Chapter 16

Emerging ‘Agricultural Involution’ in Indonesia: Impact of Natural Hazards and Climate Extremes on Agricultural Crops and Food System

Jonatan A. Lassa
Nanyang Technological University, Singapore

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CHAPTER 16

Emerging 'Agricultural Involution' in Indonesia: Impact of Natural Hazards and Climate Extremes on Agricultural Crops and Food System

JONATAN A. LASSA[*]

Institute of Catastrophe and Risk Management, Nanyang Technological University

The nature of does nothing in itself to stimulate the growing of agricultural crops but it can insure the non-growing of them (Geertz, 1963). The non-growing and loss of crops due to biophysical and geophysical processes have been interpreted as risks and catastrophes that human being need to anticipate. This paper asks: what were the impacts of natural catastrophes on Indonesian agricultural crops during the last four decades? And what are the options available to mitigate future agriculture loss and safeguard food production in Indonesia? The quantitative analysis is based on two national datasets from Indonesia, namely the Disaster Loss data from Agricultural Statistics produced by the Ministry of Agriculture in 2009 and an online disaster database from the National Disaster Management Office updated in March 2012. This research concludes that Indonesia can achieve better food production by adopting multi-loss mitigation scenarios. The chapter further highlights the impact of climate change on Indonesian agriculture, and existing policy instruments concerning disaster risk reduction in agricultural sectors. In addition, it makes policy recommendations for the Indonesian government and the international community regarding alternative solutions towards agricultural resilience.

Keywords: Agricultural crop, rice, corn, risk management, disasters, climate change, Indonesia, agricultural resilience, food system.

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1. Introduction

The Indonesian population has increased from 94 million people in 1960 to about 239 million people in 2010 (FAO 2012). The United Nations estimates that the Indonesian population will be about 293 million people in 2050.[1] The question is: “How can Indonesia feed its population in the next 50 years?” This question had been partly posed 50 years ago. Fortunately, a Malthusian crisis did not really happen (or has not yet happened) mainly because of two factors: First, Indonesia has been adopting the technological changes required for better yields year-on-year during the last 50 years. Secondly, it has been expanding production areas significantly over the last five decades.

In retrospect, Indonesia has been expanding its agricultural land area to anticipate the increasing need for food. The island of Java, as the largest contributor of rice production in the country has reached its limit for agricultural expansion. Therefore the government has recognized the need to open up new areas for food production. The total area of rice cultivation In Indonesia in 1960 was 6.4 million hectares (ha). It had reached 13.2 million ha in 2010.

Over the last 50 years, the average annual growth rate of harvested areas was 2%, while the population grew on average by 3% (calculated from 1960 to 2010 – however, over the last decades, it has been consistently growing at 1.5%). In absolute terms, the Indonesian agricultural population has moved from 80.8 million (54%) in 1980 to 89.6 million (37%) in 2010. Over the past five decades, however, rice yields increases significantly from 1.76 (1960) to 5.01 ton/ha in 2010 – with an average annual rate of 4%. A similar trend occurred in maize production, which grew from 2.45 million ha of cultivated land in 1960 to 4.1 million in 2010 (or a 1% annual rate). Positive progress was also seen in the maize yield, which increased from 0.93 ton/ha in 1960 to 3.51 ton/ha (or an 8% annual rate - See Figure 1).

Agricultural land covers 26.4% of Indonesia’s area (Förster, *et al.* 2011) of which, in 2012, rice and corn areas are respectively 7% and 2%. Geertz (1963) made a classical division of Indonesian agriculture into two types of ecosystem. The first is the sawah system (or rice system) and the second is the swidden system of

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[1] See http://esa.un.org/unpd/wpp/unpp/panel_population.htm [last access 21 Mar 2012]

agriculture. The first is mainly located in the islands of Java and Madura. Swidden agriculture is seen in the 'outer islands' such as Sumatra, Kalimantan, Sulawesi, Nusa Tenggara, Papua and Maluku. In 1956, 63% of Indonesia's rice and 74% of its maize were produced in Java (Geertz 1963:13). Today, Java still maintains its domination in the main crops by producing 60% of Indonesian rice and 51% of maize. Sumatra, Kalimantan and Sulawesi respectively accounted for 24%, 8%, and 12% of Indonesia's total rice production in 2008.

What should be noted is that Java's domination in rice production is led by higher yields. Java's share of Indonesia's overall cultivated area is only 47% in the case of rice, and 58% in maize. Lower yields occur in Sumatra, Kalimantan and Sulawesi where the areas of rice cultivation in 2008 were 26%, 11%, and 11% respectively of Indonesia's total (Ministry of Agriculture, 2009).

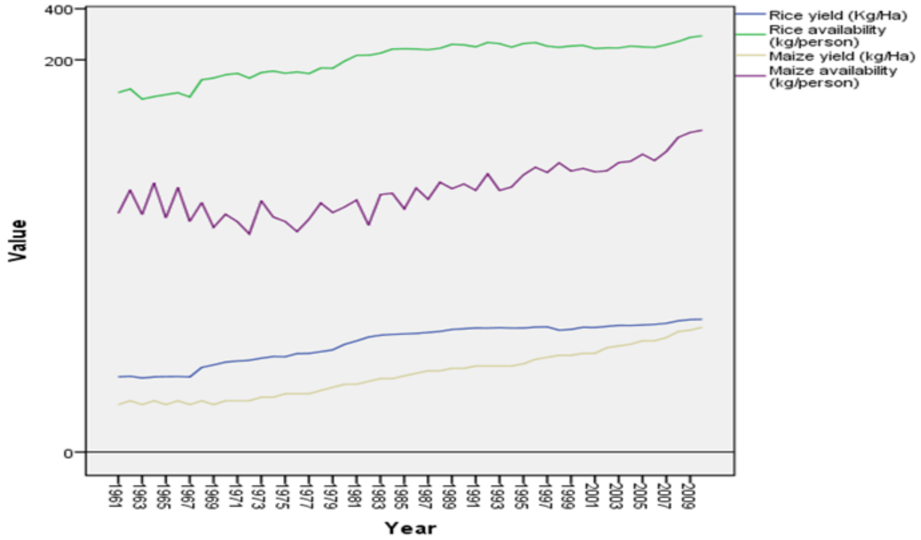
The question posed is whether expanding the agricultural area and raising rice yields are the only ways to increase production, given the fact that the yield growth may have its limit. There are gaps in yields between Java Island and the 'outer islands', where increasing yield in the 'outer islands' may always be a legitimate option. Land expansion may not always be the best alternative, but it has been government's key policy in boosting agricultural production.

What, therefore, are the conditions for future sustainability of Indonesian agriculture, especially in the context of changing climate and increasing catastrophic risks? Academic work on conditions for agricultural growth has barely considered the mitigation of natural catastrophe risk. For instance, Boserup's (1965) "conditions for agricultural growth" hardly considered natural hazards in agriculture. This paper argues for the need to face the challenges of the second wave of "agricultural involution" in Indonesia. The first phase of agricultural involution is defined by Geertz (1963) as Indonesian's reluctance to adopt technological change which eventually led to stagnation in production (as compared with Japan from the late 19th century and prior to the 1960s). In other words, there had been huge production opportunity loss as a result of late adoption of technology offering increased production.

Geertz (1963) defines 'agricultural involution' as a phenomenon where Indonesian agricultural growth was once dominated by high labor intensiveness (driven by population change) rather than the adoption of technological change (innovation) addressing market demands for agricultural crops. Geertz predicted that Indonesia’s rice production would decline as a result of delays in adopting necessary agricultural innovation. Later on, researchers found that Geertz’s prediction was not accurate (See Booth 1989). However, this paper argues that Geertz (1963) has shed light on the impact of hazards and risks on the conditions for sustainable growth of agriculture. Geert’s emphasis on ecological change has its merits in today’s discourse around risk management and natural catastrophes, as he highlighted some flood problems in regards to agriculture and irrigation management.

When natural hazards hit an agricultural area, the livelihoods of the people will be at risk. Recent experiences from Jogjakarta, Aceh, Nias Island and West Sumatra (Indonesia), where geological processes such as earthquakes, tsunamis and volcanoes have significantly affected agricultural production, exemplify this point. For instance, the 2005 earthquakes in Nias Island (North Sumatra, Indonesia) caused damage to the local irrigation infrastructure. Sisobambowo community in Nias called this phenomenon ‘drought’ not because there was less rainfall, but because of the disruption in rice production during the last 7 years due to the damage caused to irrigation systems during the earthquakes. Personal observation from Sisobambowo in 2011 suggests that the rate of production has been declining since 2005. Similar experiences have also recently been seen in the post disaster areas in many Indonesian islands.

Figure 1: Rice and Maize Production and Availability in Indonesia: 1980-2010



Source: Author. Data from Agricultural Statistics 2003-2008 and FAO Statistics.

The Indian Ocean Tsunami of 2004 that hit Aceh Province (Indonesia) claimed about 170,000 lives. The reported impact of the tsunami on the agricultural sector (FAO 2012) was that "92,000 farms and small enterprises have been partially or wholly destroyed. Prior to the disaster, these enterprises provided employment for approximately 160,000 people."[2] About 600,000 men and women in Aceh and Nias (or about one quarter of the total working population), lost their livelihoods as a result of the disasters. On the West Coast of Aceh, about 17,500 ha experienced high damage where reorientation of land use is suggested. In addition, about 2,900 ha agricultural land on the West Coast of Aceh was permanently lost to the sea.

Climate change may have also adversely affected agricultural crops such as rice. Naylor, *et al*. (2002) predicts that for every 1°C change in May-August SSTAs (sea surface temperature anomalies), Indonesia rice production varies on average by 1.4 million tons. Research at the International Rice Research Institute in the Philippines suggests that for every 1°C increase in the minimum temperature, rice yields decrease by 10% (Naylor, *et al*. 2007; Peng, *et al*. 2004).

There is a lack of long term agricultural loss data arising from the impact of natural hazards. Data are either unavailable or inadequate to suggest sound policy prescriptions for risk/loss reduction in the agricultural sector. The impact of natural hazards on the agriculture sector is not comprehensively covered in the literature. It is therefore timely to assess the impact of disasters on agricultural sectors in Indonesia, in order to understand how to reduce losses in agriculture.

This chapter asks: what are the impacts of disasters and climate hazards on Indonesian agricultural and food crops? And what are the options available to mitigate future agriculture losses so as to safeguard food security? The objectives of this research include: First to understand the impact of natural catastrophes on food crops and crop production in Indonesia. This involves loss assessment at the national scale. Second, it is to highlight the impact of climate change on Indonesia agriculture, based on existing literature and data. This chapter highlights existing policy instruments concerning disaster risk reduction in agriculture sectors. In addition, it suggests policy recommendations for the Indonesian government and

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[2] See http://www.fao.org/ag/tsunami/assessment/assess-damage.html [last access 19 Mar 2012].

international communities regarding alternative solutions towards less risky and more resilient production of agricultural crops.

The rest of the chapter is structured as follows. The next section discusses the conceptual frameworks of agricultural development and risk management. Section 3 provides methods for data collection. Section 4 discusses the results of loss assessment of disaster impacts on Indonesian agriculture since the 1970s. Section 5 briefly highlights the impact of climate change on Indonesian agriculture, based on a recent literature survey and secondary data. Section 6 provides the overall institutional and disaster risk management policy setting, and highlights institutional gaps in managing agricultural risks (ex-ante and ex-post scenario) in Indonesia. Section 7 concludes the chapter.

2. Conceptual Framework: Agricultural Development and Disasters

2.1. Agricultural Development and Risk Management

Mitigation of natural catastrophe is one of the conditions for the sustainability of agricultural development elsewhere in the planet under pressure. Nature (e.g. the physical climate and environmental processes) does nothing in itself to assist the growing of agricultural crops but it can ensure the non-growing of them (Geertz, 1963). This implies that physical climate does nothing to sustain agricultural crops but it can render the growing of the crops unsustainable.

Rainfall, temperature and wind force are among the climate variables that may transform the biophysical world into hazards such as drought (when it is too hot and dry) or floods (when it is too wet). Risk is embedded in climate variability and agriculture is prone to certain climate risks. The climate dependency of an agricultural crop makes it is more likely to be impacted by the increased warming, sea level rise and changing precipitation patterns (Naylor & Mastrandrea 2010; Förster, *et al*. 2011). In addition, depending on the risk context, the agriculture sector may have been exposed to multiple hazards and risks may accumulate over the years.

Literature concerning the impact of natural catastrophes on the agricultural sector has highlighted the differences in risk reduction between nations. Developed countries have reduced their agricultural risks more effectively than developing nations. The latter have been struggling with the mitigation of agricultural risks. A previous exploratory study on this topic was pioneered by Frank Long (1978) who argues that the attempts to provide food self-sufficiency in developing nations have hit the brick wall of natural disasters. Long (1978) contextualizes the theoretical framework of disaster planning for risk sensitive agricultural planning. He suggests that developing countries draw up plans for controlling disaster risk in their national agricultural sectors. Long also suggests that governments create a rational institutional framework to deal with the physical aspect of natural hazards in their national development plans. Unfortunately the literature concentrates on ideas concerning the protection of agriculture from market shocks such as price shocks, barriers to imports and/or exports, increasing incentives/disincentives for farmers and so on (see Fane & Warr, 2008) including improving technology.

In the early 1900s, 31 out of 43 million Indonesians lived on the island of Java, where transportation and communication were still undeveloped, and agricultural productivity was still poor due to lack of technology and infrastructure. The increase in agriculture's importance in the Indonesian economy during the 1929-1940 periods (compared with prior periods) was considered as an indirect outcome of the colonial government's investment in railways, the road network, the construction of bridges and flood control structures (and to some degree 'flood mitigation' - See Van der Eng 1992). During this period, agriculture contributed 60.8% of Indonesian economic growth. It later fell to 17.2% during the period 1973-1989 (Van der Eng, 1992). Nevertheless, agriculture has remains strategic to overall economic growth during the last decades. The Ministry of Finance (2010) reports agriculture as one of the three main sectors that contributed to gross domestic product (GDP), to the tune of 15.3%. The other two sectors are processing industry (24.8%) and trade and tourism (13.7%).

Classical works such as Geertz's 'agricultural involution' in fact suggest that the relatively unsuccessful Javanese agricultural production (especially before the 1960s) could be attributed to a failure to adopt technological change. One of the outcomes of the involution was the relatively low production per worker compared with yields (ton/ha). In terms of today’s risk management concern, Geertz (1963) is right about the ability to manage floods as one of the prerequisite in sustainability of agricultural production. He therefore argues for the need to develop flood control systems.

This rest of this chapter argues that Indonesia may have been trapped into a second wave of ‘agricultural involution’ due to failure to adopt multiple-risk management strategies in sustaining agricultural crop production.

2.2. Agricultural Crop Loss Assessment Framework

Hypothetically, the impact of natural hazards on agricultural production can be assessed by at least three approaches: First, the direct impact can be measured by direct losses and damage to crops, infrastructure and land. This depends on loss assessment models. Second, the indirect impact can be measured by loss of agricultural labor (e.g. deaths as a result of catastrophe) and disruption to production (e.g. delays in planting caused by long delays in reconstruction of irrigation systems and dams). These approaches utilize ex-post event records to measure relative vulnerability and the exposure of agriculture and food crops production to natural hazards. The third assessment method is the future projection of hazards impacting on agriculture which can either be built on the past loss data records, or on scenario building given the lack of past data. The latter practice is common in climate change studies.

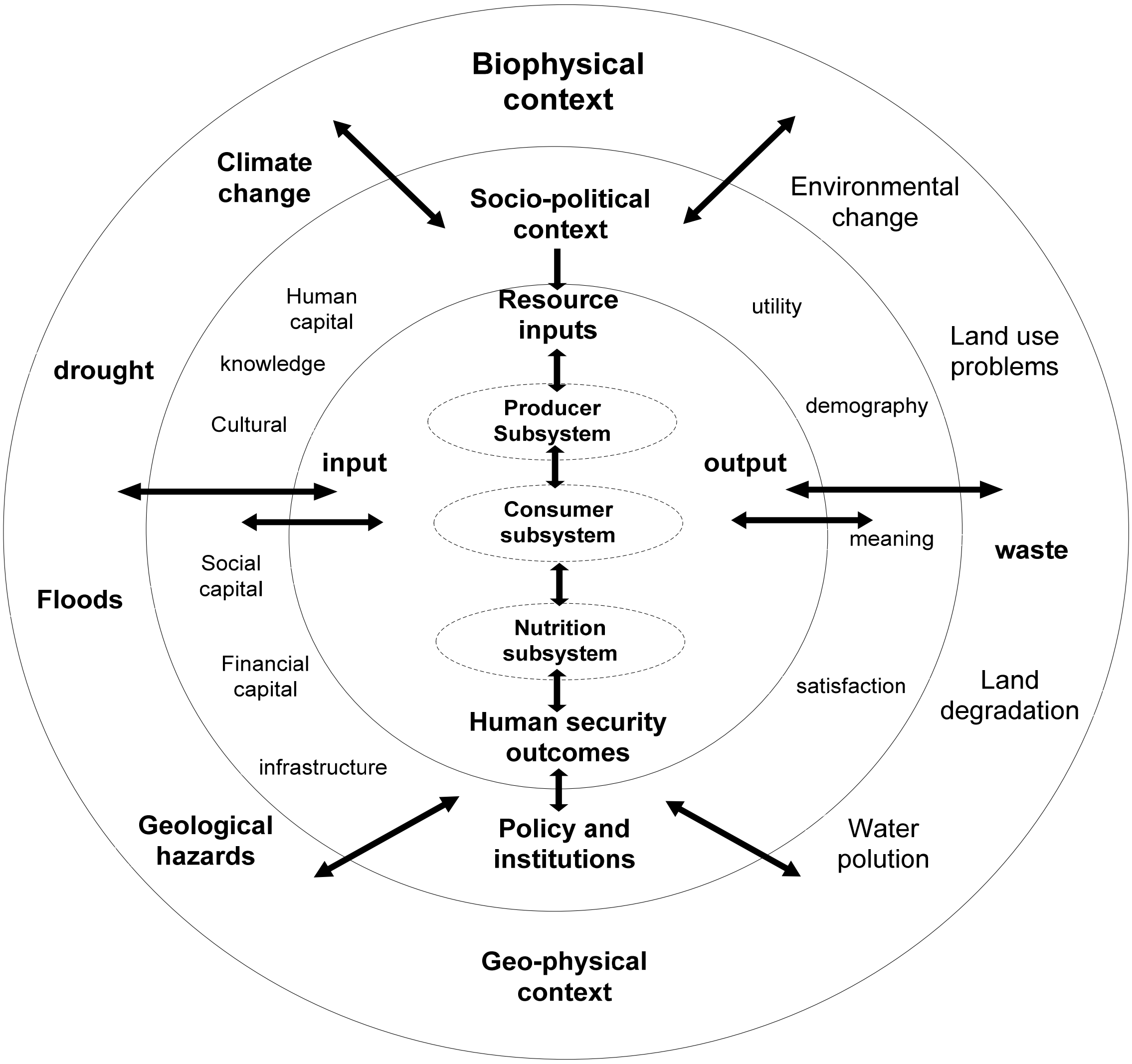
There is enough literature in the field of disaster studies to explain the causation of material/economic/ livelihood loss in regards to the impact of natural hazards on development infrastructure and outcomes. Burton, *et al*. (1993) suggest disaster risk as an outcome of interaction between human systems and natural systems. Today, it has become obvious that when natural hazards such as floods, tropical cyclones, tsunamis and earthquakes (the natural system) hit vulnerable infrastructure and human systems, disasters are likely to occur. Smith & Petley (2009) coined the idea of ‘risk as a double helix’ to illustrate the ‘DNA code’ of risks as joined and intertwined strands of DNA that underpin disasters. One strand represents the human system (vulnerability) and the other represents natural systems (hazards). The two elements- hazards and vulnerability- are interwoven and interlinked like a DNA double helix, where disasters arise from the complex interaction between them (Smith & Petley 2009: 43).

One of the old but still relevant disaster risk (R) models is R = E.V.H; where E is the level of exposure of elements at risk (e.g. valuable agricultural and livelihood assets). V is a vulnerability function such as economic, social and environmental vulnerability. H is a natural hazard function which can be manifested in floods, tropical cyclones, tsunamis and earthquakes (Alexander, 1993: 7).

This paper approaches the task of assessing the impact of natural hazards to agriculture by looking at the different sub-systems of the agriculture and food system. The elements at risk are the sub-components of agricultural systems. The author assumes that natural hazards affect different layers of agriculture and the food system (hereinafter AFS). AFS consists of three sub-systems, namely production, consumption and nutrition sub-systems. Figure 2 shows the natural hazard and agriculture-food system nexus. The core comprises the agricultural sub-systems (production, consumption and nutrition) that are situated in the larger context of both the biophysical and geophysical environments (natural hazards, climate change, land degradation, environmental change and processes). Each sub-system has its own input-throughput-output process (see Figure 2 and also Sobal, *et al*. 1998; Lassa, 2009). The intermediary between the core and the biophysical/geophysical context is the human system (social-economic-cultural and built environment, including the demographic context) that modify the human security outcomes. The sustainability of the sub-systems depends very much on the intermediaries, namely the socio-political and governance and institutional context. In disaster studies, these intermediaries are the vulnerability and agricultural resilience driving forces.

Barbier (1989) proposes a definition of ‘agricultural sustainability’ as the ability of an agricultural system to ‘maintain its productivity when subject to stress or shock and disturbances. These include regular shocks such as land degradation, soil salinity or indebtedness and the ‘irregular, infrequent, relatively large and unpredictable disturbance’ such as drought or flood or a new pest.’ Unfortunately, reality seems to suggest that the irregular and infrequent shocks are becoming more frequent and routine risks.

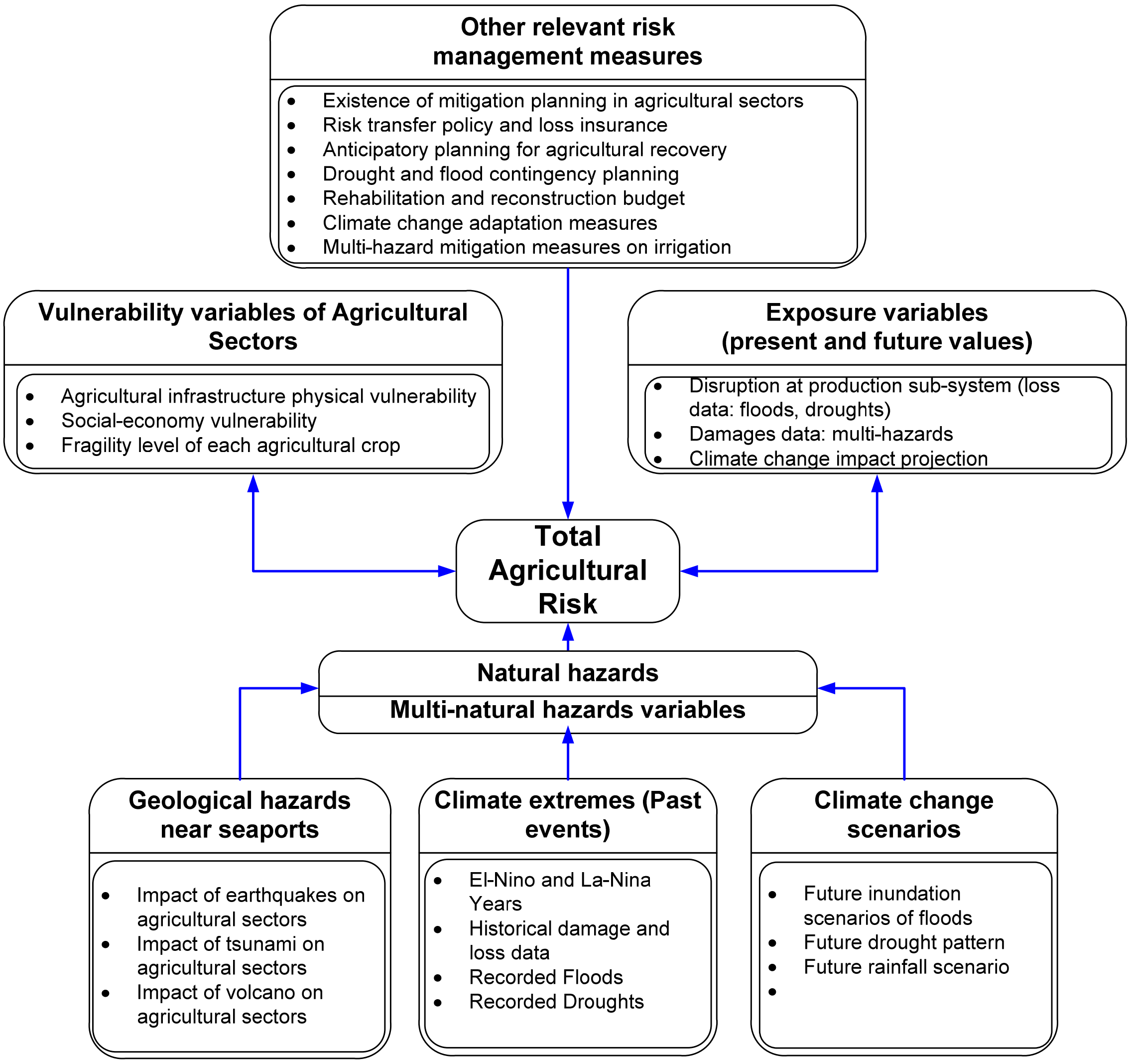
Figure 2: Natural Hazards and Agriculture-Food System Nexus



Source: Author, modified from Sobel, *et al*. 1998 and Lassa 2009.

Figure 2 suggests that disasters occur when hazards hit vulnerable agricultural infrastructure, which leads to direct/indirect loss and disruption in production, processing and distribution (including damaged roads and disrupted transportation). Disruption in production affects the whole chain of sub-systems. Vulnerable infrastructure (human factors) includes poorly designed irrigation infrastructures, poor drainage and bad site selection, poor maintenance, poor flood planning (Zwahlen, 1992) and other bad practices such as the uncontrolled expansion of wet-agricultural land into the flood plain areas. In short, in between the geophysical and biophysical world and AFS, there are mediating factors such as the socio-political context and the context of policy and institutions. Inside these two broad categories include knowledge, culture, human capital, social capital, financial capital, infrastructure, satisfaction, meaning, demography, utility, satisfaction and so on.

Figure 3: Assessment Framework for Total Agricultural Risks



Source: Author's

Total agricultural risk (Figure 3) is a derivative of Figure 2. It provides the overall step by step assessment framework for this research. It suggests that natural hazards such as floods, cyclones, drought, tsunamis, earthquakes and volcanoes often cause disruption to different food systems, measured by *ex-post* loss and damage and projected loss and damage (ex-ante). The lower half of Figure 3 shows the hazard components and the upper half the vulnerability components of the framework. At the production sub-system level, earthquakes (geological factors) can damage irrigation systems and crop fields, eventually leading to harvest failures due to shocks in water availability. This assessment framework includes mitigation planning and policy in agricultural sectors, risk transfer policy and loss insurance, anticipatory planning for agricultural recovery, drought and flood contingency planning, rehabilitation and reconstruction budgets, climate adaptation measures and the different fragilities of each agricultural crop.

3. Research Methods and Data Sources

3.1. Research Methods

Mixed methods are used. Table 1 lists selected methods that guide the research process. The Ministry of Agriculture’s Agricultural Statistics 2009 released a database relating the impact of floods and drought on 23 agricultural crops (measured by losses and damage) from 2003-2008 at provincial levels. This paper mainly uses two main crops namely rice and maize.

Table 1: Selected Methods

Methods	**National data**	**Central Bureau of Statistics**	**Agricultural Statistics**	**Disaster policy documents**	**Formal reports**	**Local data**	**Climate data**
Desk reviews	X	X	X	X	X	X	X
Literature survey	X	X	X	X	X	X	X
Open-ended interviews						X	
Media reports						X	
Past interviews in Padang, Aceh, East Nusa Tenggara, West Nusa Tenggara and Papua						X	
Email correspondence/ informal communication					X	X	X

The author also conducted field observations primarily but not limited to July-November 2011 field trips to disaster affected areas such as West Sumatra, West Papua,

Papua, East Nusa Tenggara, West Nusa Tenggara, North Sumatra and Central Java provinces. Field observations after the Indian Ocean Tsunami 2004 in Aceh and the Jogjakarta earthquakes in 2006 and volcano eruption in 2010 are also considered useful tools for reflection of the quantitative analysis.

3.2. Data Sources

Different data sources are used. Quantitative data is collected from the Indonesian Statistical Office, Agricultural Statistics of the Ministry of Agriculture 2004-2009, FAO Statistics Online 2012, and a national disaster database managed by the Indonesian National Disaster Management Office (BNPB). There have been difficulties in integrating the different data sources, especially the dataset on the impact of disasters on agriculture. Indonesia has recently established a disaster data and information source, namely DIBI. DIBI is indexed according to the Desinventar system, a UN-supported open-sourced disaster management system. It captures disaster events and codes each event into sets of data cards. One interregional event can be split into two cards or more. In total, there have been more than 10,000 data cards and events included in the online portal at DIBI BNPB. DIBI covers both man-made and natural hazards since 1850. Due to its broad coverage in terms of time period and region, one should be cautious about the level of accuracy of data. The author does not include all the events prior to 1970because there is lack of consistency in the quality of the data. The weaknesses of DIBI data are: first, it coded creeping hazards such as drought as a set of single events occurred at a particular date. Secondly, it is not commodity and crop specific data. Therefore the analysis cannot suggest crop specific policy and inter-crop considerations. Additionally, as of June 2012 not all the provinces' loss data have been included in the DIBI database.

However, overall, the DIBI data system can be informative and very locality-specific (event specific) which is beneficial for local policy makers. However, this study is only interested in macro analysis at the national scale. In addition, DIBI provides information concerning the damage and loss of transportation networks (measured in km). This is a good proxy for the impact of hazards on the food production sub-system (Figure 2) in a limited way, such as the impact of the transportation damage on the food supply chain. Finally, the data provide a broad overview of the different impacts of natural hazards, from geological hazards (earthquakes, tsunamis and volcano) to climatic hazards (floods, storm surges, drought etc.).

Another data source (See Table 2) is Indonesia Agricultural Statistics 2009. This records the loss of specific commodities or crops in every province in Indonesia during 2003-2008. It also provides data concerning different types of risk, ranging from floods and droughts to different types of pest attacks. The data provides clues to agricultural vulnerability based on crop sensitivity for different types of crops. It is also more consistent in showing the aggregative impact of floods and drought in every province annually.

Table 2: Data Sources

Variables	Periods	Data Source	Remarks
Demographic and agriculture production areas	1960-2010	Agricultural Statistics Indonesia and FAO	Online/CD (aggregate and provinces)
Rice production	1960-2010	Agricultural Statistics Indonesia and FAO	Online/CD (aggregate and provinces)
Maize production	1960-2010	Agricultural Statistics Indonesia and FAO	Online/CD (aggregate and provinces)
Selected flood loss data on 21 food crops	2003-2008	Agricultural Statistics Indonesia 2009	CD/book (aggregate and provinces)
	1970-2011	DIBI BNPB	Online dibi.bnpb.go.id
Selected drought loss data on 21 food crops	2003-2008	Agricultural Statistics Indonesia 2009	CD/book(aggregate and provinces)
	1970-2011	DIBI BNPB	Online dibi.bnpb.go.id
Other historical data	Colonial period	Previous research	Literature review
Policy data	1970-2011	Formal documents and previous research	Literature review
Climate change	1 m and 2 m SLR	Förster et. al. 2011	Literature review (Secondary data)

Demographic data and gross agricultural production during the period 1960-2010 are based on the Indonesian Agricultural Statistics report from 2000-2009 and the FAO Statistics Online dataset from 1960-2010. The different data systems can be complementary to each other because each data source its their own strengths and weaknesses. Each dataset may thus validate and fine tune findings from the other dataset.

This paper follows the Ministry of Agriculture's (2009) definition of floods as conditions where agricultural fields are inundated, lead to crop damage that may cause crop loss (or failures) that reduce agricultural production overall. Factors that cause floods include hydrological, improper land use and climatological factors. In this paper, all data concerning all crop loss (in ha) is included in the data of affected agricultural fields (in ha). However, not all affected areas are included in the loss data. The definition of flood loss is based on the national term *puso*, which means harvest failures. While 'affected agricultural fields' or 'affected crop fields' means inundated areas. For a projection of agricultural exposure to sea level rise (SLR), as a result of climate change, Förster, *et al*. (2011) use the term 'loss' to mean an estimated inundated crop fields.

4. Results 1: Natural Catastrophe Impact on Indonesian Agriculture

The assessment framework (Figure 3) guides this research by paying attention to the impact of natural hazard events on crops and agricultural related infrastructure. Table 3 provides a general overview on the impacts of natural hazards and plagues (i.e. including pest attacks) on general crops. It shows that floods, droughts and landslides are the dominant hazards. The data suggest that during the period 1970-2010, a total of 3,446,708 ha of crops were damaged as a result of 7576 hazard events. Interestingly, the data claim that more than 100,000 km of road (or 20 times the length of Indonesia from the Westernmost to the Eastern most borders) have been damaged as a result of more than 7500 events (mainly earthquakes and floods).

Table 3: General Crop and Infrastructure Damage Assessment

Type of hazards	∑ events	∑ of crop damages (ha)	∑ of road damages (km)	Crop damage probability (ha/event)	Road damage probability (km/event)
Floods 1970-2011	3,980	1,187,349	65,026	298	16
Drought 2003-2011	1,411	1,667,766	-	1,182	-
Earthquake-Tsunamis 1970-2010	268	60,673	37,041	227	138
Landslides 1999-2011	1,596	52,273	1,324	33	1
Landslides+Floods 1970-2011	305	287,046	1,135	941	4
Plague 1990-2009	17	191,601	-	11,271	-
Total	7,576	3,446,708	104,526	455	14

Source: Author, based on data from DIBI BNPB.go.id. This data does not include Indian Ocean Tsunami in Aceh as in the original dibi.bnpb.go.id as of 1 March 2012.

Damage is highly associated with *puso* or harvest failure. The data shows that at least 3.44 million ha of general food crop loss occurred during 1970-2010, as a result of more than 7,500 events. Overall, the average crop damage probability was 455 ha per any hazard. Floods have a damage probability event of 298 ha/flood event. Combined floods and landslides have significant damage probability of 941 ha/event. While drought obviously has a higher crop damage probability at the rate of 11.182 ha/drought event). In terms of road infrastructure, earthquake-tsunamis dominated the damage probability with 138 km/event. One of the reasons could be that roads are often built in hazard-exposed areas such as coasts, to link food consumers in cities with food producers in rural areas. However, earthquakes can also have significant effects on road damage, especially in areas where soil liquefaction takes place, and roads near coasts are likely to be affected by this phenomenon.

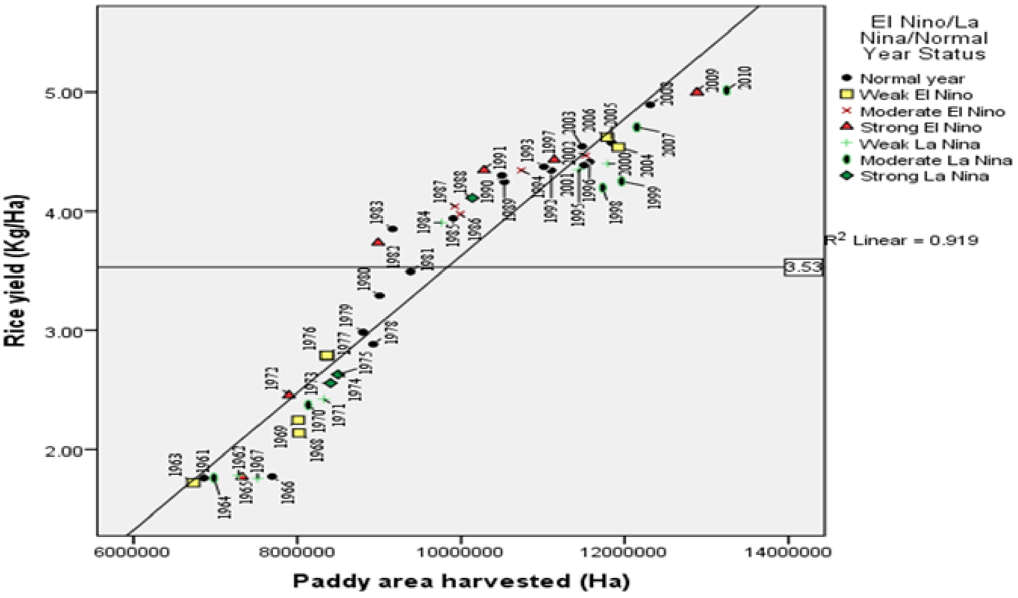
Plague (pest attacks) shares the highest loss probability of all, as Table 3 shows. Even though plague is the least recorded event (with a very high crop damage probability rate), readers should be cautious with this data, especially when calculated based on the DIBI recorded events. Closer investigation suggests the data do not cover some significant events during the period 1990-2009. In this case, the Agricultural Statistics 2009 publication provides more reliable data concerning plague, especially during 2003-2008, which suggest that plague is a much more routine event which needs to be explored in a different study. Data from Table 3 is simply a gross analysis, as it does not tell the readers the types of crops affected by floods, droughts, earthquakes/tsunamis and so on.

Figure 4A shows a high correlation between increased yield and expansion of rice field as shown by correlation test (r=.96). A separate exercise was also carried out to test the correlation between production and field expansion, and the result shows that they are almost identical (r=0.99). However, there were apparently shocks which impacted annual production over the years. For instance, the 1998-1999 rice production rate was lower than the levels of 1989 and 1996.Intuitively, one may assume that a strong El-Nino combining with a moderate La-Nina in 1998 were the causal events. It is clear from Figure 4 that the worst shock to production was associated with the El-Nino event. However, it is also clear that not every strong El-Nino or strong La-Nina creates shocks in yield. There is, nevertheless, a clear indication that they are likely to create shocks, and this indicates the need for a food crisis early warning system. For instance 2009 was considered as a strong El-Nino year. In fact, the 2009 yield was higher than the prior years. However, given the fact that there was a significant increase in the area of rice field in 2010, the yield in 2009 is relatively 'stagnant' compared to 2010, a strong La-Nina year.

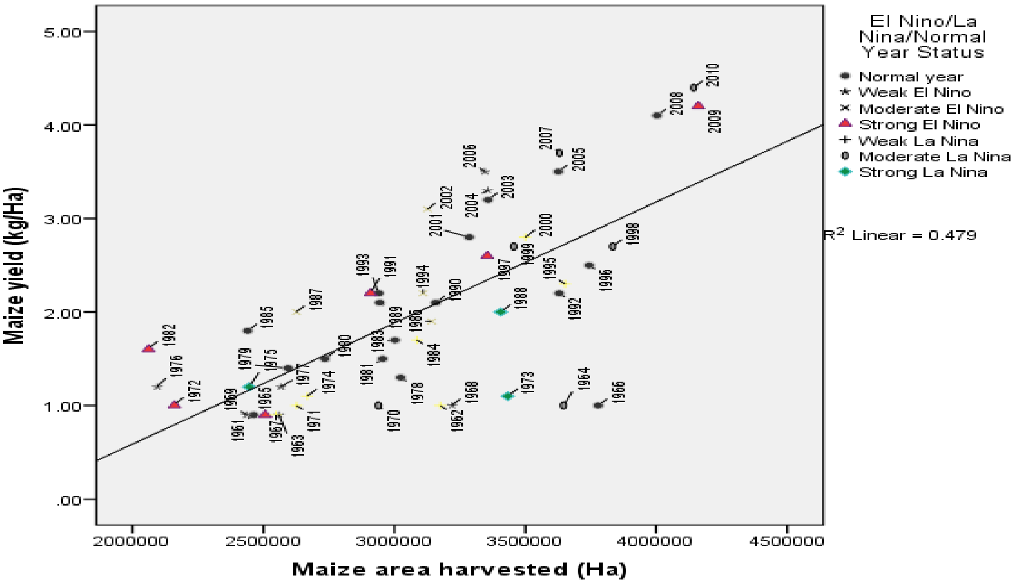
The rather S-shaped yield year-on-year scatter plots in Figure 4A begs for more in-depth research and data collection in the regression function of the yield. Natural and social political economic variables could be carefully considered to build a firmer yield prediction model (nonlinear multiple regression analysis) in comparison to the observation above.

Figure 4: Scatter Plots of Indonesian Rice and Maize Yields and Areas Cultivated 1960-2010

A)



B)



Source: Author's based on Indonesia Agricultural Statistics 2000-2009 and FAO Stat online; El-Nino and La-Nina years is based on NOAA approximate.

Unlike rice, the correlation between maize yield and maize area is relatively modest (Figure 4B). The regression line demonstrates a weaker predictive power, especially when increased maize yield is moderately associated with the increase of area harvested. The maize yield is very volatile. On average, as far as the macro data at the national scale are concerned, strong El-Nino years do not necessarily lead to shocks. However, some strong La-Nina years (e.g. 1978, 1998) indeed brought down the yield. It is also clear that during the course of the 1960s, increases in area harvested gave little yield increase. Some of the main reasons could be due to low productivity (Figure 1) as noted by Geertz's agricultural involution insight.

For future work, especially when data allows, a more detail study could be done on the seasonal scale rather than using an annual calculation.

4.1. Impact of Drought and Floods on Maize and Rice Crops

Agricultural statistics show an increase in crop loss in Indonesia due to drought and floods (Table 4). The total accumulation of rice area affected by floods in the period 2003-2008 equals 15% of the 2009 total area under cultivation (about 1.8 out of 12 million ha). During the same period, drought has affected 17% of the 12 million ha of rice field. Floods and drought combined have affected 32% of the total cultivated areas.

The total rice loss (termed locally as *puso*, or absolute quantity of harvest failure) caused by floods during 2003-2008 was about 564k ha and by drought about 424k ha. The total loss from both hazards was about 988kha (Table 4). The calculation was rather conventional and data collection is still focused on both drought and floods. The total affected area is equivalent to 4 million ha. In addition, existing data also contain a comprehensive list of primary to secondary crop loss (which will not be discussed in detail in this draft due to time and space limitation).

Table 4: Maize and Rice Loss due to Flood and Drought

No	Region	Crop area '000 ha (2008)	Total flood and drought during 2003-2008				Avg Yield (t/ha) 2008	Direct monetary loss ($)
			Crop affected (Ha)	Crop loss (Ha)	% crop affected	% crop loss		
A	Rice/PaddyCrop							
	Sumatra	3,184,493	848,168	247,346	0.27	0.08	3.97	156,527,959
	Java	5,712,172	2,261,715	545,351	**0.40**	**0.10**	5.42	471,992,674
	Kalimantan	1,282,931	357,536	59,702	0.28	0.05	3.30	31,398,589
	Sulawesi	1,284,999	313,399	85,735	0.24	0.07	4.65	63,586,323
	Bali	144,756	3,309	177	0.02	0.00	5.84	165,060
	NTT	168,412	50,935	38,729	0.30	0.23	3.06	18,920,495
	NTB	327,791	91,680	11,221	0.28	0.03	4.86	8,710,799
	Papua	27,859	13,463	46	0.48	0.00	2.98	21,841
	Maluku's	32,075	289	28	0.01	0.00	3.73	16,673
	National	12,165,488	3,940,494	988,335	0.32	0.08	4.26	671,252,801
B	Maize/corn crop							
	Sumatra	802,817	115,830	22,631	0.14	0.03	3.39	19,727,275
	Java	2,012,027	214,667	20,493	0.11	0.01	3.78	19,894,963
	Kalimantan	68,414	5,514	872	0.08	0.01	3.57	800,443
	Sulawesi	657,349	58,669	14,275	0.09	0.02	3.69	13,534,354
	Bali	27,069	12,018	1,625	0.44	0.06	2.71	1,131,764
	NTT	271,791	8,193	70	0.03	0.00	2.48	44,651
	NTB	55,374	12,027	887	0.22	0.02	3.25	741,779
	Papua	6,853	4	0	0.00	-	2.39	-
	Maluku's	19,775	955	549	0.05	0.03	2.03	286,772
	National	3,921,469	427,877	61,402	0.11	0.02	3.34	52,746,417

During 2003-2008, the accumulation of rice loss was 3.9 million ha (8% of 2008 total rice field) and maize loss was 427k ha or 2% of the total maize cultivation area in 2008. Monetary value of these losses equals USD 618 million.

The main areas of rice loss include the islands of Java and Sumatra. The combined Java and Sumatra rice loss amounted to 80% of total losses. Rice but Sumatra and Java together account for only 73% of Indonesia's rice-growing area. There is therefore an urgent need to mitigate losses within the wet-agricultural system in Java and Sumatra. The annual growth rate of rice loss was on average 5% during 2003-2008. This is obviously far above the annual rate of rice field expansion promoted by central governments during past decades.

Total monetary losses during 2003-2008 as shown in Table 4 were USD 723 million. This amounts to 81% of the total national budget earmarked for the Ministry of Agriculture in 2010. It is also about 115% of the government budget for irrigation in fiscal year 2010.[3] It is 29 times the overall disaster recovery budget managed by the National Disaster Management Office (BNPB) in 2010 (Ministry of Finance 2010).

Table 5 shows that the government's promotion of rice field expansion to boost production was countered by high annual loss rates during 2003-2010. For instance, the rice field expansion in 2008 was reported to be 1.3%. Unfortunately, evidence suggests that there was a rice loss equivalent to -1.6% rice in 2008. Therefore, the net balance was actually -0.3% (Table 5).

Table 5: Rice Filed versus Loss data

Year	2003	2004	2005	2006	2007	2008	2009	2010
Rice area (Ha)	11,477,400	11,923,000	11,839,100	11,786,400	12,147,600	12,309,200	12,883,600	13,244,200
Rice loss (Ha)	183,844	110,972	125,214	211,272	157,680	199,353	116,461	113,566
Rice area (Ha) – Corrected	11,293,556	11,812,028	11,713,886	11,575,128	11,989,920	12,109,847	n/a	n/a
Rice innundated (Ha)	831,800	475,169	529,165	668,087	783,534	652,739	183,844	110,972
Rate of annual rice area %	-0.4%	3.9%	-0.7%	-0.4%	3.1%	1.3%	4.7%	2.8%
Rate of annual rice loss %	1.6%	0.9%	1.1%	1.8%	1.3%	1.6%	0.9%	0.9%
Rate of annual rice area % (corrected by loss)	-2.0%	3.0%	-1.8%	-2.2%	1.8%	-0.3%	3.8%	1.9%
Rate of annual innundated	7.2%	4.0%	4.5%	5.7%	6.5%	5.3%	n/a	n/a

Source: Author. Data 2003-2008 is taken from Ministry of Agriculture 2009; Data from 2009-2010 is adjusted from DIBI.

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[3] See Fiscal Data from Ministry of Finance:www.fiskal.depkeu.go.id/webbkf/download/datapokok-ind2010.pdf

The mission to expand the rice land turns out to be less effective when the government were unaware of and unable to mitigate rice loss. Similar trends may have occurred in other crops at lower rates, especially in the case of maize. This phenomenon begs the question of whether the government should strategically seek the systematic prevention of crop loss without expanding the rice and maize areas of cultivation? Or should the government creatively increase the level of production efficiency through combining both expansion and loss prevention?

4.2. Agricultural Loss and Poverty

The agriculture/food system framework recognizes the consumption sub-system to be affected by natural hazards. In approaching consumption, this paper uses proxy data such as poverty levels by province. The Indonesian Central Bureau of Statistics differentiates two types of poverty as seen in Table 6. P1 is the poverty depth index and P2 is the poverty severity index at the rural level.

Correlation tests at provincial scale show insignificant correlation between the rate of agricultural losses (drought and flood combined) and the level of poverty (based on BPS 2008 data on poverty). However, it is interesting to note that exposure data (measured by flood inundated and drought affected agricultural areas) shows significant correlation with the rural poverty level (at 0.371 with sig. 2-tailed 0.033).

Even though there is no correlation between the loss and poverty (the sum of P1 and P2) based on Table 6, the exposure data is still consistent with qualitative observations from the field, and also observations in the literature. In addition, crop loss seems to be ' locally specific. At the micro level, evidence provides richer data concerning the impact of natural hazards on agriculture. For instance in Nias (North Sumatra) and Padang Pariaman (West Sumatra), earthquakes in 2005 and 2009 destroyed the existing irrigation infrastructures. The Indian Ocean Tsunami of 2004 affected thousands of hectares of agricultural land, including aquaculture land.

Table 6: Correlations Tests: Drought, Flood and Poverty

		% Total production loss by flood	**% Total production loss by drought**	**% Total drought & flood affected land (Exposure)**	**% Total production loss by drought and flood**
Rural Poverty Level P1P2	Pearson Correlation	.338	.150	.371*	-.041
	Sig. (2-tailed)	.055	.405	.033	.823
	N	33	33	33	33

Note: * Correlation is significant at the 0.05 level (2-tailed). P1 and P2 subsequently represent Depth Poverty Index and Severity Poverty Index at rural level. Poverty lines varies between regions however, national poverty line at rural level in 2008 is Rp.161,831/month (or USD17).

Agricultural losses suffered by poor farmer households and vulnerable communities, due to frequently occurring extensive disasters such as floods and drought, which have a huge aggregate effect, are often under-recorded and are increasing rapidly (UNISD 2011: 18). The economic implication of such losses cannot simply be calculated by the total production loss but should include a comprehensive account of the opportunity loss caused by meteorological and geological hazards. The Bengkulu earthquakes in September 2007 destroyed the irrigation infrastructure and led to ‘localized drought’ at the downstream rice areas.

A damage and loss assessment (DALA) report suggests that the Sumatran earthquakes in 2009 had an impact on the agriculture sector especially damage to irrigation systems and fishponds. The earthquakes of 2009 affected the livelihoods of many rural and coastal villages, however agriculture sectors have been much less affected than other sectors such as housing.[4] This means that the poverty-disaster relationship should be explored more deeply, especially when the drivers of poverty come from non-agricultural sectors (such as the impact on housing, non-natural based livelihoods and so on).

Cases from Bali and West Nusa Tenggara Province suggest that high (or rather extreme) rainfall often leads to the breakdown of irrigation. This leads to a lack of the water required for crop production. Recent flooding in West Nusa Tenggara province

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[4] West Sumatra and Jambi Natural Disasters: Damage, Loss and Preliminary Needs Assessment A joint report by the BNPB, Bappenas, and the Provincial and District/City Governments of West Sumatra and Jambi and international partners, October 2009 Public. http://www.gfdrr.org/gfdrr/sites/gfdrr.org/files/documents/GFDRR_Indonesia_DLNA.2009.EN_.pdf

collapsed some small bridges that disrupted inter-village transportation and the local food supply chain.

In Nias Island, for example in Sisobambowo village, rehabilitation of dams has not fully taken place after seven years of disasters.

In addition, the collapse of small dams (either earth dams or ones made of wire mesh gabion) often take years to be repair/reconstructed. This is due to lack of financial capacity and anticipatory disaster recovery planning knowledge routinized within the local government system. The consequence is clear – long delays in recovery will cause delays in production and hence opportunity cost increases (for inter-regional comparison, please see Annex 1).

4.3. Loss Pattern of Primary and Secondary Crops

Table 7 presents findings on the sensitivity of specific crops to different types of hazard. Cucumber, watermelon, potato, eggplants, cabbage and long bean are more sensitive to floods. A high loss rate is very probable (between 75-100%) once they are affected by floods. Onion and durian are more sensitive to drought. Overall, secondary crops are more sensitive to floods rather than drought. This should be read cautiously because the observation period is limited to 2003-2008. However, this does suggest that hazard mitigation should also be crop specific.

Table 7: Flood and Drought Crop Loss Pattern during 2003-2008

Commodity	Drought		Flood		Crop loss rate	
	Affected (ha)	Loss (ha)	ha affected	Loss (ha)	Drought	Flood
Tomato*	16	1	149	22	0.06	0.15
Coccumber*	2	-	260	248	-	0.95
Eggplants*	36	-	245	183	-	0.75
Watermelon*	16	-	599	465	-	0.78
Potato*	125	-	1,228	1,218	-	0.99
Chili*	793	3	2,659	1,537	0.00	0.58
Onion*	11	11	96	1	1.00	0.01
Banana*	290	1	2,502	986	0.00	0.39
Cabbage*	27	-	9	9	-	1.00
Soybean**	45,931	1,600	37,185	11,111	0.03	0.30
Groundnut**	76,714	4,236	12,610	1,735	0.06	0.14
Longreen bean*	18	-	643	553	-	0.86
Orange*	209	1	9,305	1,609	0.00	0.17

Commodity	Drought		Flood		Crop loss rate	
	Affected (ha)	Loss (ha)	ha affected	Loss (ha)	Drought	Flood
Durian*	140	58	96	1	0.42	0.01
Salak*	318	1	327	2	0.00	0.01
Rambutan*	5	-	92	39	-	0.42
Manggo*	1	0	308	16	0.17	0.05
All secondary crops	124,676	5,912	68,328	19,745	0.05	0.29
Maize (primary crops)**	331,697	23,661	96,180	37,741	0.07	0.39
Rice (primary crops)**	2,128,044	423,667	1,812,450	564,668	0.20	0.31

Note: *Total value 2004-2007; **. Total value 2003-2008.
Source: Author, data from Ministry of Agriculture 2009.

Very often, smaller scale agriculturally disastrous events receive less attention (as can be seen from the scale of losses versus national spending in 2010). Deeper analysis of the data shows that the loss depends on type of crop, time and place. For instance, during 2003-2008, overall tomato loss to drought in 2006 occurred in North Sulawesi while tomato loss to flooding occurred mainly in 2005 in Aceh. The potato crop was affected by drought mainly in Central java in 2006 while flood loss occurred almost exclusively in East Java in 2006. Banana loss to floods was significantly concentrated in Sumatra (Riau, South Sumatra and Jambi province) in 2004. 80% of groundnut losses were concentrated in Jogjakarta and Central java in 2006. The ‘drought’ in Jogjakarta during 2006 may be associated with alterations to the local microclimate caused by an increase of activity in the nearby Merapi volcano. However, it is also important to note that 2006 was a weak El-Nino year as noted by the US National Oceanic and Atmospheric Administration (NOAA).[5]

5. Climate Change and Agricultural Loss Assessment

Climate change is unequivocally happening (Intergovernmental Panel on Climate Change (IPCC) (2007)) and experts have reached high agreement supported by robust

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[5] See http://www.noaanews.noaa.gov/stories2006/s2699.htm [last accessed 30 Mar 2012].

evidence of climate change (IPCC 2012). The impact of climate change and climate extremes reported by IPCC (2012) shows that there will be increasing losses from climate extremes in some sea basins. Agricultural crops near coasts are likely to be more exposed to climate extremes and sea level rise. For the future, it is important to note that climate change is affecting the weather patterns and crop productivity in South and Southeast Asia. Basuno & Weinberger (2011) highlights that the impact is highly "place based" thus requiring location-specific responses.

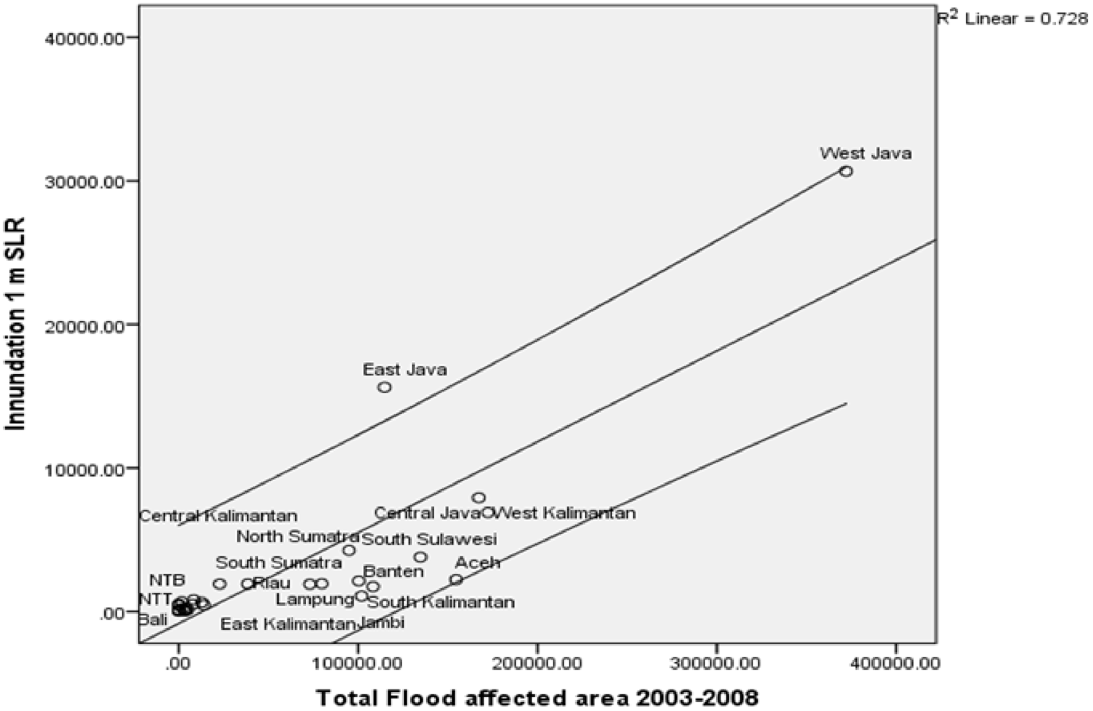
The Förster, *et al*. (2011) study on the impact of sea level rise on coastal agriculture suggests different impact scenarios: the 1 m and 2 m sea-level rise (SLR) scenarios in Indonesia. For the 1 m SLR scenario, the impact on 'absolute dietary impact' (ADI) is likely to concentrate in West Java, East Java and Central Java, followed by West Kalimantan and North Sulawesi. For 'relative dietary impact' (RDIP), West Kalimantan, West Java, Central Kalimantan, Aceh and South Sulawesi are predicted to be the most affected provinces. In the 2 m SLR scenario, the 'absolute dietary impact' (ADI) is predicted to be concentrated in West Java, East Java and Central Java, North Sumatra and West Kalimantan. The top 5 areas impacted by RDIP include West Kalimantan, West Java, North Sumatra, Aceh and Lampung (See Table 8). The author compares findings from rice field flood inundation data with the Förster, *et al*. (2011) projected data concerning coastal flood inundation due to a 1 m sea level rise (SLR).

Figure 5 shows that the projections of Förster, *et al*. (2011) are highly associated with the present trend of flood inundation (as shown in Section 4), especially based on provincial rice field inundation data during 2003-2008. Correlation testing shows a highly significant result (r=0.85) at .01. Table 8 presents a comparison of the top 5 flood affected areas with provinces to be impacted under the 1 m and 2 m scenarios. It is interesting to note that West Java is the most consistent province to experience flood inundation and loss, followed by Central Java and South Sulawesi. There is obviously a shift in regars to the different projection scenarios. For instance, North Sumatra and East Java are predicted to experience higher losses (in terms of absolute number of field inundations) for both scenarios of SLR 1 and 2 m.

Apart from loss assessment for SLR scenarios, the changing of seasonal patterns is likely to occur and may have a serious impact on agricultural outcomes. Previous studies such as Naylor, *et al*. 2007 found that, there are probability scenarios of a 30-

day delay in monsoon for West/Central Java and East Java/Bali (based on rice production data from Java and Bali during 1983–2004). They argued that “although the probability of a 30-day monsoon delay was lower in East Java/Bali than in West/Central Java, the impacts on rice production were higher”. A 30-day delay caused rice production to fall by 11%, on average, in East Java/Bali during the main rice harvest season between January and April, as compared with 6.5% in West/Central Java. Their findings supports the findings in Section 4 and Förster, *et al*. (2011) as they predict that a 30-day monsoon delay in the January–April period is likely to cause a drop in rice output by as much as 580,000 metric tons in West/Central Java and 540,000 metric tons in East Java/Bali.

Figure 5: Scatter Plots of Historical Flooding and Future Flood Inundation Scenarios



Source: Author, data from Ministry of Agriculture 2009 and Förster, *et al*. 2011

Table 8: Comparison of Past Events and Future Loss Scenario in Top 5 Provinces

No	Past flood events		Future scenario ADI, 1 m SLR		Future scenario ADI, 2 m SLR	
	Inundation	**Total loss harvest failure**	**ADI**	**RDIP**	**ADI**	**RDIP**
1	West Java	West Java	West Java	West Kalimantan	West Java	West Kalimantan
2	West Kalimantan	Aceh	East Java	West Java	East Java	West Java
3	Central Java	Sulawesi Selatan	Central Java	Central Kalimantan	Central Java	North Sumatra
4	Aceh	Central Java	West Kalimantan	Aceh	North Sumatra	Aceh
5	Sulawesi Selatan	Sumatera Selatan	North Sumatra	South Sulawesi	West Kalimantan	Lampung

Source: Author. ADI 1m and 2m Scenario is taken from Förster, *et al*. 2011

6. Discussion

Losses in the agricultural production sub-system are by no means new phenomena. Conventional loss assessment in rice production often throws up surprises associated with the inefficiency of the harvest and post-harvest activities ranging from harvesting, threshing, transporting, drying, milling and storage. Simatupang & Timmer (2008) estimate that the total loss in Indonesian rice production (in ha cultivated areas) during 1976/1987 and 1994/1995 could have reached 21% and 20.8% respectively. Harvesting loss was the main source of loss of all processes (above 9% for both periods) in the production sub-system.

Loss and damage have also been associated with biophysical and geophysical events that have impacts upon the production sub-system. Quinn, *et al*. 1978 (p. 675-679) highlighted the impact of El-Nino on the fall of fisheries production. They suggest that 93% of Indonesian droughts during 1844-1976 (with exception of 1954-75 due to unavailability of drought data) occurred during El-Nino years. Using Indonesian rice production data, D'Arrigoa & Wilson (2008) highlights the impact of drought driven by El-Nino on Java's rice production, where production loss was about 3 million tons of rice during 1997-1998 (in comparison to 1996 production data – See also Figures 1 and

4). The findings from other studies are quite consistent with the Section 4.1 based on year on year loss assessment.

Table 9: Hierarchy of Rice Crop Loss and Mitigation Options

No	Type of agricultural loss	Causation of loss	Likelihood of occurrence	Mitigation option
1	Productivity loss	Lack of basic plot management measures incl. labor inputs	Every planting season, extensive	Training, basic management, incentives for crop specific farmers
2	Harvesting loss	Inefficiency in harvesting	Every planting season, extensive	Technological and logistical option
3	Post-harvesting loss	Inefficiency	Every planting season, extensive	Technological option; infrastructure development
4	Cyclones and floods	Exposure of agricultural ports to extreme rainfalls	La-Nina events, extensive	Flood management measures
5	Drought hazard	Exposure of agricultural ports	El-Nino events, extensive	Water management, drought resistance seeds
6	Geological hazard	Vulnerability of irrigation infrastructure	Area specific, intensive	Seismic Codes of dams and irrigation systems
7	Pest attacks/Plagues	Local environmental change, lack of bio-security measures	Area specific, intensive	Pest management and bio-security measures
8	Combination of losses	Lack of multi-loss mitigation measures	Worst scenario can happen	Multi-loss reduction scenarios

Source: Author's.

Food self-sufficiency is not a popular policy in academic studies but politically seen as politically a legitimate food security policy in Indonesia during the last four decades. Unfortunately, food self-sufficiency is often short lived (Simatupang &Timmer 2008). Early government investment in irrigation system rehabilitation and expansion combined with a 'green revolution' policy at the national scale in the 1970s in Indonesia was considered a necessary decision. However, the government officials were seriously challenged by series of droughts and pest attacks that caused severe harvest loss during the 1970s and in 1982-1983 (Simatupang &Timmer 2008).

Simatupang & Timmer (2008) briefly note the condition of irrigation systems in 2006 based on reports from the Ministry of Public Works. The data shows serious damage in canals, dams and reservoirs. 1.5 out of the total 6.7 million ha irrigation canals were reportedly damaged. While 14,000 of the total 273,000 ha irrigation (associated with engineering dams as source of irrigation), experience severe damage. Some of the damage may be attributed to the biophysical condition surrounding both the canals and dams.

There is adequate evidence to conclude that Indonesian agricultural production is highly inefficient due to failure to mitigate losses associated with multiple risks (Table 9). The first of the major losses is loss associated with natural catastrophes (cyclones and floods, drought hazard, geological hazard). The second is loss associated with the internal human activities during the processes of production, harvesting and dealing with post harvesting problems. The third is loss due to the lack of a resilient irrigation infrastructure to cope with biophysical and geophysical problems. The rest of the losses relate to risk associated with pest attacks/plagues and to combinations of the risks.

Selection of new agricultural areas should be carefully made. Recent trends in losses may indicate that government’s drive to create new rice field may have ignored the risks embedded in the newly expanded areas, such as flood proneness The question is whether the expansion of agriculture is taking place in hazard-prone areas. Or is there ecological change taking place that modifies losses? In order to answer these questions, one needs to assess at high data resolution to see the correlation between loss data and disaster risk assessment.

7. Policy and Institutional Scenarios

Indonesia adopts the United Nations’ Hyogo Framework for Action (HFA) which aims to “Building the resilience of nations and communities to disasters - to make the world safer from natural hazards." It is a 10-year plan 2005-2015 adopted by 168 Member States of the United Nations in 2005 at the World Disaster Reduction Conference. HFA consist of five major priorities namely: Priority Action 1: Ensure that disaster risk reduction is a national and a local priority with a strong institutional basis for implementation; Priority Action 2: Identify, assess and monitor disaster risks and enhance early warning; Priority Action 3: Use knowledge, innovation and education to build a culture of safety and resilience at all levels; Priority Action 4: Reduce the underlying risk factors; Priority Action 5: Strengthen disaster preparedness for effective response at all levels.

The highest-order disaster risk management (DRM) planning [time scale of mid-term planning] in Indonesia since the reform in 2007 is the national disaster risk management plan, a five-year policy document that guides national ministries to allocate resources for risk reduction annually. The DRM Plan 2010-2014 provides shopping lists of ministries/agencies with a clear budget line. The planning suggests that the Ministry of Agriculture should plan and control mitigation efforts in in respect of drought and other hazards related to agriculture.

In addition to the five-year DRM Plan (2010-2014), under the leadership of the National Development Planning Minister, a series of three-year national action plans (NAP 2006-2009 and NAP 2010-2012) have been added as complementary plans which include non-state actors' DRM planning. The NAPs are basically a national level implementation of HFA Priorities. The NAPs also listed basic commitments to DRM from other agencies.

The internal division of government labor in regard to agricultural risk reduction can be simplified by using the historical mandates of the central government ministries. The Ministry of Agriculture (MoA) deals with agricultural production in general. The Ministry of Public Works deals with investment in irrigation infrastructure. The Ministry of Environment directs climate change mitigation and adaptation. The National Disaster Management office (BNPB) deals with disaster risk reduction. BMKG (The Meteorology, Climatological and Geophysical Office) serve as the primary node of a multi-hazard early warning system framework for different sectors. The National Development Planning Ministry (Bappenas) is the planning coordinator. This is a gross explanation concerning the leading ministries/agencies that have been playing roles as in responding to risks in agricultural sectors.

BNPB is still new and inexperienced body to manage risk reduction according to the new disaster management law, as it was only established in 2008. Evidence suggests that BNPB has been struggling with the vision of promoting loss prevention not only in agricultural sectors but overall. BNPB's Strategic Planning 2010-2014 document made no mention of agricultural risks and how to deal with them.[6]

Gap analysis between the NAPs and their implementation suggests that actual gaps between planning and investment are enormous (Lassa 2011). Priority on post disaster intervention outweighed the rest of the Hyogo Framework for Action (HFA) priorities in 2007, which continues to be the case today. For the first three years after the enactment of the Disaster Management Law 2007, DRR investment was still being directed to emergency preparedness and post-disaster response. This is understandable and justifiable because the period 2007-2009 coincided with the time of responses to recent big disasters, such as post-tsunami activities in Aceh in 2004, Nias in 2005, and the devastating earthquake in Yogyakarta in 2006 (Lassa, 2011).

The recent National Action Plan 2010-2012 shows that national actors including the government have now tried to shift their focus from reactive responses to dealing with the root causes of disaster risks, such as investing in mitigation plans, integration of DRR into land use, natural resource management, and better social development policy. There is clearly a willingness on the part of all actors, including the government, to radically shift from emergency preparedness and post-disaster response towards mitigation and prevention-oriented intervention. However, such a radical turn from *ex-post* oriented interventions to *ex-ante* risk reduction seems to be unrealistic because, institutionally and culturally, change may only occur incrementally. Wignyo (2012) recently shows that that government spending on disaster prevention/mitigation remains low in 2012 (USD 11 million) in comparison to disaster recovery funds (USD 440 million). Gaps between planning and implementation remain future challenges.

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[6] See http://www.bnpb.go.id/userfiles/Renstra%20BNPB%202010%20-2014.pdf [last accessed 30 Mar 2012].

Table 10: BNPB's View on How to Reduce Risk in Agricultural Sectors

Selected terms	Quantity of the selected terms in Indonesia Progress Report		BNPB's notes on the subject
	2009	**2011**	
Food security	3	0	establishment of Food Security Council toensureimplementation of food security policy (p. 19, p.20)
Agriculture	2	1	The report refers to Ministry of Agriculture
Food security assessment	1		There is need to have comprehensive food security assessment P. 20
Food security council	1	0	FSC is responsible for food security monitoring (P. 20)

Source: Author. Data from Indonesia Progress Report 2009; 2012

At the discursive level, a quick audit of BNPB's reports to the United Nations International Strategy for Disaster Reduction (UNISDR 2009 and 2010) suggest that the terms 'food security' and 'agriculture' are untraceable. The reporting system requires member states to report theses sector(s). However, the reports have been silent about the multiple risks faced by agriculture and the necessary steps needed to begin mitigating agricultural risks.

The perception from Indonesia's disaster management bureaucrats concerning measures to reduce disaster risks in agricultural sectors can be traced from the recent Indonesia Progress Report for the Hyogo Framework for Actions (HFA) to the United Nations International Strategy for Disaster Reduction (UNISDR) 2009 and 2011. The HFA Priority 4 requires substantial reduction in the root causes of disaster risks. Its second "core indicator" is "*Social development policies and plans are being implemented to reduce the vulnerability of populations most at risk*". The2009 Report argued that "the awareness of food diversification is being promoted by the Ministry of Agriculture" (p. 19, Indonesia Progress Report on DRR to UNISDR 2009). In the 2011 Report, the government reported that "Ministry of Agriculture has started to develop programs to diversify food crops to reduce vulnerability to climate change and disaster" (p. 20).

Public Works Department (at different levels) often allocate annual budget for 'recovery and maintenance of irrigation infrastructure. So far, there is no mention of 'mitigation and loss prevention' in the Ministry of Agriculture annual budget.

However, there is some freedom of action in allocating the disaster recovery and maintenance budget. For instance, in 2010, the Ministry of Agriculture received IDR 4.2 trillion (or USD 460 million) to response to loss and damage due to flooding in the agricultural sector.

Recently, the government issued a new law (Law 41/2009) namely ‘Protection of (Sustainable) Agriculture Land’. In the cases of natural hazards, the law regulates the change of land use due to disaster or to central government’s interest. It further specifies the timelines and indemnity ‘insurance’ from the government concerning the change of land use after disasters. Chapter 37 regulates incentives to farmers including: building and land tax exemption, infrastructure development, support in terms of research and development of high yield seeds, and facilitating access to information and technology. Aside from this law, there is no clarity on what the ministry of agriculture and hundreds of local agriculture departments do towards risk reduction in the sector.

In regard to anticipatory planning for climate change, the central government, through the National Development Planning Ministry (hereinafter BAPPENAS) recently released the Indonesia Climate Change Sectoral Roadmap (ICCSR) which integrates climate change and development. This is the first step towards explicitly bringing climate change into national development planning. In addition, this is the first time, that climate adaptation has been mentioned in a BAPPENAS report as it claims to provide a: “national roadmap for mainstreaming climate change into development planning.” In the ICCSR Chapter 5-7, there is detailed elaboration of climate adaptation in several sectors, including the water sector (water availability, floods, and droughts), the marine-fisheries sector (coastal inundation, sea temperature, extreme events) and the agriculture sector (food and plantation production).

The ICCSR for the agricultural sector is claimed to be a policy guide in the agriculture sub-sectors for 2010-2029. To address the impact of climate change in the agricultural sector, the government will focus on the following areas. First, adaptation in the agricultural crops sub-sector in sustaining and stabilizing national food resilience. Second, to promote carbon mitigation in the plantation sub-sector through environmentally friendly and low carbon technology.

At the local level, there is still no agricultural resilience. New dynamics arising from Indonesian decentralization is also delaying implementation of risk reduction measures at the local level, as prioritized by the central government. Missing links in disaster governance in Indonesia have been recently addressed by creating a stronger national disaster management agency (BNPB). The approach is to pool funds at the BNPB and enable regions (districts and provinces) to access the funds as long as they are willing to establish specialized institutions in disaster reduction at the local level. Even though this policy is well justified, recent close investigation shows that there remains a need for significant reform in balancing pre and post disaster oriented funds.

Questions remains on how these ministerial policies interact and streamline efforts towards agricultural risk reduction. In addition, it is unclear how local-national government can work in a clear risk governance framework that allows them to recognize and prioritize strategic sectors such as agricultural risk. Recent efforts to integrate disaster risk reduction and climate adaptation in Indonesia may keep hope alive that there will be sustained efforts in agricultural risk reduction.

8. Final Conclusion

This paper examines the impact of disasters and climate hazards on Indonesian agricultural and food crops. The findings firmly conclude that natural catastrophes have already caused a great deal of loss. This challenges the government's existing policy in expanding crop fields and agricultural areas. Loss accumulation over the last decade has caused significant leakage of central government funds, and reduced agricultural production.

Bourgeois & Kusumaningrum (2008) ask "what cereals will Indonesia still import in 2020". Should Indonesia change its rice import policy to be able to feed its people once widespread droughts and floods occur in the future, triggered by climate change? Climate change is likely to challenge agricultural crops in the Mekong Delta, the main source of rice imports for Indonesia (Thailand and Vietnam).

The emerging 'agricultural involution' - as an outcome of ignorance in dealing with multiple stressors in agricultural crops – suggests that Indonesia may hardly achieve stable food production. This challenges the long standing food 'self-sufficiency' policy.

In theory, one of the keys to achieving food 'self-sufficiency' in the broader sense could be loss prevention. The average rate of losses during 2003-2008 was 1%. Average area expansion was 2% per annum during the same period. This suggests that expansion is always held back by losses, by as much as 1%.

Agricultural crop losses will persist if the "business as usual" scenario (no mitigation or loss prevention) takes place. Global climatic change has certainly impacted local climate patterns and their impact on agriculture is clearly suggested by previous studies. It is very likely that Indonesia will continue to experience high levels of loss and damage in food crops. Therefore, hazard mitigation and adaptation strategies are needed for all agricultural crops.

Flood management and water management in agricultural fields should be continuously integrated and sustained. In addition, it has become clear that earthquakes and tsunami mitigation in the agricultural infrastructure should also be considered. While these suggestions are technically feasible and necessary, they remain challenging at institutional levels.

Global discourse concerning risk management for future drought, within the context of agricultural adaptation to climatic change, suggests drought resistance seeds. Naylor, *et al*. (2007) added 'water storage, crop diversification, and early warning systems' to the list of investments needed for loss prevention in response to drought and El-Nino.

Agricultural catastrophe insurance has been barely recognized in the country. Most of the losses are therefore largely uninsured. This suggests the importance of risk transfer mechanisms such as agricultural insurance. The challenge is to find ways of making such a policy a reality in the future in both the local and the national context.

A question for future research concerns the kind of institutional scenarios required for Indonesia to be able to safeguard its agricultural infrastructure and agricultural crops from the impact of the natural hazards and climate change that are embedded in the nation's biophysical and geophysical systems.

Indonesia is likely to experience agricultural involution in the 21st century, not because it fails to adopt the required technology but because there is a lack of loss mitigation and adaptation policy and planning relating to both natural catastrophes and to climate risks.

What is clear is that the definition of future sustainable agriculture must be revised to take account of natural hazards, climate risks and other relevant stressors.

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ANNEXES

Annex 1. Rice Loss due to Flood and Drought