MEKONG DROUGHT AND CROP WATCH IN THE CONTEXT OF A CHANGING CLIMATE

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Abstract

Anticipating the impacts of climate change in agriculture and agriculture water management, it is now amply getting clearer that long-term climate risk will have direct impacts on agriculture and food security in Southeast Asia. Over the years, it has been seen that the frequency of natural disasters too has been on the rise. Several studies have stated that one of the most frequently occurring natural disasters is drought. Drought being a slow onset disaster is difficult to detect. However, 'prolonged dry periods' results in loss of crops leading to direct impacts on farmers' livelihoods and increase in food insecurity. Over the years, it has been seen that the frequency of drought is on an increasing trend in Southeast Asia with most countries in the Lower Mekong facing severe dry conditions.

This article, therefore, talks about enhancing drought resilience in the Lower Mekong through implementation of Mekong Drought and Crop Watch that provides drought nowcasts and forecasts at the regional, national, and provincial level using hydrological and crop simulation model information through the Regional Hydrologic Extremes Assessment System (RHEAS), a state-of-the-art water resources nowcast and forecast framework.

Introduction

Southeast Asia is frequented by dry periods in concurrence with the El Niño phenomenon. In the recent years, the increasing frequency of dry periods has resulted in severe dry conditions leading to extreme droughts with the Lower Mekong countries bearing the brunt of it. Drought affects many sectors of life, especially agriculture, which can lead to a food insecurity (Syaukat, 2011). 'Prolonged drought' will result in water scarcity and household access to clean drinking water and sanitation, as a result affecting large number of populations.

Over the past 30 years, droughts have affected over 66 million people in South-East Asia (UNESCAP, 2019). The most severe events have been during the El Niño years. Most of the economic impact of drought which is around four-fifths is absorbed by agriculture. However, the impact is found to extend beyond agriculture based on both demand and production, as it is linked with industry and services as well. Drought being a slow onset disaster, occurring as a result of prolonged deficient precipitation, its scale of the impact depends on the extent, intensity, and duration. The outcome also varies according to local conditions, land use patterns, and water usage (UNESCAP, 2019).

According to the findings of the Intergovernmental Panel on Climate Change (IPCC), across Southeast Asia, temperature has been increasing at a rate of 0.14°C to 0.20°C per decade since the 1960s, coupled with a rising number of hot days and warm nights, and a decline in cooler weather (IPCC, 2013: WGI AR5 Section 14.8.12). If droughts intensify in lowland Southeast Asia, the synergies between warmth, drought, logging, fragmentation, fire, and tree mortality would make the conditions to further worsen resulting in deforestation, smoke aerosols, and reduced rainfall, that could greatly increase the vulnerability of fragmented forest landscapes.

Droughts may also lead to wildfires and smoke exposure, with increased morbidity and mortality, as observed in Southeast Asia (Johnston et al., 2012). It can disrupt food security, increasing malnutrition (Kumar et al., 2005) and thus susceptibility to infectious diseases. For much of Southeast Asia, increase in drought stress as a result of declining rainfall trends or rising temperatures is a major concern. Frequent droughts could negatively affect agricultural production, increase water demand for irrigation, and exacerbate the already existing water crisis and human-induced desertification. Livelihoods are also likely to be impacted by droughts while also disproportionately impacting small farmers, agricultural laborers, and small businessmen who have least access to rural safety net mechanisms, including financial services.

The Lower Mekong River Basin (LMB) covers an area of approximately 606,000 km^2 across the countries of Thailand, Laos, Cambodia, and Vietnam (IPCC, 2014). More than 60 million people are heavily reliant on natural resources, particularly agriculture and fisheries, for their well-being and livelihood. However, in recent years it has been observed that there has been an increased frequency in the occurrence of drought in the region leading to prolonged dry periods. The effects of 2015/2016 El Niño further compounded the already fragile agricultural ecosystem of the region. The El Niño outlook for 2015/2016 considered the event to be one of the strongest El Niño events since 1997–1998. El Niño Advisory Notes prepared by United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP, 2015) and the Regional Integrated Multi-Hazard Early Warning System (RIMES) suggest that the effects were severe in certain locations such as Cambodia, Central and Southern India, Easter Indonesia, Central and Southern Philippines, Central and Northeast Thailand, Papua New Guinea, and other Pacific Island countries.

This article discusses about the implementation of the Mekong Drought and Crop Watch (MDCW) through SERVIR-Mekong program of Asian Disaster Preparedness Center (ADPC) that addresses the Lower Mekong countries need in appropriately monitoring and forecasting drought for effective decision-making while considering the context of climate variability and its impacts on agriculture and food security for the region.

Geographical scope

The Lower Mekong region comprises of five countries namely Cambodia, Lao PDR, Myanmar, Thailand, and Vietnam (Figure 1).

Cambodia (FAO AQUASTAT 2011): It is situated in Southeast Asia on the coast of the Gulf of Thailand and has a total area of 181,040 km2. It is bordered by Thailand in the west, Lao People's Democratic Republic in the north, and Vietnam in the east. Together, with these countries and China and Myanmar, Cambodia shares the Mekong river basin. Water surfaces, including Lake Tonle Sap, occupy approximately 2.2% of the total area of the country. Cambodia has a tropical monsoon climate and is influenced by various factors, including its location within the Inter-Tropical Convergence Zone and the monsoon. There are two distinct seasons: (1) dry season from November to April and (2) wet season from May to October.

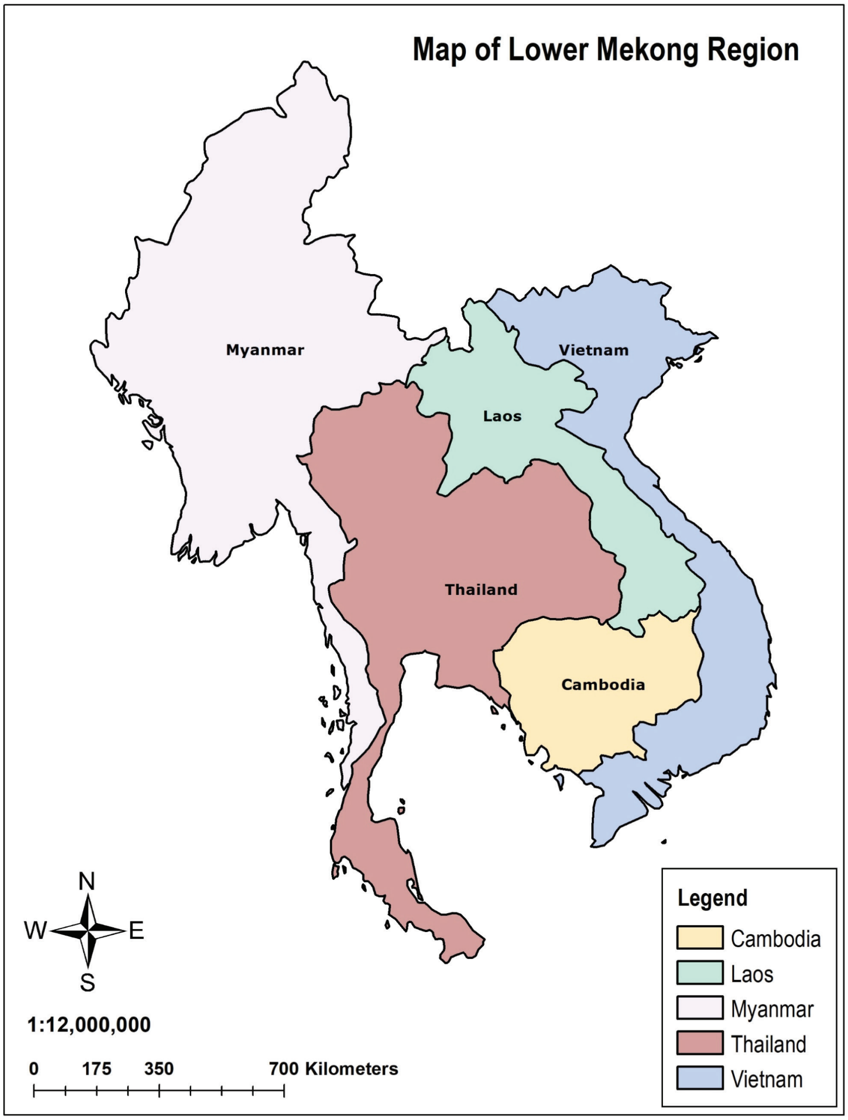

Figure 1: Map of Lower Mekong countries (Source: Nature Earth Data)

Lao PDR (FAO AQUASTAT 2011): The Lao People's Democratic Republic is a landlocked country in the mainland Southeast Asia with a total area of 236,800 km^2. The country is bordered by China to the north, Vietnam to the east, Cambodia to the south, Thailand to the west and Myanmar to the northwest. The cultivable area is an estimated 2 million ha, composed of narrow valleys and the flood-prone plain of the Mekong river and its tributaries. In 2009, the total cultivated area accounted for 1468,000 ha, around 6% of the total area of the country. Arable land was an estimated 1360,000 ha and the area under permanent crops was 108,000 ha. Lao PDR has a tropical climate with a rainy season from mid-April to mid-October dominated by the humid southwest monsoon. The average annual rainfall is 1,834 mm but ranges from 1,300 mm in the northern valleys to over 3,700 mm at high elevations in the south. About 75% of the rainfall occurs during the rainy season. The water level in the Mekong river may fluctuate by up to 20 m between wet and dry seasons.

Myanmar (FAO AQUASTAT 2011): Myanmar has a total area of 676,590 km^2. The country's southern coastline lies on the Andaman Sea and to the southwest the Bay of Bengal; it is bordered by Bangladesh to the west, India to the northwest, China to the northeast, and Lao People's Democratic Republic and Thailand to the east. Myanmar's climate is tropical monsoon. Rainfall is highly seasonal, being concentrated in the hot humid months of the southwest monsoon (May–October). In contrast, the northwest monsoon (December–March) is relatively cool and almost entirely dry. The total cultivable area is almost 18.3 million ha. Total cultivated area in 2009 was around 12.1 million ha of which 11.0 million ha or 91% was for annual crops and 1.1 million ha or 9% for permanent crops.

Thailand (FAO AQUASTAT 2011): Thailand covers an area of 513,120 km² and is located in the southeastern region of the continent of Asia. Its immediate neighbors are Myanmar to the north and the northwest, Lao People's Democratic Republic to the northeast, Cambodia to the east, and Malaysia to the south. The climate is mainly governed by the alternation between the southwest monsoon, which brings heavy rainfalls (May–October), and the northeast monsoon, which is comparatively dry and cool (October–February). The transitional period (March–April) is characterized by heavy thunderstorms. The average annual rainfall is about1 622 mm. It ranges from 1 100 mm in the central plain and the northeast of the country to 4,000 mm in the southern peninsula near the Andaman Sea. About 26.79 million ha are considered as cultivable, which represents 52% of the country. In 2009, the cultivated area was an estimated 18.995 million ha. Of this total, 15.300 million were under annual crops (mainly paddy rice) and the remaining 3.695 million ha were under permanent crops.

Vietnam (FAO AQUASTAT 2011): Viet Nam is located in the eastern part of the Indochina peninsula, bordered by China in the north, the South China Sea in the east and south, the Gulf of Thailand in the southwest, and Cambodia and Lao People's Democratic Republic in the west. The total area of the country is 331,052 km². Viet Nam is located in a complicated climatic zone: hot, humid, and rainy. It is characterized by a subtropical climate with four separate seasons, spring, summer, autumn, and winter in the north and a tropical climate with only two seasons, dry and wet in the south. Average annual precipitation is around 1,820 mm. Agriculture plays a very important role in socio-economic development, in poverty alleviation, and in food security. The country has recently become one of the three top countries in the world for rice exports, together with Thailand and the United States.

SERVIR-Mekong

Through a unique partnership between United States Agency for International Development (USAID) and the United States National Aeronautics and Space Administration (NASA), SERVIR-Mekong[1] is harnessing space technology and

Figure 2: Map showing the global hubs of SERVIR (Source: SERVIR-Global)

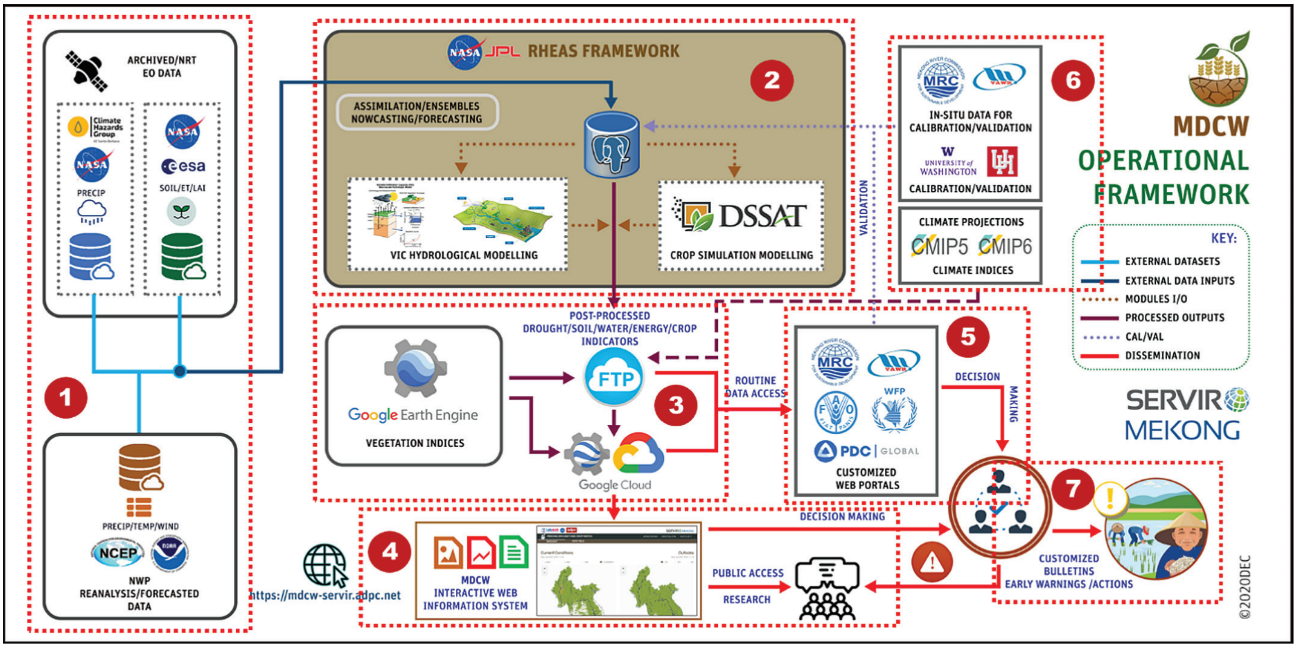

Figure 3: Mekong Drought and Crop Watch (MDCW) (Source: ADPC/SERVIR-Mekong)

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[1] https://servir.adpc.net/

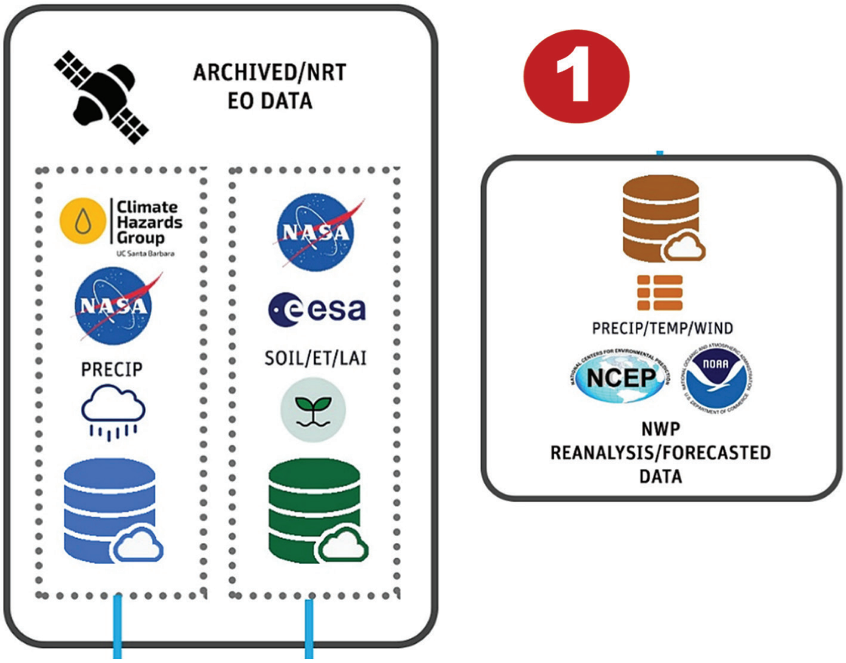

Figure 3a: Earth observation data component

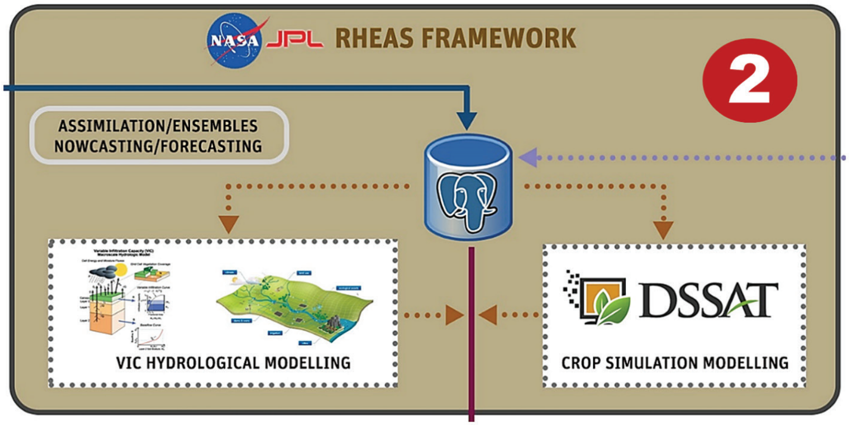

Figure 3b: RHEAS framework

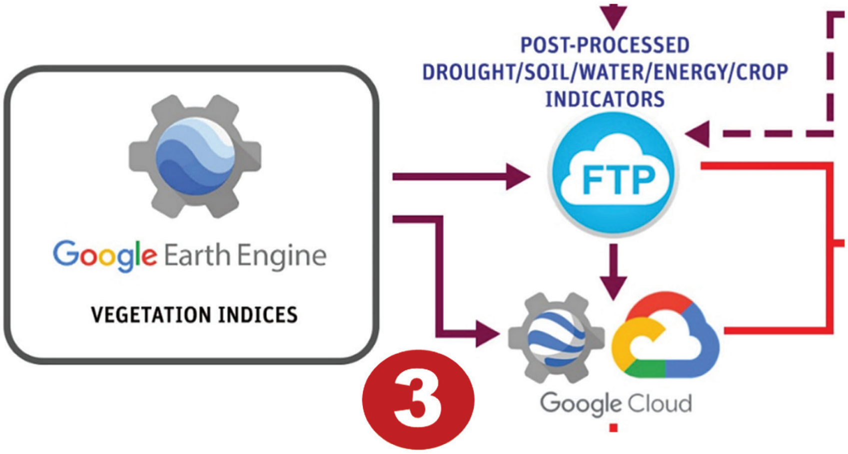

Figure 3c: Cloud computing platform

open data to help address developmental challenges related to climate change by bringing in technologies that could help monitor sea levels rise, floods, and droughts whose frequency and intensity have increased thus threatening ecosystems and people's livelihoods. SERVIR-Mekong works in partnership with leading regional organizations to help the five countries in the Lower Mekong Region that includes Cambodia, Lao PDR, Myanmar (Burma), Thailand, and Vietnam, use information provided by Earth observing satellites and geospatial technologies to manage climate risks. The program activities are designed to meet the overall regional objectives of:

i. Building and institutionalizing the technical capacity of government decision-makers and key civil society groups to integrate geospatial information into their decision-making, planning, and communication.
ii. Improving the sharing of user-tailored geospatial data, products, and services.
iii. Developing new high-quality user-tailored data, tools, applications, and models to address on-the-ground priorities.
iv. Strengthening the SERVIR-Mekong hub as a regional provider of geospatial data, analyses, and capacity building services

The SERVIR-Mekong hub is hosted at Asian Disaster Preparedness Center (ADPC) in Thailand and is designated to be the fourth global hub focusing on the Mekong region (Figure 2).

Mekong Drought and Crop Watch

The Mekong Drought and Crop Watch (MDCW) (https://mdcw-servir.adpc.net/) is an integrated web-based information system intended to (1) improve the operational, technological, and institutional capabilities to prepare for and respond to droughts in the Lower Mekong region; (2) support local decision-makers in drought monitoring, analysis, and forecasting; (3) provide policy makers and growers with current and forecast drought indices to facilitate decision-making within the current growing season; and (4) provide ecological and financial forecasting information to inform seasonal cropping decisions.

MDCW can be used to assist local governments and the agricultural sector with seasonal drought forecasting and in implementing short- and long-term mitigation measures during and in advance of droughts. It can also be used to characterize droughts through accurate, reliable, and timely estimates of their severity and impacts. In addition, the system can inform assessments of the economic, social, and environmental impacts of drought on vulnerable people and water-related resource systems. And finally, it can help develop critical regional and local thresholds reflecting increasing levels of risk and vulnerability to drought, as agreed by stakeholders (Figure 3).

MDCW comprises of seven components that includes

i. Earth Observation Data Component (Figure 3a)
ii. The RHEAS Framework (Figure 3b)
iii. Cloud Computing Platforms (Figure 3c)
iv. MDCW Interactive Web Information System and Public Access (Figure 3d)
v. Customized Web Portals (Figure 3e)
vi. Climate Impact Map (Figure 3f)
vii. Information Dissemination (Figure 3g)

MDCW deploys the Regional Hydrologic Extreme Assessment System (RHEAS) that is an integration of hydrological and crop simulation models developed by NASA-Jet Propulsion Laboratory. The core of the RHEAS framework is the Variable Infiltration Capacity (VIC) model and the Decision Support System for Agrotechnology Transfer (DSSAT) model that automates the deployment of nowcast and forecast hydrologic simulations and ingests satellite observations through data assimilation. It also allows coupling of other environmental models and facilitates the delivery of data products to users via a GIS enabled database. The system's ability to carry out nowcast and forecast within the framework at the same time gives an upper edge to the present existing resources or systems available for drought monitoring (Figure 4).

Figure 3d: MDCW interactive web information system and public access

Figure 3e: Customized web portals

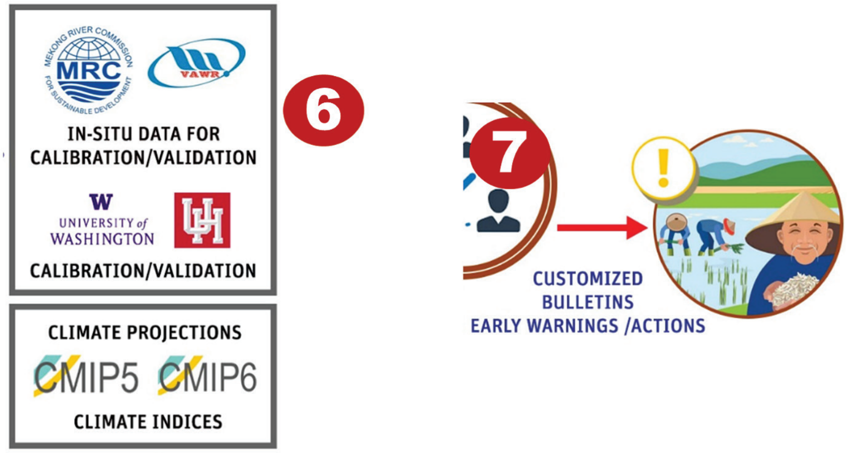

Figure 3: (f) Climate Impact Map (g) information dissemination

A number of earth science datasets are available to be used in RHEAS representing many hydro-meteorological variables such as precipitation, with each being defined as a class within the datasets package. The PostGIS database, where the RHEAS datasets are stored, is a spatial extension to the widely used PostgreSQL object-relational database system. The overall RHEAS software follows a hybrid

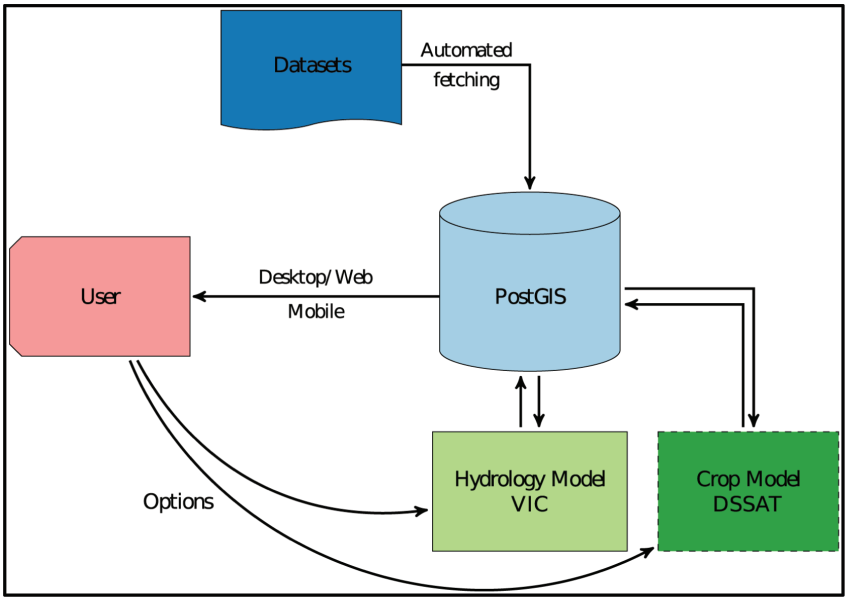

Figure 4: Simplified schematic of the RHEAS software architecture (Andreadis et al., 2017)

approach that combined modular and object-oriented programming with the functionalities of the software broken down into a set of components: (i) configuration, (ii) database operations (I/O and processing), (iii) model simulations, and (iv) data assimilation.

The overall outputs of RHEAS are made available through a web portal called the MDCW Portal whose webpage together with an integrated interactive map allows users to access all drought-related products in the form of charts and figures.

Integrated climate scenarios in Mekong drought and crop watch

It is a plausible and simplified representation of the future climate, which is projected based on an internally consistent set of climatological relationships and assumptions of radiative forcing (Santoso et al., 2008). Scenarios[2] that include time series of emissions and concentrations of the full suite of greenhouse gases (GHGs) and aerosols and chemically active gases, as well as land use/land cover are called Representative Concentration Pathways (RCPs). The word representative signifies that each RCP provides only one of many possible scenarios that would lead to the specific radiative forcing characteristics. The term pathway emphasizes that not only the long-term concentration levels are of interest, but also the trajectory taken over time to reach that outcome. Four RCPs were produced from Integrated Assessment Models that were used in the IPCC Fifth Assessment Report (AR5). The brief details of the RCPs are given below:

- RCP2.6 is one pathway where radiative forcing peaks at approximately 3 W m^{-2} before 2100 and then declines (the corresponding ECP assuming constant emissions after 2100).
- RCP4.5 and RCP6.0 are the two intermediate stabilization pathways in which radiative forcing is stabilized at approximately 4.5 W m^{-2} and 6.0 W m^{-2} after 2100 (the corresponding ECPs assuming constant concentrations after 2150).
- RCP8.5 is one high pathway for which radiative forcing reaches greater than 8.5 W m^{-2} by 2100 and continues to rise for some amount of time (the corresponding ECP assuming constant emissions after 2100 and constant concentrations after 2250).

However, the future scenarios considered for the Lower Mekong region includes RCPs 4.5 and 8.5 to understand the projected drought conditions based on near-future (2030s), middle-future (2050s), and far-future (2080s) periods.

Overview of MDCW and its functionalities

Drought Nowcast and Forecast Information

The MDCW (https://mdcw-servir.adpc.net/home/) provides near-real-time drought information for the entire Lower Mekong region by ingesting multiple satellite data through its RHEAS model and deriving drought information both at nowcast and forecast (Figure 5). The nowcast information is available for the following period as given below:

- < 24 days
- < 16 days
- < 8 days
- Current Conditions

The forecast conditions can be obtained as future "Outlooks" and are available for the following period as given below:

- 1-Month
- 2-Month
- 3-Month

The MDCW portal tends to provide drought conditions based on its intensity categorized as:

- No drought
- Moderately dry
- Severely dry
- Extremely dry
- No data

The outlooks information is available as

- None
- Watch
- Warning alert

These information guides the users to get an instant update on the prevailing drought situations in the Lower Mekong region be it an individual country or the region as a whole.

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[2] https://www.ipcc-data.org/guidelines/pages/glossary/glossary_r.html

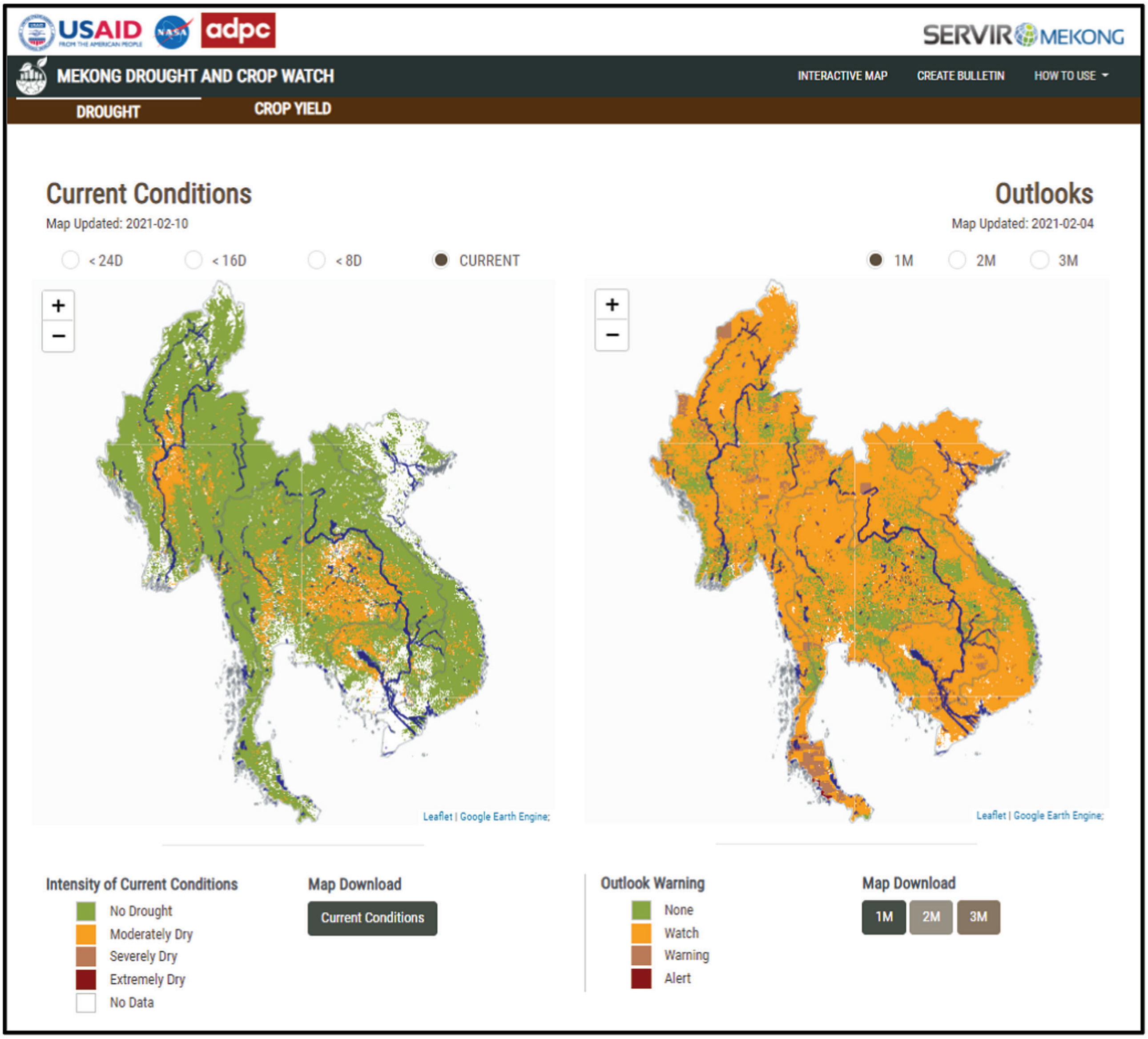


Figure 5: Front-end of Mekong Drought and Crop Watch (MDCW)

Interactive map with model-based and satellite-based indicators

The interactive map (https://mdcw-servir.adpc.net/map/) of the Mekong Drought and Crop Watch (MDCW) allows users to visualize a number of satellite- and model-based drought indicators together with other indicators in an interactive manner. All these indicators are derived from the RHEAS model and are available for observations at the regional level, country level, provincial levels, and local levels.

The interactive map provides a series of model-based indices (Figure 6) that include:

- Keetch-Byram Drought Index (KBDI)
- Combined Drought Index (CDI)
- Drought Severity (DS) (%)
- Dry Spell Events
- Soil Moisture Deficit Index (SMDI)
- Standardized Precipitation Index (SPI) 1-Month
- Standardized Precipitation Index (SPI) 3-Month
- Standardized Runoff Index (SRI) 1-Month
- Standardized Runoff Index (SRI) 3-Month
- Root Zone Soil Moisture (mm)
- Soil Moisture (mm)
- Soil Temperature (C)
- Rainfall (mm)
- Average Surface Temperature (C)
- Relative Humidity (%)
- Evaporation (mm)
- Potential Evapotranspiration (PET) (mm)
- Baseflow (mm/day)
- Surface Runoff (mm)

The satellite-based indices (Figure 7) from MDCW include:

- Visible and Shortwave Infrared Drought Index (VSDI)
- Moisture Stress Index (MSI)

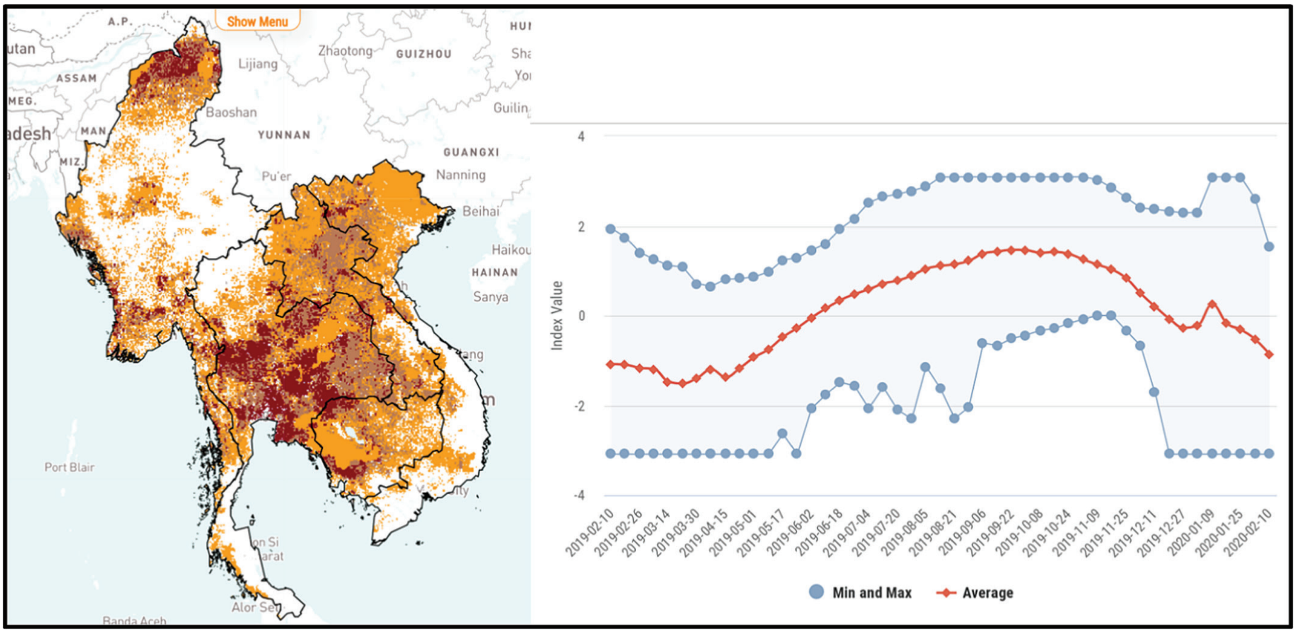


Figure 6: Model-based Standardized Precipitation Index (SPI) of Lower Mekong: 3-Month for February 2020

- Atmospherically Resistant Vegetation Index (ARVI)
- Soil Adjusted Vegetation Index (SAVI)
- Enhanced Vegetation Index (EVI)
- Normalized Difference Vegetation Index (NDVI)

Remote sensing-based indices are an effective tool for water and nutrient requirement monitoring including crop growth and yield estimation through various phenological stages while also monitoring vegetation health status and abiotic stresses. Vegetation indices are derived by combining remote sensing data and the reflectance of monitored surfaces within different wavelengths, mainly visible and Near Infrared (NIR) portion of the visible spectrum. Vegetation indices also provide consistent spatial and temporal comparisons of global vegetation conditions over time and space using data from different sensors and allow users to perform useful geospatial operation and functionalities addressing various weather- and climate-related problems.

Both satellite-based indices and mode-based indices play an important role in comparative evaluation of ground conditions that allows users to appropriately monitor conditions on the ground related to drought and its impact on agricultural productivity.

The MDCW can also provide country-level drought outputs using both satellite-based and model-based indicators. The same indices can be derived for country-level drought monitoring and forecasting (Figure 8).

While all the indices shown above can be easily accessed from the MDCW Interactive Portal, the portal also allows users to directly download such data and information for reporting and research purposes as these data and products are publicly available for free.

Climate impact map of Mekong drought and crop watch

The Climate Impact Map (https://mdcw-servir.adpc.net/climate-studies/) of Mekong Drought and Crop Watch (MDCW) enables users to visualize and explore climate variables and indices derived from CMIP5 projections from different timeframes and emission scenarios for ensemble mean of selected climate models. The climate scenarios included in the portal are regionally calibrated to meet with the regional conditions and are available at near-future (2030s), middle-future (2050s), and far-future (2080s). Representative Concentration Pathways (RCPs) 4.5 and 8.5 were included for the region to understanding the future drought severity in the Lower Mekong.

Under the different scenarios, the indicators used includes,

- Amount of Cold Nights (%)
- Amount of Hot Days (%)
- Consecutive Dry Days (days)
- Consecutive Wet Days (days)
- Daily Mean Temperature (C)
- Daily Minimum Temperature (C)
- Daily Maximum Temperature (C)
- Drought Susceptibility (based on SPEI) (%)
- Drought Susceptibility (based on SPI) (%)
- Growing Degree Days (degree-days)
- Growing Season Length (days)
- Number of Very Heavy Rain Days (days)

How Mekong drought and crop watch will help lower Mekong countries?

The system has been used to assist local governments and the agricultural sector with seasonal drought forecasting and in implementing short- and long-term mitigation measures during and in advance of droughts. It can also be used to characterize droughts through accurate, reliable, and timely estimates of their severity and impacts. In addition, the system can inform assessments of the economic, social, and environmental impacts of drought on vulnerable people and water-related resource systems. And finally, it helps develop critical regional and local thresholds reflecting increasing levels of risk and vulnerability to drought, as identified by regional stakeholders.

Customization of Mekong drought and crop watch at regional level

The Mekong River Commission (MRC) Secretariat has been one of the direct beneficiaries of the Mekong Drought and Crop Watch (MDCW) where the customized version of the MDCW is being used to provide weekly drought forecast and early warning for the Lower Mekong Basin using Combined Drought Index (CDI) (http://droughtforecast.mrcmekong.org/maps) (Figure 11).

This helps MRC Member States to receive advanced information on drought situation enabling decision-makers and farmers to take appropriate measures. The MRC Drought Management Strategy 2020–2025 considered MDCW as a strategic focus to further strengthen MRC's drought forecasting and early warning by customizing the Regional Hydrologic Extreme Assessment System (RHEAS) model of MDCW to develop an MRC stand-alone drought forecasting system (MRC, 2019).

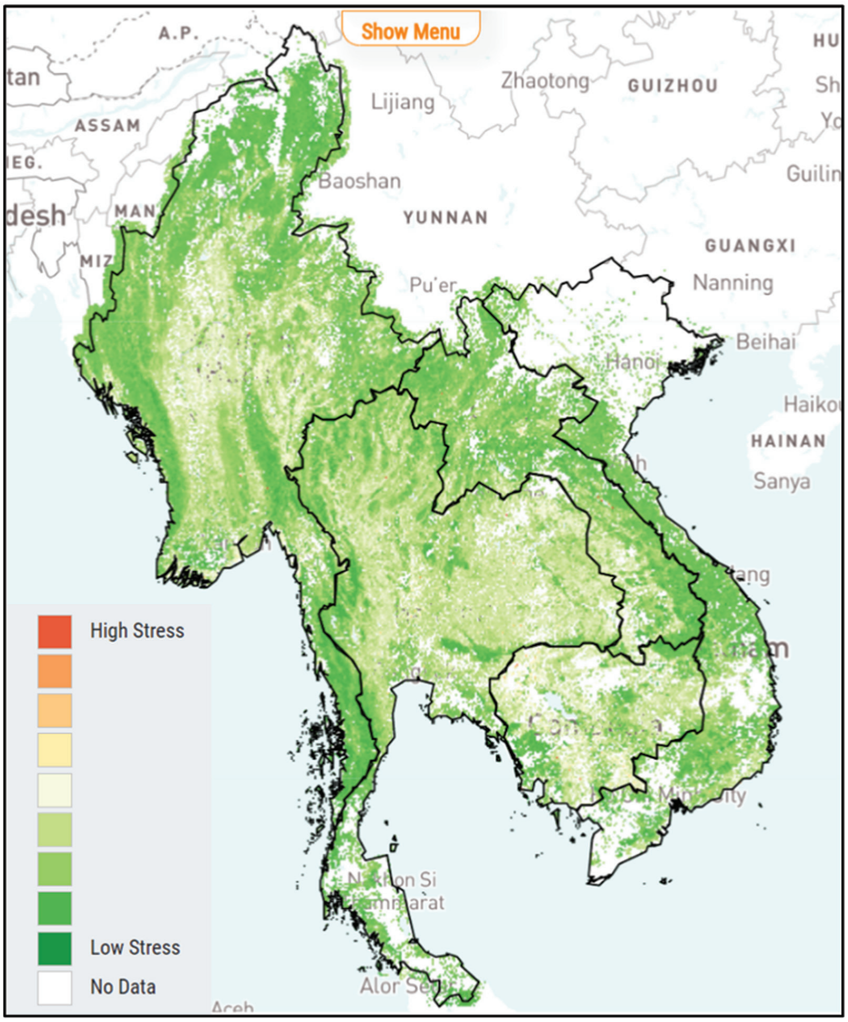


Figure 7: Satellite-based Moisture Stress Index map of Lower Mekong for February 2020 showing prevalence of stress conditions (Source: Interactive Map of SERVIR-Mekong)

Customization of Mekong drought and crop watch in Viet Nam

At the national level, Vietnam has been provided with the customized version of MDCW for drought monitoring, forecasting, and decision-making (Figure 12). With the technical support from SERVIR-Mekong, the Vietnam Academy of Water Resources (VAWR), under Ministry of Agriculture and Rural Development (MARD), calibrated and customized the MDCW which is now been used for monitoring and forecasting drought conditions in South and South-Central Vietnam. VAWR is using this drought information in their monthly drought bulletins, which is then disseminated locally through the Department of Agriculture and Rural Development (DARD) informing the farmers of the prevailing drought conditions.

Improving the drought monitoring and early warning systems (EWS)

Over the years significant advances have been made towards drought monitoring and early warning. With the occurrences of several severe drought events in the Lower Mekong region, it is very well acknowledged that countries need to set-up effective drought monitoring and early warning mechanism for improved decision-making. National and international agencies have come together to improve their ability to predict food insecurity in the region while also working closely with national governments to implement a number of early warning systems to monitor drought that may indicate the likelihood and magnitude of food insecurity. However, the region still lacks a comprehensive system where drought monitoring tools becomes part of an early warning system that could provide decision-makers with improved and timely information. Moreover, an EWS using improved drought monitoring tools can trigger timely and appropriate preventive measures if a country has adequate institutional capacity to communicate and implement recommendations or advisories. This will allow decision-makers to assess food security indicators to detect major changes in

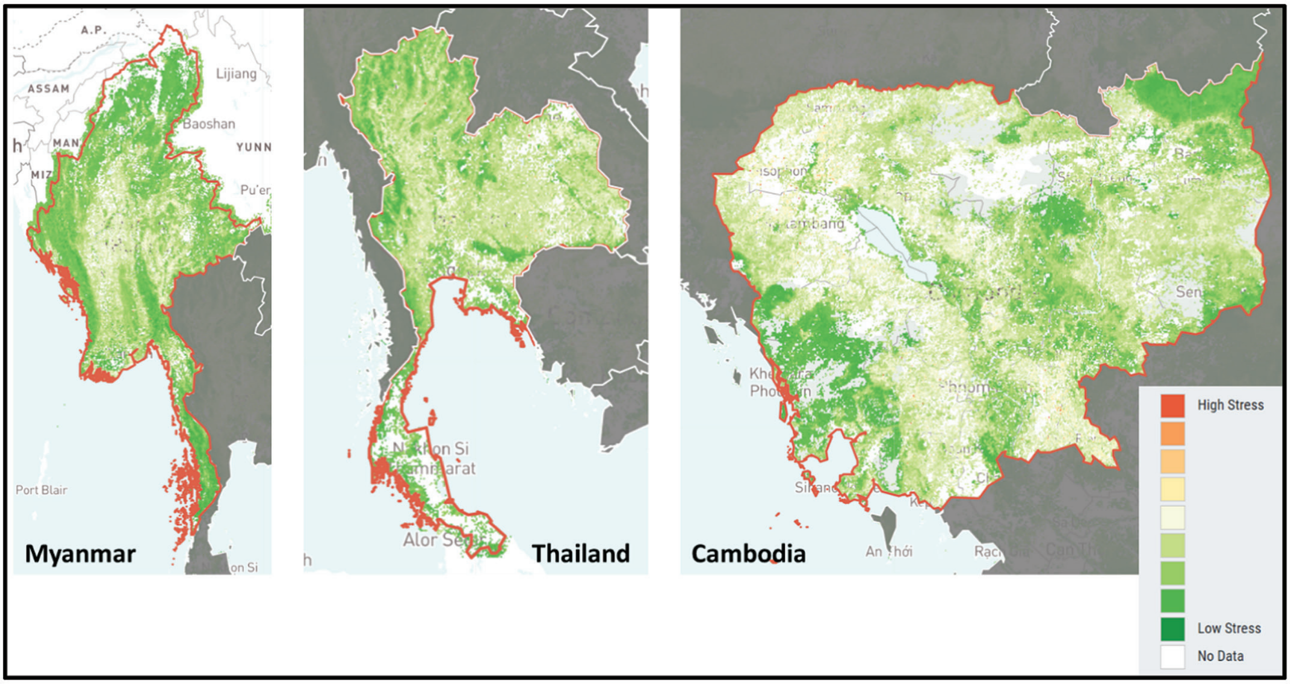


Figure 8: Country-level satellite-based Moisture Stress Index maps for February 2020 showing prevalence of stress conditions (Source: Interactive Map of SERVIR-Mekong)

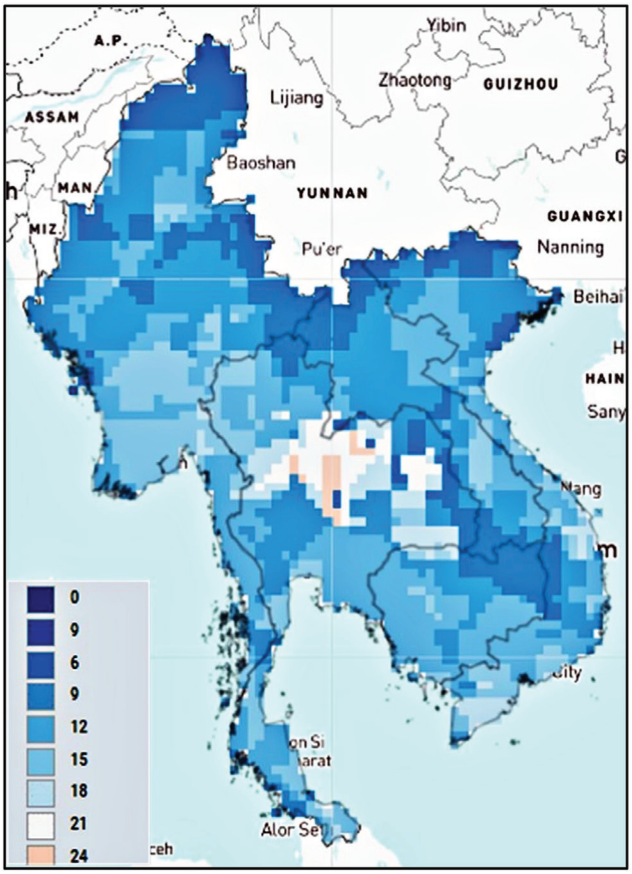


Figure 9: Standardized Precipitation Index (SPI) based on present climate scenario (Source: Climate Impact Map of SERVIR-Mekong)

food availability and advise on the likely occurrence of food crises due to drought in advance of a severe event.

Every country in the Lower Mekong region should have their own drought monitoring and early warning systems. Such system would help alert key sectors such as agriculture while also providing social protection to the low-income groups that are vulnerable to the direct impacts of drought. With accurate meteorological observations, risk can also be reduced by providing weekly, 14-days, and monthly forecast that will allow decision-makers to provide necessary advisories to the farmers for their early response to drought in terms of mitigation measures and the required changes to their cropping cycle/calendar. Further, longer-range forecasting can be complemented with near-real-time and in-season monitoring that can offer additional warnings several days ahead.

MDCW towards improving regional and national linkages and supporting adaptation

Drought being a slow onset disaster has always brought long-term and cumulative environmental changes to the Mekong region with issues raising from soil degradation and desertification processes to changes in ecosystems and habitat fragmentation to coastal erosion, among others. Such kind of changes normally do not get the attention of policymakers to cope with the emerging crises that results in situations that becomes costlier to deal with once it goes beyond the critical thresholds limits of irreversible and irreparable changes. Early Warning Systems (EWS) in such contexts becomes important to understand the onset of the event beyond the exceeded threshold, its intensity and duration from a single season to months and years and spatially from a few hundreds to thousands of square kilometers. Therefore, under such situations, a drought monitoring system such as the Mekong Drought and Crop Watch (MDCW) may help assess and analyze the risk and communicate the risk to decision-makers for operational decision-making. As change detection is a critical phenomenon in natural resources management, a comprehensive and integrated approach would help users consider numerous indicators that is required for drought monitoring and early warning with location-specific information on environmental changes. With the availability of high to medium resolution satellite data providing multiple, synoptic, global coverage having multi-spectral imagery, any changes related to the ground conditions can be obtained near-real to real-time allowing users to understand the drought extent and its impacts.

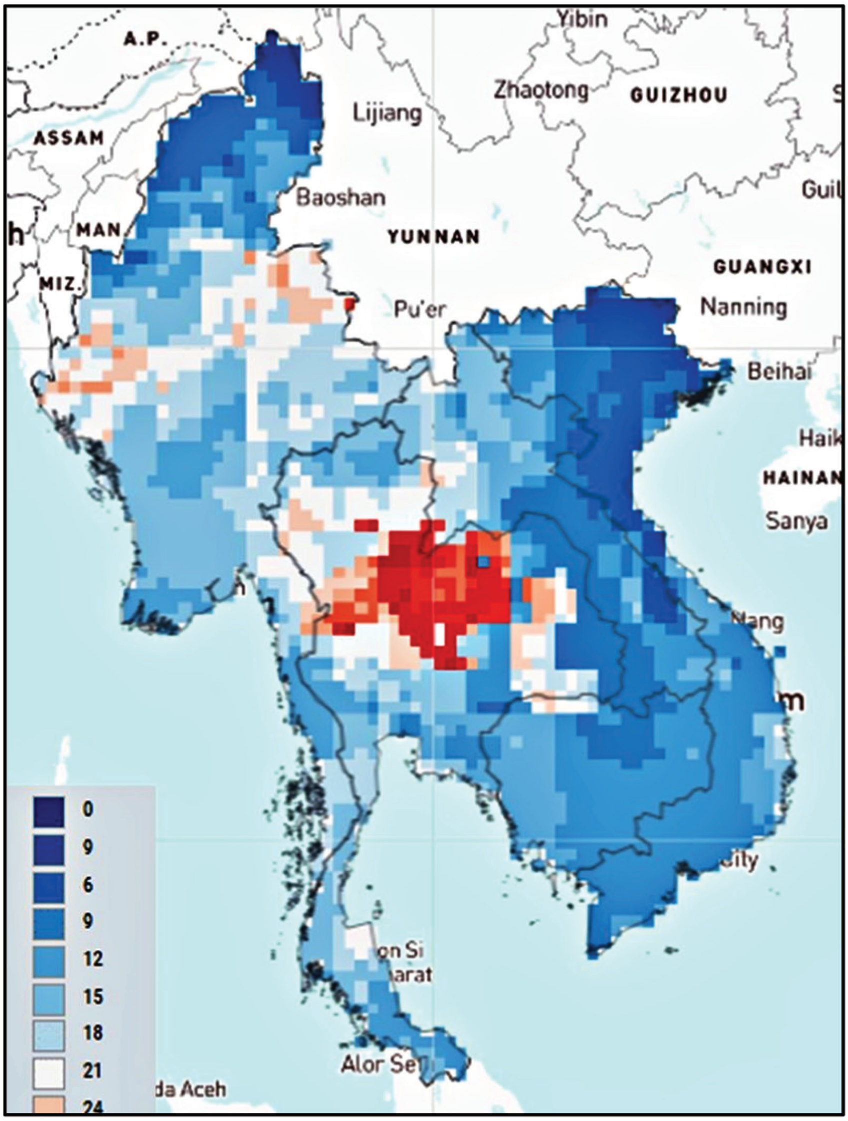


Figure 10: Standardized Precipitation Index (SPI) based on future climate scenario (RCP4.5, Near-Future (2030s)) showing extreme drought conditions towards Northern Thailand (Source: Climate Impact Map of SERVIR-Mekong)

Not many countries in the Lower Mekong have developed drought monitoring and forecasting tools that are capable of integrating earth observation and geospatial information from various sources and providing warnings related to drought situations. SERVIR-Mekong's MDCW not only provide farmers with advanced information to mitigate the impact of droughts on their crops but also give policymakers access to better data and tools to implement drought risk reduction strategies while also adapting to the adverse climate change impacts. MDCW uses innovative approaches to generate indicators using earth observation and geospatial data to understand drought patterns and its severity in the Lower Mekong, henceforth helping the farming community in providing credible information that is nowcast and forecast based to help mitigate the direct impacts of drought by re-adjusting their cropping schedules or adapting alternative cropping schemes.

Tools such as the MDCW are important for the region, government, and the community to achieve adaptation as an output to sustainable practices. Indicators can help identify when and where policy interventions could be made and how historical and institutional level analysis can help understand the processes and entry points that could be a way forward to reduce vulnerability. Therefore, leveraging the experience gained in deploying and operationalizing Mekong Drought and Crop Watch in the Lower Mekong, it makes us realize the importance of local knowledge and practices, acceptability to the information

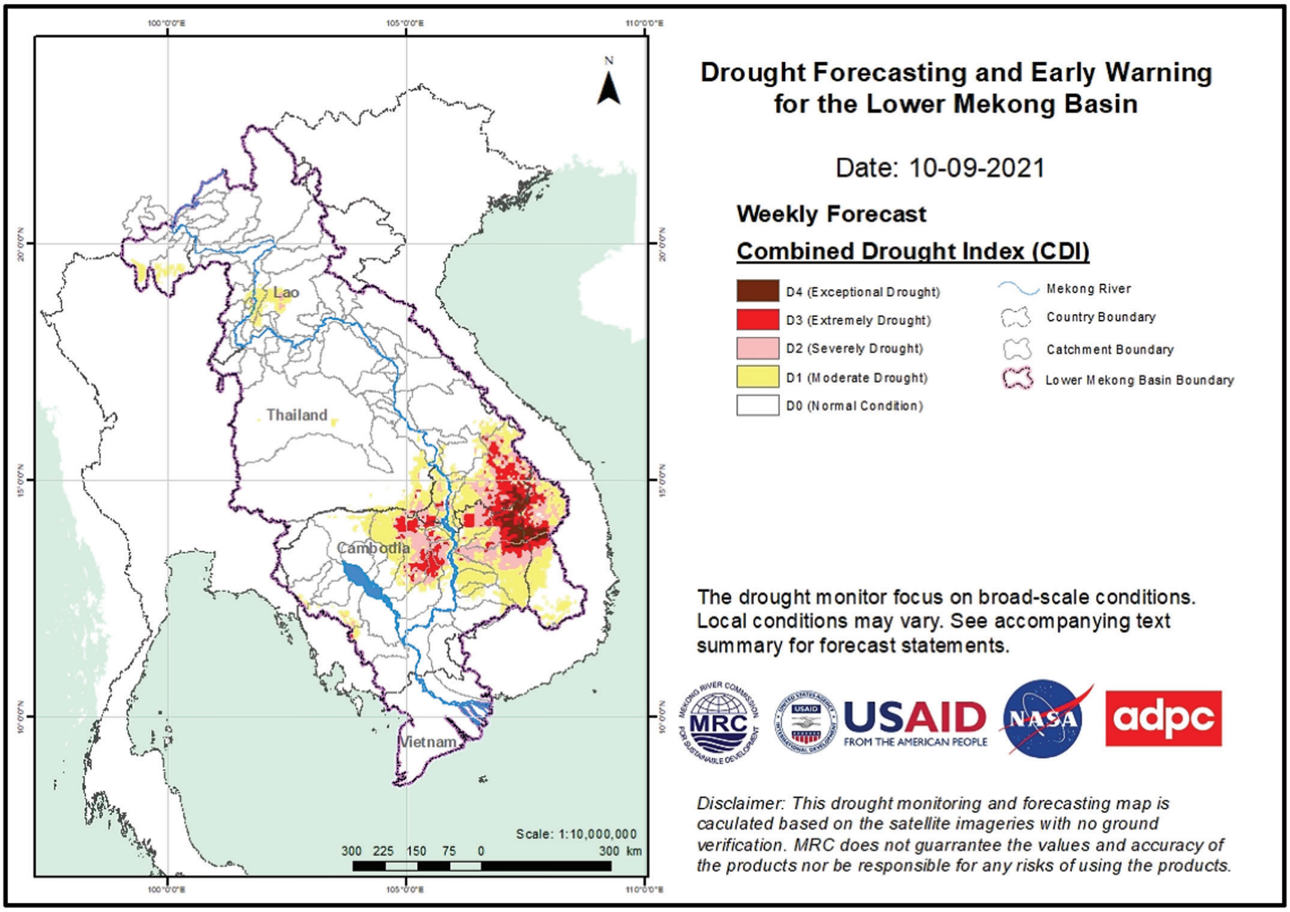
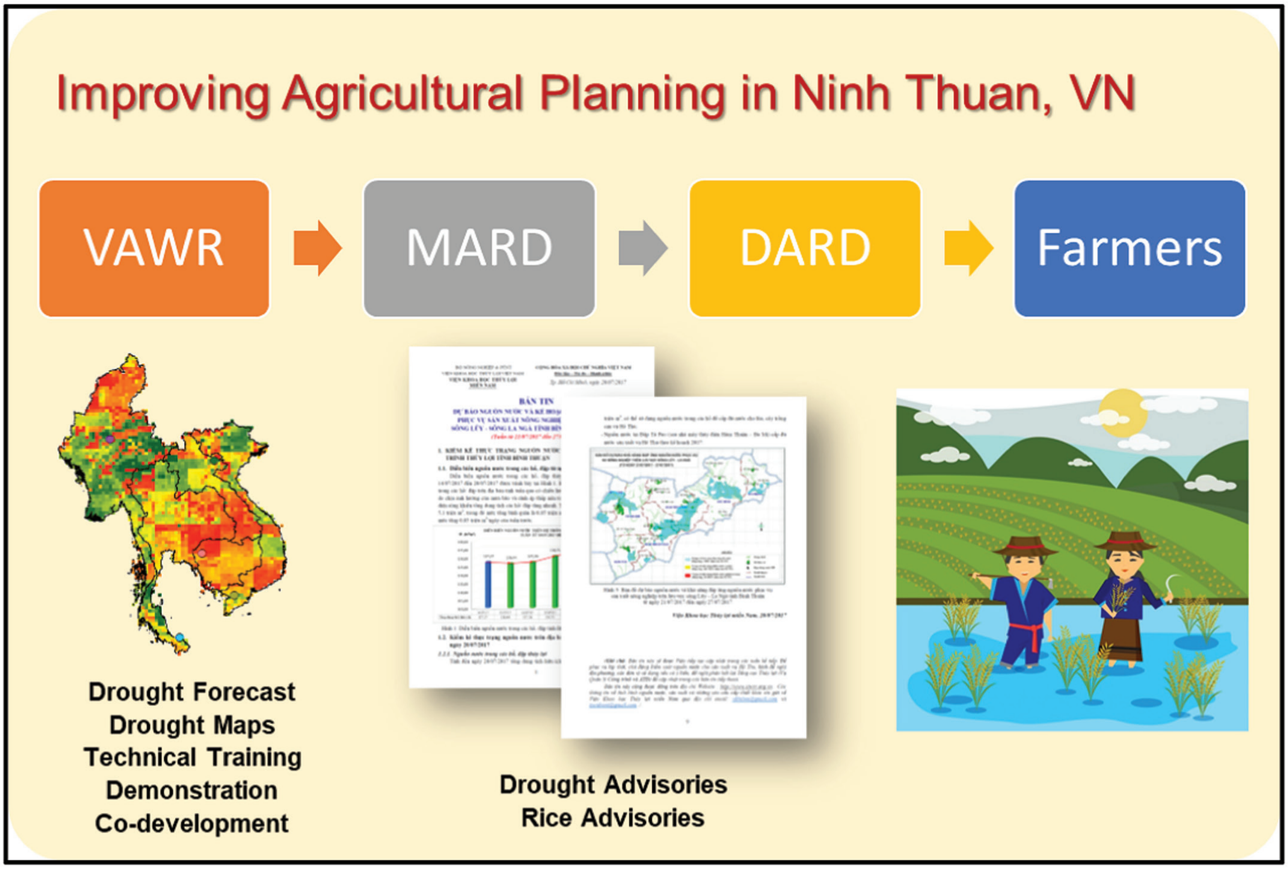


Figure 11: Weekly drought forecast of Mekong River Commission for the Lower Mekong Basin (Source: Mekong River Commission)

shared, having a good and common understanding about the tool and information and a sense of self-confidence and ownership among the community members. These forms an important set of indicators for calibrating and customizing a tool like MDCW to the extent that the advisories sent out to the farming communities are people-centered including addressing the last-mile connectivity.

Conclusion

The MDCW being integrated with the Regional Hydrologic Extreme Assessment System (RHEAS) is the only drought monitoring tool in the Mekong region having both nowcast and forecast capabilities. The MDCW allows drought to be easily monitored near-real-time using satellite-based and model-based indicators to observe changes in precipitation, temperature, and the status of surface water. It helps decision-makers understand the drought impacts while also providing information to update policies and strategies related to drought risk management. MDCW is a user-friendly interactive web-based interface that allows the users to display, analyze, and download the necessary drought- and crop yield-related information that can be accessed by anyone from anywhere around the world. The public access to data and information can be done through two steps that include decision-making and research. For decision-makers, the MDCW tends to address the much-needed drought preparedness, monitoring, and forecasting while also assessing the economic, social, and environmental impacts in the Lower Mekong countries. The system not only provide insurers with spatially explicit, documented drought condition records but also allows targeted decisions to be taken in the context of drought warnings, crop subsidies, and insurance programs. Similarly, the Climate Impact Map integrated within MDCW will help to visualize, evaluate, and analyze climate change data that is intended for audience such as the climate research scientists, meteorologists, hydrologists, and anyone who needs to understand past and future climate patterns.



Improving Agricultural Planning in Ninh Thuan, VN

VAWR → MARD → DARD → Farmers

Drought Forecast
Drought Maps
Technical Training
Demonstration
Co-development

Drought Advisories
Rice Advisories

Figure 12: Country-level customization of Mekong Drought and Crop Watch in Vietnam (Source: SERVIR-Mekong)

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Guidelines for Integrating Ecosystem-based Adaptation into National Adaptation Plans

The Guidelines for Integrating Ecosystem-based Adaptation into National Adaptation Plans published by the United Nationa Environment Programme (UNEP) aims to show national and local officials around the world how to integrate ecosystem-based adaptation into national plans designed to counter the effects of climate change.

The guidelines detail the benefits as well as the challenges of adopting ecosystem-based approaches to climate change adaptation. They also cover what information planners should collect, what expertise is needed and which stakeholders they should engage to successfully integrate ecosystem-based adaptation into national adaptation plans.

The guidelines were developed under the National Adaptation Plan-Global Support Programme, implemented jointly by UNEP and the United Nations Development Programme. The initiative, funded by the Global Environment Facility, assists least-developed and developing countries to identify technical, institutional and financial needs to integrate climate change adaptation into medium- and long-term national planning.

The programme supports the process to formulate and implement national adaptation plans under the UN Framework Convention on Climate Change. In doing so, it works with development partners to implement the Nationally Determined Contributions and promotes ambitious climate action in alignment with the Sustainable Development Goals.

The Guidelines aim to guide adaptation practitioners at national and local levels on how to take different steps when factoring ecosystems functions and services into countries' NAP processes and instruments. The Guidelines detail the multiple benefits as well as the challenges of adopting ecosystem-based approaches to climate change adaptation; what information to collect and generate; what expertise to seek; and which stakeholders to engage for successfully integrating EbA into NAP formulation, implementation and review processes. The Guidelines have been developed under the NAP-Global Support Programme (NAP-GSP), implemented jointly by UNDP and UNEP that supports the Least Developed Countries (LDCs) in advancing their NAPs.

For more information, access:

https://www.unep.org/news-and-stories/story/new-guidelines-help-states-adapt-climate-change