NATIONAL ADAPTATION PLAN OF THE PHILIPPINES

NAP

2023 - 2050

Appendices


Cebu-Cordova Bridge (CCLEX) [credit: cclex.com.ph]

Appendices

1. Appendices - NAP Development Process Participants

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NAP Inter-agency National Steering Committee (NSC)

DA and its Bureaus/Offices

- Bureau of Fisheries and Aquatic Resources (BFAR)
- Bureau of Animal Industry (BAI)
- Bureau of Soils and Water Management (BSWM) - Water Resources Management Division (WRMD)
- Climate Resilient Agriculture Office (CRAO)
- High Value Crops Development Program (HVCPD)
- Halal Program
- National Corn Program (NCP)
- National Urban and Peri-Urban Agriculture Program (NUPAP)
- National Organic Agriculture Program (NOAP)
- National Livestock Program (NLP)

Department of Budget and Management (DBM)

- Budget and Management Bureau (BMB)
- Fiscal Planning and Reforms Bureau (FPRB)

Department of Energy (DOE)

- Energy Policy and Planning Bureau

Other DENR Bureaus/Offices:

- Climate Change Service (CCS)
- Ecosystems Research and Development Bureau (ERDB)
- Land Management Bureau (LMB)
- Mines and Geosciences Bureau (MGB)
- National Mapping and Resource Information Authority (NAMRIA)
- National Water Resources Board (NWRB)
- River Basin Control Office (RBCO)

Department of Finance (DOF)

- International Finance Policy Office (IFPO)

Department of Health (DOH)

Department of Human Settlement and Urban Development (DHSUD)

Department of Interior and Local Government (DILG)

Department of Labor and Employment (DOLE)

- Bureau of Workers with Special Concerns (BWSC)

Department of National Defense - Office of Civil Defense (DND-OCD)

Department of Public Works and Highways (DPWH)

Other DOST Offices

- Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA)
- Philippine Institute of Volcanology and Seismology (PHIVOLCS)

Department of Tourism (DOT)

Department of Transportation (DOTr)

Department of Trade and Industry (DTI)

League of Cities of the Philippines (LCP)

League of Municipalities of the Philippines (LMP)

National Commission for Culture and the Arts (NCCA)

National Commission on Senior Citizens (NCSC)

National Economic and Development Authority (NEDA)

- Agriculture, Natural Resources, and Environment Staff (ANRES)
- Social Development Staff (SDS)

National Security Council (NSC)

Philippine Commission on Women (PCW)

Philippine Statistics Authority (PSA)

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Aksyon Klima Pilipinas

Asian Development Bank (ADB)

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) Philippines

International Organization for Migration (IOM)

Japan International Cooperation Agency (JICA) Philippines

Lasalian Insitute for the Environment

Miriam College- Environmental Studies Institute

Nestle Philippines

Oxfam Pilipinas

Parabukas

Philippine Green Building Council (PhilGBC)

Philippine Red Cross

Tebtebba

United Nations Children's Fund (UNICEF)

University of the Philippines - Manila College of Public Health

University of the Philippines Resilience Institute (UPRI)

World Vision Development Foundation (WVDF)

World Wide Fund for Nature (WWF) Philippines

2. Appendix 2 - Chapter 3

2.1 CID modeling methods - summary

The methodologies used for the CID analysis are summarized below.

CID	Increased Temperatures	Drought	Extreme Precipitation	Sea Level Rise and Extreme Sea Levels	Wind Patterns and Tropical Cyclones
Data source	CMIP6 ERA5 Reanalysis	CMIP6	CMIP6 Fathom Global release 3.0	IPCC AR6 Coastal Futures Nasa Earth data (NASADEM) Alaska satellite facility	IBTrACS CIMP6

[326] Civil society organizations

[327] Non-Government organizations

CID	Increased Temperatures	Drought	Extreme Precipitation	Sea Level Rise and Extreme Sea Levels	Wind Patterns and Tropical Cyclones
Methodology	**Temperature projections:** Utilize CMIP6 for near surface air temperature projections and ERA5 reanalysis for historical data to project temperature patterns for the Philippines. **Heat index:** Heat index is a heat stress indicator used by the US National Oceanic and Atmospheric Administration (NOAA) National Weather Service for issuing heat warnings. It is calculated using multiple linear regression based on daily maximum temperature and relative humidity (calculated from daily mean specific humidity and surface pressure). **Wet-bulb globe temperature index:** A heat stress indicator that is calculated as weighted mean of wet-bulb temperature, globe temperature, and daily maximum temperature. The wet-bulb temperature index is a heat stress indicator that indicates the human cooling capacity through sweating. It is calculated from the equivalent potential temperature based on daily maximum temperature and water vapor mixing ratio (calculated from daily mean specific humidity and surface pressure). **Unproductive days:** Identify and count the number of unproductive days based on the heat index exceeding 42°C (danger classification according to PAGASA)	**Consecutive Dry Days (CDD):** Maximum number of days in a row with precipitation below 1 mm in a year. **Standardized Precipitation-Evapotranspiration Index (SPEI):** Calculate standardized anomalies of the water balance by comparing precipitation and potential evapotranspiration (PET) data to historical climatology. **Standardized Soil Moisture Index (SSMI):** Determine standardized anomalies of soil moisture content by considering precipitation, PET, soil properties, and vegetation characteristics. **Standardized Surface Flow Index (SSFI):** Measure standardized anomalies of surface water flow by comparing current flow values to the long-term average. **Effective Drought Index (EDI):** Assess the severity of drought conditions by quantifying the deviation of current weather conditions from projected climate conditions	**Precipitation:** The sum of liquid and frozen water, comprising rain and snow, that falls to the Earth's surface. It is the sum of large-scale precipitation and convective precipitation. This parameter does not include fog, dew or the precipitation that evaporates in the atmosphere before it lands at the surface of of the Earth. **Max 24hr precipitation:** Maximum precipitation on a single day in period (year or month). Precipitation is deposition of water on the Earth's surface, either rain, snow, ice, or hail. **Pluvial and fluvial flooding:** Incorporate hydraulic models based on shallow water equations to predict how the water behaves during flooding events. Pluvial flooding refers to flooding that happens due to excessive rainfall overwhelming the local drainage capacity. Fluvial flooding refers to flooding that occurs as a result of the overflowing of rivers, streams etc. **Landslide:** Geological data and logistic regression used to project the annual frequency of significant rain-induced landslides at 1 km x1 km resolution over the last ~30 years	**Flooding scenario (areas and depth):** Calculate inundated areas using bathtub model with an eight-way hydrological connectivity rule provided elevation from NASA and vertical displacement from Alaska satellite facility and sea level/extreme sea level scenario from IPCC AR6/Coastal Futures. **Vertical displacement:** Synthetic Aperture Radar (SAR) data used to understand the slope and roughness of the earth's surface & distance from satellite to earth's surface. Images of the same area every six months for two years (January 2021 to Dec 2022) is used to calculate the displacement of the surface from the line of sight of the satellite (adjusting for the satellite's orbit) and converted to vertical displacement.	**Cyclone track simulation:** Use spatial probability based on coordinates of past cyclones' first observations (Poisson Law) and past cyclone tracks + statistical correlation with climate drivers from CMIP6

2.2 CID modeling methodologies – details

Increased Tempeartures	
Output model	Temperature projections, heat Index, wet-bulb globe temperatures, unproductive days per region for Philippine area of responsibility across SSP2-4.5 and SSP5-8.5 scenarios until period of 2050
Detailed methodology	• Temperature Projections: Utilize climate model (ACCESS-CM2) for temperature projections, heat index, wet-bulb globe temperatures and unproductive days for the Philippines under two different scenarios, namely SSP2-4.5 and SSP5-8.5. These scenarios represent different pathways of future greenhouse gas emissions and socioeconomic development. • Heat index: A heat stress indicator used by the US National Oceanic and Atmospheric Administration (NOAA) National Weather Service for issuing heat warnings. It is calculated using multiple linear regression based on daily maximum temperature and relative humidity (calculated from daily mean specific humidity and surface pressure). • Wet-bulb globe temperature index: A heat stress indicator that is calculated as weighted mean of wet-bulb temperature, globe temperature, and daily maximum temperature. The wet-bulb temperature index is a heat stress indicator that indicates the human cooling capacity through sweating. It is calculated from the equivalent potential temperature based on daily maximum temperature and water vapor mixing ratio (calculated from daily mean specific humidity and surface pressure). • Unproductive Days: Identify and count the number of unproductive days based on the heat index exceeding 42°C
Method of validation	Compare model projections with observed temperature data for past years from ERA5 reanalysis as well as observing high level trends from PAGASA reports
Data sources	• Climate model data from CMIP6 (Coupled Model Intercomparison Project Phase 6) • ERA5 Reanalysis (ECMWF atmospheric reanalysis 5th generation) data for historical temperature data to validate the model projections
Next steps	• Currently, only 1 GCM is used (ACCESS-CM2). Aggregating multiple models is recommended. • There may be systematic biases in CMIP6/ERA5 data e.g., due to topography. Downscaling/localizing the dataset is recommended. • Update historical baselines and projections for heat index and wet-bulb globe temperature index to historical (1991-2020), near-term (2021-2040) and mid- term (2041-2060) • Use projected populations
Assumptions	• Climate models provide reliable projections of future temperature patterns • Population impacted: Populations located in area exposed to heat Index greater than 42°C; Based on PAGASA, this is the "Danger" threshold above which the human body may experience "heat cramps or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity"

2.2 CID modeling methodologies – details

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Output model	Temperature projections, heat Index, wet-bulb globe temperatures, unproductive days per region for Philippine area of responsibility across SSP2-4.5 and SSP5-8.5 scenarios until period of 2050
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2.2 CID modeling methodologies – details

Landslides	
Output model	Gridded map of estimated annual frequency of significant landslides per square kilometer. Significant landslides are those which are likely to have been reported had they occurred in a populated place.
Detailed methodology	Approach for the estimation of quantitative precipitation-triggered landslide hazard: • Global landslide susceptibility map: identify places with high susceptibility of landslides (infrastructure built, trees cut down or burned, close distance of tectonic default, high slope). • Enrich this map with historical landslides recorded by in the NASA Global Landslide Catalogue. • NOAA Global Precipitation Data used to describe the amount of precipitation which occurred in the days & weeks leading up to each historical landslide. • Logistic regression analysis calibrated using the landslide catalogue estimating the probability that a landslide will occur in any location given the landslide susceptibility and the precipitation data as inputs • Application at a global scale using daily precipitation data between 1980 and 2018 to estimate the daily probability of landslide occurrence on a 1 km grid for any location in the world. These daily estimates are aggregated on a yearly basis to produce estimates of the total annual frequency of landslides.
Method of validation	The data was randomly split into a training (80%) and a test (20%) dataset to allow verification of the model accuracy.
Data sources	Global Landslide Hazard map—precipitation trigger—the World bank NASA Global Landslide Catalogue NASA Global Susceptibility Mao NOAA CPC Precipitation Data
Next steps	Outputs are historical and need to consider the change in landslide frequency due to future precipitation patterns. Outputs should consider landslide intensity
Assumptions	

Sea Level Rise and Extreme Sea Levels	
Output model	Projected level of coastal flooding (acute and chronic) in 2030 and 2050, across both SSP2-4.5 and SSP5-8.5 scenario: Level of coastal flooding includes: • Chronic risk (slow accelerating phenomenon): identification of submerged areas and depth of projected inundation due to sea level rise in 2030 and 2050, across SSP2-4.5 and SSP5-8.5 scenario. Sea level rise projections consider sterodynamic sea level, glaciers, land water storage, ice sheets and subsidence. • Acute risk: 1 in 10-year return period extreme sea levels including astronomical tides, storm surges, waves and swash

Sea Level Rise and Extreme Sea Levels	
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Detailed methodology	Model to determine flooding risk combines four components: 1. Absolute sea level rise 2. Projected extreme sea levels 3. Land elevation 4. Vertical displacement The model uses an eight-way hydrological connectivity rule: • The land is split into ~30m grid (1 arcsecond) based on the resolution of our NASADEM digital elevation data • A cell is flooded if: (1) + (2) > (3) + (4) i.e., Flood depth > Land elevation after considering vertical displacement • A cell is flooded only if it is connected to a water body directly or via an adjacent flooded cell in either cardinal or diagonal directions.
Method of validation	Comparison with historical sea levels. Sanity checks of projected flood levels with world bank reports and Climate Central.
Data sources	Sea level rise: IPCC AR6 sea level projections Extreme Sea Level events: Coastal futures Elevation data: Nasa earth data Land subsidence: Alaska satellite facility
Next steps	• Incorporate existing adaptations (e.g., sea walls) • Downscaling and localized validation • Include uncertainty • Use projected populations • Apply process based models e.g. shallow water equations
Assumptions	Sea level rise population and area impacted: Population located in area flooded with at least 30 cm to 50 cm of water; 30 cm: light vehicles cannot pass through (half-knee level); Local government can put in place short-term solutions to elevate road profile & housing floor height at around 50 cm. Extreme sea levels population and area impacted: Population located in area flooded with at least 30 cm to 60 cm of water; Warning systems in the Philippines considers flood depth > 60cm will result in forced evacuation. According to MMDA flood gauge, 30cm is the height where light vehicles cannot pass through (half-knee level).

Vertical Displacement	
Output model	Heat map of average vertical displacement from January 2021 to December 2022
Detailed methodology	• Synthetic Aperture Radar (SAR) data from Alaska Satellite facility transmits pulses of microwave energy to the Earth's surface and records the amount of backscattered energy. • This allows us to understand the slope and roughness of the earth's surface and distance from satellite to earth's surface. • Hyp3 software is used to identify images of the same area every six months for two years and calculate the displacement of the surface from the line of sight of the satellite (adjusting for the satellite's orbit) which is then converted to vertical displacement of the surface
Method of validation	Compare subsidence hotspots with groundwater usage. On the ground further validation is required
Data sources	Alaska satellite facility
Next steps	• Localized validation
Assumptions	• Historical vertical displacement is reflective of future displacement • Full coverage of Palawan Island only contained six months historical data instead of two years and assumed to be representative • SAR data have limitations in accuracy due to factors such as atmospheric conditions, surface roughness, and system noise.

Wind Patterns and Tropical Cyclones	
Output model	Cyclone trajectory projections for Philippine Area of Responsibility across SSP2-4.5 and SSP5-8.5 scenarios until period of 2050
Detailed methodology	• Analyze spatial distribution of historical cyclones • Build a spatial probabilistic model based on the Poisson law to define the cyclogenesis, i.e., starting points of cyclones for each year and each scenario. • Build a statistical model defining the correlation between Climatic impact-drivers (mean sea level pressure, relative humidity (near surface), sea surface temperature, tropopause temperature) and cyclones tracks and characteristics (wind speed, pressure). • Apply this model to cyclogenesis to compute the tracks of the cyclones, for each year and each scenario, incorporating therefore the impact of climate change. • Repeat that operation 15 times to get 15 independent samples of simulated cyclones, for each year and each climate scenario. • Classify simulated cyclones based on their wind speed, following PAGASA Tropical Cyclones classification. • For each region of the country, compute the projected occurrence of each class of cyclone as the sum of cyclones occurring in that region across all samples, divided by the number of samples.
Method of validation	Compare projected occurrence per region and per type of cyclone with number of cyclones per region in the historical data. Compare the projected wind speed and projected pressure drop with historical data. Analyze projected tracks of cyclones, to make sure they are consistent with historical patterns.

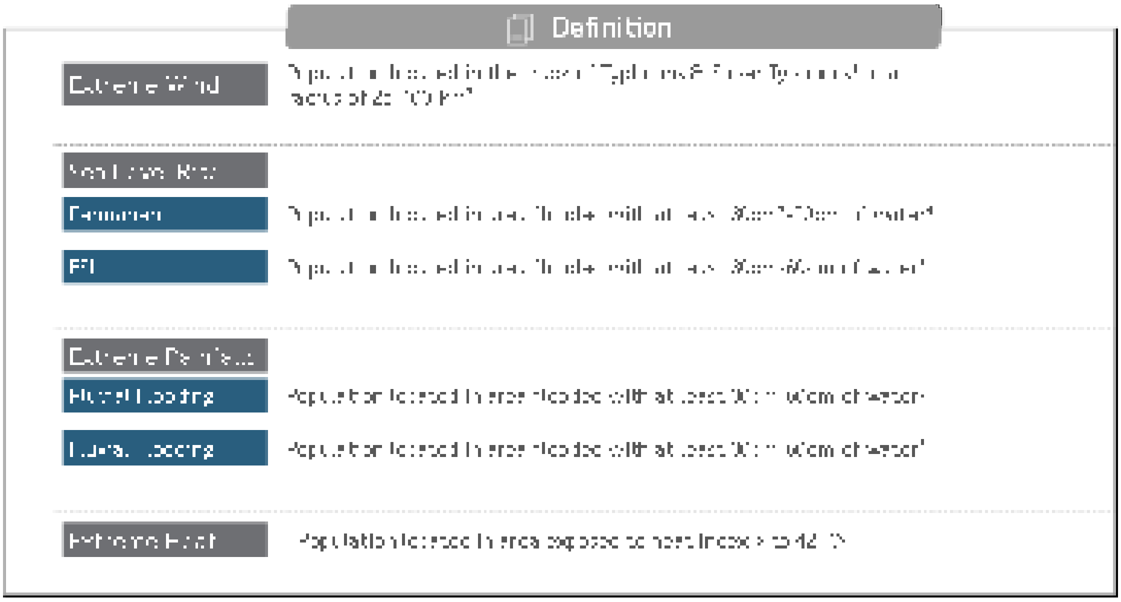
Wind Patterns and Tropical Cyclones	
Data sources	International Best Track Archive for Climate Stewardship (IBTrACS) CMIP6 (Coupled Model Intercomparison Project Phase 6)
Next steps	• Further localization and downscaling of projected data taking into account land cover (e.g., mountains) that might have an impact on wind speed • Aggregate multiple GCMs from CMIP6 • Update historical baselines and to historical (1991-2020), near-term (2021-2040) and mid- term (2041-2060) • Project larger sample of cyclone trajectories (currently 15 ensembles)
Assumptions	Population and area impacted: Population located in the track of Typhoons & Super Typhoons (min speed 118 km/h) in a radius of 25 to 100 km. The World Meteorological Organization considers areas of high winds [of mature tropical cyclones] is usually no more than about 150 to 250 km across. At the center of the storm is the "eye", a roughly circular area, typically 20 to 50 km in diameter. National Disaster Risk Reduction and Management Council (NDRRMC) guidelines consider medium to low risk as 1 to 100 km away from breadth of the storm.

Population and Area Impacted by CIDS per Region	
Output model	Number of people and number of square kilometers yearly exposed to each CID for 2030 decade and for 2050 decade, per province, for scenario SSP2-4.5 and SSP5-8.5. We also compute the number of females, children, aged people and people below poverty threshold (PHP12,030 per month for a family of five) within the exposed population.
Detailed methodology	Population data covers the entire Philippines land at a resolution of 3 arc (approximatively 100m at the equator). For each geo coordinate in that data source, we consider it exposed to a CID if it is in the bounds of the below definition of exposed based on literature and country-specific policies. • A population is considered exposed to cyclones if the wind speed is greater than 177 km/h (lower bound of Typhoons according to PAGASA classification) and within 100 km of radius (average area of high speed for strong cyclones according to the world meteorological organization) • A population is considered exposed to permanent flooding (permanent sea level rise) if it is located in a flooded area with at least 50 cm of flooding depth (local government in Philippines can put in place short-term solution to elevate road profiles or house floor by maximum 50 cm). • A population is considered exposed to exceptional flooding (Extreme Sea Level rise events, pluvial or fluvial floodings) if located in an area flooded at least by 60 cm of water (threshold resulting in forced evacuation in Philippines Warning System). • A population is considered exposed to increased temperature if exposed to a heat index greater than to 42°C ("Danger" classification according to PAGASA—level above which human body may experience heat cramps or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity). Each geo coordinate of that data source is assumed to be 2500 m2 (square of 50 m size). We then add all the exposed areas according to the above parameter per province to get the total area exposed per province and per CID. And we add all the population associated to each geo coordinate to get the total population exposed per province and per CID.
Method of validation	For each CID, we've compared our results with official reports from the Philippine government (including the PAGASA website) and from international institutions (including the World Bank) to make sure we've landed on the same order of magnitude. We've also compared our results with past events, comparing the expected population & area impacted with past exposure.

Population and Area Impacted by CIDS per Region	
Data sources	• Population data per Municipality: PSA • Age and Gender Data: The Humanitarian Data Exchange • Poverty Data: PSA • Exposure Parameters: Cyclones: World Meteorological Organization Sea Level Rise: Philippines global report on internal displacement • Extreme Sea Levels, Pluvial & Fluvial Flooding: Philippines Flooding Warning System
Next steps	2020 population according to PSA is used. Projected populations should be considered as a next step
Assumptions	See above

Economic Impact of CIDS	
Output model	Cost of damages to infrastructure across SSP2-4.5 and SSP5-8.5 scenarios until period of 2050
Detailed methodology	• Location of points of interests were obtained from Open Street Maps, Google APIs and Philippines government and mapped to sectors and their asset values provided by University of the Philippines Diliman and literature scan. • Flooding damage curves from University of the Philippines Diliman and European Commission Joint Research Centre were used to assess the percentage of damage at flood heights for each scenario for each point of interest. These damage curves were used to calculate sea level rise, extreme sea levels, pluvial and fluvial flood damage. • Wind damage curves from University of the Philippines Diliman is used to assess the percentage of damage depending on wind speeds (from tropical cyclones trajectories) for each scenario for each point of interest. • The damage to an infrastructure is calculated as the % damage from damage curves multiplied by the asset value • To avoid double counting of damage to an asset from multiple acute events, e.g., if a home is already damaged by pluvial floods, the impact of wind damage should not be counted. For each point of interest, only the maximum damage from annualized acute events is considered (pluvial floods, fluvial floods, extreme sea levels and wind)
Method of validation	Total annual damage is compared to historical statistics from PSA as well as literature e.g., World Bank
Data sources	Damage curves: University of the Philippines Diliman and European Commission Joint Research Centre Asset Values: University of the Philippines Diliman and various literature Locations of assets: Open Street Maps, Google APIs, and Philippines Government
Next steps	• Currently, only 10-year return period events are considered and are annualized. Damage from different return period events e.g., 100-year, 500-year should be considered and annualized. • Consider adaptive capacity by location e.g., barangay/municipality. • Localization/downscaling of projections of CIDs and validation including considering adaptations e.g., sea walls • Aggregate multiple GCMs in the climate projections
Assumptions	Damage curves used were defined by building type. Assumptions were made on the building type of each asset: • Residential (64% C1-L-1 and 36% W1-L-1), commercial (C1-M), industrial (S1-L-1), transport (S1-L-1)

2.2.1 Definition of Exposed by CID



1. Min speed: 118 km/h;
2. 2. World Meteorological Organization: the area of high winds [of mature tropical cyclones] is usually no more than about 150 to 250 km across. At the center of the storm is the "eye", a roughly circular area, typically 20 to 50 km in diameter. National Disaster Risk Reduction and Management Council (NDRRMC) guidelines: Medium to low Risk: 1 to 100 km away from breadth of the storm.
3. 330 cm: light vehicles cannot pass through (half-knee level) according to MMDA flood gauge
4. Local government can put in place short-term solutions to elevate road profile & housing floor height for around 50 cm based on local experience.
5. Warning system in the Philippines considers flood depth > 60 cm will result to forced evacuation according to select LGU standards and DILG.
6. PAGASA Danger Classification: threshold above which the human body may experience "heat cramps or heat exhaustion likely, and heat stroke possible with prolonged exposure and/or physical activity"
7. Assumption is at the national level—there is no distinction from rural or urban land

2.2.2 Province Exposure Categorization Methodology

Population and Area Impacted by CIDS per Region	
Output model	Mapping of each province/independent city to a category of exposure (high, medium-high, medium, medium-low, low)
Detailed methodology	• For each climatic impact-driver, social, economic, and physical dimensions are considered with equal weighting between the 3. • The ranking of each province for each dimension is summed as a normalization technique to get the exposure score for each province. • High exposure corresponds to 80-100th percentile value of exposure score, medium-high exposure corresponds to 60-80th percentile value of exposure score, medium exposure corresponds to 40-60th percentile value of exposure score, medium-low exposure corresponds to 20-40th percentile value of exposure score, low exposure corresponds to 0-20th percentile value of exposure score. • The exposure score from each CID is added together and ranked to get a multi-hazard exposure categorization.

Province Exposure Categorization			
Detailed methodology	The dimensions considered are below:		
	CID	**Type of Dimension**	**Dimensions Included**
	Sea level rise, extreme sea levels, pluvial and fluvial flooding	Social	# Population exposed & % of population exposed (half weighting for each)
		Social	# of people in poverty exposed & % of people in poverty exposed (half weighting for each)
		Economic	Cost of damages (PHP)
		Economic	Damages of the region/GDP of region if exposed
		Physical	% Area exposed
		Physical	Area exposed (km2)
	Increased temperature and drought	Social	# agricultural and construction workers in region
		Social	% agricultural and construction workers/total workers in region
		Economic	Productivity lost (PHP)
		Economic	Productivity lost (PHP) of region/GDP of region
		Physical	Days above 42 degrees heat index (half weighting)
		Physical	Consecutive dry days (half weighting)
		Physical	Mean temperature (half weighting)
		Physical	Maximum temperature (half weighting)
	Wind patterns and tropical cyclones	Social	# Population exposed & % of population exposed (half weighing for each)
		Social	# of people in poverty exposed & % of people in poverty exposed (half weighting for each)

Province Exposure Categorization	
Detailed methodology	The dimensions considered are below: <table><tr><th>CID</th><th>Type of Dimension</th><th>Dimensions Included</th></tr><tr><td rowspan="6">Wind patterns and tropical cyclones</td><td>Social</td><td># Population exposed & % of population exposed (half weighing for each)</td></tr><tr><td>Social</td><td># of people in poverty exposed & % of people in poverty exposed (half weighting for each)</td></tr><tr><td>Economic</td><td>Cost of damages (PHP)</td></tr><tr><td>Economic</td><td>Damages of the region/GDP of region if exposed</td></tr><tr><td>Physical</td><td>% Area exposed & Area exposed (km2) (half weighting for each)</td></tr><tr><td>Physical</td><td>Number of typhoons & Number of strong typhoons (half weighting for each)</td></tr></table>
Data sources	Please refer to relevant models
Next steps	• Consider adaptive capacity • Reweight dimensions as applicable (social, economic, and physical factors are currently weighted equally)
Assumptions	

2.2.3 Region-Province Mapping

Bangsamoro Autonomous Region in Muslim Mindanao
Basilan
Lanao del Sur
Maguindanao
Sulu
Tawi-Tawi
Cordillera Administrative Region
Abra
Apayao
Benguet
Ifugao
Kalinga Province
Mountain Province

National Capital Region
NCR, City of Manila, First District
NCR, Fourth District
NCR, Second District
NCR, Third District
Region I
Ilocos Norte
Ilocos Sur
La Union
Pangasinan

Region II
Batanes
Cagayan
Isabela
Nueva Vizcaya
Quirino
Region III
Aurora
Bataan
Bulacan
Nueva Ecija
Pampanga
Tarlac
Zambales
Region IV-A
Batangas
Cavite
Laguna
Quezon
Rizal
Region IV-B
Marinduque
Occidental Mindoro
Oriental Mindoro
Palawan
Romblon
Region V
Albay
Camarines Norte
Camarines Sur
Catanduanes
Masbate
Sorsogon
Region VI
Aklan
Antique
Capiz
Guimaras
Iloilo
Negros Occidental

Region VII
Bohol
Cebu
Negros Oriental
Siquijor
Region VIII
Biliran
Eastern Samar
Leyte
Northern Samar
Samar
Southern Leyte
Region IX
City of Isabela
Zamboanga del Norte
Zamboanga del Sur
Zamboanga Sibugay
Region X
Bukidnon
Camiguin
Lanao del Norte
Misamis Occidental
Misamis Oriental
Region XI
Davao de Oro
Davao del Norte
Davao del Sur
Davao Occidental
Davao Oriental
Region XII
Cotabato
Cotabato City
Sarangani
South Cotabato
Sultan Kudarat
Region XIII
Agusan del Norte
Agusan del Sur
Dinagat Islands
Surigao del Norte
Surigao del Sur

2.2.4 CID-specific Provincial Categorization (2030, SSP 5-8.5)[328]

Sea Level Rise				
High Exposure	Medium High Exposure	Medium Exposure	Medium Low Exposure	Low Exposure
Basilan	Aklan	Albay	Batangas	Abra
Bataan	Aurora	Antique	Camiguin	Agusan del Norte
Bohol	Capiz	Biliran	City of Isabela	Agusan del Sur
Bulacan	Catanduanes	Cavite	Cotabato City	Apayao
Cagayan	Cebu	Davao de Oro	Davao Oriental	Batanes
Camarines Norte	Davao Occidental	Davao del Norte	Guimaras	Benguet
Camarines Sur	Ilocos Sur	Davao del Sur	NCR, Third District	Bukidnon
La Union	Lanao del Norte	Dinagat Islands	Siquijor	Cotabato
Leyte	Maguindanao	Eastern Samar	Surigao del Norte	Ifugao
Northern Samar	Masbate	Ilocos Norte	Surigao del Sur	Isabela
Occidental Mindoro	Misamis Occidental	Iloilo		Kalinga
Pampanga	Misamis Oriental	NCR, City of Manila, First District		aguna
Pangasinan	Negros Occidental	NCR, Fourth District		Lanao del Sur
Quezon	Palawan	Oriental Mindoro		Marinduque
Samar	Sarangani	Romblon		Mountain Province
Sulu	Sorsogon	Southern Leyte		NCR, Second District
Zamboanga del Sur	Zambales			Negros Oriental
Zamboanga Sibugay				Nueva Ecija
				Nueva Vizcaya
				Quirino
				Rizal
				South Cotabato
				Sultan Kudarat
				Tarlac
				Zamboanga del Norte

[328] List of provinces is listed in Alphabetical Order

Extreme Sea Levels

High Exposure	Medium High Exposure	Medium Exposure	Medium Low Exposure	Low Exposure
Bohol	Aklan	Bataan	Agusan del Norte	Abra
Bulacan	Albay	Biliran	Aurora	Agusan del Sur
Camarines Sur	Antique	Cagayan	Batanes	Apayao
Cebu	Basilan	Catanduanes	Batangas	Benguet
Eastern Samar	Camarines Norte	City of Isabela	Camiguin	Bukidnon
Leyte	Capiz	Davao Occidental	Davao de Oro	Cotabato
Masbate	Cavite	Dinagat Islands	Davao del Norte	Ifugao
Misamis Oriental	Cotabato City	Guimaras	Davao Oriental	Kalinga
Negros Occidental	Davao del Sur	La Union	Ilocos Norte	Laguna
Northern Samar	Ilocos Sur	Misamis Occidental	Isabela	Mountain Province
Palawan	Iloilo	NCR, Fourth District	Lanao del Sur	NCR, Second District
Pampanga	Lanao del Norte	Negros Oriental	Maguindanao	Nueva Ecija
Pangasinan	NCR, City of Manila, First District	Occidental Mindoro	Marinduque	Nueva Vizcaya
Quezon	NCR, Third District	Oriental Mindoro	Sarangani	Quirino
Samar	Surigao del Norte	Romblon	Siquijor	Rizal
Sorsogon	Surigao del Sur	Southern Leyte	South Cotabato	Tarlac
Sulu	Tawi-Tawi	Zamboangadel Norte	Sultan Kudarat	
Zamboanga del Sur	Zamboanga Sibugay		Zambales	

Fluvial Flooding

High Exposure	Medium High Exposure	Medium Exposure	Medium Low Exposure	Low Exposure
Abra	Aklan	Bataan	Agusan del Norte	Abra
Agusan del Norte	Apayao	Biliran	Aurora	Agusan del Sur
Agusan del Sur	Bohol	Cagayan	Batanes	Apayao
Bukidnon	Cotabato City	Catanduanes	Batangas	Benguet
Bulacan	Davao del Sur	City of Isabela	Camiguin	Bukidnon
Cagayan	Iloilo	Davao Occidental	Davao de Oro	Cotabato
Capiz	Kalinga	Dinagat Islands	Davao del Norte	Ifugao
Cotabato	Lanao del Norte	Guimaras	Davao Oriental	Kalinga
Davao de Oro	Lanao del Sur	La Union	Ilocos Norte	Laguna
Davao del Norte	Misamis Oriental	Misamis Occidental	Isabela	Mountain Province
Eastern Samar	Northern Samar	NCR, Fourth District	Lanao del Sur	NCR, Second District
Isabela	Nueva Vizcaya	Negros Oriental	Maguindanao	Nueva Ecija
Maguindanao	Samar	Occidental Mindoro	Marinduque	Nueva Vizcaya
Negros Occidental	Sultan Kudarat	Oriental Mindoro	Sarangani	Quirino
Nueva Ecija	Surigao del Sur	Romblon	Siquijor	Rizal
Pangasinan	Zamboanga del Sur	Southern Leyte	South Cotabato	Tarlac
Tarlac	Zamboanga Sibugay	Zamboangadel Norte	Sultan Kudarat	
			Zambales	

Pluvial Flooding

High Exposure	Medium High Exposure	Medium Exposure	Medium Low Exposure	Low Exposure
Albay	Agusan del Sur	Abra	Agusan del Norte	Basilan
Batangas	Bataan	Antique	Aklan	Batanes
Bukidnon	Benguet	Apayao	Aurora	Biliran
Bulacan	Cotabato	Camarines Norte	Bohol	Camiguin
Cagayan	Eastern Samar	Davao de Oro	Capiz	City of Isabela
Camarines Sur	Ilocos Sur	Davao del Sur	Catanduanes	Cotabato City
Cavite	Iloilo	Ifugao	Davao del Norte	Davao Occidental
Cebu	Laguna	Ilocos Norte	Davao Oriental	Dinagat Islands
Isabela	Lanao del Sur	Kalinga	Misamis Occidental	Guimaras
Leyte	Misamis Oriental	La Union	Mountain Province	Marinduque
Masbate	Northern Samar	Lanao del norte	Pampanga	NCR, City of Manila, First District
Negros Occidental	Nueva Ecija	Maguindanao	Quirino	NCR, First District
Negros Oriental	Oriental Mindoro	Nueva Vizcaya	Sarangani	NCR, Second District
Pangasinan	Tarlac	Occidental Mindoro	Southern Leyte	NCR, Third District
Quezon	Zambales	Palawan	Sultan Kudarat	Romblon
Rizal	Zamboanga del Norte	South Cotabato	Surigao del Norte	Siquijor
Samar	Zamboanga del Sur	Surigao del Sur	Zamboanga Sibugay	Sulu
Sorsogon				Tawi-Tawi

Extreme Wind

High Exposure	Medium High Exposure	Medium Exposure	Medium Low Exposure	Low Exposure
Batangas	Agusan del Sur	Abra	Batanes	Basilan
Bulacan	Albay	Agusan del Norte	Biliran	City of Isabela
Cagayan	Antique	Aklan	Bukidnon	Cotabato
Camarines Sur	Bataan	Apayao	Camiguin	Davao de Oro
Cavite	Benguet	Aurora	Davao Occidental	Davao del Norte
Cebu	Bohol	Camarines Norte	Dinagat Islands	Davao del Sur
Iloilo	Capiz	Eastern Samar	Ifugao	Davao Oriental
Laguna	Ilocos Sur	Guimaras	Marinduque	Lanao del Norte
Leyte	Isabela	Ilocos Norte	Mountain Province	Lanao del Sur
Masbate	La Union	Kalinga	Northern Samar	Maguindanao
NCR, Fourth District	NCR, Third District	Misamis Oriental	Nueva Vizcaya	Misamis Occidental
NCR, Second District	Nueva Ecija	NCR, City of Manila, First District	Quirino	Sarangani
Negros Occidental	Occidental Mindoro	Negros Oriental	Siguijor	South Cotabato
Pampanga	Oriental Mindoro	Palawan	Southern Leyte	Sulta Kudarat
Pangasinan	Sorsogon	Romblon	Sulu	Tawi-Tawi
Quezon	Surigao del Sur	Surigao del Norte	Zamboanga del Norte	Zamboanga del Sur
Rizal	Tarlac	Zambales		Zamboanga Sibugay
Samar				

3. Appendix 3 - Chapter 4

3.1 Agriculture and Fisheries, and Food Security

3.1.1 Sector-specific programs and priorities aligned with NAP development

The adaptation priorities and strategies outlined in the NAP build on and complete the following policies and programs:

- Adaptation and Mitigation Initiative in Agriculture (AMIA) program
- Agrarian Production Credit Program
- Agricultural Credit Support Project
- Climate-Resiliency Field Schools (CFS)
- Community-Based Participatory Action Research (CPAR)
- Comprehensive National Fisheries Industry Development Plan (CNFIDP) 2021-2025
- Corn Germplasm Utilization through Advanced Research and Development
- National Agriculture and Fisheries Modernization and Industrialization Plan (NAFMIP) 2021-2023
- National Irrigation Masterplan 2020-2030
- National Soil Health Program (NSHP)
- Network of Protected Areas for Agricultural and Agro-Industrial Development (NPAAAD)
- Pest Risk Identification and Management Efficiency (PRIME)
- Philippine Development Plan (PDP) 2023-2028
- Program for Bantay-Peste Brigade and Management (PBBM)
- Project - Smarter Approaches to Reinvigorate Agriculture as an Industry (Project SARAI)
- RA 10068 Organic Agriculture Act of the Philippines
- S&T Community-based Program for Inclusive Development (STC4ID)
- Sikat Saka Program
- Strategic Agriculture and Fisheries Development Zones (SAFDZ)
- Water Balance-Assisted Irrigation Decision Support System (WAISS)
- Water Efficient and Risk Mitigation Technologies (WateRice)

3.1.2 Quantitative outputs from sectoral climate analytics

Projected impacts of high-impact climatic impact-drivers in this sector are highlighted in the table below.

Climatic impact-driver	Impact to Agriculture and Fisheries / Food Security (SSP 5-8.5)	
	Projected impacts in 2030 decade	Projected impacts in 2050 decade
Sea level rise	• 70 km2 (3%) fishponds exposed	• 85 km2 (3.5%) fishponds exposed
Wind patterns and tropical cyclones	• 6.5K km2 (5%) farmland exposed • 135 km2 (5.5%) fishpond exposed	• 7.5K km2 (6%) farmland exposed • 145 km2 (6%) fishpond exposed
Pluvial flooding	• 10K km2 (7.5%) farmland exposed • 70 km2 (3%) fishpond exposed	• 11K km2 (8.5%) farmland exposed • 85 km2 (3.5%) fishpond exposed
Extreme sea levels	• 360 km2 (15%) fishpond exposed	• 370 km2 (15%) fishpond exposed
Fluvial flooding	• 35 km2 (~1%) fishpond exposed	• 38 km2 (1.5%) fishpond exposed
Overall	• Corn yield of 2.48 tonnes/ha (-19% compared to 2020 yield) • Rice yield of 3.63 tonnes/ha (-6% compared to 2020 yield)	• Corn yield of 2.54 tonnes/ha (-18% compared to 2020 levels) • Rice yield of 3.67 tonnes/ha (-5% compared to 2020 yield)

3.1.3 Methodology for sectoral climate analytics

Agriculture Yield Model	
Output model	Per province, for 2030 decade and 2050 decade, for SSP 2-4.5 and 5-8.5 scenarios we project the % change in production of corn and palay and the absolute change in tonnes
Detailed methodology	1. Get historical and projected values of the below climate variables from CMIP6 (ACCESS-CM2 (Australia)) and ERA5: - Minimum temperature - Maximum temperature - Days above 20 mm precipitation - Maximum 24hr precipitation (rx1day) - Total precipitation - Precipitation coefficient of variation - Consecutive dry days - Consecutive wet days - Cold spell duration - Warm spell duration - Temperature coefficient of variation 2. Train a pooled ordinary least squares model on the above dataset with yield per hectare of each crop as the dependent variable, applying a natural log transformation of the dependent variable, cube root transformation of independent climate indicators and sigmoid transformation of predictions. The dataset is trained using data from 2010 to 2019 and 2020 data is used for validation. 3. Use the model and CMIP6 projections to predict for 2030, 2050, SSP2-4.5 and SSP5-8.5
Method of validation	1. Our projection for 2020 is validated against the actual historical value with MSPE of 3.3% for the corn model and 0.8% for Palay. 2. Results are also compared against research from IFPRI (international food policy research institute) https://www.ifpri.org/news-release/study-climate-change-put-additional-2-million-filipinos-risk-hunger-2050
Data sources	Production of corn and palay: PSA Historical climate indicators: ERA5 Reanalysis Climate Projections: CMIP6
Next Steps	1. Extend current models to project change in yield of all crops and include other factors e.g., soil type, growing season, location and topography of the farms 2. Use localized climate projections
Assumptions	1. Only key climate indicators selected to reduce multi-collinearity of the model 2. Only provinces with production in every training year is included 3. Training and predictions only include provinces in top 95% of yield for each crop type

3.3 Health

3.3.1 Sector-specific programs and policies aligned with NAP development

The adaptation priorities and strategies outlined in the NAP build on and complete the following policies and programs:

- First 1,000 Days Law (RA 11215)
- Mandatory Reporting of Notifiable Diseases and Health Events of Public Health Concern Act (RA 11332)
- Mental Health Act (RA 11036)
- National Environmental Health Action Plan (NEHAP) 2017- 2022
- National Human Resources for Health Master Plan (NHRHMP 2020-2040)
- National Integrated Cancer Control Law (RA 11215)
- National Objectives for Health (NOH)
- National Unified Health Research Agenda
- New Sin Tax Reform Law of 202 (RA 11467)
- Philippine Development Plan (PDP) 2023-2028
- Philippine Disaster Risk Reduction and Management Act 2010
- Philippine Health Facilities Development Plan (PHFDP 2020-2040)
- Universal Health Care (UHC) Law (RA 11223)

3.3.2 Quantitative outputs from sectoral climate analytics

Projected impacts of high-impact climatic impact-drivers in this sector are highlighted in the table below.

Climate Impact-Driver	Impact to Health (SSP 5-8.5)	
	Projected impacts in 2030 decade	Projected impacts in 2050 decade
Wind patterns and tropical cyclones	• 25% of health infrastructure exposed • PHP745 million in projected damages/year	• 21% of health infrastructure exposed • PHP580 million in projected damages/ year[330]
Pluvial flooding	• 8% of health infrastructure exposed • PHP610 million in projected damages/year	• 10% of health infrastructure exposed • PHP740 million in projected damages/year
Extreme sea levels	• 7% of health infrastructure exposed • PHP490 million in projected damages/year	• 8% of health infrastructure exposed • PHP590 million in projected damages/year

Impact to Health (SSP 5-8.5)				
	Projected impacts in 2030 decade		Projected impacts in 2050 decade	
	Annual projected Cases	Incidence Rate	Annual projected Cases	Incidence Rate
Leptospirosis	5,600	0.044‰	6,300	0.049‰
Dengue	210,000	2.12‰	200,000	2‰

[330] Despite more intense cyclones projected in the decade of 2050, decreases in cyclone damage and exposure is likely caused by reduced frequency of cyclones impacting less points of interest. This is highlighted in Chapter 3.3.4

3.3.3 Methodology for sectoral climate analytics

Climate-related diseases	
Output model	The output of the disease models is the projected average number of incidences of leptospirosis and dengue per region for the two decades, 2030 and 2050, and the two scenarios, SSP2-4.5 and SSP5-8.5.
Detailed methodology	We used a DLNM (Distributed lag non-linear model) in a quasi-Poisson regression framework to analyze the non-linear relationship between climate factors and cases for both diseases over multiple lag weeks. **Leptospirosis:** According to an article that studied the association between climate factors (rainfall and temperature-with a lag of four weeks, flooding-with a lag of up to seven weeks), and the number of hospital admissions (San Lazaro Hospital in Manila) for leptospirosis, rainfall showed a strong correlation with an increase in hospital admissions for leptospirosis. To train our model, we considered the same variables as those considered in the article and used the same hospital database as training data for the period 2001 to 2012. We then applied this model nationwide and applied a scaling factor depending on the population per region. **Dengue:** Another study in Metro Manila found that climate factors (rainfall, temperature, and humidity) are associated with dengue incidence. The research suggests potential transmission due to climate variability with a time lag of up to two months. We leveraged this study to train a model using data from humanitarian data exchange that provides the number of observed dengue cases per region and per month for the period 2016 to 2018. Additionally, we included the El Niño variable in our model to capture the outbreaks.
Method of validation	To validate our model, we compared our results with PSA yearly incidence rate at regional level.
Data sources	**Dengue cases:** Humanitarian Data Exchange & Philippines Statistics Authority Leptospirosis cases: San Lazaro Hospital in Manila & Philippines Statistics Authority **Climate factors:** (ERA5 reanalysis for historical data & CMIP6 for projections)
Next Steps	Model for other water/vector borne diseases and refining current models by including other factors such as drainage, land cover and topography factors and adaptive capacity
Assumptions	Rescaling to a national level was performed according to population in the region

3.4 Ecosystems and Biodiversity

3.4.1 Sector-specific programs and policies aligned with NAP development

The adaptation priorities and strategies outlined in the NAP build on and complete the following policies and programs:

- Enhanced National Greening Program
- Natural Resources Assessment
- Philippine Development Plan (PDP) 2023-2028
- Philippine Wealth Accounting and the Valuation of Ecosystem Services (Phil-WAVES) (ended 2017)
- Protected Area Management Enhancement (PAME) Project
- RA 7586 or National Integrated Protected Area System Act (NIPAS)
- RA 11038 or Expanded National Integrated Protected Area System (ENIPAS) Act
- Roadmap to Institutionalize Natural Capital Accounting (NCA)
- Strengthening the Marine Protected Area System to Conserve Marine Key Biodiversity Areas (SMART SEAS Philippines)
- Threatened Species Conservation and Management Program
- Wetland Conservation Program, and Coastal and Marine Ecosystems Management Program (CMEMP)

3.4.2 Quantitative outputs from sectoral climate analytics

Projected impacts of high-impact climatic impact-drivers in this sector are highlighted in the table below.

Climate Impact-Driver	Impact to Ecosystems & Biodiversity (SSP 5-8.5)	
	Projected impacts in 2030 decade	Projected impacts in 2050 decade
Increased temperature and droughts	• 4,700 km^2 (19%) coral reef exposed to 1°C increase in air temperature	• 4,900 km^2 (20%) coral reef exposed to 1°C increase in air temperature
Pluvial and Fluvial flooding	• 23,750 km^2 (34%) forest exposed to 1 m pluvial or fluvial floods	• 33,000 km^2 (47%) forest exposed to 1 m pluvial or fluvial floods
Sea level rise	• 1000 km^2 (32%) mangroves exposed to 1 m of sea level rise	• 1500 km^2 (48%) mangroves exposed to 1 m of sea level rise

3.4.3 Methodology for sectoral climate analytics

Ecosystem	
Output model	For each of the three key ecosystems—mangroves, coral reefs, and forest, we select a key climatic impact-driver for that ecosystem and compute the number of square kilometers exposed to the CID per region, for the 2030 decade and 2050 decade, for SSP2-4.5 and SSP5-8.5 scenarios.

<table>
<tr><th colspan="2">Ecosystem</th></tr>
<tr><td>Output model</td><td>For each of the three key ecosystems—mangroves, coral reefs, and forest, we select a key climatic impact-driver for that ecosystem and compute the number of square kilometers exposed to the CID per region, for the 2030 decade and 2050 decade, for SSP2-4.5 and SSP5-8.5 scenarios.</td></tr>
<tr><td>Detailed methodology</td><td>Each ecosystem is described with high resolution data. Each data point describing the ecosystem in Philippines is geolocalized and associated with an area in square meters. For each ecosystem, an area is considered exposed to the associated CID if a data point of the ecosystem is within the bounds considered as exposed.
Exposed definition:
• Mangroves are considered exposed to sea level rise if it is exposed to 1m depth-flooding in the decade (Source: Simulation of Impacts of Sea Level Rise on Mangrove Survival in Central and Eastern Visayas). Sea level rise increases risk of inundation of mangroves forest, causing saltwater intrusion.
• Coral reefs are exposed to extreme temperatures if it is exposed to an increase of 1°C or above according to the Great Barrier Reef Foundation. Elevated ocean temperature can stress the coral, leading to coral bleaching.
• Forests are exposed to flooding if it is exposed to pluvial or fluvial flooding of greater than 1 m depth. Inland flooding can cause soil erosion, carrying away topsoil and nutriments. It can also cause waterlogging, reducing oxygen available to tree roots and increasing susceptibility to diseases.
Source: Seidl, R., Thom, D., Kautz, M., Martin-Benito, D., Peltoniemi, M., Vacchiano, G., ... & Honkaniemi, J. (2017). Forest disturbances under climate change. Nature Climate Change, 7(6), 395-402</td></tr>
<tr><td>Method of validation</td><td>For each ecosystem, we compared our results with official reports and articles to make sure we landed on the same order of magnitude (https://maps.oceanwealth.org).</td></tr>
<tr><td>Next Steps</td><td>Mangroves forest data: Department of Environment and Natural Resources
Coral Reef data: Coral reef watch
Forest data: Department of Environment And Natural Resources
• Project the damage to each ecosystem and consider each climatic impact-driver.
• Consider existing adaptation strategies in the exposure assessment.</td></tr>
</table>

Ecosystem	
Assumptions	• A more important CID for mangroves is sea level rise as it increases risk of inundation of mangroves forest, causing saltwater intrusion. We consider a mangrove exposed to sea level rise when exposed to 1 m depth-flooding in the decade (Source: Simulation of Impacts of Sea Level Rise on Mangrove Survival in Central and Eastern Visayas). • A more important CID For coral reef is temperature increase as elevated ocean temperature can stress the coral, leading to coral bleaching. We consider a coral reef exposed to temperature increase when exposed to +1°C or above (Great Barrier Reef Foundation)—using air temperature as a proxy for sea temperature. • A more important CID for forests is pluvial and fluvial flooding as it can cause soil erosion, carrying away topsoil and nutriments. It can also cause waterlogging, reducing oxygen available to tree roots and increasing susceptibility to diseases. We consider a forest exposed to inland flooding when exposed to >1 m depth of flooding.

3.5 Cultural Heritage, Population Displacement, and Migration

3.5.1 Sector-specific programs and policies aligned with NAP development

The adaptation priorities and strategies outlined in the NAP build on and complete the following policies and programs:

- 2022 State of the Indigenous Peoples Address
- Framing the Human Narrative of Migration in the Context of Climate Change
- Human Mobility in the Context of Climate Change
- Philippine Development Plan (PDP) 2023-2028
- Policy Briefs on Internal Migration in Southeast Asia
- Post-Disaster Shelter Recovery Policy Framework
- Resolving Post-Disaster Displacement: Insights from the Philippines after Typhoon Haiyan (Yolanda)
- Unravelling the Nexus: A Participatory Action Research on the Dynamics of Climate Change, Conflict and Human Mobility in the Bangsamoro Region, Philippines

3.5.2 Quantitative outputs from sectoral climate analytics

Projected impacts of high-impact climatic impact-drivers in this sector are highlighted in the table below.

Climate Impact-Driver	Impact to Cultural Heritage, Population Displacement and Migration (SSP 5-8.5)	
	Projected impacts in 2030 decade	Projected impacts in 2050 decade
Sea level rise	150k people/year exposed, of which 9k are elderly, 50k are children and 38k are impoverished	425k people/year exposed, of which 25k are elderly, 130k are children and 92k are impoverished
Wind patterns and tropical cyclones	Five million people/ year exposed, of which 280k are elderly, 1.6 million are children and one million are impoverished	Six million people/ year exposed, of which 310k are elderly, 1.8 million are children and 1.4 million are impoverished

Climate Impact-Driver	Impact to Cultural Heritage, Population Displacement and Migration (SSP 5-8.5)	
	Projected impacts in 2030 decade	Projected impacts in 2050 decade
Pluvial flooding	4.8 million people/ year exposed, of which 260k are elderly, 1.5 million are children and 1.3 million are impoverished	5.2 million people/ year exposed, of which 280k are elderly, 1.7 million are children and 1.4 million are impoverished
Extreme sea levels	Two million people/ year exposed, of which 100k are elderly, 600k are children and 480k are impoverished	Two million people/ year exposed, of which 100k are elderly, 610k are children and 485k are impoverished

3.6 Land Use and Human Settlements

3.6.1 Sector-specific programs and policies aligned with NAP development

The adaptation priorities and strategies outlined in the NAP build on and complete the following policies and programs:

- National Housing and Urban Development Sector Plan (NHUDSP)
- National Urban Development and Housing Framework (NUDHF)
- Philippine Development Plan (PDP) 2023-2028
- Philippine Disaster Risk Reduction and Management Act 2010
- Philippine New Urban Agenda (NUA)
- Resilient and Green Human Settlements Framework (RGHSF)
- Roadmap to Institutionalize Natural Capital Accounting (NCA)
- The Department of Human Settlements and Urban Development Act (Republic Act No. 11201) and its Implementing Rules and Regulations

3.6.2 Quantitative outputs from sectoral climate analytics

Projected impacts of high-impact climatic impact-drivers in this sector are highlighted in the table below.

Climate Impact-Driver	Impact to Land Use and Human Settlements (SSP 5-8.5)	
	Projected impacts in 2030 decade	Projected impacts in 2050 decade
Sea level rise	• 160 km^2 land inundated (<1%) • 85,000 residential homes inundated • PHP7 billion damage/year	• 380 km^2 (>1%) land inundated • 120,000 residential homes inundated • PHP14 billion damage/year
Pluvial flooding	• 170,000 km^2 (>55%) land exposed • 11 million residential homes exposed • PHP210 billion damage/year	• 180,000 km^2 (60%) land exposed • 11 million residential homes in exposed • PHP225 billion damage/year

Climate Impact-Driver	Impact to Land Use and Human Settlements (SSP 5-8.5)	
	Projected impacts in 2030 decade	Projected impacts in 2050 decade
Wind patterns and tropical cyclones	• 180,000 km^2 (>80%) land exposed • 17 million residential homes exposed • PHP32 billion damage/year	• 220,000 km^2 (>80%) land exposed • 18 million residential homes inundated • PHP36 billion damage/year
Extreme sea levels	• 2200 km^2 land exposed (<1%) • 300,000 residential homes exposed • PHP67 billion damage/year	• 2300 km^2 land exposed (<1%) • 305,000 residential homes exposed • PHP72 billion damage/year

3.6.3 Methodology for sectoral climate analytics

Residential assets/Human settlements	
Output model	Number of households exposed to each CID, by scenario and time horizon. Following the same assumptions as the population exposed to each CID model
Detailed methodology	1 – Obtain the number of residential assets exposed by considering the population exposed to each climatic impact-driver and dividing by the average people per household by municipality. The population exposed to each climatic impact-driver is determined by getting the population raster at 30mx30m granularity and overlaying with exposure hazard maps for each CID.
Data sources	Household Population, Number of Households, and Average Household Size of the Philippines (2020 Census of Population and Housing): PSA
Next Steps	2020 population according to PSA is used. Projected populations should be considered as a next step. Adaptive capacity and current adaptations applied should be considered.
Assumptions	• Same assumption of exposure as the population impacted model • Assumes number of households is the number of residential assets

3.7 Livelihoods and Industries

3.7.1 Sector-specific programs and policies aligned with NAP development

The adaptation priorities and strategies outlined in the NAP build on and complete the following policies and programs:

- Innovation Act, Innovation Startup Act, and the Digital Competitiveness Act
- Livelihood and Emergency Employment Program (DILEEP)
- National Green Jobs Human Resources Development Plan
- National Tourism Development Plan
- Philippine Development Plan (PDP) 2023-2028
- Strategic Investment Priority Plan (SIPP)

3.7.2 Quantitative outputs from sectoral climate analytics

Projected impacts of high-impact climatic impact-drivers in this sector are highlighted in the table below.

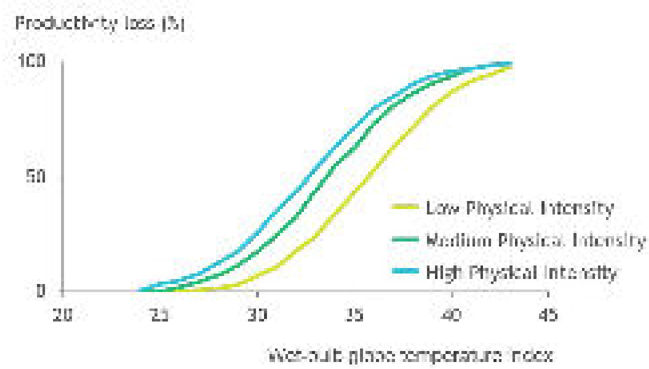
Climate Impact-Driver		Impact to Livelihoods & Industries (SSP 5-8.5)	
		Projected impacts in 2030 decade	Projected impacts in 2050 decade
Manufacturing	Wind patterns and tropical cyclones	• 6% of manufacturing infrastructure exposed • PH 4.5 billion in projected damages/ year	• 5% of manufacturing infrastructure exposed[331] • PHP2.4 billion in projected damages/year
	Pluvial flooding	• 5% of manufacturing infrastructure exposed • PHP560 million in projected damages/ year	• 6% of manufacturing infrastructure exposed • PHP650 million in projected damages/year
	Extreme sea levels	• 2% of manufacturing infrastructure exposed • PHP305 million in projected damages/year	• 2% of manufacturing infrastructure exposed • PHP370 million in projected damages/year
	Increased temperature and droughts	• PHP35 billion in productivity losses/ year	• PHP68 billion in productivity losses/ year

[331] Despite more intense cyclones projected in the decade of 2050, decreases in cyclone damage and exposure is likely caused by reduced frequency of cyclones impacting less points of interest. This is highlighted in Chapter 3.3.4

Climate Impact-Driver		Impact to Livelihoods & Industries (SSP 5-8.5)	
		Projected impacts in 2030 decade	Projected impacts in 2050 decade
Tourism	Wind patterns and tropical cyclones	• 5% of tourism infrastructure exposed • PHP1.9 billion in projected damages/year	• 5% of tourism infrastructure exposed • PHP1.5 billion in projected damages/year[332]
	Pluvial flooding	• 3% of tourism infrastructure exposed • PHP50 million in projected damages/ year	• 4% of tourism infrastructure exposed • PHP57 million in projected damages/year
	Extreme sea levels	• 2% of tourism infrastructure exposed • PHP25 million in projected damages/year	• 2% of tourism infrastructure exposed • PHP33 million in projected damages/year
Professional Service	Wind patterns and tropical cyclones	• 5% of professional services infrastructure exposed • PHP16 billion in projected damages/year	• 4% of professional services infrastructure exposed [333] • PHP10 billion in projected damages/year
	Pluvial flooding	• 3% of professional services infrastructure exposed • PHP260 million in projected damages/ year	• 4% of professional services infrastructure exposed • PHP310 million in projected damages/year
	Extreme sea levels	• 2% of professional services infrastructure exposed • PHP450 million in projected damages/year	• 2% of professional services infrastructure exposed • PHP620 million in projected damages/year
	Increased temperature and droughts	• PHP2 billion in productivity losses/ year	• PHP5 billion in productivity losses/ year

332 Despite more intense cyclones projected in the decade of 2050, decreases in cyclone damage and exposure is likely caused by reduced frequency of cyclones impacting less points of interest. This is highlighted in Chapter 3.3.4

333 Despite more intense cyclones projected in the decade of 2050, decreases in cyclone damage and exposure is likely caused by reduced frequency of cyclones impacting less points of interest. This is highlighted in Chapter 3.3.4

<table>
<tr><th colspan="2">Productivity Loss</th></tr>
<tr><td>Output model</td><td>Cost in M PH Pesos of annual productivity loss due to increased temperature per region, for 2030 and 2050 decades, for scenario SSP 2-4.5 and 5-8.5.</td></tr>
<tr><td>Detailed methodology</td><td>
Based on the article, “Working on a warmer planet: The impact of heat stress on labour productivity and decent work” from the International Labour Organisation, economic sectors were mapped to three classes of physical work intensity: low medium and high as per below:
<table>
<tr><th>Low Physical Work intensity</th><th>Medium Physical Work intensity</th><th>High Physical Work Intensity[1]</th></tr>
<tr><td>Information & communication</td><td>Mining & quarrying</td><td>Agriculture, forestry & fishing</td></tr>
<tr><td>Finance & insurance</td><td>Manufacturing</td><td>Construction</td></tr>
<tr><td>Real estate activities</td><td>Electricity, steam, water…</td><td></td></tr>
<tr><td>Professional & business services</td><td>Wholesale & retail trade</td><td></td></tr>
<tr><td>Public administration</td><td>Transportation & storage</td><td></td></tr>
<tr><td>Education</td><td>Other services</td><td></td></tr>
<tr><td>Human health & social work</td><td></td><td></td></tr>
<tr><td>Accommodation and food service activities</td><td></td><td></td></tr>
</table>
The ILO defines a curve linking the wet-bulb globe temperature index to productivity loss percentage for each class as per the chart below. Projected wet-bulb globe temperature indices from CMIP6 were used to obtain projected productivity loss.


</td></tr>
</table>

Productivity Loss	
	To turn productivity loss into productivity loss cost, we simply multiplied the regional GDP of each economic field with the % of productivity loss. Productivity loss per sector in pesos is the number of employees in the sector multiplied by % of productivity loss multiplied by the median wage of the sector.
Method of validation	Comparison to literature on productivity loss for the Philippines from ILO
Data sources	• Number of employees per region: PSA • Number of employees per sector: PSA • Median wage per Sector: PSA
Next Steps	• Localize climate projections. • Consider adaptive capacities.
Assumptions	Mangroves forest data: Department of Environment and Natural Resources Coral Reef data: Coral reef watch Forest data: Department of Environment And Natural Resources • Project the damage to each ecosystem and consider each climatic impact-driver. • Consider existing adaptation strategies in the exposure assessment.

3.8 Energy, Transport & Communications

3.8.1 Sector-specific programs and policies aligned with NAP development

The adaptation priorities and strategies outlined in the NAP build on and complete the following policies and programs:

- Asset Preservation Program
- Energy Efficiency and Conservation Act
- KATUPARAN or the Kalsada Tungo sa Paliparan, Riles at Daungan Program
- National Building Code
- National Broadband Programme
- National Energy Contingency Plan
- National Land Use Act (pending approval)
- Philippine Development Plan (PDP) 2023-2028
- Philippine Energy Resiliency Policy
- Roadmap to Institutionalize Natural Capital Accounting (NCA)

3.8.2 Quantitative outputs from sectoral climate analytics

Projected impacts of high-impact climatic impact-drivers in this sector are highlighted in the table below.

Climate Impact-Driver		Impact to Energy, Transport, Communications (SSP 5-8.5)	
		Projected impacts in 2030 decade	Projected impacts in 2050 decade
Manufacturing	Wind patterns and tropical cyclones	• 6% of energy infrastructure exposed • PHP1.5 billion in projected damages/year	• 6% of energy infrastructure exposed • PHP2.4 billion in projected damages/year [334]
	Pluvial flooding	• 8% of energy infrastructure exposed • PHP1.1 billion in projected damages/ year	• 9% of energy infrastructure exposed • PHP1.3 billion in projected damages/year
	Extreme sea levels	• 1% of energy infrastructure exposed • PHP650 million in projected damages/year	• 1% of energy infrastructure exposed • PHP850 million in projected damages/year
Transport	Wind patterns and tropical cyclones	• 2% of transport infrastructure exposed • PHP4.8 billion in projected damages/year	• 2% of transport infrastructure exposed • PHP6.5 billion in projected damages/year
	Pluvial flooding	• 5% of transport infrastructure exposed • PHP21billion in projected damages/ year	• 5% of transport infrastructure exposed • PHP24 billion in projected damages/ year
	Extreme sea levels	• 1% of transport infrastructure exposed • PHP6.5 billion in projected damages/year	• 1% of transport infrastructure exposed • PHP7.5 billion in projected damages/year
Communications	Wind patterns and tropical cyclones	• 15% of communications infrastructure exposed • PHP450 million in projected damages/ year	• 14% of communications infrastructure exposed[335] • PHP300 million in projected damages/year
	Pluvial flooding	• 10% of communications infrastructure exposed • PHP10 million in projected damages/ year	• 11% of communications infrastructure exposed • PHP12 million in projected damages/year
	Extreme sea levels	• 3% of communications infrastructure exposed • PHP55 million in projected damages/year	• 4% of communications infrastructure exposed • PHP65 million in projected damages/year

[334] Despite more intense cyclones projected in the decade of 2050, decreases in cyclone damage and exposure is likely caused by reduced frequency of cyclones impacting less points of interest. This is highlighted in Chapter 3.3.4

[335] Despite more intense cyclones projected in the decade of 2050, decreases in cyclone damage and exposure is likely caused by reduced frequency of cyclones impacting less points of interest. This is highlighted in Chapter 3.3.4

4. Appendix 4 - Chapter 5

4.1 Roles and responsibilities of select government entities in the climate change agenda

Relevant government entities	Roles & responsibilities overview
Lead climate change government agencies	
Climate Change Commission (CCC)	Lead policy-making body of the government tasked to coordinate, monitor, and evaluate programs and action plans of the government to ensure the mainstreaming of climate change into the government plans and programs
Department of Environment and Natural Resources (DENR)	Oversees the establishment and maintenance of a climate change information management system and network, including climate change risks, activities, and investments, in collaboration with other relevant government agencies, institutions, and LGUs
Inter-agency committees and working groups	
Cabinet cluster on Climate Change Adaptation, Mitigation, and Disaster Risk Reduction (CCAM-DRR)	Inter-agency body responsible for the effective integration of policies and programs on climate risk management, disaster risk reduction, and sustainable development.
Climate Change Advisory Board (CCAB)	Inter-agency body composed of secretaries from different departments and representatives from selected sectors (e.g., academe, business, NGOs) and is tasked to assist CCC in the formulation of climate adaptation and mitigation policies and give advice on matters related to the mandate of the agencies / offices
People's Survival Fund Board	Inter-agency body tasked to provide guidance in management of PSF, including identifying additional funding sources, granting final approval for climate change adaptation proposals, and awarding these grants to qualifying LGUs.
Inter-agency Task Force for Sustainable Finance or the PH Green Force	Tasked to harmonize all government policies concerning green and sustainable projects, establish a cohesive action plan to institutionalize the role of sustainable finance, and develop a pipeline for sustainable investments
National Disaster Risk Reduction & Management Council (NDRRMC)	An inter-agency tasked with responding to natural calamities, with one of its functions being the development of assessment tools for existing and potential hazards and risks arising from climate change in vulnerable areas and ecosystems, in coordination with CCC.

Relevant government entities	Roles & responsibilities overview
House of representatives committee on climate change	The lower house of congress handling policies and programs mitigating the impact of climate change to the environment
Senate committee on environment, natural resources, and climate change	The national legislative branch / upper house of congress handling policy matters on environment, natural resources, and climate change
Government agencies	
Department of Science and Technology (DOST)	Through PAGASA is tasked to promote, assist, and where appropriate, undertake scientific and technological research and development, projections and analysis of future climate scenarios, including activities relative to observation, collection, assessment, and processing of climate-related data such as, but not limited to, precipitation, sea-level rise, extreme climate events, rise in temperatures, and records of severe droughts monitored over long periods of time, in coordination with LGUs in priority/target monitoring sites, for the benefit of agriculture, natural resources, commerce, and industry and in other areas identified to be vital to the country's development.
Department of Interior and Local Government (DILG)	Facilitates capacity-building programs for LGUs in climate change, including technology provision, in collaboration with the Local Government Academy and NEDA
National Economic and Development Authority (NEDA)	Independent socio-economic planning body responsible for coordinating the national and sub-national development activities, conducting critical analyses of development issues, and offering policy alternatives to decision-makers
Department of Budget and Management (DBM)	Undertakes the formulation of the annual national budget that ensures the appropriate prioritization and allocation of funds to support climate change programs and projects in the annual program of government.
Department of Finance (DOF)	Coordinates with the Commission on matters concerning fiscal policies related to climate change; monitors and reports measures including climate finance.
Department of Foreign Affairs (DFA)	Reviews international agreements related to climate change and makes the necessary recommendation for ratification and compliance by the government on matters pertaining thereto
Department of Public Works and Highways (DPWH)	Responsible for the planning, design, construction, and maintenance of national highways, major flood control systems, and other public works.

Relevant government entities	Roles & responsibilities overview
Philippine Information Agency (PIA)	Disseminates information on climate change, local vulnerabilities and risk, relevant laws and protocols, and adaptation & mitigation measures
Department of Education (DepEd)	Responsible for integrating climate change into the primary and secondary education curricula, subjects, and education materials including textbooks and primers.
Department of Health (DOH)	Responsible for ensuring access to basic public health services by all Filipinos through the provision of quality health care and regulation of providers of health goods and services.

4.2 Indicative List of Existing National-Level Policies, Plans, and Strategies

Policies, plans, and strategies	Purpose
Policies	
National Environmental Awareness and Education Act of 2008 (RA 9512)	Promotes national awareness on the role of natural resources in economic growth and the importance of environmental conservation and ecological balance towards sustained national development.
Philippine Disaster Risk Reduction and Management Act of 2010 (RA 10121)	Strengthens the Philippine disaster risk reduction and management system by providing for the national disaster risk reduction and management framework and institutionalizing the national disaster risk reduction and management plan.
Climate Change Act of 2009 (RA 9729) as amended in 2012 (RA 10174)	Provides the policy framework with which to systematically address growing threats on community life and its impact on environment.
DILG MC No. 2015-77	Mainstreams climate change adaptation and disaster risk reduction in the Local Development Planning.
DILG-NEDA-DBM-DOF JMC No. 1 Series of 2016	Updated guidelines on the harmonization of local planning, investment programming, resource mobilization, budgeting, expenditure management, and performance monitoring and coordination in fiscal oversight.

Policies, plans, and strategies	Purpose
Plans	
National Climate Change Action Plan 2011-2028 (NCCAP)	• Sets the directional plan for the government on implementing short-, medium-, and long-term actions across seven thematic areas. • Highlights strategic direction and actions, and theory of change across seven thematic areas.
CCAM-DRR cabinet cluster roadmap (2018-2022)	Aims to increase adaptive capacities of vulnerable communities; ensure adequate supply of clear air, water, and other natural resources; increase resilience of critical infrastructure; and enhance knowledge, access to information and institutional capacities.
Philippine Sustainable Finance Roadmap (2022)	• Provides the high-level action plans to promote sustainable finance in the Philippines. • Sets out a comprehensive approach that will serve as the foundation for effective strategies to facilitate the mainstreaming of sustainable finance in the Philippines.
Philippine Development Plan 2023-2028 (PDP)	• Includes accelerating climate action and strengthening disaster resilience as an important outcome. • Climate-related strategies are mainstreamed across chapters of the PDP.
Strategies	
National Framework Strategy on Climate Change 2010 (NFSCC)	Identifies the key result areas to be pursued in key climate-sensitive sectors.
Disaster risk reduction and management Framework (DRRM)	Fosters awareness, guides national and local DRM efforts, and links DRR and DRM with sustainable development by outlining direction, priorities, and essential elements of disaster risk reduction and management.
People's Survival Fund 2012 (PSF)	Provides long-term financing for adaptation projects of local government units and communities.
Climate Change Expenditure Tagging 2015 (CCET)	Climate budgeting and tracking framework developed to sustain the country's climate reform initiatives.

Policies, plans, and strategies	Purpose
National Climate Risk Management Framework 2019 (NCRMF)	• Promotes multisectoral and multistakeholder activities of the national government agencies and local government units. • Harmonizes and integrates climate risk management efforts across sectors, aiming for a unified and science-based climate action planning system with accessible risk database and analytics. • Conducts a national stocktake to assess climate risk information, tools, and methodologies, identifying gaps and setting minimum standards for data and assessment.
Sustainable Finance Framework (2021)	Sets out how the Philippines intends to raise green, social, or sustainability bonds, loans, and other debt instruments.
Risk Resiliency Program (RRP)	• Apply program convergence planning and budgeting approach to strengthen the country's actions for climate change adaptation, mitigation, and disaster risk reduction (CCAM-DRR) • Help GoP to optimally use its available budget on priority CCAM-DRR programs • Increase the size and quality of CCAM-DRR responsive investments

4.3 Indicative List of Existing Stakeholder Engagement Mechanisms

Engagement mechanisms	Overview
Vertical coordination and community participation	• Pursuant to RA 10174 • Efforts to consult and coordinate with NGOs, civic organizations, academia, people's organizations, the private sector, corporate sectors, and other relevant stakeholders during the development and implementation of various action plans, ensuring broad stakeholder involvement. • Ensures transparency and participation of vulnerable and marginalized groups in the supported adaptation projects through the involvement of their representatives
Participatory Governance Cluster (PGC)	• Enhances citizen participation in governmental processes by formulating mechanisms to facilitate public understanding and implementation of national government programs and projects. • Strengthens consultative mechanisms to ensure effective implementation at the local government and grassroots level.
Klimathon	Facilitates an innovation hub dedicated to generating innovative and practical solutions to address pressing issues and challenges linked to the climate crisis.

Engagement mechanisms	Overview
Active Climate Change Engagement Leading to Resilient, Adaptive, and Transformative Empowerment (ACCELERATE)	Enhances partnerships with foreign embassies and development partners with particular focus on national and local climate change adaptation and mitigation activities.
Empowering Alliance for Climate Action and Transformation (ENACT)	Coordinates future climate investments and projects from development partners and foreign governments. This involves aligning and managing investments and projects to maximize their effectiveness in addressing climate change challenges.
Working to Empower Climate Action Network (WE CAN	A consultation mechanism enabling civil society organizations (CSOs) to contribute inputs on the formulation of policies and programs by CCC, fostering a whole-of-society approach in pursuing climate resiliency
Communicating Opportunities to Network,Navigate,and Explore Climate Transformations (CONNECT)	Establishes a platform for dialogue between the government and the private sector.
Philippine Information Agency (PIA)	Government body that disseminates information about government programs, projects, and services to the Filipino public

4.4 List of innovative financing instruments implemented in the Philippines

Instrument type	Description[336]	Key advantage[337]	PH Example
Development policy loan with a Catastrophe Deferred Drawdown Option (CAT DDO)	Contingent credit line allowing a borrower to rapidly meet its financing requirements following a shortfall in resources due natural disaster (e.g., drought, hurricane, or typhoon).	Provides immediate liquidity until a country can secure additional financing. Access to the line of credit is contingent upon the occurrence of a defined major event, typically the client country's declaration of a state of emergency.	The Fourth Disaster Risk Management Development Policy Loan with a Catastrophe-Deferred Drawdown Option (CAT-DDO 4) in 2021 provides USD500 million funding that the Philippines can quickly tap to manage financial impacts brought about by disasters and disease outbreaks.

[336] IISD (2023)
[337] Ibid.

Instrument type	Description[336]	Key advantage[337]	PH Example
Regional insurance pools	Typically offer parametric insurance products and build regional capacity, as well as collecting and disseminating information on hazards and risk exposure.	Provide quick liquidity at reasonable costs and pull region-specific knowledge/best practices to navigate ecosystem.	The Philippines is part of SEADRIF, which provides participating ASEAN countries with insurance and risk management solutions against climate shocks and natural disasters.
CAT bonds	Debt instrument to raise money in the insurance industry in the event of a natural disaster, allows the issuer to receive the money from the bond only if specific conditions occur	Tap capital markets to raise money from private and institutional investors and secure financing for adequate relief and rehabilitation before a disaster strikes.	The World Bank issued two tranches of CAT bonds in 2019 to provide the Philippines with financial protection of up to USD75 million for losses from earthquakes and USD150 million against losses from tropical cyclones for three years.

4.5 Alignment Between International Frameworks and Standards, and Philippines' Strategic Framework

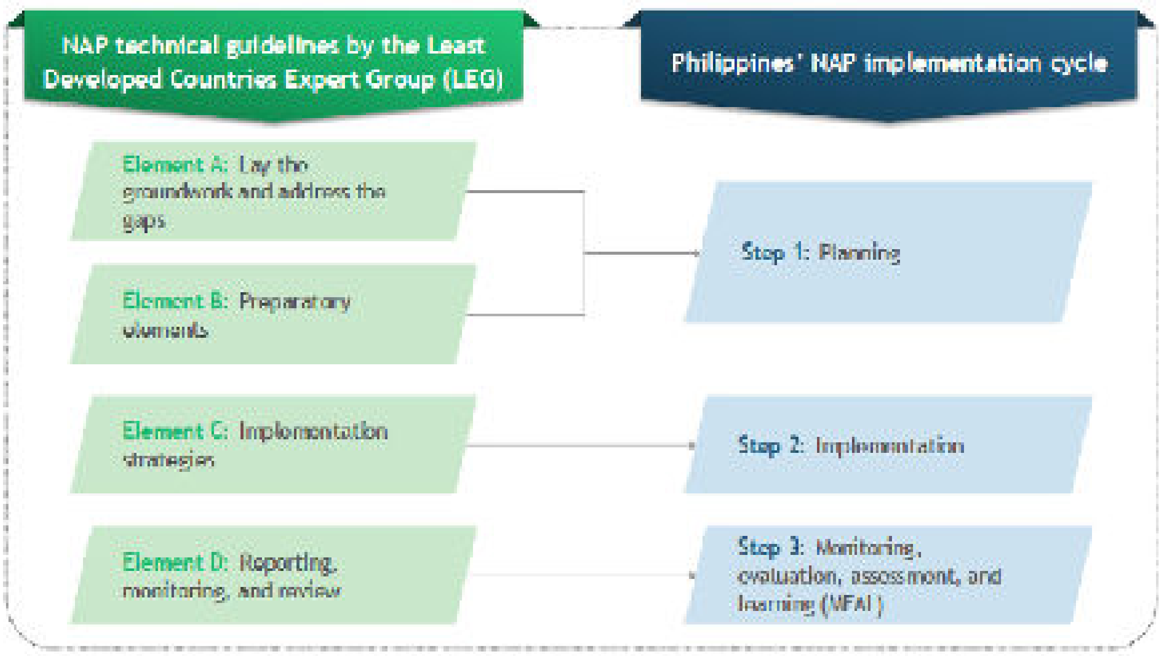


Figure 3.5.1. How the NAP's 3 overlapping phases link to the technical guidelines for the NAP process developed by the Least Developed Countries Expert Group (LEG)

The NAP is aligned with the NAP technical guidelines developed by the LEG, as depicted in Figure 3.5.1. The planning phase of the NAP encompasses the steps outlined in elements A and B of the LEG technical guidelines, which include activities ranging from stocktaking to evaluating and integrating adaptation options. The implementation phase follows the steps presented in element C of the LEG technical guidelines, focusing on the execution of the national adaptation plan. The monitoring, evaluation, assessment, and learning (MEAL) phase corresponds to the steps outlined in element D, during which the entire NAP process is closely monitored and reported. This phase serves as an opportunity for improvement, as key learnings observed during the MEAL phase inform and enhance the subsequent iterations of the NAP process.

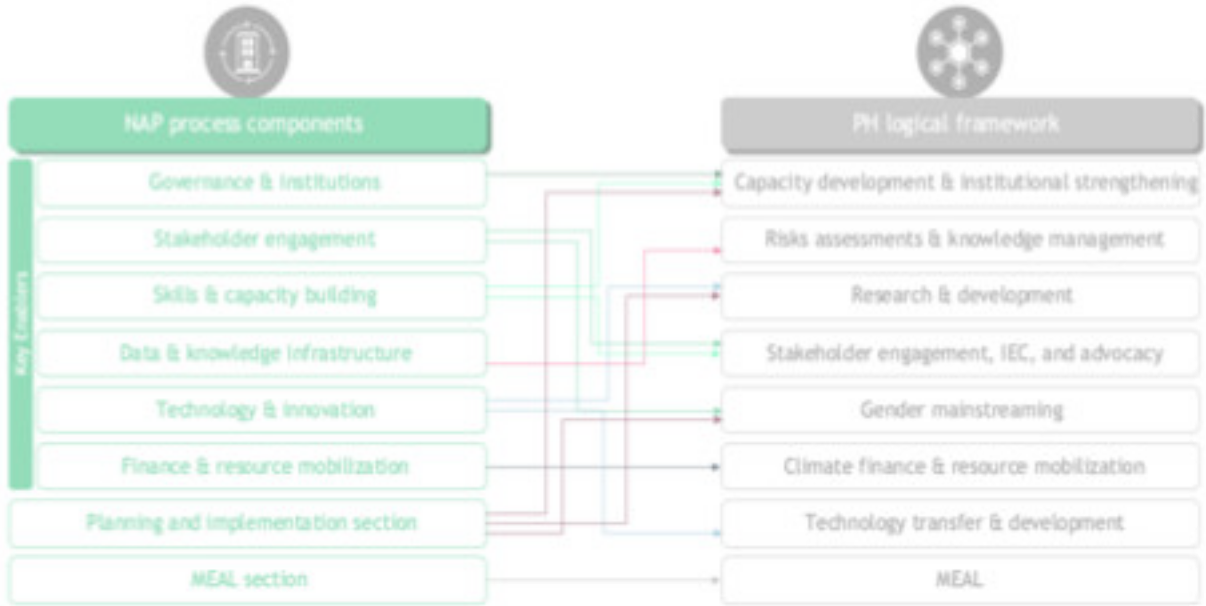


Figure 3.5.2. Philippines' NAP process components link to achieving cross-cutting outcomes under the Philippines' Strategic Framework (SF)

In addition to the linkages with the technical guidelines, the NAP also supports the Philippines' SF for the NAP. Every component of the NAP implementation framework, including the key cross-cutting enablers, contributes not only to sectoral outcomes but also to the cross-cutting outcomes defined in the SF as depicted in Figure 3.5.2. These linkages demonstrate how the NAP, drawing from international guidelines and learnings, aligns with the nation's SF, thereby advancing the global and national adaptation agenda. Together, these connections illustrate the comprehensive approach of the NAP towards achieving adaptation goals at both the local and international levels.

5. Appendix 5 - References

5.1 Chapter 3 References

5.1.1 Introduction

1. Climate Watch. (n.d.). Philippines (PHL) Country Profile. Retrieved Month Day, Year, from https://www.climatewatchdata.org/countries/PHL?end_year=2020&start_year=1990.
2. PAGASA. (2018). Observed Climate Trends and Projected Climate Change in the Phils 2018 [Report]

5.1.2 Historical Climate Trends

1. AsiaViews. (2022, October 24). PHILIPPINES:NO.1 IN WORLD RISK INDEX 2022. AsiaViews. https://asiaviews.net/philippinesno-1-in-world-risk-index-2022/#:~:text=The%20World%20Risk%20Index%202022%20%28released%20September%29%20ranked,second%20and%20third%2C%20followed%20by%20Colombia%20and%20Mexico.
2. Baclig, C. E. (2023, March 29). Extreme heat in PH: Health risks, economic impact | Inquirer News. INQUIRER.net. https://newsinfo.inquirer.net/1749716/extreme-heat-in-ph-health-risks-economic-impact
3. Boston Consulting Group. (2023). Data Model on Land subsidence [Data model]. Retrieved from Alaska satellite facility database.
4. Climate Risk Country Profile: Philippines (2021): The World Bank Group and the Asian Development Bank.
5. Collins M., M. Sutherland, L. Bouwer, S.-M. Cheong, T. Frölicher, H. Jacot Des Combes, M. Koll Roxy, I. Losada, K. McInnes, B. Ratter, E. Rivera-Arriaga, R.D. Susanto, D. Swingedouw, and L. Tibig, 2019: Extremes, Abrupt Changes and Managing Risk. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]. In press.
6. DOST-PAGASA, 2018: Observed and Projected Climate Change in the Philippines. Philippine Atmospheric, Geophysical and Astronomical Services Administration, Quezon City, Philippines, 36 pp.
7. Food and Agriculture Organization of the United Nations. (2022). Environmental and Social Management Framework for GCF project “Adapting Philippine Agriculture to Climate Change” (p. 7). https://www.fao.org/3/cc2093en/cc2093en.pdf
8. IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 3−32, doi:10.1017/9781009157896.001
9. IPCC, 2023: Sections. In: Climate Change 2023: Synthesis Report. Contribution of Working Groups I, II and III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, H. Lee and J. Romero (eds.)]. IPCC, Geneva, Switzerland, pp. 35-115, doi: 10.59327/IPCC/AR6-9789291691647
10. Keller, Lauren. THE IMPACT OF SEA LEVEL RISE IN THE PHILIPPINES Charting Climate Change in Metropolitan Manila. (2013). In sites.tufts.edu. Tufts University. Retrieved August 15, 2023, from https://sites.tufts.edu/gis/files/2013/11/Keller_Lauren.pdf
11. Luz, G. M. (2022, October 20). No. 1 in World Risk Index 2022 | Inquirer Opinion. INQUIRER.net. https://opinion.inquirer.net/158015/no-1-in-world-risk-index-2022

12. Magramo, K. (2023, July 26). Typhoon Doksuri kills at least five as Philippines battles floods and landslides. CNN. https://www.cnn.com/2023/07/25/asia/philippines-typhoon-doksuri-egay-landfall-intl-hnk
13. Office of the President of the Philippines Malacañang & Climate Change Commission. (2010). National Framework Strategy on Climate Change 2010-2022.
14. ONEOCEAN Infomations. (n.d.). http://oneocean.org/flash/the_philippine_seas.html
15. Oscar M. Lopez Center for Climate Change Adaptation and Disaster Risk Management Foundation, Inc. (Oscar M. Lopez Center) and Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA), 2023. State of the 2020 Philippine Climate, January 2023.
16. Philippines National Drought Plan. (2019). Retrieved August 15, 2023, from https://knowledge.unccd.int/sites/default/files/country_profile_documents/1%2520FINAL_NDP_Philippines.pdf
17. Philippine Atmospheric, Geophysical and Astronomical Services Administration (PAGASA) & Department of Science and Technology (DOST). (2023). ANNUAL REPORT ON PHILIPPINE TROPICAL CYCLONES 2020. In pagasa.dost.gov.ph.. Retrieved August 15, 2023, from https://pubfiles.pagasa.dost.gov.ph/pagasaweb/files/tamss/weather/tcsummary/PAGASA_ARTC_2020.pdf
18. PAGASA. (2023). Total number of TCs in the Philippines per 1° x 1° grid, for the period 1948-2020.
19. PAGASA. (2023). Number of typhoons per year from 1960-2022 with at least 150 kph sustained winds entering the PAR.
20. Sarao, Z. (2023, April 5). DOH records 118 cases of heat exhaustion of students in March | Inquirer News. INQUIRER.net. https://newsinfo.inquirer.net/1752307/doh-records-118-cases-of-heat-exhaustion-in-march
21. Tropical Cyclone Associated Rainfall. (2023). pagasa.dost.gov.ph. Retrieved August 15, 2023, from https://www.pagasa.dost.gov.ph/climate/tropical-cyclone-associated-rainfall
22. UNICEF. (2021). The Climate Crisis is a Child Rights Crisis: Introducing the Children's Climate Risk Index. UNICEF. https://www.unicef.org/media/105376/file/UNICEF-climate-crisis-child-rights-crisis.pdf
23. UNICEF. (2022). The Coldest Year of the Rest of their Lives: Protecting children form the escalating impacts of heatwaves. https://www.unicef.org/media/129506/file/UNICEF-coldest-year-heatwaves-and-children-EN.pdf
24. Villafuerte M et al. 2021. ClimDatPh: an Online Platform for Philippine Climate Data Acquisition. Philipp J Sci 150(1): 53–66. https://doi.org/10.56899/150.01.05
25. World Bank Climate Change Knowledge Portal. (n.d.). https://climateknowledgeportal.worldbank.org/country/philippines/vulnerability

5.1.3 Future Climate Risks and Scenarios

1. Boston Consulting Group. (2023). Data Model on Extreme Heat and Droughts [Data model]. Retrieved from CMIP6 (Coupled Model Intercomparison Project Phase 6) database.
2. Boston Consulting Group. (2023). Data Model on Extreme Precipitation [Data model]. Retrieved from CMIP6 (Coupled Model Intercomparison Project Phase 6) database.
3. Boston Consulting Group. (2023). Data Model on Landslides [Data model]. Retrieved from Global Landslide Hazard map – precipitation trigger from the World Bank, NASA Global Landslide Catalogue, NASA Global Susceptibility Map, NOAA CPC Precipitation Data, and WorldPop population databases.
4. Boston Consulting Group. (2023). Data Model on Pluvial and Fluvial Flooding [Data model]. Retrieved from Fathom Global release 3.0 database.
5. Boston Consulting Group. (2023). Data Model on Sea Level Rise and Extreme Sea Level Events [Data model]. Retrieved from IPCC AR6 Sea Level Projections, Coastal Futures, Nasa Earth data, and Alaska satellite facility databases.

6. Boston Consulting Group. (2023). Data Model on Tropical Cyclones [Data model]. Retrieved from CMIP6 (Coupled Model Intercomparison Project Phase 6) and International Best Track Archive for Climate Stewardship (IBTrACS) databases.
7. IPCC. (2013). Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report. Cambridge University Press.
8. IPCC. (2019). Special Report on the Ocean and Cryosphere in a Changing Climate, Chapter 6 [PDF document]. P. 603. Retrieved from https://www.ipcc.ch/site/assets/uploads/sites/3/2019/11/10_SROCC_Ch06_FINAL.pdf
9. IPCC. (2021). Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report. Longer Report.
10. Kiest, K. (2023, June 1). Research: Global warming contributed to decline in tropical cyclones in the 20th century. NOAA Research. https://research.noaa.gov/2022/06/27/research-global-warming-contributed-to-a-decline-in-annual-tropical-cyclones-in-the-20th-century
11. PAGASA. (2023). Flood Information. https://www.pagasa.dost.gov.ph/flood#flood-information
12. World Bank Group. (2022). Philippines Climate Change and Disaster Risk (CCDR) full report. Washington, D.C.: World Bank.

5.1.4 Social vulnerability and underlying impacts

1. Porio, E. and See, J. 2017. Social Well-Being in the Philippines: Indicators and Patterns. The Senshu Social Well-being Review 4, 95-116.
2. See, J. and Porio, E. 2015. Assessing Social Vulnerability to Flooding in Metro Manila Using Principal Component Analysis. Philippine Sociological Review 63, 53-80.
3. Cutter, S.L., Boruff, B.J. & Shirley, W.L., 2003. Social Vulnerability to Environmental Hazards. Social Science Quarterly, 84(2), 242–261.
4. Porio, E. 2011. Vulnerability, Adaptation, and Resilience to Floods and Climate Change-Related Risks among Marginal, Riverine Communities in Metro Manila. Asian Journal of Social Science 39, 425–445.
5. Delfino, A.N., Dizon, J.T., Quimbo, M.A.T. and Depositario, D.P.T. 2019. Social Vulnerability and Adaptive Capacity to Climate Change Impacts of Women-headed Households in the Philippines: A Comparative Analysis. Journal of Environmental Science and Management 22 (2), 36-54.
6. Toda, L., Orduna, J.R., Lasco, R., and Santos, C.T. 2016. Assessing Social Vulnerability to Climate-Related Hazards Among Haiyan-affected Areas in Leyte, Philippines. Climate, Disaster and Development Journal 1, 39-53.
7. Yonson, R., Noy, I. and Gaillard, J.C. 2018. The Measurement of Disaster Risk: An Example from Tropical Cyclones in the Philippines. Review of Development Economics 22 (2), 736–765.
8. Balisacan, A., and N. Fuwa. 2001. Growth, Inequality and Poverty Reduction in the Philippines, UPSE Discussion Paper, 1–9 and Balisacan, A., and E. Pernia. 2002. What Else Besides Growth Matters for Poverty Reduction? ERD Policy Brief No. 5. February 2002.
9. Porio, E. and See, J. 2023. Manila: Aspiring to be an Inclusive, Resilient, and Sustainable City amidst Climate and Disaster Risks. In R. Hu (ed) Routledge Handbook of Asian Cities.
10. Lloyd, S., Gray, J., Healey, S., and Opdyke, A. 2022. Social Vulnerability to Natural Hazards in the Philippines. International Journal of Disaster Risk Reduction 79, 103103.
11. Ignacio, J.A. 2014. Measuring social vulnerability to climate change-induced hazards in the Philippines. PhD Dissertation. Département de Géographie, Université de Namur.
12. Porio, E. et al. 2021. WP 1.2.3 Social Vulnerability Analysis using PCA. Final Synthesis Report (2018-2021): Coastal Cities at Risk in the Philippines (CCARPH) Investing in Climate and Disaster Resilience Project. IDRC Project No. 108688, CRM: 002425.

Figure 1.1.4.1 NAP Strategic Framework

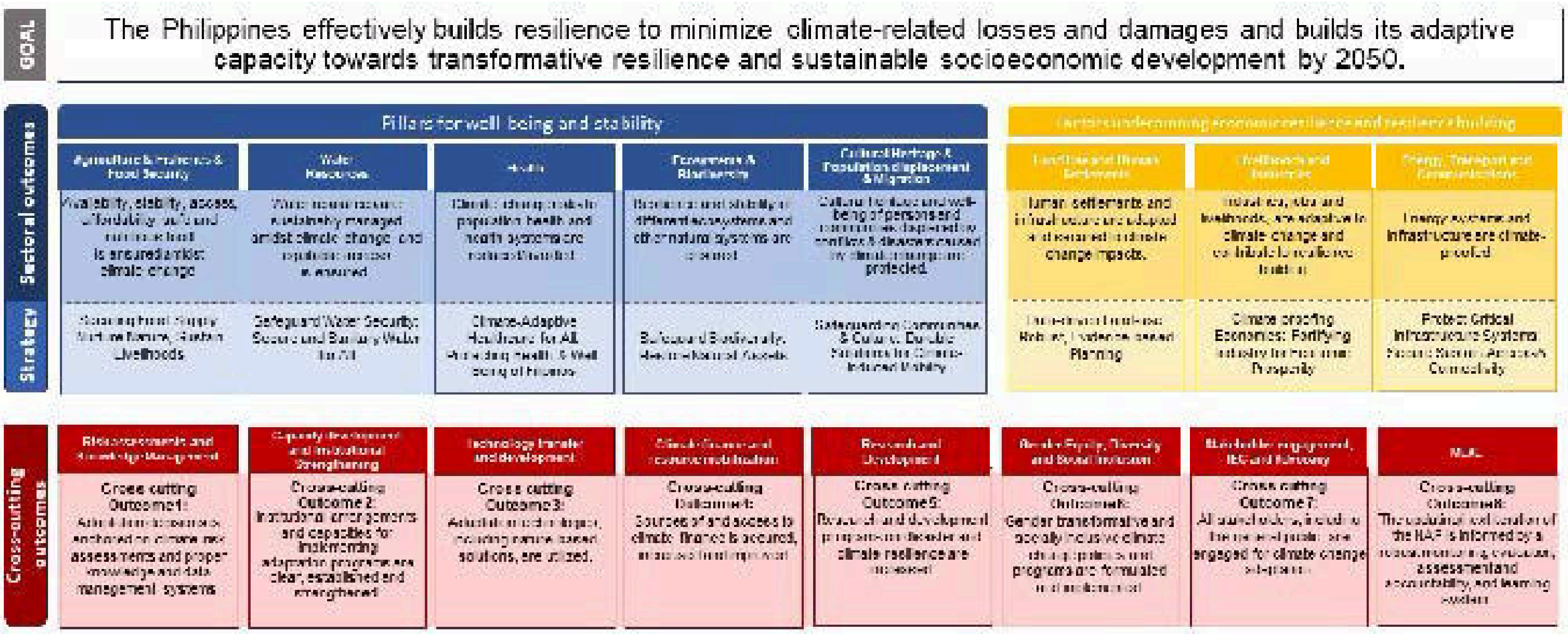


Table 3.3.4.2: Typhoon and/or Super Typhoon occurrence in a 10-year return period, maximum wind speed, population impacted by Typhoon or Super Typhoon occurrence in a 100 km and 25 km radius from the center of the cyclone, area impacted, and percent of total area impacted by Typhoon or Super Typhoon occurrence in a 100 km and 25 km radius from the center of the cyclone, and economic impact (PHP) under SSP5-8.5 scenario by 2030 to 2040 decade

REGION	Typhon and/or Super Typhoon Occurrence	Max wind speed (km/h)	Pop. Impacted (k people) Within 100km Radius	% of Total Pop. (2020 figures)	Pop. Impacted (k people) within 25km Radius	% of Total Pop. (2020 figures)	Area Impacted ('000 sq km) 25km to 100km Range	% of Total Area Impacted	Economic Impact (PHP Bn)
Region II	89%	220	241	7%	20	1%	Jan-22	4%-77%	2
Region IV-B	58%	248	166	5%	26	1%	Feb-15	6%-55%	3
Region IV-A	47%	232	1,048	7%	411	3%	Mar-14	17%-85%	27
Region V	44%	218	410	7%	29	0%	Jan-13	5%-75%	6
Region I	40%	180	341	7%	60	1%	01-Oct	8%-78%	5
Region III	36%	224	772	6%	58	0%	Mar-17	16%-78%	11
Region VIII	31%	172	282	6%	11	0%	Jan-15	3%-71%	2
Region VI	24%	184	503	6%	-	0%	0-12	0%-59%	8
CAR	22%	183	110	6%	52	3%	-	-	2
Region XIII	18%	214	156	6%	15	1%	0-9	1%-45%	2
Region VII	16%	204	493	6%	3	0%	01-May	7%-33%	4
Region XI	7%	205	-	0%	-	0%	0-7	1%-38%	0
Region X	7%	182	106	2%	4	0%	0-4	0%-22%	1
Region XII	4%	154	-	0%	-	0%	0-1	0%-4%	0
Region IX	4%	161	-	0%	-	0%	-	-	0
National Capital Region	4%	220	714	6%	135	1%	0-1	4%-85%	9
Bangsamoro Autonomous Region in Muslim Mindanao	2%	139	-	0%	-	0%	0-1	0%-7%	1

Top metrics under each category