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D2.2 REVIEW OF CLIMATE INFORMATION SYSTEM IN CAMBODIA

CLIMATE RISK ASSESSMENT FOR SUBNATIONAL ADAPTATION AND ESTABLISHMENT OF A LOCAL CLIMATE INFORMATION SYSTEM FOR CLIMATE CHANGE ADAPTATION (LISA)

January 2023

Prepared for: **United Nations and MoE**
Prepared by: **ICEM**

icem

DISCLAIMER

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Suggested Citation	ICEM 2023. *Review of Climate information systems in Cambodia.:* Technical Assistance: Climate risk assessment for subnational adaptation and establishment of a local climate information system for climate change adaptation (LISA). Prepared for UN-CTCN.
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ABBREVIATIONS

CamDI	Cambodia Disaster Damage and Loss Information System
CAM-MeDiA	Cambodia Mekong Delta Digital Atlas
CIS	Climate Information System
CMIP5	Coupled Model Intercomparison Project Phase 5
DCC	Department of Climate Change
CSO	Civil Service Organization
DCDM	District Committee for Disaster Management
EWS1294	Early Warning System 1294
GCM	General Circulation Model
GCF	Green Climate Fund
GFCS	Global Framework for Climate Services
GHG	Greenhouse gas
GIZ	German Agency for International Cooperation
ICEM	International Centre for Environmental Management
IIED	International Institute for Environment and Development
KAP	Knowledge, Attitude, and Practice on Climate Change
LISA	Local Climate Information System for Climate Change Adaptation
MAFF	Ministry of Agriculture, Forestry and Fisheries
MoE	Ministry of Environment
Mo I	Ministry of Interior
MoP	Ministry of Planning
MoWRAM	Ministry of Water Resources and Meteorology
MRC CCAI	Mekong River Commission - Climate Change and Adaptation Initiative
MRC	Mekong River Commission
NASA	National Aeronautics and Space
NCDDS	National Committee for Sub-national Democratic Development Secretariat
NCDM	National Committee for Disaster Management
NCSD	National Council for Sustainable Development
NEX-GDDP	NASA Earth Exchange Global Daily Downscaled Projections
PCDM	Provincial Committee for Disaster Management
PDOWRAM	Provincial Department of Water Resources and Meteorology
PRISM	Platform for Real-time Impact and Situation Monitoring
RCP	Representative Concentration Pathway

TA	Technical Assistance
UN-CTCN	United Nations Climate Technology Centre and Network
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
WMO	World Meteorological Organization

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EXECUTIVE SUMMARY

This report is a deliverable under Output 2 of the *Technical Assistance (TA) on Climate risk assessment for subnational adaptation and establishment of a local climate information system for climate change adaptation (LISA) in Cambodia*. This document presents findings from a review on the status of climate information systems (CISs) in Cambodia, with the aim of informing development of the LISA platform.

For the purpose of this report, a CIS is defined broadly as a platform that can be used to share climate data and information, which may contain value added information (climate services), that is useful to inform decision making for a given group of end-users or sector(s). Over recent years, eight web-based platforms have been developed for Cambodia, which function as either early warning for local communities (EWS1294, PRISM) or have potential to support the data needs for climate change adaptation planning (CAM-MeDiA, Cambodia Climate Change Toolbox, Cambodia Climate Change Data Portal, MRC-GIZ 9C9T Atlas, CamDI).

With regard to adaptation planning, of the current CISs, only CAM-MeDiA and the 9C9T Atlas have potential to function as standalone systems to inform adaptation planning by enabling the overlaying of climate, flood and drought data with sector-related data. An intuitive map-based interface is required to allow decision makers to overlay data of management/sector interest (e.g., cropping data, infrastructure) on future projections of climate, and hazards data (e.g., flood and drought). However, the geographical area of interest in each application is limited, either restricted to the Cambodian Mekong delta or 9C9T subbasin of the Mekong River respectively. There is currently no CIS that can address adaptation planning in a national context.

There is limited information on how decision makers can use the existing CIS to support future planning and investment. The exception is the CAM-MeDiA platform that provides case studies on how the tool might be used to address aspects of the mandates of the Ministry of Environment (MoE), Ministry of Water Resources and Meteorology (MoWRAM) and Ministry of Agriculture, Forestry and Fisheries (MAFF). To facilitate adaptation planning, an interactive table of potential adaptation measures, including nature-based solutions, could be integrated into the LISA application to provide guidance to decision makers on the selection of appropriate adaptation options.

Adaptation planning in Cambodia requires future projections of climate data, as well as data on hazards (flood and drought), and inclusion of data on vulnerability. Climate data are found in four tools - CAM-MeDiA, Climate Change Toolbox, the 9C9T Atlas, and MRC Data Portal, although as indicated above, only two systems enable the overlaying of climate and hazards data on other types of data to identify hotspot areas of climate risk. Furthermore, adaptation planning requires that CISs are updated with reliable and up-to-data, and this requires that the government take ownership of the web-based platform to ensure its ongoing operation and maintenance.

Web-based applications should be readily accessible and hosted appropriately, with adequate hardware, internet connectivity and technical expertise. Two systems developed earlier by ICEM (CAM-MeDiA and the Cambodia Climate Change Toolbox) were not deployed to government servers due to the lack of hardware and available expertise within government. Another system appears to be intermittently inaccessible (PRISM). Through consultations with government, it is proposed that the ICEM team will work with the Provincial Committee for Disaster Management (PCDM) to develop a plan for future hosting, operation and maintenance of the LISA platform for Battambang municipality (an output of the LISA project).

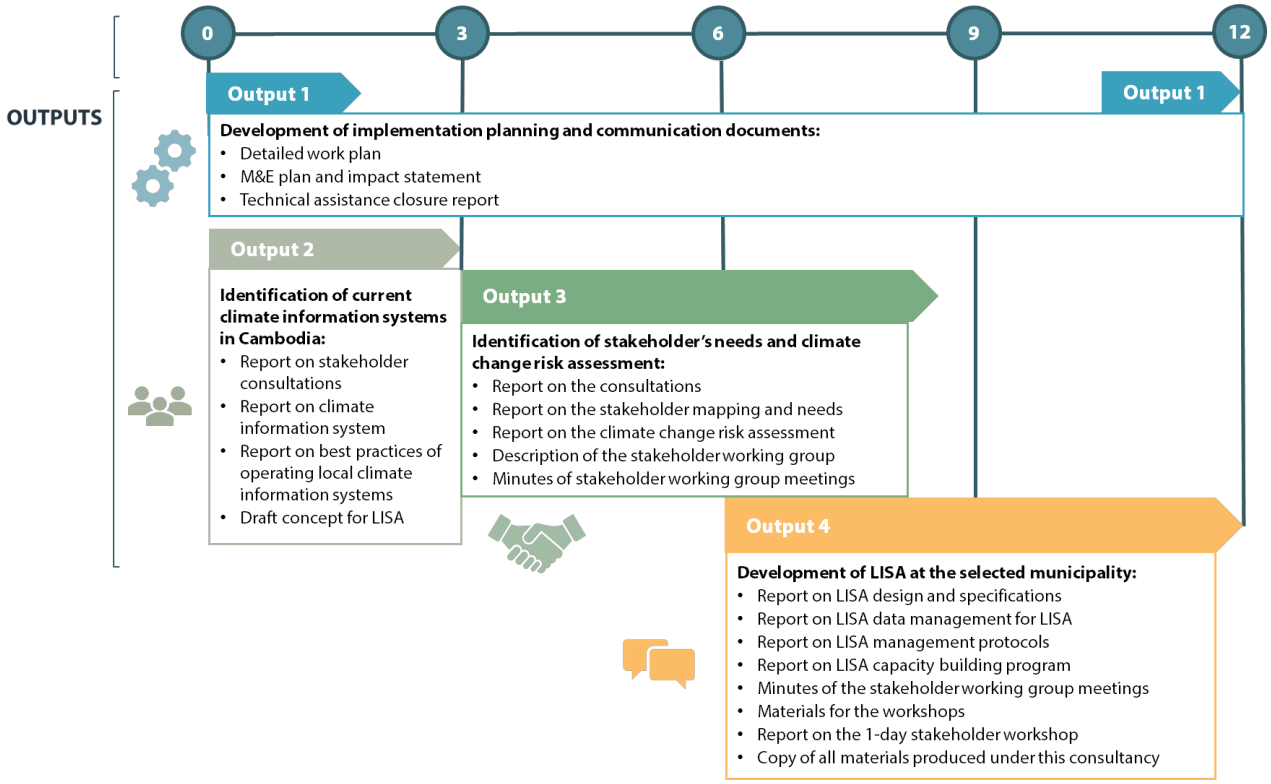
1 INTRODUCTION

1.1 Overview of this report

This report is a deliverable under Output 2 of the *Technical Assistance on Climate risk assessment for subnational adaptation and establishment of a local climate information system for climate change adaptation (LISA) in Cambodia*. This *Review of Climate Information Systems in Cambodia* focuses on reviewing the status of CISs in Cambodia, with the aim of informing development of the LISA platform.

The TA is funded by the United Nations Climate Technology Centre and Network (UN-CTCN) and aims to design a web-based local CIS, which can support adaptation decision making processes, and provide services for climate information delivery at the sub-national (local) level. It is centred around four outputs, as shown in Figure 1.

Figure 1: Timeline of TA outputs over the 12-month project implementation period



1.2 What is a climate information system?

There is no single definition for a CIS. Broadly a CIS can be considered as a platform that can be used to share climate data and information, and may contain value added information that is useful to inform decision making for a given group of users or sector (Box 1). A CIS might be designed as an early warning system to alert communities of an imminent hazard, provide medium-term advisories to farmers, or in the long-term used to identify areas at highest risk from climate hazards for prioritising investment planning.

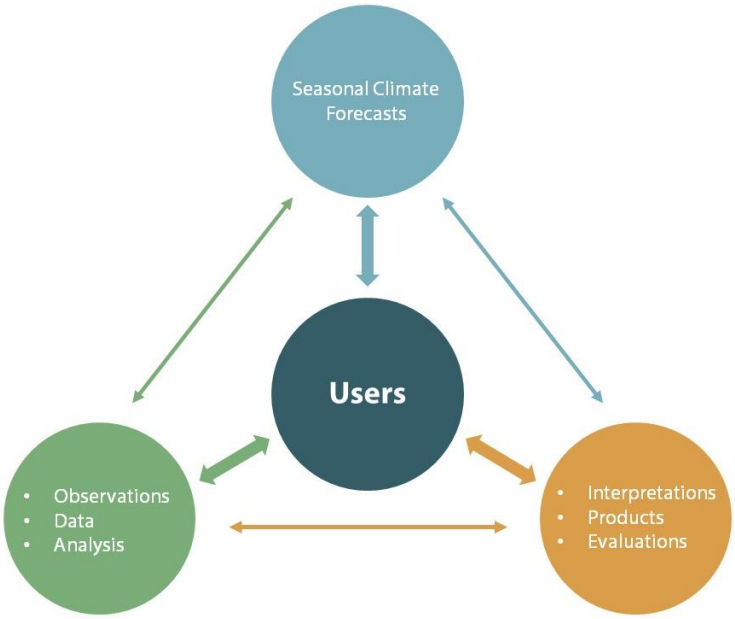
Box 1: 'Climate information includes all aspects of climate, from observations and forecasts to application of this information for relevant segments of society' (Ropelewski 2003)

According to Ropelewski (2003), the components of a CIS can include the following features (Figure 2):

- Robust real-time climate observations
- Archives of climate data
- Real-time analyses of current climate data
- Climate forecasts from a range of sources
- Comprehensible forecast products
- Analyses of past forecast performance
- Effective dissemination modalities of climate information to end users
- Engagement and feedback from end users.

Figure 2: Schematic diagram of climate information system components

Source: Ropelewski, 2003



Trenberth (2016) advocates a similar 'end-to-end' design approach for CISs. An end-to-end system considers the entire process from provision of climate observations, data archiving, data access, to dissemination of climate services to end users and decision makers. Such a system is one that not only provides access to data but also data interpretation (Rood and Edwards 2014). For this report, a CIS is similarly viewed broadly as a system that encompasses data collection, archiving, access, and dissemination of climate data and climate services, and a local CIS as one that informs end-users on climate resilient planning at subnational, municipal or local level.

1.3 Climate services

Box 2: Climate services are "climate information prepared and delivered to meet users' needs". (WMO 2011)

Climate services are needed by decision makers to inform climate resilient planning and development, or 'climate smart development'[1], by ensuring that the most appropriate adaptation options are considered for addressing the future impacts of human-induced climate change. Hewitt et al. (2021) suggested a simple and generic definition of a climate service as "*the provision of climate information for use in decision-making*". Multiple sectors of the economy including those in the

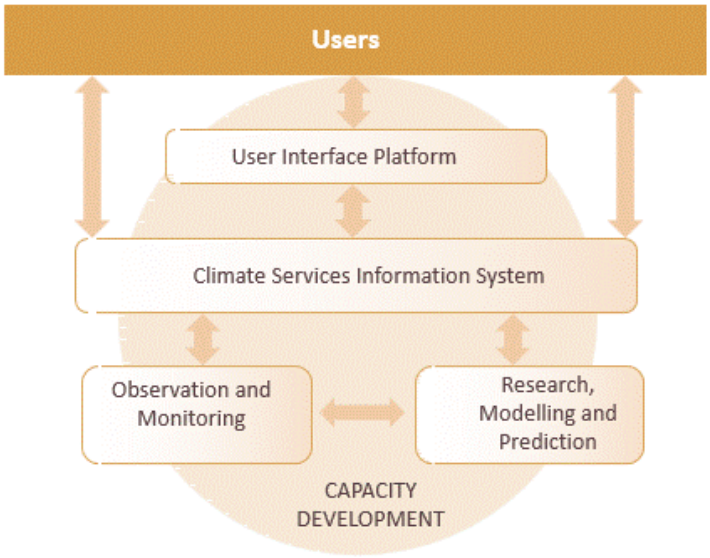
[1] https://gfcs.wmo.int/what-are-climate-services

primary (agriculture, forestry, fisheries), secondary (industry, transportation, water, energy, housing) and tertiary (health care, tourism) sectors require the mainstreaming of climate change into decision making to bolster climate resilient development. The form of climate services will vary by sector. For instance, climate advisories are commonly used to inform medium-term agricultural planning, and may advise on appropriate crops and varieties, and diverse cropping patterns (WMO 2019). Regarding urban areas, heat stress is one potential adaptation concern, and climate services may include the creation of maps showing the number of heat wave days, and adaptation measures may include increasing surface coverage of green spaces and water. [2,3] However, while there is a clear need for climate services to drive appropriate adaptation, there have been challenges in applying climate services to urban planning (Giodano et al., 2020).

At the global level, the World Meteorological Organization (WMO 2009) established the Global Framework for Climate Services (GFCS) to support climate resilient planning.[4] The purpose of the GFCS is to support regional, national and local government in mainstreaming climate change into decision making in priority areas such as health, water, agriculture, energy and disaster risk reduction.[5] The climate service information systems is the central mechanism of the GFCS and comprises institutes and centres responsible for collecting, analysing, archiving, and sharing climate information data and services (Figure 3).

Figure 3. Five pillars of the Global Framework for Climate Services

Source: adapted from WMO, 2014



A series of eight principles were proposed to guide the implementation of the GFCS including the third principle which states that "activities will address three geographic domains - global, regional and national", with the most important aspect being the implementation at subnational and local levels (WMO, 2012). Engagement between producers of climate information and its end-users is also stated as critical to mainstreaming climate change into decision making.

[2] https://www.urban-climate.eu/c/services_projections/
[3] https://www.urban-climate.eu/c/Adaptation_scenarios/
[4] https://www.gfcs-climate.org/overview/
[5] https://www.gfcs-climate.org/partnership/

2 INSTITUTIONAL RESPONSIBILITIES

Building on the CIS frameworks as presented in previous chapter, this section reviews relevant institutions and agencies that play important roles in generating and using climate information services in Cambodia.

2.1 National Council for Sustainable Development

The National Council for Sustainable Development (NCSD) is responsible for mainstreaming sustainable development into the country's policies, strategies, and programmes, and for meeting its international obligations. Established in 2015, the NCSD comprises 36 ministries/agencies and 25 provincial/capital governors. Climate change issues are addressed by the Department of Climate Change (DCC), which include ensuring the government meets its commitments to the United Nations Framework Convention on Climate Change and for also implementing climate change initiatives (such as the UN-CTCN LISA project). Under the NCSD, key climate change initiatives have been articulated in the Cambodian Climate Change Strategic Plan 2014-2023, the Sectoral Climate Change Action Plans and the Climate Change Financing Framework.[6]

2.2 National Committee for Disaster Management

Disaster management is coordinated by the National Committee for Disaster Management (NCDM). Under the Law on Disaster Management, NCDM, together with the MoWRAM, is tasked with the overall coordination of the response to flood and drought events and for improving resilience to disasters. MoWRAM is responsible for forecasting and early warning, and together with NCDM works at provincial and district levels to issue warnings and manage emergency response.

A key role of NCDM is to establish links between disaster risk reduction and climate change adaptation, through the formulation and implementation of the Strategic Plan on Climate Change for the Disaster Management.

NCDM has sub-national bodies at all administrative levels including province, district, and commune. Every province has a disaster management committee chaired by the Provincial Governor. The provincial governor presides over the PCDM and district governor and commune-chiefs also preside over the district and commune committees. Commune and district disaster committees manage disaster events, collecting information about a disaster in their administrative area and report to higher levels.

2.3 Ministry of Water Resources and Meteorology

MoWRAM's role is to implement legislation on water resources management and to coordinate with ministries at national level and line departments at sub-national levels on the topic.

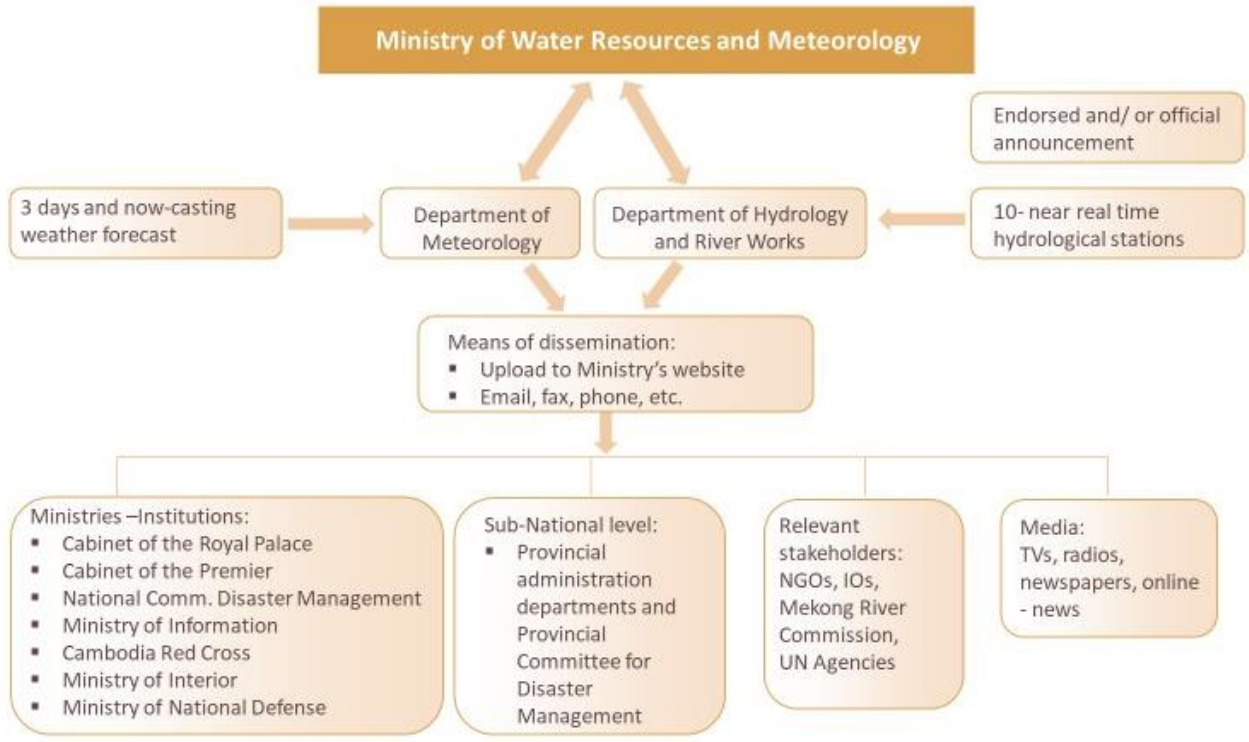
At the national level, there are two main technical departments in MoWRAM involved in the management and generation of climate information and forecasting including: (i) the Department of Hydrology and River Works, and (ii) the Department of Meteorology (Figure 4). Flood forecasting is the responsibility of the Department of Hydrology and River Works, while the Department of Meteorology performs activities related to forecasting, which includes early warning based on weather station observations and incoming data from satellite and radar observations.

[6] https://ncsd.moe.gov.kh/ncsd/about-ncsd

MoWRAM manages hydrological and meteorological stations throughout the country at the main rivers, lakes, and vulnerable areas for the collection of meteorological and hydrological information, and is responsible for the generation of short and long-term forecasts for multiple sectors and communities. For example, under the GEF-funded project *Strengthening Climate Information and Early Warning Systems,* implemented between 2015-2020, 24 automatic weather stations and 29 hydrological stations for surface and ground water monitoring were installed by MoWRAM (UNDP, 2020).

Figure 4: Dissemination of forecasting and early warning information

Source: adapted from Mao Saohorn 2018



2.4 National Committee for Sub-national Democratic Development Secretariat

The National Committee for Sub-national Democratic Development Secretariat (NCDDS) coordinates government budget disbursement including the Commune/Sangkat Fund and District Fund, and other development partner projects implemented under NCDDS.

NCDDS coordinates and implements several climate change projects including the *Local Governance and Climate Change Project*, which is a demonstration project with potential to be scaled up in other provinces. NCDDS is committed to mainstreaming climate resilience into its local development projects. However, the capacity of sub-national authorities is limited with regard to mainstreaming climate change adaptation into their planning and project implementation.

NCDDS has also become the national accredited entity of the Green Climate Fund (GCF) for Cambodia, and within this mandate, NCDDS can access funds directly from GCF for implementing GCF-funded projects at national and sub-national levels.

3 EXISTING CLIMATE INFORMATION SYSTEMS IN CAMBODIA

The following section provides an account of CISs that are currently operational in Cambodia. (i) Early Warning System 1294, (ii) Platform for Real-time Impact and Situation Monitoring (PRISM), (iii) Cambodia Disaster Loss and Damage Information System (CamDI), (iv) Cambodia Climate Change Data Portal, (v) Mekong River Commission Data and Information Service Portal, (vi) Cambodia Mekong Delta Digital Atlas (CAM-MeDIa), (vii) Cambodia Climate Change Toolbox, and (viii) the MRC-GIZ 9C9T Atlas. An overview of each system is given, with a focus on the data inputs and outputs of each system.

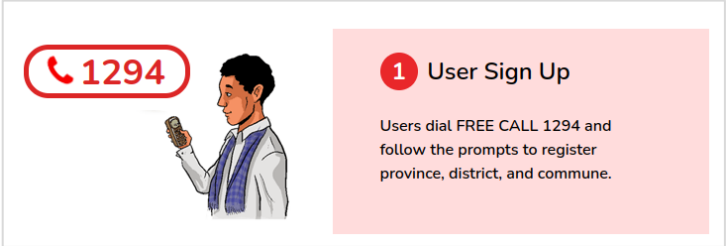
3.1 Early Warning System 1294

The Early Warning System (EWS) 1294 disseminates early warning information to vulnerable communities at risk from natural hazards. EWS 1294 is a free mobile phone service developed by the non-governmental organization People in Need and through the collaboration of various stakeholders including NCDM, Ministry of Post and Telecommunications, international organizations, civil society organizations, the private sector and local communities.[9] EWS1294 is now operational for all provinces in Cambodia and implemented through the support of NCDM.[7,9]

Users can register to EWS 1294 by calling '1294', and will receive an audio warning when there is an emergency, such as a flood or storm. EWS 1294 was piloted in 2013 and has since been integrated into NCDM's disaster management strategy (UNDP, 2019).

Figure 5. End-user registration for EWS1294

Source: https://ews1294.org/how-it-works



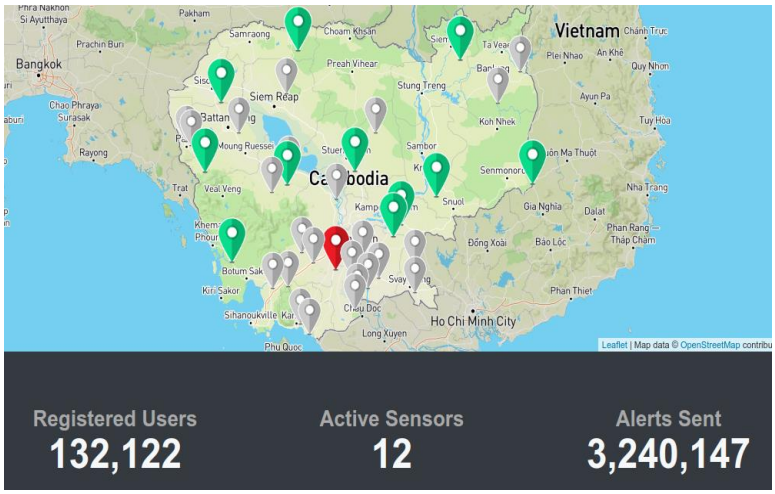
A system of water monitoring stations has been established across Cambodia and the data from these stations is collected every 15 minutes using the country's cell phone network (Figure 6).[8] When potentially hazardous conditions are detected, warning messages are shared with EWS1294 users via voice messages from provincial and sub-provincial CDMs.[9]

The major cell phone companies - Smart, Cellcard and Metfone - support the EWS 1294 system. The use of voice message alerts ensures that vulnerable people, including those with poor literacy, receive forewarning to respond to an emergency.[9] Message alerts are also sent out through public speakers (in Battambang), and the ABC radio station since 2022, and there is future scope to send out messages via SMS broadcasting to all members of a given cell phone company in a given geographical area (i.e., without the prior need to register) .[9]

A key challenge to operating ESW1294 relates to the operation and maintenance of the sensors which need servicing every couple of years. There is a lack of suitably qualified personnel at provincial and national levels to ensure the continued operation of a growing network of sensors.[9] Another challenge is to increase the number of people registered to EWS1294, which is being addressed by holding local meetings to raise awareness, but growing the subscriber base is hampered by the common practice of changing mobile SIM cards.[9] Nevertheless, in light of these ongoing issues, EWS1294 has been attributed to saving lives and livelihoods in Cambodia.[99]

[7] https://reliefweb.int/report/cambodia/cambodia-people-need-pin-places-climate-change-adaptation-high-our-agenda-pin-and
[8] https://ews1294.org/
[9] https://www.preventionweb.net/news/cambodias-early-warning-system-1294-adaptable-technology-promoting-safety-all

Figure 6. Location of active sensors (green icons)

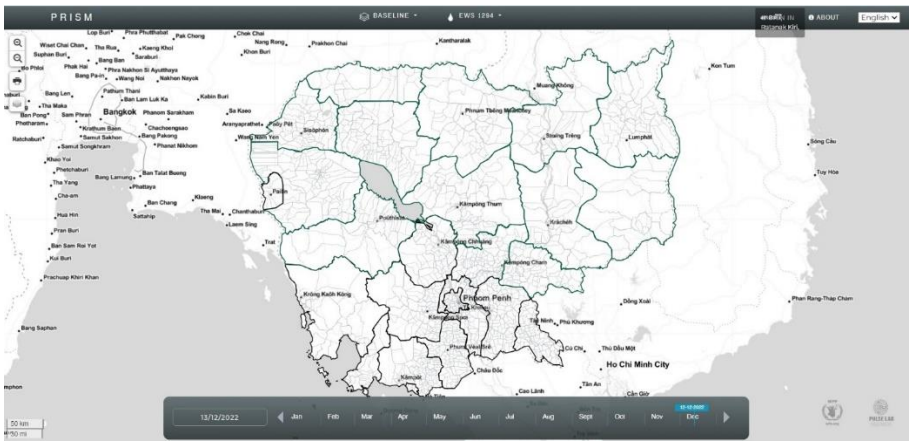


3.2 Platform for Real-time Impact and Situation Monitoring

The *Platform for Real-time Impact and Situation Monitoring* (PRISM) is an open source web-based monitoring tool that is designed to provide information on the potential risk of climate hazards to local communities. The PRISM software was initially developed in 2016 and was upgraded in 2020 by the World Food Programme.[10], PRISM integrates a variety of data including satellite imagery and ground sensor measurements, and supports NCDM in collecting and sharing information for emergency response to disasters.[11] PRISM also offers potential to integrate with Kobo Toolbox, an open source tool that can be used for field data collection using mobile devices.[12]

PRISM helps NCDM to prioritise the government response to potential hazards and disasters. Prior to a disaster occurring, PRISM enables NCDM to access climate hazard and vulnerability information through a web-based geospatial application (Figure 7). For instance, using the PRISM tool, NCDM can monitor rainfall and identify potential locations at the highest risk to flood. The Cambodian PRISM is connected to EWS 1294 to receive real time monitoring of river water levels. The system is only fully accessible to government officials and not to the general public.

Figure 7. Map view of PRISM platform



[10] https://innovation.wfp.org/project/prism
[11] https://docs.wfp.org/api/documents/WFP-0000120144/download/
[12] KoboToolobox can facilitate real-time data collection in the field, which can then be overlaid and displayed on hazard information and other data layers in the PRISM platform to inform disaster response.

3.3 Cambodia Disaster Loss and Damage Information System

The *Cambodia Disaster Loss and Damage Information System* (CamDI) is based on the open source DesInventar software[13], which is used to develop disaster management information systems that comprise inventories of disasters and associated loss and damage.[14] The tool is hosted by the United Nations Office for Disaster Risk Reduction and has been widely implemented globally in scores of countries through the support of the United Nations Development Programme (UNDP).[15]

The CamDI was established by NCDM, with technical and financial support from UNDP, and was officially launched in July 2014. The CamDI database stores data on the impacts of hazards on infrastructure, housing, agriculture, people, and social services such as hospitals and schools (UNDP, n.d.). Data is sourced from various organisations including provincial and district committees for disaster management, and various government ministries, and addresses multiple types of disaster (flood, drought, fire, storm, epidemics, lightning, river bank collapse, pest outbreak) (Table 1) (UNDP, n.d.). Over 10,000 records of disaster were collected from 1996 to 2020.[16] Each record represents a disaster event at commune level, or at district or municipality level if commune data is unavailable; multiple records may be collected for a single disaster event that impacts more than one commune (UNDP, n.d.). Data collection for CamDI is ongoing.

Table 1: Data inputs for CamDI

Source: UNDP, n.d.

Item	Data description	Data source
1	Human life, housing	NCDM, PCDMs, DCDMs and Cambodian Red Cross
2	Agriculture	MAFF and provincial departments
3	Roads: rural	Ministry of Rural Development
4	Roads: National, provincial and town	Ministry of Public Works and Transport and provincial departments
5	Dams, dikes	MoWRAM and provincial departments
6	Hospitals, health centres	Ministry of Health
7	Schools	Ministry of Education, Youth and Sport, NCDM, PCDMs, DCDMs and Cambodian Red Cross

Disaster loss and damage data in CamDI is presented in tables (Table 2), charts (Figure 8), and maps (Figure 9). The products present details on the effects and damage resulting from natural disasters in Cambodia by hazard type on human life, housing, agriculture, infrastructure, schools and hospital/health centers.

[13] www.desinventar.net
[14] https://www.desinventar.net/whatisdesinventar.html
[15] https://www.desinventar.net/DesInventar/
[16] https://www.desinventar.net/DesInventar/profiletab.jsp?countrycode=khm&continue=y#more_info

Figure 8: Example of CamDI data in chart form: ratio of deaths by disaster type (left) and database records by disaster type (right)[17]

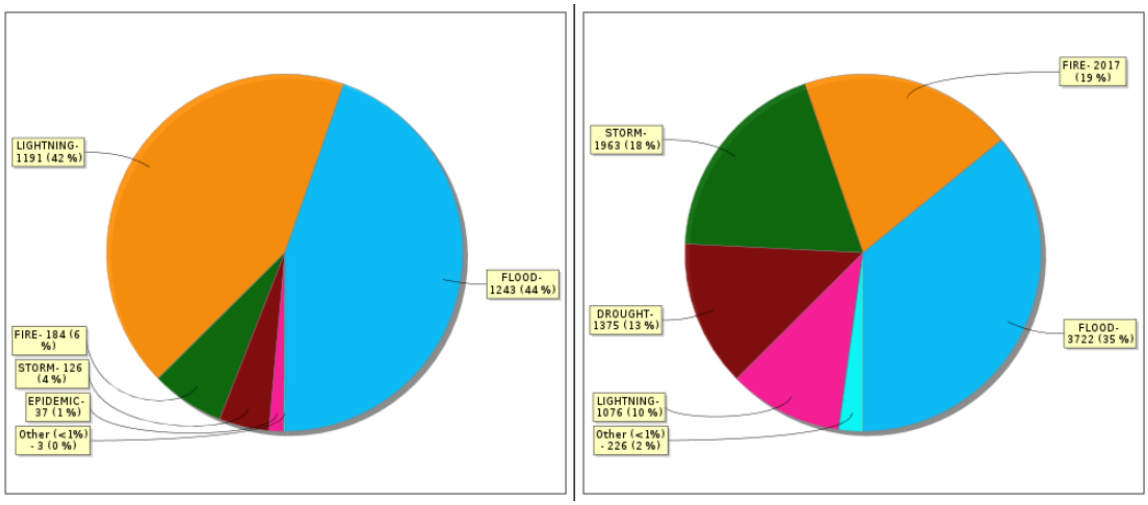
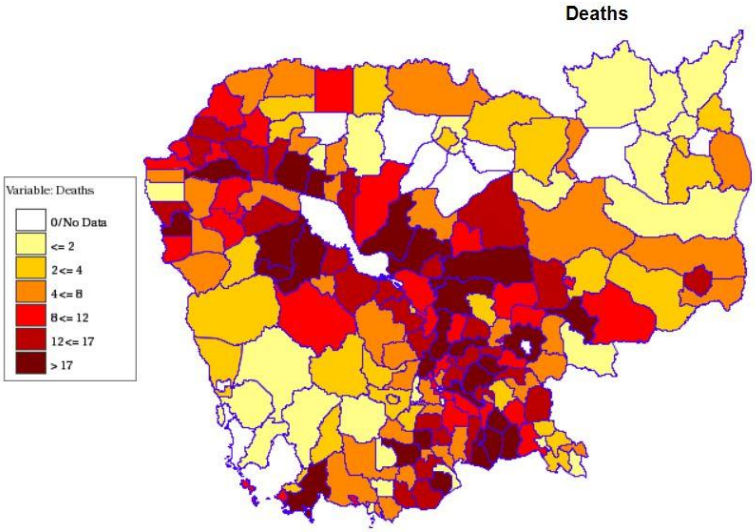


Figure 9: Example of CamDI output in map form: spatial distribution of deaths due to disaster[17]



CamDI data is accessible in tabular format below the graphics and downloadable in Microsoft Excel format (Table 2).

Table 2: Summary of disasters in CamDI inventory[17]

Event	Data Cards	Deaths	Injured	Missing	Houses Destroyed	Houses Damaged	Directly affected	Indirectly Affected
Drought	1,375						2,818,433	204,050
Epidemic	57	37					19	
Fire	2,017	184	227		5,527	676	37,970	9
Flood	3,722	1,243	1,115	2	2,401	31,810	13,457,143	307,596
Lightning	1,076	1,191	661	1	39	185	2,252	36
Pest outbreak	102						2,378	
River bank collapse	67	3	2		199	526	1,222	
Storm	1,963	126	676	2	13,723	42,521	113,417	1716

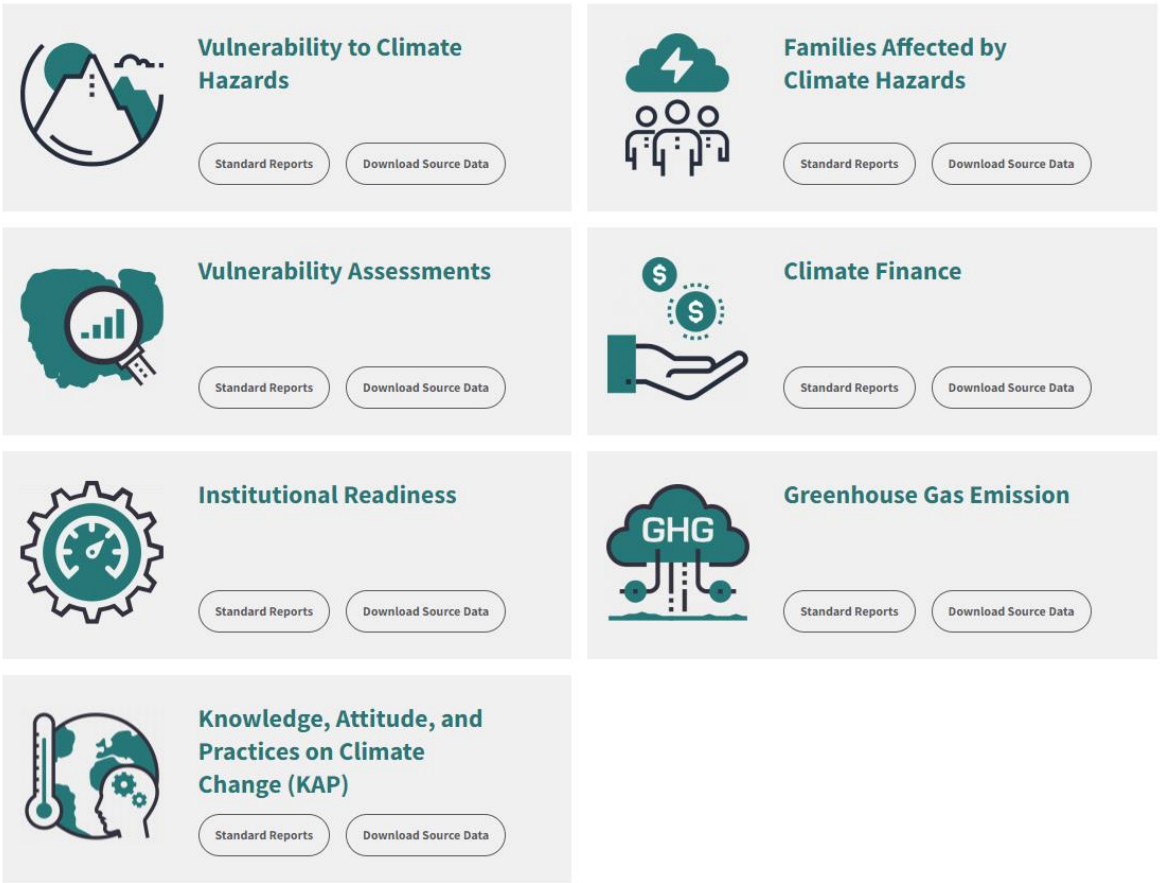
[17] Source: https://www.desinventar.net/DesInventar/profiletab.jsp?countrycode=khm&continue=y#more_info

Event	Data Cards	Deaths	Injured	Missing	Houses Destroyed	Houses Damaged	Directly affected	Indirectly Affected
Event	**Relocated**	**Evacuated**	**Losses $USD**	**Losses $Local**	**Education centers**	**Hospitals**	**Damages in crops Ha.**	**Lost Cattle**	**Damages in roads Mts**
Drought					11		1,033,461.5	1,154	1,110
Epidemic									
Fire		69	180,000		1		117.5	8	
Flood	17,186	764,838			947	1,839	2,057,517	2,4683	821,8237
Lightning		337			1	1	502	458	
Pest outbreak							15,915		
River bank collapse	694	46							1,870
Storm		3,111			75	39	5,458	74	210

3.4 Cambodia Climate Change Data Portal

To address the scarcity of information for mainstreaming of climate change at sectoral and subnational levels, the NCSD developed a *Data Portal* to improve access to data including on vulnerability, climate finance, and mitigation projects (Figure 10).[18]

Figure 10: Access to the Data Portal



[18] https://ncsd.moe.gov.kh/dcc/data-portal

The sources in the data portal come from multiple sources, including from government and development partners. The data disaggregated by administrative area (commune/district/province), institutions, indicators with maps, charts and tables, etc. The data is downloadable in different contents and categories

- ***Vulnerability assessment**:* To assist communities in addressing climate risk, the Vulnerability Reduction Assessment has been used as a participatory tool for planning purposes since 2017. Data sources include the Commune Database developed by the NCSD, quality assured by Ministry of Planning and compiled by DCC. The *vulnerability index* scores are calculated based on the methodology developed by the International Institute for Environment and Development in 2015 and General Secretariat for NCSD in 2016 for Cambodia's National Climate Change Monitoring and Evaluation Framework. Data is disaggregated to commune level.
- ***Climate finance**:* the Cambodia Official Development Assistance database is quality assured by the Ministry of Planning and compiled by DCC. Data is disaggregated by sector, donor and province.
- ***Institutional readiness**:* derived from the assessment conducted by the Climate Change Technical Working Group under NCSD. Information for 2014, 2017, and 2019 is available.
- ***Knowledge, Attitude, and Practice on Climate Change**:* third study on understanding public perceptions of climate change in Cambodia, and the actual survey.
- ***Greenhouse gas emissions**:* data sources include First Biennial Update Report (2020), and Cambodia's Second National Communication (2015), and greenhouse gas emission reduction projects in Cambodia developed under different mechanisms, including those under the United Nations Framework Convention on Climate Change, bilateral, and voluntary certification mechanisms. Data is disaggregated by sector.

Data displayed in the Data Portal is presented as maps, charts and tables on vulnerability to climate hazards; institutional readiness; knowledge, attitude, and practices on climate change; families affected by climate hazards; climate finance; and greenhouse gas emissions.

In relation to climate vulnerability, there are five key outputs provided:

1) *Vulnerability to climate hazards*. Shows the Vulnerability Index of province and communes which are classified in four levels 'High Quite, Less, and Least,' to multiple climate change hazards, disaggregated as flood, drought and storm as a vulnerability index score (Figure 11-Figure 14, Table 3).
2) *Vulnerability indicator view*. 'Standardized indicators' are expressed as a percentage (%) for each province or commune (Figure 14).
3) *Geographical coverage of the Vulnerability Reduction Assessment* displays the communes, districts and provinces/capital where the assessment was carried out. The online report provides the total number of assessments conducted.
4) *Findings from the Vulnerability Reduction Assessment.* The vulnerability to climate change is expressed as a vulnerability assessment score from 1 (lowest) to 5 (highest). Examples of outputs are shown in Table 4.
5) *Families affected by climate hazards.* Categorised by hazard type (flood, storm and drought), the percentage (%) and number of families affected are presented (e.g., Figure 15).

Figure 11: Storm vulnerability by province

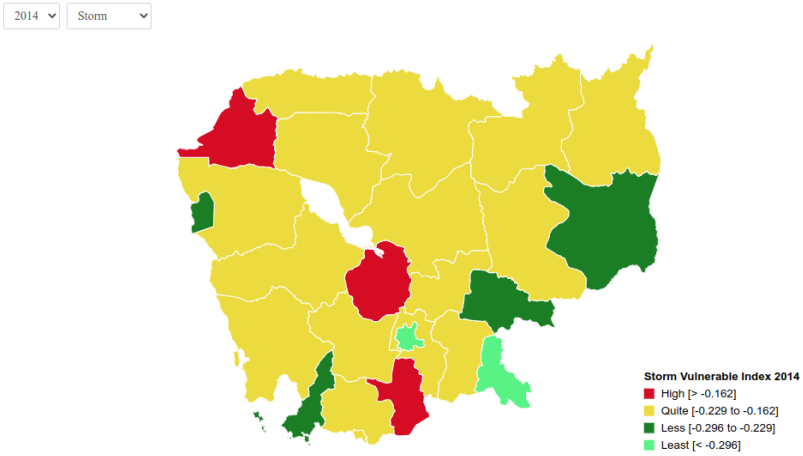


Figure 12: Percentage of highly vulnerable communes per province in Battambang over time for flood, drought and storm

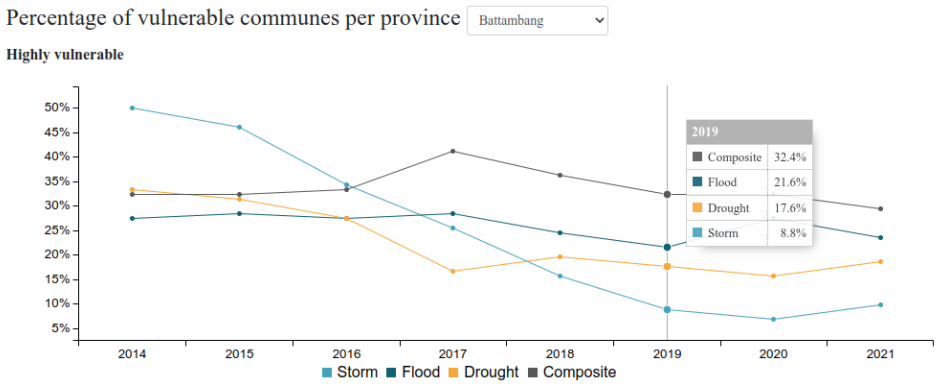


Figure 13: Percentage of highly vulnerable communes by province for flood, drought and storm in 2021

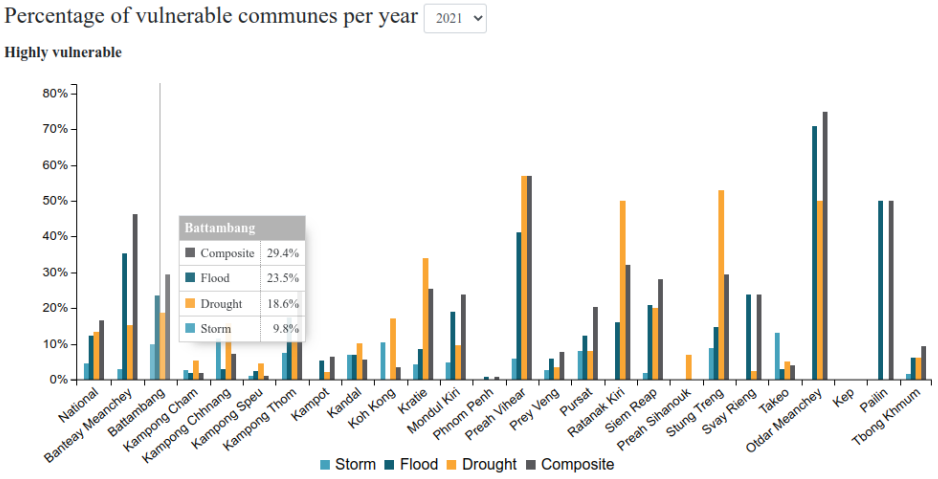


Table 3: Table of provinces ranked as highly and quite vulnerable to climate hazards in 2021

Top provinces that ranked **highly** and **quite** vulnerable to climate hazards in 2021

	Composite	Flood	Storm	Drought
Highly vulnerable	Otdar Meanchey (1)	Otdar Meanchey (1)	Pursat (1)	Preah Vihear (1)
	Preah Vihear (2)	Ratanak Kiri (2)	Battambang (2)	Stung Treng (2)
	Ratanak Kiri (3)	Preah Vihear (3)	Preah Vihear (3)	Ratanak Kiri (3)
	Banteay Meanchey (4)	Banteay Meanchey (4)	Banteay Meanchey (4)	Otdar Meanchey (4)
Quite vulnerable	Svay Rieng (5)	Svay Rieng (5)	Stung Treng (5)	Kratie (5)

Figure 14: Vulnerability index following the National M&E framework for climate change

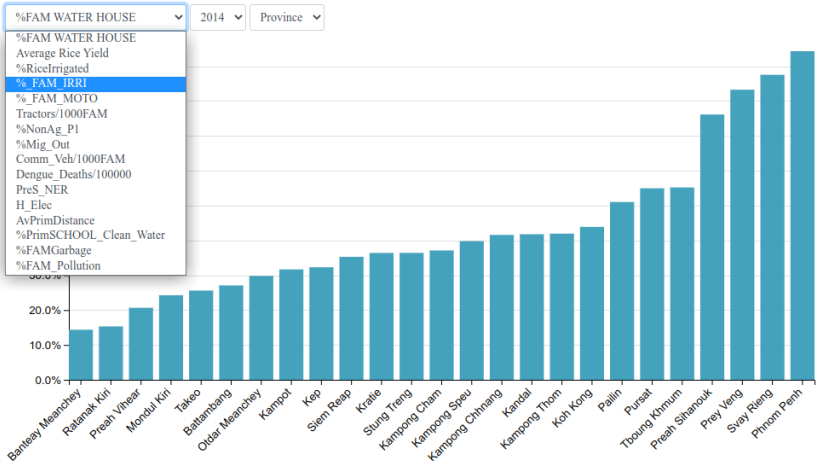
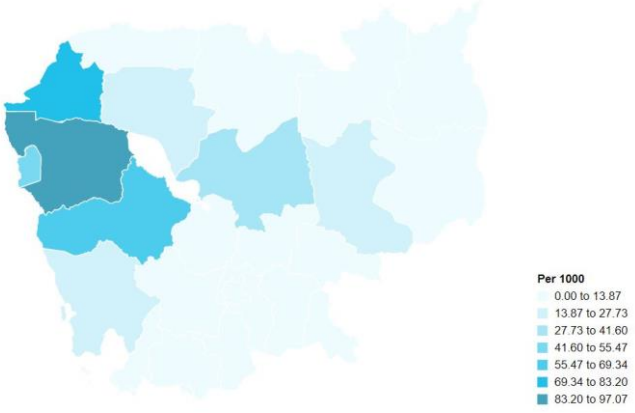


Table 4: Vulnerability scores for climate change

Province	2019		2020		2021		2022		2023	
	Avarage Score	Communes Assessed	Avarage Score	Communes Assessed	Avarage Score	Communes Assessed	Avarage Score	Communes Assessed	Avarage Score	Communes Assessed
Battambang	1	1	-	-	-	-	-	-	-	-
Kampong Cham	1	1	-	-	-	-	-	-	-	-
Kampong Speu	3	1	-	-	-	-	-	-	-	-
Kandal	1	1	-	-	-	-	-	-	-	-
National	1.5	4	-	-	-	-	-	-	-	-

Figure 15: Number of households affected by drought in 2021



3.5 Mekong River Commission Data and Information Service Portal

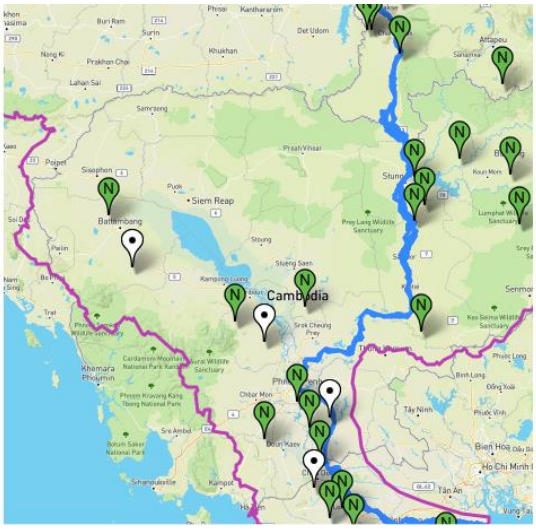
The *Mekong River Commission (MRC) Data and Information Service Portal* or 'Data Portal' is a web-based portal to provide data and products generated by the MRC (Figure 16).[19] The MRC plays an important role in data collection and analysis related to water resources in the Lower Mekong Basin covering hydrology, sediments, water quality, fisheries, ecological health, climate change, flood and drought. MRC provides weekly flood and drought forecasts, and has an online interactive climate change atlas.

Figure 16: Access to MRC Data Portal

The MRC Member Countries are required to monitor water resources, and the MRC Secretariat is responsible for post-processing of data and reporting. Hydrometeorological monitoring is achieved through a network of stations that extend across Cambodia, Lao PDR, Thailand and Vietnam. In Cambodia, MRC manages 17 automated telemetry, near real-time hydrometeorological stations (Figure 17), and MRC provides **weekly flood forecasting** at water level monitoring stations (Figure 18).

[19] https://portal.mrcmekong.org/home

Figure 17. MRC hydrometeorological stations in Cambodia



Source: https://portal.mrcmekong.org/monitoring/river-monitoring-telemetry

Table 5. List of MRC hydrometeorological stations in Cambodia

No.	Station	River	Status
1	Koh Key	Mekong	Normal
2	Stung Treng	Mekong	Normal
3	Kratie	Mekong	Normal
4	Siempang	Sekong	Normal
5	Voeun Sai	Sesan	Normal
6	Lumphat	Sre Pok	Normal
7	Prek Kdam	Tonle Sap	N/A
8	Chaktomuk	Bassac	Normal
9	Koh Khei	Bassac	Normal
10	Sisophon	Stung Mongkolborey	Normal
11	Battambang	Sangker	N/A
12	Kompong Loung	Tonle Sap	N/A
13	Boribo	Stung Boribo	N/A
14	Kompong Thom	Stung Sen	Normal
15	Kampong Ampil	Tonle Touch	N/A
16	Kompong Speu	Prek Thnot	Normal
17	Angkorborey	Stung Angkor Borey	N/A

Regional drought forecasts are made using the Regional Hydrologic Extremes Assessment System, which is a hydrological now-cast and forecast framework developed by the National Aeronautics and Space Administration (NASA) Jet Propulsion Laboratory. Two models are used in the Regional Hydrologic Extremes Assessment System: the hydrological model Variable Infiltration Capacity model and crop simulation model Decision Support System for Agrotechnology Transfer, which are used to compute drought indices.

An example of a spatial drought forecast product is shown in Figure 19.

Figure 18: Water level monitoring and weekly forecast at Phnom Penh

Source: http://ffw.mrcmekong.org/stations.php?StCode=PPB&StName=Phnom%20Penh%20(Bassac)

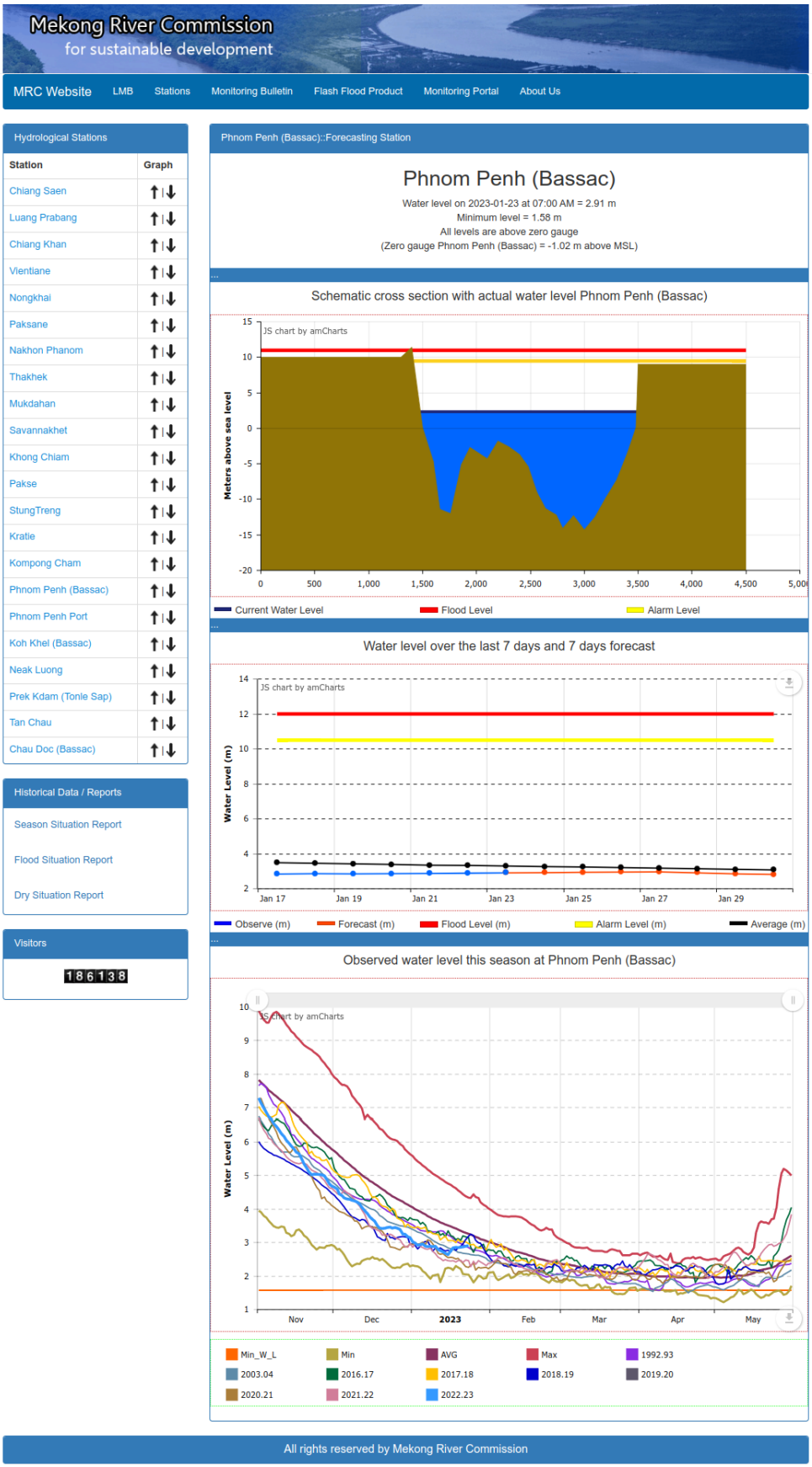
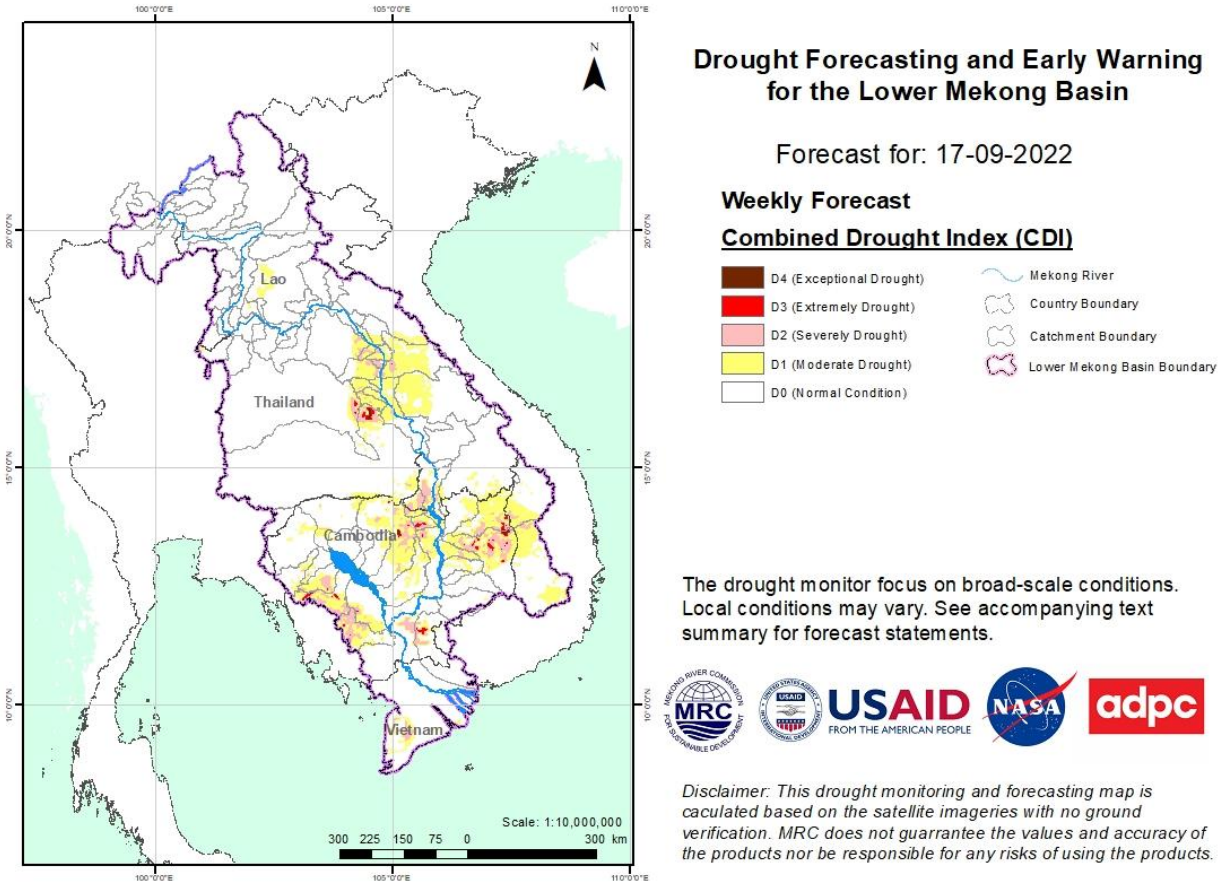


Figure 19: Example of weekly drought forecast map from MRC's Data Portal

Source:
http://droughtforecast.mrcmekong.org/maps/filter?page=home&manage_type=forecasting&type=cdi&select_type=3&select_year=2022&select_month=&select_week=37

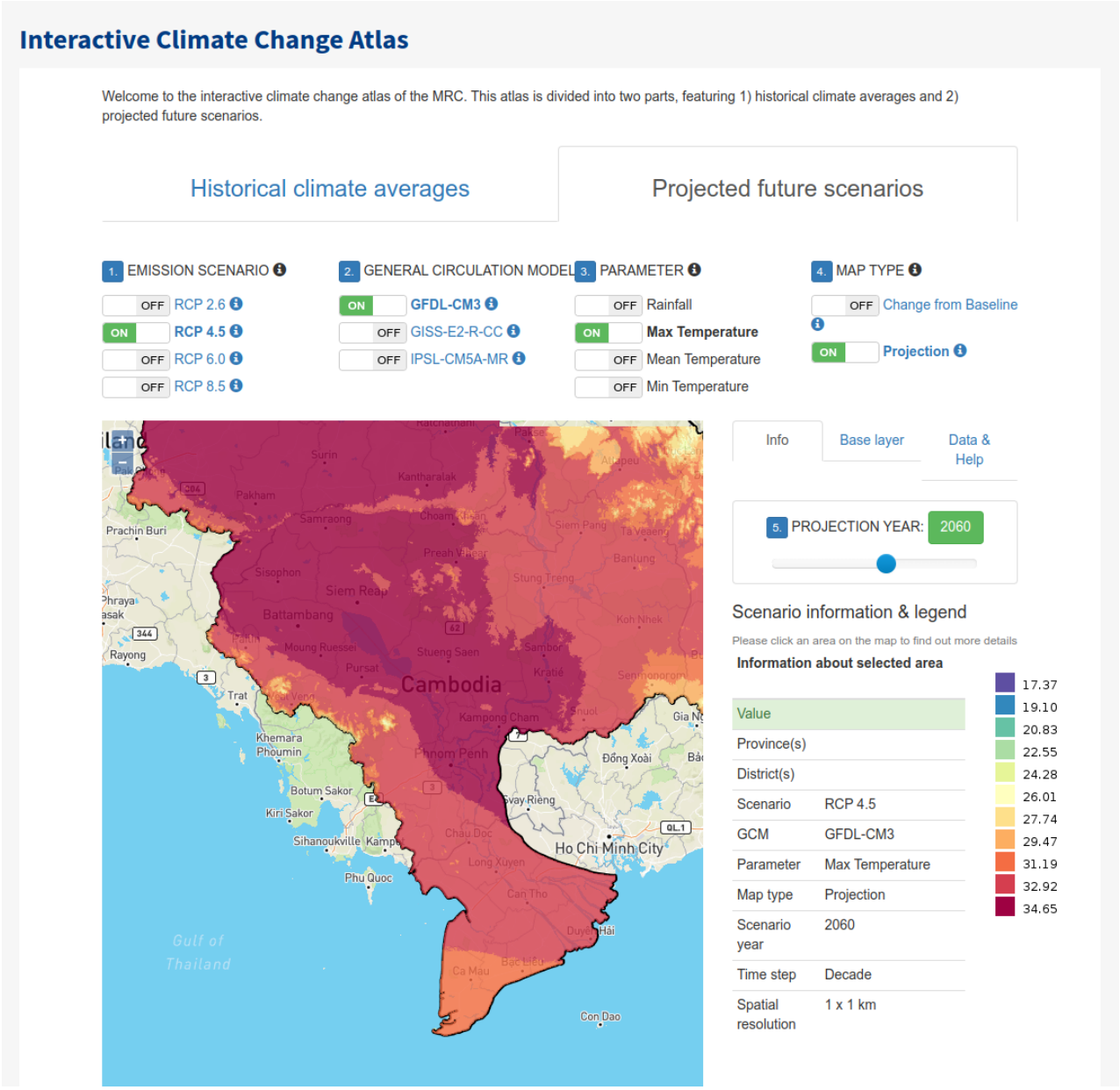


MRC's **interactive climate change atlas** visualizes the spatial distribution of historical averages and future climate projections (Figure 20). The atlas allows users to investigate various climate parameters, such as rainfall and mean temperature and view various future scenarios. For projected future scenarios, two map types are generated – change from baseline and future projections. Four parameters are analysed – rainfall, maximum temperature, mean temperature, and minimum temperature. Four emission scenarios (Representative Concentration Pathways, RCPs, 2.6, 4.5, 6.0 and 8.5) and three general circulation models (GCMs) (GFDL-CM3, GISS-E2-R-CC, ISPL-CM5A-MR) can be selected.

For historical climate averages, four map types are generated – average, trend, extreme, and extreme trend. Four parameters are analysed – highest/ lowest maximum temperature, and highest/ lowest minimum temperature, and four time periods are used – 1901 – 2010, 1901 – 1940, 1941 – 1980, and 1981 – 2010.

Figure 20: Future projection of maximum temperature in the 2060s (RCP 4.5, GFDL_CM3)

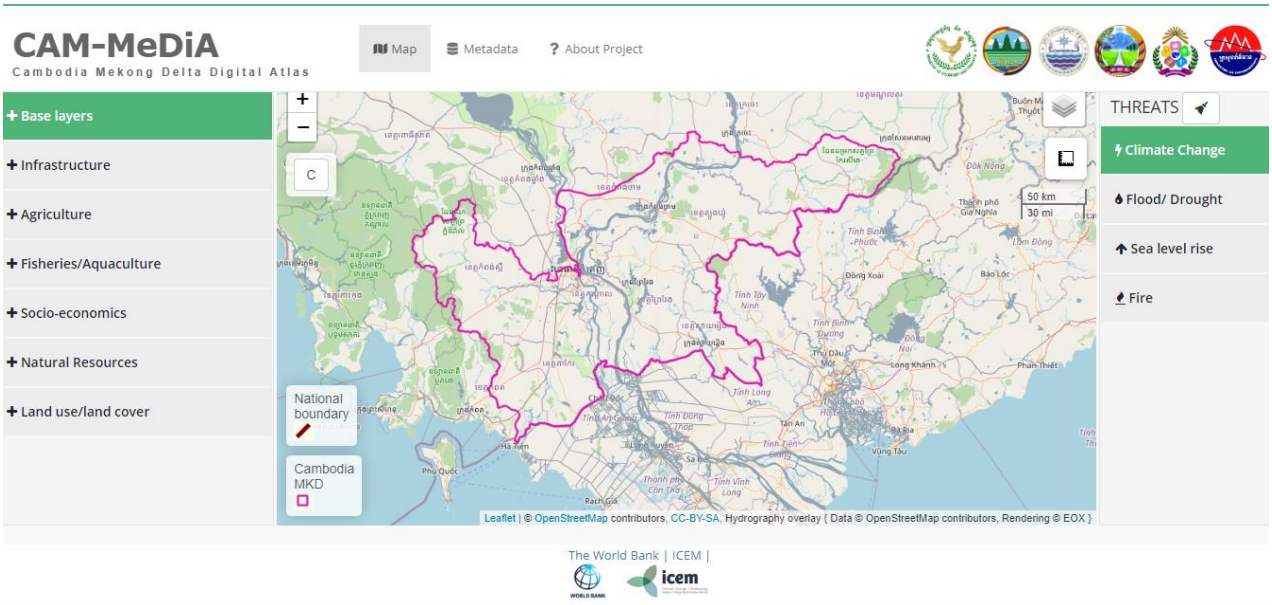
Source: https://portal.mrcmekong.org/topic/climate-change



3.6 Cambodia Mekong Delta Digital Atlas

The *Cambodia Mekong Delta Cambodia Mekong Delta Digital Atlas* (CAM-MeDiA)[20] seeks to improve understanding of the potential consequences of future climate change on infrastructure assets, agriculture and natural ecosystems. The digital Atlas is an open source web-based geospatial application developed by ICEM under the TA *Cambodia Mekong Delta Digital Atlas*, funded by the World Bank. The Atlas provides a contemporary knowledge base to support decision making of national and subnational government officials responsible for planning in the Cambodia Mekong Delta and for promoting transitions to more sustainable livelihoods in the context of climate change (Figure 21).

Figure 21: Access to CAM-MeDiA decision support tool



Integrated into the CAM-MeDiA application are multi-sector data sets sourced from the Royal Government of Cambodia, as well as from other organisations nationally and globally. Government data sources include those from MOWRAM, MOE, MAFF, Ministry of Rural Development, Ministry of Land Management, Urban Planning and Construction, Electric Authority of Cambodia, Ministry of Economy and Finance, Ministry of Health, and the National Institute of Statistics.

Other sources of data are from the MRC, Cambodia National Mekong Committee, Save Cambodia's Wildlife's Atlas, SERVIR-Mekong, BirdLife, World Bank, Asian Development Bank, United Nations Environment Programme, USAID, Google Earth Engine, United States Geological Survey, Climate Central, and OpenStreetMap.

Data is stored into vector and raster GIS data formats - shapefiles store vector data which represents geographic data symbolized as points, lines, or polygons; and raster files, as commonly found in topographic data, satellite imagery, and climate data are stored in geotiff format. Data is inked to and published using Geoserver, an open source application for publishing and sharing spatial data services. These spatial data services are then input into CAM-MeDiA's frontend, and can also be accessed through desktop GIS applications such as QGIS.

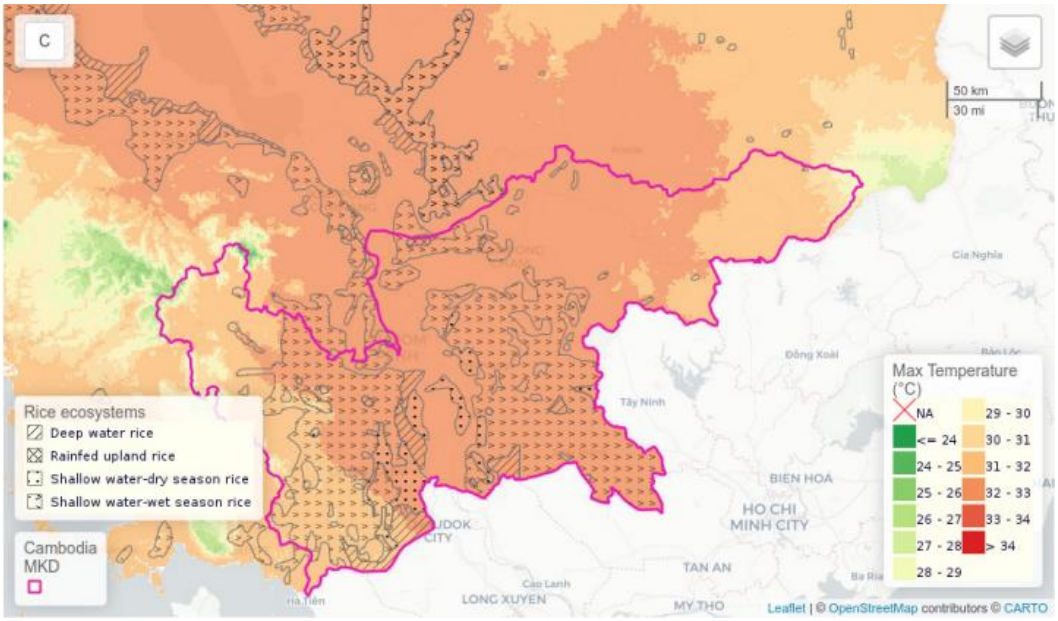
[20] https://dss.icem.com.au/camatlas/

Data layers available in CAM-MeDiA include climate change projections, flood, and drought, land use/land cover, forests, agriculture, irrigated areas, cropping patterns, water resources, water infrastructure, and fisheries. The map viewer allows the overlay of various information layers to provide valuable insights for sustainability planning in the Cambodian Mekong Delta.

A series of case studies were prepared to demonstrate how CAM-MeDiA can address the mandates of MoWRAM, MAFF and MoE[21].

MAFF: CAM-MeDiA enables users to overlay crop patterns and land use/land cover on future projected climate change variables (maximum temperature and precipitation), and projections of future drought and flood. Overlaying of future projected scenarios of temperature, precipitation, drought and flood and crop patterns/land use can provide insights as to whether alternative climate resilient cropping options are required (Figure 22).

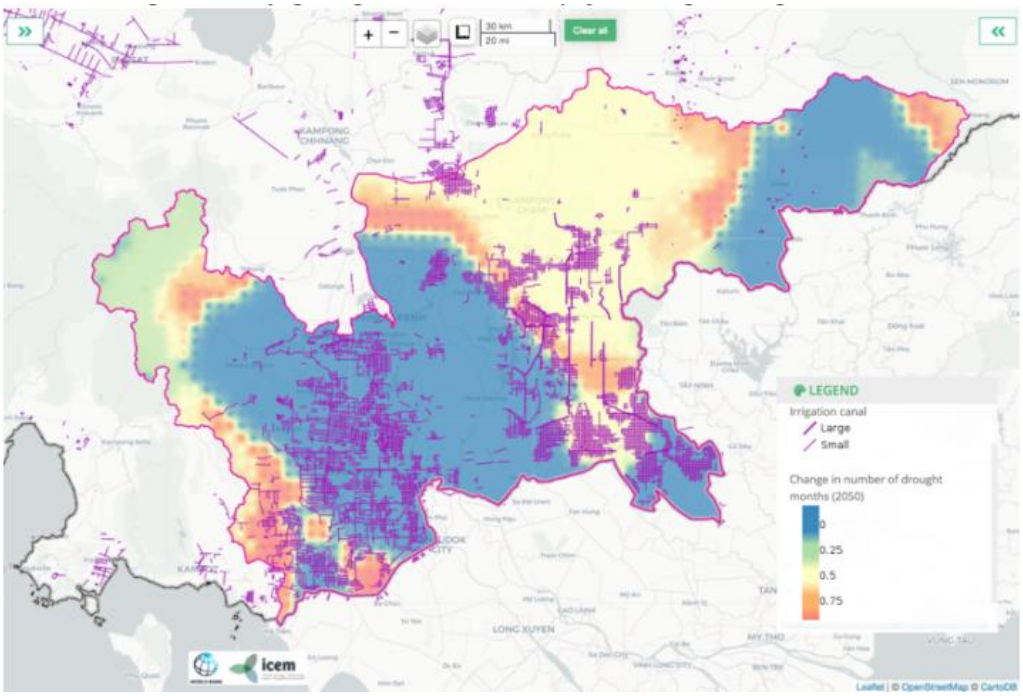
Figure 22: Rice ecosystems (2013) overlain on projected average Tmax in the 2030s (RCP 8.5, wet season)



[21] See 'About' tab at https://dss.icem.com.au/camatlas/

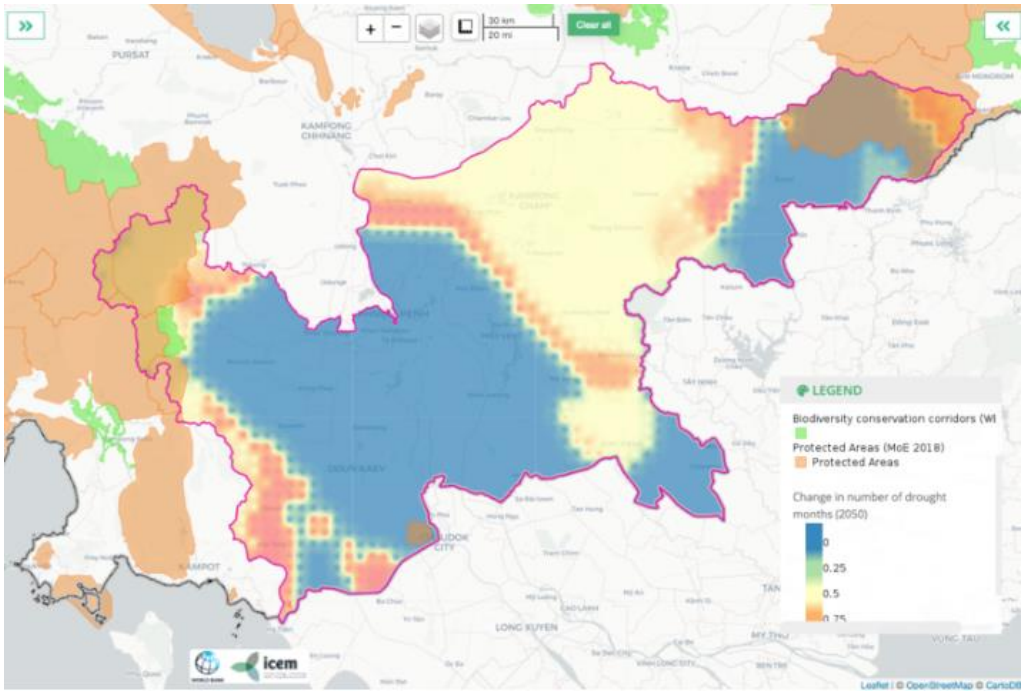
MoWRAM: A key mandate of MoWRAM is the provision of irrigation capacity to support agricultural livelihoods. CAM-MeDiA enables the visualization of irrigation canal infrastructure within the context of climate change (Figure 23).

Figure 23. overlaying of irrigation canal network on projected changes in drought in the 2050s in the Cambodia Mekong Delta



MoE: CAM-MeDiA can provide insights into sustaining biodiversity across the delta though overlaying areas of high biodiversity value on future projected changes in temperature, precipitation, flood and drought (Figure 24).

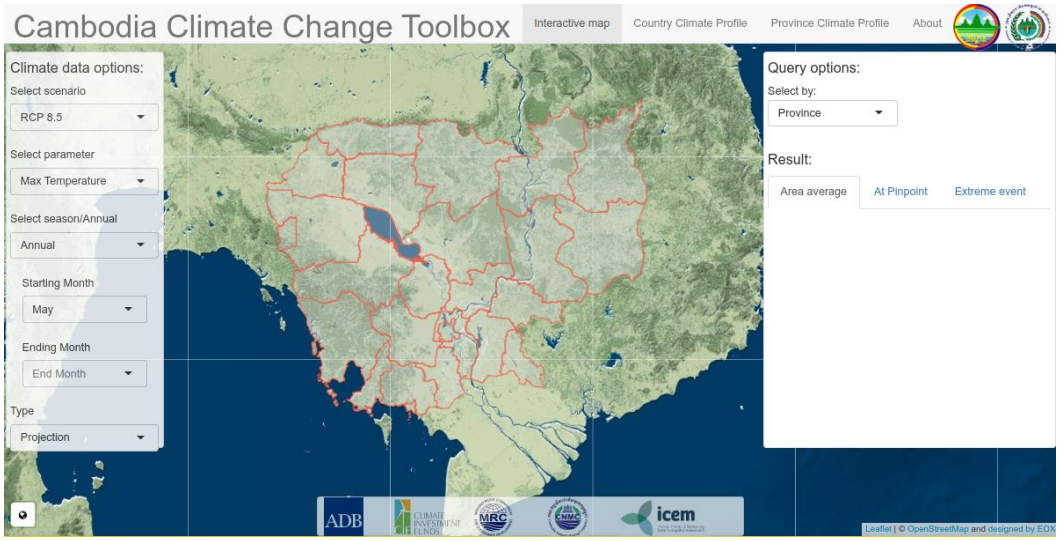
Figure 24: Overlaying of protected areas on projected changes in drought months in the 2050s in the Cambodia Mekong delta



3.7 Cambodia Climate Change Toolbox

The Cambodia Climate Change Toolbox is an open-source information portal that provides climate change projections for Cambodia (Figure 25).[22] It was developed in collaboration with MoE's Department of Geospatial Information Services and DCC as part of the Asian Development Bank-funded project *TA-8179 CAM Mainstreaming Climate Resilience into Development Planning,* which was implemented by ICEM.

Figure 25: Web-based interface of the Cambodia Climate Change Toolbox



The four main components of the application can be selected on the navigation bar at the top of the page:

1. *Interactive map:* the interactive map is the primary component of the tool, allowing users to query climate data in a variety of ways including by province, point location, or area. Users can define the climate condition they are interested in by selecting the desired climate scenario, climate parameter, and season. The interactive map also provides information on projected extreme weather events.
2. *Country climate profile:* a dual-map view showing projected precipitation and maximum temperature for the 2050s. This component also includes a table providing current and projected changes in temperature and rainfall that can be sorted by province. Users can select the climate condition (based on GCM) and season.
3. *Province climate profile:* a map showing projected precipitation and maximum temperature in the 2050s for the selected province. This component also includes a table providing projected changes in temperature and rainfall that can be sorted by district. Users can select the climate condition (based on GCM) and season.
4. *About:* reference information on the data sources used and relevant terminology necessary to understand and use the toolbox.

Climate data integrated into the Toolbox include projections of temperature and precipitation under different climate change scenarios. The toolbox has incorporated two main sources of climate data: Mekong River Commission - Climate Change and Adaptation Initiative (MRC CCAI) and the NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP):

[22] https://dss.icem.com.au/CambodiaDSS/

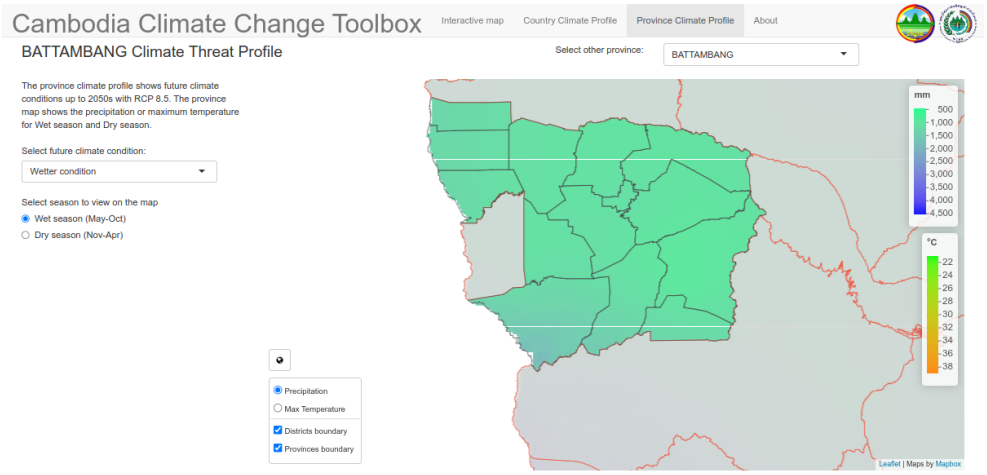
- MRC CCAI: is a collaborative effort among MRC Member Countries to collaborate on adaptation strategies. One of major outputs of the program is the high-resolution climate change data set for Lower Mekong Basin based on SimCLIM.
- NASA NEX-GDDP: This dataset comprises downscaled climate scenarios that are derived from the GCM runs conducted under the Coupled Model Intercomparison Project Phase 5 (CMIP5) across two of the four RCPs for the periods from 1950 through 2100 with a spatial resolution of 0.25 degrees (~25 km x 25 km).

Climate change projections can be defined by scenario, parameter, and time frame:

- Scenario: two climate scenarios are available: RCP 4.5 and RCP 8.5;
- Parameter: two climate parameters are available: maximum temperature and precipitation;
- Timeframe: four options are available: Annual (January to December); wet season (May to October); dry season (November to April); and user-defined time frame by selecting the start and end months;
- Data type: two options are available - projection values and change from baseline

An example of how the Toolbox can display future climate projections is shown in Figure 26 for the province of Battambang. Tabulated data beneath the map displays district level data for projected maximum temperature and precipitation. It is also possible to output graphs at province level to show trends in project maximum temperature and precipitation (Figure 27).

Figure 26: Future projection of precipitation over the province of Battambang for the 2050s (RCP 8.5) showing district boundaries

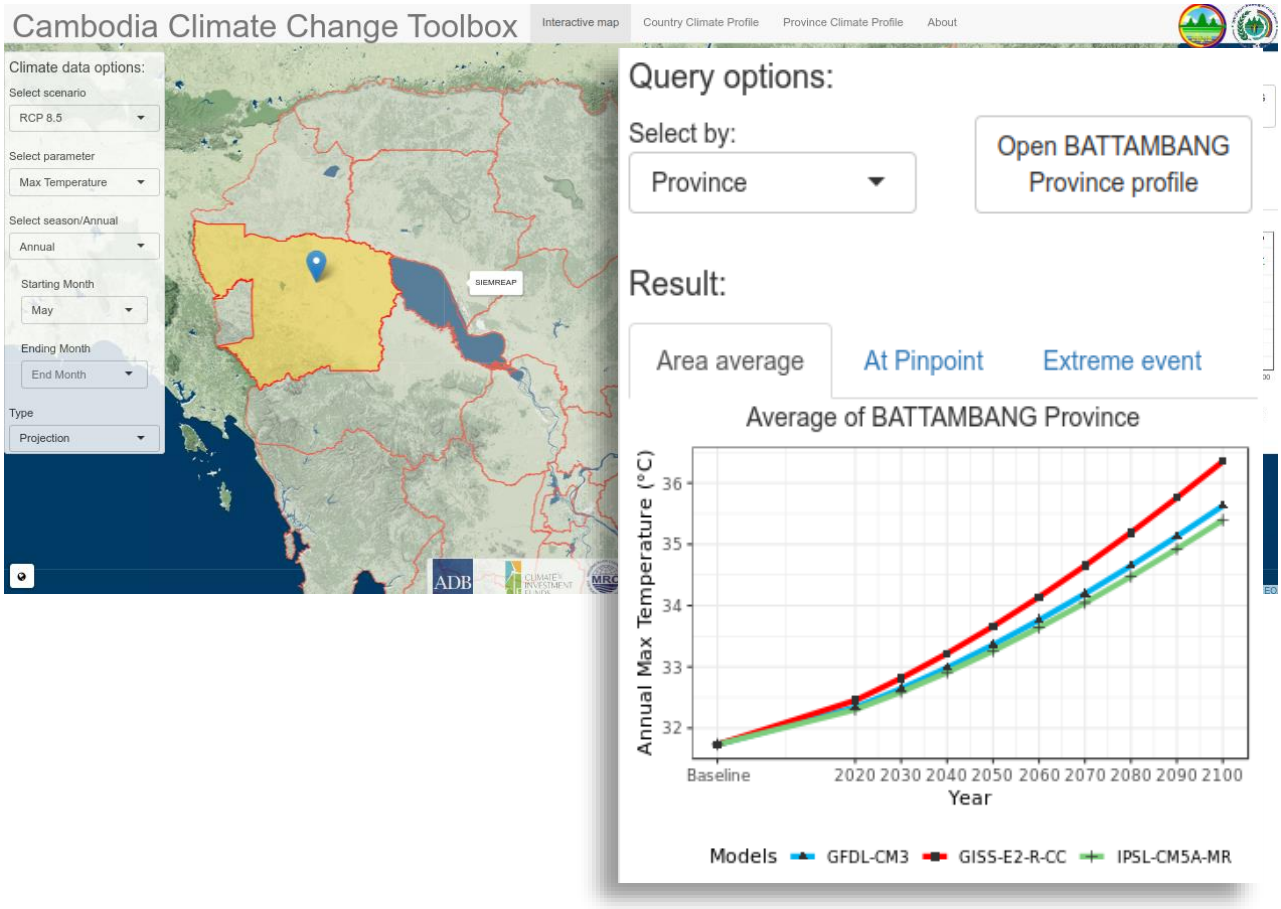


Detailed climate change data by district in BATTAMBANG for future Wetter condition

District Name	Precipitation (mm)						Max Temperature (°C)					
	Wet Season			Dry Season			Wet Season			Dry Season		
	Baseline	2050s	Change (%)	Baseline	2050s	Change (%)	Baseline	2050s	Change (°)	Baseline	2050s	Change (°)
Aek Phnum	1004	1054	4.9	203	258	27	31.9	33.7	1.7	32.3	33.9	1.5
Banan	1035	1086	4.9	272	346	27.3	31.7	33.4	1.7	32.3	33.8	1.5
Bat Dambang	1044	1094	4.8	252	321	27.7	31.9	33.6	1.7	32.4	33.9	1.5
Bavel	1037	1088	4.9	248	307	23.7	31.9	33.7	1.8	32.6	34.2	1.6
Kamrieng	1130	1185	4.9	278	341	22.9	31.5	33.2	1.7	32.3	33.8	1.6
Koas Krala	1139	1193	4.8	305	392	28.3	30.8	32.5	1.7	31.5	33	1.5
Moung Ruessei	946	996	5.3	252	326	29.1	31.7	33.4	1.7	32.1	33.6	1.5
Phnum Proek	1142	1197	4.9	263	321	21.8	31.5	33.2	1.7	32.3	33.9	1.6
Rotanak Mondol	1055	1107	4.9	300	378	25.9	31.1	32.9	1.7	31.9	33.4	1.5
Rukhak Kiri	1115	1171	4.9	294	378	28.5	31.3	33	1.7	31.8	33.3	1.5
Samlout	1350	1411	4.6	351	441	25.6	30.1	31.8	1.7	31	32.5	1.5
Sampov Lun	1158	1215	4.9	249	302	21.1	31.8	33.5	1.8	32.6	34.2	1.6
Sangkae	983	1032	5	232	298	28.6	31.8	33.6	1.7	32.2	33.8	1.5
Thma Koul	1005	1054	4.8	226	283	25.5	32	33.8	1.8	32.6	34.1	1.5

Showing 1 to 14 of 14 entries

Figure 27: Graph (inset) showing trend of projected annual maximum temperature for Battambang province



3.8 MRC-GIZ 9C9T Atlas

The *9C9T Atlas* is a key output of the MRC-GIZ project *Joint Project on Flood and Drought Management in the 9C-9T Sub-basin* which is currently under implementation by ICEM (Figure 28).[23] The project and Atlas web-based application focus on improving transboundary waters management and in particular increasing resilience to flood and drought in the 9C9T subbasin of the Mekong River.

The Atlas application includes an interactive geospatial mapping tool that allows users to explore spatial layers associated with five key areas of importance to flood and drought management in the context of climate change: environment, social, economics, climate change, and resilience building. Similar to the CAM-MeDiA application, the 9C9T Atlas enables the overlay of climate variables (maximum temperature and precipitation) in the map viewer, as well as the selection of RCP, period of analysis (seasonal, annual) and GCM (Figure 29). Additionally, the Atlas integrates an interactive table of potential adaptation measures (nature-based solutions) that could be used to build flood and drought resilience in the 9C9T subbasin (Figure 30).

[23] https://9c9t.mrcmekong.org/9c9t [development version]

Figure 28: Default landing page of the 9C9T Atlas

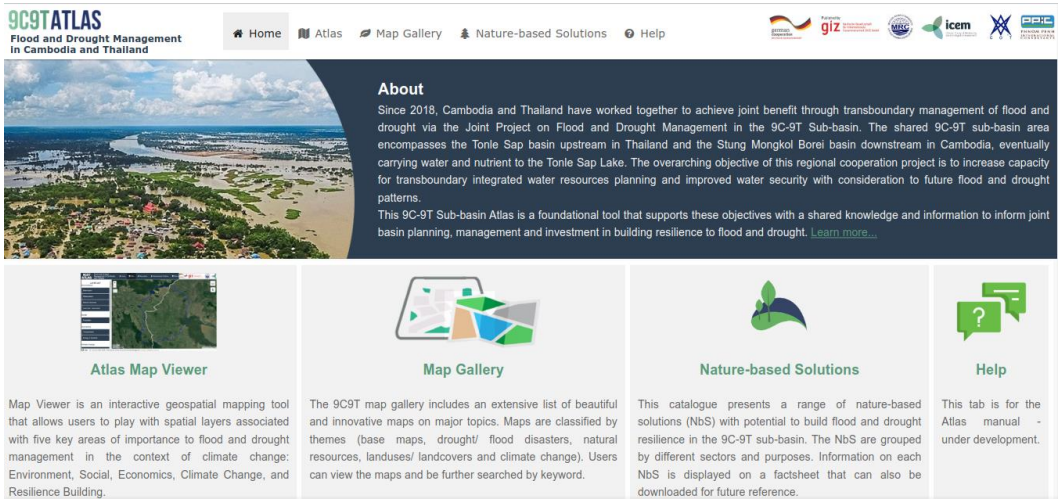


Figure 29: Future temperature projection over the 9C9T subbasin (RCP 8.5, change by 2050s, dry season, IPSL-CM5A_RM GCM)

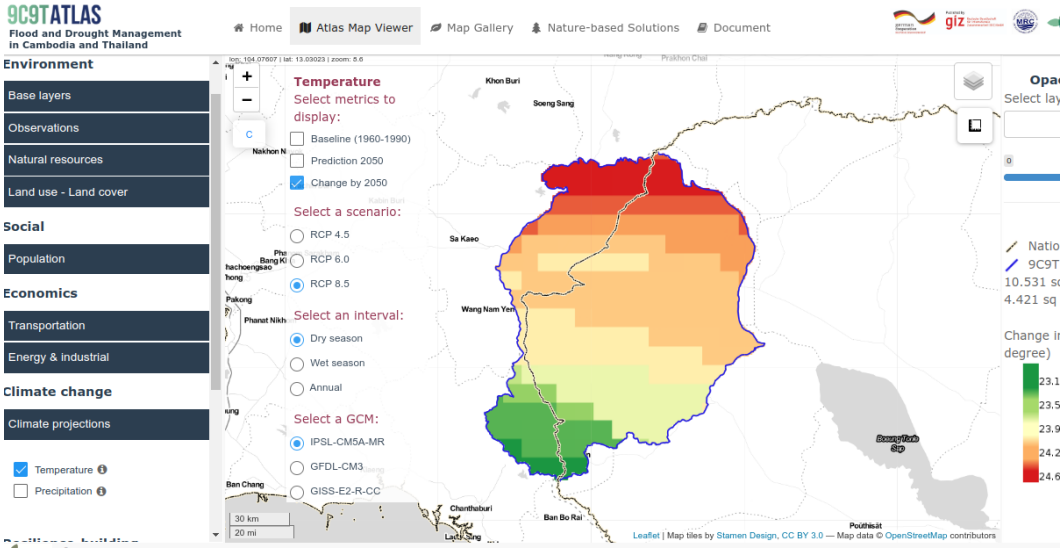
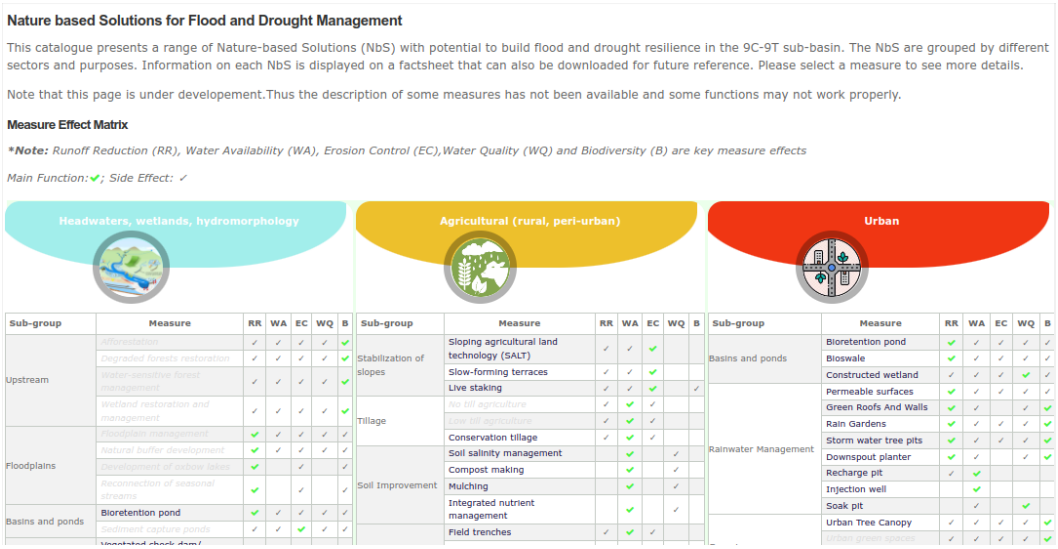


Figure 30: Inventory of nature-based solutions for the 9C9T subbasin



4 EXISTING GAPS ON CLIMATE INFORMATION FOR ADAPTATION PLANNING

Over recent years various CISs have been developed for Cambodia, which function as either early warning for local communities (e.g., EWS1294, PRISM) or have potential to support adaptation planning (CAM-MeDiA, Cambodia Climate Change Toolbox, Cambodia Climate Change Data Portal, 9C9T Atlas, CamDI). With regard to adaptation planning, there is scope to further facilitate climate smart planning through the development of decision support systems that expand geographical areas of interest; increase resolution and disaggregation of spatial data; integrate contemporary climate change projection data (from CMIP6); integrate future projections of flood and drought, and vulnerability data; and enable the spatial overlaying of data of management interest/sector-based data (e.g., transportation, energy, water, health, agriculture, social services) on future projections of climate variables, flood and drought (as well as historical disaster events). Based on the current review, the following provides a list of observations on currently operational CIS in Cambodia that are viewed in the context of adaptation planning and resilient infrastructure:

- There is limited information on how decision makers can use the existing CISs to support future planning and investment. An exception is the CAM-MeDiA platform that provides case studies on how the tool might be used to address aspects of the mandates of MoE, MoWRAM and MAFF.
    - CAM-MeDiA aims to enhance understanding of future climate change risks on infrastructure, agriculture and natural ecosystems of the Cambodia Mekong Delta.
    - A key mandate of MoWRAM is to plan irrigation capacity to support agricultural production, and CAM-MeDiA enables the visualization of existing and future planned irrigation canal infrastructure within the context of climate change.
    - CAM-MeDiA can support MoE in assessing the future potential loss of existing protected areas and opportunities for expanding and developing new sites for conservation, through overlaying the existing network of protected areas over future projected climate change variables and on projected changes in future drought and flood.
    - Agricultural planning and development comes under the remit of the Ministry of Agriculture, Forestry and Fisheries (MAFF). By overlaying existing crop patterns/land uses on future projected scenarios of temperature, precipitation, drought and flood, CAM-MeDiA can indicate whether alternative climate resilient cropping options need to be considered.
- An intuitive map-based interface is required to allow decision makers to overlay data of interest (e.g., cropping data, infrastructure) on future projections of climate, flood and drought. Only CAM-MeDiA and the 9C9T Atlas offer this functionality, but the geographical area of interest in each application is limited, either restricted to the Cambodian Mekong delta or 9C9T subbasin respectively.
- Adaptation planning in Cambodia requires future projections of climate data, as well as data on flood and drought, and inclusion of data on vulnerability. Climate data are found in four tools - CAM-MeDiA, Climate Toolbox, 9C9T Atlas, and MRC Data Portal.
- Of current CISs, only CAM-MeDiA and the 9C9T Atlas have potential to function as standalone systems to inform adaptation planning for their respective areas of interest by enabling the overlaying of climate, flood and drought data with sector-related data.
- Adaptation planning requires that CISs are updated with reliable and up-to-data. The data in some CIS require updating (e.g., irrigation canal data in CAM-MeDiA).
- Web-based applications should be readily accessible and require appropriate hosting, which require adequate hardware, internet connectivity and technical expertise. Some of the CIS applications are

sometimes inaccessible or slow (e.g., PRISM). Two of the systems developed by ICEM have not been deployed to government servers due to the lack of hardware and available expertise.

- Data used for adaptation planning should be open and accessible to the entire population. For instance, access to data in the PRISM application appears to be limited to users with appropriate login credentials.
- Web-based applications should be designed so that they are accessible in devices with small or large screens (mobiles, tablets and laptop/desktop computers). Though viewing an application (especially a map or a large table) with a mobile device is more difficult than on a larger screen, all of the site content and data should at least be accessible (especially as some members of the community may only have access to mobile devices).
- The operation and maintenance of any CIS needs be to embedded in the hosting organisation (e.g., specified in the terms of reference of staff).

5 RECOMMENDATIONS FOR A LOCAL CLIMATE INFORMATION SYSTEM

Based on the above review of known CISs in Cambodia, the design, development and maintenance of the proposed local CIS for adaptation or LISA platform will consider the following aspects:

- The LISA application will be unique among existing CISs in that it will focus on supporting urban adaptation planning in a municipality of Cambodia. The tool will be of relevance to the local municipality, though will also have potential to be applied (scalable) to other municipalities across the country.
- The LISA web-based application will use the climate projection data as integrated into the CAM-MeDiA and 9C9T Atlas applications (derived from the MRC), and will integrate additional or newer climate data sources and historical datasets where readily available.
- Vulnerability data will be disaggregated to commune level (where possible) and integrated into LISA.
- The extent of ongoing hazards in the municipality will be determined through participatory mapping, with outputs integrated into LISA.
- LISA will primarily be a spatial map-based tool that allows users to overlay data of management interest (e.g., sector-based data) on climate and hazards data.
- An interactive table of potential adaptation measures, including nature-based solutions, will be integrated into the application to provide guidance to decision makers on the selection of appropriate adaptation options.
- Content, including data, should be open and accessible to the entire population, including the general public.
- LISA will be designed to be accessible in all types of devices, including mobile, tablet and laptop/desktop computers.
- An appropriate hosting organisation needs to be identified with adequate hardware, internet connectivity and staff capacity to ensure LISA's ongoing operation, maintenance, and sustainability.

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