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Working Paper

Impacts of Natural Disasters on Agriculture, Food Security, and Natural Resources and Environment in the Philippines

PIDS Discussion Paper Series, No. 2012-36

Provided in Cooperation with:
Philippine Institute for Development Studies (PIDS), Philippines

Suggested Citation: Israel, Danilo C.; Briones, Roehlano M. (2012) : Impacts of Natural Disasters on Agriculture, Food Security, and Natural Resources and Environment in the Philippines, PIDS Discussion Paper Series, No. 2012-36

This Version is available at:
http://hdl.handle.net/10419/126912

Philippine Institute for Development Studies
Surian sa mga Pag-aaral Pangkaunlaran ng Pilipinas

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DISCUSSION PAPER SERIES NO. 2012-36

October 2012

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IMPACTS OF NATURAL DISASTERS ON AGRICULTURE, FOOD SECURITY, AND NATURAL RESOURCES AND ENVIRONMENT IN THE PHILIPPINES

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Abstract

This study quantitatively and qualitatively analyzed the impacts of natural disasters, particularly typhoons, floods and droughts, on agriculture, food security and the natural resources and environment in the Philippines. It aimed to propose recommendations as to how best to respond to the impacts of natural disasters and to identify further economic studies that can be undertaken. The study found that: a) typhoons, floods and droughts have an insignificant impact on agricultural production at the national level, yet typhoons have a significant negative impact on paddy rice production at the provincial level; b) typhoons, as exemplified by Ondoy and Pepeng in 2009, have a significant negative impact on the food security of the households in the affected areas; c) households have varying consumption and non-consumption strategies to cope with the impacts of typhoons; and d) the different impacts of typhoons, floods and droughts on the natural resources and environment have not been quantitatively assessed in detail but the available evidence suggests that these are also substantial. Based on its results and findings, the study recommends the following: a) Since typhoons have significant negative impacts on rice production at the local level as opposed to the national level, assistance for rice farmers and the agriculture sector as a whole should be made more site-specific, zeroing in on the affected areas that actually need it; b) Those assisting affected households and areas in overcoming the ill-effects of natural disasters should consider not only consumption strategies, such as the provision of emergency food aid, but also non-consumption strategies, such as the provision of post-disaster emergency employment; and c) While the available evidence suggests that the natural resources and environment sector is significantly affected by natural disasters, it is currently less considered, as attention is presently focused on agriculture. It may now be high time to provide concrete assistance to this sector, in particular by allocating for it defensive investments and rehabilitation expenditures to cope with these natural disasters.

Keywords

Natural Disasters, typhoons, floods, droughts, Agriculture, Food Security, Natural Resources and the Environment, Agricultural Multi-Market Model for Policy Evaluation (AMPLE)

IMPACTS OF NATURAL DISASTERS ON AGRICULTURE, FOOD SECURITY, AND NATURAL RESOURCES AND ENVIRONMENT IN THE PHILIPPINES[1]

1. Introduction

In Southeast Asia, the Philippines is among the hardest hit by natural disasters, particularly typhoons, floods and droughts. These natural disasters have negative economic and environmental impacts on the affected areas and the people who live there. Furthermore, the agriculture and natural resources sectors are highly vulnerable because they are directly exposed to natural disasters and their unwelcome consequences.

An analysis of the impacts of typhoons, floods and droughts on agriculture, food security and the natural resources and environment of the Philippines will help bring further to light the nature and extent of these effects. For an economy largely dependent on agriculture and its natural resources and environment, the data and information as well as overall knowledge gained from the study may prove useful in developing strategies to address the ill-effects of natural disasters. Moreover, the results and findings can be utilized in identifying new studies that can be undertaken in the future in relation to natural disasters, an important research concern which currently lacks the necessary level of focus in the Philippines.

The main objective of this study is to quantitatively and qualitatively analyze, to the extent possible with available secondary data and information, the impacts of typhoons, floods and droughts on agriculture, food security and the natural resources and environment in the Philippines. The specific objectives of the study are to: a) present an overview of agriculture, natural resources and environment, disaster management, and the occurrences of typhoons, floods and droughts in the country; b) evaluate the impacts of typhoons, floods and droughts on agriculture at both the national and provincial level; c) assess the impacts of these disasters on food security; and d) analyze the effects of these disasters on the natural resources and environment.

[1] This study has been funded by the Economic Research Institute for ASEAN and East Asia (ERIA).

2. Methodology

2.1 Definitions

Put simply, a natural disaster is a natural event with catastrophic consequences for living things in the vicinity (Sivakumar 2005). From an economic perspective, a natural disaster is an event that causes a perturbation to the functioning of the economic system, with significant negative impact on assets, production factors, output, employment, or consumption (Hallegatte and Przyluski, 2010). In the Philippines, the Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), which is the institution that provides meteorological, astronomical, climatological and other specialized data and information and services, defines a disaster as "a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts which exceeds the ability of the affected community or society to cope using its own resources". On the other hand, it defines a hazard as "a dangerous phenomenon, substance, human activity or condition that may cause loss of life, injury or other health impacts, property damage, loss of livelihood and services, social and economic disruption, or environmental damage".

Natural disasters are generally meteorological, hydrological, geological or biological. Examples of meteorological and hydrological disasters are typhoons, floods and droughts. A typhoon is the name given to a storm system that occurs in and around the Philippines and Southeast Asia (elsewhere commonly known as a cyclone or hurricane, depending on the location). According to PAGASA, a typhoon is a "tropical cyclone with winds that exceed 118 kilometres per hour that occurs in the western Pacific". A flood is defined as "an abnormal progressive rise in the water level of a stream that may result in the overflowing by the water of the normal confines of the stream with the subsequent inundation of areas which are not normally submerged". A drought is defined as "abnormally dry weather in a region over an extended period of time".

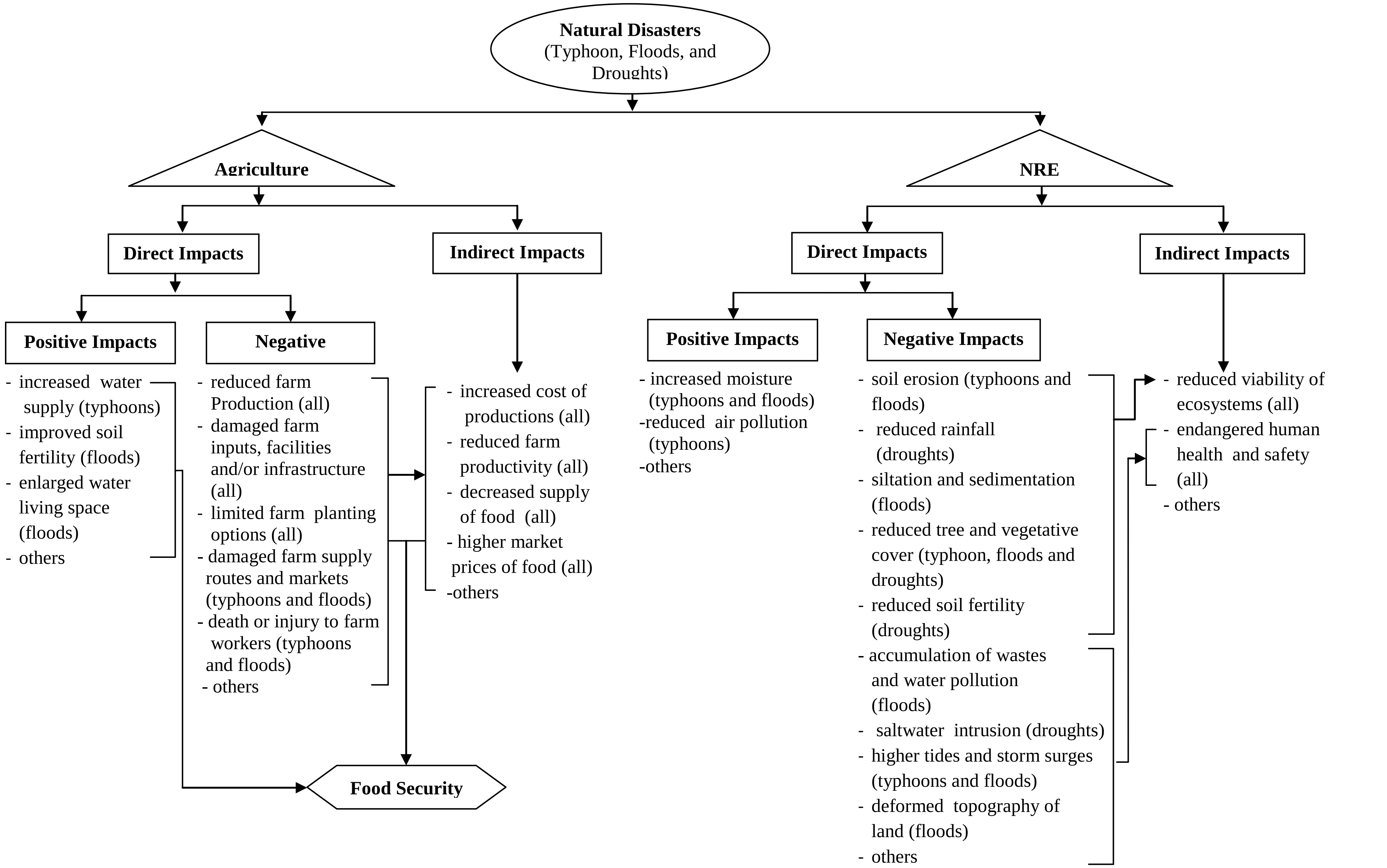
Food security is defined as "a situation that exists when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (FAO, 2002; 1996). The basic features of food security are accessibility, affordability and absorption (Kurien, 2004). Firstly, food should not only be in sufficient quantity, it must also be actually accessible to people of all economic classes and in all locations. Secondly, its supply should also be stable so that it is affordable in both the short and long term. Thirdly, and equally importantly, food should be absorbable and safe for people to consume.

2.2 Framework of analysis

Theoretically, the impacts of natural disasters on agriculture and the natural resources and environment sectors can be direct or indirect as well as positive or negative (Figure 1). In the case of agriculture, the direct and positive impacts are readily identifiable. Typhoons increase the supply of water for agriculture as they usher in rain. Floods improve soil fertility as they deliver nutrients from the uplands to the lowlands. In addition, floods temporarily create a larger water habitat for inland fish and other aquatic animals. Together with other yet-to-be-identified factors, these impacts of typhoons and floods are viewed as positive because, other things the same, they facilitate an increase in agricultural production in the affected areas and help improve the food security situation.

In contrast, there are direct and negative impacts of natural disasters on the agriculture sector as well. Typhoons, floods and droughts have the potential to reduce farm productivity; damage farm inputs, facilities and/or infrastructure, and limit farm planting options. Furthermore, individually, typhoons and floods can damage farm supply routes and cause death or injury to farm workers. As a consequence, these direct and negative factors can further lead to indirect and negative impacts on agriculture and the economy as a whole. Specifically, as a result of typhoons, floods and droughts, the overall cost of agricultural production increases; agricultural production output declines; food supply falls and, as a result, food prices rise. Taken together, the direct and indirect negative impacts on agriculture and threaten food security in the affected areas.

Figure 1: Framework of analysis on the impacts of natural disasters on agriculture, food Security, and the natural resources & environment (NRE)



As in the case of agriculture, natural disasters impact the natural resources and environment sector. On the positive side, typhoons and floods directly increase the moisture content in the air, resulting in a temporary cooler temperature for the local people to enjoy. Typhoons clear the air of pollution to the benefit particularly of the population residing in congested urban areas. On the negative side, typhoons, floods and droughts reduce the impact area's total vegetative cover; typhoons and floods lead to soil erosion, higher coastal tides and storm surges; floods result in siltation and sedimentation, accumulated waste, polluted water and deformed land topography; and droughts reduce rainfall, lower soil fertility and increase saltwater intrusion. Taken together, all three natural disasters indirectly reduce the viability of both land and water ecosystems as suppliers of ecosystem services and endanger human health and safety.

In the aforementioned framework of analysis, while there are both positive and negative impacts on agriculture and the natural resources and environment sectors, it is assumed that the net impact is negative. Furthermore, it should be emphasized that beyond the framework, not only do natural disasters affect the natural resources and the environment but the latter influences the former as well (For instance, forests block the force of incoming winds and limit the damage caused by typhoons, while watersheds store rainwater and reduce the incidence of flooding). Although important, these reverse relationships are not covered in this study. Thirdly, while it would be interesting to quantitatively measure all the actual impacts of previous natural disasters on agriculture and the natural resources and environment, this would not be possible given the presently limited secondary data available.

2.3 Econometric methods

For quantitatively analyzing, using econometric methods, the impacts of typhoons, floods and droughts on agriculture, the Agricultural Multi-market Model for Policy Evaluation (AMPLE) is used in this study. AMPLE is an 18-production sector partial equilibrium model covering crops, livestock, poultry and aquatic products which generates projections of output, area, consumption, imports, exports, and prices. In common with other supply-demand models, AMPLE is suitable for understanding the evolution of underlying economic fundamentals, as opposed to actually predicting market movements. A full description of AMPLE is presented in Briones and Parel

(2011) and Briones (2010) and the sets, variables, and equations of the model are listed in the annexes of these two papers. The model is programmed and solved with the use of the Generalized Algebraic Modeling System (GAMS). Another econometric approach used here in analyzing the impacts of natural disasters on agriculture is regression analysis, the specifics of which are explained in the relevant section below.

2.4 Data and data sources

This study used secondary data from institutional sources. Data on the annual occurrence of typhoons at the national, regional and provincial levels were taken from the unpublished records of the PAGASA. There were no data available at the time of this writing on the annual occurrence of floods and droughts, but national and regional data for the areas affected by them were available and generated from the unpublished records of the Department of Agriculture (DA). Data on the annual damage by agricultural commodity in terms of production in metric tons, cost of production in million pesos, and area in hectares caused by typhoons, floods and droughts were available only for the national level, except those for rice, which were also available for the regional level. These data were also taken from the unpublished records of the DA. Data on the provincial quantities and prices of paddy rice were generated from the Bureau of Agricultural Statistics (BAS). All the aforementioned data utilized were supplemented by secondary quantitative and qualitative data, as well as information taken from the related literature.

3. Review of related literature

Recent empirical studies on the impacts of natural disasters on economic growth have been conducted. Cavallo et al. (2010) found that only extremely large disasters have a negative effect on output both in the short and long term. Cavallo and Noy (2010) asserted that on average, natural disasters have a negative impact on short-term economic growth. Toya and Skidmore (2005) found that countries with higher incomes, higher educational attainments, greater openness, more complete financial systems and smaller governments experience fewer losses from natural disasters. Loayza et al. (2009) argued that natural disasters affect economic growth but not always negatively and the effects are different across disasters and economic sectors; although moderate disasters can have a positive growth effect in some sectors, severe disasters do not; and growth in developing countries is more sensitive to natural disasters with more of their economic sectors being significantly affected.

Some empirical works on the impacts of natural disasters on agriculture have also been conducted as well. Loayza et al. (2009) found that, in contrast to the weak effects on overall GDP growth, droughts and storms have negative impacts on agriculture while floods have a positive effect. Sivakumar (2005) explained that the predominant impacts of natural disasters on agriculture are negative. Long (1978) argued that the negative effects are a powerful partial explanation of the lack of agricultural self-sufficiency in a large number of low income countries and consequently go some way towards explaining the occurrence of hunger and poverty in these countries.

The impacts of natural disasters on natural resources and the environment have also been investigated but only sparingly. Sivakumar (2005) explained that natural disasters cause environmental degradation which in turn contributes to the disaster vulnerability of agriculture, forestry and rangelands. NRC (1999) mentioned that not all natural disasters result in significant ecosystem impacts and that some extreme events actually have positive impacts. However, it further explained that many of these impacts are non-market related and are exceptionally difficult to quantify and/or monetize.

Recent studies have been carried out on the impacts of natural disasters in the Philippines and selected neighboring countries. Israel (2011) reviewed the occurrence of disasters caused by weather and climate-related disasters in Cambodia, Indonesia, The Lao PDR, the Philippines and Viet Nam and explained that in the 1990s and 2000s, these disasters occurred on a regular basis in these countries, with the Philippines being the most affected. Israel (2010) studied the occurrence of weather and climate-related natural disasters in the Philippines in the last two decades and found that they have increased and the monetary damage caused by the disasters has been substantial. Both studies argued for the importance of improving and integrating the national meteorological systems (NMHS) of Southeast Asian countries in order to address natural disasters.

Lastly, some qualitative studies on the impacts of natural disasters on agriculture and the natural resources and environment in the Philippines have been conducted in the past also and these will be cited below in the relevant sections of the study.

4. Review of the agriculture and natural resources and environment sectors of the Philippines

4.1 Agriculture

From 2004 to 2010, the agriculture and fisheries sector of the Philippines contributed an average of 18.4 percent to gross domestic product (GDP) and grew at an average rate of 2.6 percent annually (NEDA 2011). Among the regions, the top contributors to output in 2009 were Region IV-A (CALABARZON) and Region III (Central Luzon). The agriculture and fisheries sector during this period employed an average of 11.8 million people, which accounted for almost 35.1 percent of the total work force of the country. Between 2004 and 2010, the exports of the sector exports increased in monetary value from US$2.5 billion to US$4.1 billion. The top agricultural exports in terms of value were coconut oil, fresh banana, tuna, pineapple, tobacco, and seaweed. It is worth noting that in 2010 as well as in some years in the past, although the country recorded an overall balance of trade deficit in agricultural products, it had positive trade balance in fishery products.

Among the main challenges facing the agriculture and fisheries sector in the Philippines is its vulnerability to the inherent climate volatility within the region, as well as global climate change. In response to this, an important development goal for the country is an increased resilience to climate change risks of the agriculture sector. With a rapidly increasing population and demand for food, another major development goal is improved food security. To attain these two goals and other objectives within the Philippines’ agricultural sector, the strategies promoted by the national government are: a) to raise the productivity and incomes of agriculture and fishery-based households and enterprises; b) to increase the investment and employment level across an efficient value chain; and c) to transform agrarian reform beneficiaries into viable entrepreneurs.

4.2 Natural resources and environment

The natural resources of the Philippines include land, forest and fisheries resources while the natural environment refers to the quality of its land, water and air resources. In general, the natural resource and environment sector is facing the twin problems of overexploitation and depletion of natural resources and the deterioration of the overall environmental quality. In recent years, little progress has been made in arresting the worsening pace of these problems even as new challenges have emerged (EC, 2009).

Similar to agriculture, among the important challenges facing the natural resources and environment sector of the Philippines are natural hazards and disasters. In response to this problem, a major development goal in this sector is the enhanced resilience of natural systems and improved adaptive capacities of human communities to cope with natural hazards and disasters including climate-related risks (NEDA, 2011). To reach this goal, the following strategies are pursued: a) strengthening the institutional capacities of national and local governments for climate change adaptation and disaster risk reduction and management; b) enhancement of the resilience of natural systems; and c) improvement of the adaptive capacities of communities.

5. Review of disaster risk management in the Philippines

5.1 Laws, institutions, and recent initiatives

The history of disaster risk management (DRM) in the Philippines began during the Commonwealth period with Executive Order 355 which created the Civilian Emergency Administration (CEA). Thereafter, other laws were passed and agencies were established for DRM in the country (Table 1). In 2010, the Republic Act (RA) 10121, otherwise referred to as the Philippine Disaster Risk Reduction and Management Act, was passed reconstituting the National Disaster Risk Reduction and Management Council (NDCC) into the National Disaster Risk Reduction and Management Council (NDRRMC). This current agency is empowered with policy-making, coordination, integration, supervision, monitoring and evaluation functions related to disaster risk management. It is headed by the Secretary of the Department of National Defense (DND) as Chairperson with Secretaries of other selected departments as Vice Chairpersons.

Table 1: Periods, laws, agencies and their functions related to disaster risk management in the Philippines

Periods	Laws	Agencies and their functions
Commonwealth to Post-Commonwealth	Executive Order No. 335	This law created the Civilian Emergency Administration (CEA) which was tasked primarily through the National Emergency Commission (NEC) to formulate and execute policies and plans for the protection and welfare of the civilian population under extraordinary and emergency conditions.
Japanese Occupation	Executive Order No. 36	This law created the Civilian Protection Service (CPS) which was empowered to formulate and execute plans and policies for the protection of civilian population during air raids and other national emergencies.
1954-1968	Republic Act 1190, otherwise known as the Civil Defense Act of 1954	This law created the Civil Defense Administration (NCDA) which was tasked primarily to provide protection and welfare to the civilian population during war or other national emergencies of equally grave character. To support the NCDA in carrying out its mission, this law also provided for the establishment of civil defense councils at the national and local levels. namely: the National Civil Defense Council (NCDC) and the provincial, city and municipal civil defense councils, Respectively.
1970s		In 1970 a disaster and Calamities Plan prepared by an Inter-Departmental Planning Group on Disasters and Calamities, was approved by the President. The Plan has provided, among others, the creation of a National Disaster Control Center (NDCC). I In 1973, The Office of Civil Defense

		(OCD) was created with the mission of ensuring the protection and welfare of the people during disasters or emergencies.
	Presidential Decree 1566	This law was issued in 1978 to strengthen the Philippine disaster control capability and to establish a community disaster preparedness program nationwide. It also created the National Disaster Coordinating Council (NDCC) as the highest policy-making body for disasters in the country.
2000s		In February 2010, the NDCC was renamed, reorganized, and subsequently expanded into the National Disaster Risk Reduction & Management Council (NDRRMC), an agency responsible for ensuring the protection and welfare of the people during disasters or emergencies.
	Republic Act No. 10121 or the Philippine Disaster Risk Reduction and Management Act of 2010	This law acknowledges the need to adopt a disaster risk reduction and management approach that is holistic, comprehensive, integrated, and proactive in lessening the socio-economic and environmental impacts of disasters including climate change, and to promote the involvement and participation of all sectors and all stakeholders concerned, at all levels, especially the local community.

The Philippine Congress also passed RA 9729 otherwise known as The Climate Change Act of 2009. This law aims to mainstream climate change into the formulation of government policy by setting up a National Framework Strategy and Program on Climate Change. It has also created the Climate Change Commission (CCC) which is tasked with the coordination, monitoring and evaluation of the programs and actions of the government in order to mitigate and adapt to the effects of climate change.

Other recent DRM-related initiatives have been conducted in the Philippines. On June 7 2010, Executive Order No. 888 was signed, adopting the Strategic National

Action Plan (SNAP) for the years 2009 to 2019. The SNAP serves as the road map for the Philippines to strategically implement disaster risk reduction (DRR) programs and projects both at the national and local levels. Furthermore, the SNAP contains a strategy that focuses on safety and well-being enhancements that aims to increase capacity, reduce vulnerability, and achieve improved public safety and well-being and build resilience to disasters in the country.

Administrative Order No. 1 Series of 2010 was also issued directing the local government units (LGUs) to adopt and use the DRR Guidelines to enhance natural disaster risk reduction efforts in the local development planning process. The National Economic and Development Authority (NEDA) is directed to conduct capacity-building activities for planning offices at local, regional and national levels towards DRR Guidelines. Moreover, the NDRRMC and the CCC have signed a Memorandum of Understanding (MOU) to harmonize the Local Climate Change Action Plans (LCCAP) and the Local Disaster Risk Reduction Management Plans (LDRRMP) by local government units (LGUs).

5.2 Regional participation in disaster risk management

At the level of the Association of Southeast Asian Nations (ASEAN), the Philippine Senate ratified the ASEAN Agreement on Disaster Management and Emergency Response (AADMER) in September 2009. AADMER binds member states together to promote regional cooperation and collaboration in reducing disaster losses and intensifying joint emergency response to disasters in the ASEAN region. It contains provisions on disaster risk identification, monitoring and early warning systems, prevention and mitigation, preparedness and response, rehabilitation, technical cooperation and research, mechanisms for coordination, simplified customs and immigration.

The Philippines is also an active member of the ASEAN Committee on Disaster Management (ACDM). At present, the regional cooperation is underway to fully establish an operational ASEAN Coordinating Centre for Humanitarian Assistance in disaster management (AHA Centre), as mandated by AADMER. Simultaneously, under the AADMER Work Programme 2010-2015, regional systems for risk identification and assessment, early warning, and monitoring systems are in the process of being established by the ACDM.

Furthermore, the PAGASA has collaborated with the Asian Disaster Preparedness Center (ADPC) and Regional Integrated Multi-Hazard Early warning System for Africa and Asia (RIMES) as well as with neighboring countries with respect to typhoon monitoring. The Philippine Institute of Volcanology and Seismology (PHIVOLCS) is also already a part of the tsunami warning system for the Pacific region.

5.3 Constraints and issues facing disaster risk management

The following are the constraints and issues facing the DRM in the Philippines as identified by the government (NDRRMC 2011): a) ineffective vertical and horizontal coordination among its member agencies; b) existing DRM efforts of governmental and partner organizations are still limited in coverage due to limited available resources; c) ineffective institutional capacities of LGUs such as the lack of managerial and technical competencies; d) limited funds, equipment and facilities for monitoring and early warning; e) Insufficient hazard and disaster risk data and information; f) inadequate mainstreaming of DRM in development planning and implementation; g) poor enforcement of environmental management laws and regulations, and other relevant regulations; and h) inadequate socioeconomic and environmental management programs to reduce the vulnerability of marginalized communities. Overall, the current state of the DRM in the Philippines has been rated as low to very low in the ladder of accomplishments and progress in implementation.

6. Results and analysis

6.1 Occurrence of typhoons

From 2001 to 2010, the country had a total of 184 typhoons; an average of 18 typhoons per year (Table 2). The occurrence of typhoons nationally had been generally erratic, increasing in some years and decreasing or remaining constant in others. On a yearly basis, the most number of typhoons occurred in 2003 and 2004 at 25 and the least in 2010 at 11.

Table 2: Number of occurrences of typhoons in the Philippines, by region, 2001-2010

Region	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	Total	Ave
National Capital Region	4	2	2	6	1	5	2	3	4	2	31	3
II - Cagayan Valley	9	5	11	9	9	11	8	11	12	4	89	9
III - Central Luzon	8	4	9	8	5	9	6	10	9	3	71	7
IVA – CALABARZON	7	3	4	10	4	9	4	6	7	2	56	6
IV-B – MIMAROPA	9	5	7	9	3	5	3	9	4	2	56	6
V - Bicol Region	8	5	10	7	6	10	4	6	4	1	61	6
VI - Western Visayas	2	1	3	4	2	5	2	6	1	0	26	3
VII - Central Visayas	4	1	5	6	2	4	1	6	3	0	32	3
VIII - Eastern Visayas	5	5	9	7	3	6	2	7	6	0	50	5
IX -Zamboanga Peninsula	1	0	0	0	0	0	0	1	0	0	2	0
X - Northern Mindanao	3	3	0	2	1	1	1	3	2	0	16	2
XI - Southern Mindanao	1	1	0	1	0	0	0	2	0	0	5	0
XII - Central Mindanao	0	0	0	0	0	0	0	1	0	0	1	0
XIII - Caraga	4	5	4	4	1	5	1	5	3	0	32	3
CAR	**7**	**4**	**11**	**7**	**7**	**6**	**5**	**10**	**10**	**3**	**70**	**7**
ARMM	1	0	0	0	0	0	0	1	0	0	2	0
National	17	13	25	25	17	20	13	21	22	11	184	18

Note: The typhoons include those with assigned signal numbers by PAGASA.
Source of data: PAGASA

Regionally, from 2001 to 2010, the highest number of typhoons in the Philippines occurred in Luzon, with Cagayan Valley topping the list. Luzon was followed by the Visayas and the CARAGA region in Mindanao. Mindanao regions except CARAGA had the least number of typhoon occurrences. The World Bank Group (2011) stated that while the trends in the occurrence of typhoons in the Philippines in the future are still a subject of much debate, they are likely to increase in intensity, and with greater consequent damage.

6.2 Occurrence of floods

Flooding occurred yearly in the Philippines from 2007 to 2011 (Table 3). More regions were affected by floods in 2008, followed by 2011, 2007, 2009, and 2010. On a regional and annual basis, the region most often visited by floods was Region VI while those with no incidence of floods included CAR, Region I, Region IV-A, and Region VII. The World Bank Group (2011) stated that over time in the Philippines, heavy rainfall associated with typhoons and other weather systems may increase in both intensity and frequency under a changing climate and exacerbate the incidence of flooding in existing flood-prone areas and introduce a risk of flooding to new areas.

Table 3: Regions affected by floods in the Philippines, 2007-2011

Region	2007	2008	2009	2010	2011
CAR	-	-	-	-	-
Region I	-	-	-	-	-
Region II	-	✓	-	✓	✓
Region III	-	✓	-	✓	-
Region IV-A	-	-	-	-	-
Region IV-B	-	✓	-	✓	✓
Region V	✓	✓	✓	-	✓
Region VI	✓	✓	✓	✓	✓
Region VII	-	-	✓	-	-
Region VIII	✓	✓	✓	-	✓
Region IX	✓	✓	-	-	✓
Region X	✓	✓	✓	-	✓
Region XI	✓	✓	✓	-	✓
Region XII	✓	✓	✓	-	-
CARAGA	✓	✓	✓	-	✓
ARMM	-	✓	✓	-	-

Source of data: DA

6.3 Occurrence of droughts

During the 2007 to 2011 period, droughts occurred in the Philippines only in 2007 and 2010 (Table 4). More regions in 2010 were affected by droughts than in 2007. In 2007, all regions in Luzon except Region IV-A and Region VI were affected while no regions in the Visayas and Mindanao were affected. In 2010, on the other hand, most regions in Luzon, Visayas and Mindanao were affected except CAR, Region VII, Region VIII, and CARAGA. The World Bank Group (2011) reported that prolonged droughts are associated with the El Niño phenomenon and that these natural events will likely intensify in the future in the Philippines.

6.4 Impacts of natural disasters on agriculture: descriptive analysis

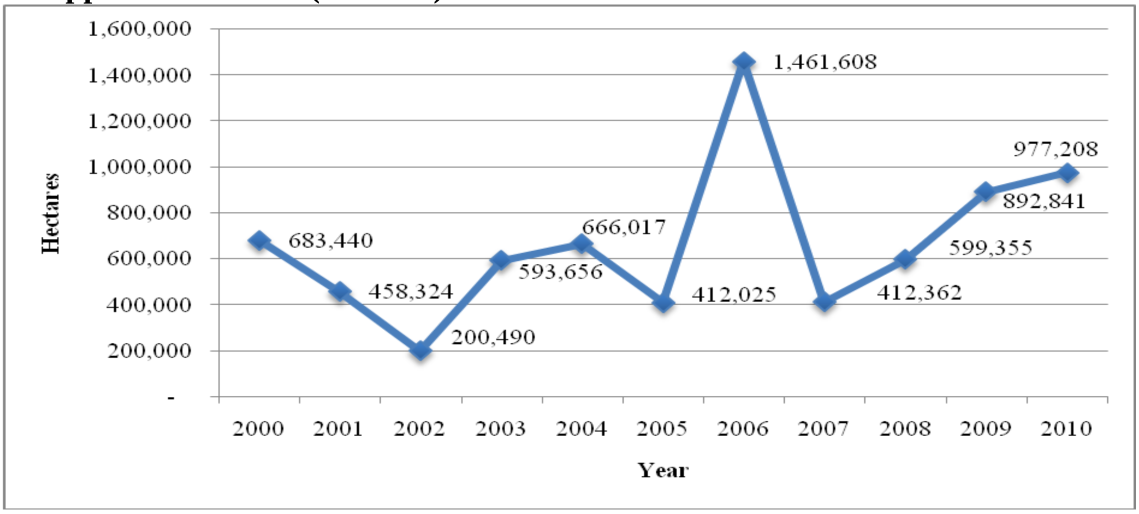
From 2000 to 2010, the national agricultural area affected by typhoons, floods and droughts in the Philippines has been trending upwards. The total area increased from 683,440 hectares in 2000 to 977,208 hectares in 2010 (Figure 2). The affected area was at its lowest in 2002 at 200,940 hectares and at its highest in 2006 at 1,461,608 hectares. There are neither available data at the regional nor the provincial levels with respect to the agricultural area affected by typhoons, floods and droughts.

Table 4: Regions affected by droughts in the Philippines, 2007-2011

Region	2007	2008	2009	2010	2011
CAR	✓	-	-	-	-
Region I	✓	-	-	✓	-
Region II	✓	-	-	✓	-
Region III	✓	-	-	✓	-
Region IV-A	-	-	-	✓	-
Region IV-B	✓	-	-	✓	-
Region V	✓	-	-	✓	-
Region VI	-	-	-	✓	-
Region VII	-	-	-	-	-
Region VIII	-	-	-	-	-
Region IX	-	-	-	✓	-
Region X	-	-	-	✓	-
Region XI	-	-	-	✓	-
Region XII	-	-	-	✓	-
CARAGA	-	-	-	-	-
ARMM	-	-	-	✓	-

Source of data: DA

Figure 2: Total agricultural area affected by typhoons, floods and droughts in the Philippines 2000-2010 (hectares)



Source of data: DA

There are few available economic studies which have investigated the effects of typhoons, floods and droughts on agriculture in the Philippines. Thus, most of the variables representing both positive and negative impacts of said disasters based on the framework of analysis presented earlier cannot be discussed at length in this paper. Of the available literature, one study (Medina et al. 2009) stated that the flashfloods and mudflows that result from heavy torrential rains in November 2004, particularly in the towns of Real, Infanta and General Nakar in Quezon Province, in addition to Dingalan in Aurora Province, resulted in 300,000 hectares of prime agricultural land, mainly lowland rice cultivation land, being seriously affected. In another study, Godilano (2004) identified 790,000 hectares in the Philippines which are potential sites for natural disasters and asserted that approximately 80 percent of these areas fell under the jurisdiction of the agriculture sector.

From 2000 to 2010, the total value of agricultural damage, by commodity, affected by typhoons, floods and droughts in the Philippines amounted to a total of P106,882.70 million (Table 5). The crops with the most damage were rice, corn and high value cash crops. Other commodities recording damage included vegetables, coconut, abaca, sugarcane, tobacco, fisheries products, and livestock. While generally increasing, the total damage to agriculture decreased from 2000 to 2002, increased in 2003 to 2004, fell in 2005, rose in 2006, declined in 2007, increased in 2008 and 2009, and decreased again in 2010. The total damage to agriculture due to typhoons, floods and droughts were lowest in 2002 and highest in 2009.

Table 5: Total value of damage to agriculture due to typhoons, floods and droughts in the Philippines, by commodity, 2000-2010 (million pesos)

Year	Rice	Corn	HVCC	Vege-tables	Coconut	Abaca	Sugar-cane	Tobac-co	Fisher-ies	Live-stock	Total
2000	1,594.87	57.6	352.03	90.79	47.17	54.28	40.8	40.8	358.04	7.77	2,644.15
2001	805.06	546.14	359.04	65.1	0.23	0.33	73.97	0	255.34	94.75	2,199.96
2002	548.35	330.35	115.08	12.13	0.05	0	0	0	127.49	16.06	1,149.51
2003	1,320.09	1,696.12	424.31	123.99	1.01	0.36	0	0	241.97	49.04	3,856.89
2004	1,698.19	1,436.24	1,155.43	737.9	439.18	17.12	0	142.29	1,905.77	43.92	7,576.04
2005	1,942.25	2,446.15	32.41	19.8	0	0	0	0	6.12	0.43	4,447.16
2006	3,400.96	1,178.78	3,178.19	233.17	1,115.29	326.49	0	275.43	1,080.56	223.3	11,012.17
2007	1,881.88	2,783.03	376.47	177.61	0.03	0	0	0	88.72	2.92	5,310.66
2008	5,015.26	1,805.75	2,282.51	0	1,133.21	12.27	36.24	0	3,152.31	245.75	13,683.30
2009	23,842.20	1,417.58	2,504.23	0	0	64.11	0	4.9	1,597.27	88.22	29,518.51
2010	15,559.07	8,486.37	1,108.11	0	0	0	0	0	302.82	27.98	25,484.35
Total	57,608.18	22,184.11	11,887.81	1,460.49	2,736.17	474.96	151.01	463.42	9,116.41	800.14	106,882.70

Source of data: DA

Aside from agricultural commodities, agricultural facilities and irrigation incurred damage due to typhoons, floods and droughts. Damage incurred from 2000 to 2010 for agricultural facilities was valued at P4,990 million while those for irrigation were estimated at P9,739 million (Table 6). The highest level of damage for agricultural facilities occurred in 2008 while that for irrigation occurred in 2009. There was no recorded damage in 2005. There were no regional and provincial data on damage to agricultural facilities and irrigation.

Nationally, NEDA (2008) assessed the direct damage due to natural disasters and found that the average cost of direct damage from natural disasters from 1970 to 2006 to be P15 billion at 2000 prices, including the damage to agricultural crops, public infrastructure and private homes. GOP (2009) estimated the impacts of typhoons

Ondoy (Ketsana) and Pepeng (Parma) which hit several parts of Philippines within a span of two weeks in September and October 2009. The typhoons and the floods they caused created havoc in both the urban and rural parts of northern Luzon, particularly affecting Regions I, CAR, II, III, NCR and IVA. The study estimated that these typhoons resulted in approximately P36.2 billion in immediate damage to the agriculture, fisheries, and forestry sectors in the typhoon-affected areas of the Philippines.

Table 6: Total value of damage to agricultural facilities and irrigation due to typhoons, floods and droughts in the Philippines, 2000-2010 (million pesos)

Year	Agricultural Facilities	Irrigation
2000	0.23	0.23
2001	880.21	880.21
2002	31.35	31.35
2003	11.66	11.66
2004	636.13	636.13
2005	0.00	0.00
2006	1,287.17	1,287.17
2007	4.87	4.87
2008	1,865.42	1,697.50
2009	194.85	3,855.56
2010	77.82	1,334.59
Total	4,990.00	9,739.00

Source of data: DA

6.5 Impacts of natural disasters on agriculture: econometric analysis

In this section, the impacts of agricultural damage or losses due to natural disasters by commodity are estimated using AMPLE. As mentioned earlier, this model is capable of simulating changes in quantities of supply, imports, consumption, and exports, together with producer and consumer prices for 18 commodities. The baseline data used in the estimation is a 3-year average for the 2008 – 2010 period. In this study, AMPLE is used to simulate a counter-factual scenario in which crop losses arising from disasters are avoided at two different levels: a) complete or 100 percent avoidance and b) 50 percent avoidance. The differences between the counter-factual scenario and baseline data are the estimated impacts of natural disasters. Crop losses are measured as a percent of output in volume (metric tons) and, where this was not available, this was proxied by cost of production (Pesos) or area affected (hectares); whichever was possible based on data availability (Table 7).The crop loss counter-factual is assumed to cause an exogenous, proportional supply shift, the size of which is stated in Table 7.

Table 7: Average losses as a percent of output or area measure in the Philippines, by commodity (1995-2010)

Item	Annual Average loss	Annual Average Production/Cost of Production/Area	Loss (%)
Rice (Production in M.T.)	570,531	13,441,901	4.2
Corn (Production in M.T.)	305,690	5,175,980	5.9
HVCC (Cost in million P)	2,801	94,267	3.0
Vegetables (Cost in million P)	202	63,721	0.3
Coconut (Cost in million P)	562	49,473	0.1
Sugarcane (Area in Ha.)	7,097	373,442	1.9
Banana (Cost in Million P)	84	46,066	0.2
Mango (Area in Ha.)	1,750	152,066	1.2
Fisheries (Cost in Million P)	619	47,655,202	0.0
Livestock (Cost in Million P)	90	139,560	0.0

Source of Data: Department of Agriculture

The results of running the counter-factual using AMPLE are shown in Tables 8 and 9, showing changes in quantity and price respectively. Since the losses as a proportion of output are small, it is not surprising that changes in quantity of output, imports, exports, and also that of prices, are commensurately minor. There are few large changes in percentage terms, but this is only due to a small base, e.g. cassava output and consumption. Thus, based on these results, it is argued that agricultural damage or losses have insignificant impacts on agricultural production and prices at the national level. The result appears to support the notion that natural disasters have little bearing when the production of the agriculture sector at the national level is taken into consideration.

It should be pointed out that the figures shown in Tables 8 and 9 may alternatively be viewed as a variation of the elasticity concept because the shocks are also stated in percentage changes (in this case, 100 percent and 50 percent reduction in crop losses). Unlike standard elasticities which are evaluated along a given functional relationship (e.g. a supply or demand function), however, the figures generated here may be seen as comparative static elasticities which take into account the entire set of market interactions.

Table 8: Changes in quantity by commodity and supply-demand component (%)

Item	Complete reduction				50 percent reduction			
	Output	Import	Export	Demand	Output	Import	Export	Demand
Rice	1.7	0.1	1.7	1.1	0.1	0.9	0.1	0.4
White corn	4.2	Na	na	4.2	1.9	Na	na	1.9
Yellow corn	2.9	-21.4	19	na	1.8	-8.6	7.8	na
Coconut	1.1	Na	0.9	1.5	2.7	na	3.7	1.2
Sugar	1.7	-5.7	2.1	1.6	0.8	-3.5	1.1	0.8
Banana	2.3	Na	9.1	0.8	0.4	na	1.8	0.1
Mango	0.7	na	3.1	0.5	0.3	na	1.7	0.2
Other fruit	2.6	0	5.3	1.6	0.2	0	-0.9	0.6
Cassava	7.1	8.3	-9.8	8.6	6.1	7	-8.4	7.3
Vegetables	1.5	1.6	-1.4	1.5	0.8	0.9	-1	0.8
Poultry	0.5	2	-1.4	1.6	0.6	2.4	-1.6	1.9
Swine	0.1	0.5	na	0.1	0.1	0.3	na	0.1
Other livestock	0.1	0.2	0	0.1	-0.4	-1.6	0	-0.7
Freshwater fish	-2.5	na	na	-2.5	-1.8	na	na	-1.8
Brackish-water fish	-4.5	-20.7	-3.6	-4.5	-3.2	-15.1	-2.6	-3.2
Seaweed	0	na	0	na	0	na	0	na
Marine fish	1	3.4	-3	1.1	0.6	2.1	-1.9	0.7

Note: Demand denotes household food consumption; "na" or not applicable denotes items of negligible quantity.

Table 9: Changes in price by commodity and market level (%)

Item	Complete reduction		50 percent reduction	
	Producer	Consumer	Producer	Consumer
Rice	-0.4	-0.3	0.2	0.1
White corn	-7.9	-7.9	-4.9	-4.9
Yellow corn	-7.0	na	-2.9	na
Coconut	0.0	0.1	-0.2	-0.5
Sugar	-3.6	-3.6	-2.1	-2.1
Banana	-1.3	-1.6	-0.3	-0.3
Mango	-0.5	-0.5	-0.3	-0.3
Other fruit	-0.5	-0.7	0.2	0.3
Cassava	9.0	8.7	7.6	7.4
Vegetables	1.5	1.3	0.9	0.9
Poultry	1.0	0.3	1.1	0.3
Swine	0.2	0.2	0.1	0.1
Other livestock	0.1	0.1	-0.9	-0.7
Freshwater fish	-7.9	-7.9	-5.8	-5.8
Brackishwater fish	-8.7	-8.9	-6.3	-6.4
Seaweed	0.0	Na	0	na
Marine fish	2.0	2.1	1.3	1.3

6.6 Impacts of natural disasters on rice farming: descriptive analysis

From 2007 to 2011, the total monetary value of damage to rice farming due to typhoons in the Philippines amounted to P49,005.73 million (Table 10). The damage increased in 2008 and 2009, decreased in 2010 and rose again in 2011. Regionally, during the same period, the highest level of damage occurred in Region III while the lowest was in the CARAGA region. Region XI did not register any damage to rice farming due to typhoons during the period. There are no available data at the provincial level.

From 2007 to 2011, the total value of damage to rice farming due to floods in the Philippines amounted to P5,181.99 million (Table 11). The damage increased in 2008, decreased in 2009, rose in 2010 and fell in 2011. Regionally, the highest level of damage occurred in Region II while the lowest was in Region VII. CAR, Region I and

Region IV-A did not register any damage to rice farming due to floods during the period. There are presently no available data at the provincial level.

Table 10: Value of damage to rice farming due to typhoons in the Philippines, by region, 2007-2011 (million pesos)

Region	2007	2008	2009	2010	2011	Total
Philippines	979.76	2,955.09	23,092.13	4,959.39	17,019.36	49,005.73
CAR	70.51	15.20	1,280.43	722.94	343.79	2,432.87
Region I	33.54	197.30	7,369.73	179.69	603.09	8,383.34
Region II	455.48	784.11	3,118.44	2,276.61	3,123.05	9,757.69
Region III	282.12	231.23	8,403.87	1,751.87	9,730.56	20,399.65
Region IV-A	-	22.27	919.50	11.91	136.49	1,090.17
Region IV-B	54.33	94.89	413.31	13.53	663.10	1,239.17
Region V	70.03	1.36	1,581.00	2.84	1,837.18	3,492.41
Region VI	0.33	1,068.71	0.17	-	2.51	1,071.71
Region VII	13.10	1.34	-	-	-	14.43
Region VIII	-	28.60	4.41	-	-	33.01
Region IX	-	109.56	0.37	-	-	109.94
Region X	0.01	-	0.90	-	28.46	29.38
Region XI	-	-	-	-	9.70	9.70
Region XII	-	176.02	-	-	318.23	494.25
Caraga	0.31	-	-	-	0.02	0.33
ARMM	-	224.49	-	-	222.79	447.28

Note: - means 0.
Source of data: DA

From 2007 to 2011, the total value of damage to rice farming due to droughts in the Philippines amounted to P9,826.76 million (Table 12). The damage increased in 2008 and 2009, increased in 2010, and fell again in 2011. Regionally, the highest level of damage occurred in Region II while the lowest was in Region IX. CAR, Region VII, Region VIII and the CARAGA Region did not register any damage to rice farming due to droughts during the 2007-2011 period. There are no available data at the provincial level.

Table 11: Value of damages to rice farming due to floods in the Philippines, by Region, 2007-2011 (in million pesos)

Region	2007	2008	2009	2010	2011	Total
Philippines	243.38	1,896.52	739.31	1,398.24	904.54	5,181.99
CAR	-	-	-	-	-	-
Region I	-	-	-	-	-	-
Region II	-	252.61	-	1,151.11	80.20	1,483.92
Region III	-	7.24	-	22.22	-	29.46
Region IV-A	-	-	-	-	-	-
Region IV-B	-	36.91	-	120.96	38.58	196.45
Region V	38.35	779.23	108.99	-	144.13	1,070.70
Region VI	78.30	219.99	85.82	103.95	55.04	543.10
Region VII	-	-	0.13	-	-	0.13
Region VIII	28.43	256.44	4.34	-	413.44	702.64
Region IX	0.31	171.40	-	-	68.66	240.37
Region X	1.35	0.29	8.16	-	37.18	46.97
Region XI	45.95	1.23	21.34	-	31.93	100.46
Region XII	26.89	36.92	239.15	-	-	302.96
Caraga	23.82	78.34	145.66	-	35.38	283.20
ARMM	-	55.92	125.72	-	-	181.63

Note: - means 0.
Source of data: DA

6.7 Impacts of typhoons on rice farming: econometric analysis

Data on the occurrence of typhoons at the provincial level in the Philippines between the years 2001 and 2010 are available and together with provincial data on palay (unprocessed rice) production and palay prices, a regression analysis was conducted to assess the impact of typhoons on provincial rice production. The first deterministic equation employed is as follows:

$$QS_{i,t} = \beta_0 + \beta_1 QS_{i,t-1} + \beta_2 p_{i,t-1} + \beta_3 typh_{i,t} + \beta_4 t$$

Where i, t are indices for the provinces and years covered, respectively; QS denotes palay output; p denotes palay price; $typh$ denotes number of typhoons; t denotes technological change and the β's denote coefficients. Effectively, the aforementioned is a supply equation incorporating response lags for output and price; the t incorporates technological change. Of interest is the coefficient β_4, which shows the effect of typhoons on quantity of provincial palay production. Given the panel nature of the data for 2001-2010, both the random and fixed effects regressions were estimated (Table 13).

Table 12: Value of damages to rice farming due to droughts in the Philippines, by region, 2007-2011 (million pesos)

Region	2007	2008	2009	2010	2011	2007-2011
Philippines	638.80	-	-	9,187.97	-	9,826.76
CAR	73.15	-	-	-	-	73.15
Region I	77.68	-	-	161.21	-	238.89
Region II	388.87	-	-	3,353.11	-	3,741.99
Region III	53.11	-	-	845.17	-	898.28
Region IV-A	-	-	-	503.25	-	503.25
Region IV-B	26.51	-	-	1,076.58	-	1,103.09
Region V	19.47	-	-	777.26	-	796.73
Region VI	-	-	-	1,476.55	-	1,476.55
Region VII	-	-	-	-	-	-
Region VIII	-	-	-	-	-	-
Region IX	-	-	-	21.52	-	21.52
Region X	-	-	-	203.61	-	203.61
Region XI	-	-	-	80.31	-	80.31
Region XII	-	-	-	636.46	-	636.46
Caraga	-	-	-	-	-	-
ARMM	-	-	-	52.93	-	52.93

Note: - means 0.
Source of data: DA

Under the random effects regression, the coefficient for number of typhoons is negative and significant at the 1 to 5 percent level. Each typhoon, on average, controlling for other supply conditions, reduces provincial output by over one thousand tons of palay. Under the fixed effects regression, on the other hand, the coefficient for the number of typhoons is insignificant even at the 1 to 5 percent level. Nonetheless, the results particularly those based on the assumption of random effects indicate that at the provincial level, typhoons have significant and negative impacts on palay production which appears to be consistent with past studies (Loayza et al., 2009, Sivakumar, 2005).

Table 13: Results of panel regression on provincial palay production in the Philippines

	Random effects		Fixed effects	
	Coefficient	z-value	Coefficient	t-value
Lagged quantity	1.02**	171.7	0.6**	17.6
Lagged price	-3,006.7*	-2.5	-4,224.1**	-2.9
Number of typhoons	-1.111.1*	-1.8	-409.1	0.6
Year	964.1	1.02	4,915**	4.6
Constant	-1,897,108	-1.02	-,728,307**	-4.6

Note: *means t-value or z-value is between 0.01 to 0.05 level of significance and **means t-value or z-value is below 0.01 level of significance.

Another alternative equation is estimated to take typhoon intensity into account. The deterministic form the equation is as follows:

$$QS_{i,t} = \beta_0 + \beta_1 A_{i,t} + \beta_2 p_{i,t-1} + \beta_3 typh2_{i,t} + \beta_4 typh3i,t + \beta_5 t$$

where *A* is a control variable for level of production input, *p* denotes paddy price averaged over the last quarter of the year, *typh2* denotes a dummy variable for incidence of at least one typhoon with an intensity of signal number 2 or more*; typh3* denotes a dummy variable for incidence of at least one typhoon with an intensity of signal number 3 or more and the other variables are defined as before. The dummy variable representation of typhoons specified above places greater emphasis on intensity of typhoons (a higher signal number denoting higher intensity) rather than the simple incidence or number of typhoons hitting a particular province in a particular year. Effectively, the aforementioned is a supply equation incorporating response lags for price, together with a control variable for level of production input (in this case reduced to land). The lagged last quarter price is used based on adaptive expectations, i.e. the farmer uses the previous quarter's price as an estimate of the current cropping season price, as a basis for planting decisions. Of interest is the coefficients β_3 and β_4 which show the effect of typhoons on quantity of provincial palay production. Again, given the panel nature of the data for the period 2001-2010, both random and fixed effects regressions were estimated (Table 14).

Table 14: Results of panel regression on provincial palay Production in the Philippines

	Random effects		Fixed effects	
	Coefficient	z-value	Coefficient	t-value
Area	0.0**	2.80	0.0**	3.17
Lagged last quarter price	-3.6**	-5.26	-3.5.**	-5.13
Dummy: Signal 2	-8.3*	-2.11	-8.4*	-2.13
Dummy: Signal 3	6.7	1.65	6.6	1.63
Year	7.0**	11.12	6.9**	10.89
Constant	-13,843.5**	-11.02	-3,597.9**	-10.79

Note: *means t-value or z-value is between 0.01 to 0.05 level of significance and ** means t-value or z-value is below 0.01 level of significance.

Under the random effects regression, the coefficient for signal number 2 dummy is negative and significant at the 1 to 5 percent level. This implies that the incidence of at least one typhoon with an intensity of signal number 2 or more, controlling for other supply conditions, reduces provincial output by over eight thousand tons of palay. Similar results are obtained under the fixed-effects regression. Somewhat anomalous is the sign of the coefficient for signal number 3 dummy for either regression method although the coefficients are not significant. These results again indicate that, at the provincial level, typhoons have significant and negative impacts on palay production.

6.8 Impacts of natural disasters on food security

It was indicated in the foregoing analysis that at the national level, typhoons, floods and droughts do not significantly impact agricultural production and prices. Hence, based on food affordability alone, these disasters may have little effect on food security at that level. On the other hand, it was also estimated beforehand that typhoons have a significant and negative effect on rice production at the provincial level. Therefore, based on rice availability alone, typhoons may have diminished food security at that level.

At present, there is a paucity of research actually quantifying the impacts of natural disasters on food security in the Philippines. An exception is the WFP (2009) which conducted a study on typhoons Ondoy (Ketsana) and Pepeng (Parma) including their impacts on food security at the household level. The study found that as a coping strategy to adapt to the effects of Ondoy and Pepeng, the most frequently reported consumption coping mechanism, used by 79 percent of the households surveyed, was to rely less on preferred or expensive food (Table 15). The least used consumption coping strategy, adopted by 5 percent of the households, was sending family members outside for food. On the other hand, the most common non-consumption coping mechanism, used by 15.1 percent of households, was selling labor in advance, while the least utilized was the selling of household and agricultural assets for food, a mechanism used by just 5.2 percent of households.

The aforementioned indicate that, particularly at the household level, natural disasters may have a significant impact on food security. They also show that households differ in their consumption and non-consumption strategies to cope with their difficult situation. They further indicate that non-consumption strategies were practiced by households, although not as commonly as consumption strategies.

6.9 Impacts of natural disasters on the natural resources and environment

Limited available data and information also preclude a quantitative evaluation of the negative impacts of natural disasters on the natural resources and the environment of the Philippines. Thus, a descriptive and generally qualitative assessment is instead conducted below based on past research.

6.9.1 Soil erosion

The water-related natural factors that influence the rate of soil erosion are rainfall, vegetative cover, slope of the land, and soil erodibility (Asio et al., 2009). Due to its wet tropical climate, the Philippines has a comparatively high average annual rainfall. It also has a rugged and mountainous topography with large sections having a gradient of more than 18 percent. These and other natural factors such as wind, and man-made factors such as slash and burn agriculture, all contribute to soil erosion. The little available evidence on the actual impact of natural disasters on soil erosion in the Philippines is site-specific and anecdotal. In particular, Medina et al. (2009) mentioned that in 2004, flashfloods and mudflows resulting from heavy torrential rains induced mountain soil erosion, landslides and the overflowing of river systems in the provinces of Quezon and Aurora in Luzon.

Table 15: Consumption and non-consumption negative coping strategies adopted by households affected by typhoons Ondoy and Pepeng, 2009 (% of households)

Coping Strategies	Northern regions (I, CAR, II)	Region III	NCR	Region IV-A	Overall
Consumption coping strategies					
Eating less preferred food	42	95	94	82	79
Borrowing food from neighbours/friends	44	33	55	34	37
Buying food on credit	53	46	50	54	51
Eating wild/gathered food	45	39	10	21	33
Reducing meal portions	31	34	32	50	39
Reducing number of meals by children	4	10	33	16	12
Reducing number of meals by adults	13	45	46	35	34
Skipping meals for the whole day	7	20	26	13	15
Sending family members outside for food	3	2	15	9	5
Non Consumption Coping Strategies					
Out-migration	5.2	4.3	18.2	15.3	9.1
Selling Labour in Advance	18.5	2.4	26.3	23.4	15.1
Taking children out of school	2.2	0.5	20.6	10.7	5.7
Selling of household assets for food		1.0	13.3	12.8	5.2
Selling Agricultural Assets for food	10.4	5.3		2.5	5.2

Source: WFP (2009)

6.9.2 Reduced rainfall

Typhoons increase rainfall while droughts decrease it, but on the net it has been projected that there will be decreases in the average annual rainfall by the year 2020 in most parts of the Philippines, except in Luzon where either an increase or no change in rainfall is projected (MO-COMSTE, 2010) It was also foreseen that by 2050, Visayas and Mindanao will be drier than normal, as will most of the western part of Luzon. Clearly then, typhoons may increase rainfall at the times they occur and places they affect, but over time and for the country as a whole, average rainfall is expected to decrease. An important water resources-related negative effect of reduced rainfall is a concomitant reduction in the country's hydropower supply.

6.9.3 Siltation and sedimentation

Silts and sediments caused by floods tend to clog rivers, lakes, drainage systems, reservoirs, dams, irrigation canals and other inland water bodies. This in turn reduces the viability of these water resources for economic activities such as fishing, aquaculture, water storage, irrigation, water recreation, water transportation and many others. Similarly, siltation and sedimentation of coastal areas damage mangroves, coral reefs, sea grasses, estuaries, beaches and other marine ecosystems, rendering them less viable as providers of ecosystem goods and services for the population.

No study, however, has quantified the impacts of floods in terms of inland and coastal siltation and sedimentation in the Philippines, although the impacts of siltation and sedimentation have been investigated. GOP (2009a) mentioned that the existing infrastructure that protects Manila and other populated areas in nearby Laguna Lake has been inadequate and has not been properly maintained. As a result, the siltation and sedimentation and other unwelcome impacts of the floods generated by Ondoy in 2009 had severe consequences for people living near the Marikina River and adjacent areas.

6.9.4 Reduced tree and vegetative cover

Because of the strong winds and water currents they carry, typhoons and floods typically flatten or uproot trees. The siltation and sedimentation produced by floods also cover grasslands and other ground-level and below-water vegetation. In a similar vein, because of the length of time that it is exposed to intense sunlight, ground vegetation withers or dies during droughts. No study has quantitatively measured the effects of typhoons, floods and droughts on trees and other vegetation in the Philippines. Mjoes (2005) mentioned that in 2004, the Philippines experienced two typhoons and two tropical storms which resulted in considerable damage including a significant number of trees being brought down.

6.9.5 Reduced soil fertility

Droughts reduce soil fertility because higher temperatures reduce soil moisture, water storage capacity and overall soil quality. There is also no study that has quantified the effects of droughts on soil fertility in the Philippines. Mitin (2009) mentioned that Ilocos Norte was one of the provinces worst hit by the drought in Northern Luzon in 2007 along with Ilocos Sur, La Union and Pangasinan. It further explained that before the dry spell hit, Ilocos Norte in particular had high sufficiency levels of rice, corn, garlic, and onions.

6.9.6 Accumulation of wastes and water pollution

Flood water currents carry all sorts of wastes that are then dumped into catchment areas. These wastes in turn pollute surface and ground water, including that used for drinking and sanitation. There is also no available study at present that quantifies the impact of floods on waste accumulation and water pollution in the Philippines. ADPC (2008) stated that while the riverbanks in Marikina City, Metro Manila used to be a site of religious celebrations in the past the river has been seen only as a site of filth and stench at present. Uncontrolled encroachment on the riverbanks by informal settlers, structures within the river, and the indiscriminate disposal of both domestic and industrial wastes have worsened the impacts of annual flooding from the Marikina River. GOP (201) also mentioned that about 50 percent of the wells monitored by the Environmental Management Bureau (EMB) in 2005 were found to be contaminated with fecal coli forms and that Regions II and Region VI, which were seasonally-arid and drought-prone areas, had the highest number of contaminated sites.

6.9.7 Saltwater intrusion

Demand for freshwater during periods of drought is higher than normal and this in turn may lead to higher rates of groundwater withdrawal. If the withdrawal rate is faster than the replenishment rate in a coastal area, seawater may be pulled into the freshwater aquifer resulting in the increased salinity of the groundwater. On a more temporary scale, high tides and storm surges caused by typhoons may also cause saltwater intrusion. The World Bank Group (2011) mentioned that during El Niño events, among the significant pressures on the freshwater resources in the coastal areas of the Philippines is saltwater intrusion. Citing past studies, GOP (2010) reported that saltwater intrusion in the country was evident in nearly 28 percent of coastal municipalities in Luzon, 20 percent in the Visayas and 29 percent in Mindanao.

6.9.8 Higher coastal tides and storm surges

Floods and typhoons bring in a lot of rain that may raise coastal tides beyond normal levels, whilst strong winds from typhoons potentially drive huge wave surges into the coastal areas.. The effects of rising coastal tides and strong storm surges have been devastating at times to people residing close to the water's edge. The World Bank Group (2011) stated that the Philippines is particularly vulnerable to rises in sea level and storm surges as about 60 percent of its municipalities and 10 of its largest cities are located along the coasts. Four Philippine cities also ranked among the top 10 East Asian cities likely to be affected by sea level rises and storm surges. In particular areas, it has been projected that a 1.0 meter rise in sea level will inundate more than 5,000 hectares of land in 19 municipalities of Manila, Bulacan and Cavite (Capili et al., 2005). The worst-case scenario of a 2.0 meter rise is expected to aggravate riverine flooding in most of the tributaries of Manila Bay, especially the Pampanga and Pasig rivers.

6.9.9 Deformed land topography

Below water level, floods deposit silts and sediments, thus raising the elevation of the soil beds and making the affected rivers and water bodies shallower than before. Above ground, floods level land areas and reduce their economic and aesthetic value. Because they deposit so much soil both under water and on land,, floods elevate the level of the soil, thus requiring substantial excavation or dredging to bring the area back to its original state. There has been no study conducted in the Philippines that quantitatively evaluates the impacts of floods on the land topography and the subsequent effects on land value.

6.9.10 Reduced viability of ecosystems

Typhoons, floods and droughts also constitute a threat to the health and survival of forests and other terrestrial ecosystems. It has been projected, for instance, that if the climate projections showing drier conditions in most regions of the Philippines actually materialize, the size of dry forests will decrease (MO-COMSTE, 2010). In line with this loss of forest cover will be the loss of existing and possibly yet to be discovered flora and fauna that constitutes the terrestrial biodiversity of the Philippines.

As well as negative aboveground effects, droughts also tend to negatively impact marine ecosystems. Rising temperatures coupled with the rising carbon dioxide levels in the atmosphere cause coral reef bleaching, or the chalky appearance coral takes on when it dies (MO-COMSTE, 2010). The destruction of coral reefs reduces marine biodiversity which is critically important for the ecological balance and productivity of marine ecosystems. It has been reported that the El Niño episode which occurred in1997 and 1998 in the Philippines, decreased the coral cover ranging from 46 percent to 80 percent in Bolinao, Pangasinan (GOP, 2010). Other areas affected included Batangas, other parts of Northern Luzon, West Palawan, and parts of the Visayas. In addition to droughts, floods could inundate mangrove, coral reef and sea grass areas along the coast, making them less viable as important providers of ecosystem goods and services to both the economy and environment.

The total value of the ecosystem goods and services provided by coral reefs, mangroves and seagrass nationally in the Philippines was estimated at about P6 billion in 2006 (Table 16). Although the exact level of damage directly caused by previous typhoons, floods and droughts on coastal ecosystems has not been measured as yet, it is clear that the marine resources provide significant economic and social benefits to the country as a whole.

6.9.11 Endangered human health and safety

Overcrowding, inadequate water supply and sanitation, and poor access to health services following the sudden displacement of an affected population after the occurrence of natural disasters increase the risk of communicable transmission of diseases (WHO, 2006). These diseases include water borne diseases such as diarrhea, hepatitis, and leptospirosis; diseases associated with overcrowding such as measles, meningitis, and acute respiratory infections; vector-borne diseases such as malaria and dengue fever; and other diseases like tetanus, coccidiomycosis and mental health problems. Other health and safety-related impacts, particularly with respect to typhoons and floods, include injuries or even death due to falling trees and debris, electrical exposure and similar accidents.

Table 16: Value of net benefits from coral reefs, mangroves and seagrass ecosystems in the Philippines, 2006

Coastal Ecosystem	Net Benefits Per Hectare (Pesos)	Total Net Benefits (Million Pesos)
Coral Reefs	1,487	4,015.2
Mangroves	8,859	1,852.6
Seagrass	921	90.1
Total	11,267	5,957.9

Source of data: Padilla (2009)

It is projected that the displacement of families living in natural disaster-prone areas in the Philippines will be a public health challenge that will become more frequent in the coming years (MO-COMSTE, 2010). A decline in the volume of groundwater will heighten water-related disputes and increasingly expose the population to water-borne diseases. In addition, health-related facilities and infrastructure could be severely damaged under increased frequency and intensity of severe weather events (PAGASA, 2011). Studying the flood hazards in Metro Manila, Zoleta-Nantes (2000) asserted that the economic losses due to floods escalated through time and health-related risks such as dengue fever, diarrhea-related diseases, unsanitary conditions, and water contamination levels were high.

7. Conclusions

This study quantitatively and qualitatively analyzed the impacts of typhoons, floods and droughts on agriculture, food security and the natural resources and environment in the Philippines using available secondary data. . In general, the study found that: a) typhoons, floods and droughts have an insignificant impact on overall agricultural production at the national level yet typhoons have a significant negative impact on paddy rice production at the provincial level; b) typhoons, as exemplified by Ondoy and Pepeng in 2009, have a significant negative impact on the food security of the households in the affected areas; c) households have varying consumption and non-consumption strategies to cope with the impacts of typhoons; and d) the different impacts of typhoons, floods and droughts on the natural resources and environment have not been quantitatively assessed in detail, but available evidence suggests that these are also substantial.

8. Recommendations

8.1 Recommendations

Recent studies undertaken in this field have provided strategies to address the impacts of: climate change on agriculture and the natural resources and environment (The World Bank Group 2011, MO-COMSTE 2010); climate change on the coastal natural resources and environment (Capili et al., 2005); natural disasters on overall and sub-national development (NEDA, 2008, WB and NDCC, n.d .); typhoons on agriculture and the natural resources and environment (GOP, 2009, 2009a); typhoons on food security (WFP, 2009); and droughts on agriculture and the natural resources and environment (GOP, 2010). The recommendations made by these works should be seriously reviewed and considered by the government.

Based on its results and findings, the study recommends the following: a) Since typhoons have significant negative impacts on rice production at the local level as opposed to the national level, assistance for rice farmers and the agriculture sector as a whole should be made more site-specific, zeroing in on the affected areas that actually need it; b) Those assisting affected households and areas in overcoming the resulting ill-effects of natural disasters should consider not only consumption strategies, such as the provision of emergency food aid, but also non-consumption strategies, such as the provision of post-disaster emergency employment; and c) While the available evidence suggests that the natural resources and environment sector is significantly affected by natural disasters, it is currently less considered, as attention is presently focused on agriculture. It may now be high time to provide concrete assistance to this sector, in particular the provision of defensive investments and rehabilitation expenditures to cope with these natural disasters.

8.2 Areas for Future Research

Based on the results and findings of the study, the potential topics for future economic research on the impacts of natural disasters on agriculture, food security and the environment in the Philippines are as follows: a) economic analysis of the impacts of natural disasters in disaster-prone local areas such as the identified typhoon belts; b) economic analysis of the defensive investments and rehabilitation expenditures needed for the natural resources and environment in ecologically sensitive and disaster-prone areas; c) analysis of the health and other social impacts of natural disasters in disaster-prone local areas; and d) detailed analysis of the impacts of natural disasters on food security at the household, local and national levels.

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