between 7°N and 11°S and 94°E and 141°W resulting in an enormous diversity in local weather and climate. Most of the islands are traversed by chains of mountains, many of them of volcanic origin and some still active.



Source: BPS, 2012

Figure 2.1 Islands and Provinces of Indonesia

Indonesia has a land area of 1,811,569 square kilometres which makes it the fifteenth largest in the world and the largest country that wholly comprises of islands. The principal islands in Indonesia are the Kalimantan, Sumatra, West Irian, Sulawesi and Java, while the other significant island groups are Maluku and the Nusatenggaras (Lombok, Sumbawa, Sumba Flores and Timor).

Almost half (111 million or 46.3 percent) of its 237.6 million population reside in rural areas, while the rest are spread across over 100 large cities, the largest being Jakarta with a population nearing 10 million (2010). Eight of its ten largest cities including Jakarta are in Java Island.

Urban population has been growing constantly with the last census (2010) marking the period when more Indonesians lived in urban areas than rural areas. The rate of growth in urban population while gradually falling (from 4.4 percent in 2000) to 3.14 per cent in 2010, is still higher than the national growth rate of 1.49 (2000-2010). The national average annual growth rate has been steadily declining from a high of 2.31 (1971-80) and 1.98 (1981-90) to the figure of 1.49 percent (1991-2000).[1] *(BPS)* The population is however quite unevenly distributed with a density of 951 people per square kilometre in Java against the average national density of 108 persons per square kilometre (2000).

Poverty and Human Development

The standard of living of the Indonesian population as seen through the Gross National Income (GNI) of US $ 2500 places them far above India (US $ 1270) but below Malaysia (US $ 7,760) *(World Bank Databank[2])*. As also seen in many other countries of the region, while poverty levels continue to decrease, it remains high in absolute numbers (over 30 million were poor as on 2011). Urban poverty is slightly lower at 9.23 per cent. Not only are the absolute numbers of rural poor higher (18.9 million or 15.72 percent), but also the rural Poverty Severity Index is much higher (0.70) compared to urban areas (0.39). Over 38 percent of the employed population in Indonesia depended on agriculture in 2011 which is much lower than the 44.5 per cent (2006) or in subsequent years. A significantly larger proportion of the rural employed could thus be said to be largely dependent on agriculture. Agriculture, livestock, forestry and fishery contribution to GDP is more or less constant (hovering around 14 to 15 per cent) annually of which food crops contribute about 7 per cent each year.

Literacy has increased among the population in the past years and is quite high above 92 per cent. Illiteracy in the 45+ age group has fallen from 25.4 per cent in 2003 to 18.2 per cent in 2010, while in the 15 to 44 years age group it fell from 3.88 per cent to 1.71, and in the 15+ age group it fell from 10.21 per cent to 7.09 per cent in the same period. Some provinces such as Papua, Sulawesi show a much slower fall in illiteracy, especially Papua which in fact shows an increase in illiteracy rate in the 15+ and 15-44 years age groups. Literacy levels are higher among men than women. More men (86.81 per cent) are literate compared to women (73.86 per cent) in the State. School Enrollment Ratios in 2010 show a slightly larger proportion of girls are enrolled in the age groups of 7 to 12 (98.26 percent girls vs. 97.68 percent boys) and 13 to 15 (87.28 vs. 85.03) compared to boys, but the reverse holds true for boys in the age group 16 to 18 (55.12 percent girls vs. 56.86 percent boys) probably indicating that more girls leave schools at that age. Higher education opportunities abound with several national/ provincial government and private universities and institutes for higher education.

Increase in the life expectancy (67 years as on 2010 for men compared to 60 years in 1990) has led to increase in elderly population. Infant Mortality Rate (IMR) seen as a reasonable indicator of level and quality of health care available to the population and mirroring its socio-economic conditions shows a significant drop in the past decades- down from 42 deaths per 1000 live births in 2000 to 28 in 2011, while Maternal Mortality Ratio (MMR) was 240 (in 2008). Expenditure on health forms only about 2.4 per cent of the GDP (2009), and provides for 0.7 physicians per 1000 people. Only 71 per cent of the rural population have access to improved water sources, while more than 36 per cent have access to improved sanitation facilities in rural areas.

Gender disaggregated data shows that in 2010 a larger percentage of females have education level of Diploma I to university than males (1.95 against 1.79) whereas in all other age groups more males than females have completed various levels of schooling, i.e., primary, junior high or senior high school. A larger proportion of households are headed by men (86 percent) compared to women (14 per cent), but there is no significant variation in the figures for rural and urban areas. Among the provinces, Aceh and Nusa Tenggara Barat have a significantly large number of women headed rural households (more than 21 percent) than the national average.

Economy

Indonesia's Gross Domestic Product for 2011 was 7427 Trillion Rupiahs *(BPS)* making it the 16th largest economy in the world. Contribution of the primary sector (including mining and quarrying) was 26.6 per cent. Agriculture, livestock, forestry and fishery contributed 14.7 percent to the GDP, and among them food crops share of the GDP was 7.1 per cent. (Table 2.1)

The national economy has been growing at a healthy rate of above 6 per cent in the last couple of years. While the agriculture, livestock, forestry and fishery sector growth is more or less stable at 3 per cent each year, the food crops is showing negative growth falling from the very high rate of growth of 6.06 per cent in 2008 to 1.64 per cent in 2010 and 1.26 per cent in 2011.

TABLE 2.1 GROSS DOMESTIC PRODUCT AT CURRENT MARKET PRICES BY INDUSTRIAL ORIGIN (BILLION RUPIAHS), 2004, 2010 & 2011

INDUSTRIAL ORIGIN	GDP			GDP CONTRIBUTION (%)		
	2004	2010*	2011**	2004	2010*	2011**
1. Agriculture, Livestock, Forestry and Fishery	329124.6	985448.8	1093466	14.3	15.3	14.7
a. Food Crops	165558.2	482377.1	530603.7	7.2	7.5	7.1
b. Estate Crops	49630.9	136026.8	153884.7	2.2	2.1	2.1
c. Livestock and Its Product.	40634.7	119371.7	129578.3	1.8	1.9	1.7
d. Forestry	20290	48289.8	51638.1	0.9	0.8	0.7
e. Fishery	53010.8	199383.4	227761.2	2.3	3.1	3.1
2. Mining and Quarrying	205252	718136.8	886243.3	8.9	11.2	11.9
a. Oil & Gas Mining	118484.9	288894	383275.3	5.2	4.5	5.2
b. Non-Oil and Gas Mining	65122.4	332970	393758	2.8	5.2	5.3
c. Quarrying	21644.7	96272.8	109210	0.9	1.5	1.5
3. Manufacturing Industry	644342.6	1595779	1803486	28.1	24.8	24.3
a.Oil and Gas Manufacturing Industry	94263.4	211139	249437.4	4.1	3.3	3.4
b. Non-Oil & Gas Manufacturing Industry	550079.2	1384640	1554049	24.0	21.5	20.9
4. Electricity, Gas & Water Supply	23730.3	49119	55700.6	1.0	0.8	0.7
5. Construction	151247.6	660890.5	756537.3	6.6	10.3	10.2
6. Trade, Hotel & Restaurants	368555.9	882487.2	1022107	16.1	13.7	13.8
7. Transport and Communication	142292	423165.3	491240.9	6.2	6.6	6.6
8. Finance, Real Estate and Business Services	194410.9	466563.8	534975	8.5	7.2	7.2
9. Services	236870.3	654680	783330	10.3	10.2	10.5
Gross Domestic Product	2295826	6436271	7427086	100.0	100.0	100.0
Gross Domestic Product Without Oil and Gas	2083078	5936238	6794373	90.7	92.2	91.5

* Preliminary figures ** Very preliminary figures

Source: BPS, 2012

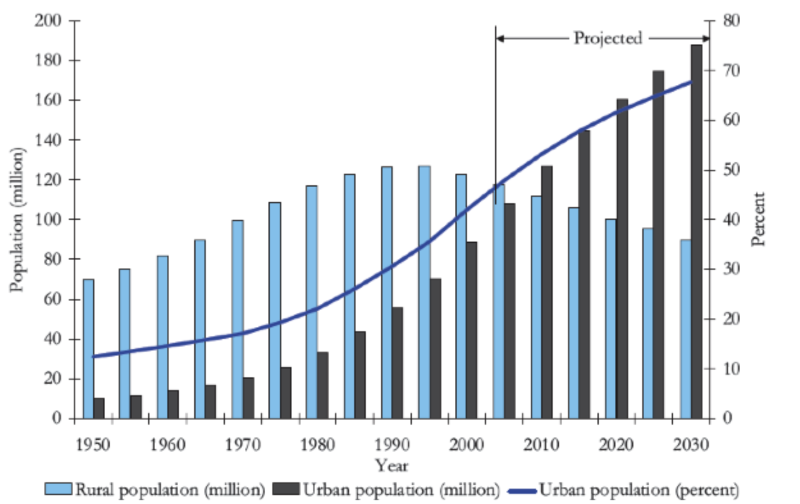
The tertiary or the services sector, comprising of construction, trade, hotel, restaurants, transport, communications, financing, insurance, real estate, business services, electricity, gas and water supply etc, is the largest contributor to the GDP (49 per cent in 2011). There is a concerted effort to improve infrastructure facilities- to better connect the various regions in the country and to promote equitable growth across all regions- hence power, roads etc are receiving a lot of attention from national government. The non-oil and gas manufacturing sub-sector has been grown at a rapid pace of over 6 per cent, and within that, food, beverage and tobacco industry and iron, steel basic metal industries have grown faster in 2011.

Indonesia's infrastructure is getting a lot of attention and investment from the government so as to provide improved services for its population and also a better investment climate. Private participation is encouraged in all critical infrastructure areas including power, roads, and telecommunications. Power continues to be an area of concern, with 100 percent electrification achieved only in Jakarta and varying levels of electrification to as low as 25 percent in outlying island provinces *(OECD Investment Policy Reviews: Indonesia 2010)*.

Environment

Deforestation, already seen as a key threat to Indonesia's rich forest resources resulting in loss of almost 40 per cent of its forest cover could further increase the problems relating to floods, landslides and water shortages. Water resources while plentiful compared to other countries of the region is also a cause for concern, particularly due to shortages during dry seasons, resulting in poor water quality leading to diseases. Ground-water extraction at unsustainable rates has led to saline intrusions in coastal areas. Air pollution due to the rate of growth as well as incidences of forest fires are also a major concern[3]. *(2008, Sida Helpdesk for Environmental Economics)*

New patterns of risk that are emerging could be as a result of the insensitivity to the environment, particularly in the urban sector. Figure below shows that after 1980, growth in the rural population began to fall. Urban population is expected to exceed 65 percent by 2030 (United Nations Secretariat 2002).



Source: Sarosa, 2006

Figure 2.2. Trend in Urban and Rural Population Growth.

The implication of these demographic changes is that urban population will increase by 70 percent from 108 million at present to 187 million over the next 25 years. In excess of 5,000 square kilometres (km2) of mainly productive farmland is likely to be converted into urban use during this period, adding to the concentration of urban risks. This is compounded by other stresses like land-subsidence, unplanned development and rapid growth and poor infrastructure and maintenance.

NATIONAL DEVELOPMENT VISION, OBJECTIVES AND PRIORITIES

Indonesia's National Long Term Development Plan (RPJPN) 2005-2025 endorsed through Act No. 17 Year 2007, provides the legal basis for Government of Indonesia to carry out an uninterrupted, sustainable development agenda, despite changes in government possible every five years. The national development plans comprise of a) long term development plan, for 20 years period; b) medium term development plans covering 5 years; and c) annual development plan for each year. While the National Long Term Development Plan (RPJPN) is the elaboration of the aspiration of Indonesia as stated in the Preamble of the Constitution (UUD 1945), in the forms of vision, mission, and the direction of the national development, the National Medium Term Development Plan (*Rencana Pembangunan Jangka Menengah Nasional* – RPJMN) is further elaboration of RPJPN. The RPJMN contains the elected president's agendas, which are translated in forms of national development strategy, general policy, development programs for ministries, cross-sectoral and cross-regional programs, as well as the macro economic framework. The annual government workplan (*Rencana Kerja Pemerintah* – RKP) is drawn based on the RPJMN, and also issued through a presidential decree. It contains development priorities, economic frameworks, including fiscal policy, and development programs, in terms of regulation and indicative budget allocation.

The National Long Term Development Plan (RPJPN) 2005-2025 envisages the poverty rate falling to five percent and increase in per-capita income to US$9,000 by 2025 and features eight goals, one of which is the creation of a competitive society so as to bring about prosperity and well-being in society. It also aims to improve the quality of human resources, including enhancement of women's roles in development, ensure a stable economy by prioritizing mining and agriculture sectors, integrate infrastructure in the transportation and energy sectors, ensure food self-sufficiency, clean governance, equitable development across all regions of the country and reduce the impact of coastal disasters and marine pollution.

Consolidating achievements under the first National Medium-term Development Plan (1st RPJM) from 2004 to 2009, the 2nd RPJM (2010-2014), emphasizes human resource development and strengthening economic competitiveness with specific focus on (i) increasing per capita income and decreasing poverty and unemployment levels (ii) promoting growth centres for development outside Java (iii) bridging the gap between sections of society and regions (iv) ensuring gender equality and children's welfare (v) ensuring better health and nutritional status of citizens (vi) strengthening manufacturing industry and agriculture development and (vii) housing development and settlements.

The National Medium-term Development Plan (2010-14) has identified 11 national priorities- poverty reduction, food resilience, health, education, environment and disaster management, energy, infrastructure, least-developed, frontier, outer and post-conflict areas, bureaucracy and governance reform, culture, creativity and technological innovation, and three other priorities- economy, people's welfare and politics, law and security. These priorities are articulated in the form of development targets including exceeding economic growth by 7 per cent and decreasing poverty rate of 8 to 10 per cent by the end of 2014 and increasing paddy production by 3.2 per cent per annum.

Agriculture rightly is given prominence, with the focus on increasing paddy and other food crops production with the ultimate aim of increasing agriculture sector contribution to the GDP, and to turn around the situation when Indonesia again has had to import rice to meet its domestic requirements to the previous state when it was self-sufficient.

CONDITIONS, TRENDS AND PRIORITIES OF PRIORITY SECTOR

The agriculture sector in Indonesia plays an important role in the economy in terms of income, employment and foreign exchange generation. Ministry of Agriculture also contributes to the national goal of food security improvement through focus on increasing food availability. During the 1980s, the agriculture sector grew at a rate of around 4 percent per annum, and led to the growth of the agriculture-based manufacturing industry, contributing an increasing share to the country's export earnings. By the mid-1980s Indonesia shifted from being the largest rice importer to being self-sufficient in the country's main staple food. After early 1990s, due to frequent El Niño's combined with economic crisis in 1998 and inability of ramping up production to meet the increasing population's demands, the Government of Indonesia had to resort to import of food grains to meet domestic consumption in the recent years.

The share of agriculture in the country's GDP was 47 percent in 1969 (at beginning of the first Long-term development plan). This share gradually decreased to 33 percent in 1978, 21 percent in 1988 and is now less than 14 percent in 2008. However, since almost 40 per cent of Indonesia's workforce directly depends on agriculture for their livelihood, and in respect of its sensitivity to weather and climate patterns, the agriculture sector may be considered as the priority sector for the purposes of the CRM TASP study.

The decreasing share of agriculture in the GDP as well as its status as the largest sector in terms of employment reflects the relatively low agricultural labour productivity. Agricultural sector grew by 3.5 percent in 2007 which was just slightly higher than its average growth rate of 3.2 percent of the previous 5 years (2003-07). The major significant shift has been in the reduction of food crops contribution from 61 percent to 49.4 percent in 2007 (a 19 percent decrease), and the increase in fisheries from 9 percent in 1970 to 16.1 percent in 2007 (a 79 percent increase), and in livestock from 6 percent in 1970 to 12.7 percent in 2007 (a 112 percent increase). The stagnation in the overall growth of the agricultural sector, esp. the decrease in contribution from the food crops sub-sector is due to, among others, limited land availability and poor land quality. The Agricultural Census reported that in 1983-2003 agricultural land declined and the average land-holding per farmer narrowed from 1.30 hectare to 0.70 hectare per farmer. Other constraints include deteriorating infrastructure, poor water management, inadequate knowledge sharing & training/extension services, poor post-harvest handling & processing, poor governance & rural institutional support, inappropriate decentralization policies, etc.[4] *(GoI, 2009)*

As of 2010, rice production contributed US $ 17.9 billion to the economy while the second largest contribution in agriculture was from palm oil about US $ 9.3 billion. In 2011 production of paddy actually fell by 0.7 million tonnes to 65.74 million tonnes compared to 2010. This is due to the decrease in harvested area (by 52,134 ha or 0.39 percent) and a fall in productivity from 5.01 tonnes/ ha to 4.98 tonnes/ ha.

Irrigation development schemes in each of the five year plans commencing from the first plan period (1969-74) have been gradually increasing the areas irrigated until about 6.8 million ha were irrigated by 1999. Some of the challenges faced are the increased dependence on rice and lack of food diversification, the change in land use from agriculture to other uses- almost 0.5 mi ha of agriculture land was converted to other used between 1969-94, lack of maintenance of irrigation infrastructure increasing. Another key constraint is that majority of the irrigation schemes depend directly on water from rivers, and not on reservoirs, hence the impacts due to rainfall variability is felt almost immediately and very severely by the agricultural operations especially for paddy. *(Framji et al, 1981)*

Rainfall variations resulting in droughts have the most significant impacts on Indonesian agriculture. While ENSO episodes are significantly related to Indonesian droughts, there were droughts also during non-El Niño years (1961, 1967 and 1977). During these non-El Niño years, 75 percent of Indonesia experienced below normal rainfall and hence severe drought conditions. Factors other than El Niño also cause drought. In the agriculture sector, food and feed crop production (rice, maize, cassava, soybean and sweet potato) together with horticulture crops are most affected by drought, followed by tree crops, livestock and fisheries. Rain-fed crops such as *palawija* (maize, cassava, sweet potato and soybean) are more directly affected than irrigated rice.

It can be noted that during the El Niño years, there is a significant increase of rice crop area affected by drought. While climate variability-associated impacts on crop production vary from year to year, there has been a significant decrease in crop production during certain years due to extreme climate events. While rice is affected consistently in all years, the impact varies on secondary crops. During 1994, the maize crop was affected significantly and soybean was significantly affected in 1991. This differential impact is due to the characteristics of rainfall distribution in different El Niño years. The dry season of the post El Niño year generally enhances rice production potential during September to December. This is because of return of normal conditions during May-June, utilization of fallow lands left uncultivated during the previous El Niño, and favourable prices for rice.

Drought impacts on agriculture sector are recognised as a high risk in Indonesia with over 152 regencies or 33 percent of the country at risk, particularly in Java and Sumatra islands. The National Action Plan for Disaster Risk Reduction accordingly also prioritises drought risk and identifies actions aimed at risk mapping, improving access to weather and climate information, improved access to water and awareness.

These efforts are in cognisance of the fact that food security is one of the priority areas under the National Medium-Term Development Plan (2010-2014). This includes revitalization of agriculture for realizing self-reliance in food, increasing the competitiveness of agricultural products, increasing the income level of farmers, and conserving the environment and natural resources, while increasing the growth rate of the agricultural sector in the GDP to 3.7 percent and increasing the Farmers Terms of Trade to 115-120 in 2014. Pertaining to agriculture, the specific priorities identified are:

1. Land, Development of Agricultural Zones and Agricultural Spatial Planning: reforming regulations for ensuring legal certainty of agricultural lands, developing new agricultural areas of 2 million hectares, optimizing the use of neglected lands;

2. Infrastructure: construction and maintenance of infrastructure in transportation, irrigation, electricity networks, communication technology, and the national information system that serves regions that are agricultural products centers, to increase the quantity and quality of production and increase the ability to market the products;

3. Research and Development: increasing research and development activities in agriculture that can create superior seeds and other research outputs towards the enhanced quality and productivity of national agricultural products;

4. Investment, Financing, and Subsidies: encouraging investment in food, agriculture, and rural industries that are based on local products with business entities and the government providing financing that can be reached, and subsidies that can ensure the availability of tested superior seeds, fertilizers, appropriate technology and post-harvest facilities on a timely basis and in the right quantity, and which are affordable;

5. Adaptation to Climate Change: taking concrete steps that are related to adaptation and anticipation of the food and agricultural system to climate change.

Agricultural development goals, as defined by the Ministry of Agriculture[5] in 2008 are still valid:

(a) improving national food security, especially by increasing production capacity of agricultural products and decreasing food imports dependency to around 5 to 10 percent of domestic production;

(b) increasing competitiveness and added values of agricultural products, particularly by increasing quality of primary agricultural commodities, diversification of agricultural processing activities, and improving agricultural trade balance;

(c) improving farmers' welfare by increasing their productivity and decreasing rural poverty incidence, and;

(d) improving sustainable utilization of natural resources particularly by enhancing application of good agricultural practices and improving quantity and quality of agricultural infrastructure.

These are further detailed in the five-year planning program planning processes of the Directorate Generals and Agencies through several programs as follows: (a) development and reparation of agricultural infrastructure including that for R&D, (b) empowerment of farmer groups and agricultural institutions, (c) improvement of agricultural extension, (d) improvement of farmers' access to agricultural finance, and (e) creation of more efficient agricultural market system. A very relevant policy has been the promotion of the Climate Field Schools, to integrate climate information into agricultural processes at the provincial, district level and at farmer groups.

The strategies identified to achieve the priorities of the National Medium-Term Development Plan (2010-14) include- integrated agricultural development policies & strategies development, rural organization reforms through governance & empowerment (through small-scale community-based agri-business enterprise development), improving agricultural inputs and services delivery to producers (by effective & efficient financial and marketing services, land use and irrigation infrastructure maintenance, innovation and technology), and human resource development through knowledge management & sharing. *(GoI, 2009)*

Accordingly, for food crops the strategic priority areas focus on increasing food crops production through intensification of sustainable farming system, and use of "green" technologies & environment-friendly agricultural practices, improving methodologies & technologies for post-harvest handling, storage, processing and transporting/distributing agriculture & food products, improving methodologies & technologies for post-harvest handling, storage, processing and transporting/distributing agriculture & food products and improving agricultural data & statistics compilation and utilization for better planning of food crops program development.

While management of disaster impacts on agriculture is indicated as a core strategy, it appears that not enough attention is devoted to developing strategies and programs to operationalise this concern into better management of climate risks (floods or droughts) to reduce negative impacts or of climate conditions (favourable rainfall during La Niña) to maximize benefits to the sector.

KEY MESSAGES (DEVELOPMENT PROFILE)

- Despite appreciable economic development and reduction of agriculture GDP contribution to overall economy to extent of 14 percent, over 40 per cent of the population still depend on agriculture.

- 70 per cent of the farmers are marginal farmers with less than 1.5 ha of land, with average farm holding size less than 0.7 ha (2003). Growth in agriculture sector is key for lifting the rural poor out of poverty.

- The national development of Indonesia recognises the seriousness of poverty in agriculture sector. The strategies and policies of agriculture sector is designed to improve agriculture productivity, diversify agriculture to reduce poverty.

CLIMATE PROFILE

CLIMATOLOGICAL SETTING

Several climate influences, operating over varying timescales, affect the Indonesia's local and regional climate, particularly rainfall distribution (Table 3.1).

TABLE 3.1: INDONESIAN CLIMATE CONTROLS

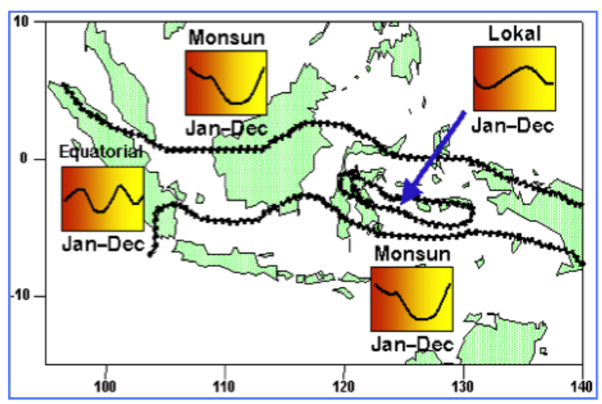
SCALE	INFLUENCES
Mesoscale (10-1,000 km)	initiation of convection by sea and land breeze convergence across many islands channeling of monsoon flow by topography and topographically-induced precipitation
Intra-seasonal	Northerly surges of low-level wind from South China Sea (associated with fluctuations in the intensity of the Siberian high pressure system) Australian west coast surges Madden-Julian Oscillation (MJO) (40-50 day oscillation in equatorial wind and rainfall)
Seasonal	Monsoon
Inter-seasonal and inter-annual	Walker circulation El Niño Southern Oscillation (ENSO)
Inter-decadal	Pacific Decadal Oscillation (PDO)

Source: Adapted and modified from ADB, 1999[6]

Rainfall patterns vary across the country's regions (Figure 3.1)[7]. The monsoonal rainfall type, prevalent over much of southern and northern Indonesia, peaks in December. A local type of rainfall, confined to a small region in the central eastern part, peaks in July-August. The rest of the country has equatorial rainfall, with peaks occurring during March and October.

Wet season onset differs geographically, starting from the western part of the country and moving to the eastern part. Amount of rainfall during the season varies from 641-4,115mm. The length of the wet season can be as short as 10-110 days or as long as 280-300 days (Asian Disaster Preparedness Center, 1998)[8].

Likewise, onset of the dry season moves from the southeastern to the northwestern part of the country. Amount of rainfall during the season ranges from 250-500mm in most areas, except in some parts, where dry season rainfall ranges from 500-750mm.



Source: Boerema, 1938

Figure 3.1: Seasonal rainfall types in Indonesia

CURRENT CLIMATE VARIABILITY AND EXTREME EVENTS

Year-to-year rainfall variability is attributed to the El Niño Southern Oscillation as follows:

- Dry season ends later than normal during El Niño years, while earlier than normal during La Niña years;
- Wet season onset is later than normal during El Niño years, while earlier than normal during La Niña years;
- Significant reduction of rainfall could be expected during El Niño years, both during the wet and dry seasons, while significant increase could be expected during La Niña years;
- Long dry spells occur during the monsoon period, particularly in Eastern Indonesia.

Droughts and floods in Indonesia are also attributed to ENSO. Of the past 28 drought years (including multiple years) since 1877, 20 were associated with strong ENSO events and 6 with weak ENSO events; 2 did not appear to be associated with ENSO. The southern and eastern parts of the country are most affected. Dry forest conditions during El Niño years increase forest fire risks.

Floods during La Niña years could increase rice crop area affected by floods by as much as 150 percent. Flood impacts in Java are higher in most La Niña years, when compared to other regions. Within Java, West Java is comparatively more vulnerable to floods.

OBSERVED TRENDS

Temperature. The average annual increases in minimum and maximum air temperatures, observed from 33 stations across the country during the period 1980-2002, are 0.047°C and 0.017°C, respectively (Boer et al., 2007 cited in MoE, 2010)[9].

Rainfall. Analysis by Boer et al (2009 cited in MoE, 2010) of 20- and 50-year rainfall data from 384 stations across the country indicates (i) significant decrease in December-January rainfall over most of Kalimantan and small parts of Java, Papua, and Sumatra (ii)significant increase in December-January rainfall over most of Java and eastern Indonesia, including Bali, Nusa Tenggara Barat (NTB), and Nusa Tenggara Timur (NTT); and (iii)significant decrease in June-August rainfall in most regions.

BMKG reported in 2005, as cited in MoE, 2010, based on data from 92 stations across the country, an increasing delay in monsoon onset, particularly in Java, and a shorter wet season, particularly in South Sumatra, Java, and Kalimantan.

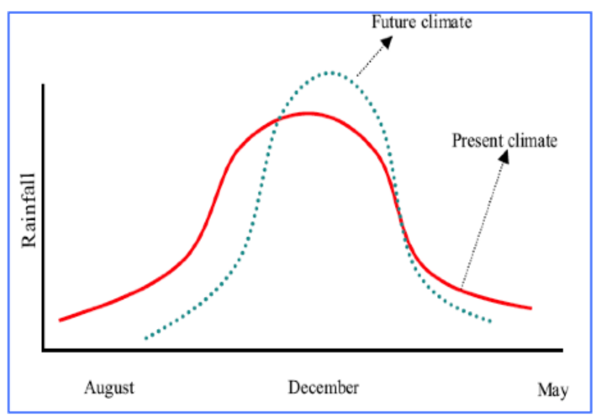
Sea Level Rise. Average sea level rise for the period 1993-2008 is 0.6cm/year (Sofian, 2010 cited in MoE, 2010).

PROJECTED CLIMATE TRENDS

Temperature. Anthropogenic impacts on Indonesia's climate will be superimposed with inter-annual and decadal climate variations. Boer and Faqih (2004)[10] reported that average temperature in the country is expected to increase at 0.034°C per year under SRES-A2 (i.e. regionally oriented economic development) scenario, and at 0.021°C per year under SRES-B2 (local environmental sustainability) scenario.

Rainfall. Global warming impact on rainfall is, however, not consistent. Regions south of the equator, such as South Sumatra, Java, and Bali, and the eastern part of Indonesia will very likely have generally shorter rainy season, but with heavy rainfall events (Figure 3.2), leading to increased flood risk. The longer dry season also increases drought risk. Regions north of the equator are expected to have the opposite trend, which could lead to positive impacts.

ENSO events are expected to become more frequent, from its current interval of 3-7 years to every 2-3 years (BAPPENAS, 2010)[11]. This projected increase in frequency, however, is not likely to have significant impacts to warrant policy interventions, except for severe events.



Source: MoE, 2007

Figure 3.2: Likely rainfall pattern in Java and Bali

Sea Level Rise. Sea level is projected to rise by up to 29 cm by 2030, potentially sinking about 2,000 small islands (Sakya, 2009)[12].

STATUS OF CLIMATE AND HAZARD INFORMATION AT NATIONAL AND REGIONAL LEVELS

Rainfall is a critical element in Indonesia. The network of observations do not so adequately capture the spatial and temporal variability of climate in general and rainfall in particular. Hence there is an inadequate capacity to generate user-relevant climate information to meet climate-sensitive sectors' requirements. Though seasonal forecast system is well-developed, considering the high correlation of ENSO, translating the national forecasts to micro-regions is still not adequate.

The climate projections largely used are still based on global circulation models although downscaled information at spatial and temporal scale relevant for application in decision-making is required to be undertaken.

KEY MESSAGES (CLIMATE PROFILE):

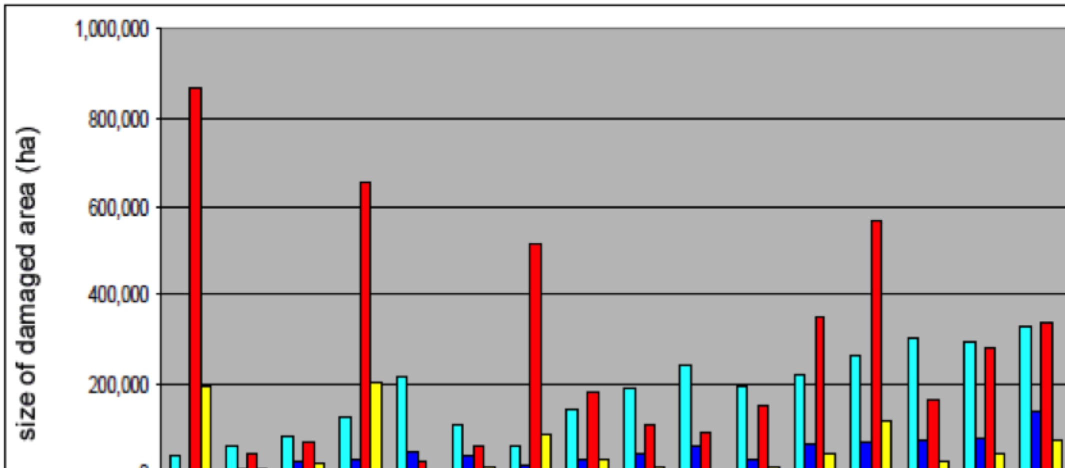
- Temperature variation in Indonesia is small due to the tropical climate, hence application value for decision-making is limited; temperature forecasts are, however, well-established.
- Observable trends in cities are useful in analysis of micro-climate influences.
- ENSO is a major driver of climate variability in Indonesia, hence is a major consideration when attributing human influence on regional precipitation patterns. Available evidence indicates that natural variability is likely to dominate up to the next 3 to 4 decades, hence anthropogenic influence-associated climate signal could be marginal during this period. ENSO influence on climate in the 2080s and beyond is uncertain, as IPCC climate models do not capture ENSO observable trends.
- Climate change science research outputs lack salience due to lack of data integrity and quality. Also, very short-term datasets of less than a decade are used (MoE, 2007).[13]

CLIMATE IMPACTS AND RISKS FOR AGRICULTURE

PAST CLIMATE IMPACTS

The agriculture sector plays an important role in Indonesia's economy, in terms of income, employment, food security, foreign exchange generation, and poverty reduction. In 2008, agriculture had a 15 percent share in the country's overall Gross Domestic Product (GDP) (The World Bank Group, 2010). Over 57 percent of Indonesia's 235 million people (2008) depend on agriculture for livelihoods. The sector absorbs the labor force that is laid off from industrial and service sectors due to occasional economic slow down, such as in 1998 (Daryanto, 1999)[14], and diminished global demand for manufactured goods, such as during 2004-2009 (Oktaviani, 2010)[15].Periodic climate shocks impact the sector, and subsequently affect food security through reduced food availability and decreased purchasing power that impairs access to food.

In Indonesia, rainfall anomalies due to ENSO are often manifested through droughts and floods, which largely impact on production of major food crops, causing temporary shortage and, sometimes, inflation. El Niño causes significant decrease in dry-season rainfall, during which about 40 percent of paddy is grown, while La Niña causes significant increase in wet-season rainfall, during which about 60 percent of paddy is grown. Figure 4.1 shows the extent of rice crop damage due to droughts and floods for the period 1991-2006.



	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Flood D	37,977	59,323	83,002	127,666	218,137	107,385	58,197	143,344	190,466	243,594	193,414	219,580	263,181	303,153	295,497	329,826
Flood CF	5,707	9,595	27,348	32,881	46,462	38,167	13,953	33,152	42,275	58,816	32,765	63,459	68,638	76,627	80,384	138,227
Drought D	867,930	42,382	66,987	654,807	28,580	59,560	517,614	180,701	104,539	91,105	151,390	348,512	568,619	163,923	283,660	338,261
Drought CF	192,331	7,262	20,411	205,305	4,614	12,482	87,099	32,557	12,631	5,116	12,434	41,690	117,006	26,384	44,829	73,045

D = hit by drought/flood, CF = crop failure

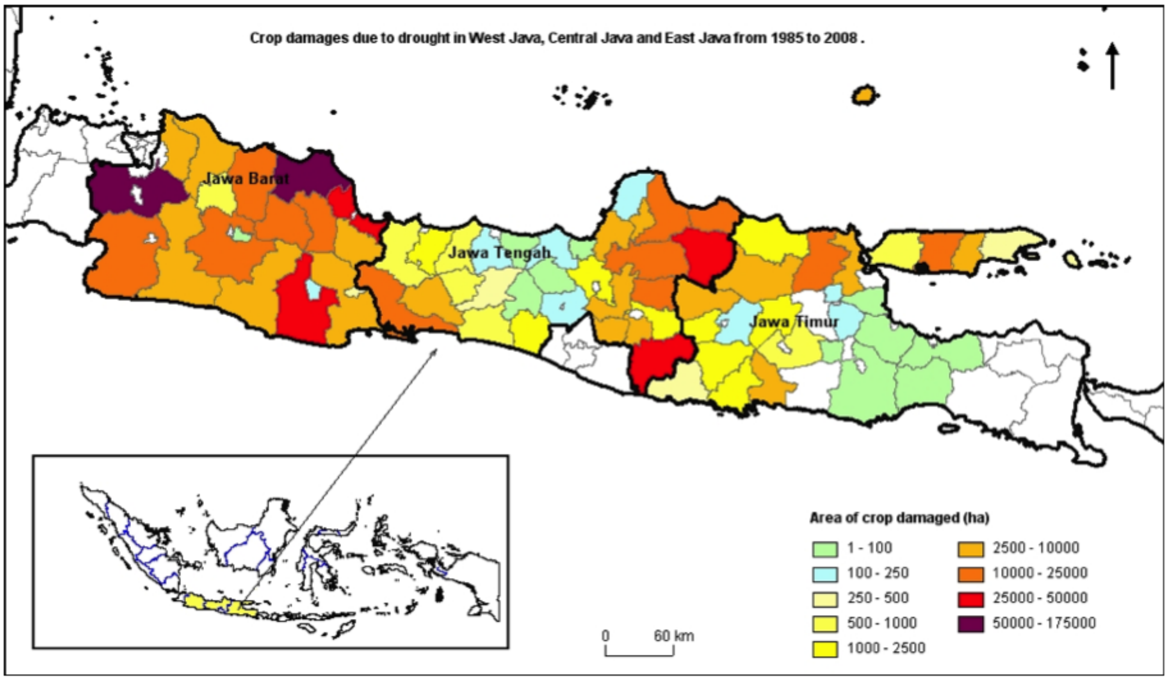
Source: Directorate of Food Crop Protection, 2007 (from Bappenas, 2011)

Figure 4.1: Rice cropping area affected (D) and destroyed (CF) due to droughts and floods

Drought. Drought affects food crop production (rice – the country's staple food, maize, cassava, soybean, and sweet potato), horticulture and tree crops, livestock, and fisheries. Periodic droughts in recent decades, e.g. 1972, 1982, 1987, 1991, 1994, 1997, 2002, and 2006, mostly associated with El Niño, caused serious impacts in the sector. The 1997-98 drought, for example, revealed the fragility of the Indonesian economy to drought. Losses from decreased crop production and forest wealth amounted to US$ 9.6billion (ADB, 1999), which then required importation of around 5 million tons of rice (Jakarta Post, 1999)[17]. Hydro-electric power production fell from 8.76 billion kWh to 5.6 billion kWh, representing about 36 percent production loss (ibid). The 1998 economic crisis compounded the impact, and resulted to a 14 percent reduction in GDP.

El Niño impact on rice production has been consistent. An El Niño event could amplify drought impacts on rice production by as much as 40 times, depending on its onset, duration, intensity, and magnitude (Figure 4.1). Paddy crop losses from recent El Niño-associated droughts were 2.6million tons in 1982, 3.2million tons in 1991, and 2.5million tons in 1997.

The magnitude of droughts (and floods) varies from one ENSO event to another. Their impacts also vary regionally. For instance, Java's share of drought-affected areas could go up to 60-70 percent. Within Java, West Java, the largest rice-producing province in the country, is most affected, compared with Central and East Java (Figure 4.2). Hence, any drought impact on West Java could have significant influence on national rice production and food security. Small disturbances to rainfall in West Java could already have major effects on harvest (Subbiah & Kishore, 2001)[18].



Source: Based on data from DesInventar

Figure 4.2: Crop damages by district due to drought in West, Central, and East Java, 1985-2008

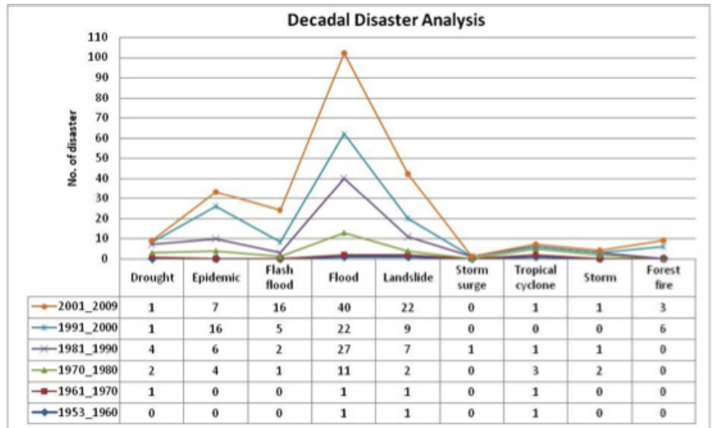
Floods. Flood events in Indonesia have been increasing over the past 25 years. Of the 154 floods recorded by the Dartmouth Flood Observatory for the period 1985-2009, 54 were classified as severe, and more than 40 percent occurred in Java. In fact, most of Java, in particular the hills and mountains, are susceptible to landslides caused by extreme rainfall events, further aggravated by settlements in high-risk areas. This situation is expected to worsen when climatic factors, such as short and heavy rainfall spells, are combined with non-climatic drivers, such as over-development (including urbanization and conversion of low-lying retention areas into residential, industrial or commercial areas), over-exploitation of natural resources, land subsidence, and sedimentation. Figure 4.3 compares the frequency of flood events with the frequency of other climate-related hazards in Indonesia.

La Niña increases flood impacts, albeit modestly, increasing risks of pests that affect crops. Recent La Niña years were 1988, 1995, 1998, 2007, and 2010.

Cyclones. Cyclones are not common in Indonesia due to its location at the equator. This explains the lack of interest in understanding cyclones and their impact on people's livelihoods. The most southern areas are exposed to cyclones. Significant impact has occurred in West Timor and Sumba, which has recorded 30 percent crop loss for corn. Cyclone frequency and intensity are linked to ENSO.

Forest Fires. Forest fires in Indonesia have been associated with strong ENSO conditions: 1877 (Central Kalimantan fires), 1914 (South and East Kalimantan), 1982-83

(East Kalimantan), 1986-87 (all of Kalimantan), 1991-94 (Sumatra, Kalimantan, and Java), and 1997-98 (Sumatra, Borneo, and Kalimantan). The 1997-98 forest fires in East Kalimantan, alone, burned over 9 million hectares of natural forest, worth at least US$ 10 billion.



	Drought	Epidemic	Flash flood	Flood	Landslide	Storm surge	Tropical cyclone	Storm	Forest fire
2001_2009	1	7	16	40	22	0	1	1	3
1991_2000	1	16	5	22	9	0	0	0	6
1981_1990	4	6	2	27	7	1	1	1	0
1970_1980	2	4	1	11	2	0	3	2	0
1961_1970	1	0	0	1	1	0	1	0	0
1953_1960	0	0	0	1	1	0	1	0	0

Source: Drawn from data from DesInventar, EM-DAT, 2009

Figure 4.3: Decadal trend of climate-related disasters, 1953-2009

While an agency like BULOG (Indonesia's National Food Logistics Agency) is largely successful in insulating grain prices through anticipatory storage of rice or through imports, marginal and subsistence farmers are hardest hit by loss of food crops and increased local food prices. For instance, many farmers in Timor District of NTT had to rely on government aid, after experiencing crop failure due to drought during the 2006-07 El Niño. Government aid became one of the main sources of income that year. Many farmers had to sell their livestock, and worked in the informal sector. In the same way, the drought brought about by the 2003 El Niño caused huge rice production loss in Indramayu. That year, the number of households that could not meet their basic food needs increased by 14 percent, when compared to normal years (Boer and Faqih, 2004).

FUTURE CLIMATE IMPACTS

Analysis of potential impacts from projected change in climate indicates the following risks in the agriculture sector:

Decrease in coastal agricultural land. Agricultural land in coastal areas will decrease due to sea level rise. By 2050, paddy fields in Java and Bali will decrease by 174,461ha and 8,095ha, respectively[19] *(ICCSR, 2010).* Decrease in paddy field areas are also expected in Sulawesi (78,701ha), Kalimantan (25,372ha), Sumatra (3,170ha), and Lombok Island (2,123ha) (ibid).

Decrease in crop productivity and damage to, or degradation of agricultural land, resources, and infrastructure. Changes in rainfall by 2050 will cause a decrease in production of rice by 4.6 percent, maize by 20 percent, soy by 65.2 percent, sugar by 17.1 percent, and palm oil by 21.4 percent, relative to current levels (Handoko et al., 2008, from BAPPENAS, 2010)[20]. By 2050, projected increase in temperature will decrease planting area, relative to the 2008 total paddy production area, by 3.3 percent in Java and by 4.1 percent outside of Java (ibid). Decrease in productivity due to early ripening could be between 18.6 percent-31.4 percent in Java and about 20.5 percent outside Java (ibid). Decrease in productivity, including rice, due to change in plant respiration rate, is predicted to reach 19.94 percent in Central Java, 18.2 percent in Yogyakarta, 10.5 percent in West Java, and about 11.7 percent outside Java and Bali (ibid).

Shifts in planting period, season, and planting pattern, as well as decrease in water availability. Climate variability and anthropogenic-caused climate anomalies could lead to changes in crop choice, in addition to modifications in planting pattern and season. Additionally, decrease in water available in reservoirs, due to the projected shorter rainy season, growing demand among various users, and uses of water are expected to reduce water for irrigation, further impacting on planting practices. These problems are likely to be compounded by non-climatic factors, such as increases in crop intensity, diversification of land for non-agricultural purposes, and aging irrigation infrastructure.

Water scarcity. Parts of Java-Bali region are at an extremely high risk of water shortage, particularly few locations in the north and south of West Java, middle and south of Central Java and East Java, as well as in the capitals of North Sumatra, West Sumatra, Bengkulu and Lampung (Sumatra), Nusa Tenggara Barat, and South Sulawesi (BAPPENAS, 2010). About 75 percent of the Java region, large parts of south Bali, and small parts of north, west, and south Sumatra, Lombok Island (Nusa Tenggara Barat), and South Sulawesi will be at high risk.

Increased drought and flood risk. The Indonesian National Atlas shows that Sumatra and Java-Bali have the largest vulnerable areas. Based from 2025-2030 drought and flood risks projections, areas like the Java-Bali region, northern Sumatra, part of Nusa Tenggara, and South Sulawesi face significant drought risk. Areas of extremely high risk are stretched out over small areas of Central Java, Northern Sumatra, and Nusa Tenggara. Areas of high drought risk are found in large parts of Central Java, Sumatra, and Nusa Tenggara, including a small part of South Sulawesi. Flood risk is extremely high in areas along major rivers, particularly in downstream areas of Java and Eastern Sumatra, and most parts of Western, Southern, and Eastern Kalimantan, Eastern Sulawesi, and Southern Papua (GTZ, from BAPPENAS, 2010).

Climate risks in urban areas could further impinge on food security of the urban poor. New patterns of risk that are emerging could pertain to urban areas. Cities and towns are growing at a rapid rate so that, by 2030, the urban population in Indonesia is expected to exceed 65 percent of the country's total population (United Nations Secretariat 2002, from Sarosa, 2006)[21]. This means a national population growth of approximately 50 percent, from the presently 128 million to 192 million, over the next 20 years, requiring conversion of more than 5,000 sq.km of mainly productive farmland into urban use. These processes are often compounded with stresses like land subsidence, unplanned development, and poor infrastructure and maintenance.

Rapid expansion, in line with population growth, is leading to occupation of floodplains and marginal areas. Major cities, such as Jakarta, Semarang, Surabaya, Bandung, Medan, and several others located in floodplains of one or more rivers, are frequently flooded. In Jakarta, for instance, the 13 rivers that flow through and around Jakarta flood for several reasons, including high intensity rainfall and runoff, urbanization, low infiltration rates, and high overland flow velocities. A very steep upstream area, such as Bogor, could mean high flow velocities and short distances/ time frame for floodwaters to travel to Jakarta, of which more than 40 percent is low-lying (Ministry of Public Works, 2007)[22].

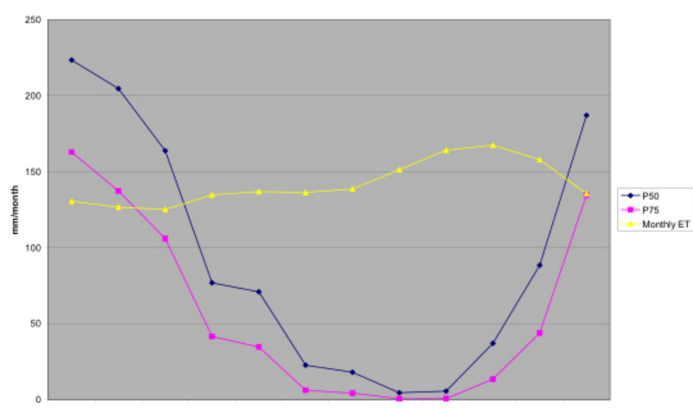
Climate risks in urban areas impact the urban poor disproportionately, thus endangering their access to food. It is anticipated that food security could continue to be a major policy concern, as vast majority of the urban poor, impacted by climate extremes, may need support from Government-managed food security system.

With these current and anticipated risks to national food security, the Government of Indonesia prioritized food security as a cross-cutting issue of national importance under climate change adaptation (BAPPENAS, 2010).

CLIMATE SENSITIVITY OF THE FOOD SECURITY SECTOR AT PROVINCIAL LEVEL

Nusa Tenggara Timur is one of the driest provinces in Indonesia, with 8 dry months (April-October) in a year. Annual rainfall is from 350-1,000mm, and is highly variable. In the absence of irrigation or moisture conservation, this rainfall is able to support crop growth for only 60-100days a year in most areas. Figure 4.4 shows the rainfall and evaporation averages for the period 1960-1991 for Atambau, and the water deficit that occurs from April to November.

Some districts, such as Belu, receive more than 1,000mm rainfall per year (Table 4.1). These districts, however, still experience risks, more because of variability in rather than the total amount of rainfall received per year (Table 4.2). For example, early rains in October-November 2010 were not sustained, such that farmers who prepared their lands aborted planting, and those who planted maize faced stunted maize growth (BTPT)[23]. Heavy rains during January-February 2011 caused harvest failure.



Source: BMKG

Figure 4.4: Average precipitation (P) and evapotranspiration (ET), Atambau, 1960-1991

ENSO and climate variability. Sensitivity of different ecological zones in NTT to El Niño is presented in Table 4.3, while Table 4.4 shows the differential impacts of each El Niño event.

TABLE 4.1: HISTORICAL RAINFALL IN SELECT DISTRICTS IN NTT

LOCATION	TIME PERIOD	NUMBER OF OBSERVATIONS (MAX)	AVERAGE ANNUAL RAINFALL (MM)
Kupang, Kab	1879-1941	63	1,413
	1972-1985	9	1,844
	1996-2005	10	1,703
So'e, Kab TTS	1922-1984	51	1,483
	1996-2006	11	1,927
Kefa, Kab TTU	1931-1983	24	1,342
	1996-2005	10	1,603
Atambua, KabBelu	1920-1984	38	1,447
	1996-2005	10	2,079
Bajawa, KabNgada	1910-1978	48	1,883
	1996-2005	10	2,111

Source: Montgomery et al, 2008[24]

TABLE 4.2: RAINFALL VARIABILITY

LOCATION	COEFFICIENT OF VARIANCE (%)				
	TOTAL ANNUAL RAINFALL	DECEMBER RAINFALL (START OF RAINY SEASON)	JANUARY RAINFALL (EARLY RAINY SEASON)	MARCH RAINFALL (RAINY SEASON)	APRIL RAINFALL (END OF RAINY SEASON)
KabKupang	23	51	45	40	96
Kab TTS	41	99	76	86	94
Kab TTU	54	45	62	103	105
KabBelu	52	103	63	72	87
KabNgada	24	26	36	59	70

Source: Montgomery et al, 2008

TABLE 4.3: ENSO IMPACTS ON DIFFERENT ECOLOGICAL ZONES IN NTT

ECOLOGICAL ZONE	ENSO IMPACTS ON NTT CLIMATE			
	DRY SPELLS/ LATE ONSET OF RAINY SEASON (EL NIÑO-RELATED)	EXCESSIVE RAINS AND FLOODING (LA NIÑA-RELATED)	CYCLONES (LA NIÑA-RELATED)	EARLY TERMINATION OF RAINY SEASON (EL NIÑO-RELATED)
Dry northern coast	Can lead to complete crop failure. Rain-fed rice is most affected; corn as well if event lasts long	Rapid; happens on flood plains, but impact is relatively small	Yields tend to be good due to excessive rainfall; wind impact is limited	Impact on rice crops if no pumping capacity available
Intermediate areas/ hills and plains	Significant impact on rain-fed rice	In river valleys, but impact limited; water logging in valley floors can have negative impact on corn	Winds damage corn; yields depressed by enhanced nutrient leaching	Can impact rain-fed rice
Mountains	Normally good yields due to lower rainfall, more sun, and less wind		Leads to crop failure	Limited
Moist south coast	Leads to delay in start of the first cropping season	Leads to loss of crops and assets	Often flooding; direct impact limited	Second crop can be delayed, or is not planted

Source: Authors' Field Notes

TABLE 4.4: IMPACTS OF MOST RECENT EL NIÑO EVENTS

	EL NIÑO EVENT			REMARKS
	1997-98	2002-03	2006-07	
Climate patterns	Severe dry spell from mid-December to mid-January, followed by normal rain Extremely high SST anomalies	Late start of rains; after initial delay, rainfall normalized SST anomalies	Extremely low rainfall until 3rd week of February SST anomalies peaked in December, then declined; situation normalized in March	El Niño-associated rainfall pattern is significantly linked to late onset of rains during November – December, upsetting planting and shortening the cropping season
Food crop output	Coastal areas severely affected; situation improved after January 1998	Dryland rice crops failed	Dryland rice failed all over the island; rain-fed rice not planted Significant crop failure in northern coast	
Food price inflation/ bargaining power	Combined with economic crisis, led to increased food prices.	Limited impact. RASKIN scheme (rice for the poor) controlled prices effectively	Rice prices increased, but no increase in wages and other agricultural commodities	Rice distribution through National Food stocks dampened food crisis in 2007
Health	The 1990s saw rapid improvement of general health, but declined during the crisis.	Increased incidence of malaria and tuberculosis	Continued high incidence of malaria and tuberculosis, and increased probability of HIV/ AIDS spread in the general population	Decentralization led to decline in quality of health services provided

Source: Kieft & Soekarjo, 2007[25]

Cyclones. Within Indonesia, Timor is the only larger island in Indonesia regularly hit by cyclones. Table 4.3 shows cyclone impacts on different ecological zones in NTT.

Sensitivity to future climate. Experimental downscaling studies for East Java (Naylor et al., 2007) showed significant exposure of rice agriculture to climate change. Most likely impacts include a major shift in rainfall pattern towards shorter and more intense rainfall periods. This was confirmed by Boer et al. (2008), specifically for NTT, who observed an increase in rainfall intensity from February to March. In combination with sea level rise, more intense rainfall could lead to loss of land in the Benain flood plain. Figure 4.6 shows the changes in seasonal rainfall in NTTin 2025 and 2050 under the A2 (regionally oriented economic development) and B1 (global environmental sustainability) scenarios.

Temperature is projected to rise gradually (Figure 4.6), with impacts aggravated by changes in rainfall. The following impacts are expected by 2025:

- Enhanced evaporation in coastal areas, both the dry northern and moist southern areas, restricting crop growth for rain-fed rice. Rice will be most likely unsuitable in the northern coast. Probability of crop failure will increase in intermediate areas;
- The intermediate zone will move upwards to higher altitude. Current climate in the drier northern areas will most likely extend to a larger geographical area.

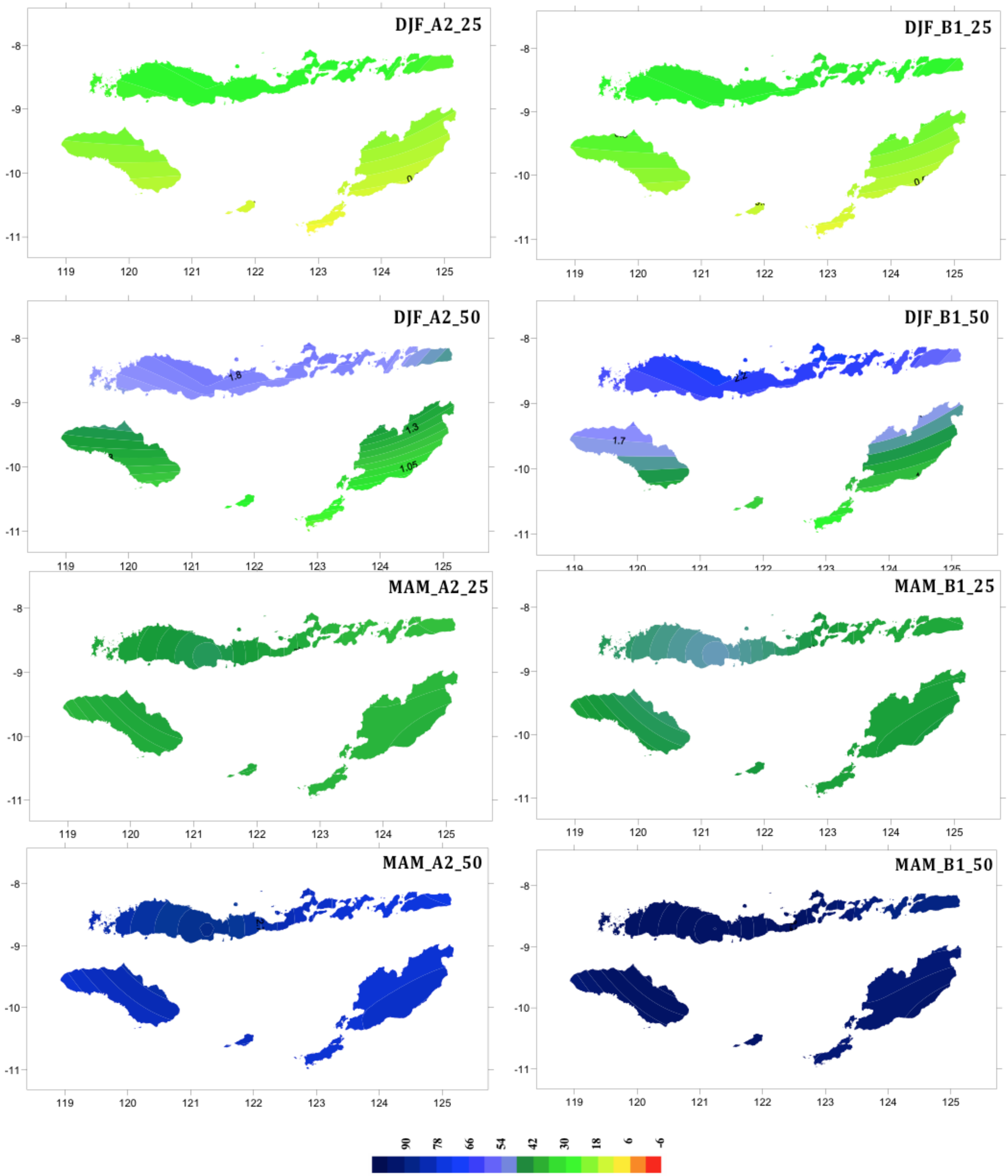
Sea level is expected to rise from 40-60 cm from 2050-2080, potentially affecting the floodplains (ICCSR, 2010). In Belu, the flat southern coast is most vulnerable. The May 2000 floods in the area, caused by a combination of flash floods and cyclone surge, took the lives of 168 people, displaced about 100,000 people, and caused significant loss of assets, with the flooding of more than 30,000 ha of land (Personal Communication, Johan Kieft). A similar event in 1939 also led to significant losses.

Table 4.5 identifies the high climate risk zones in NTT and anticipated climate change impacts.

TABLE 4.5: HIGH CLIMATE RISK ZONES IN NTT

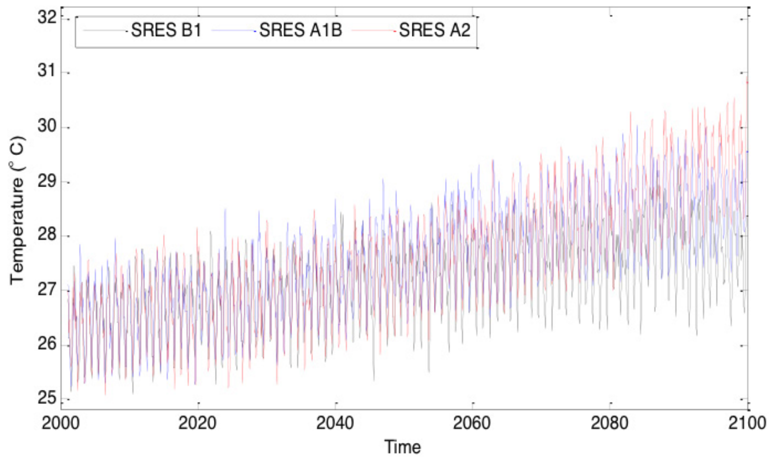
HIGH CLIMATE RISK ZONE	CLIMATE	VULNERABILITY, INDICATORS	OBSERVED HAZARD FREQUENCY AND EXPOSURE	ANTICIPATED CLIMATE CHANGE IMPACTS
1. Benain floodplain	Coastal	• Very vulnerable • 80% of income is from agriculture and allied sources • 60% of income spent on food • 30% of households earn less than US$ 1 per day • 85% of households are food insecure and vulnerable • Poor roads and communication facilities	Floods and cyclonic storms, of different intensities and periodicities, impact more than 70% of the population	• Sea level rise could inundate most of the floodplain • Increased flooding frequency
2. Atambau plateau/ Aroki plain	Intermediate (mean sea level up to 1,000m)	• High dependency on rain-fed rice. If crop failure frequency increases, livelihoods for around 50,000 people will be at risk	Drought and flash flood, of different intensities, affect most farming households	• Rice cultivation under pressure; alternative crops/ livelihoods need to be identified
3. Northern coast	Dry coastal	• Relatively poor • Has seen significant population growth due to East Timor refugees • Around 15,000 people at high risk	Cyclones and drought impact most farming and fishing households	• Minor impact from sea level rise • Drier and hotter climate will create semi-arid conditions

Source: Authors' field notes



Source: Boer, 2007

Figure 4.5: Changes in December-February (DJF) and March-May (MAM) rainfall in NTT for 2025 and 2050 under A2 and B1 scenarios



Source: Team VA, 2009[26]

Figure 4.6: Temperature projections under A2, B1, and A1B scenarios for NTT

Even with high climate sensitivity and low soil fertility, agriculture remains the main livelihood source of about 80 percent of NTT's 4.4million people. The sector contributes 43 percent to the province's GDP. Annual per capita income is USD 180, of which about 70 percent is spent on food. Around 70 percent of the people experience seasonal hunger, which lasts for about 4 months. Recurring climate shocks, such as heavy rainfall, flood, and drought can extend this period to 6-7 months. Malnutrition is 50 percent more than the national average.

LOCAL ADAPTIVE CAPACITY

Periodic droughts are a recurrent feature of semi-arid and arid regions. Communities perceive both positive (normal) and negative (drought) rainfall variations as an integral part of climatic variations, and manage situations in a holistic manner. The basic principle that guides dryland farmers' response to climatic risks is the capitalizing of opportunities provided by good monsoon conditions, to build buffers against rainfall-related uncertainties in subsequent years. Table 4.6 shows climate risk management strategies in the agriculture sector.

TABLE 4.6: RISK MANAGEMENT STRATEGIES IN THE AGRICULTURE SECTOR

TYPE OF STRATEGY	INFORMAL MECHANISMS	FORMAL MECHANISMS	
		LOCAL INSTITUTIONS	NATIONAL INSTITUTIONS
Ex-ante strategies: On-farm	• Avoiding exposure to risk • Crop diversification and inter-cropping • Plot diversification; mixed farming • Buffer stock accumulation of crops or liquid assets • Adoption of advanced cropping techniques (e.g. fertilization, irrigation, resistant varieties)	• Agricultural extension • Supply of quality seeds, inputs, etc. • Pest management systems • Infrastructures (roads, dams, irrigation systems)	• Provision of technical and resource support. About 90% of local institution resources are from the national government, hence local institutions act only as delivery mechanisms. More than 70% of local institution resources are spent on operational budget (e.g. salary cost), and less than 30% of are used for developmental purposes.
Ex-ante strategies: Sharing risk with others	• Crop sharing • Sharing of agricultural equipment, irrigation sources, etc. • Informal risk pool	• No role	• No role

TABLE 4.6 CONTINUED

TYPE OF STRATEGY	INFORMAL MECHANISMS	FORMAL MECHANISMS	
		LOCAL INSTITUTIONS	NATIONAL INSTITUTIONS
Ex-post strategies: Coping with shocks	• Reduced consumption patterns • Deferred/ low key social and family functions • Sale of assets • Migration • Reallocation of labor • Mutual aid	• Delivery of food and relief logistics	• Social assistance (e.g. calamity relief, food-for-work, etc.) • Rescheduling loans • Agricultural insurance • Relaxation in grain procurement procedures • Supply of fodder • Cash transfer

The strategies that farmers in drought-prone regions of NTT adopt, to manage risks associated with high rainfall variability, are well documented through various surveys and studies (WFP, 2011[27], Oxfam, 2010[28], and Kieft, 2007[29]). The literature review revealed that farmers expect seasonal rainfall changes similar to the local historical averages, and certain amount of deviations around these averages. They devised ways to deal, not only with expected rainfall variability around the averages, but also some surprises due to the occurrence of random events, like droughts (Subbiah, 2003[30], Jodha, 1989[31], and Chen, 1991[32]).

Community coping strategies in different zones in NTT, as elsewhere, reveal unique adaptive features. These strategies were developed over several generations. Since water constraint is a feature of the production environment, moisture security and its management are a key strategy for sustenance in such an environment. Farmers in rain-fed land, located on slopes of varying steepness and altitude, would, every even year in a 5-year then fallow shift farming, use gently sloping land, which has no access to irrigation and located close to home gardens, for planting tuber crops, corn, grain legumes, and tree crops (ACF, 2007)[33].

Similarly, in dry areas, where grain production may often be inadequate and uncertain due to the short and undependable growing season, traditional sustenance efforts are linked to overall biomass availability and stability. Farmers practice mix-crop farming, planting corn, cassava, and dry field-rice in the same fields. Such diversification enriches the household diet, enhances the soil structure, and mitigates the impact of corn harvest failure. Cash crop production, livestock raising, and other income sources that are less sensitive to rainfall are also practiced. Often, cash crops become the people's only source of income, which is spent entirely on food purchase (ibid).

Collective sustenance is another strategy for managing weather-induced scarcities, taking advantage of the differences in endowments and capacities of households within the community. Also, farmers opt for activities that are relatively stable against rainfall fluctuations, to ensure greater production flexibility. Diversification is also an important strategy, integrating dairy, poultry, and sheep rearing with crop cultivation, as well as engaging in non-farm labor and small enterprises. These strategies are summarized in Table 4.7.

TABLE 4.7: FARMERS' ADAPTATION/ ADJUSTMENT STRATEGIES AGAINST DROUGHT IN DRY TROPICAL REGIONS

CATEGORIES/ MEASURES	STRATEGIES				
	MOISTURE SECURITY	BIOMASS STABILITY	COLLECTIVE SUSTENANCE	FLEXIBILITY	DIVERSIFI-CATION
Folk agronomy					
Cultivars with varying maturity and combinability				√	√
Long duration, high stalk-grain ratio, yield stability		√			√

TABLE 4.7 CONTINUED

CATEGORIES/ MEASURES	STRATEGIES				
	MOISTURE SECURITY	BIOMASS STABILITY	COLLECTIVE SUSTENANCE	FLEXIBILITY	DIVERSIFI-CATION
Cropping					
Mixed cropping, role of minor crops				√	√
Spatial, temporal variations in planting	√			√	√
Crop-fallow rotations		√			√
Input use variations				√	
Ethno-engineering					
Tillage practices, weeding	√				
Moisture conservation/ harvesting	√		√	√	
Irrigation structures					
Indigenous agro-forestry	√	√		√	√
Farm forestry, shelter belts		√			
Crop-bush fallow rotation		√			
Annual perennial linkages		√		√	
Occupational diversity					
Crop-livestock mixed farming				√	√
Premium on stable earning/ remittance				√	√
Acceptance of low payoff options				√	√
Diversity of asset structure					√
Self provisioning systems					
High dependence on own resources				√	
On-farm storage, recycling			√	√	
Flexible consumption/ resource use				√	
Asset depletion-replenishment cycle				√	√
Collective sharing systems					
Forms of mutual self-help	√	√	√	√	
Common property resources		√	√	√	
Migration, spatial linkages			√	√	

Source: Jodha et al (1998)[34], modified based on field surveys by Kieft (2008)[35], Fox (1995)[36], Oxfam (2010), and WFP (2010)[37]

TABLE 4.8: SUSCEPTIBILITY OF CROP VARIETIES TO CLIMATE-RELATED RISKS AND PESTS, TEAKAS HAMLET, NTT, AT 800M ASL (0-RESISTANT, 5-VERY SUSCEPTIBLE)

CROP	CYCLONIC WINDS	HEAVY RAINS	SNAILS	WEEVILS	RICE BUG	IMPORTANCE FOR CONSUMPTION, RANKING (1-IMPORTANT, 5-LIMITED IMPORTANCE)
Maize (*pena*)						
Pena nais	1	5	5	1	0	1
Pena molo	5	3	5	2	0	1
Pena muti	5	5	5	5	0	1
Upland rice (*ane*)						
Anemollo	5	0	1	0	5	2
Anemuti	5	0	1	0	5	2
Ane meal	5	0	1	0	5	2
Foxtail millet (*sain*)						
Suisio	2	0	1	0	0	4
Suisuso	2	0	1	0	0	4
Sorghum (*buka*)						
Tekal	4	0	5	2	0	5
Noa	4	0	5	2	0	5
Cassava						
Mollo	0	0	5	0	0	3
Muti	0	0	5	0	0	3
Impact on yield, ranking (1- high, 5- low)	1	5	3	2	4	

Farmers of NTT have skills and experience to select crop varieties that could withstand climate variations, and to maintain and improve these varieties. Table 4.8 shows the different crop varieties that could withstand cyclonic winds, heavy rains, and pests, and how these risks affect yield. Cyclonic winds and weevils affect crop yields the most in Teakashamlet, hence farmers select seeds that have high resistance to cyclonic winds (e.g. early maturing seeds) and weevils.

Farmers generally sequence their strategies in response to the progressing drought, with the primary aim of surviving the drought without losing productive assets, such as land and livestock, and then quickly recover and take advantage of the coming monsoon.

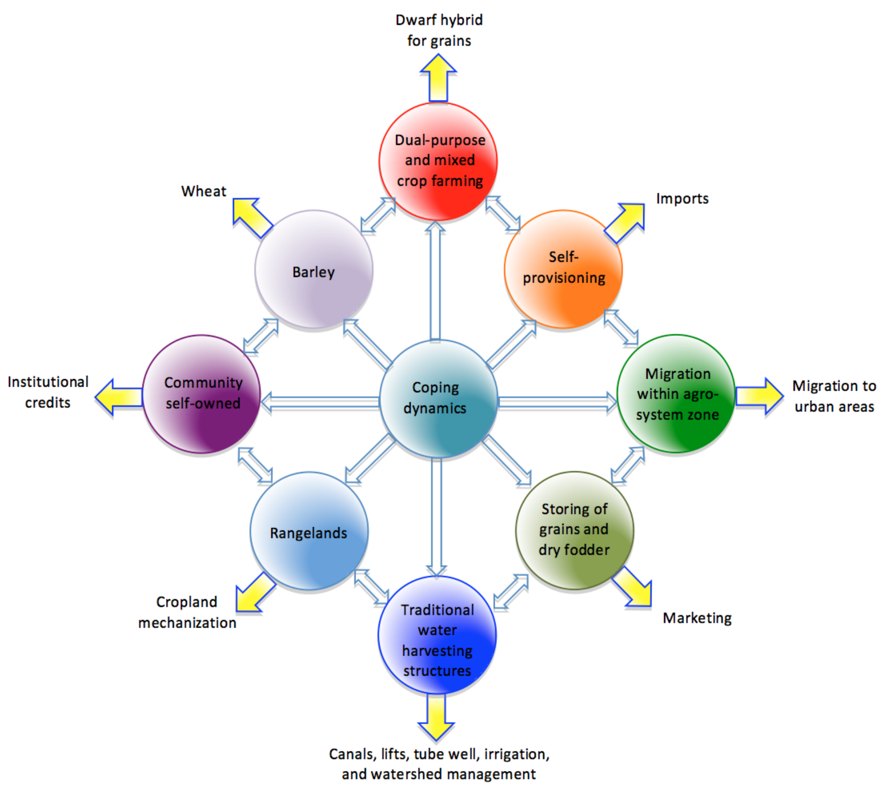
Preferred responses are actions that are most reversible and involve the least household resources. Table 4.9 ranks responses to drought according to reversibility. While farmers in dry areas are able to adapt to high rainfall variability, farmers in coastal areas often face crop failure during dry years.

TABLE 4.9: FARMERS' RESPONSES TO DROUGHT

RESPONSE	REVERSIBILITY (RANK)
Drawing down inventories	1
Drawing upon common property resources	2
Drawing upon social relationships	3
Reducing or modifying consumption	4
Borrowing	5
Mortgaging non-productive assets	6
Disposing non-productive assets	7
Migration	8
Mortgaging productive assets	9
Disposing productive assets	10
Drastic measures	*

** Only when all strategies are exhausted. Involves the disengagement of all normal systems of survival, particularly during acute famine conditions*
Source: Chen, 1991

Gaps. Population growth and its increased pressure on land, greater role of market forces, and institutional and technological changes pose challenges to traditional risk management strategies. Grazing lands and rural common property resources have been shrinking with increasing demand for arable land, thereby straining diversification from crop-livestock mixed farming. Rural produce supplies increased market demands, leaving little for responding to rural scarcities. Changes in land ownership patterns, from big landowners to smallholder farmers, affected traditional irrigation arrangements, such as water harvesting, previously regulated and maintained by these big landowners. Figure 4.8 shows these shifts in traditional coping mechanisms.



Source: Authors' Field notes

Figure 4.7: Shifts in traditional coping mechanisms (indicated by solid arrows)

THREATS TO DEVELOPMENT

Droughts and floods keep the poorer sections of society under the poverty line. Two-thirds of Indonesia's 32 million poor live in rural areas, and over 80 percent of the country's rural population is engaged in agriculture. Adverse drought and flood impacts on the agriculture sector, in the form of loss of crops and income, negate progress made towards poverty reduction.

The decreasing poverty rate in the country, from almost 50 million poor people in 1998 to less than 35 million in 2008, is commendably noted. If severe events, such as the 1997-98 El Niño, recur, the proportion of the poor could increase, eroding the gains made during the decade. When coupled with non-climatic factors, impacts of an extreme event of the same magnitude as in the past could be more severe, and could drag a large section of those just above the poverty line down below once again. Poverty impairs people's purchasing power, adversely affecting their ability to access food.

Historically, any rice production shortfall, due to climate shocks, led to serious food security concerns and political crisis in the country. Ensuring food security entails diversion of investment that is otherwise meant for development purposes.

KEY MESSAGES (CLIMATE IMPACTS AND RISKS FOR AGRICULTURE)

- El Niño and La Niña associated droughts and floods is a serious climate risk to Indonesian agriculture and other economic sectors.
- On average, 300,000 ha of crop lands are affected by drought and El Niño could amplify that impact to 1 million ha (1991 El Niño).
- Climate projections indicate further amplification of the risks due to increasing frequency and intensity of El Niño and La Niña.
- Indonesian food security is delicately balanced with a gap of around 1.2 million tonnes every year. El Niño induced impacts could widen this gap to around 5 million tonnes (1997-98 El Niño), thus causing serious food security problems.
- Most of the farmers are poor and their adaptive capacities are very low to manage these periodic climate risks.
- Compared to Western Indonesia, Eastern Indonesia, viz., NTT faces high climate risk and also has low-adaptive capacities to manage these risks both at the provincial institutional and household levels.
- Periodic climate shocks hamper Government of Indonesia's effort to reduce poverty hence increasing agricultural resilience to climate risks is a major development concern of Government of Indonesia.

CURRENT CLIMATE RISK MANAGEMENT

The most common practices to reduce climate risks in agriculture include adjustments in cropping pattern, calendar, and farm management; use of heat-resilient and drought-resistant crop varieties; inter-cropping; diversified farming; and variations of crop rotation patterns. This local capacity, however, needs to be enhanced through provision of public goods and services, such as detailed, time-specific forecast information (including Southern Oscillation index); research and development on drought-resistant crop varieties and other techniques; and early warning, index-based insurance, and water-efficient irrigation systems.

INSTITUTIONAL AND POLICY ARRANGEMENTS FOR CRM

In Indonesia, three distinct frameworks address the climate risks- development planning, disaster management, and climate change adaptation, however there is no integration of climate risk management process. These three domains are discussed further in succeeding paragraphs.

Development Planning Framework

The Long-Term Development Plan recognizes the adverse impacts of climate and geophysical hazards on the people and on the country's overall development. Under the Development Direction: Terwujudnya Indonesia yang Asridan Lestari (Everlasting Indonesia), the Plan highlights various disasters caused by extreme climate events in Indonesia, including the floods and droughts that resulted in heavy losses to the national economy (Bappenas, 2009). Although the plan does not explicitly identify measures to reduce risks, it outlines broader strategies leading to key outcomes, such as poverty reduction, food security, and stable economy. Similarly, the Medium-Term Development Plan highlights environmental conservation and disaster management as part of 11 national priorities. Sectoral policies also incorporate climate change adaptation.

The 'National Development Planning – Indonesia's Response to Climate Change', also referred to as the 'yellow book', prepared by BAPPENAS, is a document that outlines the process of integrating climate change programs into national development planning, lists sectoral priorities and climate change-related measures within the framework of sustainable development, and provides an overview of funding mechanisms and institutional arrangements for implementing sectoral and cross-sectoral activities, including guidance on developing partnerships to address climate change (Embassy of Denmark, Jakarta, 2009).[38]

Although climate risk is a major concern in the country, other non-climatic stresses have been playing key roles in shaping policy trends. Highlighted in the national policy planning process are areas and themes concerned with economic growth, governance, corruption prevention, poverty eradication, farmers' welfare, and food security, especially for the poorer sections of the population. The key challenge for this is related to increased exposure across all sectors to climate risks than in the past. Aimed at maximizing economic benefits, these growth and production-oriented policies could increase risks that are likely to affect and get affected by climate change risks. But even against this backdrop, there are opportunities to integrate climate risk management within each sector. For instance, governance is in transition from centralized to decentralized, hence there is some window to incorporate CRM in local capacity building initiatives. Additionally, the environment ministry is now adopting 'trade-offs' between development and environmental conservation. Policies in the water sector also reflect movement from construction to conservation, and basin management through Integrated Water Management (IWM). Similarly, the forestry sector policy aims to curb exploitation and encourage conservation through Integrated Forestry Management (IFM). Integrated Coastal Zone Management (ICZM) is also being applied to improve the state of coastal resources. In general, Natural Resource Management policies are moving from exploitation to conservation and management. Disaster management policy is following suit, with its shift from response to disaster risk reduction (DRR), while agriculture is likely to change its focus from food production to farmers' welfare and food security, targeting the poorer sections of society. Thus the development planning framework is yet to address both climate and non-climatic stresses in a holistic manner.

Disaster Risk Management Framework

The integration of DRR into development planning through participatory processes in Indonesia can be used as a model for integrating current (and future) climate risks into development planning processes. Disaster Management has evolved rather successfully in Indonesia, following a paradigm shift from response to risk reduction, and with increased emphasis on local communities through action plans for DRR. The Law on Disaster Management was supported with regulations on disaster management (DM) arrangements, funding and external support, including the establishment of the national disaster management agency (BNPB), and subsequently the local (regional and provincial) DM Boards. National and local budgets predominantly fund DM activities, with contributions from the private sector, international donors, and NGOs.

BAPPENAS collaborated with other ministries and agencies in preparing the 2nd National Action Plan on Disaster Risk Reduction (Rencana Aksi Pengurangan Risiko Bencana/RAN PRB) for 2010-2012. RAN PRB is one of the elements in the National Development Plan, with DRR being one of the development priorities. Table 5.1 outlines some Annual Government Work plans that include DRR (and CCA), demonstrating how DRR (and CCA) is integrated in development planning.

TABLE5.1: DISASTER RISK REDUCTION IN INDONESIAN POLICY

POLICY	NATIONAL PRIORITY	FOCUS
Presidential Regulation No. 19 (2006) on Annual Government Work Plan (RKP) for 2007	Priority VII: Disaster Mitigation and Management	Focus 3: Institutional Strengthening for Disaster Prevention, Management at National and Local Levels Focus 4: Disaster Prevention and Disaster Risk Reduction
Presidential Regulation No. 18 (2007) on Annual Government Work Plan (RKP) for 2008	Priority VIII: Disaster Management, Disaster Risk Reduction, and Improvement of Contagious Disease Eradication	Focus 2: Elaboration of the national action plan for DRR Focus 3: Development of institutional/ human resource capacity in disaster mitigation and early warning system Focus 4: National and local spatial planning based on disaster risk reduction
Presidential Regulation No. 38 (2008) on Annual Government Work Plan (RPK) for 2009	Priority II: Acceleration of Economic Development through Fortification of Economic Resilience Supported by Agriculture Development	Focus 5: Strengthening Capacity in Global Climate Change Mitigation and Adaptation

Source: Bappenas, 2009

The DM law guided the participatory, multi-stakeholder process that led to the preparation of the National DM Plan (2010-14) and the National Action Plan on DRR (NAP-DRR, 2010-12). Both the National Medium Term Development Plan (RPJM) and the National Long Term Development Plan (RPJPN) were integrated into the NAP-DRR, which provides inputs to the Government's Annual Work plans (RKPs) for 2010, 2011 and 2012.

The NAP-DRR also guides the formulation of local action plans, which in turn coincides with local government plans and local sectoral annual work plans. Funding mechanisms are guided by action plans, in line with national development plans. In 2007 and 2008, a significant sum was allocated for DRR in the annual government work plans (0.222 billion Rupiah in 2007, 1.443 billion Rupiah in 2008). This increased further in 2009 to 1.736 billion Rupiah (Bappenas, 2009). The NAP-DRR has also received significant financial support from donors and NGOs, with grants or loans of 0.717 billion Rupiah exceeding the proposed budgets of 0.058 billion Rupiah (ibid). From this, it appears that the integration of DRR into development planning is quite advanced at national levels, and increasingly so at local level planning. This process could be replicated to integrate climate change adaptation into development planning.

Climate Change Framework

Indonesia's framework for climate change is quite advanced in the region. At the national level the National Council for Climate Change (NCCC) is highest policy coordination body on climate change, with key responsibility for managing impacts of climate change. It comprises of key ministries such as Energy, Forestry, Agriculture and Environment and is chaired by the President of Republic of Indonesia, with the Minister for Environment as executive chair. The Head of the NCCC Secretariat is the Indonesian national focal point for UNFCCC. NCCC formulates policies, strategies on climate change, carbon trade and coordinates activities relating to adaptation, mitigation, technology transfer and financing, and supports Indonesian negotiators in UNFCCC negotiations. NCCC has constituted seven Working Group focusing on Mitigation, Adaptation, Technology Transfer, and LULUCF (including REDD), Financial Mechanism, Post 2012, and Scientific Basis and Green House Gases (GHGs) Inventory, to function as its think tanks for development of Indonesia's climate change policies. *(Embassy of Denmark, Jakarta, 2009)*

The National Planning Agency (Bappenas) had coordinated an effort in 2008 involving all line ministries to list key climate change initiatives from both adaptation and mitigation perspectives. It resulted in a document called National Development Planning: Indonesia Response to Climate Change, or the Yellow Book, that served as a bridging document to integrate climate change concerns into the on-going National Medium Term Development Plan (2004-2009). It followed and built on the earlier effort of the Ministry of Environment in 2007 through the Climate Change National Action Plan (Rencana Aksi Nasional Perubahan Iklim or RAN PI) which identified actions for adaptation and reducing emissions. Both are seen as living documents that could be improved and updated from time to time, and serve as a policy umbrella[39] *(Government of Indonesia, 2009)*. This plan is cross-sectoral and mobilizes the whole array of tools available, including governmental organization, taxation, investment policies, decentralization, and awareness-raising.

Indonesia Climate Change Trust Fund (ICCTF) was set up in 2009 by Government of Indonesia to finance Indonesia's climate change policies and programs and to pool and coordinate funds from various sources such as international donors and the private sector. The two main objectives of the ICCTF are to achieve Indonesia's goals of a low carbon economy and greater resilience to climate change, and to enable the GOI to increase the effectiveness and impact of its leadership and management in addressing climate change issues. It also aims to be an important policy dialogue forum for Development Partners and GoI on climate change issues. *(ibid)* The ICCTF operates across 3 priority windows: energy, forestry/peatlands (mitigation) and focuses on adaptation and resilience initiatives in agriculture, health, coastal zone management and water resources[40] (Rondonuwu, 2010).

Indonesia Climate Change Sectoral Roadmap (ICCSR) is a 20-year road map formulated to provide inputs for the five year National Medium-term Development Plan (RPJMN) 2010-2014, and also for the subsequent RPJMNs until 2030. It identifies key adaptation and mitigation measures formulated taking into consideration the current conditions and the projected impacts in forestry, energy, industry, agriculture, transportation, coastal area, water, waste and health sectors.

As the different functions relevant to CRM are carried out by different institutions without much integration under a CRM framework, these frameworks in isolation would not be able to address climate risks. Ministry of Environment has hence embraced this CRM approach and formed a working group which has evolved an action plan through CRM TASP, initially focused on agriculture and food security. A copy of sample action plan is annexed (Annex 1).

CAPACITY ASSESSMENT FOR CLIMATE RISK MANAGEMENT

A capacity assessment for climate risk management has been undertaken utilising the World Resources Institute's National Adaptive Capacity framework (WRI, 2009). The assessment results are as follows:

Assessment function: Assessment capacities in Indonesia are discernable in all the key policy documents discussed earlier which have undertaken broad level of risk assessments in the process of formulating their strategies. The Yellow Book and the ICCSR to name a few, have assessed the risks and vulnerabilities in several key sectors including agriculture. DRR sector has also undertaken several assessments at national, provincial and local levels to assess vulnerabilities and risks- eg: vulnerability assessment and climate change risk assessment in Lombok Island supported by GTZ. MoHA, BMKG, Public Works the National Mapping Agency (BAKOSURTANAL) all have risk assessment capabilities and have undertaken disaster risk assessments.

Despite strong capacities and the several completed and on-going efforts in the absence of a policy for cross-sectoral coordinated assessment, these assessments are not holistic. Assessment functions are not carried out in a coordinated manner to manage climate information for risk management. Lack of the coordination of assessment functions between agriculture and water resources is evident- especially as 86 percent of rice production depends on irrigation, assessment in water resources does not fully consider the possible favourable rainfall conditions to fund and undertake necessary upkeep and maintenance of irrigation structures (over 50 percent of them are in poor conditions and unable to utilise full design capacities). In agriculture sector this is further illustrated by the case wherein implications of production figures provided by the agriculture department are not factored into food security decisions undertaken by the BULOG which is responsible for imports and maintaining buffer stocks. Before October 2011, possible La Niña impacting Indonesia resulting in favourable rains and possibly increased rice production was already known. However, the decision to not import rice was taken only in May 2012, resulting in a glut in the market and depressed prices for local rice farmers to their disadvantage.

Prioritization function: In the absence of coordinated, stakeholder-based, scientific assessment of risks process, prioritisation of risks is not adequately focussed. Despite the Roadmaps which have identified a comprehensive range of adaptation and risk management actions in several sectors, actual prioritisation in terms of actions in their order of critical importance and budget provision is not undertaken.

Agriculture sector spending has been increasing from 2001 to 2008 (from 11 trillion Rupiah to 53 trillion Rupiah) or an average of 11 per cent per year in real terms. Share of agriculture in the national budget also increased from 3 per cent in 2001 to 6 per cent in 2008. However, closer examination shows that the bulk of this increase has gone towards agriculture subsidies in the form of fertilizers, seeds etc, and not towards enhancing infrastructure (irrigation, transport linkages for marketing etc) or research capacities (extension). These are prerequisites for realisation of value of climate information. The increased budget spending did not result in prioritisation of productive aspects (irrigation, extension, research), and instead focussed on more remunerative aspects through subsidies[41] (World Bank, 2012), such that 1 Rupiah input in 2008 generated only 2.5 Rupiah compared to 9 Rupiah in 2001.

Hence, for effective CRM in agriculture, improving the status of these prerequisites is most critical.

The current level of prioritisation of interventions appears to stop at a broad geographical or sectoral level. Even in a highly vulnerable area, such as Kupang district in NTT, the risk varies with reference to land characteristics such as low-land, mid-land and high-lands, and socio-economic characteristics of farmers and livestock-dependent nomads. While low-land livestock depending nomads have more flexibility to manage risks, the mid-land farmers have less flexibility and as such are more vulnerable to climate risks. This level of risk diagnosis would help in designing more targeted and prioritized CRM interventions.

Coordination function: There are a number of national, provincial and local agencies and organizations that include climate risks in their agenda. However, intra- and inter-linkages among these agencies and organizations at various levels and foci appear to be limited. Table below indicates the various agencies working on climate-related risks without much cross-sectoral coordination.

TABLE 5.2: INDONESIA AGENCIES AND ORGANIZATIONS WITH CLIMATE-RELATED RISKS IN THEIR AGENDA

INSTITUTION	TYPE	RELEVANT OBJECTIVE	ROLE IN CRM
National Council on Climate Change	Council for coordination on climate change	• National level policy coordination • UNFCCC focal point	• Responsible for managing impacts of climate change • Has established a working group on adaptation (one among seven groups)
BMKG (Badan Meteorologi, Klimatologi dan Geofisika)	Meteorological, Climatological, Geophysical Agency	• Generation and communication of weather, climate (and seismic) information	• Responsible for generating required climate and weather information • Is developing its capacities and facilities in a big way
BAPPENAS (Agency for National Development Planning)	GoI Ministry	• National development planning • Integration of climate change in development	• Currently developing roadmap to mainstream CCA into national development planning
KLH (Ministry of Environment)	GoI Ministry	• Development of mitigation and adaptation strategies	• Involved in the preparation of Second National Communication
Ministry of Home Affairs	GoI Ministry	• Regulation and implementation at local government level	• Key role in the context of decentralization with its linkages to local governments • Most ministries now strive to work at local levels through this key ministry

TABLE 5.2 CONTINUED

INSTITUTION	TYPE	RELEVANT OBJECTIVE	ROLE IN CRM
Ministry of Public Works	GoI Ministry	• Management of dam systems, irrigation infrastructure and water resources • Development of housing, settlements, roads and highways, and spatial planning	• One of the key users of climate and weather information, but largely for design of physical structures (irrigation), and to an extent for managing reservoirs • Also supports local governments on Spatial Planning through its Directorate General
BNPB (National Disaster Management Agency)	GoI National Institution	• Disaster Risk Management • Mainstreaming DRR into development	• National Action Plan for DRR prepared in collaboration with BAPPENAS and sectoral agencies • Could play a larger role in CCA
Ministry of Agriculture	GoI Ministry	• Increase Food Crop Production for food self-sufficiency and food security • Ensure rural livelihoods through agriculture and processing	• A key user of BMKG's short-term weather and seasonal forecast information • Has evolved activities that integrate available climate information into cropping decisions through innovative mechanisms (e.g. Climate Field Schools)
BULOG (National Food Logistics Agency)	Parastatal Agency	• Maintain food security through price stabilization of rice • Implement social protection programs for the poor (18 million in 2009)	• Maintains a steady buffer stock and undertakes additional procurement (domestic or import) if a possible crisis (natural or humanitarian) threatens food availability
LAPAN (National Institute of Aeronautics and Space) – Climate and atmospheric science application center	GoI National Institution	• Application of climate and atmospheric models in agriculture, farming, forestry, health, transportation, spatial planning, hydrology and oceanography • Research programs on impacts of climate change	• Communicate medium- and long-term climate information and climate change impact analysis to users
BAPPEDA(s)	Provincial Govt. Institution	• Plays a role similar to Bappenas but at provincial levels	• Assists in the preparation of regional and provincial level plans (long-, medium- and short-term)
BPBD (Local Disaster Management Agency)	Provincial/ Municipal/ District Govt. Institution	• Plays a role similar to BNPB but at local levels	• Incorporation of climate change adaptation into local regulations on disaster management and into disaster management implementation at sub-national levels
Technical Units	Representative units of line ministries	• Support district governments in the development of policies and programs	• Due to limited technical capacities and the enormous role of local governments, Technical Units play a key role in guiding the implementation of technical activities
Rural advisory and information agencies	Local Govt. agency	• Responsible for extension activities at district (BIPP) & provincial (BKP) levels	• Provides extension services to natural resource user groups such as farmers, fishermen and forest-dependent communities

Source: Embassy of Denmark, Jakarta, 2009

Analysis of roles and functions of various departments shows the disconnect from research (agriculture), to policy formulation to advocacy to implementation. For example, when research has brought out the deficiencies and ineffectiveness of the CFS, they have not yet been taken into account by policy formulation, advocacy and implementation process, highlighting the lack of horizontal and vertical coordination. Another case is that among agriculture and disaster management, seasonal forecasts are considered only by agriculture sector for their planning, while BNPB only takes note at the time of a looming crisis; they are not coordinated enough with the other to make use of each other mandates, such as for agriculture to get support from BNPB and utilise its funds for providing seed support to farmers as may be required based on the forecasts.

Information management function: Information and data is gathered through established structures in all key sectors- Agriculture, Water Resources, Meteorology, Statistics are notable agencies. BMKG has a dense observation data gathering mechanism which has received increased funding support in the aftermath of the several disasters that Indonesia experienced in the last decade. Information is managed without taking the decision-contexts into consideration through a user-needs assessment and then designing information generation systems to address the user needs. BMKG data gathering and collection could be better related to specific user requirements, eg: agriculture, water, information generation capacity, and integrated into their decision-making contexts and feedback obtained. An attempt to integrate climate information from BMKG into agricultural processes at the provincial, district and local farmer group levels has been made in the last decade through the Climate Field Schools (CFS).

BOX 5.1: THE CLIMATE FIELD SCHOOL

The Climate Field School (CFS), modeled after the Integrated Pest Management Field School, was developed in 2002 to facilitate the communication of climate information for reducing flood and drought risks in Indramayu District in West Java, Indonesia. The Indramayu Agriculture Office led CFS development, in collaboration with the Directorate for Crop Protection (DITLIN) and BMKG, and with technical inputs from Bogor Agricultural University (IPB) and Asian Disaster Preparedness Center.

Interactive modules cover the basic concepts of probabilistic forecasting, climate forecast products, methods of observing and recording climate data, use of historical data to assess impacts of climate variability on agriculture, and development of cropping strategies based on climate prediction scenarios. The training program includes:

1) Training of agricultural extension specialists at district level to interpret and translate scientific climate information into potential impacts, and subsequently prepare response options;

2) Training of trainers at sub-district level;

3) Training of agricultural extension workers at sub-district level to communicate climate information in farmers' language;

4) Training of farmers;

5) Dissemination of adaptive farming practices and adoption of new technology – i.e. the application of seasonal climate forecast in farming decisions.

Training of farmers is conducted in two planting seasons (12 meetings during the dry season, and another 12 during the wet season), with knowledge application in farming operations.

However, as an evaluation study on the CFS undertaken in 2009[42] (Raja, 2009) points out, there is scope for improving this initiative to address concerns relating to different socio-economic contexts, crop preferences, risk aversion of farmers and absence of support mechanisms such as seeds, fertilizers. CFS addresses only the climate risks but as the farmers manage in a holistic manner various risks, such as market risks, pests etc., this approach needs revamping. *(Chapter 6 provides more details on the recommendation relating to CFS)*

The ICCSR have projected El Niño, La Niña occurrences on a yearly-basis from 2011 to 2030 in 2010. However, the very first year of the prediction is off the mark and policy makers appear to have serious reservations in using such information. Hence it is not possible for policy-makers to prioritize CRM actions on the basis of this information.

Climate risk reduction function: Despite strong capacities in the national level agencies, decision-support tools to facilitate operational climate risk reduction functions are not available.

This is evident in the case of food security. Climate risk has been one of the major impediments in preventing Indonesia to achieve its food self-sufficiency policy goals due to recurrent El Niño associated droughts and weather related pests and diseases. As national food production and demand gap is delicately balanced a risk averse national Government has had to resort to food imports to cushion potential impact of climate shocks, and food security being a politically sensitive issue, decision makers actively seek decision support tools for decision making. In the absence of decision-support tools, decision-makers could potentially underestimate domestic food production or over-estimate import requirements. Thus causing depression of domestic food prices that resulted in losses to farmers. In some years the decision makers overestimated production and underestimated import requirements thus causing increase of food prices thus harming net food consumers both in urban and rural areas. With advance in climate prediction and very high predictability of Indonesian Climate there is a possibility of producing adequate food domestically by incorporating climate information in different time scales especially for the three islands – Java, Sumatra, Sulawesi which together produce 90 percent of the country's two main staple food. However, these climate risk reduction measures though known and to an extent accepted and appreciated, are not put into practice.

Ministry of Environment through the CRM TASP spearheaded a stakeholder workshop to identify and focus on climate risk reduction functions. The workshop prioritised several options as tabulated, as well as identified several policy and institutional constraints holding back the operationalization of these options for managing food security.

TABLE 5.3: CRM OPTIONS FOR FOOD SECURITY AT NATIONAL LEVEL & CONSTRAINTS IN IMPLEMENTING OPTIONS

CLIMATE RISK MANAGEMENT OPTIONS	THE ROLE OF CRM	EXPECTED OUTCOME	STAKEHOLDERS	POLICY & INSTITUTIONAL CONSTRAINTS
Application of seasonal forecasts for enhancing rice and corn and other crop production in favourable zones and favourable seasons and reduce crop losses in unfavourable areas and seasons	There is a potential possibility of using ENSO index-based & other indicators climate forecast to institutionalize CRM to manage crop system in favourable areas (areas that have agric. potential due to long wet season) to maximize potential gains and minimize losses in other areas	Forecast result (timely, accurate) could be made available, understood, easily accessed, by users at all levels and at no cost	Intermediary institutions to translate and communicate info from BMKG to local levels by involving Universities, Local institutions, Farmer groups, research institutes, civil society; MoA, PWD and BMKG	1. Regulation for facilitating information dissemination from BMKG under preparation (could be issued end 2011) 2. Policy to support BMKG to hold regular information user-producer dialogue 3. Decree from MoA, Marine-Fisheries, Provincial, District decree to facilitate information application by users

TABLE 5.3 CONTINUED

CLIMATE RISK MANAGEMENT OPTIONS	THE ROLE OF CRM	EXPECTED OUTCOME	STAKEHOLDERS	POLICY & INSTITUTIONAL CONSTRAINTS
Strengthen Climate Field school program based on constrains and shortcomings highlighted by Evaluation Studies MOA BMKG and PWD Agriculture Research institutions	Seamless integration of weather/ climate forecast for risk management Improve training curriculum for application in West Java, Central Java (evaluated already); & all other districts where CFS is on-going	Flexible Crop Calendars in Anticipatory risk management options extended to Agriculture Cooperatives Improved curriculum is implemented considering local conditions. Recommended operational decisions (crops, calendar) are fully implemented by farmers, Capacity to adapt to new sources of income, greater awareness on use of climate information & networking	BMKG, MOA, M/ Education, MOHA & local govt, Marine & Fisheries, NGOs, Universities, Research Institutions, Community institutions, Farmers' groups, Parliament, mass organisations, womens' organisation and religious organisation	1. Current institutional arrangements under BMKG needs reform 2. Policy to adapt and adopt CFS for fisheries, animal husbandry and other user groups (at all levels)
Integrate decision support tools for food logistics management relating to ENSO & other indicators' forecasts into MOA, Bulog and Ministry of Trade and BPS with involvement of BKMG	Incorporation of climate information into food availability estimation model of BULOG, BPS, M/Trade, MOA, M/Planning, M/ Transportation and related ministries and a distribution model according to specific requirement of provinces	Food availability estimation model integrating climate information is pilot tested and integrated into operations	MOA, BULOG, BPS, Planning, BMKG, Trade, Transportation, local govts, MOHA, M/ Forestry, local NGOs, BNPB, BPBD	1. Decree of MOA, BULOG, MOHA & local govts on integrating climate information into food availability estimation model

Source: CRM TASP Workshop, Bogor, Indonesia, 19-20 October 2011

Use of Climate Information in agriculture

Use of climate information at the local level is still limited. Some communities, for instance the *subaks* (socio-religious agriculture and irrigation associations) in Bali, use indigenous forecasting methods; these are, however, not linked to BMKG. Indramayu (West Java) and Kupang (NTT) have experience in climate forecast application through a project implemented by the Directorate for Crop Protection (DITLIN), Indramayu Agriculture Office, and Bogor Agricultural University (IPB), and CARE, in collaboration with BMKG and the Asian Disaster Preparedness Center, International Research Institute for Climate and Society, with support from USAID/OFDA, from 1998-2008. Through the program, BMKG provides, at least a month before the onset of the dry and wet seasons, localized seasonal climate forecasts in the demonstration sites, as required by farmers and other local users such as seed distributors, fertilizer traders, and other farming support institutions. Trained in risk and potential impact assessments, district level DITLIN and the Indramayu Agriculture Office assess the potential impact of the rainfall forecast for the incoming season. They then prepare response options, and communicate these to farmers through agricultural extension workers and farmers' group representatives.

Information on season onset, rainfall characteristics, and length of dry spell in the wet season are provided, as required by farmers. The local government also provides institutional support to farmers, such as through a revolving fund that farmers can access without interest and with a pay-back period of 2 to 4 seasons. Additionally, the local government mobilized agriculture input distributors to provide enough fertilizers and seed stocks, among many others, to enable farmers to respond to crop management options in response to the forecast. Finally, an agreement was established with a local cooperative to provide a market for the farmers' products.

Farmers were trained in Climate Field Schools to understand forecasts and their constraints, to analyze crop management practices appropriate for the climate outlook, and to receive information on new cropping practices and support mechanisms such as establishing farmers' cooperatives. The Climate Field School, which meets once a week, is an important institutional mechanism that allows regular interaction between BMKG, DITLIN, Indramayu Agricultural Office, IPB, and farmers.

The Ministry of Agriculture plans to build upon the work done in Indramayu. Challenges, however, remain, in particular concerning forecast reliability and lead time and the farmers' socio-economic constraints.

In support of agriculture, the Public Works Ministry uses historical climate information for technical design of irrigation structures, and, to a lesser extent, seasonal forecasts for operation and maintenance of dams and reservoirs. Apart from these, there remains little incorporation of climate information in decision-making.

Climate Information System for agriculture and food security

The climate information system developed under the climate forecast application project, mentioned above, involves BMKG as forecast provider, DITLIN and the district agriculture office as intermediaries, and farmers as end users. The Climate Information System for agriculture and food security, however, is not fully developed as this institutional system is designed to respond to crisis, and not having intrinsic capacity to anticipate and manage agricultural production and food distribution. The current institutional system for food security management, which is cross-sectoral and has delineated institutional roles, an action plan, and funding scheme is elaborated (Box 5.2).

BOX 5.2: INSTITUTIONAL SYSTEM FOR FOOD SECURITY

At provincial level, a Food Security Council (Dewan Ketahanan Pangan), created in 2002, having 24 government agencies as members, with participation of universities, and chaired by the Governor and facilitated by the planning ministry (Bappeprov), coordinates multi-sector response and intervention to address food security problems. Five task forces, namely Food Production, Distribution Control and Price Monitoring, Food and Nutrition Diversification, Food Quality Monitoring, and Nutrition and Supporting Infrastructures, implement the Council's strategic action plan. The Council addresses food security through three main strategies including (i) mainstreaming food security into particular sectors' development programs (ii) emergency response programs like rice and seeds distribution aimed at relieving acute food insecurity and (iii) community development programs for overcoming chronic and recurrent food crises.

Food security and nutrition interventions at the district level, involving several government agencies are coordinated by Bappeda. Bappeda reviews project proposals received from each office, according to guidelines provided by the funding ministries, then submits the proposals to the Bupati office and the local House of Representatives, for final approval at the district level. Bappeda then submits the approved project to funding agencies at provincial and national levels. In NTT, the provincial government's reliance on Central Government budget for food and nutrition programs, however, constrains the design and financing of interventions that are more tailored to the NTT context.

The government budget for food security and nutrition programs at district level funds:

(i) short-term responses aimed at meeting immediate food needs (e.g. food aid or food for work);

(ii) middle-term actions, such as seeds distribution, to enable people to get enough food for one planting season, provided people still possess production assets, and;

BOX 5.2 CONTINUED

(iii) long-term interventions, aimed at strengthening people's livelihoods in the agriculture and forestry sectors, such as training, transportation infrastructure, and farm inputs.

A wide-array of programs are funded by the central government and Bupati office which include (a) seed provision and infrastructure rehabilitation (b) rice subsidy for poor households (RASKIN) (c) cash transfer for poor households (BLT) (d) free health care for poor households (e) cash nutrition support (f) school operation cost support (BOS) (g) regional development programs (h) farmers welfare improvement (i) coastal community empowerment (j) income support through livestock production (k) supplementary feeding for children and pregnant women (l) national community empowerment program (m) income support (n) asset for nutrition support and (o) health and nutrition education.

Source: WFP, 2010

KEY MESSAGES (CURRENT CLIMATE RISK MANAGEMENT)

- Despite climate change adaptation concerns and preparation of road maps to address climate change risks, the interventions still are not well-integrated, and continue to be undertaken in their separate domains of CCA, DRR, and development. CRM TASP contributed to bringing synergy among these three sectors.
- Risk assessment, risk prioritization and climate risk reduction processes are still under development and enormous capacity building of institutions are required to undertake these functions in a systematic, coherent and user-focussed manner.
- High predictability of El Niño has enormous potential for reducing climate risks in Indonesia. The recent experiences of climate forecast applications in Indonesia require an evaluation to appreciate technical, institutional and socio-political constraints in integrating climate information for risk management.
- The Ministry of Environment have evolved potential CRM options and assessed the constraints in implementing the options and has started the process of preparation of operational action plans based on the CRM approach.
- For effective realisation of climate information functioning irrigation infrastructure, research and development support, and extension support are perquisites. Analysis of government spending reveals that subsidies and safety net programs are prioritised over these prerequisites.

RECOMMENDATIONS FOR CLIMATE RISK MANAGEMENT

Food security is a government priority in adapting to a changing climate. Several strategies, as shown below, are available for managing drought and flood risks to ensure food availability and improve food accessibility.

NATIONAL FOOD SECURITY

Delineation of risk zones for food production. Food production risk zones could be delineated, using climate risk assessment results and water management and agronomic practices data, and building on the existing agro-climatic zones shown in Table 6.2 (zone classification is provided in Table 6.1). Generally, zones A and B are climatically stable zones, where 2 paddy rice crops are possible. Zones C to E are climate-sensitive – rain fluctuations can upset the established cropping pattern and extreme weather events can adversely impact crop production. With risk zones delineated, efforts could focus on production surplus in favourable zones (A and B), and on minimizing crop losses in high-risk zones (C to E).

TABLE 6.1: AGRO-CLIMATIC ZONE CLASSIFICATION, INDONESIA

ZONE CLASSIFICATION	LENGTH OF WET SEASON	CROPPING
Zone A	9 consecutive months	Wetland rice can be cultivated any time of the year
Zone B	7-9 consecutive months	2 wetland rice crops possible
Zone C	5-6 consecutive months	2 rice crops can be cultivated, only if the first rice crop is planted/ sown as dry land crop (*gogorancah* system)
Zone D	3-4 consecutive months	Only 1 wetland rice crop possible
Zone E	<3 consecutive months	Wetland rice cultivation not recommended, unless irrigation water is available
ZONE SUB-CLASSIFICATION	**LENGTH OF DRY SEASON**	**CROPPING**
Subzone 1	<2 dry months	No restrictions on water availability
Subzone 2	2-3 dry months	Careful planning required to grow crops throughout the year
Subzone 3	4-6 dry months	Fallow period is part of the rotation system due to water constraints
Subzone 4	7-9 dry months	Only 1 crop can be cultivated; remainder of the year is too dry
Subzone 5	>9 consecutive	Generally not suitable for cropping

Source: Central Research Institute for Agriculture, Bogor, Indonesia

TABLE 6.2: AGRO-CLIMATIC ZONES IN INDONESIA

AGRO-CLIMATIC ZONE	A1	B1	B2	C1	C2	C3	D1	D2	D3	E1	E2	E3
Sumatra	24	46	1	6	9	0	10	2	0	0	2	0
Sulawesi	1	21	4	10	11	4	10	8	4	12	11	4
Java	4	16	7	0	25	14	0	5	20	0	0	9
Kalimantan	40	50	1	8	7	0	3	1	0	5	1	0

Source: Central Research Institute for Agriculture, Bogor, Indonesia

Crop relocation and/or de-concentration of food crop production. At present, food crop production is concentrated in Java (which accounts for 60 percent of the country's rice and maize production), Sumatra (20 percent), and Sulawesi (about 10 percent). Decentralization to areas that are productive and conducive for crop growth, taking into consideration current and future climate trends, could help limit the country's vulnerability to climate shocks.

Climate information as decision-support tool. The Indonesian climate has very high predictability and, with advances in climate prediction, it is possible to generate climate information at different timescales for application in food production. An El Niño forecast, with lead time of 9-12 months, can inform the exploitation of normally water-logged marginal lands, which dry up due to the longer dry season, for agriculture. The forecast could also inform water resource management planning for the longer dry season. A La Niña forecast can inform crop planning (Box 6.1). For example, with early onset and late withdrawal of the wet season due to La Niña, planting and, hence, harvest could be advanced, freeing land for one additional crop. Seasonal forecasts can inform rice production projections. Absence of robust decision support tools has led to under-estimation of domestic food production and over-estimation of import requirements, causing depression of domestic food prices and subsequent losses to farmers. In some years, domestic food production was over-estimated and import requirements under-estimated, which led to food price increases that harmed net food consumers in both urban and rural areas.

BOX 6.1: CROP PRODUCTION STRATEGIES DURING A LA NIÑA YEAR

Crop production data from previous La Niña years show that advance climate information can provide significant opportunity to increase crop production in the incoming crop season, through the following strategies:

Enhancing rice yield potential.

With increased rainfall, natural yield growth can be realized, with potential increase from normal yield of about 0.1 ton per cropped hectare.

Restructuring cropping patterns to increase crop intensity.

Cropping patterns may be restructured, as shown in the table below, to take advantage of the extended rainy season. For example, under agro-climatic zone D rain-fed system, the cropping pattern for a normal year is paddy-fallow. If the rainy season is extended up to 7-9 months (Type I), cropping pattern could be changed to paddy-paddy. If rainy season is extended up to 7-8 months, cropping pattern could be changed to paddy-secondary; if up to 6-7 months, secondary-paddy.

CROPPING PATTERN RESTRUCTURING TO TAKE ADVANTAGE OF LA NIÑA-INDUCED RAINS

TYPE OF IRRIGATION	NORMAL CROPPING PATTERN	SUGGESTED CROPPING PATTERN		
		TYPE I	TYPE II	TYPE III
Semi-technical	Paddy-paddy-fallow	Paddy-paddy-paddy	Paddy-paddy-secondary	Secondary-paddy-paddy
Technical	Paddy-paddy-secondary	Paddy-paddy-paddy	Paddy-secondary-paddy	Secondary-paddy-paddy
Non-technical	Paddy-secondary-fallow	Paddy-paddy-secondary	Paddy-paddy-fallow	Secondary-paddy-fallow
Rain-fed	Paddy-fallow	Paddy-paddy	Paddy-secondary	Secondary-paddy

Note: Type I-rainfall extended up to 7-9 months; Type II-rainfall extended up to 7-8 months; Type III-rainfall extended up to 6-7 months

Expanding cropping area by bringing idle lands under rice cultivation.

The Ministry of Agriculture indicated that at least 100,000 hectares of idle land could be cultivated, with potential production of 500,000 tons.

BOX 6.2: CASE OF 2011-12 LA NIÑA

ADDITIONAL PADDY PRODUCTION POTENTIAL DURING 2011-2012 (MILLION TONS)

STRATEGIES	JAVA	REST OF INDONESIA	TOTAL
1. Potential increase in rice production by increasing yield	0.4	0.00	0.40
2. Potential increase in rice production by restructuring cropping patterns	1.0	2.2	3.20
3. Potential increase in rice production by expanding cropping area		0.50	0.50
Total	1.04	2.70	4.10

Additional paddy production of 4 million tons could translate into milled rice of 2.40 million tons of milled rice. This was the estimate made by the project and presented at the stakeholder's consultation in October 2011.

What actually happened is that not factoring in La Nina forecasts Food Logistics agency (Bulog) was authorised to import of 1.6 million tons of rice in July 2011

- July is the critical month for taking important decisions relating to imports. During July 2011 Bulog confronted the following factors:
  - Rising domestic price of rice an account of overestimation of 2010 crop production high consumer demand during Ramadhan;
  - Rising prices in International Market as Thailand Govt that promised 300,000 tons rice increased the domestic price by about 30 percent;
  - Min. stock levels of 1. 5 million with obligation to release 260,000 tons rice every month at 15 kg per household;
- As such Bulog has been under severe pressure to import 1.6 to 2.0 million tons of rice, and system are yet be put in place with climate risk information decision support tools to make use of potential gains associated with La Nina during forth coming season 2011-2012;
- In case climate risk management approach is adopted there could be a surplus of (2.40-1.6) or 800,000 tons. Hence instead of importing 1.6 Million tons of rice the country could export 800,000 tons of rice during Market year October 2011 – Sep 2012.

PROVINCIAL FOOD SECURITY

For high climate risk zones, such as NTT, design of risk management options could consider reduction of climate risk to agriculture (a high climate-sensitive sector) and promotion of agroforestry-based livestock system (a moderately climate-sensitive sector), with gradual shift to non-farm occupations (least climate-sensitive sector), in addition to being socially acceptable, environmentally sustainable, and economically viable.

Climate risk reduction in agriculture. Climate information could be used to anticipate inter-annual and intra-seasonal variability. For example, where corn is the only crop possible, if a normal monsoon is expected, planting could be advanced to July-September, to take advantage of water still available from springs and water storage structures after the monsoon. Low-cost pumps could be used.

Farmers could also consider crop diversification. Already, efforts are ongoing to grow hybrid maize and vegetables, like tomatoes and greens, particularly around water impounding structures. Heavy rain and strong winds during February constrain the scaling up of these initiatives into commercially viable enterprises. Through contract farming, supported by insurance instruments, this could shift farming from subsistence to market-oriented farming, in a risk management framework. Another risk management strategy is to build food and/or fodder reserves during the normal or above-normal seasons, for use during below normal years.

Risk management measures could be incorporated into supply chain management. The first step would be an assessment of climate impact pathways (refer to Table 6.3) and non-climate risks, such as credit, fertilizer, and seeds availability, and the role of market price in affecting a farmer's decision, through feedback pathways. Managing climate risk within the supply chain framework could pave the way for addressing production and market risks holistically.

TABLE 6.3: DIFFERENTIAL IMPACTS OF 'INSUFFICIENT RAINFALL' AFFECTING MAIZE

SUPPLY CHAIN PARTICIPANT	WHAT IS EXPOSED TO RISK?	RISKY EVENT	CONSEQUENCE	HOW IMPACT IS MANIFESTED	EXPECTED MAGNITUDE OF LOSS
Small farmer	Rain-fed maize production	No rains in key month	30% decreased yield, lower water table	Lower income, limits planting for next year	Medium income loss
Large farmer	Irrigated maize production	No rains in key month	Need to increase irrigation	Increased irrigation costs (electricity and labor)	Minimal income loss
Food processor	Maize purchases for milling	No rains in key month	10% less maize available for purchase	Higher costs for maize	Minimal income if cost increases can be passed on
Urban poor consumer	Processed maize	Changing maize prices	15% higher maize cost, potential compromise of nutrition/health	Less real income, less money for vegetables	Depends upon availability of affordable substitutes

Integration of agriculture and animal husbandry. The Australian Centre for International Agricultural Research (ACIAR) has shown in Timor and Flores that forage legumes integrated into maize cropping systems increases maize yield by as much as 700 kg/ha due to improvement in soil nitrogen. The resulting high quality forage supply contributes to an increase in livestock production.

Agroforestry-based animal husbandry system. Sobang's (1997)[43] research in Kupang District has shown that cattle husbandry in dry areas could contribute about 30 percent-70 percentto a farmer's income, depending on the number of stocks owned and forage type and availability. The Bali cattle, found in about 90 percent of Nusa Tenggara, is able to thrive and reproduce, with high conception rates, even under adverse climatic and nutritional conditions. Management systems to enhance calf survival and productivity are in place, such as early weaning of calves born in the dry season, use of communal pens, and mixed grass-legumes feeding. Bamaulin and Wirdahayati (2003)[44] reported that this system reduces the fattening period from 1.5 – 2 years to about 6 months. Other sources of forage could include tarramba (*Leucaena leucocephala*, high protein source), and palm pith and cassava (energy sources). Tarramba thrives even during the peak of the dry season, hence is a year-round source for high quality fresh forage. Harvest of tarramba seeds also provides additional income.

INSTITUTIONALIZED CLIMATE INFORMATION SYSTEM

The existing seasonal forecast delivery mechanism, involving BMKG and the Ministry of Agriculture, could be expanded to include BULOG, BPS (national statistics agency), National Food Security Council, Ministry of Trade, and Ministry of Power, for a climate information system that supports food security stakeholders at the national level. At the provincial level, the Food Security Council can be expanded to include BMKG as member, and climate impact analysis and risk management options identification as additional functions. This would require capacity building in forecast interpretation and translation to transform the Council from a reactive to proactive group. BMKG also needs to enhance its forecasting capability to improve forecast reliability and lead time. In July 2011, BMKG shared its efforts in enhancing its climate observation system, with infusion of USD 5.9 million, to improve quality of forecast products (Faizal, 2011)[45].

Establishment and institutionalization of a user-relevant climate information system involves:

a) *Assessment of users' information requirements*. Different users have different climate information requirements. Within the same group of users, information requirements are guided by the planning horizon, which could vary from 20-25 years at the organizational/ ministerial level to 5 years and below at the Directorate level;

b) *Tailoring of climate information to users' needs*. Forecast resolution and lead time vary with user type, for example climate projections of 20-25 years lead time at a spatial scale required for adaptation;

c) *Characterizing and packaging uncertainties associated with climate information of different timescales*. Uncertainties inherent in longer-lead climate information need to be characterized and communicated to facilitate application in a risk management framework. This would also prevent untrained and non-technical users from immediately perceiving and attributing climate variability-related phenomena to global warming;

d) *Interpretation and translation of climate information*. Climate information should be interpreted in terms of sector-specific thresholds that are jointly determined by institutional users and communities;

e) *Application in a risk management framework*. Climate information is applied in planning and decision-making, cognizant of the risks due to uncertainties in the information;

f) *Demonstration of the economic benefits in using climate information and adopting the CRM framework*. Appreciation of the economic and social benefits derived from investment in an end-to-end climate risk management system, in terms of time, human resources, and finances shall lead to the adoption of the CRM framework and institutionalization of the CRM system.

Information on market behaviour of input costs and their availability (e.g. seeds for alternate crops, fertilizer, etc.), as well as incidence of pest and diseases, should accompany climate information and response menus for farmers. Linking weather/ climate information with production input- and output-related information (e.g. market) is essential for meeting challenges of seasonal and inter-annual climate fluctuations.

CAPACITY DEVELOPMENT

The following capacity building activities are recommended to address capacity gaps identified in the previous chapter.

National Level

Capacity building would be required in the following areas, consistent with needs identified in Indonesia's Climate Change Sectoral Roadmap (ICCSR, 2010-2014):

1) *Data, information, and knowledge management.* This pertains to data collection, information development, and knowledge management in GHG emissions from each sector and climate change impacts through collaborative scientific research involving universities, research institutions, and the government;

2) *Planning and policy, regulation, and institutional development.* Formulation of adaptation plans, policies, regulations, and institutional mechanisms, using results from 1) above;

3) *Implementation and control of plans and programs, with monitoring and evaluation.*

Until 2014, capacity building could focus on strengthening capacities in assessing climate information needs, climate modeling, impacts knowledge building, and risk assessment and communication. The period 2015-2019 (RPJM) could then focus on resource mobilization. Adaptation planning and implementation could then be intensified from 2020-2025, according to the ICCSR. Simultaneous integration of the above-listed areas has not been considered.

District and Local Levels

Institutional capacity building at the district and local levels is a pre-requisite for climate information application in risk management.

1) *Climate observation and monitoring systems*. The district government can help create a climate-conscious society by establishing climate observation systems and information delivery mechanisms from BMKG through to the last household unit in the community. This could either be funded solely by the district, or by pooling resources with other contiguous district units;

2) *A database system that "seamlessly" links climate information of all timescales (from 48-hour weather forecast to seasonal forecast and climate change scenarios) from BMKG to the districts, and documents climate impacts on various sectors*. This linking of climate information helps in the aligning of plans for different timescales. It also allows the assessment of such plans and recording of lessons learned so that future plans and actions can be better aligned;

3) *Continuous engagement between users and providers* through the regional monsoon forums, where users at the district and local levels participate;

4) *An institutional mechanism for handling probabilistic climate information flow in a CRM framework*, for example, an expanded Food Security Council recommended under Section 6.3 above. The district government must invest in the development of district-specific and sector-targeted climate information products and monitoring services for constant updating and fine-tuning of adaptation strategies. This same institutional system should regularly assess adaptation deficits, incorporating both autonomous and planned adaptations. For instance, ENSO is a key factor that modulates seasonal and inter-annual climate in Indonesia. Better integration of ENSO forecasts into sectoral decision-making processes can help address current and future variability, although users should remain cognizant of the fact that (the value of) ENSO predictions could vary across seasons and across regions;

5) *Capacity for assessing autonomous adaptation and adaptation deficits, with reference to current climate extremes to enable targeted adaptation interventions*. This can lead to better planned adaptation strategies and actions.

INTEGRATING CRM INTO DISTRICT-LEVEL PLANNING PROCESS

The decentralization efforts implemented in the last decade has allowed the transfer of resources and authority for undertaking adaptation planning and decision making to district governments. Due to the cross-sectoral nature of adaptation, the district planning office is in the best position to lead adaptation processes.

KEY MESSAGES (RECOMMENDATIONS FOR CLIMATE RISK MANAGEMENT)

- Managing drought and flood risks is imperative to ensure national food security and improve food accessibility in the face of a changing climate. Several strategies to achieve this include (i) delineation of risk zones for food production by using climate risk assessment results (ii) application of seasonal forecasts to enhance food production (iii) integrate CRM decision-support tools for food logistics management and (iv) reforming the Climate Field School (CFS) program.

- On the provincial level, particularly for high climate risk zones such as NTT, design of risk management options could consider reduction of climate risk to agriculture and promotion of agroforestry-based livestock system, with gradual shift to non-farm occupations. A number of climate risk management options are recommended such as (i) identification of potential farm sites, based on agro climatic parameters and considering new crop and agriculture practices (ii) integrating climate data for siting watersheds (iii) food crop management and crop diversification (iv) livestock management such as group cattle farming with supply chain risk management (v) addressing production and market risk by applying supply chain management (vi) adoption of non-farm income enterprise that is less sensitive to climate stress.

- Capacity building in forecast interpretation and translation is needed within national and provincial government agencies involved in climate information system. Elements to be considered to address capacity gaps include generation of user-relevant climate information, climate modeling, impacts knowledge building, risk assessment and communication and resource mobilization.

ANNEX 1: DRAFT ACTION PLAN FOR CRM

(evolved by Ministry of Environment, GoI at CRM TASP Stakeholder Consultation Workshop, Oct 19-20, 2011)

CLIMATE RISK MANAGEMENT OPTIONS	THE ROLE OF CRM	EXPECTED OUTCOME	STAKEHOLDERS	POLICY & INSTITUTIONAL CONSTRAINTS	KEY ACTIONS (INCL. CAPACITY BUILDING)
CCA priority by Govt of Indonesia: National Food Security					
Application of seasonal forecasts for enhancing rice and corn and other crop production in favourable zones and favourable seasons and reduce crop losses in unfavourable areas and seasons	There is a potential possibility of using ENSO index-based & other indicators climate forecast to institutionalize CRM to manage crop system in favourable areas (areas that have agric. potential due to long wet season) to maximize potential gains and minimize losses in other areas	Forecast result (timely, accurate) could be made available, understood, easily accessed, by users at all levels and at no cost	Intermediary institutions to translate and communicate info from BMKG to local levels by involving Universities, Local insitutions, Farmer groups, research institutes, civil society	1. Regulation for facilitating information dissemination from BMKG under preparation (to be issued end 2011) 2. Policy to support BMKG to hold regular information user- producer dialogue 3. Decree from MoA, Marine-Fisheries, Provincial, District decree to facilitate information application by users	1. Model to generate forecast made available 2. Information translation, communication & dissemination 3. Facilitate application by users through capacity building/ training of users (incl. extension personnel) 4. Establish infrastructure for information system from national to local levels
Strengthen Climate Field school program based on constrains and shortcomings highlighted by Evaluation Studies MOA BMKG and PWD Agriculture Research institutions	Improve training curriculum for application in West Java, Central Java (evaluated already); & all other districts where CFS is on-going	Improved Curriculum is implemented considering local conditions. Recommended operational decisions (crops, calendar) are fully implemented by farmers, Capacity to adapt to new sources of income, greater awareness on use of climate information & networking	BMKG, MOA, M/ Education, MOHA & local govt, Marine&Fisheries, NGOs, Universities, Research Institutions, Community institutions, Farmers' groups, Parliament, mass organisations, womens' organisation and religious organisation	1. Policy to adapt and adopt CFS for fisheries, animal husbandry and other user groups (at all levels)	1. Refinement of curriculum; dissemination for application by users 2. Customisation of curriculum for fisheries, animal husbandry, water user associations, other users 3. Pilot testing and application, replication

CLIMATE RISK MANAGEMENT OPTIONS	THE ROLE OF CRM	EXPECTED OUTCOME	STAKEHOLDERS	POLICY & INSTITUTIONAL CONSTRAINTS	KEY ACTIONS (INCL. CAPACITY BUILDING)
Integrate decision support tools for food logistics management relating to ENSO & other indicators' forecasts into MOA, Bulog and Ministry of Trade and BPS with involvement of BKMG	Incorporation of climate information into food availability estimation model of BULOG, BPS, M/ Trade, MOA, M/ Planning, M/ Transportation and related ministries and a distribution model according to specific requirement of provinces	Food availability estimation model integrating climate information is pilot tested and integrated into operations	MOA, BULOG, BPS, Planning, BMKG, Trade, Transportation, local govts, MOHA, M/ Forestry, local NGOs, BNPB, BPBD	1. Decree of MOA, BULOG, MOHA & local govts on integrating climate information into food availability estimation model	1. Develop, pilot test and operationalise model for food availability estimation incorporating climate information 2. Capacity building, training and transfer of technology for application
CCA priority by Govt of Indonesia: Provincial Food Security : NTT					
BAPPEDA in NTT, to regulate land use planning to maximise productivity over the long term, protect the environment and reduce disaster risk	Risk Map (UNDP for NTT), Vulnerability Mapping from WFP, and potential for crops can be used to zone areas for various uses. Climate information can be overlaid on zones to reduce risks and maximise potential. Highlighted by representatives of the northern and southern areas				
Define priority areas for agriculture, agroforestry, forests, etc. on the community and municipal level	Especially highlighted by representatives of the northern and southern areas				

CLIMATE RISK MANAGEMENT OPTIONS	THE ROLE OF CRM	EXPECTED OUTCOME	STAKEHOLDERS	POLICY & INSTITUTIONAL CONSTRAINTS	KEY ACTIONS (INCL. CAPACITY BUILDING)
Assignment of land titles to smallholders	Especially highlighted by representatives of the northern and southern areas				
CCA priority by Govt of Indonesia: Water management					
Establish micro-irrigation and water retention systems	Particularly important in dry areas of south and west				
Regulate water use at (micro-) watershed level taking into account precipitation, sources, geomorphology and different water uses	Particularly important in dry areas of south and west				
Promote reforestation in water catchment areas	Everywhere				
Implement payment for ecosystems services schemes	Everywhere				
CCA priority by Govt of Indonesia: Soil management & agricultural practices					
Training in adequate use of organic fertilizers	Everywhere				
Promote soil conservation practices such as reduced tillage, mulching and compost application	Everywhere				
Diversify crops: promote more resistant crops such as cassava and sorghum, new varieties of currently grown crops (e.g. malakemaize, and chinapopo beans) and horticulture	Everywhere				
Implement agroforestry systems	Everywhere				

CLIMATE RISK MANAGEMENT OPTIONS	THE ROLE OF CRM	EXPECTED OUTCOME	STAKEHOLDERS	POLICY & INSTITUTIONAL CONSTRAINTS	KEY ACTIONS (INCL. CAPACITY BUILDING)
CCA priority by Govt of Indonesia: Infrastructure					
Establish adequate norms and construction codes	Particularly important in cyclone and flood-prone areas				
Build better access roads to rural areas	Especially in poor and remote areas of the southwest				
Combat corruption as a key source for weak infrastructure	All levels of governance				
CCA priority by Govt of Indonesia: Climate Information and Services					
Improve and extend weather data collection and processing	Everywhere				
Strengthen coordination and sharing of climate data among different institutions and facilitate access to data	National level				
Promote climate research on extreme events, current trends and projections	National level				
CCA priority by Govt of Indonesia: Capacity Building					
Build communities' capacities to build, maintain and use water retention and other relevant infrastructure adequately	Particularly important in dry areas of south and west, and flood-prone areas				
Provide training on soil management and agricultural best practices	Everywhere				
Provide training on valuation and commercialisation of new, diversified crops; strengthen value chains	Especially important in poor and remote areas of the southwest				

RFERENCES

1. Badan Pusat Statistik. 1971, 1980 , 1990 , 2000 Population Census, and 1995 Intercensal Population Census

2. The World Bank Group, 2010. Indonesia Data and Statistics. [Online] Available at: http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/EASTASIAPACIFICEXT/INDONESIAEXTN/0,,menuPK:287097~pagePK:141132~piPK:141109~theSite PK:226309,00.html

3. [Accessed 7 October 2011].

4. 2008, Indonesia Environmental and Climate Change Policy Brief, 8 September, 2008. Sida Helpdesk for Environmental Economics, University of Gothenburg, School of Business, Economics and Law, Department of Economics

5. 2009, National Medium-Term Priority Framework (NMTPF) 2010 – 2014 for Indonesia's External Assistance in the Agriculture Sector (incl. Forestry & Fisheries). Government of Indonesia (GOI)-National Development Planning Agency (BAPPENAS); Ministry of Agriculture (MOA); Ministry of Forestry (MOF); Ministry of Marine Affairs & Fisheries (MMAF) with the assistance from Food and Agriculture Organization (FAO) of the United Nations

6. Siregar, Hermanto, 2008. Problems facing the Indonesian economy and current policy responses for Agriculture, Bogor Agricultural University (IPB), Indonesia presented at Vietnam Economic Association, Hanoi, 27-28 November

7. ADB, 1999.Causes, Extent, Impact and Costs of 1997-98 Fires and Drought. Jakarta: Asian Development Bank (ADB).

8. Boerema, J., 1938. Rainfall Types in Nederlands Indie.Verhandelingen, 18.

9. ADPC, 1998.La Niña 1998-99 - Challenges and Opportunities for Indonesia. Report on the ADPC-NOAA-BAKORNAS PB mission to pre-assess the possible impacts of La Niña 1998-99.Bangkok: Asian Disaster Preparedness Center.

10. MOE, 2010.Indonesia Second National Communication under the United Nations Framework Convention on Climate Change. Jakarta, Ministry of Environment.

11. Boer, R. &Faqih, A., 2004. Global climate forcing factors and rainfall variability in West Java: Case study in Bandung district. Indonesian Journal of Agriculture Meteorology, 18, pp.1-12.

12. BAPPENAS, 2010.Indonesia Climate Change Sectoral Roadmap. Jakarta: Badan Perencanaan Pembangunan Nasional (BAPPENAS).

13. Sakya, A.E., 2009. Climate Observation: Risks and Challenges – Indonesian Case. Parallel Session of the World Climate Conference-3. Geneva, 1 September 2009.

14. MOE, 2007.Indonesia Country Report: Climate Variability and Climate Change, and their Implication. Jakarta, Ministry of Environment, Republic of Indonesia.

15. Daryanto, Arief., 1999. UNEAC Asia Papers No.2 1999, Journal of the UNE Asia Centre, The University of New England

16. Oktaviani, Rina., Setyoko, Nur Rakhman., and Vanzetti, David., 2010. Indonesian agricultural trade policy at the crossroads. Contributed paper at the 54th AARES Annual Conference, Adelaide, South Australia 10-12 February 2010

17. National Development Planning Agency (BAPPENAS)/ Ministry of National Development Planning, 2011. Indonesia Adaptation Strategy- Improving Capacity to Adapt. November 2011. Jakarta: Badan Perencanaan Pembangunan Nasional (BAPPENAS).

18. Bulog set to resume rice imports soon. The Jakarta Post. 07/10/1999

19. Subbiah A and Kishore K. 2001. Long-range Climate Forecasts for Agriculture and Food Security. Extreme Climate Events Program. Presented at the Asia-Pacific Conference on Early Warning, Prevention, Preparedness and Management of Disasters in Food and Agriculture Organized by the Food and Agriculture Organization. 12-15 June 2001, Chiang Mai, Thailand.

20. BAPPENAS, 2010.

21. Handoko, I., Y. Sugiarto, dan Y. Syaukat. 2008. Keterkaitan Perubahan Iklim dan Produksi Pangan Strategis: Telaah kebijakan independen dalam bidang perdagangan dan pembangunan.. Bogor, Indonesia: SEAMEO BIOTROP.

22. United Nations, 2008

23. Ministry of Public Works. 2007. 2002 Jakarta Flood. Research Center for Water Resources, Agency for Research And Development, Ministry of Public Works, 2007. Presentation.

24. BTPT, year

25. Montgomery R, Rohandi and Kinseng R. 2008. Indonesia: Smallholder Agribusiness Development Initiative – Farm Reduction Assessment for Nusa Tenggara Islands, Indonesia. Asia Research Centre Working Paper 31. Asia Research Centre, London. July 2010.

26. Kieft, J. &Soekarjo, D., 2007.Food and nutritional security assessment, March 2007: Initial impact analysis of the 2006/2007 crop season in comparison to 1997/1998 and 2002/2003 El Niño events for the Eastern NTT region. Jakarta. CARE/unpublished paper.

27. Team VA, 2009. Vulnerability Assessment to Climate Change in Indonesia using Regional Multi-Sectors Approach: Case Study of Lombok, NTB, CRM-TASP Workshop. Jakarta, 01 April 2009

28. WFP, 2011

29. Oxfam, 2010

30. Kieft,

31. Subbiah, 2003

32. Jodha, 1989

33. Chen, 1991

34. ACF, 2007

35. Jodha, et al., 1998

36. Kieft, 2008

37. Fox, 1995

38. WFP, 2010

39. Embassy of Denmark, Jakarta. 2009. Climate change screening of Denmark's development cooperation with Indonesia. October 17, 2009.

40. Government of Indonesia, 2009. Blueprint for INdonesia Climate Change Trust Fund (ICCTF). National Development Planning Agency. Jakarta, 11 September 2009.

41. Rondonuwu,Vrilly,. 2010. ICCTF- Indonesian Climate Change Trust Funds, Ministry of Environment, Republic of Indonesia. Presentation on 21 April 2010. Global Forum on the Environment – Key issues for the post-2012 climate framework, organised by the Climate Change Expert Group on the UNFCCC 21-22 April 2010. OECD Conference Centre; Paris, France.

42. World Bank, 2012. Agriculture Public Spending and Growth in Indonesia. East Asia Region Poverty Reduction and Economic Management Unit, World Bank. February 2012.

43. Raja, Prakarma,. 2009. 'Do farmers use climate forecast information to respond to climate variability?'- Technographic studies on impact of Climate Field School in year 2003 on crop management strategy of farmers in Indramayu District, Indonesia. MSc Thesis Technology and Agrarian Development. Management of Agro-ecological Knowledge and Social Change (MAKS), Department of Social Science- Wageningen University and Research Centre. January 2009.

44. Sobang's, 1997

45. Bamaulin and Wirdahayati, 2003

46. Faizal, E., 2011. Agro-climate posts may help food security. The Jakarta Post, [Internet] 27 July.

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