DEVELOP National Program

Disasters Project Proposals

Summer 2015

Proposals Snapshot

Landslides

1. Himalaya Disasters II: Expanding Upon Landslide Identification Product and Hazard Assessment Model Capabilities for Enhanced Landslide Detection in the Koshi River Basin (Goddard)
Objective: Three complementary activities to better characterize landslide hazards within the Koshi River Basin: 1) Improving global and regional landslide catalogs using a sudden landslide identification product, 2) integrating a dynamic soil moisture or antecedent rainfall product into a landslide hazard assessment model, and 3) develop a regional relationship with ICIMOD to maintain and visualize landslide data and hazard products.

2. East Africa Disasters: Assessing Landslide Characteristics and Developing a Landslide Potential Hazard Map in Rwanda and Uganda Using NASA Earth Observations (Marshall)
Objective: Assess the characteristics of landslide-prone regions of Rwanda and Uganda by using TRMM, GPM, CHIRPS, SRTM2, and other geospatial datasets such as topography, hydrology, land cover, and soils.

Sinkholes

3. Georgia Disasters: Utilizing NASA Earth Observations to Monitor Sinkhole Development and Identify Risk Areas (UGA)
Objective: Develop a sinkhole inventory map to determine environmental risk to human health, infrastructure, and water supply. Specifically, this project will identify and map sinkholes, analyze the factors influencing the development of sinkholes, and produce an accurate hazard map and a groundwater risk map for Dougherty County, Georgia.

Oil Spills & Seeps

4. Alaska Disasters: Utilizing NASA Earth Observations to Identify Oil Seeps Off the Northern Shore of Alaska (Langley)
Objective: Create a procedure to identify oil spills in the Arctic and to identify current oil seeps in Northern Alaska.

Fires

5. Texas Disasters: Utilizing NASA Earth Observations to Assist the Texas Forest Service in Mapping and Analyzing Fuel Loads and Phenology in Texas Grasslands (Stennis)
Objective: Use and produce regional geospatial mapping products from MODIS data to depict locations of potential wildfire fuel types, fuel loads, and vegetation phenology for Texas' vegetation types vulnerable to wildfire, especially during drought years.

6. Indonesia Disasters: Creating an Enhanced Methodology for Mapping Burn Scars in Indonesian Forests Using Landsat (IRI)
Objective: Create a methodology for effectively mapping burn scars in the forests of Indonesia using Landsat by testing a technique of converting Red Green Blue (RGB) colors from Landsat scenes into Hue Saturation Value (HSV) in order to see if it is a more effective procedure for identifying burn scars and to assess carbon emissions and map deforestation in Indonesia.

7. California Disasters II: A New Method for Providing Near-Real-Time Active-Fire and Post-Burn Support to Fire Responders Using Data Products Derived from NASA's Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR) (JPL)
Objective: Explore the viability of UAVSAR-derived polarimetric imagery to provide near-real-time map products to active fire responses as well as post-burn imagery to support fire severity assessments.

8. US Disasters II: Using GRACE-Derived Water and Moisture Products as a Predictive Tool for Fire Response in the Western United States (JPL)
Objective: Analyze correlations between GRACE Data Assimilated Products (GDAPs) surface soil moisture, root zone soil moisture, and groundwater with NDVI values, fuel moisture data, and MODIS-based fire-severity data to establish the potential predictive capability of GDAPs for directing ground-response efforts during fire seasons and fire outbreaks.

9. Southern California Disasters II: Assessing the Effectiveness of Simulated HyspIRI Data for Use in USDA Forest Service Post-Fire Vegetation Assessment and Decision Support (Stennis)
Objective: Utilize simulated HyspIRI data (produced from co-located AVIRIS and MASTER imagery) to produce wildfire burn severity and vegetation monitoring products comparable to existing operational USDA Forest Service products, and quantitatively evaluate simulated HyspIRI derived products to investigate if and how HyspIRI will provide improved capabilities beyond current Landsat-derived products.

10. Idaho Disasters III: Using Landsat Earth Observations to Identify Heightened Fire Susceptible Areas Due to Cheatgrass Invasion (BLM-ISU)
Objective: Explore heightened fire susceptibility by identifying areas of cheatgrass infestation. The results of this study will benefit the broader fire community and extend the data products and technical capabilities of the RECOVER decision support system for use by the Bureau of Land Management and Idaho Department of Lands in southern Idaho.

Flooding
11. Thailand Disasters: Monitoring Risk and Extent of Flood and Drought for Enhanced Decision Making and Resource Allocation (Goddard)
Objective: Improve near real-time flood inundation and drought monitoring techniques for Thailand by leveraging a previously created online flood dashboard and incorporating additional land and weather products into an enhanced agricultural drought severity index for Thailand.

12. Peru Disasters II: Identifying and Mapping Flood Prone Regions in the La Libertad Region of Peru using NASA's Earth Observations (Wise)
Objective: Utilize NASA Earth Observations and mathematical models to produce historic and predictive flood maps for the La Libertad Region in Peru.

13. Malawi Disasters II: Applications of Flood Definitions and NASA Earth Observations to Create a Flood Forecasting Tool Targeting Region-Specific Flood Types (IRI)
Objective: Create an early warning flood detection and prediction product that will target specifically defined flood types using previously developed flood definitions to assess effectiveness and utility to assist in the prediction of the flood events.

14. Southwest US Disasters: Incorporating Atmospheric Teleconnections and CDRs to Create a Predictive Model of Post-Burnout Flood Risk (NCDC)
Objective: Incorporate atmospheric teleconnections to create a statistical model which utilize PERSIANN and NDVI Climate Data Records (CDRs) to predict the risk of post-burnout flooding.

Partners Snapshot

Local Partners

- City of Albany and Dougherty County Planning and Development Services (End-User/Partner, POC: Randy Weathersby, GIS Manager for the City of Albany and member of the Southwest Georgia Water Resources Task Force)

- Southwest Georgia Water Resources Task Force (End-User, POC: Randy Weathersby, GIS Manager for the City of Albany and member of the Southwest Georgia Water Resources Task Force)

State Partners

- California Department of Forestry and Fire Protection (CAL FIRE) (End-User, POC: Jana Luis, Division Chief, Predictive Services)
- Idaho Department of Lands, Boise Field Office (End-User, POCs: Dixie Booker-Lair, GIS Analyst and Robin Dunn, GIS Specialist)
- Texas Forest Service (TFS) (End-User, POC: Tom Spencer, Department Head, Predictive Services & Curt Stripling, Geospatial Systems Coordinator, Predictive Services)

Federal Partners

- Bureau of Land Management, Idaho State Office and Cooperating District Offices (End-User, POCs: Mike Kuyper, Natural Resource Specialist)
- NASA HyspIRI Science Team, JPL (Partner, POC: Dr. Robert Green, Science Lead)
- NASA RECOVER Project (Partner, NASA Goddard POCs: John Schnase, Mark Carroll; Partner/ Boundary Organization, Idaho State University POC: Keith Weber)
- NASA SERVIR Coordination Office at MSFC (Collaborator/Boundary Organization/End-user, POC: Eric Anderson, Research Associate)
- NASA Terrestrial Hydrology Program at Goddard Space Flight Center (Collaborator, POC: Dr. Matt Rodell, Laboratory Chief of Hydrological Sciences)
- SERVIR Applied Sciences Team at NASA GSFC (Collaborator/End-user, POC: Dr. Dalia Kirschbaum, GPM Applications Scientist)
- Tactical Fire Remote Sensing Advisory Committee (TFRSAC) (Collaborator/Boundary Organization, POC: Everett Hinkley, National Remote Sensing Program Manager)
- United States Coast Guard (End user, POC: MST1 Justin Hoffer, CG-MER-1)
- United States Coast Guard Auxiliary University Programs (USCG AUP) (Collaborator/Boundary Organication, POC: Dr. David Kellogg, Internship Coordinator)
- US Forest Service Remote Sensing Activities Center (Boundary Organization, POC: Brad Quayle, Program Leader, Rapid Disturbance Assessment and Services [RDAS] Program)
- USDA Forest Service Eastern Forest Environmental Threat Assessment Center [EFETAC] (End-User, POC: Dr. Steve Norman, Research Ecologist)
- USDA Forest Service ForWarn (Collaborator, POC: William "Bill" Hargrove, Research Ecologist)
- USDA Forest Service Remote Sensing Applications Center (RSAC) (Collaborator/End-User, POC: Brad Quayle, RS/GIS Specialist)
- USDA Forest Service Remote Sensing Applications Center [RSAC] (End-User, POC: Tony Guay, Remote Sensing Specialist)
- USDA Forest Service Rocky Mountain Research Station, Missoula Fire Sciences Laboratory (Partner/Boundary Organization, POC: Dr. Robert Keane, Research Ecologist)

International Partner

- Asian Disaster Preparedness Center / SERVIR Mekong (Collaborator/Boundary Organization, POCs: Pete Cutter, Science & Data Co-Lead & Bill Crosson, Hub Science Coordinator)
- Bogor Agricultural University (IPB) (Partner, POC: Rizaldi Boer, Research Scientist)
- Center for International Forestry Research (CIFOR) (Boundary Organization, POC: Louis Verchot, Research Director, Senior Scientist)
- Instituto Nacional de Defensa Civil del Peru (INDECI) (End-User, POC: Miguel Angel Saldarriaga Jiron , Direccion Desconcentrada de INDECI La Libertad)
- International Centre for Integrated Mountain Development [ICIMOD) (Collaborator, End-user, Boundary Organization. POCs: Basanta Shrestha (Director Strategic Cooperation), Birendra Bajracharya (Regional Programme Manager), Manchiraju Sri Ramachandra

Murthy (Theme Leader for Geospatial Solutions), Deo Raj Gurung (Remote Sensing Specialist), Sebastian Wesselman (Senior Geospatial Capacity Building Specialist)
- National Safety Council of Thailand (End-User, POC: TBD)
- Red Cross / Red Crescent Climate Centre (RCRCCC) (Boundary Organization, POC: Erin Coughlan, Senior Climate Specialist)
- Red Cross: Malawi and Regional Office for southern Africa (End-Users, POC: Hastings Kandaya, Director of Programmes and Development)
- Regional Centre for Mapping of Resources for Development (RCMRD) (Collaborator/End-User, POC: Denis Macharia, SERVIR-Eastern & Southern Africa Disaster Lead)
- Royal Thai Embassy (Collaborator/Boundary Organization, POC: Bunyakiat Raksaphaeng, Office of Science & Technology)
- Thai Department of Disaster Prevention and Mitigation (End-User, POC: TBD)

NGO Partners

- Water for People (Boundary Organization, End-User, POC: Mark Duey, Head of Program Quality, and Francisco Soto, Director for Peru)

Letters of Support

- MSFC Rwanda-Uganda Disasters – Partner – Writer
- SSC Texas Disasters – Partner – Writer
- UGA Georgia Disasters – Partner – Writer

Project Proposals

Landslides

1. Himalaya Disasters II (Goddard)

Expanding Upon Landslide Identification Product and Hazard Assessment Model Capabilities for Enhanced Landslide Detection in the Koshi River Basin

Objective:
The proposed project involves three complementary activities to better characterize landslide hazards within the Koshi River Basin: 1) Improving global and regional landslide catalogs using a sudden landslide identification product, 2) integrating a dynamic soil moisture or antecedent rainfall product into a landslide hazard assessment model, and 3) develop a regional relationship with ICIMOD to maintain and visualize landslide data and hazard products.

Community Concern:
The Koshi River Basin is a hotspot for landslide activity due to its complex topography, monsoon rains, and poor building practices. On average, the region experiences 135 casualties and loses millions of dollars annually due to landslide damages. It is suspected that because landslides are the outcome of other natural disasters, such as floods and earthquakes, their impacts are responsible for greater loss than currently recognized due to under-reporting of event details. With current underestimation of landslide impacts and the increasing trend in frequency and intensity of landslide events due to anthropogenic factors, it is critical to develop a landslide hazard assessment model that has the ability to accurately quantify hazard and has the capability to serve as a decision support tool for end-users.

End-Users/Partners/Boundary Organizations:
International Centre for Integrated Mountain Development [ICIMOD) (Collaborator, End-user, Boundary Organization. POCs: Basanta Shrestha (Director Strategic Cooperation), Birendra Bajracharya (Regional Programme Manager), Manchiraju Sri Ramachandra Murthy (Theme Leader for Geospatial Solutions), Deo Raj Gurung (Remote Sensing Specialist), Sebastian Wesselman (Senior Geospatial Capacity Building Specialist)

This project works with ICIMOD to develop landslide hazard detection, monitoring and reporting systems and products for their end users. Science advisor, Dr. Dalia Kirschbaum, is already in close contact with ICIMOD, and they will be close collaborators in guiding the product and tool development to ensure regional end user requirements are met. For the summer term, a team of DEVELOP participants at ICIMOD will also participate in the project.

A quote from a recent e-mail from Deo Raj at ICIMOD encapsulates the interest of the end user group and how this project will engage with ICIMOD for the proposed DEVELOP work:

December 4th, 2014
"We at ICIMOD are also gearing towards initiating landslide related activities (landslide mapping, hazard/risk assessment and EWS) there is synergy between what you have indicated and what we are planning. We can provide the team with local perspective, data, and help validate the output and test system performance, in addition to help interface with national agencies."

Decision Making Process:
While there has been published research in Nepal on landslides and landslide hazards, there is currently not a regionally consistent system to integrate data, easily visualize information and share this information through a social networking and crowd sourced environment on

landslides. Leveraging research and capabilities that have already been developed through funded NASA ROSES work, the proposed DEVELOP project will expand the capabilities of the current landslide hazard system to provide the Koshi River Commission and other end users within the area access to landslide hazard assessment and remote sensing information that they can then use to improve situational awareness for these hazards and improve disaster response.

Earth Observations:

Platform	Sensor	Geophysical Parameter
MODIS	Aqua and Terra	Land cover and vegetation products
Landsat 5, 7, 8	TM, ETM+, OLI	Visible detection of landslide scars
TRMM	TMPA (TRMM Multi-satellite Precipitation Analysis)	Rainfall information
GPM	IMERG (multi-satellite precipitation analysis)	Rainfall
Shuttle	SRTM	Topography
Terra	ASTER	Topography

NASA Earth Observations to be Highlighted:
This model features TRMM and (soon) GPM data as well as uses SRTM, ASTER, MODIS, Landsat and other remote sensing sources to build the landslide hazard model. Dr. Dalia Kirschbaum is also working with DEVELOP Science Lead Dr. John Bolten on his soil moisture data product which hopefully will be used for improved assessment of antecedent soil moisture conditions. Given the delayed launch of SMAP, the team will not plan to integrate SMAP estimates within the DEVELOP project.

Ancillary Datasets:
SEDAC Socio-economic variables CIESIN – provides socio-economic indicator datasets
ICIMOD Landslide Dataset 1992-2010 – provides regional landslide data
ICIMOD Lithology Dataset- supplies regional geological information
USGS Landscan 2011- offers accurate global population information
USGS HydroSHEDS- provides river feature data
OpenStreetMap – presents updated and accurate road records
ISRIC SoilGrids 1km – supplies global soil property information at 1-kilometer resolution

Models:
Landslide Hazard Assessment System (POC: Dalia Kirschbaum (NASA GSFC))

Decision Support & Analyses:

Proposed End Products	Decision Impacting	Current Partner Tool/Method
Global Landslide Inventory	Identification of landslides using remote sensing imagery allows for a more accurate landslide database and hazard model calibration	Online landslide editor, global landslide catalog
Regional Landslide Hazard Assessment System	Estimation of potential landslide activity in near real-time provides end-users with a landslide hazard identification system	Landslide Hazard Assessment for Situational Awareness (LHASA)
Landslide Susceptibility Map	Use socio-economic, geographic, and infrastructure data to predict landslide hazards	Regional and local emergency response, government or decision making personnel

Real-time Generation of Landslide "Alerts" Based on Landslide Hazard Model	Real-time information to ICIMOD and other identified end user groups for situational awareness of current landslide potential conditions	MMADS system within Himalayas, focusing on Nepal

Global Landslide Inventory – Expansion of the Global Landslide Catalog with the objective of providing a global view of landslide hazards. This catalog will also be supplemented with landslides identified by remote sensing imagery from the Landsat mission.

Regional Landslide Hazard Assessment System – The regional landslide model produced by Dr. Dalia Kirschbaum and her team will be evaluated for the Koshi River Basin. Together with ICIMOD, the proposed work will develop complementary products and databases to the landslide hazard model with direct guidance from end users. Dr. Dalia Kirschbaum has a NASA ROSES funded project through SERVIR to conduct a feasibility study of the SERVIR-Himalaya node for potential transfer of the landslide hazard model to this area. The proposed project builds off of this research to develop new tools and products for the Koshi River Basin.

Landslide Susceptibility Map – The model will be using socio-economic, geographic, and infrastructure data to predict landslide hazards for the region. It will build upon the landslide susceptibility map created during the first term. A logistic regression model will be implemented and evaluated. Partners at ICIMOD will aid in validation and usefulness of products.

Project Details:
National Application Area Addressed: Disasters
Source of Project Idea: This work is supported by the SERVIR Science Team and builds on previous research in this field, particularly from science advisor Dr. Kirschbaum.

Advisor: Dalia Kirschbaum, NASA GSFC
# of Participants Requested: 3

Project Timeline: 3 Terms: 2015 Spring to 2015 Fall
Study Location: Nepal
Period being Studied: Retrospective analysis and Near Real-Time

Multi-Term Objectives:
- **Term 1** – The first term involved data acquisition, processing and image analysis of landslide information. There was already a wealth of potential landslide data in Nepal available through publications and via ICIMOD. Students worked to update landslide events within the landslide editor framework that was recently launched, as well as to develop a methodology for image analysis of landslides using remote sensing data. Students also transitioned the landslide hazard assessment model to the Koshi River Basin and enhanced its capabilities. The team worked very closely with ICIMOD personnel to define the key products of interest to ICIMOD and its end users. By the end of the term, the team used the landslide inventory information obtained from their research to develop and test a susceptibility map for the region.
- **Term 2 (Proposed Term)** – The second term will focus on fully implementing and evaluating the Himalayan node hazard assessment model. Using the inventory developed in the first term, the DEVELOP team will create a set of landslide vulnerability indicators to better represent the impact of landslides in Nepal. The team will work to port products developed in the first term into this system and develop tutorials and documentation for end users of this material.

- **Term 3 –** If awarded, students during this term would take the landslide system, which will be routinely run at ICIMOD and determine how to create landslide "alerts" for the landslide hazard system. Using the alert concept, they will develop a crowd-sourcing tool to validate the alerts made as well as improve the landslide event reporting method. A mobile app code base has already been developed as an off shoot of the funded work, but more work is needed to make this a functioning application. The app development is contingent on the expertise of the students.

2. East Africa Disasters (Marshall)

Assessing Landslide Characteristics and Developing a Landslide Potential Hazard Map in Rwanda and Uganda Using NASA Earth Observations

Objective:

The objective of this project is to assess the characteristics of landslide-prone regions of Rwanda and Uganda by using Tropical Rainfall Measuring Mission (TRMM), Global Precipitation Measurement (GPM), Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS), SRTM2, and other geospatial datasets such as topography, hydrology, land cover, and soils.

Community Concern:

For disaster risk management to be effective, certain information is required such as hazard identification, structural vulnerability, and risk assessment. Rwandan and Ugandan officials face challenges in disaster risk management due to lack of spatial and temporal information. Documenting known landslides and determining landslide-prone areas is are important components for effective disaster risk management. The Regional Centre for Mapping of Resources for Development (RCMRD) – in partnership with SERVIR – is assisting the Rwandan government in the development of disaster information.

End-Users/Partners/Boundary Organizations:

NASA SERVIR Coordination Office at MSFC (Collaborator/Boundary Organization/End-user, POC: Eric Anderson, Research Associate)
SERVIR Applied Sciences Team at NASA GSFC (Collaborator/End-user, POC: Dr. Dalia Kirschbaum, GPM Applications Scientist)
Regional Centre for Mapping of Resources for Development (RCMRD) (Collaborator/End-User, POC: Denis Macharia, SERVIR-Eastern & Southern Africa Disaster Lead)

RCMRD is an international organization that promotes sustainable development by utilizing Geo-Information products. Their mission is to solve natural resource and environmental management problems. Contact has not been made at this time, but will be facilitated through the SERVIR Coordination Office.

NASA SERVIR has been supporting landslide hazard monitoring efforts in Mesoamerica, Eastern and Southern Africa, and the Hindu Kush Himalayan region. One of the significant contributions to these efforts is a new Global Landslide Catalog, which provides a collection of rainfall triggered landslides, including dates and locations of these landslides. SERVIR will provide assistance in acquiring and processing GPM and SRTM2 data. Contact has been made with Eric Anderson and Dr. Dalia Kirshbaum of SERVIR to discuss important factors to consider for a regionally specific Landslide Potential Hazard Map for Rwanda and part of Uganda.

Decision Making Process:

Currently, the Global Landslide Catalog (GLC), led by Dr. Kirschbaum, shows the locations of landslides that are identified by media reports. In Rwanda, basic information about landslide

occurrences is collected by the Ministry of Disaster Management and Refugee Affairs (MIDIMAR). Additional analyses done by SERVIR and RCMRD in eastern and southern Africa have used visible evidence from Google Earth, Landsat, ISERV, and Digital Globe imagery to digitize landslide records into a catalog. These records will help disaster managers have a better understanding when and where landslides occur. SERVIR shows an interest in assessing the characteristics of landslides and landslide susceptibility. They offer providing support, collaboration, and sharing technical expertise.

The results of this project will contribute to cataloging previously unidentified landslides and provide more information on those that have already been cataloged. This project will also focus on informing the mitigation and preparation aspects as well as landslide hazards.

Earth Observations:

Platform	Sensor	Geophysical Parameter
Landsat 5	TM	Visible and Near Infrared (VNIR) Reflectance
Landsat 7	ETM+	Visible and Near Infrared (VNIR) Reflectance
Landsat 8	OLI	Visible and Near Infrared (VNIR) Reflectance
TRMM	TMPA	Precipitation
GPM	DPR	Precipitation
SRTM-2	C-Band	Digital Elevation Models
Digital Globe & Google Earth	Various	Visible and Near Infrared (VNIR) Reflectance

NASA Earth Observations to be Highlighted:
Landsat 5 Thematic Mapper (TM), Landsat 7 Enhanced Thematic Mapper Plus (ETM+), and Landsat 8 Operational Land Imager (OLI) data (among other commercial sources available for free) will provide scenes of the study areas and will be used to visually pinpoint specific landslide initiation points and debris runout areas, using the Global Landslide Catalog and media reports as hints for where to start. The Landsat data will also help determine other land cover classifications as well. TRMM Multi-satellite Precipitation Analysis (TMPA) sensor will provide information regarding the intensity and distribution of rain, as well as the type of rain. The Dual-Frequency Precipitation Radar (DPR) sensor onboard GPM will provide information regarding rainfall measurements for dates that TRMM is unable to obtain data. The C-Band from SRTM2 data will provide high resolution 30m elevation data, newly released for the African continent.

Ancillary Datasets:

- Global Landslide Catalog, NASA/SERVIR, dates and locations of landslides
- Population data, NASA's Socioeconomic Data and Applications Center (SEDAC), population density and locations
- Climate Hazards Group InfraRed Precipitation and with Station Data (CHIRPS), USGS, rainfall measurements

Decision Support Tools & Analyses:

Proposed End Products	Decision Impacting	Current Partner Tool/Method
Improve Global Landslide Map	Disaster Risk Management	Online media reports
Landslide Hazard Potential Map	Alerts and evacuation orders for surrounding communities, land use planning	Ground monitoring
Preliminary Assessment of Satellite Rainfall Performance in Identifying Landslide Conditions	Determine landslide conditions and moisture thresholds	N/A

Improve Global Landslide Map – Dates and locations of landslides in Rwanda and Uganda will be added to the Global Landslide Map. This will help determine what characteristics can trigger a landslide.

Landslide Hazard Potential Map – This map will created to highlight areas where landslides can potentially be hazardous. The map will also show what characteristics can trigger a landslide.

Preliminary Assessment of Satellite Rainfall Performance in Identifying Landslide Conditions – This assessment will show how satellite rainfall products, such as the PR sensor on TRMM and the DPR sensor on GPM, and the CHIRPS rainfall product, characterize what conditions are needed to create a landslide.

Project Details:
National Application Area Addressed: Disasters
Source of Project Idea: The project idea came about from a conversation with Eric Anderson (SERVIR) and the need to implement satellite remote sensing for landslide monitoring. This is directly tied to SERVIR-Eastern and Southern Africa activity at RCMRD, which holds stakeholder engagement workshops to refine data and information needs.

Advisor: Dr. Jeffrey Luvall (NASA at NSSTC)
# of Participants Requested: 3-4

Project Timeline: 1 Term: 2015 Summer
Study Location: Rwanda and landslide-prone areas of Uganda
Period being Studied: January 1998 to present

Previous Related DEVELOP Work:
Pakistan Disaster: Impact Assessment of Attabad Lake Disaster on Agriculture and Associated Food Security in Gilgit Baltistan - Fall 2014 (ICIMOD/Marshall Space Flight Center)

Rwanda Agriculture: Quantifying Population Dynamics and Risk of Soil Degradation in Rwanda by Novel Use of NASA EOS for settlement Efforts by the Republic - Summer 2013 (Langley Research Center)

Rwanda Agriculture I & II: Utilizing NASA's Earth Observations to Estimate Rice Yield and Study Soil Erosion in Rwanda - Spring 2014 & Summer 2014 (Wise County)

Kirshbaum et al., 2009: http://www.nat-hazards-earth-syst-sci.net/9/673/2009/nhess-9-673-2009.html
Kirschbaum et al., 2010: http://link.springer.com/article/10.1007%2Fs11069-009-9401-4

Sinkholes

3. Georgia Disasters (UGA)

Utilizing NASA Earth Observations to Monitor Sinkhole Development and Identify Risk Areas

Objective:
The overall objective of this proposal is to develop a sinkhole inventory map to determine environmental risk to human health, infrastructure, and water supply. Specifically, this project will identify and map sinkholes, analyze the factors influencing the development of sinkholes, and produce an accurate hazard map and a groundwater risk map for Dougherty County, Georgia.

Community Concern:
Sinkholes are a risk to both human safety and infrastructure in the coastal plain of the Southeastern United States, particularly roads and buildings. Additionally, sinkholes pose a threat to groundwater pollution, as they can quickly introduce contaminants to karst aquifer systems (i.e., the Upper Floridan Aquifer) which supply a large percentage of drinking and agricultural water in the Southeast (Gordon et al., 2012). Thus, it is important to improve understanding of and predictive capabilities for sinkhole formation. This knowledge would be useful for farmers who rely on groundwater resources, land use and city planners responsible for infrastructure development, and municipalities responsible for delivering safe drinking water to consumers. This research is directly applicable to other urban areas underlain by karst aquifer systems exhibiting sinkhole formation, such as Florida.

End-Users/Partners/Boundary Organizations:
City of Albany and Dougherty County Planning and Development Services (End-User/Partner, POC: Randy Weathersby, GIS Manager for the City of Albany and member of the Southwest Georgia Water Resources Task Force)
Southwest Georgia Water Resources Task Force (End-User, POC: Randy Weathersby, GIS Manager for the City of Albany and member of the Southwest Georgia Water Resources Task Force)

The primary contact for this project has been Randy Weathersby. So far, interactions have included gathering resources, specifically GIS data necessary to provide successful, verifiable answers to the research questions. Mr. Weathersby was instrumental in gathering high-resolution LiDAR elevation data for Dougherty County. After discussing this DEVELOP proposal with Mr. Weathersby, he has agreed to serve the dual purpose of research support and disseminating results to Dougherty County Planning and Development Services and the community through action groups. He is interested in gathering an up-to-date sinkhole database and inventory, sinkhole hazard analysis results, and a groundwater contamination risk map for future use in his work as a member of the Southwest Georgia Water Resources Task Force.

Letters of Support: City of Albany and Dougherty County Planning and Development Services, Randy Weathersby, Geographic Information System (GIS) affiliate

Decision Making Process:
The historical role of the City of Albany and Dougherty County Planning and Development Services (PDS) is to promote the improvement, conservation, and revitalization of the physical and social environment. They are responsible for governing land use and development and providing resources to contractors, builders, and developers to ensure the built environment is safe. This department has recognized that to be successful, dangers associated with karst environments (i.e., sinkholes) must be considered. To do this, spatial data on sinkhole density and occurrence can be used to avoid high-risk areas.

Recently, PDS has utilized GIS to generate maps and reports on natural hazards, particularly flooding hazards. To date, NASA datasets haven't been used for these projects. However, the availability of NASA products makes them ideal for other natural hazard assessments, specifically sinkholes which require ongoing monitoring. This team will use the ASTER elevation datasets to assess sinkhole development through time, which requires fine-resolution data. Given the long-term standing of Randy Weathersby in water resource management for the area and his position on the task force, Mr. Weathersby is ideally suited and motivated to disseminate the results of this research for improved decision-making regarding future infrastructure and water resource development.

Earth Observations:

Platform	Sensor	Geophysical Parameter
Landsat 5 & 7	TM and ETM+	Land cover and land use
Sentinel-1	C-band SAR	Small elevation changes (e.g., sinkholes and depressions)
Terra	ASTER	Elevation data
GRACE	GRACE	Regional Groundwater changes

NASA Earth Observations to be highlighted:
ASTER data will provide high spatial and temporal resolution elevation data necessary for the identification of sinkhole density and variations in sinkhole occurrence from 2000 to 2011. Landsat TM and ETM+ data will allow for detection of land use and land cover changes that may correlate with sinkhole density and occurrence. The influence of land use and land cover changes on sinkhole formation will be measured using spatial statistics tools within ArcGIS, specifically geographically weighted regression and ordinary least squares techniques. GRACE data will provide estimates of groundwater changes in the region. These measurements will further the analysis of possible conditioning factors for sinkhole development.

Ancillary Datasets:
This study will utilize archived and current USGS National Water Information System (NWIS) surface water, groundwater, spring, and stream data. Specifically, USGS aquifer level data for the Upper Floridan Aquifer will be used to build interpolated groundwater levels for the regression models. NOAA National Climatic Data Center (NCDC) precipitation data will be used for further analysis of hydrologic changes. Previously mapped fracture traces and lineaments for Dougherty County will serve the role of further explaining sinkhole density and occurrence. The Natural Resources Conservation Service (NRCS) land use and orthoimagery data will be used for verifying land cover changes. Additionally, NRCS soil data will be utilized in the models to help describe and determine the lithologic controls on sinkhole formation. Sentinel-1 data will be used to monitor land surface deformations. With higher spatial resolution than ASTER DEM's, Sentinel-1 data would strengthen this project's capabilities to detect small elevation changes (e.g., sinkholes and depressions) and land cover/land use changes.

Decision Support Tools & Analyses:

Proposed End Products	Decision Impacting	Current Partner Tool/Method
Sinkhole Inventory Map	Current and future land use changes/infrastructure development to reduce risks associated with sinkholes	Local field observations, which are limited in space and time
Sinkhole Hazard Map	Where the Albany and Dougherty County PDS plans future development of infrastructure	Local field observations, which are limited in space and time
Groundwater Contamination Risk Map	Locations for safe water resource extraction and subsequent allocation	Groundwater quality monitoring based on surficial analyses
Groundwater Storage Change Map	Locations for efficient water wells and proper land use practices that will limit groundwater depletion	Local field observations, which are limited in space and time

Sinkhole Inventory Map – A sinkhole delineation procedure (Cahalan and Milewski, 2014) will be employed using ASTER and Sentinel-1 elevation data to map sinkholes through time. The most current map will be highlighted for decision support related to current and future land use changes/infrastructure development for maximization of resources and minimization of risk.

Sinkhole Hazard Map – Elevation and land use/land cover change data derived from satellite observations (e.g., ASTER, Landsat), soil, fracture trace/lineament, and aquifer level data will be used to conduct a geographically weighted regression analysis. This will further our understanding of sinkhole formation processes, which will in turn provide a comprehensive nearest neighbor analysis, which relies on sinkhole density and occurrence factors as inputs. The end product will be a GIS map outlining hazards using a nearest neighbor distance model by quantifying the degree of clustering-dispersion of sinkholes. The construction of a comprehensive sinkhole map for Dougherty County is imperative for the reliability of a sinkhole hazard map and the subsequent mitigation efforts depend largely on the completeness and accuracy of recorded sinkholes (Gutierrez et al., 2011; Galve et al., 2009 a,b).

Groundwater Contamination Risk Map – The results of the sinkhole hazard map based on ASTER elevation data will be coupled with the land use and land cover development analysis derived from Landsat Earth observations to determine which areas (e.g., urban, agricultural, etc.) exhibit the greatest risk of future groundwater contamination. This is based on the concept that sinkholes act as an immediate conduit to the local groundwater system. Thus, areas with greater probability of sinkhole development pose a higher risk to groundwater contamination.

Project Details:

National Application Areas Addressed: Disasters, Water Resources
Source of Project Idea: This project's motivations are concurrent with the goal of NASA Earth Science of developing a scientific understanding of the Earth as an interconnected system and to better predict variability and trends in natural hazards. This research is further fueled by the goal of developing early detection tools to aid in karst hazard forecasting.

Advisor: Dr. Adam Milewski, Assistant Professor, Department of Geology, University of Georgia
Number of Participants Requested: 5-6

Project Timeline: 2 terms: Summer 2015 to Fall 2015
Study Location: Dougherty County, Georgia
Period being Studied: January 2000 to December 2011

Multi-Term Objectives:

- **Term 1 (Proposed Term)** - The first objective of term 1 is to assess the probability and risk of sinkhole occurrence by examining correlations between sinkhole distribution and land use changes and hydrologic fluctuations (i.e., precipitation, aquifer levels) through time and space. Building upon the first objective, the team will also produce a sinkhole occurrence hazard map for the area based on results from Sentinel-1 elevation change data and geographically weighted regression models that consider various conditioning factors (i.e., land use, aquifer levels) that help explain sinkhole density. This will aid in developing early detection tools for karst hazards. Project partners will aid in data collection, analysis, and research oversight. The results of this work will allow for further analysis on groundwater contamination risk.
- **Term 2** - Coupling the results of the previous objectives and land use/land cover change analyses, the final goal of this project is to produce a groundwater contamination risk map for the study area to help improve groundwater quality used for municipal, agricultural, and industrial purposes, as well as a groundwater storage change map from GRACE to quantify groundwater storage variations, specifically the Upper Floridan Aquifer. The results of the sinkhole hazard assessment and groundwater contamination risk map will be distributed amongst the end-users for decision-making purposes to reduce groundwater contamination and its associated risks.

References:

Cahalan, M. and Milewski, A., 2014, Spatiotemporal Analysis of Sinkhole Development in the Covered Karst Terrain of Dougherty County, Georgia, Geological Society of America Annual Meeting Abstracts with Programs, Vol. 46.

Galve, J.P., Bonachea, J., Remondo, J., Gutierrez, F., Guerrero, J., Lucha, P., Cendrero, A., Gutierrez, M., Sanchez, J.A., 2008. Development and validation of sinkhole susceptibility models in mantled karst settings. A case study from the Ebro valley evaporite karst (NE Spain). Engineering Geology, 99: 185 - 197.

Galve, J.P., Gutierrez, F., Lucha, P., Guerrero, J., Remondo, J., Bonachea, J., Cendrero, A., 2009a. Probabilistic sinkhole modelling for hazard assessment. Earth Surface Processes and Landforms, 34: 437 - 452.

Gordon, D.W., Painter, J.A., McCranie, J.M., 2012. Hydrologic Conditions, Groundwater Quality, and Analysis of Sinkhole Formation in the Albany Area of Dougherty County, Georgia, 2009. USGS-SIR 2012-5018: pg. 1-60.

Gutierrez, F., Galve, J.P., Lucha, P., Castaneda, C., Bonachea, J., Guerrero, J., 2011. Integrating geomorphological mapping, trenching, InSAR and GPR for the identification and characterization of sinkholes: A review and application in the mantled evaporite karst of the Ebro Valley (NE Spain). Geomorphology, 134: 144 - 156.

Oil Spills & Seeps

4. Alaska Disasters (Langley)

Utilizing NASA Earth Observations to Identify Oil Seeps Off the Northern Shore of Alaska

Objective:

This project will create a procedure to identify oil spills in the Arctic and to identify current oil seeps in Northern Alaska.

Community Concern:

Oil spills can shut down valuable shipping channels. This can have economic impacts for the United States and other Arctic countries. Environmental impacts from oil seeps are more severe in the Arctic because lower temperatures slow down the rate of degradation of hydrocarbons, which poses a threat to a sensitive environment.

End-Users/Partners/Boundary Organizations:

United States Coast Guard Auxiliary University Programs (USCG AUP) (Collaborator/Boundary Organization, POC: Dr. David Kellogg, Internship Coordinator)

United States Coast Guard (End user, POC: MST1 Justin Hoffer, CG-MER-1)

A connection has already been established with the USCG AUP through Auxiliary members studying at the College of William and Marry including Chris Webber, Ben Silliman, and Will Manion. Through this group, a connection has been established within the Office of Marine Environmental Response at USCG Headquarters (Justin Hoffer). Through various dialogues with USCG members at Headquarters, the USCG AUP group, and the DEVELOP team, the idea of collaborating on a project was discussed. The USCG is expanding operations in the Arctic due to increasing shipping traffic in the region. This surge in traffic increases the risk of an oil spill or seep in the area. More resources are needed to aid in the search and identification of oil in the region.

Decision Making Process:

The US Government requires all vessels responsible for an oil spill to immediately notify the federal government. The US Coast Guard will delegate an on scene coordinator to investigate the spill.

This person will be responsible for the decision making process. The US Coast Guard has claimed responsibility over the Arctic. Any spills in this area will be under US Coast Guard jurisdiction and recommendations will be made based on the Coast Guard Scene Coordinator. In addition, many natural oil seeps are undetected. It is the objective of this project to use NASA Earth observations to be able to provide an easy and cost effective way to detect these oil seeps.

Earth Observations:

Platform	Sensor	Geophysical Parameter
Aqua & Terra	MODIS	Reflectance
Landsat 8	OLI/TIRS	Land Cover
Aircraft	AVIRIS	Reflection of Oil

NASA Earth Observations to be Highlighted:
MODIS will be used to look at main regions off the shore of Alaska to identify potential areas of oil seeps. Because of the high temporal resolution MODIS offers, the team will be able to look at these areas and study them over time. Landsat 8 will be used to look for oil over ice and snow surfaces in in northern Alaska. Once oil is identified, AVIRIS data will be used to acquire a high resolution of these areas to study and validate them.

Ancillary Datasets:
Environmental Response Management Application (ERMA): this dataset will be used to acquire historic records of past oil seep.

Models

- General NOAA Operational Modeling Environment (GNOME) – POC Mike Bender

Decision Support & Analyses:

Proposed End Products	Decision Impacting	Current Partner Tool/Method
Oil Seeps Time Series	Validation of our methodology. Useful information for decision makers to see how oil spills interact with the environment.	Individual Studies
Oil on Ice Time Series	Validation of our methodology. Useful information for decision makers to see how oil spills interact with the environment.	Individual Studies
Oil Seeps Detection Tool	Assist US Coast Guard identify possible oil spills and their coordinates.	Reports from passing facilities and/or vessel and airborne search
Oil on Ice Detection Tool	Assist US Coast Guard identify possible oil spills and their coordinates.	Reports from passing facilities and/or vessel and airborne search

Oil Seeps Time Series – MODIS data will be used to identify previous oil seeps and conduct a retrospective study from 2000 to present.

Oil on Ice Time Series – Landsat 8 data will be used to identify previous oil on ice and snow surfaces and conduct a retrospective study from 2000 to present.

Oil Seeps Detection Tool – Using MODIS and radar data, a map will be created to identify suspected areas for future oil seeps to help USCG targets their efforts

Oil on Ice Detection Tool – Using Landsat 8 data, a map will be created to identify suspected areas for future oil drainage on ice and/or snow surfaces.

Project Details:
National Application Area Addressed: Disasters
Source of Project Idea: The project ideas was formed through a brainstorming session between Justin Hoffer, Dr. Kenton Ross, Ben Silliman, Will Manion, and Merna Saad.

Advisor: Dr. Kenton Ross (NASA DEVELOP National Science Advisor)
# of Participants Requested: 3 or 4

Project Timeline: 1 Term: 2015 Summer
Study Location: Alaska/Arctic
Period being Studied: 2000 - present

Previous Related DEVELOP Work:
Mid-Atlantic Water Resources: Detection of Natural Oil Seeps in the Atlantic Ocean using MODIS Fall 2009 (Stennis Space Center)

Fires

5. Texas Disasters (Stennis)

Utilizing NASA Earth Observations to Assist the Texas Forest Service in Mapping and Analyzing Fuel Loads and Phenology in Texas Grasslands

Objective:
This project will use and produce regional geospatial mapping products from MODIS data to depict locations of potential wildfire fuel types, fuel loads, and vegetation phenology for Texas' vegetation types vulnerable to wildfire, especially during drought years.

Community Concern:
Texas' vegetation types (grasslands, shrublands, and forests) can be highly susceptible to seasonal wildfires, especially during severe droughts. In recent years, the risk of severe wildfires has been increasing due to weather phenomena (e.g., drought) and recent urban expansion into wildland areas. Grassland vegetation growth during wet years can increase fuel loads that, in turn, increase wildfire risk and can lead to more frequent, intense fires during dry years. The ability to accurately and timely monitor vegetation conditions (e.g., vegetation greenness and phenology) is an important aspect of forecasting wildfire risk, especially in grassland and shrubland regions which are more susceptible to rapidly spreading fires during dry conditions.

End-Users/Partners/Boundary Organizations:
Texas Forest Service (TFS) (End-User, POC: Tom Spencer, Department Head, Predictive Services & Curt Stripling, Geospatial Systems Coordinator, Predictive Services)
USDA Forest Service ForWarn (Collaborator, POC: William "Bill" Hargrove, Research Ecologist)

The TFS has partnered previously with DEVELOP, including projects mapping invasive grassland plant species for assessing their contribution to changing fire regimes. Initial partner contact for this project took place in late January 2015. Subsequent communication between TFS partners and SSC and LaRC DEVELOP center leadership took place in February 2015. The TFS expressed interest in mapping and monitoring fuel load conditions, wildfire risk assessments, and phonological monitoring of grasslands, shrublands and forests. End products will likely be transferred to project partners via email and telecon or video conferencing. We anticipate that project results will also be presented at the Annual Earth Sciences Applications Showcase at NASA Headquarters later in the summer. Partners will benefit from this work by incorporating it into their decision making processes, allowing for more accurate predictions of wildfire risk.

Letters of Support: Texas Forest Service, Tom Spencer and Curt Stripling, Protective Services Department Head and Geospatial Coordinator, respectively

Decision Making Process:
Currently, the TFS uses products from the LANDFIRE Program and the National Predictive Services Unit to assess and monitor wildfire fuel types and potential fuel loads. LANDFIRE fuel type and fuel load data relies largely on modeling with some remote sensing inputs derived from Landsat data and existing USGS datasets. However, Landsat fuel type maps do not necessarily consider vegetation phenology. MODIS-based vegetation phenology products will be used to supplement the content available from Landsat-based products, including cumulative integral growing season NDVI and pheno-region products resident to the USFS ForWarn system.

Earth Observations:

Platform	Sensor	Geophysical Parameter
Aqua & Terra	MODIS	Spectral vegetation indices and phenology products
Landsat 8	OLI	Spectral vegetation indices, Land cover classifications
Landsat 5	TM	Spectral vegetation indices, Land cover classifications

NASA Earth Observations to be Highlighted:
This project will use MODIS and Landsat data to classify fuel types, calculate fuel loads, and monitor vegetation phenology in Texas' grasslands, shrublands, and forests. MODIS data from the ForWarn system will primarily be used for assessing the role of vegetation phenology in depicting vegetation fuel loads, tracking average "green-up" dates, and assessing green-up and brown-down trends that potentially affect wildfire fuel loads. Landsat 8 and Landsat 5 data will be primarily used to classify fuel types and fuel loads and also calculate spectral vegetation monitoring indices (e.g. NDVI, NDMI) to assess vegetative condition.

Ancillary Datasets:
Field surveys, in situ measurements, and modeled data may be available from project end users. Aerial NAIP data and DEM data will also be utilized.

Models:
IDRISI Land Change Modeler for ArcGIS (POC: JPL DEVELOP)

Decision Support Tools & Analyses:

Proposed End Products	Decision Impacting	Current Partner Tool/Method
Fuel Type & Fuel Load Maps	Where the Texas Forest Service allocates wildfire management resources	Aerial imagery and field surveys
Seasonal Vegetation	Where the Texas Forest Service allocates	Field surveys

Phenology	wildfire management resources	

Fuel Type & Fuel Load Maps – Landsat 8 OLI and Landsat 5 TM data will be processed to create geospatial products depicting locations of potential grassland, shrubland, and forest fuel types and fuel loads.

Seasonal Vegetation Phenology – MODIS and Landsat data will be processed to create geospatial products depicting forest and grassland phenology, average "green-up" dates, and growing season dates as it relates to potential wildfire fuel loads.

Project Details:
National Application Areas Addressed: Disasters, Ecological Forecasting, Agriculture, Water Resources
Source of Project Idea: Communication between DEVELOP National Program Office and TFS

Advisors: Joseph Spruce (Senior Scientist and Lead Science Advisor at NASA SSC), James "Doc" Smoot (Senior Scientist and Assistant Science Advisor at NASA SSC), Dr. Kenton Ross (NASA DEVELOP National Science Advisor, LaRC)
# of Participants Requested: 4

Project Timeline: 2 Terms: 2015 Summer (Start) to 2015 Fall (Completion)
Study Location: Texas
Period being Studied: 2000-present with specific times of year TBD

Previous Related DEVELOP Work:
Texas Natural Disasters: Potential of MODIS Vegetation Phenology Data for Aiding Wildfire Risk Assessments - Fall 2011 (SSC)

Multi-Term Objectives:
- **Term 1 (Proposed Term)** – The first term of the project will focus on mapping wildfire fuel types and fuel loads across the state of Texas. Partners will be engaged throughout the term providing guidance and direction as needed.
- **Term 2**– The second term of the project will be focused on mapping vegetation type specific vegetation phenology as it relates to potential wildfire fuel loads, and bringing together results from the SSC and LaRC projects to provide a more synergistic analysis of wildfire risk in Texas. Term 2 will also be focused on ensuring proper hand off of all project end products, results, and methodology to partners.

Notes: This project will be conducted in parallel with the Texas Water Resources project at Langley Research Center monitoring Texas drought and drought severity.

6. Indonesia Disasters (IRI)

Creating an Enhanced Methodology for Mapping Burn Scars in Indonesian Forests Using Landsat

Objective:
This project will create a methodology for effectively mapping burn scars in the forests of Indonesia using Landsat. The project will test a technique of converting Red Green Blue (RGB) colors from Landsat scenes into Hue Saturation Value (HSV) in order to see if it is a more effective procedure for identifying burn scars. This methodology will be used to assess carbon emissions and map deforestation in Indonesia.

Community Concern:
Forest fires across Indonesia have increased over recent years, and those fires have endangered the country's forests, communities, and wildlife. The issue became ever more pressing following the June 2013 Southeast Asian Haze crisis and in September of 2014 Indonesia ratified the ASEAN Haze Agreement, initially signed in 2002, which agreed to concentrate efforts to reduce pollution from forest fires. Additionally, after forest fires have burned an area it becomes more susceptible to future fires. Therefore, the ability to assess where fire damage has occurred over many years will be useful in evaluating what areas are prone to future fires. Additionally, the burn scar maps will be used to assess deforestation and carbon emissions in the Kalimantan region. Overall, the use of remotely sensed products to monitor fire damage in remote regions of Indonesia is a valuable asset for areas that are otherwise inaccessible.

End-Users/Partners/Boundary Organizations:
Bogor Agricultural University (IPB) (Partner, POC: Rizaldi Boer, Research Scientist)
Center for International Forestry Research (CIFOR) (Boundary Organization, POC: Louis Verchot, Research Director, Senior Scientist)

The IRI has been working with IPB and CIFOR for several years to develop an early warning system for active fires monitoring and forecasting based on climate monitoring and forecast (see link below), which is used operationally by IPB and the Indonesian Ministry of Forestry office in Kalimantan. In order to analyze the impact of fires on deforestation and CO_2 emissions, the warning system is now required to monitor burn scars. The new methodology developed will be used to assess carbon emissions and the impact of deforestation in Indonesia.

Decision Making Process:
IPB, the Ministry of Forestry and CIFOR currently use the Fire Early Warning System developed by IRI to monitor and forecast risks of active fires based on climate information. Climate information is based on precipitation anomalies derived from NOAA's CPC Morphing Technique (CMORPH) data, active fires are monitored using MODIS hotspots, fire vulnerability is derived from a Landsat land cover map created by IRI and IPB, vegetation status is monitored using MODIS and fire risk is created by combining a fire vulnerability map with precipitation anomalies. Burn scar maps will be used to assess deforestation and carbon emissions in Kalimantan.

Earth Observations:

Platform	Sensor	Geophysical Parameter
Landsat 5	Thematic Mapper (TM)	Land Cover
Landsat 7	Enhanced Thematic Mapper Plus (ETM+)	Land Cover
Landsat 8	Operational Land Imager (OLI)	Land Cover

NASA Earth Observations to be Highlighted:
The benefit of using remotely sensed products for this project is their ability to examine remote areas that are otherwise not easily accessible. The Landsat series is the best remote sensing choice for this project because of its high spatial resolution (30 m) along with its long-term (30+ years) acquisition of imagery. In addition to these benefits, the technique of converting the RGB to HSV is a new approach for mapping burn scars in the area which may prove to be better than previous methods of burn scar identification.

Models:
Hue Saturation Value (HSV) Model (Pekel et al., 2011) POC: Jean Francois Pekel

Decision Support Tools & Analyses:

Proposed End	Decision Impacting	Current Partner

Products		Tool/Method
Burn Scar Maps	Accurately map areas in high spatial resolution which have been burnt in remote parts of Indonesia for better resource allocation	Aerial imagery and field photos

Burn Scar Maps – Landsat imagery covers over 30 years and therefore will provide a large dataset to test the new methodology. The Landsat scenes will be converted from RGB to HSV in order to better identify burned areas in Indonesia.

Project Details:
National Application Areas Addressed: Disasters, Ecological Forecasting
Source of Project Idea: This project came from research looking into decadal variability of fires as they relate to climate. Additionally, the IRI has been working with IPB and CIFOR for several years to develop an early warning system for active fires monitoring and forecasting based on climate monitoring and forecast, which is used operationally by IPB and the Indonesian Ministry of Forestry office in Kalimantan. In order to analyze the impact of fires on deforestation and CO_2 emissions, the warning system is now required to monitor burn scars.

Advisor: Pietro Ceccato, (Research Scientist, Lead Environmental Monitoring Program, The International Research Institute for Climate and Society, The Earth Institute, Columbia University)
# of Participants Requested: 2

Project Timeline: 1 Term: 2015 Summer
Study Location: Indonesia
Period Being Studied: 1982 to 2014

Reference:
Pekel, J. F., Ceccato, P., Vancutsem, C., Cressman, K., Vanbogaert, E., & Defourny, P. (2011). Development and application of multi-temporal colorimetric transformation to monitor vegetation in the desert locust habitat. *Selected Topics in Applied Earth Observations and Remote Sensing, IEEE Journal of*,*4*(2), 318-326.

7. California Disasters II (UAVSAR) (JPL)

A New Method for Providing Near-Real-Time Active-Fire and Post-Burn Support to Fire Responders Using Data Products Derived from NASA's Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR)

Objective:
This project explores the viability of UAVSAR-derived polarimetric imagery to provide near-real-time map products to active fire responses as well as post-burn imagery to support fire severity assessments. The proposed project is a continuation of the previous term's project, which produced promising results requiring a more thorough analysis.

Community Concern:
Severe drought conditions have exacerbated the risk of fire in California, and increased the necessity for fast, effective fire response. As the 2013 Rim Fire and 2014 King Fire showed, small fires quickly grow to raging infernos when fire severity potential is not accurately gauged. Currently, responders such as the California Department of Forestry and Fire Protection (CAL FIRE) are limited to visual assessments during most fires, but smoky conditions and uneven terrain can make accurately assessing the intensity of a fire and its growth potential difficult. The US Forest Service National Infrared Operations (NIROPs) Unit located in Idaho can provide airborne support producing useful remote sensing products, but is constrained to nighttime operations

and limited passes. Post-burn analysis using Landsat scenes provides rough assessments of burn intensity, but this method is not relevant during an active fire.

End-Users/Partners/Boundary Organizations:

California Department of Forestry and Fire Protection (CAL FIRE) (End-User, POC: Jana Luis, Division Chief, Predictive Services)

US Forest Service Remote Sensing Activities Center (Boundary Organization, POC: Brad Quayle, Program Leader, Rapid Disturbance Assessment and Services [RDAS] Program)

Contact with both the US Forest Service and with CAL FIRE was established at the Tactical Fire Remote Sensing Advisory Committee meeting in Reno, NV, in October 2014. Subsequently, CAL FIRE personnel including Chief Luis visited JPL to discuss the project. Similarly, a telecon was held with Brad Quayle. Both Chief Luis and Brad Quayle have provided the team with information contributing to the success of the project's first term. The results of the first term were relayed to them in a closeout presentation for the term. With the continuing project, more case studies will be analyzed and the analysis is expected to delve further into the practical considerations of using synthetic aperture radar in fire monitoring. The team will present results at the Spring TFRSAC meeting in May of 2015, and will provide the partners with the technical report for the project at the end of the second term.

Decision Making Process:

Currently, fire response by CAL FIRE is managed through on-ground and in-air visual inspection during fires. Infrared imagery is available through the National Infrared Operations program in Idaho. This program provides once-per-night flight scans during a fire-response campaign, producing just a few images. Some other remote-sensing approaches have been field-tested with mixed results. CAL FIRE also uses MODIS products with low temporal and spatial resolution (1 km, daily) for synoptic views during active fire responses and for post-burn assessments. Post-burn assessments are also produced by the US Forest Service using Landsat imagery.

Earth Observations:

Platform	Sensor	Geophysical Parameter
Gulfstream III	UAVSAR	Polarimetric SAR imagery (PolSAR)
Landsat 7	ETM+	Normalized Burn Ratio (dNBR)
Landsat 8	OLI	Normalized Burn Ratio (dNBR)

NASA Earth Observations to be Highlighted:

This project presents an innovative use for NASA's UAVSAR instrument. Current active-fire monitoring practices depend on visual, daytime observations, with some limited infrared remote-sensing data available at night. Post-burn assessments are conducted remotely using Landsat data at 30 m resolution. Radar instruments such as NASA's Gulfstream III-mounted UAVSAR are cloud- and smoke-penetrating and "see" as well at night as during the day because they are active sensors. The resolution of radar products is on the order of meters. Polarimetric L-band SAR has well-known characteristic backscatter variations with respect to changes in vegetation and forest that can be exploited for fire-detection efforts.

Data from the Enhanced Thematic Mapper (ETM+) and Optical Land Imager (OLI) on Landsat 7 and Landsat 8, respectively, will be used to create dNBR images, which will be compared with PolSAR imagery from the UAVSAR to assess the effectiveness of using airborne radar to produce useful post-fire products.

Ancillary Datasets:

- USFS MTBS website – Fire perimeter shapefiles and Landsat burn severity images

- USFS California Vegetation (CALVEG) Mapping Zones – Vegetation cover
- CAL FIRE Fire Resource and Assessment Program (FRAP) website – Fire perimeter shapefiles

Decision Support Tools & Analyses:

Proposed End Products	Decision Impacting	Current Partner Tool/Method
Active Fire Radar Imagery and Analysis	Where CAL FIRE and the Forest Service direct fire-response efforts	Visual inspection at fire site and in the air
Post-burn Radar Imagery and Analysis	Where CAL FIRE and the Forest Service allocate post-fire resources	Aerial imagery, field surveys, and MODIS imagery

Active Fire Radar Imagery and Analysis – PolSAR imagery of active fires will be created and analyzed for usefulness in accurately delimitating fire boundaries and assessing fire intensity. The analysis will summarize what information can be derived from the imagery with certainty, and will include a discussion of error sources and error abatement.

Post-burn Radar Imagery and Analysis – PolSAR imagery of burnt areas will be analyzed for usefulness in describing burn severity and type, as well as land conditions post-fire. The analysis will summarize what information can be derived from the imagery with certainty, and will include a discussion of error sources and error abatement. Similarities and differences between Landsat dNBR products and UAVSAR post-burn products will be analyzed to help the end-users decide which technique is most effective for post-burn damage assessment.

Project Details:
National Application Area Addressed: Disasters
Source of Project Idea: Prof. Mark Simons and graduate student Brent Minchew at the California Institute of Technology developed a method to use synthetic aperture radar to highlight changes in vegetation cause by fire. They reached out to former DEVELOP advisor Dr. Sang-Ho Yun for help in locating a partner in the fire-response community who could benefit from this approach. DEVELOP located contacts at CAL FIRE and the US Forest Service who expressed support for the project and interest in the potential for this novel use of NASA's UAVSAR sensor.

Advisors: Dr. Mark Simons (California Institute of Technology), Dr. Sang-ho Yun (Jet Propulsion Laboratory)
# of Participants Requested: 3

Project Timeline: 2 Terms: Spring 2015 to Summer 2015
Study Location: California
Period being Studied: Jan 2009 - Present

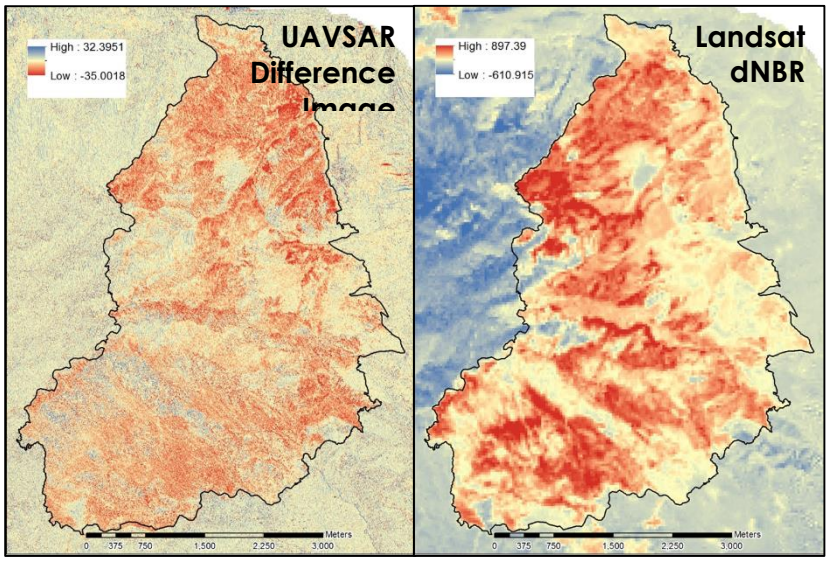
Previous Related DEVELOP Work:
CA Disasters I: A New Method for Providing Near-Real-Time Active-Fire and Post-Burn Support to Fire Responders Using Data Products Derived from NASA's Uninhabited Aerial Vehicle Synthetic Aperture Radar (UAVSAR) - Spring 2015 (JPL)

Multi-Term Objectives:
- **Term 1** – During this term, dozens of potential case studies were identified, and 11 were chosen for preliminary analysis. Differenced-UAVSAR products were generated for each case study, and the team examined the pattern of burns, comparing them with Landsat

dNBR images and examining the role of vegetation cover in how well the products were correlated. Direct contact with US Forest Service personnel facilitate by our partner Brad Quayle aided the production of these images. In addition, CAL FIRE personnel provided links to ancillary datasets and information on what remote sensing products would be the most useful to their field operations.

- **Term 2 (Proposed Term)** – This term will focus on expanding the methodology developed in the first term to as many case studies as possible to create a wider base for correlation analyses. In addition, field data, which is scarce for the study period, will be used to further validate the UAVSAR products. A Radar Burn Index (RBI) that provides comparable burn severity information to the dNBR will be developed. The final products will be delivered to the partners in the form of an electronic catalogue of case study results and a tech paper. CAL FIRE, in particular, has expressed an interest in understanding the viability of taking this novel approach to fire monitoring.

Notes: The figure below juxtaposes a UAVSAR-derived post-burn image (left) with a Landsat 8-derived differenced normalized burn ratio (dNBR) image (right) from the Grand Fire, which occurred in Southern CA, 2013. The UAVSAR-derived map shows the change in HV polarization from before and after radar scenes at ~5 m resolution. The dNBR image shows the change in infrared reflectance from before and after Landsat scenes at 30 m resolution. The radar and optical results are broadly consistent, though there are clear differences between the two. Further analysis is needed to identify the causes of the differences and to assess the accuracy of the UAVSAR image.



8. US Disasters II (JPL)

Using GRACE-Derived Water and Moisture Products as a Predictive Tool for Fire Response in the Western United States

Objective:

The team will analyze correlations between GRACE Data Assimilated Products (GDAPs) surface soil moisture, root zone soil moisture, and groundwater with NDVI values, fuel moisture data, and MODIS-based fire-severity data to establish the potential predictive capability of GDAPs for directing ground-response efforts during fire seasons and fire outbreaks.

Community Concern:
In the last several years, drought conditions in the western United States have given rise to some of the worst fire seasons on record. One of the most important factors in determining fire danger is fuel moisture content (FMC). Low FMC means higher fire risk, as well as higher potential fire severity. Previous attempts to remotely sense FMC have faced difficulty, in part because fuel often lies close to the ground and thus out of sight of most sensors. Furthermore, studies have shown the that fuel accumulation occurs in wet years, so both wet and dry years are needed in sequence for increased fire risk and increased potential fire severity. A remotely-sensed FMC product combined with an analysis of yearly wet and dry patterns could potentially provide fire managers and responders with a powerful predictive tool for understanding fire risk and response.

End-Users/Partners/Boundary Organizations:
Tactical Fire Remote Sensing Advisory Committee (TFRSAC) (Collaborator/Boundary Organization, POC: Everett Hinkley, National Remote Sensing Program Manager)
USDA Forest Service Remote Sensing Applications Center (RSAC) (Collaborator/End-User, POC: Brad Quayle, RS/GIS Specialist)
NASA Terrestrial Hydrology Program at Goddard Space Flight Center (Collaborator, POC: Dr. Matt Rodell, Laboratory Chief of Hydrological Sciences)

The Tactical Fire Remote Sensing Advisory Committee (TFRSAC) is a joint think tank for the USDA FS and NASA, investigating how to leverage NASA capabilities toward fire management. Contact with Everett Hinkley was made through JPL scientist Justin Boland. Everett Hinkley is participating as a partner and has communicated the need for a predictive fire-severity product was established. The USDA Remote Sensing Applications Center (RSAC) in Salt Lake City offers fire-support remote sensing products to on-the-ground (OTG) agencies. Brad Quayle also works with the National Interagency Coordination Center to provide predictive services showing short- and long-term fire risk on both regional and national levels. Risk assessment is an active area that is continually looking for improvement and new ideas. Mr. Quayle has been involved in this project through its first term and maintains a strong interest. Dr. Matt Rodell is in charge of the team that produces GRACE data assimilated products at Goddard Space Flight Center, and assisted the phase one team in data acquisition and advising regarding its use.

The results of this project will be communicated to TFRSAC and RSAC through a presentation at the end of its second term. The DEVELOP team will offer Python tools and tutorials as appropriate to the partners for further development and incorporation of fire-severity risk maps into their toolkits. The hand-off will be conducted remotely. These products will serve as the basis for a new approach that could provide OTG response agencies with important fire-severity risk information for a given year.

Decision Making Process:
Currently RSAC uses MODIS, VIIRS, and AVHRR data to monitor active fires in the CONUS. They also create post-fire severity maps using remote sensing, which are used to predict erosion and other effects after a fire. RSAC GIS specialist Brad Quayle also works with the National Interagency Coordination Center to provide fire predictive services such as Fuels and Fire Behavior Advisories based on modeling and in situ measurements.

Earth Observations:

Platform	Sensor	Geophysical Parameter
GRACE	GRACE	GRACE Data Assimilated Products (GDAPs) for groundwater, root zone soil moisture, and surface soil moisture
Terra	MODIS	NDVI/EVI, GFED4 burned area

NASA Earth Observations to be Highlighted:
"GRACE is unique in its ability to sense water stored at all levels and data assimilation can be used to spatially and temporally disaggregate and vertically decompose coarse-resolution GRACE terrestrial water storage into components of groundwater, soil moisture and snow" (Houborg et al., 2009). Products derived in this fashion have been shown to be consistent with other water-monitoring indices, such as those provided by the National Drought Mitigation Center. These products may provide a new approach for estimating fire risk through fuel moisture content as well as fire-severity risk based on alternating wet- and dry-year patterns that have previously been difficult to measure via remote sensing. These GRACE data assimilated products have a resolution of 25 km which could be combined with the MODIS fire data set and the Global Fire Emissions Database (GFED) at UC Irvine, and also compared with vegetation indices from MODIS to create a predictive fire product based on fuel accumulation and dryness. Fire predictive products based on GRACE data could help with national-scale early fire management and provide a decision-support tool when combined with other data sources such as weather conditions and topography, what assets are at risk and where people are at risk.

Ancillary Datasets:
Historical fire records in the CONUS (http://gacc.nifc.gov/)
National Fire Danger Rating Fuel Model Map (http://www.wfas.net)

Models:
GRACE Data Assimilated Products for groundwater, root zone soil moisture, and surface soil moisture, based on Land Catchment model (POC: Dr. Matt Rodell, NASA GSFC)

Decision Support & Analyses:

Proposed End Products	Decision Impacting	Current Partner Tool/Method
Analysis of Correlations between FMC and GDAPs	Identification of high-risk fuel conditions	In situ measurements
Analysis of Correlations between burned area and GDAPs	On-the-ground response to fire ignition	None—new method
GDAP-Based Fire Risk Map	On-the-ground response to fire ignition	In situ measurements and fuel moisture modeling
GDAP-Based Fire Risk Map Analysis Tool	On-the-ground response to fire ignition	Various modeling

Analysis of Correlations between FMC and GDAPs – A time series depicting how well the Grace data assimilation products correlate with fuel moisture content.

Analysis of Correlations between Fire Occurrence and Severity and GDAPs – A time series depicting how well the Grace data assimilated products correlate with historical fire severity. This analysis will include wet/dry year pattern identification and FMC data.

Fire Risk Map – Projections for fire-risk based on previous analyses.

Risk Map Analysis Tool – A Python tool to perform analysis and generate above maps.

Project Details:
National Application Area Addressed: Disasters

Source of Project Idea: Brainstorming with Dr. J.T. Reager and identifying research needs assessing the use and feasibility of GRACE applications to fire risk.

Advisor: Dr. John T. Reager (JPL)
# of Participants Requested: 3

Project Timeline: 2 terms: 2015 Spring to 2015 Summer
Study Location: US west of the Mississippi River: Arizona, Arkansas, California, Colorado, Idaho, Iowa, Kansas, Missouri, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Texas, Utah, Washington, Wyoming
Period being Studied: January 2003 to December 2012

Previous Related DEVELOP Work:
Texas Disasters: Utilizing NASA EOS to Assess Burn Severity, Risk Mapping and Effects on Air Quality Caused by the 2011 Texas Wildfires - Fall 2011 (Langley Research Center)

Multi-Term Objectives:

- **Term 1** – Obtained and input all relevant data into Python and scripted the structure for analysis. Performed preliminary analysis of GRACE assimilated data correlations with GFED4 burned area data following wet/dry year patterns.
- **Term 2 (Proposed Term)** – This term's project aims to build upon the preliminary analysis and scripted toolset from the first term. This entails incorporating and building upon results with additional environmental variables and statistical analysis. The results will lead to a more accurate model of fire risk, map set, and programmed toolset to be shared with partners.

Notes:
Chen, Y., I. Velicogna, J. S. Famiglietti, and J. T. Randerson (2013), Satellite observations of terrestrial water storage provide early warning information about drought and fire season severity in the Amazon, J. Geophys. Res. Biogeosci., 118, 495–504, doi: 10.1002/jgrg.20046.

Houborg, R., Rodell, M., Li, B., Reichle, R., Heim, R., Lawrimore, J., … Zaitchik, B. F. (2010). Toward integrating enhanced GRACE terrestrial water storage data into the U.S. and North American drought monitors. In *American Society for Photogrammetry and Remote Sensing Annual Conference 2010* (Vol. 1, pp. 1–5). https://ams.confex.com/ams/pdfpapers/161080.pdf.

9. Southern California Disasters II (Stennis)

Assessing the Effectiveness of Simulated HyspIRI Data for Use in USDA Forest Service Post-Fire Vegetation Assessment and Decision Support

Objectives:
This project will utilize simulated HyspIRI data (produced from co-located AVIRIS and MASTER imagery) to produce wildfire burn severity and vegetation monitoring products comparable to existing operational U.S. Department of Agriculture (USDA) Forest Service products, and quantitatively evaluate simulated HyspIRI derived products to investigate if and how HyspIRI will provide improved capabilities beyond current Landsat-derived products.

Community Concern:
When the Hyperspectral Infrared Imager (HyspIRI) is launched, its unprecedented spectral, spatial, and temporal resolution will enable new capabilities for assessing natural disaster impacts on ecosystems. To maximize the benefits of these capabilities, it is important to develop early prototype applications of the data by using simulated products before the mission is

launched. Accordingly, NASA recently conducted an extensive campaign to collect co-located Airborne Visible/Infrared Imaging Spectrometer (AVIRIS) and MODIS/ASTER (MASTER) airborne simulator imagery over large portions of central and southern California and funded fourteen ROSES projects to develop applications for simulated HyspIRI data produced from this imagery. Although these ROSES projects cover diverse topics, none of them are specifically focused on evaluating the usefulness of HyspIRI data for Forest Service post-fire decision support regarding the assessment of burn severity, vegetation condition, and proper allocation of post fire response resources. Leveraging DEVELOP SSC's strong collaboration with the Forest Service, this proposed project seeks to fill that niche and provide enhanced vegetation assessment and monitoring tools to agencies such as the USDA Forest Service.

End-Users/Partners/Boundary Organizations:

USDA Forest Service Remote Sensing Applications Center [RSAC] (End-User, POC: Tony Guay, Remote Sensing Specialist)
USDA Forest Service Eastern Forest Environmental Threat Assessment Center [EFETAC] (End-User, POC: Dr. Steve Norman, Research Ecologist)
USDA Forest Service Rocky Mountain Research Station, Missoula Fire Sciences Laboratory (Partner/Boundary Organization, POC: Dr. Robert Keane, Research Ecologist)
NASA HyspIRI Science Team, JPL (Partner, POC: Dr. Robert Green, Science Lead)

To maximize the anticipated benefits of this project to the USDA Forest Service partners, project planning teleconferences have been held with Mr. Tony Guay and Dr. Steve Norman. During these meetings, discussion topics included current Forest Service decision making processes, how to tailor the research to their needs, technical and scientific merits of the project, and sources for ancillary data. Additionally, Tony Guay used a shapefile of the simulated HyspIRI data coverage area to provide a list of 2013 fires for which both Rapid Assessment of Vegetation Condition after Wildfire (RAVG) and simulated HyspIRI data are available. Once the second term of the project begins, partners will be involved as needed regarding general advising, research methodology, or data access. Upon project completion, results will be transferred to partners via webinar, as well as through digital transfer of project deliverables. The results of this project hold great potential for enhancing the Forest Service's long term strategic planning efforts as they consider possible applications for future HyspIRI data in post-fire vegetation management and assessment.

Decision Making Process:

Currently, the Forest Service operates the Burned Area Emergency Response (BAER) Mapping Support, Rapid Assessment of Vegetation Condition after Wildfire (RAVG), and Monitoring Trends in Burn Severity (MTBS) programs. All three initiatives make use of Landsat imagery (and occasionally other multispectral sensors such as SPOT) to generate geospatial products that are used to aid decision making regarding post-fire vegetation management. Additionally, the Forest Service RSAC also produces a fire burn scar product derived from MODIS data. Though a few Forest Service studies have examined the potential use of hyperspectral data to examine post-fire soil properties, the Forest Service does not use hyperspectral remote sensor data to generate BAER, RAVG, or MTBS standard products.

Earth Observations:

Platform	Sensor	Geophysical Parameter
ER-2 Aircraft	AVIRIS	Simulated HyspIRI Data: Burn Severity and Vegetation Condition
ER-2 Aircraft	MASTER	Simulated HyspIRI Data: Burn Severity and Vegetation Condition
Landsat 8	OLI	Vegetation Condition (Pre & Post Fire), Land Use/Land

		Cover, and Burn Severity
Landsat 5	TM	Vegetation Condition (Pre & Post Fire), Land Use/Land Cover, and Burn Severity
Terra	MODIS*	Vegetation Condition (Pre & Post Fire)
Aqua	MODIS*	Vegetation Condition (Pre & Post Fire)

NASA Earth Observations to be Highlighted:
Using simulated HyspIRI data created from AVIRIS and MASTER imagery collected during NASA's 2013 and 2014 airborne campaign, this project will produce post-fire burn severity and vegetation condition products comparable to the Forest Service's current Landsat-derived products. These products will then be compared to the existing Forest Service data layers to examine if and how HyspIRI can be used to improve current capabilities. This project will be novel in its approach by capitalizing upon the never-before-available capabilities of hyperspectral data at such high spatial and temporal resolution and wide swath extent. Moreover, this application holds great promise for enhancing the Forest Service's current Landsat-based decision support products and influencing their decisions regarding future use of HyspIRI data.

**Although MODIS will not be the primary sensor used in this project, MODIS vegetation products originally generated for use in the ForWarn decision support system will provide long-term observations and baseline data regarding regional vegetation condition.*

Ancillary Datasets:
- USDA Forest Service BAER, RAVG, and MTBS program products such as BARC, NBR, dNBR, RdNBR
- GIS shapefile delineating geographic coverage of Forest Service RAVG products (provided by Tony Guay, RSAC)
- Historic fire perimeter, burn scar, and MODIS Normalized Difference Vegetation Index (NDVI) data from the Forest Service *ForWarn* Forest Change Assessment Viewer
- California Department of Forestry and Fire Protection (CAL FIRE) Fire and Resource Assessment Program (FRAP) historic fire perimeter GIS shapefiles
- USDA Forest Service CALVEG vegetation classification GIS vector data layers
- Existing vegetation type and fire regime data products from LANDFIRE (Landscape Fire and Resource Management Planning Tools Program operated by U.S. Department of the Interior and the USDA Forest Service)
- USDA Farm Service Agency National Agricultural Imagery Program (NAIP) aerial photos from the Natural Resources Conservation Service (NRCS) Data Gateway

Decision Support & Analyses:

Proposed End Products	Decision Impacting	Current Partner Tool/Method
Normalized Burn Ratio (NBR) product	Estimating vegetation condition and burn severity. Allocation of post fire response resources	NBR products derived from Landsat and other multispectral sensors
Differenced Normalized Burn Ratio (dNBR) product	Estimating vegetation condition and burn severity. Allocation of post fire response resources	dNBR products derived from Landsat and other multispectral sensors

Relative Differenced Normalized Burn Ratio (RdNBR) product	Estimating vegetation condition and burn severity. Allocation of post fire response resources	RdNBR products derived from Landsat and other multispectral sensors
Burned Area Reflectance Classification (BARC) maps	Allocation of post fire response resources	BARC maps derived from Landsat and other multispectral sensors
Quantitative Product Comparison	Feasibility of utilizing HyspIRI imagery in the BAER, RAVG, or MTBS programs	None

NBR, dNBR, RdNBR, and BARC Map Products – HyspIRI data will be simulated by combining co-located AVIRIS and MASTER imagery. Then, using methods currently employed by the Forest Service, NBR, dNBR, RdNBR, and BARC map products will be generated from the HyspIRI imagery to depict and analyze post-fire vegetation conditions.

Quantitative Product Comparison – Results and accuracy of products derived from the simulated HyspIRI data will be quantitatively compared and contrasted to equivalent Forest Service products that have been derived from Landsat imagery. This analysis will assist in determining the feasibility of using future HyspIRI data for Forest Service post-fire decision support.

Project Details:
National Application Area Addressed: Disasters
Source of Project Idea: This project idea stemmed from the goal of conducting a simulated HyspIRI data project (platform-driven) and from discussions with members of the USDA Forest Service remote sensing and research ecology communities about their decision support needs (partner-driven).

Advisors: Joseph Spruce (Senior Scientist and Lead Science Advisor at NASA SSC), James "Doc" Smoot (Senior Scientist and Assistant Science Advisor at NASA SSC), Dr. Kenton Ross (DEVELOP National Science Advisor, LaRC)
# of Participants Requested: 5

Project Timeline: 2 Terms: 2014 Summer and 2015 Summer
Study Location: Southern California: areas that were imaged during NASA's 2013 HyspIRI airborne campaign (see Notes section below for details on specific fire locations to be studied)
Period being Studied: 2001(beginning of MODIS product availability in *ForWarn*) through 2013-2015 HyspIRI simulation airborne campaign

Previous Related DEVELOP Work:
California Disasters I: Assessing the Effectiveness of Simulated HyspIRI Data for Use in USDA Forest Service Post-Fire Vegetation Assessment and Decision Support - Summer 2014 (Stennis Space Center)

Multi-Term Objectives:
- **Term 1** – Burn severity indices and vegetation monitoring indices exploiting simulated HyspIRI "red-edge" bands were calculated for 2013 California wildfires. These products were visually comparable to Forest Service products produced from Landsat data. Partners and end-users were engaged regularly during the first term and example end products and methodologies were handed off digitally.

- **Term 2 (Proposed Term)** – Objectives for the proposed term include calculation of burn severity and vegetation monitoring indices for additional 2013 and 2014 California wildfires, as well as quantitative evaluation of simulated HyspIRI-derived products to further investigate if and how HyspIRI will provide improved capabilities beyond current Landsat-derived Forest Service products. Second term goals will also focus on partner engagement and hand-off. Upon project completion, results will be transferred to partners via "WebEx" style Videocon or Telecon, as well as through digital hand off of project deliverables and end products.

Notes: According to spatial analysis by and feedback from Tony Guay (Remote Sensing Specialist at RSAC), RAVG data are available for the following 2013 fires which occurred under the HyspIRI simulation campaign flight lines: 1) American, 2) Rim, 3) Carstens, 4) Aspen, 5) Powerhouse, 6) Hathaway, 7) Silver, and 8) Mountain. To facilitate comparison between existing Forest Service remote sensing products and the proposed HyspIRI-based products, a portion or all of these fires will be selected for analysis.

10. Idaho Disasters III (BLM-ISU)

Using Landsat Earth Observations to Identify Heightened Fire Susceptible Areas Due to Cheatgrass Invasion

Objective:

The proposed DEVELOP project will explore heightened fire susceptibility by identifying areas of cheatgrass infestation. The results of this study will benefit the broader fire community and extend the data products and technical capabilities of the RECOVER decision support system for use by the Bureau of Land Management and Idaho Department of Lands in southern Idaho.

Community Concern:

Wildfire is a common hazard throughout semiarid savanna ecosystems. Following fire, ground vegetation is typically eliminated, leaving the landscape devoid of cover. These communities may then experience a series of adverse changes due to landslides, soil erosion, and invasive plant infestations. Wildfires have occurred for millennia, but various factors appear to be increasing their frequency and intensity, creating a demand for advanced wildfire decision support capabilities. More specifically, project end-users can use the results of these analyses to "allocate resources to regions that are more susceptible to fires" (Mike Kuyper, BLM).

End-Users/Partners/Boundary Organizations:

Bureau of Land Management, Idaho State Office and Cooperating District Offices (End-User, POCs: Mike Kuyper, Natural Resource Specialist)
Idaho Department of Lands, Boise Field Office (End-User, POCs: Dixie Booker-Lair, GIS Analyst and Robin Dunn, GIS Specialist)
NASA RECOVER Project (Partner, NASA Goddard POCs: John Schnase, Mark Carroll; Partner/ Boundary Organization, Idaho State University POC: Keith Weber)

The GIS TReC at Idaho State University has worked in close collaboration with the BLM since 1999 on a variety of rangeland research projects, with many focusing on the effect of wildfire on rangeland health. More recently (2012) similar collaborations have begun with Idaho Department of Lands. Since the beginning of DEVELOP's Idaho Disasters project in the fall term of 2014, these relationships have only grown stronger. The Idaho Disasters I team (fall 2014) met with the project end-users in Idaho in October 2014. They discussed at length various products and tools that will be useful for the end-users. Results from the summer 2015 term will be incorporated into the ROSES-funded RECOVER platform which is currently available and used by

the end-users.

Decision Making Process:
Currently, the BLM uses vegetation moisture measurements that are collected at two-week intervals in discrete locations across the state. The measurements are collected from March to October by various national, state, local, and independent agencies and inputted into the National Fuel Moisture Database. At a recent meeting with end-users on March 17th it was discussed that these field data, coupled with a reliable map of cheatgrass infestation areas, will allow for more effectively allocation of resources to fight wildfires.

Earth Observations:

Platform	Sensor	Geophysical Parameter
Landsat	Landsat	NDVI, MSAVI2, Tassled cap transformed data
Terra	MODIS	NDVI, FPAR Vegetation quality

NASA Earth Observations to be highlighted:
The summer 2015 term is well timed as initial results from the spring term can be immediately implemented by end-users. In addition, refinements to the cheatgrass infestation areas map made during the summer term will be available relatively early in the term and accessible by end-users prior to the 2015 fire season, which may begin as early as mid-July. The success of this project hinges upon its timeliness and accuracy. Using 8-day and 16-day MODIS composite imagery as well as 16-day Landsat imagery will not only allow improved cheatgrass infestation area mapping but also a temporal visualization of vegetation phenology leading into the fire season.

Ancillary Datasets:
National Fuel Moisture Database – United States Forest Service Wildland Fire Assessment System Historic Fire polygons – RECOVER Geodatabase, ISU GIS TReC

Decision Support Tools & Analyses:

Proposed End Products	Decision Impacting	Current Partner Tool/Method
RECOVER Website Extension	Allocation of resources	Google imagery and field surveys.

RECOVER Website Extension – The cheatgrass infestation area map will be integrated into the RECOVER DSS and available to aid fire managers during the 2015 Idaho wildfire season. While it is still to be determined by further discussion with end-users, these data could be presented as either a single pre-fire description of vegetation land cover or as a temporal stack of pre-fire imagery allowing the end-user to view vegetation phenology leading up to a given fire.

Project Details:
National Application Area Addressed: Disasters
Source of Project Idea: This project is associated with Phase 2 operational deployment of the RECOVER DSS sponsored by NASA's Applied Sciences Program under ROSES A.35 - Wildland Fires (See Phase 1 and Phase 2 proposals titled " RECOVER: Rehabilitation Capability Convergence for Ecosystem Recovery — An Automated Burned Area Emergency Response Decision Support System for Post-fire Rehabilitation Management of Savanna Ecosystems in the Western US" for additional information).

Advisors: John Schnase, Mark Carroll (NASA GSFC), Keith Weber (ISU GIS TReC)
# of Participants Requested: 4 (ISU GIS TReC)

Project Timeline: 3 Terms: 2014 Fall to 2015 Summer
Study Location: Idaho
Period being studied: January 2015 – July 2015

Previous Related DEVELOP Work:
Idaho Disasters I: Using NASA Earth Observations to Create a Database and Determine Regional and Temporal Wildfire Susceptibility in Idaho Savannahs - Fall 2014 (GSFC and ISU GIS TReC)

Idaho Disasters II: Using NASA Earth Observations to Identify Savannah and Shrubland Vegetation in Southern Idaho - Spring 2015 (GSFC and ISU GIS TReC)

Multi-Term Objectives:

- **Term 1** – During this term, the team investigated the relationship between NDVI, surface temperature, and fire occurrence. The remote sensing parameters did not have any strong correlations with the number of fires each year. A secondary analysis compared the NDVI at locations that burned versus those that didn't burn. The participants found that in April the NDVI at burned locations was significantly higher than unburned regions, which may be an indicator of more fuel for fires later in the year.
- **Term 2** – The objective of this term was to use Landsat Imagery to identify vegetation at the plant functional group level. These vegetation maps aid the end-user as grasses (a fine fuel) exhibit different characteristics that make them more susceptible to fire relative to shrubs and trees.
- **Term 3 (Proposed Term)** – The goal of the final term is to further refine the vegetation layer with specific focus on cheatgrass infestation areas and the subsequent relationship with fire susceptibility. The resulting fire susceptibility map will aids wildfire managers in allocating resources prior to the active fire season.

Flooding

11. Thailand Disasters (Goddard)

Monitoring Risk and Extent of Flood and Drought for Enhanced Decision Making and Resource Allocation

Objective:
This project aims to improve near real-time flood inundation and drought monitoring techniques for Thailand by leveraging off of a previously created online flood dashboard and incorporating additional land and weather products into an enhanced agricultural drought severity index for Thailand.

Community Concern:
Situated in one of the most hazard prone regions of the world, Thailand is annually threatened by flooding and drought. Tools that can aid in mitigating this risk and improving resource allocation are of great use in response and resource management.

End-Users/Partners/Boundary Organizations:
Royal Thai Embassy (Collaborator/Boundary Organization, POC: Bunyakiat Raksaphaeng, Office of Science & Technology)
Asian Disaster Preparedness Center / SERVIR Mekong (Collaborator/Boundary Organization, POCs: Pete Cutter, Science & Data Co-Lead & Bill Crosson, Hub Science Coordinator)
Thai Department of Disaster Prevention and Mitigation (End-User, POC: TBD)

National Safety Council of Thailand (End-User, POC: TBD)

The Royal Thai Embassy initiated contact with NASA to discuss potential collaboration which sparked engagement with DEVELOP. Since May of 2014, the DEVELOP National Program Office has met multiple times with officials at the Embassy to discuss the collaboration - projects involved and the engagement of Thai Scholars on DEVELOP projects. Through these meetings the project topics were selected and the Embassy will serve as a liaison to organizations and decision makers in Thailand. Communication with the newly opened SERVIR Mekong hub has begun and final project objectives are being aligned with projects and initiatives they have outlined. ADPC/SERVIR Mekong will serve as the main point of contact for end-users in country.

Decision Making Process:
Currently, limited remote sensing inputs are used for flood forecasting and monitoring, and floodplain management.

Earth Observations:

Platform	Sensor	Geophysical Parameter
Landsat 8	OLI / TIRS	Multispectral to static water and flood levels
Terra	ASTER	DEM
TRMM	PR	Precipitation location & intensity
Terra/Aqua	MODIS	Daily reflectance values & composite NDVI
GPM	DPR	Precipitation location & intensity

NASA Earth Observations to be Highlighted:
Aqua/Terra MODIS, and Landsat 8 OLI data will be used to create flood impact maps based on vegetative indices and band specific thresholds. TRMM and GPM, once available, will provide valuable precipitation information that will help identify areas prone to inundation. The ISERV camera will provide high resolution optical imagery for validation of the flood mapping products emerging from the DEVELOP project.

Ancillary Datasets:
- NASA Near Real Time Global MODIS Flood Mapping (http://oas.gsfc.nasa.gov/floodmap/)
- TRMM Rainfall Accumulation: (http://trmm.gsfc.nasa.gov/publications_dir/hydro_model_2.html)
- International Water Management Institute (IWMI) Flood Mapping Products for Indonesia
- University of Maryland Global Flood Monitoring System (http://flood.umd.edu/)
- Dartmouth Flood Observatory (http://floodobservatory.colorado.edu/)
- TRMM Precipitation Accumulation Calculator (PAC)
- Stream gage data provided by the Mekong River Commission

Decision Support Tools & Analyses:

Proposed End Products	Decision Impacting	Current Partner Tool/Method
Flood Impact Maps	The Mekong River Commission manages urban and agricultural development	Similar, but outdated tools
Online 'Flood Dashboard'	Comprehensive visualization of flood extent and impacts for near-real time resource allocation during natural disasters	Flood prediction based on outdated land-use maps and SWAT model

Flood Impact Maps – Use MODIS NDVI data to reveal areas that have been historically inundated or damaged by flood water in calibrated 'level 2' map products, revealing areas prone to flood damage.

Online Flood Dashboard – Automatically map flood extent as well as severity of flood impacts, and precipitation data, in near-real time for disaster relief and mitigation.

Project Details:
National Application Areas Addressed: Disasters, Water Resources, Climate
Source of Project Idea: This topic was highlighted as a priority by the Royal Thai Embassy officials during multiple meetings with DEVELOP.

Advisor: Dr. John Bolten (NASA Goddard)
# of Participants Requested: 5

Project Timeline: 1 Term: 2015 Summer (Start/Completion)
Study Location: Thailand
Period being Studied: 2000 to present

Previous Related DEVELOP Work:
Southeast Asia Disasters I/II/III: Utilizing NASA Earth Observations to Improve Flood Impact Mapping and Mitigation in Southeast Asia. Spring 2014-Summer 2014-Fall 2014 (DEVELOP Goddard)

12. Peru Disasters II (Wise)

Identifying and Mapping Flood Prone Regions in the La Libertad Region of Peru using NASA's Earth Observations

Objective:
The main objective is to utilize NASA Earth Observations and mathematical models to produce historic and predictive flood maps for the La Libertad Region in Peru.

Community Concern:
Water For People, a non-profit organization currently working with the Peruvian government to establish better water resources management systems lacks adequate local datasets necessary for their projects. Additionally, they also aim at assisting the Peruvian government with flood risks mitigation, an important part of water resources management. As reported by ReliefWeb, a service provided by the UN Office of Humanitarian Affairs (OCHA), in 2008, floods in Peru affected over 45,012 people, and resulted in enormous economic losses. These losses particularly affected the agriculture sector, which is the largest source of income for Peru (contributing13% of the Gross Domestic Product, and employs approximately 10,000,000 Peruvians).

End-Users/Partners/Boundary Organization:
Water for People (Boundary Organization, End-User, POC: Mark Duey, Head of Program Quality, and Francisco Soto, Director for Peru)
Instituto Nacional de Defensa Civil del Peru (INDECI) (End-User, POC: Miguel Angel Saldarriaga Jiron , Direccion Desconcentrada de INDECI La Libertad)

Water for People conduct their work in three stages: determining the water balance, determining the water security and developing a comprehensive water management plan (which includes assessing flood risk). Peru Water Resources management projected conducted

during Fall 2014 and Spring 2015 developed tools and methodologies required to determine different parameters of water balance. The proposed project will assist the partners to utilize NASA Earth observations and mathematical models to achieve the last step – flood risk assessment. INDECI is directly responsible for disaster management in Peru. Partners from Water for People are currently in contact with INDECI and Consejo de Cuenca who will partner with DEVELOP. The end results could be used to produce flood inundation maps and along with the model outputs, it will help the partners to utilize in further decision making.

Decision Making Process:

Current flood disaster management plans are incomplete and there are not enough proactive plans to handle widespread disaster. Development of an effective flood warning system has not advanced properly due to several factors such as lack of accurate rainfall and geophysical data and the ability to produce and disseminate near real time flood hazard maps. The project would assist local policy makers to develop stronger and research-backed efforts to better manage floods. The end results will enable the partners to utilize satellite data and cost effective models to simulate, predict and better understand floods in the study area.

Earth Observations:

Platform	Sensor	Geophysical Parameter
Landsat 5	Thematic Mapper (TM)	Surface Reflectance
Landsat 8	Operational Land Imager (OLI)	Surface Reflectance
Aqua/Terra	Moderate Resolution Imaging Spectroradiometer (MODIS)	Surface Reflectance
Tropical Rainfall Measuring Mission (TRMM)	Multi Satellite Precipitation Analysis - Precipitation Radar (PR)	Rainfall
Terra	Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER)	Elevation data

NASA Earth Observations to be Highlighted:

Landsat 8 (OLI) / Landsat 5 (TM) – Landsat imagery will allow visual identification of the flooded regions. A supervised classification map can help to identify flood affected areas. Normalized Differential Water Index (NDWI) maps can be calculated to delineate water from the surrounding area

Aqua/Terra (MODIS) – MODIS surface reflectance data can be utilized in case of large study areas to identify flooded regions

TRMM (PR) – Precipitation measurements from TRMM gives rainfall data which will be used as an input for hydrologic models.

Terra (ASTER) – Elevation data from ASTER will be used as inputs for flood models

Ancillary Datasets:

- Modern Era Retrospective-Analysis for Research and Applications (MERRA)
- Temperature data from Giovanni Database
- Rain gauge data from local weather stations
- CMORPH and QMORPH data from Climate Prediction Center, NOAA
- Geology maps from Indice de Cartas Geologicas

Models:

Integrated Flood Analysis System (IFAS) - POC: Brett Sanders - professor at the University of California Irvine in the Civil and Environmental Engineering department. He has used IFAS in South Korea for the Gamcheon basin.

MicroDEM - POC: Rohini Swaminathan -graduate from Perdue with a Masters in Geomatics and past NASA DEVELOP Participant. She has worked with MicroDEM in past projects.

Decision Support and Analysis:

Proposed End Products	Decision Impacting	Current Partner Tool/Method
Flood Inundation Map	Planning evacuation routes, insurance coverage and urban planning	Aerial imagery and field surveys.
Flood Risk Map	Planning evacuation routes, insurance coverage and urban planning	Aerial Imagery and field surveys (flood risk maps are currently available only for coastal regions prone to tsunami)
Interactive Web Map	User friendly deliverable for partners to be able to easily access products for decision support	N/A

Flood Inundation Map – Inundation maps show the extent of flooding expected spatially over a given area. Maps of this nature can be used to enhance flood risk preparedness, communication, warning, response and mitigation. Landsat 5 and Landsat 8 surface reflectance data will be used to derive flood inundation maps.

Flood Risk Maps – Flood risk maps that take into account socio economic as well as geographic parameters will provide a detailed product highlighting the risk associated with specific areas. Combining elevation data from ASTER, rainfall data from TRMM and in situ data (depends on availability) and by weighing each parameter, flood risk maps will be derived.

Interactive Web Map – A utility that will incorporate the data derived from our models as toggle layers. The web map will be comprised of our study area and flood datasets deemed suitable for end user analysis. This will be a user friendly mechanism for our partners to use in order to easily enhance their decision making.

Project Details:
National Application Area Addressed: Disasters, Water Resources
Source of Project Idea: DEVELOP has worked on three projects with Peru in previous terms which led to contacts with Water For People. The proposed project originated during a discussion with the partners from Peru during Fall 2014 closeout.

Advisor: Kenton Ross, NASA DEVELOP National Advisor
# of Participants Requested: 5

Project Timeline: 2 terms: 2015 Spring (start) to 2015 Summer (Completion)
Study Location: Ochape district, Peru
Period being studied: 2007 – 2014 (3 major floods identified during 2008, 2013 and 2014)

Previous Related DEVELOP Work:
Peru Water Resources I: Utilizing NASA EOS Evapotranspiration data to assist in the development of water budget for Gran Chimu Province, Peru - Summer 2014 (Langley)

Peru Water Resources II: Utilizing NASA Earth Observations to Develop a Comprehensive Water Budget for La Libertad region, Peru - Fall 2014 (Wise)

Peru Water Resources & Disasters: Utilizing NASA Earth Observations to Develop a Comprehensive Water Resources Management Plan for Asunción district in Cajmarca province, Peru - Spring 2015 (Wise)

Multi-Term Objectives:

- **Term1** - In this term we provided our partner with tools that would help them better their efforts in creating water security for Peru. We developed a SWAT model for the Asunción district within the Cajamarca Province. The team did as much validating and calibration as could be achieved with the available historical data. Tutorials were created so that our partners could completely calibrate the model as time progressed with additional data. This term the team was able to get support from ARSET to develop webinars that provided our partners with the knowledge and methodology that will allow them to create the SWAT model where needed and the ability to disperse it to other organizations. During this term flood areas were located through help with our partners. The team began researching flood models for these areas in order to be prepared to focus primarily on floods in the next term.
- **Term2 (Proposed term)** - The main focus of this term will be on flood modeling in identified study areas and deriving flood inundation maps. Landsat data will be used to produce historic flood maps to better understand the severity and also in model validation. IFAS model will be utilized for flood modeling. Tutorials will be created in both English and Spanish to assist the local and federal partners in knowledge transfer. In addition, an interactive web will be created to make the data created from these models easily accessible to ease decision making support.

13. Malawi Disasters II (IRI)

Applications of Flood Definitions and NASA Earth Observations to Create a Flood Forecasting Tool Targeting Region-Specific Flood Types

Objective:

This project continues and builds upon the research of its predecessor in attempting to create an early warning flood detection and prediction product. The product will target specifically defined flood types that are applicable to the specific regions of interest. The project will focus on using previously developed flood definitions to assess where skill can be found with the various products, as well as their utility in specific areas and with particular flood types, to assist in the prediction of the flood events.

Community Concern:

Globally, floods are among the most devastating natural disasters affecting human livelihoods and economic resources. Flooding can occur due to a range of catalysts such as heavy rainfall, rapid snowmelt, monsoons, broken levees and dams, and storm surge, and events can last for varying time periods as well, from hours to several weeks. Given this information, creating a model tailored to specific regions for distinct flood types is crucial in creating an effective early warning system. Producing this early warning system would be a great benefit to the affected regions, both in terms of economic cost and human cost. Along with the direct threat of floods, previous studies have linked inundation to outbreaks of vector-borne diseases. Future work on this project could work on using the new inundation products to create an Early Warning System (EWS) tool for both flooding as well as outbreaks of vector-borne diseases.

End-Users/Partners/Boundary Organizations:

Red Cross / Red Crescent Climate Centre (RCRCCC) (Boundary Organization, POC: Erin Coughlan, Senior Climate Specialist)

Red Cross: Malawi and Regional Office for southern Africa (End-Users, POC: Hastings Kandaya, Director of Programmes and Development)
Regional Centre for Mapping and Resources for Development (RCMRD) (Boundary Organization, POC: Denis Macharia, Disaster Lead)

Decision Making Process:
The use of accessible remotely sensed data is critical to project partners as it increases the temporal and spatial scales of proposed projects. Currently, the end-users have the International Federation of Red Cross (IFRC) extreme heavy rainfall forecast tool at their disposal, but not all inundation is related to heavy rainfall. Examining the skill of the heavy rainfall forecast, along with how it correlates to inundation, can help improve flood risk maps. With these newly created products in the IRI data library, project partners at the RCRCCC will be able to better prepare countries for both inundation events and for epidemiological outbreaks of vector borne diseases.

Earth Observations:

Platform	Sensor	Geophysical Parameter
QuikSCAT	SeaWinds	Inundated areas
Terra	MODIS	Inundated areas, water body delineation
Aqua	MODIS	Inundated areas, water body delineation
Aqua	AMSR-E	Inundated areas, water body delineation
Landsat 7	ETM+	Water body delineation
Landsat 8	OLI/TIRS	Water body delineation
ALOS	PALSAR	Inundated areas
TRMM	TMI	Precipitation

NASA Earth Observations to be Highlighted:
The project will focus on developing new methods to map water bodies and inundated areas based on PALSAR on ALOS, Aqua AMSR-E, QuikScat SeaWinds, Aqua and Terra MODIS, Landsat 7 ETM+, Landsat 8 OLI and TIRS, and GCOM-W1 AMSR-2 data. The team will crosscheck the water bodies with data from three sources; the CUNY/SWaMPS inundated fraction values, the NASA Goddard Space Flight Center MODIS Near Real-Time Global Flood Mapping Project (NRT-GFM), and the Dartmouth Flood Observatory (DFO).

Decision Support Tools & Analyses:

Proposed End Products	Decision Impacting	Current Partner Tool/Method
Framework for monitoring different types of floods	How to locate the areas of greatest impact during a flood event.	IFRC Heavy Rainfall Forecast
Early Warning System	Where and how to allocate resources before a flood event occurs	IFRC Heavy Rainfall Forecast

Early Warning System – After the best method(s) of identifying flood inundation have been selected, they will be used in an attempt to validate and build upon the IFRC forecasts to design a more accurate early warning system for flood events.

Project Details:
National Application Area Addressed: Disasters
Source of Project Idea: The idea for the project originated from three terms of work on understanding the relationship between leishmaniasis and flood inundation. The team learned

that forecasting floods was actually more difficult than anticipated and that lumping all flood types into a single category was not a viable solution to flood monitoring or prediction.

Advisor: Dr. Pietro Ceccato (Research Scientist, Lead Environmental Monitoring Program, The International Research Institute for Climate and Society, The Earth Institute, Columbia University)
# of Participants Requested: 2

Project Timeline: 2 Terms: 2015 Spring to 2015 Summer
Study Location: Malawi
Period being Studied: 1985-2014

Previous Related DEVELOP Work:
Fall 2013 (IRI): Sudan Health and Air Quality - Using MODIS, Landsat, and TRMM to better understand the dynamics of water bodies in relation to Leishmaniasis (Kala Azar) in Sudan

Spring 2014 (IRI): East Africa Health and Air Quality I - Using NASA Earth Observations as a Tool for Understanding the Relationship between Rainfall Extreme Events and Inundation in East Africa to Predict Epidemic Dynamics

Summer 2014 (IRI): East Africa Health and Air Quality II - Creating a Flood Forecasting Tool Using NASA Earth Observations Built on the Understanding of the Relationship between Rainfall Extreme Events, Inundation, and Epidemic Dynamics in East Africa

Fall 2014 (IRI): East Africa Health and Air Quality III - Using a Flood Forecasting Tool Built from NASA Earth Observations and Creating Inundation and Epidemiological Early Warning Systems to understand the relationship between Rainfall Extreme Events, Inundation, and Epidemic Dynamics in East Africa

Spring 2015 (IRI): Malawi and Botswana Disasters - Creating a Flood Forecasting Tool Derived from NASA Earth Observations and Based on Flood Definitions

Multi-Term Objectives:
- **Term 1** – This project started the creation of an early warning flood detection and prediction product series. The project focused on defining which types of floods were prone to specific regions and determining the best products to monitor and predict those floods.
- **Term 2 (Proposed Term)** – This project will continue and build upon the research of its predecessor in creating an early warning flood detection and prediction product. The product will target specifically defined flood types that are applicable to the regions of interest. The project will focus on using the previously stated flood definitions to assess where skill can be found with the various products, as well as their utility in specific areas and with particular flood types, to assist in the prediction of the flood events.

14. Southwest US Disasters (NCDC)

Incorporating Atmospheric Teleconnections and CDRs to Create a Predictive Model of Post-Burnout Flood Risk

Objective:
The objective of this project is to incorporate atmospheric teleconnections to create a statistical model which utilize PERSIANN and NDVI Climate Data Records (CDRs) to predict the risk of post-burnout flooding.

Community Concern:
Wildfires and flooding are two major disasters which cause economic damage and loss of life in the Southwest. Flood events that occur after periods of wildfires can lead to an increase in soil erosion and larger debris in flood waters. Predicting the risk of these events is vital. Atmospheric teleconnections have been shown to impact precipitation, leading to periods of low or high precipitation. Incorporating this influence can lead to improved predictive capability of the potential for post-burn-out flood events.

End-Users/Partners/Boundary Organizations:
Global Science & Technology (GST) National Climatic Data Center (NCDC) (Partner, POC: DeWayne Cecil, Chief Climatologist and Program Manager)
Climate Assessment for the Southwest (CLIMAS) (Partner, POC: Dr. Gregg Garfin, Investigator)
Western Regional Climate Center (WRCC) (Partner, POC: Dr. Tim Brown, Director)
USGS Landslide Hazards Program (Partner, POC: Dennis Staley, Research Physical Scientist)
National Interagency Coordination Center Predictive Service (NICC-PS) (Potential End-User, POC: Ed Delgado, Meteorologist)

Contact has been made with all the partners and the potential end-user. Dr. Garfin provided feedback on the project idea several times and the team has maintained strong communication with him throughout the process. Dr. Brown has expressed interest in the project and preliminary discussions on the direction of the project have already occurred. Ed Delgado was referred as a contact for the potential end-user by Dr. Garfin. Dr. Garfin and Dr. Brown will both provide feedback and input throughout the project. Dr. Garfin has agreed to act as a science advisor for the project. Ed Delgado will provide input in terms of what end products and analysis would best serve his and the Predictive Service's needs. Dennis Staley is a research working within the USGS Landslide hazards Program. He has worked to design the Emergency Assessment of Post-Fire Debris-Flow Hazards tool, which estimates debris volume and risk after a fire. We plan to reach out and work with him to incorporate his insight into the project.

Decision Making Process:
The National Interagency Coordination Center Predictive Service bridges various services and combines resources from several federal agencies including, but not limited to, Federal Emergency Management Administration, USDA Forest Service, and US Fish and Wildlife to aid in wildfire suppression. These resources range from estimates of fuels and fire danger to monthly outlooks of precipitation and drought status. These services aid local and regional agencies in their ability to respond to and mitigate wildfire and its impacts. The USGS Landslide Hazards Program currently has a tool for estimating the likelihood of post-fire debris flow and the debris volume. The tool only estimates the risk of debris flow and not flash-flooding and flooding risk. The tool also does not incorporate the influence of atmospheric teleconnection or provide seasonal outlook of post-fire flood risk. This is a gap in existing tools that this project aims to address.

Earth Observations:

Platform	Sensor	Geophysical Parameter
PERSIANN-CDR	GridSat-B1	Infrared water vapor
NDVI-CDR	Advance Very High Resolution Radiometer (AVHRR) Level 1B	Reflectance & brightness temperature
CMORPH - CDR	Passive microwave and infrared from several geostationary satellites	Precipitation rate
Terra	ASTER	Digital Elevation Model (DEM)
Landsat7 & 8	Operational Land Imager (OLI)	Land cover change detection

NASA Earth Observations to be Highlighted:
This project will utilize the ASTER sensor aboard the Terra platform to gain a Digital Elevation Model to calculate slope for our given study area. The two National Oceanic and Atmospheric Administration (NOAA) National Climatic Data Center (NCDC) Climate Data Records (CDR) to be incorporated in this study are Precipitation Estimation from Remote Sensing Information using Artificial Neural Network CDR (PERSIANN-CDR) and Normalized Difference Vegetation Index CDR (NDVI-CDR). The PERSIANN-CDR will be used to estimate daily precipitation in our study area. Daily NDVI values will come from the NDVI-CDR and provide estimated vegetation greenness.

Ancillary Datasets:
Other datasets could include NOAA stream flow and flood datasets
Burn data will come from Landfire.gov. If time permits Landsat data will also be used to estimate burn severity and extent.

Software & Scripting Utilized:
Software package - use/data

- Python – Data Processing and Data Conversion
- ArcGIS - Raster Manipulation/Analysis, Image Enhancement, & Map Creation
- ENVI – Land Cover Classification
- R –Stepwise Regression, Logistic Regression

Decision Support Tools & Analyses:

Proposed End Products	Decision Impacting	Current Partner Tool/Method
Teleconnection Post-Burnout Flood Risk	This information will help the end users better target preventative measures at the beginning of each fire season based on the predicted atmospheric teleconnection for the season.	USGS Emergency Assessment of Post-Fire Debris Flow Hazards Tool. This tool estimates risk and volume of debris flow immediately after a fire occurs.
NDVI Extended Post-Burnout Flood Risk	This tool allows the end-user to see how vegetation regrowth impacts the risk of post-fire flooding 4 months after the initial start of the fire. This can be used to improve post-fire risk of the previous and existing tools.	Nothing specific. The USGS Emergency Assessment of Post-Fire Debris Flow Hazards tool does not account for risk for an extended period after a fire.

Post-Burnout Flood Risk – This end product will be a set of maps which depict the risk of post-burnout flooding events based on each phase of the most influential atmospheric teleconnections. Different atmospheric teleconnections can lead to conditions that would inhibit or enhance the likelihood of a post-burnout flood even. Atmospheric teleconnections are not accounted for in the existing tools to assess post-fire flooding.

NDVI Extended Post-Burnout Flood Risk – This tool allows the end-user to see how vegetation regrowth impacts the risk of post-fire flooding 4 months after the initial start of the fire. Current literature indicates that it can be up to two years after the initial fire before post-fire flood risk returns to pre-fire levels. Vegetation regrowth is a big factor in how quickly these pre-fire levels are reached. This aspect of post-fire flood risk is not currently incorporated in the USGS Emergency Assessment of Post-Fire Debris Flow Hazards tool.

Project Details:
National Application Areas Addressed: Disasters, Climate

Source of Project Idea: The idea for this project initiated from several conversations between the Fall 2014 Southwest Climate team, Dr. Garfin, and Dr. Tim Brown.

Advisors: Dr. DeWayne Cecil (GST/CDR) Gregg Garfin (CLIMAS), Dr. Tim Brown (WRCC)
# of Participants Requested: 3

Project Timeline: 1 Term: 2015 Summer
Study Location: Southwest US – Southern California, Arizona, New Mexico, Western Texas
Period being Studied: 1998 - 2014, May - October