

Analysis of Loss and Damage in Philippine Agriculture Due to Natural Hazards: Evidence-Based Policy Recommendations for Climate Adaptation

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Abstract. The Philippines is highly vulnerable to natural hazards, especially typhoons, floods, and droughts. This study analyzed Department of Agriculture (DA) data from 2011 to 2020 to assess the impact of six hazard types—typhoons, floods, moisture stress, pests and diseases, earthquakes, and volcanic activity—on the agriculture sector. Loss and damage reports were compiled under the DA's Disaster Risk Reduction and Management Operations Manual. Using descriptive statistics, frequency mapping, and index calculations, the study quantified commodity-specific losses and provincial hazard exposure. Climate-related hazards accounted for about 99% of the PHP295 billion in total losses, with typhoons alone responsible for PHP262 billion (88%). Rice was the most affected crop, with over PHP112 billion in losses, primarily due to typhoons and flooding. Luzon provinces experienced the highest frequency of typhoons, followed by parts of the Visayas and Mindanao. These findings underscore the urgent need for targeted adaptation strategies, such as adjusting planting calendars, improving disaster response funding, and promoting climate-resilient farming practices. The study provides strong empirical support for policy reforms aimed at reducing the impacts of extreme weather events on food security and agricultural productivity in one of the most climate-vulnerable countries in the world.

Keywords: climate hazards, loss and damage, Philippine agriculture, value of production losses

The Philippines, due to its geographic location, is highly exposed to natural hazards. Being part of the Pacific Ring of Fire, the country has several active volcanoes that occasionally erupt, leading to significant damage. Certain areas of the archipelago rest on different tectonic plates, making them particularly susceptible to earthquakes. Situated west of the Pacific Ocean, the country lies in the path of originating weather systems, making it one of the first to experience landfall from typhoons and other severe weather disturbances. Additionally, in the eastern tropical Pacific Ocean, there is a phenomenon known as the El Niño-Southern Oscillation (ENSO), which includes a warm phase called El Niño and a cool phase known as La Niña. El Niño leads to drought, while La Niña brings extended periods of heavy rainfall to the country. According to the 2020 World Risk Index, the Philippines ranked ninth globally as one of the most affected countries by extreme weather events. Consequently, these climate phenomena result in substantial annual damage and losses across various sectors, with agriculture being especially vulnerable.

Previous estimates of typhoon damage to rice production in the Philippines were derived using fragility curves based on typhoon-track data within a wind field model, combined with satellite-derived precipitation measurements and imagery of rice fields (Blanc & Strobl, 2016). Israel and Briones (2013), using data obtained from various sources, conducted a quantitative and qualitative analysis of the impacts of natural disasters—specifically typhoons, floods, and droughts—on agriculture, food security, and natural resources in the Philippines. Their findings revealed that adverse effects on rice production are highly site-specific, thereby justifying the current approach of the government, particularly the Department of Agriculture (DA), in providing targeted assistance to farmers and the agriculture sector only in areas that are directly affected and actually need it. It is the purpose of this study to analyze actual data on loss and damage in agriculture collected after each natural disaster and to recommend specific policies for adaptation. Notably, this is the first study to utilize actual field data for assessing loss and damage in the agricultural sector in the country.

Recent regional syntheses (Food and Agriculture Organization [FAO], 2023a; Intergovernmental Panel on Climate Change [IPCC], 2022) estimate that weather related shocks cause up to USD5 billion in annual agricultural losses across Southeast Asia, yet commodity and province level evidence for the Philippines remains sparse. Country-specific work has largely used remote sensing or modelled overlays (e.g., Blanc & Strobl, 2016; Israel & Briones, 2013), while micro-level post-event assessments have largely focused on single hazards or single commodities. By contrast, multi-hazard, multi-commodity loss accounting with a decadal time horizon is limited, leaving a gap in evidence for integrated policy design.

Materials and Methods

For the analytical framework, our study adapts the widely used risk assessment equation (Birkmann 2013; IPCC, 2022; United Nations Office for Disaster Risk Reduction [UNDRR], 2025):

$$Risk = Hazard \times Exposure \times Vulnerability$$

In this study:

1. Hazard is the frequency and intensity of six natural events (typhoons, floods, drought/moisture stress, pests & diseases, volcanic eruptions, earthquakes).
2. Exposure is the spatial distribution of agricultural production areas across 80 provinces.
3. Vulnerability is commodity specific sensitivity (e.g., rice > corn > coconut) and the capacity of farmers to cope.

Economic loss and damage (L&D) is the observable outcome of this interaction. We posit that accurate L&D measurement informs evidence-based adaptation and social protection policies.

This study is also anchored on the pressure–state–impact–response (PSIR) framework, a variant of the broader driver–pressure–state–impact–response (DPSIR) model (Kristensen, 2004), which provides a structured approach for linking environmental pressures to policy responses. In this context, the framework connects biophysical hazards (pressure) to their effects on the agriculture sector (state), the resulting monetary value of loss and damage (impact), and the set of policy and technological options that may reduce future risk (response). Originally developed to support environmental decision-making, the DPSIR framework has been adapted by institutions like the Food and Agriculture Organisation (FAO) to guide indicator development and feedback loops between environmental conditions and policy action. It outlines a causal sequence from underlying drivers such as economic activities, to pressures like emissions or land degradation, which alter the physical or biological state of systems, result in socio-ecological impacts, and ultimately trigger policy responses. Following this logic, the analytical sequence of the present study was: (a) identify and classify natural hazards, (b) quantify their spatio-temporal footprint, (c) translate the footprint into biophysical and economic loss, and (d) derive evidence-based adaptation measures.

Raw data on loss and damage in agriculture and fisheries from natural hazards were obtained from the Field Operations Service, Office of the Undersecretary for Operations, Department of Agriculture (DA). These data are periodically reported by the DA's regional field offices (RFOs) following a standardized protocol outlined in the *Operations Manual Disaster Risk Reduction and Management in Agriculture and Fisheries* (Lim et al., 2019). Loss refers to the decline and/or destruction of the production outputs. In rice, this loss is valued depending on the growth stage of the plants. Damage is the impairment or injury to physical assets, reducing their value, functionality, and usefulness. Damage can range from partial to total destruction of an asset. The damage value reflects either the cost of fully replacing damaged assets or repairing partially affected ones. The damage and loss assessment methodology used is consistent with that of the Economic Commission for Latin America and the Caribbean (ECLAC), which is promoted by the World Bank and adopted by the National Disaster Risk Reduction and Management Council (NDRRMC) of the

Philippines. Data collection on crops was aggregated for rice, coconut, corn, high-value commercial crops (HVCCs), banana, vegetables, tree crops, abaca, sugarcane, cassava, and root crops. The crop aggregation of HVCC was derived from the crop list in Republic Act (RA) 7900, also known as the High-Value Crops Development Act of 1995, with some modifications. Certain crops classified as HVCC under the law, such as root crops and tree crops (including coffee, mango, and papaya), were monitored separately. The category for vegetables specifically includes lowland varieties like eggplant, tomato, and *pechay* (Chinese cabbage).

The data was aggregated by year, province, month, commodity, hazard type, value of production loss, and area affected. Policy implications were derived from the trends observed. The climate hazards that caused loss and damage included typhoons, moisture stress (encompassing dry spell and drought induced by El Niño), floods resulting from heavy and/or continuous rainfall, and pest and disease outbreaks. In this context, typhoons include all weather systems, such as intense monsoon rains, tropical storms, tropical depression, low-pressure areas, and typhoons of varying intensities based on the Saffir-Simpson Hurricane Wind Scale. Damage from typhoons is attributed to heavy rains, flooding, erosion, landslides, strong winds, and storm surges. Floods included flash floods not associated with weather systems, while moisture stress covered both El Niño-induced droughts and dry spells. The other natural hazards considered were volcanic activity and earthquakes.

Flood risk for each province per month was determined based on the annual frequency of occurrence of typhoons and floods (see Table 7). These events were grouped together due to their similar negative impact to rice production. Assuming that the historical data on typhoons and floods from 2011 to 2020 is indicative of future flood risks in rice-growing areas, months for each province were color-coded according to the number of such events recorded. Months with five or more typhoons and floods were shaded in black, indicating the highest risk of these events in the coming years. Months with three to four occurrences were shaded in gray, suggesting a moderate risk level. Those with one to two occurrences were shaded in light gray, indicating a lower risk compared to the gray category. Finally, months with no recorded typhoons or floods were not shaded, suggesting a minimal likelihood of such events in the near future. The volume of rice lost, measured in metric tons (MT), was estimated by calculating the annual productivity rate (determined by dividing the volume of rice produced by the area harvested, as reported by Philippine Statistics Authority [PSA], 2021) and multiplying this rate by the area of rice fields affected by typhoons and floods (see Table 6).

In terms of its delimitations, this study focused on six natural hazards that have a demonstrable impact, either rapid-onset or slow-onset, on crops, livestock, fisheries, and on-farm infrastructure. The hazard types analyzed are (1) typhoons, (2) floods, (3) moisture stress (dry spells and droughts), (4) pest and disease outbreaks triggered by climate anomalies, (5) volcanic activity, and (6) earthquakes. The period of analysis spans the calendar years 2011 to 2020, representing the longest timeframe for which electronically archived and fully validated L&D reports are available. Several loss categories were excluded from the scope of analysis, including price shocks, armed conflict, civil unrest, postharvest handling losses, and the 2020 African swine fever outbreak, which, as a transboundary animal disease, is not directly attributable to

weather-related events. The analysis covered 11 crop groups (as detailed in Table 5), as well as livestock and both inland and coastal fisheries.

Results and Discussion

Data cleaning involved removing duplicate entries by creating a composite key consisting of region, province, municipality, barangay, date, commodity, and hazard type. This ensured that each record was uniquely identifiable and minimized the risk of double-counting losses. All monetary values were deflated to constant 2020 pesos using the PSA's Agricultural Producer Price Index (2011 = 100) to ensure comparability across years. Summary tables were then generated from the cleaned dataset to support analysis by region, commodity, and hazard type. To estimate the physical volume of rice production loss, the affected area (in hectares) was multiplied by the annual productivity rate, which was calculated using the PSA data as the ratio of total rice production to harvested area per year. The resulting estimates, expressed in metric tons, reflect a year-specific computation of losses without the use of multi-year averages.

Descriptive statistics were computed to summarize patterns of agricultural L&D from 2011 to 2020. These included total and average annual losses in both volume and value, disaggregated by commodity group and hazard type. Tabulations and visualizations were developed to highlight spatial and temporal trends and to identify the most frequently reported hazards and affected agricultural subsectors. All analyses were conducted using spreadsheet-based tools and validated through consistency checks against the original submissions by the Department of Agriculture's RFOs. No inferential statistical models were applied.

Ethical safeguards and quality-assurance procedures were built into the entire data processing and analysis workflow. From the source of the data at the RFOs, all personally identifiable information, such as the names of individual farmers, was removed prior to analysis to uphold data privacy standards. An internal audit was implemented to verify the consistency of the cleaned dataset with the original RFO reports. This involved randomly spot-checking 10% of the data entries per region, and resolving any discrepancies in consultation with the submitting RFOs. These procedures helped ensure the reliability and integrity of the aggregated national loss and damage database.

Table 1 shows the annual loss and damage in agriculture over the past decade (2011- 2020) from the six types of natural hazards that were identified. The total cost of loss and damage from these natural hazards exceeded PHP295 billion over the 10-year period, averaging about PHP29 billion per year. Notably, losses from climate-related hazards alone accounted for more than half of the Department of Agriculture's annual budget of PHP50 billion during that period.

However, note that the annual costs varied significantly, ranging from PHP12.5 billion to PHP46.3 billion. This variability is influenced by the type and severity of the hazards, the extent of affected areas, and the specific crops affected—particularly for rice, where the stage of growth affects vulnerability. The years 2017 and 2019 saw the lowest losses, at PHP12.49 billion and PHP15.89 billion, respectively, due to the absence of super typhoons. Total cost of loss and damage from climate-related hazards alone was over PHP291 billion, constituting approximately 99% of the total loss and damage for the period.

Table 1
Annual Cost of Agricultural Loss and Damage (in Billion PHP)
Due to Natural Hazards (2011-2020)

Year	Typhoon	Moisture Stress	Floods	Pests & Diseases	Volcanic Activity	Earthquake	Total
2011	24.14	-	1.08	-	-	-	25.22
2012	33.20	-	0.63	-	-	0.01	33.84
2013	45.31	0.90	0.07	-	-	-	46.28
2014	40.12	0.84	-	-	-	-	40.96
2015	21.50	3.43	-	-	-	-	24.93
2016	19.55	11.78	-	-	-	-	31.33
2017	12.13	0.06	0.05	0.25	-	-	12.49
2018	36.48	-	0.02	-	-	-	36.50
2019	7.92	7.95	-	0.02	-	-	15.89
2020	21.35	3.03	0.03	0.02	3.54	-	27.97
Total	261.70	27.99	1.88	0.29	3.54	0.01	295.41
		Total value of loss due to climate hazards		291.86			

Among the six natural hazards, typhoons cost the most substantial loss and damage, amounting to around PHP262 billion or 88% of the total, as shown in the table. Unlike other climate-related hazards, typhoons occur annually, while events like moisture stress, floods, and pest and disease outbreaks are less frequent. Moisture stress was a distant second, with losses of about PHP28 billion, particularly severe during the El Niño years of 2015, 2016, and 2019. The worst year was 2016, with drought-related losses exceeding PHP11 billion, followed by 2019 at nearly PHP8 billion, and 2015 at more than PHP3 billion.

A far third in causing loss and damage at almost PHP2 billion was flooding from heavy rains not triggered by typhoons and other weather systems. In contrast, losses from pest and disease outbreaks were minimal, only 0.1% of those caused by typhoons, with significant outbreaks occurring just three times during the decade. The highest loss reported was in 2017, due to pest infestation affecting rice, corn, and HVCCs. This may indicate that pest and disease management efforts have been relatively effective. It should be noted, however, that the decline in abaca productivity due to viral diseases was not accounted for, though it remains a continuing concern (Galvez et al., 2021). The livestock loss from African swine fever (ASF) outbreak in 2020 was excluded from the table since this outbreak is not associated with the weather. A loss of three million hogs has been attributed to ASF, causing the swine and related industries over PHP100 billion in losses and driving up pork prices for consumers, as noted in Presidential Proclamation 1143 series of 2021.

The volcanic activity recorded in 2020 was associated with the eruption of Taal Volcano, located on the boundary of Batangas and Cavite provinces in Luzon. This event primarily affected high-value crops such as coffee and pineapple, as well as

aquaculture. Meanwhile, losses attributed to earthquakes were reported only in 2012, with no available estimates for the events in 2017 and 2019. Production losses from frost, hailstorms, and fish kill were not included in the table, as these phenomena could not be linked to conventional weather patterns. During the period, these were first reported in 2020, with a total value exceeding PHP54 million.

Table 2 shows the aggregate area affected by climate hazards per year. Typhoons impacted the largest aggregate area, covering approximately seven million hectares, with the smallest affected aggregate area recorded in 2017 and 2019. Moisture stress came second, affecting a cumulative area of 1,035,804 hectares, while floods ranked third in terms of affected area. In contrast, disease outbreaks were largely confined to small, isolated areas.

Table 2
Annual Area Affected (Ha) by Type of Climate-Related Hazard (2011-2020)

Year	Typhoon	Moisture Stress	Floods	Pests & Diseases
2011	1,010,971	-	115,934	-
2012	373,990	-	15,159	-
2013	1,102,878	58,948	99	-
2014	779,985	37,193	-	-
2015	1,055,393	146,188	-	-
2016	683,028	410,532	-	-
2017	273,095	961	4,194	5,606
2018	1,131,984	-	-	-
2019	203,389	277,890	729	530
2020	375,846	104,092	1,333	470
Total	6,990,559	1,035,804	137,448	6,606

During the period, a total of 85 typhoons were recorded, with super typhoons occurring each year except in 2017 and 2019. Unsurprisingly, these two years reflected the lowest cost of loss and damage. In contrast, 14 typhoons each caused losses exceeding PHP5 billion (see Table 3). Among them, Super Typhoon Yolanda (international name: Haiyan) inflicted the highest damage, exceeding PHP35 billion, followed by Super Typhoon Glenda (international name: Rammasun) with over PHP33 billion in losses. Notably, 10 out of these 14 highly destructive typhoons occurred in the fourth quarter, while the remaining four took place in the third quarter.

As a result, the aggregate production loss was highest in the fourth quarter, reaching nearly PHP150 billion (58% of the total), as shown in Table 4. The third quarter followed with losses exceeding PHP71 billion (39%). In contrast, the first and second quarters each experienced losses of just over PHP5 billion, accounting for approximately 2% each of the total. The significantly higher production losses during the fourth quarter can be attributed to the increased frequency of super typhoons during this period, as previously discussed.

Table 3
Typhoons Causing PHP5 Billion or More in Damages (2011-2020)

Typhoon	Category	Total Production Value Lost (PHP)	Total Area Affected (has)	Month of Occurrence
Nina (Nock-Ten) 2016	Cat. 5 super typhoon	5,445,444,310	138,356	December
Rolly (Goni) 2020	Cat. 5 super typhoon	5,794,133,992	127,344	November
Quinta (Molave) 2020	Cat. 3 typhoon	6,009,806,721	152,414	October
Ulysses (Vamco) 2020	Cat. 4 typhoon	6,719,716,913	336,336	November
Karen (Sarika) and Lawin (Haima) 2016	Cat. 4 typhoon Cat. 5 super typhoon	13,194,694,400	467,612	October
Pedring (Nesat) and Quiel (Nalgea) 2011	Cat. 4 typhoon Cat. 4 typhoon	16,328,525,679	616,247	September
Nona (Melor) 2015	Cat. 4 typhoon	7,260,632,221	385,838	December
Lando (Kappu) 2015	Cat. 4 super typhoon	12,062,685,626	563,531	October
Ompong (Mangkhut) 2018	Cat. 5 super typhoon	27,442,484,331	752,513	September
Pablo (Bopha) 2012	Cat. 5 super typhoon	29,102,638,433	163,181	December
Glenda (Rammasun) 2014	Cat. 5 super typhoon	33,703,951,618	398,682	July
Yolanda (Haiyan) 2013	Cat. 5 super typhoon	35,735,946,720	693,305	November

Table 4
Quarterly Agricultural Production Loss and Damage (in Million PHP) Due to Climate-Related Hazards (Excluding El Niño-Induced Dry Spells and Droughts)

Year	Q1	Q2	Q3	Q4	Total
2011	919.08	2,485.24	21,080.04	707.75	25,189.11
2012	558.12	224.14	3,229.99	29,907.06	33,919.31
2013	153.11	109.29	4,902.07	40,217.29	45,381.76
2014	427.75	-	37,725.25	1,813.23	39,966.23
2015	744.73	-	1,437.05	19,323.32	21,505.10
2016	-	-	668.65	18,878.43	19,547.08
2017	1,538.44	2.62	518.94	6,135.84	8,195.84
2018	307.93	119.33	30,910.67	5,879.56	37,217.49
2019	37.84	13.9	926.9	7,129.23	8,107.87
2020	21.18	1,399.51	67.36	19,930.02	21,418.07
Total	4,708.18	4,354.03	101,466.92	149,918.73	260,447.86
% in Total	1.8%	1.7%	39.0%	57.6%	100%

All commodities, except cassava, suffered the majority of their damage (65.9% to 100%) from typhoons (see Table 5). Among these, rice crops incurred the highest aggregate loss, amounting to over PHP112 billion, which represents around 38% of

the total losses over the reporting decade. Rice is the most vulnerable to climate hazards as it is primarily cultivated in lowland areas prone to flooding. Additionally, in rainfed areas, rice is susceptible to dry spells and drought. It is also the single crop that incurred the most damage from pests and diseases.

Coconut ranks second in terms of losses, with over PHP46 billion in damages. The bulk of this loss was inflicted by just two super typhoons: Yolanda (Haiyan) in 2013, which resulted in over PHP22 billion in damages, and Glenda (Rammasun) in 2014, with losses exceeding PHP21 billion. The extremely strong winds caused by these super typhoons, exceeding 260 km/h (162 mph), uprooted coconut trees in 2013 and decapitated trees in 2014. Unlike rice, coconut is less affected by drought, floods, or pest and disease outbreaks.

Corn, similar to rice, suffers damage every year from all four climate hazards. It is either planted in low-lying areas after rice, making it vulnerable to floods, or in upland and sloping regions, where it is more susceptible to drought. Since corn areas are predominantly rainfed, they are particularly prone to drought conditions.

The cost of production losses in bananas ranks fourth among affected commodities, primarily due to the impact of Super Typhoon Pablo (international name: Bopha) on commercial banana plantations in Eastern Mindanao in 2012, which alone caused losses exceeding PHP22 billion, accounting for about 83% of the total banana losses during the period. Following bananas, the losses in high-value commercial crops amounted to more than PHP25 billion. HVCCs are grown in relatively small patches across various parts of the country, making them susceptible to nearly every typhoon that makes landfall.

The total losses for the crop sector reached more than PHP261.2 billion, representing close to 90% of the overall losses. The fisheries sector ranked fifth, with losses exceeding PHP14 billion (4.9% of total), while the livestock sector incurred PHP2.62 billion (around 0.9%).

Interestingly, the total cost of damage to irrigation systems, facilities, infrastructure, and machinery was relatively low at just PHP13.6 billion, accounting for 4.7% of the total losses. This may indicate that the design and construction of these infrastructures have taken into account potential impacts from climate-induced hazards. Additionally, the mobility of most machinery allows them to be relocated, minimizing potential damage. Conversely, this implies that 95.3% of the total loss and damage is absorbed by the agriculture sector, with crops (89.5%), livestock (0.9%), and fisheries (4.9%) bearing the brunt. As a result, the burden of these losses falls predominantly on farmers and fisherfolk, with the crop sector suffering the most.

Table 5
Commodity Losses (in Billion PHP and Percent to Total)
Due to Climate-Related Hazards

Commodity	Typhoon	Drought	Floods	Pests & Diseases	Total	% to Overall Total
Rice	98.46 (87.86%)	11.73 (10.47%)	1.79 (1.60%)	0.08 (0.07%)	112.06	38.39%
Coconut	46.25 (100%)	0	0	0	46.25	15.85%
Corn	26.01 (65.90%)	13.42 (34.00%)	0.03 (0.08%)	0.01 (0.03%)	39.47	13.52%
Banana	26.81 (100%)	0	0	0	26.81	9.19%
HVCCs	22.84 (88.98%)	2.58 (10.05%)	0.06 (0.23%)	0.19 (0.74%)	25.67	8.80%
Vegetables	4.72 (99.12%)	0.04 (0.84%)	0.002 (0.04%)	0	4.76	1.63%
Tree crops	2.18 (99.91%)	0	0	0.002 (0.09%)	2.18	0.75%
Abaca	2.03 (100%)	0	0		2.03	0.70%
Sugarcane	1.21 (100%)	0	0	0	1.21	0.41%
Cassava	0.10 (45.45%)	0.12 (54.55%)	0	0	0.22	0.08%
Root crops	0.56 (100%)	0	0	0	0.56	0.19%
Livestock	2.62 (99.87%)	0.0004 (0.02%)	0.003 (0.11%)	0	2.62	0.90%
Fisheries	14.42 (99.96%)	0.001 (0.01%)	0.005 (0.03%)	0 (0.00%)	14.43	4.94%
Irrigation	6.98 (99.01%)	0	0.07 (0.99%)	0	7.05	2.42%
Infrastructure	6.54 (100%)	0	0	0	6.54	2.24%
Total	261.73 (89.68%)	27.89 (9.56%)	1.96 (0.67%)	0.28 (0.10%)	291.86	100.00%

Table 6
*Annual Area Damaged by Typhoons and Floods,
Estimated Rice Production Loss (MT), and Rice Imports*

Year	Total Rice Area Affected	MT/ha	Volume of rice lost ('000 MT)	Volume of rice imports* ('000 MT)
2011	930,536	3.68	3,424	707
2012	226,634	3.84	870	1,041
2013	448,883	3.88	1,742	398
2014	839,713	4.00	3,359	1,087
2015	758,842	3.89	2,952	1,478
2016	402,406	3.87	1,557	605
2017	216,062	4.00	864	885
2018	842,152	3.97	3,343	2,002
2019	287,884	4.04	1,163	3,118
2020	273,446	4.08	1,116	2,219

*Source of data on rice imports. Philippine Statistics Authority, 2021

Table 6 presents the area affected by typhoons and floods, along with the corresponding volume of rice lost and rice imports for each year. The production loss in rice and corn is most severe when these crops are flooded or damaged by strong winds during harvest. In such cases, produce is lost because flooded fields make harvesting difficult, and wet conditions prevent the harvested grain from drying properly due to the lack of sunlight. Additionally, strong winds during anther dehiscence can blow pollen away from the stigma, leading to reduced grain formation and lower yields. The annual data on production losses indicate that in some years, the volume of rice lost exceeded the volume of imports. This suggests that, by addressing these production losses caused by extreme weather events, the country may have the potential to reduce dramatically or even eliminate its dependence on rice imports.

Table 7 shows the number of typhoons that affected each province per month during the period 2011-2020, along with the flood risk for each month indicated by color codes. Out of the 85 typhoons that struck the country during this period, the majority made landfall in Luzon (Provinces #1-38), leading to significant agricultural losses and damage. Luzon provinces were hit by 9 to 47 typhoons each during the period, with Bulacan (#18) and Pampanga (#20) being the most frequently affected, each visited by 47 destructive typhoons.

In contrast, Visayas provinces (Provinces #39-54) were affected by 1 to 22 typhoons each during the same period, while Mindanao provinces (Provinces #55-78) experienced 0 to 18 typhoons each. Notably, Basilan, Sulu, and Tawi-Tawi in Mindanao (#76, #79, #80) were not visited by any typhoons. Among the Visayas provinces, Guimaras and Siquijor were each struck by only one significant typhoon, Yolanda (Haiyan).

The most vulnerable region to typhoons and floods was Region 3, which includes the provinces of Bataan, Bulacan, Nueva Ecija, Pampanga, Tarlac, and Zambales (#17-22). Each of these provinces was visited by 32 to 47 typhoons during the study period, highlighting their susceptibility to extreme weather events.

Flood risks, indicated by yellow, orange, and red shading, are present in most provinces during many months of the year, with the exception of Basilan, Sulu, and Tawi-Tawi, where flood risk is zero and all months are shaded green. Notably, Albay (#33) and Camarines Sur (#35) face flood risks in 10 out of 12 months each year. The provinces of Nueva Ecija (#19), Oriental Mindoro (#30), Camarines Norte (#36), and Samar (#53) experience flood risks in nine months. Meanwhile, Pangasinan (#10), Aurora (#16), Bataan (#17), Bulacan (#18), Pampanga (#20), Catanduanes (#36), Masbate (#37), Sorsogon (#38), Eastern Samar (#50), and Southern Leyte (#52) are at risk in eight months. The remaining provinces have flood risks in seven months or fewer within a year.

Table 7
*Monthly Frequency of Typhoons and Floods per Province,
with Color-Coded Flood Risk Indicator (2011-2020)*

#	Province	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
1	Abra							8	6	6	4	1		25
2	Apayao							3	3	6	6	3		21
3	Benguet						1	9	7	5	6	2		30
4	Ifugao					1		5	3	5	6	1		21
5	Kalinga							6	3	5	4	3		21
6	Mt Province							8	7	6	4	2		27
7	Ilocos Norte						2	8	6	4	8	1		29
8	Ilocos Sur						1	9	8	7	7	1		33
9	La Union						2	8	7	6	7	1		31
10	Pangasinan					1	5	8	7	6	7	2	1	37
11	Batanes							1	3	4	1			9
12	Cagayan						1	8	4	6	8	3	3	33
13	Isabela							4	2	4	8	2	3	23
14	Nueva Vizcaya							2	2	3	6	1	2	16
15	Quirino							1	1	3	5	1	1	12
16	Aurora		1			1		7	3	7	10	2	1	32
17	Bataan						5	8	8	7	10	2	1	41
18	Bulacan					1	5	10	8	8	11	3	1	47
19	Nueva Ecija	1				1	5	8	4	6	11	2	1	39

Note. Flood risk indicators: black (highest risk), gray (medium risk), light gray (low risk), and white (no risk)

20	Pampanga					1	5	9	9	9	10	2	2	47
21	Tarlac						3	8	5	9	11	3	1	40
22	Zambales						5	8	8	10	11	1	1	44
23	Batangas						2	5	2	10	5	4	2	30
24	Cavite					1		5	1	6	5	3	2	23
25	Laguna					1		5	3	7	7	4	3	30
26	Quezon					1	1	4	1	8	8	4	4	31
27	Rizal					1	1	6	3	8	8	3	3	33
28	Marinduque					1	1	1			4	3	4	14
29	Occidental Mindoro			1			3	8	3	5	5	4	4	33
30	Oriental Mindoro	1		1			2	6	2	3	5	2	6	28
31	Palawan	2						4			1	1	4	12
32	Romblon					1	1	2			1	1	3	9
33	Albay	3	1			2	3	2	1	6	3	5	7	33
34	Camarines Norte	2	1			2		2	1	5	4	4	5	26
35	Camarines Sur	2	1			2	5	3	1	8	5	5	8	40
36	Catanduanes	2				2		2	1	4	3	4	5	23
37	Masbate	2	1			2		2	1		5	5	8	26
38	Sorsogon	3				2	1	2		3	6	5	5	27
39	Aklan							5			1	2	2	10
40	Antique							5	1	3	1	2	1	13
41	Capiz	3		1			1	1			1	2	4	13
42	Guimaras											1		1
43	Negros Occidental	1						7	1	2	5	4	2	22
44	Iloilo									3	1	3	4	11
45	Bohol	2										2	1	5
46	Cebu	2			1							2	3	8
47	Negros Oriental	1										2		3
48	Siquijor											1		1
49	Biliran			1				1			2	4	3	11
50	Eastern Samar	3	1	1		1		1			1	5	6	19
51	Leyte	2	1	1				1			1	5	7	18

Note. Flood risk indicators: black (highest risk), gray (medium risk), light gray (low risk), and white (no risk)

52	Southern Leyte	2	1	1			1	1			1	1	4	12
53	Samar (Western Samar)	3	1	1		1	1	1			1	4	5	18
54	Northern Samar	3		1		1		1			1	4	5	16
55	Zamboanga del Norte	1	1								4		3	9
56	Zamboanga del Sur							1			2	2	1	6
57	Zamboanga Sibugay									1			1	2
58	Bukidnon	2	1				4		1			1	4	13
59	Camiguin	1										1	2	4
60	Lanao del Norte	3	1					1				1	1	7
61	Misamis Occidental	2	1				3					1	3	9
62	Misamis Oriental	2	1									2	4	9
63	Compostela Valley	4						1				1	4	10
64	Davao del Norte	3					3	1				1	4	12
65	Davao del Sur						3					1	1	5
66	Davao Oriental	2										1	1	4
67	North Cotabato		2				4	2	1		4	1	1	15
68	Sarangani		1						1			1		3
69	South Cotabato		1				3	1	1	1		1		8
70	Sultan Kudarat		2				5	2	1	1		1		12
71	Agusan del Norte	6	1									2	6	15
72	Agusan del Sur	6	2									3	7	18
73	Dinagat Island	2	1									1	4	8
74	Surigao del Norte	5	1									2	5	13
75	Surigao del Sur	6	2									2	5	15
76	Basilan													0
77	Lanao del Sur						3						1	4
78	Maguindanao		1				3	1				1		6
79	Sulu													0
80	Tawi-Tawi													0

Note. Flood risk indicators: black (highest risk), gray (medium risk), light gray (low risk), and white (no risk)

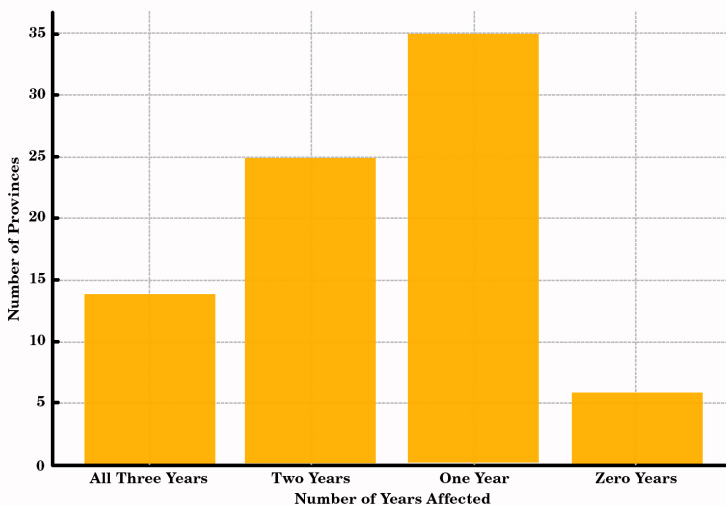
Table 8 presents the classification of Philippine provinces based on the frequency of reported agricultural losses during the El Niño events of 2015, 2016, and 2019. It highlights which provinces experienced losses consistently across all three years, those affected in two of the events, those impacted only once, and those that did not report any losses.

Over the study period, 14 provinces consistently reported losses in all three El Niño events. Another 25 provinces experienced losses during two of the occurrences, while 35 provinces were affected in only one year. Notably, six provinces—Aklan, Batanes, Bataan, Tarlac, Zambales, and Dinagat Islands—did not report any El Niño-related losses. The table highlights how provinces vary in their susceptibility to drought, as indicated by the frequency of reported losses during El Niño events. Those consistently affected across all three occurrences may face higher vulnerability to drought, while provinces with fewer or no reported losses could indicate relatively lower exposure or better resilience. This gradation of risk can serve as a basis for more targeted drought adaptation strategies from the government.

Table 8
Number of Provinces Experiencing Production Losses During El Niño Events (2015, 2016, and 2019)

Category	Number of Provinces
All three years	14
Two years	25
One year	35
Zero years	6

Figure 1
Number of Provinces Experiencing Production Losses During El Niño Events (2015, 2016, and 2019)



Summary and Policy Recommendations¹

Six types of natural hazards—typhoons, floods, moisture stress, pests and diseases, earthquakes, and volcanic activity—caused significant loss and damage to Philippine agriculture and fisheries from 2011 to 2020. A substantial 99% of the total loss and damage amounting to PHP295 billion was due to climate-related hazards, specifically typhoons, moisture stress, floods, and pest and disease outbreaks. Typhoons, which occur annually with an average of 8.5 occurrences per year, accounted for the largest share of loss and damage, totaling approximately PHP262 billion or 88% of total loss and damage, and affected the largest aggregate area. Super typhoons, each causing over PHP5 billion in damages, predominantly occurred in the fourth quarter, with the remainder in the third quarter. Consequently, the highest losses were reported in the fourth quarter (57%), followed by the third quarter (39%), while the first and second quarters accounted for a mere 2% each.

All commodities, except cassava, suffered the most damage from typhoons, with rice alone comprising over one-third of the total loss and damage (38%). About 96% of the total costs of loss and damage were borne by farmers and fisherfolk, with the crop sector incurring 90%, livestock 1%, and fisheries 5% of the damage. The estimated annual volume of rice lost due to typhoons and floods could significantly offset the country's rice import requirements.

Nearly all provinces, except Basilan, Tawi-Tawi, and Sulu, are at risk from typhoons and floods. The level of risk varies by location and fluctuates monthly across different provinces, reflecting the need for localized adaptation strategies.

Thus, loss and damage due to climate-related hazards are significant, underscoring the urgent need for effective adaptation and risk reduction strategies to achieve a climate-resilient food system. The recommended measures to address these challenges are discussed in the subsections that follow.

Enhancing Social Protection Programs

The data shows that farmers and fisherfolk bear nearly all the impacts of climate-related hazards. To help them recover quickly from these disasters, a comprehensive social protection program is needed. This program should include:

1. Crop and life insurance – To strengthen the resilience of the Philippine agriculture sector against climate-related hazards, enhancing the current insurance system is essential. Crop insurance provides cash for inputs needed to re-establish new crops after disasters, while life insurance can support families affected by fatalities or debilitating injuries caused by extreme weather events. The Philippines could benefit from adopting models used in other countries, such as India's weather-based crop insurance scheme, which utilizes weather data to expedite payouts and reduce assessment costs, thereby supporting faster recovery for farmers (Mahul & Stutley, 2010). Jensen and Barrett (2017) provide further evidence on the potential of index-based agricultural insurance in developing countries. Their review highlights that such insurance can effectively transfer covariate

risk from smallholder farmers to global markets, potentially catalyzing rural economic growth. However, they also note challenges in product design and implementation, emphasizing the need for careful adaptation to local contexts. Integrating such insurance models into existing programs could streamline processes, ensuring timely financial assistance for affected farmers and enabling more efficient recovery in the wake of severe climate events.

2. Cash assistance – Immediate cash support after disasters will help address urgent needs, especially for those who have lost everything to the disaster. This article has discussed how farmers and fisherfolk are the most affected by loss and damage to agricultural productivity from climate hazards. Several studies have also demonstrated the effectiveness of cash-based interventions in post-disaster contexts. Doocy et al. (2016) found that cash transfers were generally more cost-effective than in-kind food assistance and had positive impacts on food security and dietary diversity in humanitarian emergencies. Hidrobo et al. (2014) compared cash, food vouchers, and food transfers in Ecuador, concluding that cash transfers were the most cost-effective in improving food consumption. A systematic review by Pega et al. (2015) revealed that unconditional cash transfers may improve some health outcomes and food security in the short term following humanitarian disasters. Gentilini (2016) conducted a comparative analysis showing that cash transfers were generally more efficient and cost-effective than vouchers or in-kind food aid, particularly in contexts with functioning markets. Additionally, Aker (2017) examined the impact of cash transfers in Niger following a drought, finding that households receiving cash transfers had higher food security and dietary diversity compared to those receiving food aid. These studies collectively provide strong evidence supporting the use of cash assistance as an effective and efficient means of addressing urgent needs following disasters, highlighting its flexibility and positive impacts on food security and overall household well-being in post-disaster contexts.

3. Cash-for-work programs – These will provide livelihoods while farmers wait for their new crops to mature, ensuring that affected households have a source of income during recovery periods. Notable cases of similar cash assistance programs in the Philippines include the Department of Social Welfare and Development's (DSWD) Emergency Cash Transfer (ECT), the SURE Aid concessional loans provided by the DA Agricultural Credit Policy Council (ACPC), and

the LandBank administered Rice Farmers Financial Assistance. Cash-for-work programs have been shown to be effective in post-disaster contexts. For instance, a study by the World Bank (2017) on recovery efforts following Typhoon Haiyan highlighted that cash-for-work programs not only provided immediate income to affected households but also contributed to community recovery through the rehabilitation of critical infrastructure. Participants reported significant improvements in their ability to meet basic needs, underscoring the program's role in facilitating faster recovery. Additionally, Beazley et al. (2021) conducted a comprehensive review of cash-for-work programs in fragile and conflict-affected situations, concluding that these interventions can effectively provide short-term employment and income support, particularly in post-disaster scenarios. The review emphasized that integrating cash-for-work initiatives with longer-term livelihood strategies and skills development can enhance their effectiveness. By implementing cash-for-work programs, the Philippine government can help stabilize the livelihoods of affected farmers and fisherfolk, ensuring they have the necessary financial support during critical recovery periods.

Targeting and Site-Specific Design

Using the provincial hazard frequency matrix (Table 7), we propose a four-tier classification of local government units (LGUs) based on average annual frequency of typhoon and flood events from 2011–2020:

1. *Very high risk* (≥ 5 events/year): e.g., Bulacan, Pampanga, Camarines Sur, Zambales
2. *High risk* (3–4 events/year): e.g., Camarines Norte, Ilocos Sur, Eastern Samar, Davao del Norte
3. *Moderate risk* (1–2 events/year): e.g., South Leyte, North Cotabato, Romblon, Bohol
4. *Low risk* (0 events/year): e.g., Basilan, Sulu, Tawi-Tawi

This classification allows national agencies to customize the social protection mix in accordance with localized climate risk. The Department of Agriculture's RFOs, in partnership with LGUs and guided by Adaptation and Mitigation Initiative in Agriculture (AMIA) village-level risk assessments, should implement the following risk-differentiated interventions:

1. Very high-risk provinces should be prioritized for parametric crop and life insurance indexed to Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) storm signals to enable faster payouts. In addition,

post-typhoon cash-for-work programs may be deployed for rapid debris removal, dike rehabilitation, and drainage clearing. The DSWD Emergency Shelter Assistance (ESA) program should be activated immediately for informal settlers and rural households whose dwellings are structurally vulnerable to typhoon impacts.

2. High-risk provinces should receive seasonally triggered cash transfers and livelihood restoration support, especially for vulnerable agricultural laborers. Mobile financial services can facilitate rapid disbursement of emergency funds. Pre-positioned emergency farm inputs—such as early maturing rice varieties and organic fertilizers—may also be distributed after flood events to support immediate replanting.

3. Moderate-risk provinces should focus on drought contingency measures such as input vouchers (e.g., for drought-tolerant seeds or small solar irrigation pumps) and canal desilting programs that offer short-term employment during dry months while simultaneously strengthening adaptive capacity.

4. Low-risk provinces should emphasize resilience building through livelihood diversification grants in sectors less exposed to typhoon and flood risks, such as seaweed culture, aquaculture, and community-based agro-processing. These areas can serve as regional hubs for value-added activities to absorb labor migration from more hazard-prone provinces.

Targeting of beneficiaries will utilize the DSWD National Household Targeting System for Poverty Reduction (NHTS-PR) unified list to minimize leakage and ensure alignment with both hazard exposure and poverty incidence. Integration with local social registries and AMIA geo-risk profiles will further enhance the precision of these interventions.

Institutional Responsibilities and Coordination

- Department of Agriculture – overall lead; Philippine Crop Insurance Corporation (PCIC) and ACPC administer parametric crop and life insurance and provide SURE Aid concessional loans. For example, PCIC paid PHP1.05 billion in indemnities after Typhoon Ulysses (2020), illustrating delivery capacity.
- DSWD – channels cash and emergency shelter assistance via the Assistance to Individuals in Crisis Situation (AICS) and ECT windows. For example, over PHP14 billion was disbursed post-Haiyan (2013).

- Department of Labor and Employment (DOLE) – implements cash-for-work (CFW) through the TUPAD (or *Tulong Panghanapbuhay sa Ating Disadvantaged/Displaced Workers*) program. For example, 190,000 beneficiaries engaged in debris clearing after Haiyan.
- LGUs – identify beneficiaries, certify losses, and co-finance counterpart funds, supported by DA RFOs.
- NDRRMC/Office of Civil Defense – triggers inter-agency cluster activation and releases Quick Response Fund tranches.
- Regular coordination meetings at regional disaster risk reduction and management councils will align agency budgets and avoid duplication.

Cash-for-Work Operational Modality

In the Philippine setting, CFW can be implemented through the DOLE TUPAD mechanism, with funds channeled from the DA Quick Response Fund (QRF) to DOLE via the NDRRMC fiduciary window. LGUs and DA RFOs pre-identify eligible barangays using the hazard tier matrix presented earlier in Table 7. The following mechanism can be used:

- Wage rate and duration – 100 % of the regional minimum wage for up to 30 days, released via LandBank cash cards within ten working days (DOLE, 173 2017).
- Typical activities:
 - o For very high- to high-risk provinces – debris clearing, dike repair, irrigation canal desilting;
 - o Moderate risk – excavation of community rainwater harvesting ponds and solar pump platforms;
 - o Low risk – nursery establishment and seedling production for watershed re greening.
- Targeting and equity–beneficiaries can be drawn from LGU master lists, cross checked with the DSWD’s NHTS-PR or *Listahan*; with 40 % reserved for women and youth.
- Monitoring – can be implemented through daily accomplishment logs verified by LGU engineers and uploaded to DOLE’s e-TUPAD database; spot audits by DA RFO.

Re-Aligning and Re-Orienting the Quick Response Fund

The Quick Response Fund (QRF) is a built-in budgetary allocation that represents a pre-disaster or stand-by fund that agencies can immediately use to assist areas stricken by catastrophes and crises (RA 10121, Section 22c). Currently,

the QRF is released in equal quarterly tranches to the Department. However, recent historical data indicate that losses are unevenly distributed across quarters, with proportions of 2:2:39:57 (Q1:Q2:Q3:Q4).

Related studies highlight the importance of a more flexible and needs-based allocation of disaster response funds. Benson and Clay (2004) emphasize that pre-disaster financial planning, when aligned with actual risk patterns, can reduce the economic damage of natural disasters. By reallocating funds to match periods of peak risk, the efficiency of disaster response can be significantly enhanced, reducing the prolonged economic strain on affected communities. Moreover, Kellett and Caravan (2013) advocate for disaster risk reduction financing to be adaptive, emphasizing that funds should be available when disaster impacts are highest. Their analysis of international aid shows that fixed funding schedules often fail to address the realities of uneven disaster impacts across different times of the year, which is directly relevant to the Philippines' QRF allocation.

Building on the evidence of loss and damage in Philippine agriculture presented earlier, it is essential to adjust budget allocations to align with historical patterns. This ensures that funds are available precisely when they are most needed. If crop insurance is assumed to fully cover all farmers and fisherfolk, the QRF can then be redirected to focus on immediate cash assistance and cash-for-work programs. The annual QRF budget should be calculated based on the average number of farmers and fisherfolk affected each year multiplied by the combined value of one-time cash assistance plus four months' worth of wages. The average number of farmers and fisherfolk affected each year can be approximated from the average area affected per year divided by 1.5, which is the average size of farms in the country. By strategically reallocating the QRF in this manner, the fund can be more effectively targeted, ensuring that resources are deployed precisely when and where they are needed most. Moreover, these recommendations are aligned with the DA's Climate-Smart Agriculture (CSA) Roadmap 2023–2027, which emphasizes resilience-oriented planning, adaptive financing mechanisms, and climate-smart agriculture (CSA) mainstreaming in national budgets.

Long-Term Resilience Financing and Structural Measures

To complement the QRF short-term focus, the Philippine government can adopt a four-pillar “risk-layered strategy” aligned with international best practices and national initiatives (World Bank, 2019; Asian Development Bank [ADB], 2023; DSWD, n.d.; FAO, 2023b; DOF, 2022):

1. Sovereign disaster risk financing (5-10 years) – In partnership with the World Bank, the Department of Finance (DOF) previously issued catastrophe-linked bonds worth USD225 million in 2019 to protect against typhoons and earthquakes. A second catastrophe bond tranche, estimated at PHP25 billion, is being drafted to transfer a portion of typhoon-related risks to global capital markets and automatically recapitalize the QRF when parametric triggers are met (World Bank, 2019).

2. Resilient infrastructure and storage bonds (10 years) – Under the national sustainable finance framework, the DA and the National Irrigation Administration (NIA), with the Department of Budget and Management (DBM), are exploring the issuance of “agri-resilience” green bonds. These bonds would finance climate-resilient infrastructure such as irrigation canals, multi-commodity storage hubs, and farm-to-market roads. Annual coupon payments may be serviced through a 5% earmark from the Rice Competitiveness Enhancement Fund (DOF, 2022; FAO, 2023b).

3. Mainstreaming climate-smart agriculture in the DA budget cycle (FY 2026–2030) – Following the 2023 CSA Roadmap developed with support from the Asian Development Bank (ADB), the DA aims to allocate at least 20% of its capital outlay to scale up CSA packages in high-risk provinces. These include drought-tolerant seeds, water-saving technologies, and digital climate advisories (ADB, 2023).

4. Adaptive social protection scaling (ongoing, 5 years) – The DSWD implements the emergency cash transfer as a post-disaster mechanism. Current efforts are underway to transform ECT into an adaptive social protection tool indexed to PAGASA early warning thresholds, allowing for anticipatory payouts that help reduce household asset loss (DSWD, n.d.).

Governance of this strategy is proposed under an Inter-Agency Agricultural Resilience Finance Committee (IARFC) chaired by the DOF, with the DA, DBM, National Economic and Development Authority, and the Bangko Sentral ng Pilipinas as members. Quarterly progress reporting would be made to the NDRRMC and the Cabinet Cluster on Climate Change Adaptation, Mitigation, and Disaster Risk Reduction.

Reducing the High Risk of Rice Production Loss

Addressing the high risk of production losses in rice requires measures to reduce vulnerability to floods and typhoons:

1. Adjusting the planting calendar – This involves shifting planting schedules to ensure harvests occur during months with minimal typhoon activity, as indicated in Table 7. Adjustments must be coordinated with input suppliers and the NIA to ensure water availability. The DA should lead this coordination at the national level. Following the success of planting calendar optimization in high-risk provinces in Region III, a pilot by the Philippine Rice Research Institute (PhilRice) and LGUs in Nueva

Ecija and Pampanga after Typhoon Lando (2015) demonstrated that transplanting rice 15–20 days earlier (in June instead of July) enabled farmers to harvest before the peak Q4 typhoon season, resulting in a 37% reduction in wet season losses (PhilRice, 2018). Based on this success, DA RFO III will replicate the adjustment across the 640 km² floodplain from San Isidro, Nueva Ecija to Candaba, Pampanga.

2. Planting submergence-tolerant rice varieties – The PhilRice should collaborate with rice seed producers to develop and distribute sufficient quantities of flood-tolerant seeds in vulnerable areas. Research by Blanc and Strobl (2016) emphasizes that developing resilient crop varieties is critical for reducing the impacts of extreme weather events on rice production, particularly in areas frequently affected by typhoons. In moderate- to high-risk areas such as Bicol and Eastern Visayas, the adoption of NSIC Rc194 (commonly known as Submarino 1 rice) has shown promising results. Across 1,870 hectares in the Baa-Buhi plain, Camarines Sur, this variety raised average yields from 3.1 tons per hectare to 4.2 tons per hectare, despite three significant flood events between 2018 and 2021 (International Rice Research Institute [IRRI], 2022). Building on this success, PhilRice and concerned LGUs will bulk 200 tons of certified seed for deployment in the 12 most flood-prone municipalities.

3. Improving access to machinery – The Rice Competitiveness Enhancement Fund (RCEF), as mandated by the Rice Tariffication Law (RA 11203), already allocates resources for rice machinery. Distribution should prioritize flood- and typhoon-prone regions, ensuring availability of harvesters and dryers during critical periods. For instance, under the RCEF Mechanization Program, a high-risk cluster of six barangays in San Jose, Occidental Mindoro received four combine harvesters in 2022. As a result, postharvest losses in the area dropped from 7% to 2%, and the turnaround time for harvesting was reduced by nine days (Philippine Center for Postharvest Development and Mechanization [PHilMech], 2023). Building on this success, similar mechanization clusters are being planned for other flood-prone areas such as Hagonoy in Bulacan and San Mateo in Isabela, where severe third-quarter flooding frequently disrupts manual harvesting operations.

4. Strengthening storage facilities – Warehouses for rice should be reinforced to withstand winds of up to 250 km/h, protecting harvested crops from damage during super typhoons. According

to Blanc and Strobl (2016), enhancing storage infrastructure is essential for safeguarding harvested crops against climate-related hazards, thereby reducing postharvest losses and ensuring food security. While various typhoon-resilient storage facilities have been established across the country, there is currently a lack of systematic studies or publicly available records evaluating their effectiveness in real-world disaster scenarios. This underscores the need for monitoring and assessment mechanisms to ensure that investments in resilient storage infrastructure translate into measurable postharvest protection and food security outcomes.

Strengthening Collaborations

Collaborations with LGUs, nongovernment organizations (NGOs), and other government entities should be strengthened through initiatives such as the establishment of AMIA villages and implementation of adaptation and risk reduction measures among neighboring LGUs.

Establishing AMIA Villages

The establishment of AMIA villages is a collaborative effort spearheaded by the DA to address location-specific climate risks. These villages consist of groups of farmers cultivating contiguous areas of at least 100 hectares, making them subject to similar climate vulnerabilities. Organized by the DA RFOs in partnership with municipal governments and, in some cases, NGOs like the Rice Watch Action Network Inc. and the International Institute of Rural Reconstruction (IIRR), these villages aim to increase and sustain agricultural productivity and incomes through integrated support services (Halos & Manalo, 2017; Koerner et al., 2019; Vidallo et al., 2019).

Each AMIA village is selected based on climate risk vulnerability assessments conducted jointly by the DA, LGUs, and participating farmers. These assessments consider exposure to hazards (such as typhoons, floods, or droughts), sensitivity of dominant crops, and local adaptive capacity. Based on these assessments, villages receive a customized package of interventions, which may include climate-resilient seeds, climate information services, diversified farming options, crop-livestock integration, and support for water harvesting or flood control (Koerner et al., 2019; Department of Agriculture Region 10, 2023). The DA provides technical support and capital investments, while LGUs are responsible for local coordination and co-financing.

Examples of existing AMIA villages include Guinayangan, Quezon (Luzon), one of the earliest pilot sites, which adopted climate-smart rice production and agroforestry practices to cope with frequent typhoons and erratic rainfall (Vidallo et al., 2019); Dao, Capiz (Visayas), where two barangays established an AMIA village in 2022 focusing on water-smart farming through the System of Rice Intensification (SRI), along with support for poultry and crop diversification (DA Region 6, 2025); and Magsaysay, Misamis Oriental (Mindanao), where upland farmers implemented sloping agricultural land technology (SALT), water impounding systems, and

seasonal climate advisories to reduce the impacts of erosion, drought, and rainfall variability (DA Region 10, 2023). These villages serve as demonstration sites or “learning laboratories,” where farmer-leaders, LGUs, and technical agencies co-develop, implement, and scale up climate adaptation practices across similar ecosystems. This approach aligns well with the Mandanas Ruling (Supreme Court, 2019), which increased the fiscal resources of LGUs and strengthened their role in implementing local development programs. Each AMIA village, depending on its climate vulnerability, market access, and farmer preferences, identifies and adopts the most suitable adaptation measures through participatory planning. Over time, AMIA villages aim to build a critical mass of farmers capable of withstanding and recovering from the increasing frequency and intensity of climate hazards.

Current measures to reduce flood risks include (a) establishing flood control systems and desilting existing canals and rivers; (b) providing technical and financial support to upland farmers for sustainable practices, such as SAL/T agroforestry (Halos & Manalo, 2017); and (c) exploring flood control solutions successfully implemented in other countries (Antolini et al., 2020; International Union for Conservation of Nature [IUCN] Nepal, 2011).

To reduce the adverse impact of droughts, some current measures include (a) providing open-source pumps and rehabilitating small scale irrigation projects (SSIPs) and diversion dams (DDs); (b) dredging upstream aprons of DDs and desilting existing irrigation canals; (c) offering grants or credit for replacing non-functional pumps and engines, and supporting the installation of solar and wind pump irrigation systems for high-value crops; and (d) constructing community rainwater harvesting systems (Halos & Manalo, 2017). Additional strategies may also be adopted from other regions’ successful experiences (Solh & Van Ginkel, 2014; Holman et al., 2021).

Two major adaptation strategies being promoted in all AMIA villages are the appropriate use of climate information services and the adoption of several integrated farming options. Timely climate information provided by DA RFOs, in collaboration with the PAGASA and the Department of Science and Technology (DOST), includes seasonal weather forecasts, localized 10-day forecasts, and special advisories for extreme weather events. Access to these services helps farmers make informed decisions, reducing climate-related risks. Encouraging diversified farming practices, such as combining crops with livestock or aquaculture, provides alternative sources of income. This diversification ensures that if one commodity fails due to a climate hazard, other commodities can still generate income, thereby enhancing the resilience of farming households.

Implementing Adaptation and Risk Reduction Measures Beyond Political Boundaries

Addressing the risks of floods and droughts requires adaptation strategies that extend beyond local political jurisdictions and are embedded within broader climate adaptation frameworks, including the Climate-Smart Agriculture Roadmap and inter-LGU watershed alliances supported by the Department of Environment and Natural Resources (DENR) and the regional development councils (RDCs). Given that a single watershed often spans multiple towns and provinces, comprehensive and coordinated management approaches are crucial to achieving effective climate resilience. Key measures, such as the greening of watersheds, riverbank stabilization,

agroforestry, and reforestation, help regulate water flow, reduce siltation, reduce flooding, and enhance water availability during droughts.

Watershed management formally falls under the supervision of DENR, in collaboration with LGUs, through its River Basin Control Office (RBCO), which is responsible for the integrated management of major river basins and watersheds. However, because of the interlinkages between upland ecosystems and downstream farming systems, the DA must play an active role in planning and implementing agricultural adaptation strategies within these landscapes. The Department of the Interior and Local Government (DILG) and LGUs are essential co-implementers, especially in harmonizing plans and allocating resources across municipalities within a single watershed (Pulhin et al., 2021).

To operationalize this collaboration, the DA should initiate the formation or strengthening of inter-LGU watershed management councils or alliances, similar to those used in the integrated river basin management (IRBM) approach. These platforms can be formalized through memoranda of agreement among LGUs, supported by plans endorsed by RDCs and funding from both national and local sources. In watersheds where IRBM structures already exist, the DA can align its AMIA and climate-resilient agriculture programs with the RBCO's watershed investment plans. At the regional level, the DA's participation in RDCs is essential to ensure that agricultural priorities are integrated into watershed-level planning and that upstream-downstream linkages are addressed through complementary investments.

Implementation strategies include (a) joint vulnerability assessments with DENR and LGUs across the watershed, (b) spatial mapping of high-risk agricultural zones and degraded forestlands, (c) co-financed projects (e.g., agroforestry buffer zones, desilting of shared irrigation sources, or inter-LGU flood control systems), and (d) shared monitoring systems for climate impacts using geographic information systems and satellite data (IUCN Nepal, 2011; Rebugio et al., 2007).

Through active engagement in RDCs and inter-LGU platforms, the DA can promote measures that enhance the resilience of farming systems while also supporting broader ecological and hydrological functions. These integrated efforts help align fragmented governance systems, optimize resources, and scale adaptation and risk reduction strategies across jurisdictions, ultimately supporting more inclusive and sustainable regional development.

Aligning Agricultural Adaptation with the National Adaptation Plan 2023–2050

The proposed measures and institutional strategies presented in this study closely align with the Philippines' National Adaptation Plan (NAP) 2023-2050 (Climate Change Commission [CCC], 2023), which outlines the country's long-term vision and priorities for climate-resilient development. Formulated through a whole-of-government and whole-of-society process, the NAP identifies agriculture, fisheries, and food security as one of the eight high-priority sectors most vulnerable to climate risks. Among the most affected are smallholder farmers and fisherfolk who face cascading impacts from rising temperatures, prolonged droughts, extreme precipitation, and intensifying typhoons.

The NAP anticipates a significant decline in agricultural productivity and rising exposure of rural livelihoods to climatic hazards. For example, rice and corn yields are projected to drop by 6% and 19%, respectively, by the 2030s. Simultaneously, 7.5% of the country's farmland may be exposed to pluvial floods, and 15% of fishponds to extreme sea levels, exacerbating vulnerability in coastal and lowland regions. The strategies proposed in this paper, including AMIA scaling, adaptive crop calendars, and layered risk financing, serve as entry points for realizing the NAP's food security objective: "Productive and resilient agriculture and fisheries are achieved; natural resources critical for agriculture, aquaculture, and fisheries are conserved; and livelihoods of farmers and fisherfolk are secured" (CCC, 2023, p. 36)

Moreover, the NAP outlines five cross-cutting adaptation strategies: (a) strengthening infrastructure resilience, (b) safeguarding livelihoods through social protection, (c) empowering LGUs and communities, (d) mainstreaming adaptation governance, and (e) scaling up nature-based solutions. These strategic themes are directly supported by this study's recommendations on risk-layered finance, CSA mainstreaming, watershed governance, and adaptive social protection. The proposed use of AMIA geo-risk profiles, local hazard tiers, and inter-LGU alliances helps operationalize the NAP's emphasis on data-driven, locally-grounded, and equity-focused adaptation.

The NAP also identifies key implementation enablers; i.e., governance, climate finance, data systems, and capacity-building, which overlap with the governance mechanisms detailed in this paper, such as coordination between DA, DSWD, DOLE, LGUs, and NDRRMC. These cross-agency platforms can be used to harmonize AMIA scaling with NAP goals and ensure alignment of agriculture adaptation programs with national climate priorities and budget tagging systems. Furthermore, the emphasis on anticipatory financing and early warning systems under the NAP bolsters the rationale for realigning the DA QRF with actual hazard risk patterns and for transforming post-disaster transfers into pre-disaster instruments.

In sum, the proposed adaptation measures for Philippine agriculture are not only responsive to observed losses and damage, but also deeply consistent with the NAP's strategic direction and development logic. Integrating these actions into the implementation of the NAP can help secure long-term agricultural resilience, enable convergence across sectors, and support the Philippines' transition toward inclusive and sustainable climate-resilient development by 2050.

Conclusion

This study provides an in-depth analysis of the significant loss and damage incurred by the Philippine agriculture sector due to climate-related hazards from 2011 to 2020. By utilizing detailed field data, the research highlights how typhoons, floods, moisture stress, and other natural hazards have led to an accumulated loss of over PHP295 billion, severely impacting the livelihoods of farmers and fisherfolk. The analysis underscores that nearly 99% of these losses are driven by climate-related events, with typhoons alone accounting for 88% of the total damage. The data not only reveals the scale of the problem but also emphasizes the urgent need for targeted adaptation measures to reduce these recurring losses. By analyzing patterns of damage across different provinces and quarters, the study provides critical insights

into how localized strategies can be tailored to address specific vulnerabilities, ensuring more effective interventions.

However, addressing these impacts requires more than just reactive measures; it calls for an evidence-based, proactive, and integrated approach to building climate resilience. The study highlights the necessity of implementing robust social protection programs, re-aligning funding mechanisms like the quick response fund, and fostering cross-sectoral collaboration. Strengthening partnerships between the Department of Agriculture, local government units, NGOs, and regional development councils is crucial to scale up initiatives like AMIA villages and ecosystem-based watershed management. Moreover, leveraging climate information services and promoting integrated farming systems can help diversify income sources for farmers, thus reducing their exposure to climate-induced risks. By aligning national policies with local realities and supporting evidence-based adaptation strategies, the Philippines can enhance its agricultural resilience, minimize future losses, and secure the livelihoods of its most vulnerable communities in the face of escalating climate threats.

In sum, this study confirms that climate-related hazards—particularly typhoons—account for the vast majority of agricultural loss and damage in the Philippines, with rice, coconut, and corn as the most affected commodities. The evidence strongly supports urgent and targeted adaptation, ranging from adjusted planting calendars and submergence-tolerant varieties to risk-differentiated social protection and realignment of the QRF. Building long-term resilience will require a multi-tiered approach, including sovereign risk financing, climate-resilient infrastructure investments, and the mainstreaming of climate-smart agriculture across government budgets. Equally important is strengthening local implementation through AMIA villages and watershed-scale coordination across LGUs. Taken together, these strategies provide a robust framework for protecting farmers and fisherfolk, reducing vulnerability, and achieving a climate-resilient agricultural system.

Endnotes

¹ Throughout this section, the term “mitigation” refers strictly to disaster risk reduction and adaptation-related measures in agriculture. Climate change mitigation (i.e., reducing greenhouse gas emissions) is not the focus of this study but may emerge as a co-benefit of selected adaptation strategies (e.g., agroforestry, reduced postharvest losses).

² This pertains to unregistered businesses that neither maintain financial records nor fulfill tax obligations.

References

- Aker, J. C. (2017). Comparing cash and voucher transfers in a humanitarian context: Evidence from the Democratic Republic of Congo. *The World Bank Economic Review*, 31(1), 44–70, <https://doi.org/10.1093/wber/lhv055>
- Antolini, F., Tate, E., Dalzell, B., Young, N., Johnson, K., & Hawthorne, P. L. (2020). Flood risk reduction from agricultural best management practices. *Journal of the American Water Resources Association*, 56(1), 161–179. <https://doi.org/10.1111/1752-1688.12812>
- Asian Development Bank. (2023). *Annual report 2023*. <https://www.developmentaid.org/api/frontend/cms/file/2024/04/adb-annual-report-2023.pdf>
- Beazley, R., Morris, R., & Vitali, A. (2016). Designing public works programmes and cash transfers to promote growth and mitigate violence. *K4D Emerging Issues Report 39*. Institute of Development Studies. <https://www.semanticscholar.org/paper/Designing-public-works-programmes-and-cash-to-and-Beazley-Morris/50a1bf0c8f20058bba6090d46e4fba5e4cc3ed05>

- Benson, C., & Clay, E. J. (2004). *Understanding the economic and financial impacts of natural disasters*. The World Bank. <https://documents1.worldbank.org/curated/en/146811468757215744/pdf/284060PAPER0Disaster0Risk0no-04.pdf>
- Birkmann, J. (Ed.). (2013). *Measuring vulnerability to natural hazards: Towards disaster resilient societies (2nd ed.)*. United Nations University Press. https://collections.unu.edu/eserv/unu%3A2880/n9789280812022_text.pdf
- Blanc, E., & Strobl, E. (2016). Assessing the impact of typhoons on rice production in the Philippines. *Journal of Applied Meteorology and Climatology*, 55(4), 993–1007. <https://doi.org/10.1175/JAMC-D-15-0214.1>
- Climate Change Commission. (2023). *National adaptation plan (NAP) 2023–2050: Strengthening resilience to climate change*. <https://www.climate.gov.ph/knowledge/ph-nap-2023-2050>
- Department of Agriculture-Regional Field Office 6. (2025, January 21). *A success story of unity and progress of AMIA Villages in Dao, Capiz*. DA Western Visayas. Retrieved from <https://westernvisayas.da.gov.ph/a-success-story-of-unity-and-progress-of-amia-villages-in-dao-capiz/>
- Department of Agriculture-Regional Field Office 10. (2023, April 23). *AMIA-10 convenes for 1Q review, planning workshop*. DA Region 10 (Northern Mindanao) News. Retrieved from <https://cagayandeoro.da.gov.ph/?p=88730>
- Department of Finance. (2022). *Republic of the Philippines Sustainable Finance Framework*. <https://www.treasury.gov.ph/wp-content/uploads/2022/01/Republic-of-Philippines-Sustainable-Finance-Framework-vF-with-disclaimer.pdf>
- Department of Labor and Employment. (2017) Department Order 173 2017: *Revised Guidelines on the Implementation DOLE Integrated Livelihood and Emergency Employment Program (DILEEP)*. <https://www.dole9portal.com/qms/references/QP-003-25/DO%20173-17.pdf>
- Department of Social Welfare and Development. (n.d.). *Emergency Cash Transfer (ECT)*. <https://drm.dswd.gov.ph/emergency-cash-transfer/>
- Doocy, S., Tappis, H., & Lyles, E. (2016). Are cash-based interventions a feasible approach for expanding humanitarian assistance in Syria? *Journal of International Humanitarian Action*, 1(1), 1-13. DOI: 10.1186/s41018-016-0015-7. https://www.researchgate.net/publication/310589671_Are_cash-based_interventions_a_feasible_approach_for_expanding_humanitarian_assistance_in_Syria
- Galvez, L. C., Koh, R. B. L., Barbosa, C. F. C., Asunto, J. C., Catalla, J. L., Atienza, R. G., Costales, K. T., Aquino, V. M., & Zhang, D. (2021). Sequencing and de novo assembly of Abaca (*Musa textilis* Née) var. Abuab genome. *Genes*, 12(1202). <https://doi.org/10.3390/genes12081202>
- Gentilini, U. (2016). The revival of the “cash versus food” debate: New evidence for an old quandary? *The World Bank Research Observer*, 31(1), 135-167. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2740118
- Food and Agriculture Organization. (2023a). *The impact of disasters on agriculture and food security. Food and Agriculture Organization of the United Nations*. <https://www.fao.org/publications/home/fao-flagship-publications/the-impact-of-disasters-on-agriculture-and-food-security/en>
- Food and Agriculture Organization. (2023b). *Regional knowledge exchange: Green bonds to mobilize finance for sustainable agriculture and food security in Asia and the Pacific*. <https://www.fao.org/asiapacific/news/news-detail/regional-knowledge-exchange--green-bonds-to-mobilize-finance-for-sustainable-agriculture-and-food-security-in-asia-and-the-pacific/en>
- Halos, S. C., & Manalo, A. J. (2017). *Guidebook on climate change and disaster preparedness, emergency response, and disaster recovery*. Adaptation and Mitigation Initiative in Agriculture, Department of Agriculture-Systems Wide Climate Change Office. Quezon City, Philippines.
- Hidrobo, M., Hoddinott, J., Peterman, A., Margolies, A., & Moreira, V. (2014). Cash, food, or vouchers? Evidence from a randomized experiment in northern Ecuador. *Journal of Development Economics*, 107, 144-156. <https://www.sciencedirect.com/science/article/pii/S0304387813001715>
- Holman, I. P., Hess, T. M., Rey, D., & Knox, J. W. (2021). A multi-level framework for adaptation to drought within temperate agriculture. *Frontiers in Environmental Science*, 8, 589871. <https://doi.org/10.3389/fenvs.2020.589871>
- Intergovernmental Panel on Climate Change. (2022). *Climate Change 2022: Impacts, Adaptation and Vulnerability*. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. <https://www.ipcc.ch/report/ar6/wg2/>

- International Rice Research Institute. (2022). *Scaling submergence-tolerant rice varieties in flood-prone regions of the Philippines: Impact assessment in Camarines Sur (2018-2021)*. <https://www.irri.org/publications>
- International Union for Conservation of Nature Nepal. (2011). *Integrated watershed conservation and management plan: Sardu Watershed, Dharan, Sunsari, Nepal*. Retrieved from <https://www.iucn.org>
- Israel, D. C., & Briones, R. M. (2013). *Impacts of natural disasters on agriculture, food security, and natural resources and environment in the Philippines*. (ERIA Discussion Paper 2013-15). <https://www.eria.org/ERIA-DP-2013-15.pdf>
- Jensen, N. D., & Barrett, C. B. (2017). Agricultural index insurance for development. *Applied Economic Perspectives and Policy*, 39(2), 199-219. <https://onlinelibrary.wiley.com/doi/abs/10.1093/aapp/ppw022>
- Kellett, J., & Caravani, A. (2013). *Financing disaster risk reduction: A 20-year story of international aid*. Overseas Development Institute. <https://media.odi.org/documents/8574.pdf>
- Koerner J., Bayot R.S., Rosimo M., Vidallo R., & Gonsalves J. (2019). *Scaling the capacities to adapt to a changing climate: Experiences of the AMIA climate resilient villages, Philippines*. CCAFS Info note. Wageningen, Netherlands: CGIAR Research Program on Climate Change, Agriculture and Food Security. <https://cgspace.cgiar.org/items/985c80ea-4e32-4e34-853c-5bf13c430262>
- Kristensen, P. (2004). *The DPSIR framework*. [Paper presentation]. Workshop on a comprehensive/detailed assessment of the vulnerability of water resources to environmental change in Africa using river basin approach, UNEP Headquarters, Nairobi, Kenya, 27–29 September 2004. <https://greenresistance.wordpress.com/wp-content/uploads/2008/10/dpsir-1.pdf>
- Lim, B. M., Morales, C. V., San Juan, B. F., & Gines, P. L. (2019). *Agriculture and fisheries disaster risk reduction and management operations manual (Part I)*. Department of Agriculture, Quezon City, Philippines.
- Mahul, O., & Stutley, C. J. (2010). *Government support to agricultural insurance: Challenges and options for developing countries*. The World Bank. <https://documents1.worldbank.org/curated/en/698091468163160913/pdf/538810PUB0Gove101Official0Use0Only1.pdf>
- Pega, F., Liu, S. Y., Walter, S., & Lhachimi, S. K. (2015). Unconditional cash transfers for assistance in humanitarian disasters: Effect on use of health services and health outcomes in low and middle income countries. *Cochrane Database of Systematic Reviews*, (9), CD011247. <https://pubmed.ncbi.nlm.nih.gov/26360970/>
- Philippine Center for Postharvest Development and Mechanization. (2022). *PHilMech annual report 2022*. <https://rcef.philmech.gov.ph/?page=rcefUpdate&action=annualReports>
- Philippine Rice Research Institute. (2018). *Optimizing rice planting calendars for typhoon-prone areas: Lessons from Typhoon Lando in Central Luzon*. Philippine Rice Research Institute. <https://www.philrice.gov.ph/publications>
- Philippine Statistics Authority. (2021). *Palay and corn: Volume of production in metric tons; Area harvested in hectares by ecosystem / croptype, by quarter, by semester, by region and province (1987–2021)* [Data set]. PSA OpenStat. https://openstat.psa.gov.ph/PXWeb/pxweb/en/DB/DB__2E__CS/?tablelist=true&rxid=bdf9d8da-96f1-4100-ae09-18cb3eae313
- Proclamation 1143. (2021) *Declaring a state of calamity throughout the Philippines due to the African swine fever outbreak*. <https://pco.gov.ph/wp-content/uploads/2021/05/20210510-PROC-1143-RRD.pdf>
- Pulhin, J. M., Tapia-Villamayor, M. A., Garcia, J. E., De Luna, C. C., Cruz, R. V. O., Pulhin, F. B., & Ramirez, M. A. M. (2021). Participatory climate change adaptation using watershed approach: Processes and lessons from the Philippines. In T. Ito, M. Tamura, A. Kotera, & Y. Ishikawa-Ishiwata (Eds.), *Interlocal adaptations to climate change in East and Southeast Asia: Sharing lessons of agriculture, disaster risk reduction, and resource management* (pp. 19–38). Springer. https://doi.org/10.1007/978-3-030-81207-2_2
- Rebugio, L. L., Pulhin, J. M., Carandang, A. P., Peralta, E. O., Camacho, L. D., & Bantayan, N. C. (2007). *Forest restoration and rehabilitation in the Philippines*. University of the Philippines Los Baños, College of Forestry and Natural Resources. https://www.researchgate.net/publication/285314978_Forest_restoration_and_rehabilitation_in_the_philippines

- Republic Act 10121. *Philippine Disaster Risk Reduction and Management Act of 2010*. (2010). <https://www.officialgazette.gov.ph/2010/05/27/republic-act-no-10121/>
- Solh, M., & Van Ginkel, M. (2014). Drought preparedness and drought mitigation in the developing world's drylands. *Weather and Climate Extremes*, 3, 62-66. <https://doi.org/10.1016/j.wace.2014.03.003>
- Supreme Court of the Philippines. (2019). Congressman Hermilando I. Mandanas, et al. vs. Executive Secretary Paquito N. Ochoa, Jr., et al./Honorable Enrique T. Garcia, Jr. vs. Honorable Paquito N. Ochoa, Jr., et al. (G.R. No. 199802/G.R. No. 208488). <https://elibrary.judiciary.gov.ph/thebookshelf/showdocs/1/64325>
- United Nations Office for Disaster Risk Reduction. (2025). *Disaster losses and damages data*. Retrieved from <https://www.undrr.org/media/105262>
- Vidallo R., Bayot R., Rosimo M., Monville-Oro E., Gonsalves J., Ilaga A., Sebastian L., Manalo U., & Baltazar P. (2019). *The AMIA experience: Supporting local actions for climate resilient agriculture*. International Institute for Rural Reconstruction. <https://cgspace.cgiar.org/items/d6572e35-1622-49b4-94c8-2d378fd47059>
- World Bank. (2017). *Philippines lessons learned from Yolanda : An assessment of the post-Yolanda short- and medium-term recovery and rehabilitation interventions of the government*. <https://openknowledge.worldbank.org/handle/10986/28540>
- World Bank. (2019, November 25). World Bank catastrophe bond transaction insures the Republic of Philippines against natural disaster-related losses up to USD225 million. <https://www.worldbank.org/en/news/press-release/2019/11/25/world-bank-catastrophe-bond-transaction-insures-the-republic-of-philippines-against-natural-disaster-related-losses-up-to-usd225-million>
- World Risk Report. (2020). *World risk index 2020*. Bündnis Entwicklung Hilft and Ruhr University Bochum. https://weltrisikobericht.de/wp-content/uploads/2020/12/WRR_2020_online_.pdf

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