NASA Science Mission Directorate
Research Opportunities in Space and Earth Sciences
NNH18ZDA001N-SERVIR
A. 35 SERVIR Applied Sciences Team, Step-2

ROSES 2018 included an Applied Sciences Program solicitation to select a new SERVIR Applied Sciences Team. The PIs constitute the core of the team and their Co-Is and collaborators constitute the broader team. Each PI has an individual project developed in collaboration with a SERVIR hub, and, as SERVIR Applied Sciences Team members, each investigator will also be available to advise SERVIR on issues that may arise in their areas of expertise during their service on the team. The solicitation was run in two steps. The Step-1 deadline was October 25, 2018 and 94 Step-1 proposals were submitted. Dr. Nancy D. Searby, the Capacity Building Program Manager overseeing the SERVIR program, headed a Step-1 peer-review panel of 18 reviewers which met in Washington DC on March 25-27, 2019 to discuss the merits of the Step-1 proposals. Dr. Searby presented the Step-1 selections to the NASA Steering Committee and signed the selection recommendation as the program officer. NASA invited 58 proposals to submit Step-2 proposals in collaboration with the SERVIR hubs.

The deadline for submission of Step-2 proposals was July 19, 2019, and NASA received 54 responses. Dr. Searby headed a Step-2 peer review panel of 16 reviewers to discuss the merits of these Step-2 proposals. The panel met in Washington DC on August 27-29, 2019. NASA has identified 20 proposals for funding, based on the panel review and the programmatic need to balance the needs identified in the thematic service areas by the five regional hubs in Eastern and Southern Africa, Hindu Kush-Himalaya, Lower Mekong, West Africa, and Amazonia regions. Funding amounts to $4.5M for the first year and a total of $13.7M over the full 3 years of the grants. Dr. Searby presented the Step-2 selections to the NASA Steering Committee and signed the selection recommendation as the program officer. The selected PIs will form the new SERVIR Applied Sciences Team. The selected PIs (in alphabetical order), their institutions and thematic service areas for their selected work are:

Emily Berndt/Marshall Space Flight Center
Advancing Air Quality Monitoring and Prediction Capabilities in the Hindu-Kush Himalayan Region
18-SERVIR18_2-0054

This proposal addresses the Weather and Climate priority topic of the NASA SERVIR Applied Sciences Team (AST) call A.35, with a specific focus on SERVIR-Himalaya and extreme weather events associated with air quality (AQ). The goal of this proposal is to design and implement a robust AQ chemistry modeling system suitable for SERVIR-Himalaya that effectively assimilates aerosol and trace gas retrievals from geostationary and polar-orbiting satellites in an effort to advance the monitoring and prediction capabilities of air quality and visibility reductions throughout the Hindu Kush Himalaya (HKH) region. Our innovative study fuses a suite of polar-orbiting and geostationary

satellite retrievals to provide an accurate and comprehensive depiction of the spatial and temporal variability of aerosols and trace gases over the HKH region. The suite of satellite retrievals will then be used for assimilating into a robust AQ chemistry model for providing critical AQ and low-visibility alerts/warnings and identify the key atmospheric constituents that lead to poor AQ conditions and visibility reductions at the local-scale, in order to enhance the decision-making process of SERVIR-Himalaya and its partners. By improving the understanding of these key constituents, partnering government organizations can address preventative measures for reducing local air pollution, along with impacts on public health and transportation activities. Our specific objectives are as follows: (1) fuse information from a suite of state-of-the-art satellite instrumentation for developing comprehensive aerosol and trace gas products that advance real-time monitoring capabilities over the HKH region; (2) assimilate the suite of satellite data into a unique modeling framework for providing accurate AQ, fog/smog, and temperature/stability forecasts; (3) utilize the data-assimilated model analysis fields for initializing a lagrangian trajectory model to aid in the rapid response to extreme aerosol and AQ events; (4) work with the SERVIR AST and SERVIR-Himalaya to assess, improve, and implement the aerosol and AQ satellite datasets and model forecasts into applicable decision support systems, and develop customized end-user training. From successfully completing these objectives, we will deliver and fully transition a real-time AQ monitoring and forecasting toolkit (i.e., imagery, derived products, and model forecasts) for assessing present and short-term AQ conditions in the HKH region, which can help provide accurate and timely alerts/warnings to the public for reducing fatalities and hospitalizations related to air pollution. The HKH region frequently experiences rapidly varying air quality conditions due to the strong, active emission sources, so our development of a trajectory forecast system for rapid response to extreme pollution episodes will have major societal benefits in the region. We implement an adaptable, inner nest grid within our modeling configuration to highlight the improvements in AQ forecasts at high-resolution scales. As computational resources continue to advance, the implementation of high-resolution operational AQ forecasting models will become more common within the scientific community. So, our results here will help guide future development of high-resolution customized AQ models for improving regional forecasting capabilities. Our proposed work will also assess the advantages and limitations of the new Geostationary Environment Monitoring Spectrometer (GEMS) Level 2 products, which will provide valuable input to the mission scientists and algorithm developers of needed refinements to the trace gas algorithms. This can ultimately lead to future releases of improved GEMS L2 products, while also helping to guide the baselining of products and capabilities of the upcoming NASA Tropospheric Emissions: Monitoring of Pollution (TEMPO) mission.

Narendra Das/Jet Propulsion Laboratory

Enhancement of the RHEAS Capabilities for Monitoring and Forecasting of Seasonal Rice Crop Productivity for the Lower Mekong Basin Countries

18-SERVIR18_2-0046

Agriculture, especially rice production, is the backbone of many economies of the Lower Mekong Basin (LMB) countries (Cambodia, Laos PDR, Viet Nam, and Thailand). According to IPCC, climate variability and extremes are expected to result in modifications to weather patterns in the LMB region. This changing climate will intensify temperature and rainfall regimes that will lead to increase in duration and frequency of extreme events (IPCC report for Southeast Asia). In the coming years, the LMB region is projected to face seasonal water shortages, and drought and flood events will become more common and more severe. Ultimately, these changing climate and weather patterns will negatively impact rice crop production in the LMB countries. Variable and changing climate, occurrence of frequent droughts, and increasing pressure due to population growth have made the situation critical for the LMB countries. Thus, it is warranted to have a reliable and comprehensive forecasting model that uses cutting edge tools, physical models and data to provide a skillful forecast of seasonal (3 months in advance) rice yield estimates, and related agricultural and hydrological drought indicators. Such a forecast model with skillful estimates and monitoring capabilities will empower LMB stakeholders and decision-makers to address various aspects of adaptability in agriculture, take preemptive actions for drought, provide important relief measures, and make additional resources available to farmers in the LMB countries.

In fact, a project is being implemented in the SERVIR Southeast Asia Hub hosted at the Asian Disaster Preparedness Center (ADPC) in Bangkok, Thailand. The PI is an investigator for this project. This SERVIR project (Monitoring and Forecasting Drought and Crop Yield for the Lower Mekong Basin) has capabilities to model hydrology and rice crop for the LMB countries by using the Regional Hydrologic Extreme Assessment System (RHEAS) developed at the NASA's Jet Propulsion Laboratory. There are few more months left with the current project, and the RHEAS implementation so far is robust computationally in terms of hydrology and crop modeling. Running the hydrologic modeling component through RHEAS does not need a lot of any human intervention, however, the crop modeling part needs regular human intervention and thorough calibration for each and every province in the LMB region. The human intervention in the crop modeling part is to address the greater degree of freedom that comes from the farm management practices that depends on various factors, such as: 1) varying planting and harvesting dates; 2) applications of different fertilizers and pesticides; 3) amount of irrigation applied, and; 4) introduction of new rice cultivars. Due to the high degree of freedom, the crop model needs regular updates when modeling during the growing season to get an optimal assessment of nowcast and forecast of rice yield in the LMB region. During the regional meetings and capacity-building workshops, the project team, members from ADPC, and collaborators/stakeholders from the LMB regions such as Mekong River Commission, Vietnam Academy of Water Resources, Institute for Agricultural Environment (IAE), and Institute of Water Resource Planning (IWRP) unanimously agreed on specific enhancements and additional tools necessary for the RHEAS to achieve implementation at ARL-9, and allow it to run at full potential. The collaborators/stakeholders agreed to provide all the necessary in situ data of farm management practices that are essential for the RHEAS enhancements for the LMB region. Therefore, we propose to incorporate and capture the evolving ground conditions

by developing new modules for the RHEAS framework crop modeling component existing in the SERVIR Mekong Hub at ADPC to achieve ARL-9 implementation.

Frank Davenport/University of California, Santa Barbara
Using Earth Observations and Statistical Models to Enhance Drought, Food Security, and Agricultural Outlooks in Eastern and Southern Africa
18-SERVIR18_2-0066

We propose to build, with East African partners, a user-defined set of Decision Support Tools (DSTs) to integrate existing empirical yield prediction models with Earth Observation (EO) data. These DSTs could be used by key stakeholders to analyze and make early predictions of agricultural yields, production, and other food security outcomes. The tools will help users identify and explore quantitative links between a variety of earth observations and food security indicators and explore outcomes at national and regional scales. This system will empower national and regional analysts by directly relating EO, weather, and climate forecasts to potential grain production outcomes, and can support these activities throughout the growing season. This could be especially useful when early-to-mid season EO observations indicate agricultural issues but are under-utilized for early warning. The system will support analysts who need to anticipate end-of-season outcomes, as well as researchers and long-term planners. Users can evaluate historical relationships between water stress and grain production and then use those historical relationships to guide future decision making under various climate scenarios. The proposed work addresses the "Food Security and Agriculture" component by directly enhancing several existing services provided by the SERVIR-eastern and southern Africa hub: Drought monitoring and assessment, yield assessment and prediction, and the development of data sets supporting crop insurance partnerships.

The work proposed here will empower the regional SERVIR Hub (RCMRD) to become a better service provider to eastern and southern African institutions by facilitating the use of EO and geospatial technologies in ways that enhance food security and agriculture related-decision making. In turn, this will contribute to greater resilience to climatic shocks, particularly droughts. The primary objective is to partner with RCMRD to co-develop improved Decision Support Tools (DSTs) that translate EOs into improved in-season drought and agricultural mapping and monitoring services. This includes a plan to explore the utility of these enhanced data sets that support index insurance applications. The proposed activities will leverage prior SERVIR-funded data services. These include — the RCMRD instance of the Early Warning eXplorer web mapping service, the Climate Hazards Center's InfraRed Precipitation with Stations (CHIRPS) and InfraRed Temperature with Stations (CHIRTS) data products. The proposed work will also utilize newly available crop data from the FEWS NET data warehouse.

Liping Di/George Mason University

Remote Sensing and Agro-Geoinformatics Based Products and Services for Supporting Agricultural and Food-Security Decision Making in Hindu-Kush-Himalayan Region
18-SERVIR18_2-0076

With population increase and climate change, food security has become a pressing issue that world has to face. The major source of food is agriculture. Therefore, timely and accurate information on agriculture productivity, such as crop planting acreages, crop condition and progress monitoring, yield estimation, as well as natural disasters (mainly agricultural drought and flood) that affect the agricultural productivity, are the key for making sound decision to ensure food security.
In the past several years, the Center for Spatial Information Science and Systems (CSISS) at George Mason University (GMU) has been funded by NASA Applied Science Program, NOAA, and USDA to develop a suite of remote-sensing-based agricultural information products and associated decision support service systems, which have become the official operational capability of USDA to support U.S. national agriculture decision making. The operational decision support systems (and their decision support products) include CropScape (annual Cropland Data Layer) and VegScape (weekly national crop condition, progress, and yield). The CropScape won the USDA Secretary Award in 2011. Those award-wining operational capabilities have been supporting more than ten thousands of agricultural and food security decision makers in U.S. and abroad. In this proposal, we propose to enhance SERVIR's capacity in supporting agricultural and food security decision making by migrating those operational USDA capabilities to SERVIR hub regions through an adoption and adaptation process. Specifically, the focus is on improving crop area mapping and crop yield estimation in terms of accuracy, and spatial and temporal resolutions. Advanced deep learning and data fusion technologies will be adopted to efficiently process time series of Earth Observations from different sensors at different resolutions. Although the proposed products and services are needed by all SERVIR hub regions, during this project we will concentrate on SERVIR Hindu-Kush Himalayan (HKH) region, particularly Bangladesh, Nepal, and Pakistan. The proposed project will consist of three major activities, including algorithm adaptation, system migration and adoption, and comprehensive training. The algorithm adaptation activity will ensure that the algorithms used to generate the decision-support products can work with the local agricultural and natural environment of the SERVIR HKH region, such as small field size and frequent cloud cover. The system migration and adoption activity will port the decision support systems to the computing environment of the SERVIR's HKH hub with consideration of possible slow network connectivity and low computing capacity. The activity may also modify existing decision support functions or develop new ones to meet the specific decision-making requirements of the SERVIR HKH region. The comprehensive training will train both geo-computing specialists at the hub to manage the decision support systems and the end-user community to effectively use the systems for their operational decision making. The project will closely collaborate with the specialists in the SERVIR HKH hub and end-user community in the region during the adoption and adaptation process to ensure the migrated products and systems can operationally support the end-users' decision making.

This proposed project offers the most advanced Earth-observation based operational agricultural and food security decision supporting products and systems to SERVIR. The success of this project will significantly enhance the capacity of SERVIR in supporting timely and accurate decision making on agriculture and food security. The knowledge and experience of the project team in agro-geoinformatics not only ensure the success of the project but also are valuable to the SERVIR regions and the SERVIR Coordination Office.

Niall Hanan/New Mexico State University
Range Monitoring for Decision Support, Pastoral Livelihoods and Food Security in Arid and Semi-Arid East and Southern Africa
18-SERVIR18_2-0086

For this SERVIR Applied Science Team (AST) project, we will work with the East & Southern Africa SERVIR hub (E&SA) on earth observations (EO) for pastoral food security (Thematic Service Area 1) and land use and ecosystems (Thematic Service Area 3). We propose range monitoring applications that leverage an earlier (2016-2019) AST project in West Africa, and earlier NASA- and NSF-funded Africa-wide research. Our EO approaches to measure, monitor and diagnose change in arid and semi-arid savannas offer significant opportunities for applications that contribute to the priorities of the E&SA SERVIR hub relating to rangeland monitoring, wildlife and livestock production and sustainability. Given the critical role of livestock for milk and protein supply across Africa, particularly in the subsistence pastoral zones, this proposal will focus on collaborative development of monitoring systems, focused on wet season forage growth and dry season biomass decline (Service 1). We will use, insofar as possible, direct EO to track resources critical for livestock production and food security. Based on E&SA priorities, we will develop short-term forecasts for wet season forage production and dry season forage decline (Service 2).

An early component of this project will engage the full AST team (i.e. Hanan, Anchang at NMSU and Ndungu, Ouko at the SERVIR E&SA hub) with regional stakeholders interested in rangeland resource monitoring and sustainable development of the grazing lands, to adapt and refine our plans based on stakeholder needs. The initial plan includes four main activities contributing to two Service Areas. Activity 1: woody canopy cover mapping at ~100 m in E&SA focal countries (methods already developed as part of our existing West Africa AST project). Activity 2: operationalization of our published leaf area index (LAI) partitioning methodology at 500 m as an index of wet season herbaceous forage production. Activity 3: operationalization of an EO approach to track dry season forage biomass decline (based on research in Australian drylands and initial testing of the approach in West Africa). Activity 4: development of approaches for forage forecasting using 1-3 month weather forecasts for wet-season growth and observed rates of decline in dry season senescent forage.

The applications proposed as part of Service 1 are well-developed in terms of concepts, algorithms and workflows. We will work with the SERVIR hub to tailor plans to E&SA

stakeholder needs, calibrate and validate using local datasets, and build automated work-flows enabling regional adoption. Some aspects of forage forecasting (Service 2), which the E&SA hub requested be part of this proposal, will be developed in consultation with stakeholders, but our ideas for forecasting are feasible, based on availability of short-term weather forecasts and modeling approaches adopted elsewhere. We anticipate this collaborative project will contribute to E&SA priorities for range monitoring, early warning for food security risk assessment, and as inputs to East African index-based livestock insurance (IBLI) programs.

PI (Hanan) and Co-I (Anchang) have considerable experience in the pastoral and agro-pastoral regions of West, Southern and East Africa. An earlier AST project focused on wood resource monitoring in West Africa (an important precursor for forage monitoring proposed here). Prior research included fundamental and applied research in savanna ecology and use of satellite remote sensing for measurement of vegetation structure, productivity and ecosystem dynamics. Co-Investigators Ndungu and Ouko lead the rangeland monitoring programs of the SERVIR E&SA hub, including development of range assessment tools using low latency MODIS NDVI products. This project will provide opportunities to refine existing approaches and increase critical mass of SERVIR investigators working on range monitoring and forecasting for East and Southern Africa.

Norm Jones/Brigham Young University
Geospatial Information Tools That Use Machine-Learning to Enable Sustainable Groundwater Management in West Africa
18-SERVIR18_2-0020

In West Africa, particularly in Niger, rain-fed agriculture is unsustainable. Groundwater development will provide a more stable water source and enhance food security. Groundwater development requires collecting and analyzing data produced at global and national levels and disseminating that data and knowledge to end users such as States, NGOs, municipalities, businesses, and agropastoralists in a format that is useful for planning and decision-making. We will develop a set of geospatial tools for stakeholders at all levels to assess and interpret groundwater data. Users will access these tools via a simple browser interface that requires minimal infrastructure or computer expertise. We will also assist hub partners in developing and using groundwater models.

A) Groundwater Resource Assessment

The Groundwater Level Mapping Tool (GW-Level) is the foundation of the system. GW-Level ingests in situ water level measurements and performs temporal and spatial interpolation to build interactive animated maps or times series plots. GW-Level uses machine learning to find correlations among Earth observation data, such as precipitation or soil moisture, with water level data and perform more accurate interpolation. This approach is particularly applicable to West Africa because it ensures that scarce in situ data are used as effectively and accurately as possible. These products help water

managers gain a better understanding of groundwater resources and determine how aquifers are responding to groundwater development, droughts, and climate change.

The Groundwater Volume Analysis Tool (GW-Volume) provides lower resolution data that gives a current picture of groundwater conditions in terms of overall water storage volumes. GW-Volume can identify and characterize conditions in data-poor areas or identify trends in other regions often obscured by noise from well data. GW-Volume uses GRACE mission data to compute and display changes in water storage in a web-based mapping system and will integrate GRACE-FO data. GW-Volume uses NASA GLDAS surface water data to derive changes in groundwater. It displays the results as time series plots at selected points or map animations. This tool will complement the GW-Level tool, providing a secondary measure of how groundwater changes in space and time.

B) Groundwater Model Development

We will work with SERVIR-West Africa to update and improve existing groundwater models and develop new regional models. We will implement workflows using data derived from Earth Observations as forcings to these models. Groundwater modeling typically requires advanced computer and software capabilities with trained and experienced modelers. We will develop the Groundwater Model Scripting Tool (GW-Model) to support groundwater model simulations for selected scenarios that managers face on a routine basis. GW-Model uses a web-based interface to add or eliminate wells, change pumping rates, or evaluate changes such as drought (e.g., changing recharge rates) or temperature (e.g., changing irrigation needs). This tool will allow stakeholders to access and use models without having to rely on modeling experts. We have helped develop similar modeling tools for the Virginia Department of Environment Quality and the Utah Division of Water Resources.

C) Stakeholder Rraining and Technology Transfer

We will work with stakeholders, including AGRHYMET, The Ministry of Hydraulics and Sanitation (DGRE), the Association for the Redynamisation of Pastoralism in Niger (AREN), and the National Network of Chambers of Agriculture of Niger (RECA), to develop and provide training for these tools. We will leverage training to refine the capabilities, tool interfaces, visualizations, and data reports.

We are uniquely qualified for this project due to our extensive experience in web-based tool development, groundwater data management, groundwater modeling, and education and training.

Jasmeet Judge/University of Florida, Gainsville
Linking Deforestation, Urbanization, and Agricultural Expansion for Land Use Decisions in Ghana

18-SERVIR18_2-0007

West Africa has experienced significant deforestation over the last several decades. Currently, Ghana consists of 18% of the remaining Upper Guinean forest, covering 24% of the country. Even though the deforestation rates have slowed in recent years, Ghana still experiences significant anthropogenic pressures, with human-driven land use change being the primary driver of vegetation dynamics in the region. Given the high rates of urbanization, agricultural expansion, and deforestation in Ghana, the complex interplay between socio-economic dynamics and emergent trends of landcover change have been the focus of multiple studies in the region. However, complex interactions among human and natural systems make it challenging to identify precursors/drivers of land cover change and hinder the development of scenarios and opportunities for effective land use planning.

Land use in the Ghana remains largely unplanned, with recent policy efforts at higher levels implemented through the Land Use Spatial Planning Agency (LUSPA) – the sole government agency for land use planning at national, regional, and district levels. These policy efforts highlight an urgent need in operational land use planning tools that account for and balance linkages among deforestation, urbanization, and agricultural expansion in Ghana. In addition, LUSPA is in the process of migrating the currently used Land Use Planning and Management Information System (LUPMIS) from proprietary software to open-source GIS-based tools. This evolution and transition from simplified mapping to integrated spatial planning and analysis presents a timely opportunity to integrate new advances in remote sensing (RS) information in the region into currently used software and approaches using open-source GIS-based planning tools for improved land use planning in Ghana.

The goal of the proposed project is to fill this timely need in effective land use planning in Ghana by enhancing the current operational planning framework and building capacity. Overall, the proposed framework will integrate remote sensing-based estimated trends in deforestation, urbanization, and agricultural expansion in the country with GIS-based modeling. This will allow to project land use changes by identifying linkages and potential overlaps/conflicts among various sectors. Specific objectives of the project are to: (i) investigate linkages among deforestation, urbanization, and agricultural expansion in stakeholder-identified (LUSPA) Eastern and Central Regions of Ghana. (ii) integrate the trends and linkages from objective (i) with GIS-based, open-source tools to develop an enhanced planning framework, henceforth LUPMISPlus, in the two Regions; and (iii) build local capacity in the use of remote sensing, GIS tools, and LUPMISPlus for sustaining these efforts beyond the lifetime of this project.

Primary outputs of the project include generating understanding of the linkages among deforestation, urbanization, and agricultural expansion using RS tools, and an open source land use planning tool based on these linkages and other physical and governmental factors. The outcomes will include better understanding of the connections among deforestation, urbanization, and agricultural expansion and, most importantly, increased capacity to use RS and GIS tools for informed and effective decision making

for future land use planning in the region. Deliverables include (1) operational LUPMISPlus model in the region for identifying land use conflict and decision making for future land use; (2) three training workshops for remote sensing, GIS-technology, and LUPMISPlus, tailored for various stakeholders, and (3) a web portal for easy access to datasets, models, and other decision- making tools.

Robert Kennedy/Oregon State University
Leveraging Cloud-Computing and an Integrated Disturbance and Vegetation Mapping Framework for Protected Areas Monitoring in the Lower Mekong
18-SERVIR18_2-0071

Because of diverse political and cultural backgrounds, the five nations that make up the Lower Mekong Basin (LMB; Myanmar, Thailand, Laos, Cambodia, and Vietnam) have experienced strong regional disparities in response to the population and economic pressures that threaten both human livelihoods and important ecological resources. To aid informed decision making, the NASA SERVIR-Mekong (servir.adpc.net) has been developing a suite of tools and data products to apply satellite and spatial analysis to monitor and understand pressures on land cover and land use in the LMB.

Here, we propose to co-develop with the SERVIR-Mekong Hub enhanced time-series analysis to improve existing land cover and land use services, and to empower both the Mekong Hub and the larger science and stakeholder community in autonomous production of the underlying datasets. Our underlying framework of analysis is based on temporal segmentation of the Landsat archive, combined with flexible statistical tools to integrate diverse reference datasets.

Under the Theory of Change (ToC) conceptual guidelines, we suggest that our overall goal for impact is to provide decision makers in the LMB with the capacity to make timely, agile, and informed decisions about land change to improve environmental resilience and human livelihoods. Guided by the Monitoring, Evaluation, and Learning (MEL) framework and using the SERVIR Service Planning approach of Needs Assessment, Service Design, and Service Delivery, we organize our work around three driving objectives:

Objective 1: Evaluate data availability and needs of stakeholders in the region.
Objective 2: Implement integrated change and state mapping in Cambodia and other SERVIR-Mekong countries
Objective 3: Improve accessibility of analytical interfaces to access the services

These will be implemented through five tasks that will involve tight integration with the Hub and with stakeholders in the region:
Task 1: Evaluate existing training and remote sensing data to form the basis of disturbance and vegetation mapping.
Task 2. Assess stakeholder needs for land cover change monitoring.

Task 3. Translate existing change detection, mapping, and attribution framework to the SERVIR-Mekong region.
Task 4. Update and adapt framework to meet the needs of stakeholders
Task 5. Improve existing web-visualization, trend analysis, and data summarization within the data portal.
Key outputs and outcomes include: evaluation and training workshops to align our framework to the needs of stakeholders in the LMB; maps of yearly land cover and continuous vegetation attributes harmonized with maps of change and change attributes; improved web-mapping, visualization, and analysis tools to integrate change; code and scripts to implement all components of the framework; greater capacity within the LMB for autonomous production and use of change products.

Because the system can provide internally consistent maps of land cover condition and change, and can link those changes to specific agents of change, we believe our approach may provide stakeholders in the region a clearer sense of trends and drivers in change. Additionally, by working with the Hub to improve and visualize change in landcover and land use, our project may broaden accessibility to stakeholders outside the current set of collaborating groups in the SERVIR-Mekong Hub. Finally, through trainings in the use and interpretation of our products during workshops, we anticipate a broader impact as our trainees return empowered to carry out further analyses beyond those initially envisioned here.

Dalia Kirschbaum/Goddard Space Flight Center
A Landslide Hazard and Risk Assessment System for SERVIR-Mekong
18-SERVIR18_2-0036

Rainfall-triggered landslides cause billions of dollars in damage to infrastructure, severe economic losses, and thousands of fatalities annually. Over the Lower Mekong Region, understanding of how landslides are distributed and impact communities varies significantly between countries. In this region, effectively characterizing landslide hazard and risk to support decision making is challenging due to limited information on historical landslide behavior, land surface characteristics, vulnerability and rainfall, particularly at regional scales. This proposal addresses this challenge by incorporating Earth Observation (EO)-based products and models in a flexible decision support system to ultimately quantify landslide hazard, exposure and risk. Under the thematic area of Water Resources and Hydroclimatic Disasters, we propose to advance a dynamic Landslide Hazard Assessment for Situational Awareness (LHASA) model over the SERVIR-Mekong region by fusing local and EO-derived information on landslides, triggering precipitation and surface characteristics.

With newly available capabilities that leverage satellite sources and new landslide models, the proposed work seeks to better define the spatiotemporal frequency and impacts of landslides across the Lower Mekong Region by co-developing services and products with the SERVIR-Mekong hub for regional decision makers and transfer capabilities to characterize landslide hazard impacts at time and space scales relevant for

their applications. Specifically, this proposal focuses on three main topics: advanced landslide cataloging and mapping, dynamic hazard modeling, and risk characterization. Throughout all elements of this work we will directly engage with the hub and its relevant partner agencies through co-development of models and products, integration of services, and stakeholder trainings on new techniques and services developed as part of this work. The ultimate objectives of this work will be to build regional knowledge, tools and services that can add significant value in supporting disaster response, recovery, mitigation and resilience from daily to decadal time scales across the SERVIR-Mekong region.

Hyongki Lee/University of Houston
Operational Services For Water, Disaster and Hydropower Applications for Lower Mekong Populations Using NASA Earth Observations and Models
18-SERVIR18_2-0006

PROGRESS OF PREVIOUS SERVIR-2 PROJECT: This proposal builds on a SERVIR project (2016 – 2019) being led by PI Lee titled "Building Lasting Capacity for Water Management in Vulnerable Deltas of Indochina" which has already made significant progress in developing real-world tools for SERVIR-Mekong, reaching high ARLs. These are: (1) Operational virtual gauging system using Jason-2/3 altimetry adopted by SERVIR-Mekong (https://vrsg-servir.adpc.net/, select "Virtual Stream Gauge") for regional Mekong applications and SERVIR SCO (https://tethys.servirglobal.net/apps/altex/) for global applications; (2) Hydrologic model (VIC)-aided altimetry-based daily river level forecasting system for Mekong River, particularly suited for downstream regions of the Tonle Sap Lake in Cambodia and Mekong Delta in Vietnam (Chang et al., 2019); (3) Operational seasonal (up to 6 months) forecast of stream flow based on North American Multi-model Ensemble (NMME) Global Climate Model (GCM) outputs with SWAT hydrologic model (http://depts.washington.edu/saswe/datavis_Timeseries.html, select "Seasonal Forecast"); (4) Operational stream flow nowcast and forecast (15-day) for Mekong mainstem (up to Kampong Cham) using VIC hydrologic model and NOAA Global Forecasting System (GFS) Numerical Weather Prediction (NWP) forcings (http://depts.washington.edu/saswe/datavis_Timeseries.html, select "Mekong") (Sikder & Hossain, 2018); (5) Operational dam monitoring and outflow prediction system (http://forecasting.vaci.org.vn) now in service with NAWAPI of Vietnam (Hossain et al., 2019). Our previous capacity building efforts have revealed that a win-win strategy can be taken for both of the scientific research and end user communities, so that the SERVIR motto "Space to Village" can be expanded to "Space (supply) to Village (demand & supply), then back to Space (demand)".

PROJECT OBJECTIVES: We propose to continue building new and improved services to be co-developed with SERVIR-Mekong hub based on identified stakeholders' urgent and real needs in order to provide missing pieces of information on the real-time availability of water for entire Lower Mekong and its inhabitants. These are: (1) Operational VIC-altimetry-based flood forecasting system using Jason-3 & Sentinel-3

altimetry and Surface Water and Ocean Topography (SWOT) data at sub-daily scale with NOAA GFS precipitation forecast for Mekong River including the Mekong Delta (stakeholders: NCHMF of Vietnam and MOWRAM of Cambodia); (2) Operational real-time reservoir monitoring system for all dams in Mekong Basin using satellite precipitation (GPM), reservoir storage derived from optical (Landsat, MODIS, Sentinel-2), Synthetic Aperture Radar (SAR) (Sentinel-1, ALOS-2, NASA-ISRO SAR: NISAR) and SWOT data, and VIC-derived inflow (stakeholders: DHM of Lao PDR, NAWAPI of Vietnam, MOWRAM of Cambodia); (3) Operational land subsidence monitoring system over the deltas and their major coastal cities using persistent scatterer interferometric SAR (PSInSAR) and multi-baseline PSInSAR (MB-PSInSAR) techniques with SAR images from Sentinel-1, ALOS-2, and NISAR missions (stakeholder: VIGMR of Vietnam); (4) Operational reservoir operations using NOAA GFS precipitation forecast to maximize hydropower and flood control by synthesizing (1), (2) and turbine data (stakeholders: Lao PDR and MOWRAM of Cambodia);

In all cases, we will use our built platform of webs, cloud services, and mobile phone apps for various applications, and contextualize them for Lower Mekong inhabitants via SERVIR-Mekong Hub, following the success story of the irrigation advisory service via cellphones for hundreds of thousands of farmers in Pakistan (https://earthobservatory.nasa.gov/images/92903/smart-phones-bring-smart-irrigation). Each of our proposed tools (or services) will be running in SERVIR-Mekong infrastructure as back up and will be converted into services for stakeholder agencies or individuals.

Franz Meyer/University of Alaska, Fairbanks
A Cloud Computing Toolbox for SAR-Based Monitoring of the Hydrologic Cycle in the SERVIR Hindu-Kush Himalayan Region
18-SERVIR18_2-0092

We propose to develop the cloud-based SAR data processing and analysis service "HydroSAR," capable of deriving hydrology-related Analysis Ready Products (ARDs) from time series of Synthetic Aperture Radar (SAR) data, ready for use by partners in the HKH region. The toolbox will be able to ingest multi-platform SAR imagery from the medium-resolution, free-and-open Sentinel-1 and NISAR sensors. Beyond these publicly available SAR data, the service will also support integration of other end user-owned SAR data collections, such as potentially available archives of the high-resolution TerraSAR-X, and TanDEM-X sensors. SAR data will be augmented with other remote sensing and non-remote sensing layers such as DEMs, watershed information, and land cover maps, to improve the robustness and accuracy of project-derived hydrology products.

As part of this project, we will transition the developed tools to the SERVIR Hindu Kush Himalaya (HKH) Hub to support their needs to monitor sub-seasonal and annual variability of hydrology in the flood-affected countries of the HKH region. We will also build resilience to these disasters by helping decision-makers in the SERVIR-HKH

region to monitor and assess the impacts of flood events on local population and agriculture.

We will develop an end-user training and engagement plan to train in-region partners in the installation and use of newly developed tools and support their efforts to integrate SAR-derived products with existing data streams.

While our work will be focused on the needs of the SERVIR-HKH region, the cloud-based implementation of our data analysis tools combined with targeted engagement and outreach activities will make the developed services extensible to other partners within the SERVIR network.

Douglas Morton/Goddard Space Flight Center
Forecasting Seasonal to Sub-Seasonal Fire and Agricultural Risk from Drought in Amazonia
18-SERVIR18_2-0038

Changes in the timing and distribution of rainfall across the Amazon region impact both human and natural systems. Water deficits disconnect river transportation networks and endanger agricultural production, spurring additional deforestation for road construction and larger farms. Drought conditions also increase the risk of large and destructive wildfires that threaten forest carbon stocks, biodiversity, and other ecosystem services. Amazon droughts are known to be triggered by exceptionally warm sea surface temperatures in the tropical Atlantic and Pacific Oceans, and these large-scale climate modes lead to predictable patterns of rainfall redistribution and changing fire risk across the basin. In previous research, our team has leveraged this understanding of the Earth system to develop seasonal forecasts of fire season severity for regions in Brazil, Bolivia, and Peru. Based on the late onset of El Niño conditions in 2018, our model predicts elevated fire risk for the 2019 fire season across southern Amazon regions in Peru, Bolivia, and the Brazilian States of Amazonas, Acre, and Rondônia.

Here, we propose three applied science tasks to adapt and implement seasonal forecasting tools in partnership with scientists and stakeholders at the SERVIR-Amazonia hub. First, we propose to expand the scope of the existing seasonal fire forecasting tool to include the entire SERVIR-Amazonia hub domain and tailor the sub-national forecast regions to best address decision-making needs. Second, we propose to develop regional fire products using VIIRS, Landsat-8, and Sentinel-2 data to better identify small fires for agricultural management and understory forest fires—low intensity fire types that are often missed by global algorithms. These data products will directly improve the ability to evaluate seasonal and sub-seasonal fire risk across the region, characterize the spatial pattern of fire regimes across both managed and natural landscapes, and quantify negative impacts of fires on ecosystem services. Third, we propose to adapt the fire forecasting tool to predict changes in dry season metrics (onset, duration, severity, and termination). The overarching goal of these tasks is to provide timely and targeted information to mitigate negative consequences of drought conditions on Amazon forests

and agriculture. The high ARL of the proposed seasonal fire forecasts and fire products increases the likelihood of success under the project lifetime. Together, these proposed efforts target three topic areas in the A.35 solicitation: Land cover and Land Use Change and Ecosystems; Weather and Climate; and Agriculture and Food Security.

Our team is uniquely qualified to transition existing methods to the SERVIR-Amazonia hub for operational use, building on nearly two decades of experience using field, airborne and satellite remote sensing, and models to assess drought impacts on Amazon forests, carbon losses from deforestation and forest degradation, and drivers and consequences of agricultural expansion in the Amazon region. In partnership with our hub contacts, we have engaged partners in Brazil, Peru, and Colombia to assess specific needs for fire and drought forecasting in these countries. Our proposed work will complement and extend ongoing efforts in the region for early warning, situational awareness, and allocation of limited resources for drought and fire responses to conserve biodiversity and maintain ecosystem services.

Catherine Nakalembe/University of Maryland, College Park
Earth Observation for National Agricultural Monitoring
18-SERVIR18_2-0055

Recent catastrophic droughts in East and Southern Africa (E&SA) have led to major food shortages. Recent consecutive drought years left millions in the region struggling to cope with the impacts. The food-insecure population in E&SA continues to grow at unprecedented rates was estimated at 23 Million in 2017. Satellite data availability, rapid developments in cloud computing and big data analytics are revolutionizing the remote sensing field and opening new opportunities to realize the value of satellite data in providing accurate, reliable and timely crop-specific information across cropping systems. Earth Observations (EO) data can improve measurement of agricultural productivity supporting efforts to evaluate and target interventions to enhance agricultural productivity and improve food security. Despite this, governments in E&SA remain poorly positioned to use the readily and freely-available EO data to make timely, necessary and informed decisions concerning food security although their desire to do so is strong.

The main objective of this proposal is to advance national agriculture monitoring with EO data in E&SA, through development of up to date semi-automated baseline datasets required for more accurate agriculture monitoring and strengthen the capacity of the SERVIR E&SA-Hub to implement and support scaling up methodologies to other use-cases, including operational national crop monitors, disaster risk, and insurance programs.

To identify opportunities for advancements and improvements that can be made with EO data, our first priority (Task 1) will be to document the status of existing national agricultural monitoring systems and develop a generic framework for EO-based systems that can be adapted to an individual country's context and at the regional scale. We will

advance the use satellite imagery for cropland and crop type mapping (Task 2) by combining very high-resolution Planet Dove data with Landsat and Sentinel 2 data, focusing on major crops, with the ultimate goal of producing in-season cropland maps that can be implemented operationally for national agriculture monitoring. Task 2B and 2C will focus on modeling yield using coarse resolution data sets. Task 3 responds to a critical need to fast-track early warning by integrating triggering email alerts when satellite-based indices hit set thresholds within regions of interest. This will increase the responsiveness of current and upcoming programs enabling early action since the alerts would trigger an immediate assessment. Task 4 will focus on addressing the need for field-data by establishing GEOGLAM Joint Experiment for Crop Assessment and Monitoring (JECAM) site(s). These sites will not only guarantee high-quality training data need for Task 2, but they also double as a means for the development of best practices for field data collection in mixed/ smallholder systems found in E&SA.

A cornerstone of our proposed project is co-development with our end-users starting with RCMRD and national partners. Major efforts will be put into the capacity building at RCMRD with the ultimate goal of building sustained national capacity. All processing code will be delivered to the project partners and iterated during several rounds of training. We will use open-source software for delivering processing data and processing chains will be transferred RCMRD and will leverage where possible existing tools and capacities, such as the Early Warning eXplore (EWX) system.

The proposed work will increase national analysts' knowledge and skills to use EO data for monitoring and reporting and improve yield indicators needed for informed responses to shortfalls in food production and contribute to data-driven decision-making. The data products will increase objectivity in decision making and reduce the burden of implementing and managing risk insurance programs. Better and timely decisions at the national level will inevitably impact farmers livelihoods.

Jim Nelson/Brigham Young University
Improving Resiliency and Reducing Risk of Extreme Hydrologic Events through Application of Earth Observations and In Situ Monitoring Information
18-SERVIR18_2-0028

The Amazon Basin is a critical component of the global climate system. In recent years extreme hydrologic events such as floods and droughts have intensified and wreaked havoc on the communities and environments of the world's largest river basin. Our proposal brings together well-established and newly developed free and open sources web tools to empower key stakeholders in the region to co-develop actionable water resources information. Ultimately, the project aims to support water security that provides adequate water quantity for livelihoods, ecosystems, and production while maintaining acceptable water-related risks to people, environments, and economies. This information enables decision-making that supports flood early warning and disaster risk reduction, as well as enhanced management for drinking water supply, improved

sanitation and wastewater, reliable energy security, drought planning and response, climate change resilience, environmental restoration and more.

We have several years of experience working in the region. Our diverse team members are fluent in Spanish and familiar with water resources management in the region. We have previously worked with several important stakeholders including Colombia's Instituto de Hidrología, Meteorología y Estudios Ambiantales (IDEAM), Peru's Servicio Nacional de Meteorología e Hydrología (SENAMHI), and Brazil's disaster management agency Centro Nacional de Monitoramento e Alertas de Desastres Naturais (CEMADEN). This experience will allow us to quickly launch project efforts to co-design/develop services together with our hub partners. Our approach will emphasize services that are meaningful and useful to stakeholders, leading to greater long-term sustainability and impact.

We will contribute not only our own scientific expertise in flood impact analysis, but are also prepared to contribute to the extended Hub network and SERVIR thematic teams by developing geospatial decision-making web apps using the free and open-source software Tethys Platform. Our Applied Sciences Team (AST) proposal has three specific objectives:

1. Provide a range of Earth observation data assets and hydroinformatics tools as service-oriented web apps to aid water resources management. We have worked on applications that deliver visualization and data services for NASA and other Earth observation information. These new and existing tools within SERVIR can form a robust base from which new and targeted services for SERVIR-Amazonia stakeholders can be co-developed.
2. Create the ability to forecast flood inundation and impact maps from our global streamflow forecasting service and use satellite and social media data for validation and enhanced information products. We bring expertise in hydrologic modeling, visualization, and use of social media for data mining and dissemination of information.
3. Help integrate other models and data from the Applied Science Team (AST) members, hub, and stakeholders, co-developing these as part of the SERVIR Amazonia Hub. We anticipate that tools can be shared across thematic and hub teams to benefit this project as well as enhance the efforts of other AST, SERVIR, and hub projects. These tools will not only be used to deliver our scientific contributions in flood impact mapping but are also useful in bringing existing SERVIR tools to the Amazonia hub. They will provide a collaborative environment around which the hub and thematic teams can build to deliver better solutions to stakeholders.

We have have worked closely with our Amazonia Hub team partners to develop the proposal and ensure that it fits within their theory of change service planning. Our efforts align with the expertise and experience of the team members there so that they will be fully integrated into our project. We have previous AST experience and are willing to blend and share our skills, interests, tools, and data for the good of the team so that maximum results and benefits are achieved.

Pontus Olofsson/Boston University

Supporting Continuous Monitoring and Sample-Based Estimation of Land Change and Forest Degradation in West Africa

18-SERVIR18_2-0004

Forest degradation and deforestation in West Africa are widespread and the lack of information about the extent, magnitude and rate has contributed to inadequate development planning, and an inability of decision-makers and society to curb and mitigate the associated negative effects on land and people. A lack of access to the techniques and data required for production of comparable area estimates combined with a lack of consistent land classification systems prevent the generation of information on land dynamics required by decision-makers to arrive at effective decisions. For example, effective land monitoring and unbiased estimation of area are mandatory when reporting within international frameworks such as REDD+ but being able to compare estimates in space and time is a necessity also for the local decision-maker. Of importance to the lack of access to more advanced monitoring and estimation techniques are algorithm complexity and demands on data processing and storage – with the emergence of computing platforms such as Google Earth Engine, we are now at a position where we can alleviate such obstacles by providing direct access to the science and technology required for addressing the environmental challenges in the region. With this proposal, we aim to provide to a set of countries in West Africa the capacity for landscape monitoring based on the analysis of time series of Landsat observations, comprehensive support for sample-based estimation of map accuracy and area of land cover and land change in Google Earth Engine. Both the PI, Co-I, and collaborators have a proven record of capacity building in tropical countries; collaboration and coordination with SilvaCarbon, GOFC GOLD, and the AST for SERVIR's Eastern and Southern Africa hub will increase the likelihood of proposed effort having societal impact.

Naiara Pinto/Jet Propulsion Laboratory
Unlocking the Power of Active Remote Sensing for Ecosystem Services Modeling in the Amazon's Forest-Agriculture Interface
18-SERVIR18_2-0082

We propose to co-develop and implement an open-source land use planning decision support system with the SERVIR-Amazonia Hub in support of the Land Cover and Land Use Change and Ecosystems thematic service area. Active remote sensing is critical for characterizing high cloud cover / high biomass tropical ecosystems such as the Amazon. Despite of that, Synthetic Aperture Radar (SAR) and lidar products are still vastly underutilized by Latin American governments. Our collaborative framework will prepare Latin American researchers and decision makers for leveraging the high volume of free imagery produced by two NASA missions launching in the near future: NISAR and GEDI.

The stakeholders are farmers enrolled in sustainable landscapes initiatives as well as decision makers in NGOs and government that support sustainable agriculture practices. We plan to leverage subnational initiatives in Ucayali - Peru, Caquetá - Colombia, and Pará - Brazil.

Through addressing the objectives below, we will build on collaborations with local communities and monitoring agencies, producing lessons and workflows that can be adapted to other Amazonian sites.

- Objective 1: Build capability of established monitoring platforms, expanding land cover maps by 3X by identifying oil palm / cacao plantations and secondary forests.
- Objective 2: Develop a prototype tool that utilizes plantation maps to assess compliance by farmers enrolled in Zero Deforestation Supply Chain initiatives.
- Objective 3: Transfer knowledge and technology to end-users and catalyze the incorporation of SAR and Lidar observations to address locally-relevant questions.

Peter Potapov/University of Maryland, College Park
Supporting Operational Regional Land Cover Monitoring at High Spatial and Temporal Resolution for the Hindu-Kush-Himalayan Region
18-SERVIR18_2-0058

Spatially explicit information on land-cover and land-use extent and change is required to achieve long-term sustainable development goals. This information is especially important for the Hindu-Kush-Himalayan region where the fragile and unique mountain ecosystems are affected by rapid population increase and economic development. Satellite earth observations provide the only practical way for operational land-cover monitoring at regional and national scales. The SERVIR-HKH hub at the International Centre for Integrated Mountain Development (ICIMOD) is developing a comprehensive Regional Land Cover Monitoring System (RLCMS) that provides critically important, timely, analysis-ready information for land management, forest monitoring, and crop area analysis. Our research team proposes to support this activity by enhancing SERVIR-HKH hub capacity for regional annual land cover monitoring. The project objective is to develop and operationally implement a set of Landsat-based regionally consistent annual characterization models to map a set of biophysical thematic layers ("primitives") required for the RLCMS. We will also perform product validation and support SERVIR training activities to promote the use of the RLCMS data for national monitoring applications. Thematic layers integrated within RLCMS and provided publicly as online services will greatly benefit the ultimate goal of the SERVIR program by providing geospatial data for the national decision-making process and strengthening the capacity of government agencies to improve environmental management and resilience in the HKH region.

Shraddhanand Shukla/University of California, Santa Barbara
Connecting West Africa Users to Cutting Edge Resources: Integrating Satellite Observations and Sub-Seasonal Climate Forecasts to Enhance Agricultural and Pastoral Water-Management Decision-Making Using 21st Century Agro-Pastoral Water Deficit Predictions
18-SERVIR18_2-0089

Here, we aim to improve West African climate information services by co-developing a 21st century Agro-pastoral Water Deficit Prediction System (21cAWDPS), with SERVIR's West Africa hub AGriculture HYdrology and METeorology (AGRHYMET) and the African Centre of Meteorological Application for Development (ACMAD). Specifically, the proposed work seeks to improve: 1. agricultural and rangeland productivity, 2. agro-pastoral water usage, 3. transhumant movement management in West Africa. This goal will be achieved by modernizing the existing agro-pastoral WD monitoring system using state-of-the-art, publicly available NASA satellite observations, and then integrating them with sub-seasonal climate forecasts from NASA's GEOS model and other North American Multimodel Ensemble (NMME) SubX models. The climate update and expected impacts on agriculture and rangeland, and agro-pastoral water will be communicated through bi-weekly bulletins in French and English, and forecast data will be provided through SERVIR's cloud based platforms. In so doing this work directly address the primary 'Weather and Climate' thematic area need, "to link in sub-seasonal to seasonal forecasts for improved water and agricultural productivity."

The proposed work will build upon past NASA and SERVIR supported projects and will empower climate services by AGRHYMET, ACMAD and their partners. Specific decisions that the proposed effort targets are related to type and timing of crop planting, food storage and trade, food insecurity relief efforts, farmers and pasture livelihood, and pastoralists and heard movements. Climate-informed and seamless and regular availability of the forecasts of agriculture, rangeland, and water productivity will help the decision makers (e.g. regional and international agencies, and national governments) plan to mitigate adverse impacts of climate variability and change in planning for the aforementioned decisions. In the long-term, the integration of sub-seasonal climate forecasts with those decisions will improve West Africa's resilience and will better equip it for climate adaptation.

The proposed work is highly relevant to the goals of NASA's Strategic Plan, NASA Earth Science's goals, and SERVIR's overarching goal. The primary goal of this proposed work is to improve agricultural and rangeland productivity, and agro-pastoral water and transhuman movement management in West Africa by facilitating the integration of sub-seasonal scale climate forecasts in the decision-making process. In doing so, the proposed work addresses one of the primary objectives of the NASA decadal survey (2017), which is "Reducing Climate Uncertainty and Informing Societal Response." This proposal also directly addresses one of the science goals of the NASA Earth System Science to "Further the use of Earth system science research to inform decisions and provide benefits to society."

The proposal team is comprised of early to mid-career researchers with extensive experience in supporting applied decision making in Africa (and in CONUS) by integrating satellite and forecast information. The team has ability to leverage ongoing support from USAID and the USGS to provide committed staff hosted at AGRHYMET (Dr. Alkhalil Adoum) and extensive science computing facilities provided by the Climate Hazards Center. The team overall also has intermediate-high french language fluency. A

GSR (Blakely) and co-PI (Dr. Grace) are fluent in french, two PIs proficient in french (Dr. Funk and Shukla) and collaborator Dr. Adoum is a native french speaker.

Stephanie Spera/University of Richmond
Quantifying the Effects of Forest Cover Changes on Provisioning and Regulating Ecosystem Services in the Southwestern Amazon
18-SERVIR18_2-0098

The Amazon rainforest provides ecosystem services to 33 million people, including 1.5 million Indigenous people from 385 different groups, living within the biome boundary. Here, we build off the outcomes of two workshops in the central borderlands of Peru and Brazil in 2013 and 2014, and address perceived changes in streamflow, soil moisture, air temperature, and humidity as a result of changes in forest cover. The goals of this research are to understand how forest degradation, deforestation, and road building affect the ecosystem services provided by the hydrologic cycle in the Southwestern Amazon and to develop data and tools to improve water management in the region. We propose to 1) characterize changes in forest cover using remotely-sensed data and fieldwork; 2) attribute these changes in forest cover to localized changes in evapotranspiration (ET), soil moisture, humidity, and surface temperature; 3) determine the effect-radius of these changes in forest cover (how far away these changes are felt); 4) generate maps that highlight areas that have undergone changes in microclimatology and land-use; 5) create a statistics-based tool that will allow users to analyze tradeoffs between land cover change and ecosystem services through scenarios modelling; and 6) disseminate this information through trainings, fieldwork, and workshops with partner communities and universities. The proposed research involves three complementary analyses: a characterization and quantification of changes in forest cover and transportation infrastructure across Ucayali, Peru and Acre, Brazil using remotely sensed data and field campaigns; an analysis of the effects and scale of the effects of these changes in land-cover on ET, soil moisture, surface temperature, and humidity through remotely sensed data, field campaigns, and spatial statistical analyses; and mapping of the most affected and vulnerable regions to forest degradation and a modeling of the biophysical consequences of planned new infrastructure and forest clearing through spatial statistical analyses. Through this collaborative research, we will increase capacity building with local indigenous and non-indigenous groups, as well as colleagues at CIAT and SERVIR Amazonia-Hub partner institutions such as ACCA-MAAP, and colleagues and students with our current partners at the Upper Amazon Conservancy, Universidade Federal do Acre-Floresta and Universidad Nacional de Ucayali. Updated maps of transportation infrastructure, forest cover change, and the disturbance of ecosystem services (temperature, ET, precipitation, and soil moisture) will be useful to locals and planners, particularly if the state and federal governments remain committed to infrastructure expansion. These maps can also provide a baseline for future climate modelling analyses on feedbacks between forest disturbance and regional climate. Moreover, involving locals will allow indigenous and non-indigenous groups to participate in the creation of knowledge in the region, and performing these analyses with partners will increase capacity building by strengthening relationships between international and intranational

institutions. The creation of a tool based on established statistical-relationships will allow local and regional partners and planners to assess tradeoffs between various land-use scenarios and ecosystem services, and the spatial scale at which these tradeoffs are felt. In focusing on regional land cover monitoring, forest vulnerability, and outcomes that address integrated development planning and ecosystem services, particularly those associated with the hydrologic cycle, the proposed research directly addresses the “Land Cover and Land Use Change and Ecosystems” overall and SERVIR-Amazonia thematic elements.

Evan Thomas/University of Colorado, Boulder
In-Situ Data Collection with Remote Sensing for Machine Learning Parameter Estimates and Improved Hydrologic Models for Flood, Drought and Agricultural Yield Forecasting - SERVIR Applied Science Team Step 2 Proposal - University of Colorado Boulder
18-SERVIR18_2-0003

Objectives

We propose partnering with the SERVIR - Eastern and Southern Africa Hub, hosted by the Regional Centre for Mapping of Resources for Development (RCMRD), to link in-situ data collection tools managed by our team and deployed in East Africa that are currently measuring local rainfall, temperature, groundwater use, and land properties, with remote sensing data sets to develop machine learning supported interpolated data products for localized rainfall, localized temperature, localized groundwater use, forecast groundwater demand, and localized land properties.

We will use these localized rainfall, temperature, groundwater use and demand forecast, and land properties data products to generate new and improved data services. Specifically, we propose developing a new SERVIR ESA service for ""Groundwater Use and Demand Forecast"" and we will support existing services. Our data products will be further used to calibrate and correct several hydrologic models including 1 - The SERVIR supported Regional Hydrologic Extremes Assessment System (RHEAS), 2 - The SERVIR supported Coupled Routing and Excess Storage (CREST) hydrological tool; and 3 - the Noah Land Surface Model with Multi-Parameterization (Noah-MP) used by FEWS NET for hydrologic estimates. Our proposal is aligned with the SERVIR thematic area Water Resources and Hydroclimatic Disasters.

We will disseminate our products to the Kenya National Drought Management Authority, the Ethiopia Ministry of Water, Irrigation and Energy, the Intergovernmental Authority on Development Climate Prediction and Applications Center, and regional government partners.

Methods

We propose leveraging several in-situ data sets that our team have developed. Our three in-situ data sets include: 1 - A network of groundwater extraction sensors connected to daily satellite reporting deployed across Kenya and Ethiopia (the SweetSense network); 2 - the Trans-African HydroMeteorological Observatory (TAHMO) weather station network; and 3 - the LandPKS smartphone-based land properties surveys. Together, these tools provide in-situ data on groundwater use and demand, rainfall, temperature, soil types and land cover.

We propose employing machine learning based interpretation of our in-situ data to generate several estimates for site-wise rainfall, temperature, groundwater use and demand, and land properties. We will fuse these local parameter estimates with remotely sensed data using several interpolation methods to generate regional scale gridded data products for rainfall, groundwater use and demand, and land properties. Using these machine learning supported parameter estimates, we will then apply interpolation methods to fuse these parameters with remotely sensed data, thereby generating regional scale data layers capable of predicting localized rainfall, temperature, groundwater use and demand, and land properties.

Our in-situ data and improved data products for localized rainfall, temperature, groundwater, use and demand forecasting and land proprieties will be integrated with existing SERVIR ESA services, and a new proposed Groundwater Use and Demand Forecast Service.

Significance

Millions of people living in the arid, drought prone regions of east Africa are facing significant threat from a lack of safe, reliable and affordable water. The region has experienced increasing frequency and severity of drought conditions. Our proposed SERVIR AST work seeks to develop and support data services that can increase regional resilience through improved management of surface and groundwater, and land use planning. Our theory of change posits that improved localized monitoring of groundwater use and demand can be coupled with a strengthened and informed network of organizations and communities to collectively improve resilience. Our groundwater use and demand forecast service can assist in the the management of groundwater resources and improve regional scale drought resilience.