## Supplementary material for "Climate vulnerability scenario of the agricultural sector in the Bicol River Basin, Philippines"

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## **Figures:**



**Figure S1.** Species occurrence points of priority commodities that are principally cultivated within the Bicol River Basin. Each crop is given corresponding color for visualization. Crop occurrences outside the BRB border was also depicted to facilitate comparison of the vegetation cover within the area.



**Figure S2.** Vulnerability matrix representing stakeholders' (*N*=330) perception towards vulnerability of the agriculture sector in terms of rural livelihoods versus the major hazards that is widely experienced in the Bicol River Basin area. Results are expressed across a color gradient that represents the perceived magnitude of impact from crimson (significant), light red (moderate), orange (minimal) to light yellow (no impact) following the Likert scale.

## **Tables:**

**Table S1.** Summary of the descriptive information in relation to the components and indicators used for the vulnerability assessment including its data sources and geospatial resolutions.

Scale	Vulnerability component	Indicator	Description / Sub-indicator	Data Sources	Resolution
Global	Sensitivity	Current climatic data	Current temperature and precipitation dating from 1950 to 2000	WorldClim	30 arc seconds (~1km)
Global	Sensitivity	GCM projected climatic data	Long term projection of climate (2040–2069 representing 2050 decadal time period)	Global Circulation Model (GCM)	30 arc seconds (~1km)
Global	Natural Hazards	Tropical cyclone	Estimate of tropical cyclone frequency based on Saffir- Simpson Category 5 and higher from year 1990-2009	ESCAP & UNISDR	1km
National	Natural Hazards	Flood	Susceptibility of flood risk for Philippines from the past 10 years	AMIA Multi-hazard map Mines and Geo-sciences Bureau	1:10,000 scale vector
National	Natural Hazards	Drought	Groundwater potential from the past 10 years	AMIA Multi-hazard map National Water Resources Board National Color-Coded Guide Map	~100 meters
National	Natural Hazards	Saltwater intrusion	Ground water potential from the past 10 years	AMIA Multi-hazard map National Water Resources Board National Color-Coded Guide Map	~100 meters
National	Natural Hazards	Erosion	Soil erosion classified from low to high susceptibility	AMIA Multi-hazard map Bureau of Soils and Water Management	1:10,000 scale vector
National	Natural Hazards	Landslide	Landslide classified from low to high susceptibility	AMIA Multi-hazard map Mines and Geo-sciences Bureau	1:10,000 scale vector

Scale	Vulnerability component	Indicator	Description / Sub-indicator	Data Sources	Resolution
National	Natural Hazards	Storm surge	Total water levels, changes in tidal levels, wave/surge height and direction	AMIA Multi-hazard map Disaster Risk and Exposure Assessment for Mitigation (DREAM-DOST)	~100 meters
National	Natural Hazards	Sea level rise	Assumption based on 5m sea level rise	AMIA Multi-hazard map	~100 meters
Sub Adaptive inational Capacity		Economic capital	Cost of living, capacity to generate employment, cost of doing business, presence of business and professional organizations	Philippine Statistics Authority - Information Services Division (PSA) National Competitiveness Council (NCC) National Wages and Productivity Council (NWPC) Bureau of Internal Revenue (BIR) Philippine Chamber of Commerce and Industry (PCCI) Regional Offices of the Department of Labor and Employment (DOLE)	Province shapefile
			Size and growth of the local economy, capacity to generate employment, cost of doing business, number of banks and financial institutions, productivity based on gross sales and number of employments, presence of business and professional organizations, access to agricultural insurance	Municipal/City Treasurer's Office (M/CTO) Business Permits and Licensing Office (BPLO) Office of Building Official (OBO) City or Municipal Engineer's Office Municipal/City Agriculture Office (M/CAO) Cooperative Development Authority (CDA) Local financial institutions Local utility service providers Other accredited business organizations	District shapefile
Sub national	Adaptive Capacity	Health capital	Capacity of health services (public & private), presence of health infrastructures or facilities	Department of Health (DOH) Philippine Medical Association (PMA)	Province shapefile
			Number of health manpower, presence of health infrastructures or facilities, access to water and sanitation, nutrition sufficiency	LGU Health Office City or Municipal Engineer's Office	District shapefile
Sub national	Adaptive Capacity	Human capital	Population, number of households, literacy rate, educational infrastructures, school enrolment, student-to- teacher ratio	Philippine Statistics Authority (PSA) National Competitiveness Council (NCC) Department of Education (DepEd) Division and Regional Offices Commission on Higher Education (CHED) Regional Office	Province shapefile
Sub national	Adaptive Capacity	Institutional capital	Civil society organization programs, government response to calamities, presence of agricultural workers, conduct of climate resiliency field schools	National Competitiveness Council (NCC) Municipal/City Agriculture Office (M/CAO) Municipal/City DRRM Council (M/CDRRMC)	District shapefile
Sub national	Adaptive Capacity	Natural capital	Forest cover, access to irrigation systems and facilities, groundwater availability, presence of Marine Protected Area (MPA)	National Irrigation Authority (NIA) Department of Environment and Natural Resources (DENR)	Province shapefile
Sub national	Adaptive Capacity	Social capital	Social protection	Department of Social Welfare and Development (DSWD)	Province shapefile
			Existence of farmer unions, membership in cooperatives, inclusion of ethnic minorities, presence of employed and elected local government unit staff and officials	Municipal/City Planning and Development Office (M/CPDO) Municipal/City Agriculture Office (M/CAO) Cooperative Development Authority (CDA)	District shapefile

Scale	Vulnerability component	Indicator	Description / Sub-indicator	Data Sources	Resolution
Sub national	Adaptive Capacity	Physical capital	Area vulnerable to hazards	Mines and Geo-sciences Bureau (MGB-DOST)	Province shapefile
			Infrastructure investment, access to services (% of households with access to electricity services, % of households with access to water services), number of public transports	National Competitiveness Council - Regional Competitiveness Committee (NCC-RCC)	Province shapefile
			Land area, farm size, land tenure, value of livestock, poultry and aquaculture, number of farmers and fisherfolks, access to seeds, farm equipment, fertilizers and biologics, number of local farm machineries/facilities, access to post-harvest infrastructure and machineries, access to market outlets and facilities, access to fishing equipment	Municipal/City Agriculture Office (M/CAO) City or Municipal Engineer's Office	District shapefile
Sub national	Adaptive Capacity	Anticipatory capital	Presence of functional MDRRMC, early warning systems, radio/TV stations, and telecommunications, access to communication technologies, presence of trainings or seminars related to DRRM, presence of Barangay Disaster Risk Reduction and Management Council (BDRRMC)	Barangay LGU Municipal/City DRRM Council (M/CDRRMC)	District shapefile

Table S2. Global Circulatio	n Models (GCMs) u	used in the study to	o assess future (year	2050) climate suitability.

Model	Modeling Center	Institution
bcc_csm1_1	BCC	Beijing Climate Center, China Meteorological Administration
bcc_csm1_1_m	BCC	Beijing Climate Center, China Meteorological Administration
bnu_esm	GCESS	College of Global Change and Earth System Science, Beijing Normal University
cccma_canesm2	CCCMA	Canadian Centre for Climate Modelling and Analysis
cesm1_bgc	NSF-DOE-NCAR	National Science Foundation, Department of Energy, National Center for Atmospheric
		Research
cesm1_cam5	NCAR	National Center for Atmospheric Research
cnrm_cm5	CNRM-CERFACS	Centre National de Recherches Météorologiques / Centre Européen de Recherche et de
		Formation Avancée en Calcul Scientifique
csiro_access1_0	CSIRO-BOM	CSIRO (Commonwealth Scientific and Industrial Research Organisation, Australia), and
		BOM (Bureau of Meteorology, Australia)
csiro_access1_3	CSIRO-BOM	CSIRO (Commonwealth Scientific and Industrial Research Organisation, Australia), and
		BOM (Bureau of Meteorology, Australia)
csiro_mk3_6_0	CSIRO-QCCCE	Commonwealth Scientific and Industrial Research Organization in Collaboration with
		the Queensland Climate Change Centre of Excellence
ec_earth	EC-EARTH	EC-EARTH Consortium
fio_esm	FIO	The First Institute of Oceanography, SOA, China
gfdl_cm3	NOAA GFDL	Geophysical Fluid Dynamics Laboratory
gfdl_esm2g	NOAA GFDL	Geophysical Fluid Dynamics Laboratory
gfdl_esm2m	NOAA GFDL	Geophysical Fluid Dynamics Laboratory
giss_e2_h	NASA GISS	NASA Goddard Institute for Space Studies
giss_e2_r	NASA GISS	NASA Goddard Institute for Space Studies
inm_cm4	INM	Institute for Numerical Mathematics
ipsl_cm5a_lr	IPSL	Institut Pierre-Simon Laplace
ipsl_cm5a_mr	IPSL	Institut Pierre-Simon Laplace
ipsl_cm5b_lr	IPSL	Institut Pierre-Simon Laplace
lasg_fgoals_g2	LASG-CESS	LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences; and CESS,
		Tsinghua University
miroc_esm	MIROC	Japan Agency for Marine-Earth Science and Technology, Atmosphere and Ocean
		Research Institute (The University of Tokyo), and National Institute for Environmental
		Studies

Model	Modeling Center	Institution
miroc_esm_chem	MIROC	Japan Agency for Marine-Earth Science and Technology, Atmosphere and Ocean
		Research Institute (The University of Tokyo), and National Institute for Environmental
		Studies
miroc_miroc5	MIROC	Atmosphere and Ocean Research Institute (The University of Tokyo), National
		Institute for Environmental Studies, and Japan Agency for Marine-Earth Science and
		Technology
mohc_hadgem2_cc	MOHC (additional	Met Office Hadley Centre (additional HadGEM2-ES realizations contributed by Instituto
	realizations by INPE)	Nacional de Pesquisas Espaciais)
mohc_hadgem2_es	MOHC (additional	Met Office Hadley Centre (additional HadGEM2-ES realizations contributed by Instituto
	realizations by INPE)	Nacional de Pesquisas Espaciais)
mpi_esm_lr	MPI-M	Max Planck Institute for Meteorology (MPI-M)
mpi_esm_mr	MPI-M	Max Planck Institute for Meteorology (MPI-M)
mri_cgcm3	MRI	Meteorological Research Institute
ncar_ccsm4	NCAR	National Center for Atmospheric Research
ncc_noresm1_m	NCC	Norwegian Climate Centre
nimr_hadgem2_ao	NIMR/KMA	National Institute of Meteorological Research / Korea Meteorological Administration

 Table S3. Bioclimatic variables used in crop distribution modeling for the current/baseline conditions.

Parameters	Description (O'Donnell and Ignizio, 2012)		
Temperature Related			
Bio_1 - Annual mean temperature	Annual mean temperature derived from the average monthly temperature.		
Bio_2 - Mean diurnal range	The mean of the monthly temperature ranges (monthly maximum minus monthly minimum).		
Bio_3 - Isothermality	Oscillation in day-to-night temperatures.		
Bio_4 - Temperature seasonality	The amount of temperature variation over a given year based on standard deviation of monthly temperature averages.		
Bio_5 - Maximum temperature of warmest month	The maximum monthly temperature occurrence over a given year (time-series) or averaged span of years (normal).		
Bio_6 - Minimum temperature of coldest month	The minimum monthly temperature occurrence over a given year (time-series) or averaged span of years (normal).		
Bio_7 - Temperature annual range	A measure of temperature variation over a given period.		
Bio_8 - Mean temperature of wettest quarter	This quarterly index approximates mean temperatures that prevail during the wettest season.		
Bio_9 - Mean temperature of driest quarter	This quarterly index approximates mean temperatures that prevail during the driest quarter.		
Bio_10 - Mean temperature of warmest quarter	This quarterly index approximates mean temperatures that prevail during the warmest quarter.		
Bio_11 - Mean temperature of coldest quarter	This quarterly index approximates mean temperatures that prevail during the coldest quarter.		
Precipitation Related			
Bio_12 - Annual precipitation	This is the sum of all total monthly precipitation values.		
Bio_13 - Precipitation of wettest month	This index identifies the total precipitation that prevails during the wettest month.		
Bio_14 - Precipitation of driest month	This index identifies the total precipitation that prevails during the driest month.		
Bio_15 - Precipitation seasonality	This is a measure of the variation in monthly precipitation totals over the course of the year. This index is the ratio of the standard deviation of the monthly total precipitation to the mean monthly total precipitation and is expressed as percentage.		
Bio_16 - Precipitation of wettest quarter	This quarterly index approximates total precipitation that prevails during the wettest quarter.		
Bio_17 - Precipitation of driest quarter	This quarterly index approximates total precipitation that prevails during the driest quarter.		
Bio_18 - Precipitation of warmest quarter	This quarterly index approximates total precipitation that prevails during the warmest quarter.		
Bio_19 - Precipitation of coldest quarter	This quarterly index approximates total precipitation that prevails during the coldest quarter.		
Bio_20 - Number of consecutive dry days	Consistent number considered as dry days.		

 Table S4. Hazard weights per Philippine island groups based from consultations with experts.

Hazards	Luzon (%), (Benguet)	Visayas (%)	Mindanao (%)
Typhoon	20.00, (19.20)	18.21	16.95
Flood	19.05, (16.81)	16.40	15.25
Drought	14.25, (12.80)	16.17	16.95
Erosion	11.43, (12.80)	12.57	12.71
Landslide	8.57, (13.24)	10.72	14.41
Storm Surge	9.52, (4.41)	10.39	8.47
Sea Level Rise	5.71, (4.41)	8.33	5.08
Saltwater Intrusion	11.43, (4.41)	7.21	10.17
Frost	(11.92)	_	-