Section 4: The Climate Extremes Risk Analysis Matrix (CERAM)

The Philippine climate extremes information presented as national-scale maps (Section 2) and provincial-scale tables (Annex A) are designed to aid policy-makers in making robust decisions on disaster risk reduction and climate adaptation. To facilitate the integration of climate extremes in the decision-making process, the Climate Extremes Risk Analysis Matrix (CERAM) is hereby introduced. The CERAM, together with the Climate Information Risk Analysis Matrix (CLIRAM) [1], are tools to help assess the current and projected climate-related risks and identify potential options for climate risk management and adaptation. These tools are designed to work with existing policy-making frameworks, such as the Climate and Disaster Risk Assessment (CDRA) process currently in use by local government units in crafting their Local Climate Change Action Plans (LCCAP) [101], Comprehensive Land Use Plans (CLUP) [102] and Zoning Ordinances (ZO) [103]. A detailed description of the CERAM and a demonstration of how it is used are discussed in this section.

4.1 The CERAM worksheets

The CERAM for each province includes 6 worksheets: one worksheet for each projected time period (early-, mid-, and late-future) and climate variable (i.e. temperature and rainfall).

It is recommended that the worksheets be accomplished initially for each sector (e.g. agriculture, human health, water resources, environment and biodiversity, and infrastructure) to allow a finer analysis of the potential impacts of climate extremes and adaptation options. After accomplishing the worksheets, the results can then be integrated to determine the impacts and options that are common among or unique to the sectors.

Table 8 shows the two major parts of each worksheet. The first part, composed of columns 1–6, contains values corresponding to the selected time period and scenario, derived from the provincial-scale tables. Thus in Table 8, columns 1 and 2 list the climate extremes index code, description and unit; column 3 shows the baseline value; and column 4 splits the data for the two scenarios, RCP4.5 (upper row) and RCP8.5 (lower row). Columns 5 and 6 then show the corresponding projected value and projected change for each scenario.

Table 8. Climate Extreme Risk Analysis Matrix (CERAM) completion guide.

part 1 part 2

RAINFALL Climate Extreme Indices				MID-FUTURE Projections					
CODE	Description (unit)	Baseline	Scenario	Projected Value	Projected Change	Historical Impacts	Projected Changes in Extremes	Potential Impacts of Changes in Extremes	Adaptation Options
Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10
Rx1day	Maximum 1-day rainfall total (mm)	81.8	RCP4.5	85.6	3.8	• What climate variable is the information about? • What climate extreme indicator is shown? Does this describe magnitude, frequency or duration? • What is its baseline value? • What climate-related events are associated with this indicator? • What high-impact historical events may be related to these index values? • Did the identified event cascade to other hazards? • What impacts did these events/hazards cause? • What sectors were affected and to what extent?	• What RCP scenario is being shown? • What RCP scenario is relevant to my planning needs? • Are the numbers referring to changes from the baseline, or to the new future values? • How big is the change from the baseline? • What is the direction of the change?	• Is the projected change significant to my locality? • What will this mean for my city/municipality? • What sectors will be impacted? • What will be the scope of its impact? • Will there be any changes to the current impacts I am experiencing? • Are actions to these impacts highly needed?	• What are the risks involved from the impacts? • What can I do to lessen these risks? • Is my current adaptation plan sufficient in addressing such risks? • Who are the relevant actors and stakeholders for these adaptation options? • To what extent can this adaptation option reduce my vulnerabilities? • Is it cost-efficient? • Is it feasible in my locality? • Are there any co-benefits? • What adaptation option can best address the current and future risks based on local capacities?
			RCP8.5	84.0	2.2				

The second part, composed of columns 7–10, requires input from the users based on their local experience and historical records. To facilitate filling-out these columns, guide questions are also provided in Table 8.

Column 7 requires information on historical impacts of the particular index. Users are asked to assess the baseline values shown in Column 3 and to identify associated historical climate-related impacts that the locality has observed and experienced. In some cases, these impacts could be induced by non-extreme meteorological events that may be compounded by other hazards as well as local exposure and social vulnerabilities. If so, users should take note of the other hazards as well as the community exposure and vulnerabilities which contributed to the impacts.

Column 8 is a summary of the projected change in the extremes index (columns 5 and 6) and sets the formulation of the statement required in column 9 on the potential impacts of the projected climate. Since the different RCP scenarios would most probably result in different outcomes, columns 8–10 should be analysed separately for each scenario.

Column 9 requires the users to assess the potential impacts of the changes on extremes. Starting with the historical impacts listed in column 7, evaluate how the projected changes will change future impacts. If there are no recorded historical impacts, will the projected changes introduce new impacts in the locality? Will other hazards, existing and projected exposure and vulnerabilities result in new or enhanced risks in the future?

It should be noted that even when the projected change in the extremes is negligible, there might be existing risks that could continue (or even worsen) future impacts. These past and/or present impacts should likewise be noted.

For example, there is no projected change in extreme rainfall in the future. However, at present, flooding already occurs regularly in the community. Will these flooding episodes stop or continue in the future despite the projections?

To aid users with their analysis, some sectoral impacts related to climate extreme indices are provided in Section 3.

Lastly, column 10 allows users to identify possible adaptation options to minimize the effects of climate extremes. To trigger interest and creative ideas, some adaptation options are listed in the tables in Section 3. Users should take note that the list contains only a very small sample of the many different options that local communities can take. Creative solutions that take into consideration a systems-thinking approach; solutions that consider the interrelation of each component, how the systems work over time and within the context of larger systems, should be considered.

4.2 Using the CERAM Tool

To demonstrate how the CERAM is used, a sample CERAM for the Agriculture sector, assessing the mid-future projections for temperature and rainfall are shown in Tables 9 and 10, respectively.

The responses for columns 7–10 in these tables are based on the answers by farmers and agricultural experts in Calapan City, Oriental Mindoro during the Australian Centre for International Agricultural Research (ACIAR) project "Action-ready climate knowledge to improve disaster risk management for small-holder farmers in the Philippines" [104].

The CERAM worksheets as well as the electronic copy of this report and related documentation will be made available through the DOST-PAGASA and the Manila Observatory web sites.

Table 9. Sample completed CERAM for the temperature extremes indices for the Agriculture sector of the province of Oriental Mindoro. The projections shown are for the mid-future (2045-2065) for both RCP4.5 amd RCP8.5

	TEMPERATURE Climate Extreme Indices				MID-FUTURE Projected Change						
	CODE	Description (*unit*)	Baseline	Scenario	Amount of Change	Projected Value	Historical Impacts	Projected Changes in Extremes	Potential Impacts of Changes in Extremes	Adaptation Option
	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10
MAGNITUDE	TNn	Coldest nighttime temperature (˚C)	14.8	RCP4.5	1.2	19.6	Coldest nighttime temperature is at 14.8˚C.	**Coldest projected annual night time temperature** will increase to 19.6˚C	• Decrease in yield • Increased spikelet degeneration	• Adopting crop breeding varieties • Fungal symbionts technology • Adjust planting calendar • Continue with the farm management • Delay crop planting • SMAW H2O Irrigation System • Shallow tube well • Pump irrigation system from open source • Increased application of ferti;izer • Crop Diversification
				RCP8.5	1.7	20.1		Coldest annual Tmin will increase to 20.1˚C		
	TNm	Average nighttime temperature (˚C)	21.8	RCP4.5	1.1	22.9	Average nighttime temperature is at 21.8˚C.	Mean annual Tmin will increase to 22.9˚C		
				RCP8.5	1.6	23.4		Mean annual Tmin will increase to 23.4˚C		
	TNx	Warmest nighttime temperature (˚C)	24.2	RCP4.5	1.2	25.4	Warmest nighttime temperature is at 24.2˚C.	Hottest annual Tmin will increase to 25.8˚C		
				RCP8.5	1.6	25.8		Hottest annual Tmin will increase to 25.8˚C		
	TXn	Coldest daytime temperature (˚C)	24.6	RCP4.5	1.2	25.8	Coldest daytime temperature is at 24.6˚C.	Coolest annual Tmax will increase to 25.8˚C	• Hardening of soil due to inadequate water • Wilting of crops • Decrease in yield • Presence of pests and fungal infection • Poor crop quality • Stunted crop growth	
				RCP8.5	1.6	26.2		Coolest annual Tmax will increase to 25.8˚C		
	TXm	Average daytime temperature (˚C)	29.7	RCP4.5	1.1	30.8	Average daytime temperature is at 29.7˚C.	Mean annual Tmax will increase to 30.8˚C		
				RCP8.5	1.6	31.3		Mean annual Tmax will increase to 31.3˚C		
	TXx	Hottest daytime temperature (˚C)	33.1	RCP4.5	1.2	34.3	Hottest daytime temperature is at 33.1˚C. Hotter temperatures have previously caused hardening of soil and crop wilting.	Hottest annual Tmax will increase to 34.3˚C		
				RCP8.5	1.7	34.8		**Hottest projected annual daytime temperature** will increase to 34.8˚C		
	DTR	Daily Temperature Range (˚C)	7.8	RCP4.5	0.1	7.9	Daily temperature range is at 7.8˚C.	Minimal to no change in mid-century	Same vulnerability to the present may continue in the future.	
				RCP8.5	0	7.8		Minimal to no change in mid-century		
FREQUENCY	TN10p	Fraction of cold nights (*days*)	11.7	RCP4.5	-9.8	1.9	Cold nights occur from 11-12 days in a year.	Cold nights will diminish to only 2 nights in the mid-century. Expect nights to be warmer.	• Reduced crop yields • Increased spikelet degeneration • Impaired grain growth	
				RCP8.5	-10.4	1.3		Cold nights will diminish to only 1 night in the mid-century. Expect nights to be warmer.		
	TX10p	Fraction of cool days (*days*)	11.4	RCP4.5	-9.9	1.5	Cool days occur from 11-12 days in a year.	Cool days will diminish to only 2 days in the mid-century. Expect days to be warmer.		
				RCP8.5	-10.2	1.2		Cool days will diminish to only 1 day in the mid-century. Expect days to be warmer.		
	TN90p	Fraction of warm nights (*days*)	11.5	RCP4.5	42.6	54.1	Warm nights occur from 11-12 days in a year	Occurrences of warm nights will increase to 54 days. Nights will become warmer.	• Reduced crop yields • Increased spikelet degeneration • Impaired grain growth	
				RCP8.5	61.9	73.4		Occurrences of warm nights will increase to 73 days. Night temperatures will become warme		
	TX90p	Fraction of hot days (*days*)	11.4	RCP4.5	43.1	54.5	Hot days occur from 11-12 days in a year. Only 4 barangays were categorized as very high vulnerability to drought.	Occurrences of hot days will increase to 55 days. Day temperatures will become hotter.		
				RCP8.5	56.9	68.3		Occurrences of hot days will increase to 63 days. Day temperatures will become hotter.		
DURATION	WSDI	Number of days contributing to a warm period (*days*)	2.7	RCP4.5	122.3	125	The number of days contributing to warm periods is only 2-3 days. Only 4 barangays were categorized as very high vulnerability to drought.	Duration of days contributing to a warm period will become 125 days. Substantially longer warm period ahead.	• Possible yield loss • Dryness of soil • Soil nutrient loss	
				RCP8.5	191.5	194.2		Duration of days contributing to a warm period will become 125 days. Substantially longer warm period ahead.		

Table 10. Sample completed CERAM for the rainfall extremes indices for the Agriculture sector of the province of Oriental Mindoro. The projections shown are for the mid-future (2045-2065) for both RCP4.5 amd RCP8.5

	RAINFALL Climate Extreme Indices		Baseline	Scenario	MID-FUTURE Projected Change		Historical Impacts	Projected Changes in Extremes	Potential Impacts of Changes in Extremes	Adaptation Options
	CODE	Description (*unit*)			Change	Value				
	Col 1	Col 2	Col 3	Col 4	Col 5	Col 6	Col 7	Col 8	Col 9	Col 10
MAGNITUDE	PRCPTOT	Total wet-day rainfal (*mm*)	1992.7	RCP4.5	-22	1970.7	Total annual wet-day rainfall of 1992.7 mm is moslty due to occurences of thunderstorms, Asian monsoon, ITCZ, LPA, and tropical cyclones events. These events have triggered incidences of flooding in the past.	Minimal decrease to total annual wet-day rainfall of 22 mm (-1.1%). Past extremes events may continue in the future.	Same vulnerability to the present may continue in the future.	• Alternate wetting and drying (AWD) • Dry direct and Direct Seeding
				RCP8.5	-50.2	1942.5		Minimal decrease to total annual wet-day rainfall of 50.2 mm (-2.5%). Past extremes events may continue in the future.		
	SDII	Average daily rainfall intensity (*mm/day*)	10.7	RCP4.5	-0.1	10.6	Baseline SDII is 10.7 mm/day. Rainfall over short durations (1 hour) pose flood hazards on low-lying areas near river channels.	Minimal to no change.	Same vulnerability to the present may continue in the future.	
				RCP8.5	-0.4	10.3		Minimal to no change.		
	Rx1day	Maximum 1-day rainfall total (*mm*)	81.8	RCP4.5	3.8	85.6	Maximum 1-day rainfall is at 81.8 mm. Previous extreme events due to TCs have exceeded the baseline average and caused flashfloods occurrence as large number of barangays are susceptible to flooding. Agricultural loses have been recorded due to flashfloods.	Maximum 1-day total rainfall will increase by 3.8 mm. Extreme events like TCs may induce more rain in the future	• Greater risk of flooding • Immersion of seeds • Submergence of plants • Seeds washout • Decrease in yield • Presence of insects and fungal infection	• Ensure working irrigation systems • Establish drainage canals • Invest on EWS • Planting recommended rice varieties against flooding • Laser land leveling • Floating agriculture or garden • Sorjan cropping system • Index-based Climate Insurance
				RCP8.5	2.2	84		Maximum 1-day total rainfall will increase by 2.2 mm. Extreme events like TCs may induce more rain in the future		
	Rx5day	Maximum 5-day rainfall total (*mm*)	172.4	RCP4.5	9.1	181.5	Maximum 5-day total rainfall is 172.4 mm. Widespread flooding was experienced in the past. Heavy rains resulted to swelling of river. Breaching of dike. Floodwater washed away newly harvested crops	Total 5-day total rainfall will increase by 9.1 mm. Increase in rainfall amount on consecutive days may worsen flooding and related hazards.		
				RCP8.5	4.7	177.1		Total 5-day total rainfall will increase by 4.7 mm. Increase in rainfall amount on consecutive days may worsen flooding and related hazards.		
	P95	Rainfall on very wet days (*mm*)	33.4	RCP4.5	0.3	33.7	Rainfall on very wet days is at 33.4 mm. Flooding in low lying areas have been experienced	Minimal to no change.	Same vulnerability to the present may continue in the future.	
				RCP8.5	-0.7	32.7		Minimal to no change.		
	P99	Rainfall on extremely we days (*mm*)	60.5	RCP4.5	1.9	62.4	Rainfall on extremely wet days is 60.5 mm. Events of such magnitude have previously brought flashflood events.	Minimal to no change.		
				RCP8.5	0.6	61.1		Minimal to no change.		
	R95p	Total rainfall from very wet days (*mm*)	462.8	RCP4.5	26.4	489.2	Total rainfall from very wet days is at 462.8 mm This amount of rainfall are mostly due to TCs and monsoon events that have caused widespread flooding and losses in agriculture.	Total rainfall during very wet days will increase up to 26.4 mm. Intense rainfall events due to TCs and monsoons may bring more rain.	• Threaten wet season crop harvest • Risk of flooding • Submergence of plants • Immersion of seeds • Seeds washout • Poor to zero germination • Delayed planting	• Ensure working irrigation systems • Establish drainage canals • Planting recommended rice varieties against flooding • Laser land leveling • Floating agriculture or garden • Sorjan cropping system • Index-based Climate Insurance
				RCP8.5	-10	452.8		Total rainfall during very wet days may decrease by 10 mm.		
	R99p	Total rainfall from extremely wet days (*mm*)	147.8	RCP4.5	15.7	163.5	Total rainfall from extreme wet days is at 147.8 mm. These are mostly due to TCs and enhancement of monsoon rains.	Total rainfall during extremely wet days will increase by 15.7 mm. TCs and enhanced monsoon rains may be more intense.		
				RCP8.5	10.7	158.5		Total rainfall during extremely wet days will increase by 10.7 mm. TCs and enhanced monsoon rains may be more intense.		
FREQUENCY	P95d	Number of very wet days (*days*)	9.2	RCP4.5	0	9.2	Number of very wet days is at 9 days. Can be attributed to frequent flooding especially in low lying and riverbank areas.	Minimal to no change.	Same vulnerability to the present may continue in the future.	
				RCP8.5	-0.5	8.7		Minimal to no change.		
	P99d	Number of extremely wet days (*days*)	1.9	RCP4.5	0.1	2	There are 2 days of number of extremely wet days. These events have caused flashfloods	Minimal to no change.		
				RCP8.5	0	1.9		Minimal to no change.		
DURATION	CWD	Longest wet spell (*days*)	22.1	RCP4.5	0.2	22.3	Long periods of rain cause flooding. Overflow of major tributaries	Minimal to no change.	Same vulnerability to the present may continue in the future.	
				RCP8.5	0.4	22.5		Minimal to no change.		
	CDD	Longest dry spell (*days*)	27.5	RCP4.5	0	27.5	Water supply is highly susceptible to drought conditions.	Minimal to no change.		
				RCP8.5	-0.3	27.2		Minimal to no change.		