

Drought monitoring and forecasting for Lower Mekong Countries via the Regional Hydrological Extremes Assimilation System (RHEAS)

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Abstract

The Lower Mekong is facing an increasing impact of droughts and at the regional level, the Mekong River Commission (MRC) is mandated to work with government agencies on creating and distributing flood, drought, water resource governance and use to improve policy and practice. The MRC is striving to provide regional, locally calibrated and downscaled information on drought forecasts and real-time monitoring through a portal. The Regional Drought and Crop Yield Information System (RDCYIS) is built on regionally and locally calibrated Regional Hydrologic Extreme Assessment System (RHEAS) framework that integrates the Variable Infiltration Capacity (VIC) and Decision Support System for Agro-technology Transfer (DSSAT) models, allowing both nowcast and forecast of drought. This model is co-developed by NASA Jet Propulsion Laboratory (JPL) and the SERVIR-Mekong teams. In this work, we outline how the MRC Drought Team's requirements were met via RHEAS. Driven with earth observation data, the main aim of this service is to improve present regional and national drought monitoring and forecasting services to Lower Mekong countries for their water allocation and drought mitigation information needs. We provide an overview of the model calibration and validation methodology, and we find reasonable reliability of the soil moisture model results with the satellite based observations from the SMAP and SMOS retrievals. Through this support to MRC in integrating new drought assessment, monitoring and warning methodologies using RHEAS, more data and analyses will be available to support them to develop improved advice on drought early warning to the National Mekong Committees across the Mekong countries. MRC's assistance is envisaged to enable comprehensive, accurate and useful warnings for the decision-makers at local and provincial level to take effective action. Ultimately this service is expected to assist farmers to make preemptive decisions about their water use, cropping and planting patterns and market decisions which should reduce crop loss and support livelihoods from farming, including from appropriate compensation to farmers from the governments, wherever this is in effect.



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Problem specification

The Mekong River Commission (MRC) is striving to provide regional, locally calibrated and down-scaled information on drought forecasts and real-time monitoring through a portal, and using methods that provide information with sufficient accuracy and coverage that their member countries need to prepare and mitigate for drought events in both the short-term and long-term. The MRC Drought Team wanted to leverage the new analytical methodology being developed by the SERVIR-Mekong team and NASA's Jet Propulsion Laboratory named RHEAS to improve their regional and national drought monitoring and forecasting services to Lower Mekong countries for their water allocation and drought mitigation information needs. In Vietnam, currently the national and provincial systems do not provide agencies mandated to monitor and forecast agricultural drought with information of sufficient accuracy and temporal resolution to ensure food security and robust livelihoods for farmers. The Prime Minister has directed the Vietnam Academy of Water Resources (VAWR) to seek a method for accurate drought forecasting. This service seeks to improve VAWR's ability to forecast and monitor drought conditions to inform better mitigative decision-making by the Ministry of Agriculture and Rural Development, including salt-water intrusion, water allocation and distributing compensation and other social welfare initiatives.

Goal

The goal is to co-develop a Regional Drought and Crop Yield Information System (RDCYIS: <https://rdcyis-servir.adpc.net>) with MRC and VAWR, with technical support from NASA JPL (AST) and SCO to tailor and implement the RHEAS framework with VIC and DSSAT components, in combination with capacity-building support. Activities are also being designed to ensure MRC and VAWR have capacity to use and further develop the system components to meet their needs of drought monitoring and forecasting in the Mekong basin and Vietnam.

Key stakeholders

Decision makers:	In Vietnam: Prime Minister, Ministry of Agriculture and Rural Development (MARD), Ministry of Natural Resources and Environment (MoNRE) In LMB: MRC and National Mekong Committee members
Users:	In Vietnam: VAWR/MARD In LMB: MRC and National Mekong Committee members
Beneficiaries:	In Vietnam: Water resource managers, farmers, communities in Ninh Thuan and Binh Dinh Provinces In LMB: Water resource managers, farmers, communities in Mekong basin countries
Special audiences:	Women, Women's Organisations, Social Welfare Agencies and NGOs working to reduce drought impacts and plan for climate change with vulnerable groups and ethnic minorities in Vietnam and LMB at risk of drought impacts

Science Contributions, Earth Observations, Models and Methods

Contributions from AST

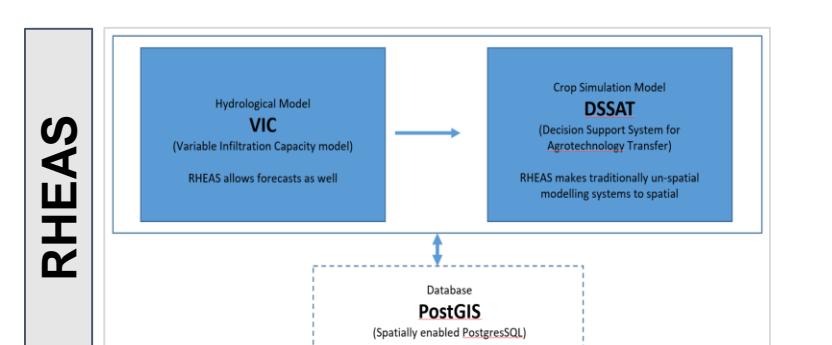
This service will continue to benefit by valuable contributions from the Andreadis AST team. Inputs from this team to date include guidance in developing a VIC calibration methodology and capacity building in implementing the RHEAS model.

Anticipated inputs include: RHEAS data product calibration and validation, delivery of an operational rice DSSAT model, and development and documentation of a comprehensive strategy for the ongoing collection and integration of empirical data to maintain and refine the RDCYIS.

Beginning ARL: 6 Current ARL: 7 Final ARL: 8

Earth Observations/Models/Methods

The Regional Drought and Crop Yield Information System uses VIC, DSSAT, CHIRPS, NCEP, NMME, GPM, TRMM, SMAP, SMOS, AMSR-E, GRACE and MODIS data



Use Case / Highlights

Service Use Case:

1. SERVIR-Mekong collaborate with VAWR to calibrate the Regional Hydrologic Extremes Assessment System (RHEAS) model in the RDCYIS in Ninh Thuan province. VAWR utilize the information and products from the RDCYIS such as drought indices, rainfall, surface runoff, base flow, soil moisture, etc. to be the input for their hydrological modeling system to estimate the water availability and to produce the monthly water resources bulletin for Ninh Thuan Province. The bulletin has been shared to the Water Resource Directorate (WRD) in MARD, and Irrigation Management Companies (IMC) and support irrigation operation in province.

2. Data from RDCYIS and GEE platform inspired Mr. Nguyen Xuan Lam and Mr. Bui Tuan Trung (Institute For Water And Environment - IWE) as co-trainers of the GEE training to use multi temporal Synthetic-aperture radar (SAR) satellite data to strengthen the capacity of reservoir operation and management for increasing resilience to drought and ensuring water and food security for Ninh Thuan province under SERVIR's small grant program.

3. RDCYIS data streams are integrated into MRC drought information system. Develop innovative Combine Drought Index (CDI) for better decision making. MRC and associated other partners capacitated to use and modify the information of RDCYIS to suit their current needs, including to modify to suit irrigated systems in future, supported by training and guidance materials

Selected Indicators / Metrics:

	Expected from Service	Expected from other services
Number of institutions engaged in regional or global knowledge exchange through SERVIR (Global SERVIR)	6	0
Number of scientists or decision-makers participating in exchanges between SERVIR hubs or partner institutions (Global SERVIR)	30	0
Number of people trained in climate change adaptation supported by USG assistance (EG.11-1)	60	0

One innovation supported through USG assistance with demonstrated uptake by the public and/or private sector

One data agreement developed/created with USG assistance

Theory of Change to Achieve Sustainability

- Assumptions:**
- The system would be outscaled if initial tests in two provinces in Vietnam are successful.
 - MRC is able to produce drought warnings that are useful and used by the National Mekong Committees.
- Inputs:**
- Prototyping: Development of VIC and DSSAT components (by JPL) including provision of specific calibration data, indices and crop estimates using MRC priorities.
 - Joint customization to VAWR and MRC needs, indices and systems, and capacity to use, maintain and adapt systems delivered.
- Outputs:**
- Integrated RDCYIS available using VIC and DSSAT modules within the RHEAS framework, and data streams designed to feed into MRC and VAWR's modelling systems, supported by guidance.
 - MRC, VAWR and others capacitated to use and modify RDCYIS to suit their current needs and to deliver improved drought forecasts (1 & 3 months) delivered to secondary users (MARD and National Mekong Committees) for communication to sub-national level for mitigative action through specific advisory bulletins for planning decisions.
- Outcomes:**
- MRC use improved data from individual components to feed existing drought management portal and crop yield models. This leads to the production of better guidance to National Mekong Committees on water availability and its impact on crops and transboundary water management.
 - Water Management and Agricultural Planning Agencies better able to make informed decisions on water allocation, reservoir operations, and provide accurate information to farmers, farmers unions, health and social welfare sectors involved in mitigating/responding to drought.
- Impact:**
- Agencies are better able to plan water use and fair allocation, meaning farmers and families either have sufficient water, or sufficient time to plan changes to cropping which means less waste or loss, and to make livelihoods choices.

Immediate Next Steps

- Integrating RDCYIS products to MRC's drought information portal and providing detailed guidance on how to use for decision making. MRC and associated other partners will be capacitated to use and modify the information of RDCYIS to suit their current needs, including to modify to suit irrigated systems in future, supported by training and guidance materials. Local level validation of drought indices (SPI, SRI, etc.) and rainfall forecasts for Ninh Thuan and Binh Dinh provinces in Vietnam would be carried out for performance testing of RDCYIS data products.
- Testing DSSAT rice crop module for Vietnam and Cambodia.
- Partnerships with community level initiatives will be formed to gather information needs and challenges from people (including women) to inform technical functionality of EWS design. Gender assessments must be carried out, focusing on the differential impacts of drought and information needs.

Looking forward

- Integrating region-specific rice crop module to DSSAT with the support from JPL to fully implement the RDCYIS
- Development of the Gender Inequality Index and how it can be combined with health/social risk factors that are connected with drought issues in Vietnam. Exploration of whether the Gender Inequality Index at provincial level could be combined with national drought forecasting to alert women's organisations, UNDP and development organisations or the health sector for pre-drought planning and risk mitigation. This is important to bring about the community-level resilience change that could be affected by this work.
- An exciting development on the horizon, leveraging the knowledge, skills and future data needs of VAWR is to co-develop new algorithms and methods to suit irrigated areas as a joint innovation between SERVIR-Mekong, NASA JPL (AST) and VAWR.