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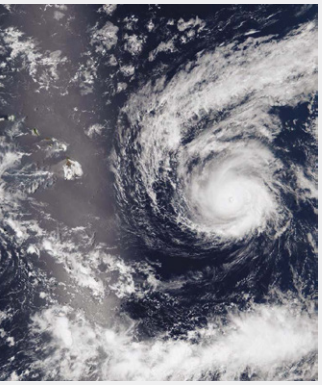
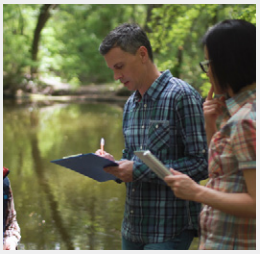
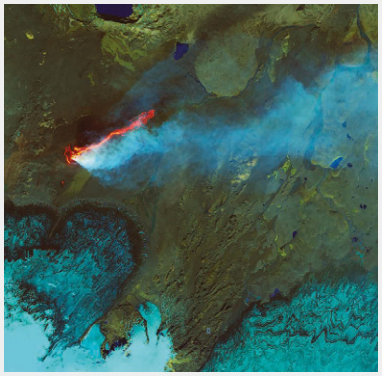
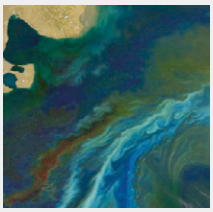






2018
Annual Summary

NASA Earth Science
Applied Sciences Program

Capacity Building

2018 Capacity Building Calendar Year Summary

Contents

Welcome

Welcome to the Capacity Building Program's 2018 Annual Report. It has been an exciting year for the program as we continue our pursuit to increase awareness and use of Earth observations. 2018 was record-breaking and saw the program's reach increase with the highest number of individuals (30% increase over 2017) and institutions (24% increase) engaged and with the broadest reach to date (146 countries). It was also a year of significant milestones – DEVELOP celebrated its 20th anniversary, SERVIR selected its 5th hub location, and ARSET began providing self-paced trainings. On behalf of the Capacity Building Program Team, I'd like to thank our many stakeholders that help us impact so many across the globe. We invite you to read on to learn about our 2018 highlights and accomplishments.

Dr. Nancy D. Searby
Capacity Building Program Manager

I. Introduction

The Earth Science Division's (ESD) Applied Sciences Program (ASP) promotes efforts to discover and demonstrate innovative and practical applications of Earth observations. ASP activities partner with organizations from the public and private sectors to apply scientific findings and satellite data in their decision-making activities. The Program has three primary lines of business: Applications, Capacity Building, and Mission Planning. All Program activities support goals to deliver near-term uses of Earth observations, build capabilities to apply Earth science data, and contribute to satellite mission planning.

The Applied Sciences' Capacity Building Program (CBP) builds capacity around the globe in an effort to expand the Earth-observations user base and increase awareness within non-traditional audiences of NASA Earth observations data and products. CBP engages across the ASP Application Areas portfolios of Water Resources, Disasters, Ecological Forecasting, Health & Air Quality, and Agriculture & Food Security, as well as other application areas including Energy, Urban Development, and Transportation & Infrastructure. The Capacity Building Program works through both program and element activities. Program activities include participating in domestic and international capacity building groups, such as the Group on Earth Observations (GEO) and the Committee on Earth Observation Satellites (CEOS), as well as identifying partnership opportunities to reach new end-users like the Indigenous Peoples Initiative and the creation of an interactive mapper. CBP supports three Elements, including Applied Remote Sensing Training (ARSET), DEVELOP, and SERVIR.

Element & Initiative Descriptions

ARSET empowers the global community through remote-sensing trainings. Through online and in-person trainings, participants learn how to use NASA Earth data, applications, and models. Participants can then apply these free resources to environmental management and decision support. Trainings are intended for policymakers, non-governmental organizations (NGOs), and other applied science professionals. To access the training materials, join the listserv, and learn about upcoming activities, visit http://arset.gsfc.nasa.gov/.

DEVELOP addresses environmental and public policy issues by conducting interdisciplinary feasibility projects that apply the lens of NASA Earth observations to community concerns. Bridging the gap between NASA Earth Science and society, DEVELOP provides workforce development opportunities for both participants and partner organizations to prepare them to address challenges that face our society and future generations. To learn more about DEVELOP, view previous projects, and propose a project idea, visit http://develop.larc.nasa.gov/.

SERVIR, a joint development initiative of NASA and the US Agency for International Development (USAID), works in partnership with leading regional organizations around the globe to help developing countries use information provided by Earth-observing satellites and geospatial technologies for managing environmental risks and land use. SERVIR empowers decision makers with tools, products, and services to improve awareness and increase access to Earth observations and geospatial data in Eastern & Southern Africa, West Africa, Hindu Kush Himalaya, and Lower Mekong. For more information about SERVIR and its network of regional hubs, visit www.servirglobal.net/.

Capacity Building Initiatives & Affiliated Activities:

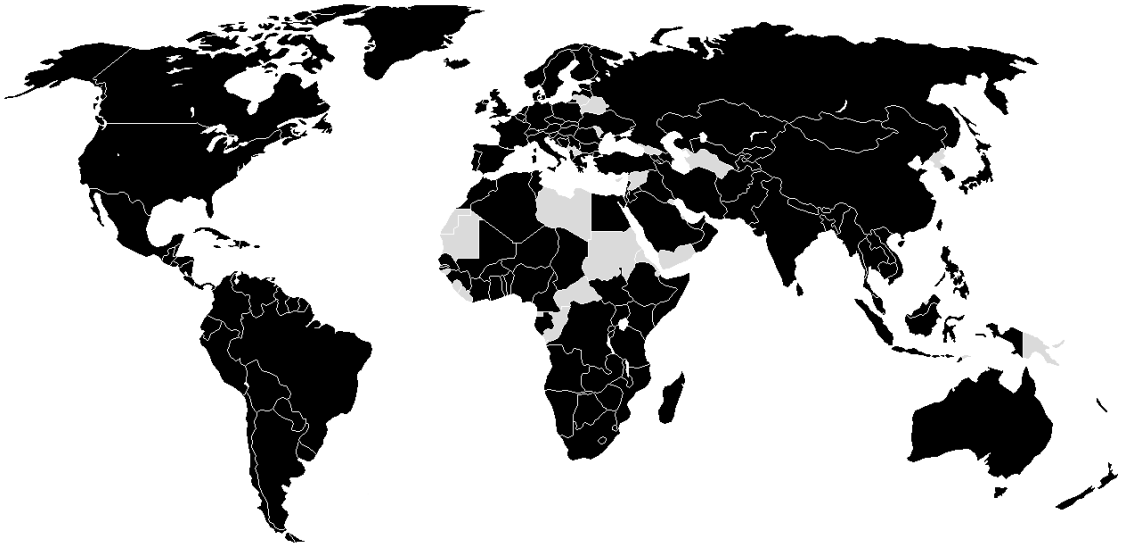
- The **Indigenous Peoples Pilot Project** focuses on building relationships between NASA and indigenous communities through remote sensing training, community engagement, and research opportunities. This pilot project aims to increase the capacity for tribal communities to continue to use NASA resources alongside Indigenous Knowledge for continued sustainable resource management.
- The **A.50 AmeriGEO** and **Human Planet projects** are managed by CBP and are a subset of a broader portfolio which represent a significant US Group on Earth Observations (USGEO) contribution to the GEO Work Programme for 2017-2019 and 2020-2022. For more information about the larger initiatives to which these projects are contributing, visit: https://www.amerigeoss.org and https://ghsl.jrc.ec.europa.eu/HPI.php. An overview and summary of these affiliated projects is included separately in section VII below.

II. 2018 Overview

Throughout 2018, the Capacity Building Program refined and strengthened its many contributions to the Agency. CBP achieved the following impacts "by the numbers" in 2018:

8,600: Individuals Engaged
2,944: Institutions Engaged
59: Custom Services & Tools
65: Feasibility Projects
85: Trainings Given
55: Earth Observation Assets Applied
50: U.S. States Impacted
146: Countries Impacted
20: Peer-Reviewed Publications
8: Application Areas Addressed
78: Conferences & Meetings Attended

The Capacity Building Program's global impact can also be shown "by the map" for 2018:



Black denotes the 146 countries reached by CBP activities; gray denotes countries not impacted

III. Accomplishments & Highlights

Programmatic Accomplishments

Throughout 2018, the program worked within its strategic goals to expand the networks of individuals and institutions aware of, able to access, and able to apply Earth observations. In support of these activities, the program continued to use a strategic framework focused around the needs of individual and institution end users.

2018 was a record-breaking year for CBP. The program engaged 8,600 individuals and 2,944 institutions with a geographic reach of all 50 U.S. states and 146 countries. Geographic reach was mapped by including project study areas and locations of end-users and individuals engaged in CBP activities. The program supported 85 trainings, 59 custom services and tools, 65 feasibility studies, 16 multi-year projects, and published 20 peer-reviewed journal articles in 2018. CBP participated in a total of 78 events, including 39 conferences, 23 meetings and workshops, and 16 NASA science team meetings and panel reviews.

Program elements had a productive year in 2018. Accomplishments and highlights are summarized below.

In 2018, **ARSET** conducted six in-person trainings, ten online trainings, and one new self-guided online training. Through the 16 trainer-led offerings, ARSET produced 140 presentations in English and Spanish, and launched a new self-guided training platform. ARSET also began posting recorded trainings to the NASA Video YouTube channel. There were 6,362 instances of live participation in trainings and 22,130 views of recorded online trainings. ARSET engaged 2,570 organizations in its trainings, with more than 1,505 organizations being new to the program. The program reached attendees that work in 138 countries.

The most popular ARSET training in 2018 was the A*dvanced Webinar: Radar Remote Sensing for Land, Water, & Disaster Applications,* with 1,039 participants. The dual-language training had one Spanish session and one English session, and has been viewed through ARSET's new on-demand trainings. Since the live training, the recordings have been viewed more than 4,400 times, with nearly 1,500 views of the Spanish sessions.

DEVELOP had a dynamic 20th anniversary year, engaging 308 participants and 121 partner organizations through 65 projects that took place at 13 office locations. These projects and the participants that conducted them impacted 46 U.S. states and 22 countries. In January 2018, DEVELOP expanded its network through the establishment of a new node in Boston, Massachusetts, hosted by Boston University with lead collaborators from the USGS Woods Hole Coastal and Marine Science Center. The program presented project results and participated in 35 science and policy conferences and meetings, co-chaired sessions at two conferences (American Geophysical Union (AGU) Fall Meeting and American Association of Geographers (AAG) Annual Meeting), and supported five NASA review panels. The program also had five peer-reviewed journal publications and continued its video series highlighting the use of Earth observations in decision making, with over 34,000 YouTube views in 2018.

In 2018, **SERVIR** was active in 41 countries, with four regional hubs located at the Regional Center for Mapping of Resources for Development (RCMRD) in Nairobi, Kenya; the International Centre for Integrated Mountain Development (ICIMOD) in Kathmandu, Nepal; through a consortium led by the Asian Disaster Preparedness Center (ADPC) in Bangkok, Thailand; and through a consortium led by Agriculture, Hydrology and Meteorology Regional Center (AGRHYMET), based in Niamey, Niger, as well as the Science Coordination Office (SCO) in Huntsville, AL, the SERVIR Support Team, and the SERVIR Applied Sciences Team (AST). The program had 42 custom services in development or delivery stages and conducted 65 trainings during the year. As part of these services, SERVIR developed, oversaw, enhanced, or launched 17 applications and tools, including data inputs for agricultural crop condition reports at the regional and national level; web applications for streamflow forecasts and flood forecast

and mapping; and an online resource developed in partnership with UN's Food and Agriculture Organization (FAO). This was designed to simplify surveying and sample collection and incorporating crowdsourcing techniques for land cover monitoring and forest classification. These products and tools operate based on data from 27 different satellite instruments. A total of 1,907 people were trained in the use of SERVIR tools, technologies, data, and methodologies, with a total of 249 institutions engaged. Approximately 36 new institutions improved their capacity to address issues relating to changing environments through engagement with SERVIR activities.

In 2018, the **Indigenous Peoples Pilot** project conducted three in-person trainings, attended multiple conferences, and organized an advisory workshop with tribal members and NASA managers. Two trainings were held in collaboration with the Samish Indian Nation, in northwest Washington, in January and October 2018. The two-part training focused on an introduction to remote sensing and advanced training focused on change detection and land cover classification. In northern Michigan in October 2018, a training was held in collaboration with the Sault Ste. Marie Band of Chippewa. A training on remote sensing and use of drones for environmental monitoring was jointly provided by NASA and the University of Michigan. The team trained 23 participants, from 11 different tribal groups, one federal agency, and 3 U.S. states. The team also organized a workshop in Red Cliff, WI in May 2018. The meeting, held with tribal members and NASA managers, focused on: 1) the identification of partnership and capacity building challenges and barriers between with NASA and tribal nations, 2) techniques to reduce these barriers, and 3) recommendations of next steps for the Indigenous Peoples Pilot Project and other NASA efforts to engage with and be include of tribal nations.

Highlight Events & Activities

The Capacity Building Program's activities are best illustrated by highlighting events and activities that delivered Earth observations to decision makers. Top highlights for 2018 are as follows:

ARSET has offered materials in Spanish for multiple years, but in 2018 ARSET presented two, advanced-level trainings in Spanish. Both *Radar Remote Sensing for Land, Water, & Disaster Applications* and *Processing Satellite Imagery for Monitoring Water Quality* were presented in two sessions: one in English and one in Spanish. As a result of these bilingual trainings, targeted outreach, and a long-term relationship of presenting high quality materials, ARSET reached attendees in every Latin American country in 2018.

In recognition of the 20th anniversary and its many accomplishments throughout the years, DEVELOP pursued several activities throughout 2018 to reconnect with alumni and past project partners, engage with the applied science community, and highlight DEVELOP's broad impacts. The program hosted "DEVELOP Day" events to recognize the unique contributions from each of its 13 locations and had a special DEVELOP anniversary presentation at the Annual Earth Science Applications Showcase at NASA Headquarters in August. Additionally, DEVELOP's 20th anniversary was featured in articles in NASA's *The Earth Observer* and on NASA.gov.

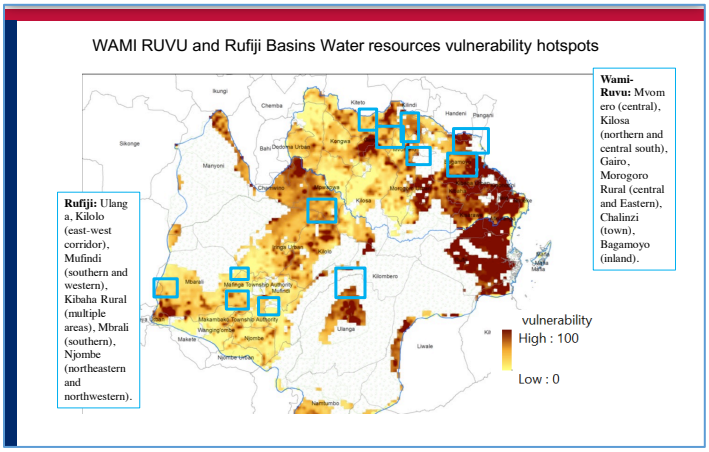
DEVELOPers authored five peer-reviewed journal articles and two articles on the LPDAAC website. DEVELOP projects were highlighted in media venues such as *Nevada Planner*, NASA's *Earth Observatory*, and in a 'Benefits to You' feature on NASA.gov. DEVELOP's people and projects were recognized through a series of awards including AGU's Data Visualization & Storytelling Contest, NASA's Silver Achievement and Exceptional Service Medals, and two United States Geospatial Intelligence Foundation (USGIF) Scholarships.

During 2018, 16 projects selected for the NASA Research Opportunities in Space and Earth Sciences (ROSES) SERVIR 2015 AST made significant progress in achieving Year Three milestones. Each of the ROSES projects conducted collaborated with a regional SERVIR hub – Eastern and Southern Africa (E&SA), West Africa, Hindu Kush Himalaya (HKH), and the Lower Mekong region of Southeast Asia) – based on needs identified for that region. These projects included tools such as the Early Warning eXplorer (EWX), Climate Hazards Infrared Temperature with Stations Maximum Temperature (CHIRTS-max), and South Asia Land Data Assimilation System (SALDAS) products described in this section and in brief summaries by region below. The AST projects increased their Application Readiness Level (ARL) by an average of over 2 by the end of calendar year 2018. Targeting a balanced portfolio in water and water-related disasters, food security and agriculture, weather and climate, and land use and ecosystems application areas, the projects continue to become increasingly integrated with the hubs. A key metric of this AST relates to integrating efforts within the scientific fabric of SERVIR as a whole. In particular, the Tethys platform, developed by HKH AST Principal Investigator (PI) Dr. Jim Nelson's team, lowered the barrier for developing hydrologic web applications and is being used across all hubs.

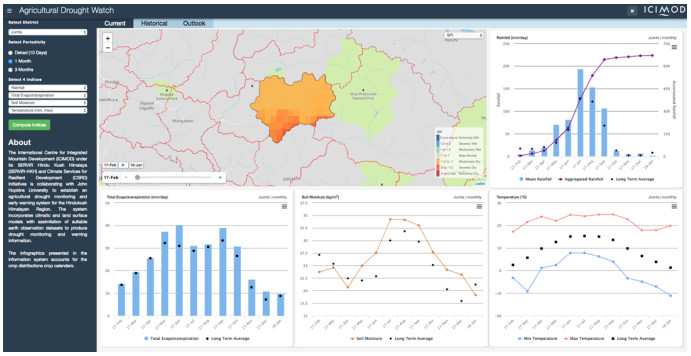
SERVIR continued to develop strategies for maturing its services and growing and strengthening existing partnerships. Several coding and production sprints were held during the year (including the West Africa Google Earth Engine Hackathon, held in San Francisco, California, in March following the SERVIR Geospatial Information Technology Exchange). Partnerships reached a new level of maturity during 2018 with FAO and the launch of Collect Earth Online, and a signed agreement with the University of Twente's Faculty of Geo-Information Science and Earth Observation (ITC) strengthened research relationships between ITC and hubs and created new opportunities for professional development for staff across the network. The 4th SERVIR Annual Global Exchange (SAGE) gathered together representatives from USAID, NASA, the SERVIR hubs, and a select group of partners. Held in Lisbon, Portugal, from November 11-16, this year's exchange explored technical and programmatic approaches towards developing and implementing mature services as a foundation for sustainability and scalability.

On November 14, 2018, the Mid-Atlantic Federal Laboratory Consortium (FLC) presented NASA and USAID with the 2018 Interagency Partnership award, honoring the SERVIR program for outstanding technology transfer achievements. This award is given to organizations demonstrating excellence in the process of transferring technology through multiple federal science agencies. Lawrence Friedl, Director of Applied Sciences in the Earth Science Division of NASA, and Carrie Stokes, Chief Geographer and Director of the GeoCenter at USAID, accepted the award for SERVIR in Rockville, Maryland, at the Mid-Atlantic Federal Laboratory Consortium Meeting and Industry Day.

SERVIR's capacity building efforts towards a widespread applied understanding of the use of Synthetic Aperture Radar (SAR) technologies for forest monitoring and biomass estimation continued in 2018. The initiative, launched in February of 2017 with a scoping meeting held at the SERVIR Science Coordination Office (SCO) in Huntsville, Alabama, was attended by representatives from SERVIR Hubs, USAID, the US Geological Survey (USGS), the US Forest Service (USFS), and NASA, along with subject matter experts (SMEs) from academia, government, and private industry. A series of SME-led SAR trainings were held throughout early 2018: in Niamey, Niger, January 29 – February 2; in Kathmandu, Nepal, on February 12-16; in Bangkok, Thailand, March 12-16; in Nairobi, Kenya, April 16-20; and a Regional Training on Synthetic Aperture Radar for Monitoring of Forest Carbon Stocks in Kathmandu, Nepal, April 30 – May 4. A SERVIR SilvaCarbon Close-Out Workshop attended by hub personnel, subject matter experts, and a representative from USFS (SilvaCarbon), was held at the SCO November 5-6, bringing this phase of SERVIR SilvaCarbon SAR capacity building activities to a conclusion. The SAR Handbook, with hands-on and practical theoretical content, was an important outcome of this activity – containing chapters provided by the SMEs leading the training events. This Handbook, along with the complementary webpage, technical videos, and easy-to-understand one-pagers, is expected to be released at the 2019 Global Forest Observations Initiative Plenary Meeting in Maputo, Mozambique, April 4-11.



The SERVIR 2015 AST project led by Shraddhanand Shukla of University of California, Santa Barbara, and the SERVIR-Eastern and Southern Africa Hub at RCMRD in Nairobi, Kenya, have been collaborating with Tanzanian national agencies—including the Tanzania Meteorological Agency and the Ministry of Water and Irrigation—on a service providing Vulnerability Impact Assessments (VIA). These assessments enable governmental officials to identify the most vulnerable districts surrounding two river basins in Tanzania. The co-developed service improves the reliability and accessibility of rainfall and temperature data in Tanzania, enabling decision makers to accurately understand the distribution of vulnerable populations. This improves intervention activities reaching at risk districts. Building on the successes in the Rufiji and Wami-Ruvu river basins, SERVIR-E&SA and the AST project are expanding assessment activities to additional river basins in Tanzania.



The SERVIR 2015 AST project led by Dr. Ben Zaitchik of Johns Hopkins University, and SERVIR's Hindu Kush Himalaya Hub at ICIMOD in Kathmandu, Nepal, are working together to support drought monitoring and early warning systems in South Asia through development of SALDAS, a near-real time to seasonal hydrologic model based on NASA's Land Information System (LIS). The Agricultural Drought Watch (AWD) tool using SALDAS was initially launched at the Regional Knowledge Forum on Drought, held October 8-10, 2018, at ICIMOD. The event was attended by researchers and regional stakeholders and co-hosted by SERVIR-HKH and Mekong Hubs, with Climate Services for Resilient Development (CSRD), the International Maize and Wheat Improvement Center (CIMMYT), and the World Food Programme (WFP) partnering with SERVIR in organizing the forum. After feedback from potential users, AWD data products are being adopted by users at the Nepal Ministry of Agriculture and Livestock Development. AWD system ownership will be fully transferred from the SERVIR AST to ICIMOD in early 2019, resulting in an operational tool.

The Indigenous Peoples Pilot Project organized a workshop with the Red Cliff Band of Lake Superior Chippewa in Wisconsin. This workshop brought together representatives from NASA's CBP including the Program Manager, the Project Manager of ARSET, representatives from the SERVIR and DEVELOP Programs and a representative from the Office of Education's Minority University Research Program (MUREP). North American tribal members representing tribal nations and regional tribal organizations from across the U.S. and Canada were also present. The meeting focused on: 1) the identification of challenges and barriers of partnerships and capacity building with NASA and tribal nations, 2) techniques to reduce these barriers, and 3) recommendations of next steps for the Indigenous Pilot Project and other NASA efforts to engage with and be inclusive of tribal nations. The primary suggestions from the group included: 1) an awareness phase for NASA/Indigenous work, 2) creating a cultural immersion program for NASA managers, 3) developing a protocol for working with indigenous groups, 4) creating a tribal liaison office, 5) including the indigenous perspective into funding solicitations, and 6) incorporating indigenous knowledge into capacity building.

IV. Community Engagement

Community Leadership

Capacity Building participated, presented, and led sessions in many national conferences, interagency, and international events in 2018. The CBP Program Manager, Dr. Nancy Searby, provides leadership for the interagency U.S. Group on Earth Observations (USGEO)'s International Activities Working Group, and co-led the U.S.'s participation in the regional AmeriGEO initiative, and served as a member of the GEO Capacity Building Coordination Working Group and Vice Chair of the CEOS Working Group for Capacity Building and Data Democracy (WGCapD). Highlights of these broader activities included the 7th annual WGCapD in São José dos Campos, Brazil in March 2018 and AmeriGEOSS Week in August 2018, also in São José dos Campos, Brazil. CBP's training best practices were also incorporated in a CEOS training best practices guide released in 2018 and CBP leadership led a training at the U.S.

Telecommunications Training Insitute on international cooperation in global remote sensing applications for disasters in October 2018.

CBP chaired oral presentation and poster sessions and a town hall at the AGU Fall Meeting in Washington DC, focused on expanding the capacity to use Earth observations to enhance environmental management decisions, actions, and policies, with the town hall focusing on the transition from Moderate Resolution Imaging Spectroradiometer (MODIS) to Visible Infrared Imaging Radiometer Suite (VIIRS) data usage. These convenings brought together multiple sectors to discuss their best practices for improving workforce skills to use Earth observations in environmental management and policy and how to grow a community of practice.

ARSET, in cooperation with remote sensing application community organizations, conducted six in-person trainings in 2018. These include the USGS Fort Collins Science Center, the U.S. EPA - Region 10, U.S. USFS, the Pacific Northwest Research Station, the Indonesian Agency for Meteorological, Climatological and Geophysics (BMKG), U.S. Embassy Jakarta, the International Society for Photogrammetry and Remote Sensing (ISPRS), Indian Institute of Remote Sensing (IIRS), and GEO. With community and stakeholder interests in mind, ARSET co-produced tailored agendas to provide attendees with the skills to access, interpret, and apply NASA data on local and global scales. One training was affiliated with a broader conference event, the eighth session of the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM 8), while the remaining trainings were events conducted either completely or partially by ARSET team members.

DEVELOP joined and led the science and policy communities in a variety of activities in 2018. The program chaired a session at the American Association of Geographers Annual Meeting and co-chaired a session at the 2018 AGU Fall Meeting. DEVELOP engaged policy makers through informative visits to state legislators and participation in Virginia's Aerospace Day in Richmond, Virginia in February.

SERVIR's SCO continued to promote and strengthen ongoing engagements with regional initiatives such as AfriGEOSS and AmeriGEOSS. In conjunction with the West Africa and Eastern & Southern Africa Hubs, the SCO participated in the 3rd AfriGEOSS Symposium 2018, in Libreville, Gabon, June 26-28. The SCO also led a CEOS WGCapD Introduction to Google Earth Engine pre-symposium training on June 25 as part of a broader Earth observation training. The SCO also participated in an Ecosystems Workshop as part of AmeriGEOSS Week, August 6-10 in São José dos Campos, Brazil; and in GEO Week 2018, October 29-November 2 in Kyoto, Japan (including an overview of SERVIR presented at the GEO Capacity Building Working Group side session).

In September, the SERVIR-Hindu Kush Himalaya Hub at ICIMOD co-organized a five-day regional training: "Asia-Oceania GEOSS Network for Capacity Building and Regional Sustainable Development: Agriculture and Disaster Monitoring in the Hindu Kush Himalaya" with the Institute of Remote Sensing and Digital Earth. The workshop, held at ICIMOD, was sponsored by Asia-Oceania GEOSS (AOGEOSS) and Himalayan GEOSS.

The Indigenous Peoples Pilot organized an IP advisory workshop, bringing together tribal elders, native science leaders, and NASA managers from the Capacity Building Program, ARSET, SERVIR, DEVELOP, and MUREP. This workshop was conducted in collaboration with the Red Cliff Band of Chippewa and a workshop facilitator from the University of Waterloo. Engagement across these communities was integral in order to focus on the concepts of "Two-eyed seeing" where western science and indigenous knowledge can be examined side-by-side. This workshop focused on story sharing, acknowledgement

of the challenges and barriers to changing the preconceptions of Indigenous Knowledge, and outlined guiding steps for future collaboration among these groups.

Enhancing Data Accessibility

To increase the capabilities of individuals and institutions to use and apply NASA Earth observations, CBP continues efforts to improve data discovery, access, and management.

ARSET helps training attendees build skills to acquire and use Earth observations for decision support. In 2018, ARSET trainings covered data from more than 80% of NASA's Earth Observing fleet. Through these capacity building activities, ARSET facilitated access to satellite data hosted by NASA and other organizations, including National Oceanic and Atmospheric Administration (NOAA), US Department of Agriculture (USDA), USFS, and non-profit organizations. The program is deeply engaged with multiple NASA data centers, serving as a formal member on six of the user working groups in order to share the perspectives and needs of the end-user community with the NASA data centers.

DEVELOP continued efforts to expand access to tools and results created by its feasibility projects through its publicly available GitHub portal of data processing tools. In 2018, the program had NASA's Software Release Authority approve the release of one tool for public dissemination. The Skyglow Estimation Toolbox or SET was developed for the National Park Service to help estimate light pollution levels in various places to aid in night sky tourism efforts and awareness. DEVELOP also used Google Earth Engine in 27 projects (41% of total projects) to harness cloud computing for running analyses, simplification of processing for project partners, and increase utility of DEVELOP products.

SERVIR SCO has been operating the SOCRATES computer cluster successfully since January 2018, providing valuable computing resources to regional Hubs to implement high-demand processes, such as the High-Impact Weather Assessment Toolkit (HIWAT) for the Hindu-Kush Himalaya region, Weather Research and Forecasting (WRF) hindcast runs for Eastern and Southern Africa, and Digital Elevation Models (DEM) production for West Africa. SOCRATES has also been used to run hydrological models for several regions and to host publicly-accessible sites supplementing the internal infrastructure of RCMRD, the SERVIR West Africa consortium and ICIMOD. ClimateSERV has been migrated to SOCRATES, and along with the SCO Tethys portal, is providing Application Programming Interface (API)-based access to several key datasets consumed by multiple applications used by different organizations in each region of interest. Finally, the collaborative FAO/SERVIR project Collect Earth Online is also hosted on SOCRATES, providing a publicly-accessible tool to stakeholders for classification and monitoring of land cover and land use change.

In 2018, the SERVIR Global Data Catalog experienced several improvements to streamline access to the growing collection of publicly-accessible datasets. The SCO provided related guidance to the Hubs, and is promoting the registration of dynamic datasets (data products generated on-the-fly) in the Global Data Catalog to enhance their usability and ease of access.

SERVIR has also made substantial progress toward publishing algorithms and applications to the project's GitHub repository to enable users beyond the SERVIR network to take advantage of programming methods in development.

In-person training activities conducted by the Indigenous Peoples Pilot Project have enhanced data access and use among tribal communities. These trainings focused not only on an introduction to remote sensing, and outlined new advanced tools, such as the use of R programming, for conducting advanced remote sensing analysis. These trainings highlighted data portals, such as GloVis and Earth Explorer, and specific satellites and sensors for land management including Landsat, MODIS, and VIIRS. These trainings also focused on the increased use of web portals that use NASA data such as Climate Engine, and open-source software, such as QGIS to analyze NASA data.

Relationship Brokering

To increase the capabilities of individuals and institutions to use and apply NASA Earth observations, CBP has pursued opportunities to engage and connect communities with available resources. Below is an overview of activities focused on brokering relationships.

ARSET maintained its relationship with capacity building teams from the NASA/USAID SERVIR program, NOAA, Yonsei University (S. Korea), and the Indian Institute of Remote Sensing (IIRS), and Conservation International.

ARSET continued its work around the UN Sustainable Development Goals (SDGs). The program conducted a two day, in-person training as a part of the eighth session of the United Nations Committee of Experts on Global Geospatial Information Management (UN-GGIM 8). The training demonstrated the potential and current applications of Earth observations and geospatial information for monitoring the UN SDGs. Presentations focused in particular on SDG indicators relating to 6.6.1.2 (Clean Water and Sanitation), 15.1.1 and 15.3.1[1](Forest Management). Participation included national statistics offices of the GGIM Caribbean Project and the Americas and other agencies charged with curating and delivering on the SDGs.

DEVELOP's work in the City of New Orleans, Louisiana served as a convening opportunity for multiple projects from AGU's Thriving Earth Exchange (TEX) and Groundwork New Orleans, one of Groundwork USA's domestic trusts. DEVELOP's New Orleans Urban Development project, conducted at the Alabama – Mobile node during DEVELOP's summer 2018 term, partnered with Groundwork New Orleans and focused on the urban heat island effects within New Orleans, similar to TEX projects working within the city. DEVELOP, TEX, and Groundwork joined in multiple science exchanges sharing work and DEVELOP-led trainings for individuals from both TEX and Groundwork to learn methodologies to evaluate urban heat variations, identify vegetation canopy and grey infrastructure, and generate flood extent maps using NASA Earth observations.

Under the larger umbrella of the NASA Earth Science Division partnerships, SERVIR and Mercy Corps began their strategic partnership with the goal to build upon one another's strengths. Each of the SERVIR hubs has a point of contact from each corresponding Mercy Corps Regional Resiliency hubs to better coordinate and find potential activity overlap. Activities with Mercy Corps in 2018 spanned from beginning a groundwater service led jointly by AGRHYMET and Mercy Corps-Niger to RCMRD and Mercy Corps-Kenya starting to work together on a livestock management system. Collaboration with Mercy Corps continues into 2019 as partnerships and coordination across all hubs grows.

NASA and the Red Cross Red Crescent Climate Centre hosted a joint workshop to explore new ways to link disaster risk reduction, preparedness, and response with the capabilities of NASA's Earth observations (EO). Convened at the NASA Marshall Space Flight Center in Huntsville, Alabama, in August, this four-day event used game-based learning to improve the ability of NASA EO scientists and coordinators to understand and address needs of local stakeholders. The workshop also helped to facilitate improved communication and partnership between the NASA Disasters program and SERVIR to design and implement future collaborations.

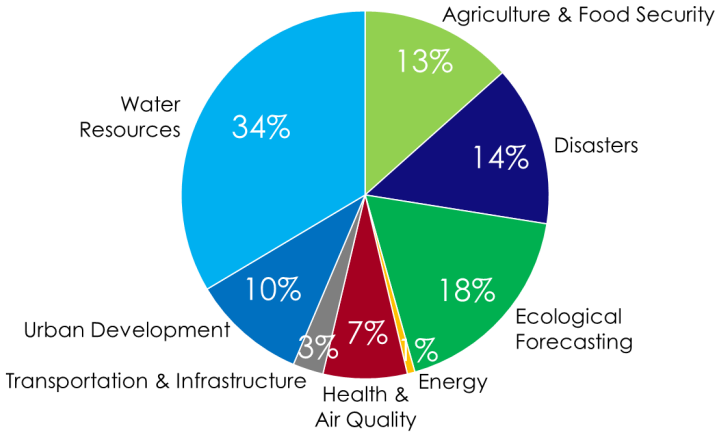
[1] United Nations Sustainable Development Goals: https://www.un.org/sustainabledevelopment/sustainable-development-goals/

Seeking to create unique and innovative opportunities between SERVIR scientists and ITC/University of Twente, the SCO began pursuing an agreement with the institute, based in Enschede, Netherlands, in 2017. Leaders from both groups met April 17-18, 2018, at NASA Headquarters in Washington, DC, to kick off the 10-year cooperative agreement. Under the agreement, ITC and SERVIR team members will work hand-in-hand with local teams to develop training, enhance service delivery and conduct research relevant to the needs of communities in SERVIR focus regions. The partnership also will create opportunities for enriched and continuing education for ITC students and SERVIR scientists.

The Indigenous Peoples Pilot Project continued to strengthen relationships between federal and tribal organizations through visits, meetings, and conference calls with the Bureau of Indian Affairs (BIA) Denver regional office, Samish Nation, multiple Pacific Northwest tribes, other NASA groups, Navajo Nation, Sault Saint Marie Tribe of Chippewa Indians, and the Canadian office of Indigenous Services and the University of Waterloo. This engagement established trust, led to in-person trainings, and opened internship opportunities for tribal students. The team also attended new conferences, such as the Rising Voices Workshop, to engage with the native science and activist communities.

V. 2018 CBP Portfolio

The Capacity Building Program engages individuals and institutions through a variety of methods for building capacity to use EO: trainings, feasibility studies, and projects. In 2018, the program conducted 85 trainings, 65 feasibility studies, and 19 multi-year projects. CBP activities addressed eight thematic topics in alignment with the Applied Sciences' Application Areas: Agriculture & Food Security, Disasters, Ecological Forecasting, Energy, Health & Air Quality, Transportation & Infrastructure, Urban Development, and Water Resources.



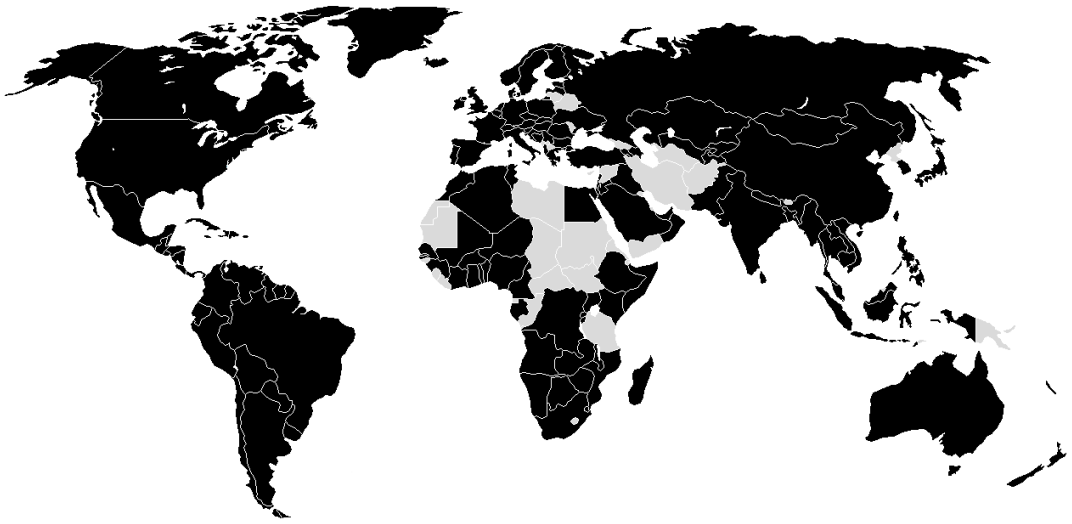
More information about individual projects and trainings can be found on ARSET, DEVELOP, and SERVIR websites.

VI. Geographic Reach

Geographic Coverage of Activities

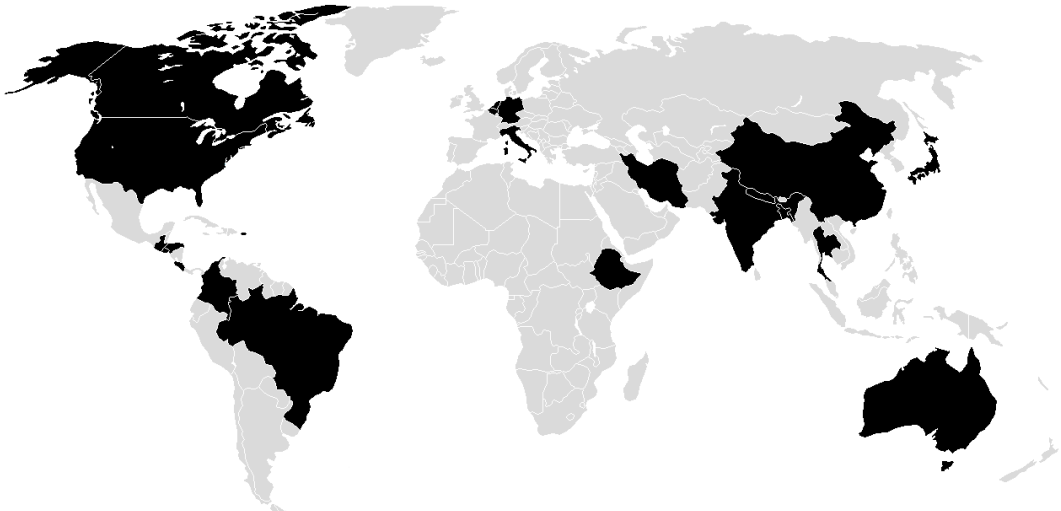
The Capacity Building Program actively participated in U.S. and international Earth observations and capacity-building activities in 2018 through USGEO, GEO, CEOS, and program element activities.

ARSET online and in-person trainings reached participants in 138 countries, an increase from 2017 (131 countries impacted). About 20 percent of the training participants were from the U.S and 80 percent from outside the U.S.



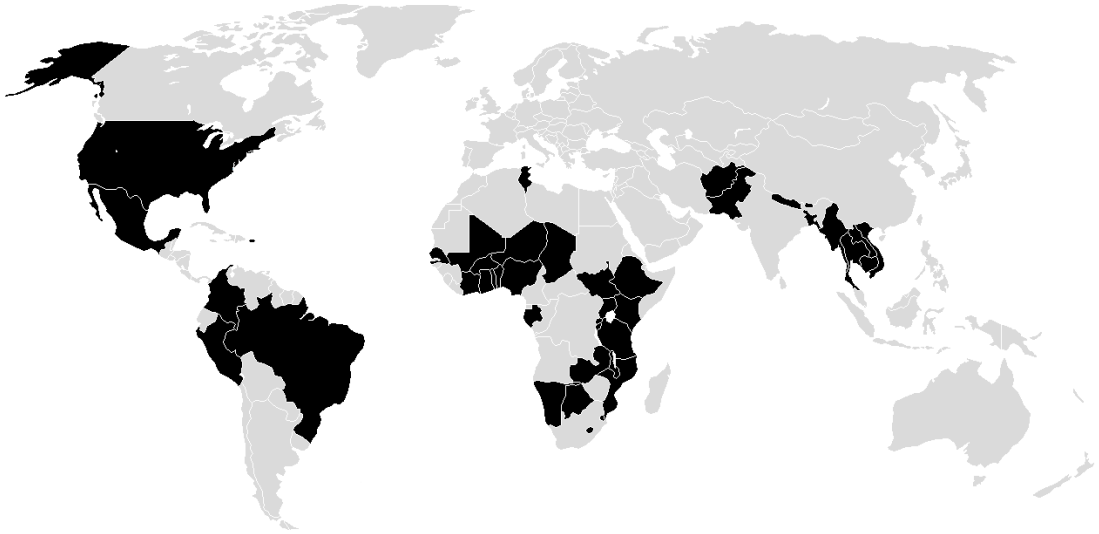
Black denotes the 138 countries impacted by ARSET

DEVELOP's primary focus is domestic capacity building and in 2018, the project portfolio consisted of 81% of projects addressing domestic issues. The program reached 35 U.S. states through project study areas and 91% of participants were U.S. citizens from 33 states, providing an impact to a total of 46 U.S. states. The program virtually conducts a limited number of projects with international study areas and engages international participants already located and studying in the U.S. In 2018, 19% of projects addressed international issues in 14 countries and international participants from 10 countries participated on projects, with a total reach of 22 countries.



Black denotes the 22 countries impacted by DEVELOP

SERVIR is inherently international, working in partnership with leading regional organizations around the globe to help developing countries use information provided by Earth observing satellites and geospatial technologies for managing environmental risks and land use. SERVIR engaged in more than 40 countries through the support of the regional Hubs in 2018. Domestically, SERVIR's SCO and AST engaged 17 U.S. states and Puerto Rico.



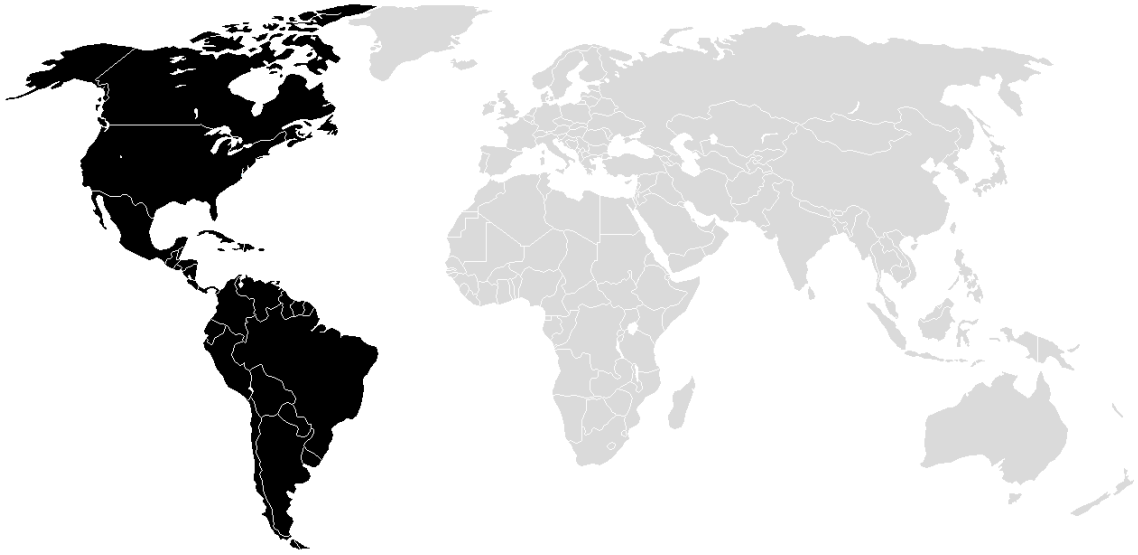
Black denotes the 41 countries impacted by SERVIR

CBP organizes international activities by GEO Regional Caucus to assess progress and identify regions that have benefited most from the Program's capacity building.

Americas

CBP reached 33 countries in the Americas caucus region through:

- ARSET – 3,602 individuals (trainees) through 3 in-person and 10 online trainings
- DEVELOP – 288 individuals (project participants) through 62 feasibility studies (projects with study area in region) and 1 training
- Indigenous Peoples – 23 individuals through 3 in-person trainings

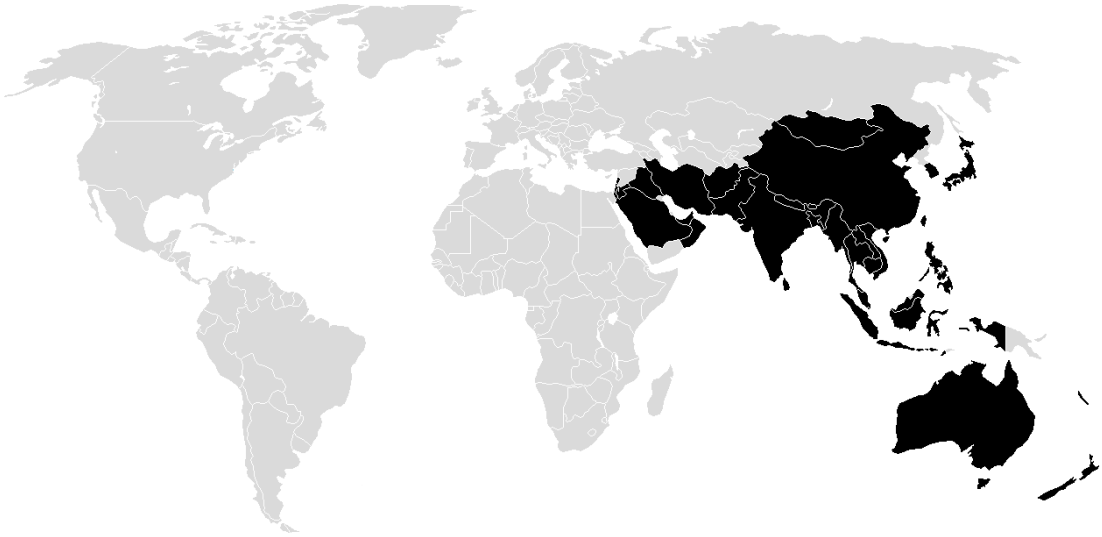


Black denotes the 33 countries in the Americas impacted by CBP

Asia and Oceania

CBP reached 33 countries in the Asia & Oceania caucus region through:

- ARSET – 1,459 individuals through 3 in-person and 10 online trainings
- DEVELOP – 17 individuals (project participants) through 2 feasibility studies (projects with study area in region)
- SERVIR – 784 individuals and 8 multi-year projects, 31 in-person trainings, 1 online training, and 2 workshops



Black denotes the 33 countries in Asia & Oceania impacted by CBP

More information for the multi-year projects:

Monitoring and Forecasting Drought and Crop Yield for the Lower Mekong Basin (ROSES 2015 - SERVIR AST)

Principal Investigator: Konstantinos Andreadis, NASA Jet Propulsion Laboratory (former PI was Stephanie Granger)
ASP Application Area: Agriculture
Thematic Service Area: Agriculture and Food Security
Description: This project uses NASA data, local ground observations, and forecasts in a modeling system to provide hydrologic data and drought assessments with associated agricultural yield for the Lower Mekong Basin. The drought-monitoring component of this project is contributing significantly towards hub services related to the Agriculture Service Area. In early 2018, Konstantinos Andreasis assumed PI duties for this project, and conducted a virtual training session on April 10. Regional Hydrologic Extreme Assessment System (RHEAS) training was also conducted at ADPC, May 20-21, and to the Vietnam Academy of Water Resources (VAWR) and other stakeholders in Hanoi, Vietnam on May 23-25, receiving positive feedback. Current ARL for this ongoing project is 7.

Improved Hydrologic Decision Support for the Lower Mekong River Basin through Integrated Remote Sensing and Modeling (ROSES 2015 - SERVIR AST)

Principal Investigator: John Bolten, NASA Goddard Space Flight Center
ASP Application Area: Water Resources
Thematic Service Area: Water Resources and Hydroclimatic Disasters
Description: This project complements and improves ADPC/SERVIR-Mekong hydrological modeling capabilities and access to state-of-the-art Earth observation satellite data to enhance water resource management decision-making, agricultural monitoring and forecasting capabilities. Leveraging a previous NASA Disasters Program project, an operational flood inundation and socio-economic impact system was transitioned and began testing, running on ADPC's server in 2018. Current ARL is 7 for this ongoing project.

Managing the Changing Water Resources South of the Himalayas (ROSES 2015 - SERVIR AST)

Principal Investigator: Cédric David, NASA Jet Propulsion Laboratory
ASP Application Area: Water Resources
Thematic Service Area: Water Resources and Hydroclimatic Disasters
Description: This project trains regional stakeholders and local water managers in the Hindu Kush Himalaya Region to combine remotely-sensed data from GRACE, MODIS, and AMSR2 with NASA modeling assets (GLDAS and

RAPID) to provide actionable information on water resources and water-related disasters (floods and droughts), focusing on historical conditions and near real time estimates. The project held trainings at the Flood Forecasting and Warning Centre (FFWC) and the Bangladesh Agricultural Research Council (BARC) in Bangladesh in April, and at ICIMOD in May. The GRACE, RAPID and MODIS applications have reached ARL 5. Current overall ARL for this ongoing project is 4.

Monitoring Intense Thunderstorms in the Hindu Kush-Himalayan Region (ROSES 2015 - SERVIR AST)
Principal Investigator: Patrick Gatlin, NASA Marshall Space Flight Center
ASP Application Area: Weather
Thematic Service Area: Weather and Climate
Description: This project integrates NASA Earth Observing System information to facilitate daily assessments of the hazards posed by thunderstorms in the Hindu-Kush Himalayan region. As showcased by the intensive thunderstorm events of April 2017 in Bangladesh, the ensemble thunderstorm prediction system is adding significant value to ongoing activities in the region. During 2018, the project completed the major milestone of a spring forecast demonstration with HIWAT. HIWAT weather forecasts were used by the Department of Hydrology and Meteorology (DHM)-Nepal in their decision-making process during the pre-monsoon and monsoon season and the project reached its goal ARL of 7. The possibility exists for attaining a final ARL of 8 for this ongoing project.

Building Lasting Capacity for Water Management in Vulnerable Deltas of Indochina (ROSES 2015 - SERVIR AST)
Principal Investigator: Hyongki Lee, University of Houston
ASP Application Area: Water Resources
Thematic Service Area: Water Resources and Hydroclimatic Disasters
Description: This project aims to develop a comprehensive, satellite data-based system that can routinely map, provide early warning of, and enable decision-making on water-related vulnerability issues in low-lying deltas of Indochina. A seasonal water availability anomaly forecasting prototype with the Soil & Water Assessment Tool (SWAT) was developed during 2018, and trainings on the hydrological modeling system continued to be offered at SERVIR-Mekong and to other partners in the region. Current ARL for this ongoing project is 6.

Comprehensive Stream Flow Prediction and Visualization to Support Integrated Water Management (ROSES 2015 - SERVIR AST)
Principal Investigator: Jim Nelson, Brigham Young University
ASP Application Area: Water Resources
*Thematic Service Area*s: Water Resources and Hydroclimatic Disasters
Description: This project is developing a cloud-based water resources applications portal and specific web applications to empower the International Centre for Integrated Mountain Development to help water resource managers and other decision-makers in the Hindu Kush Himalaya region access and use streamflow forecasts, flood mapping, and data. Access to these tools and information is enabling preparation for and public warnings of impending floods and related disasters, promoting resilience and recovery after flood events. Tools including HIWAT, Streamflow Prediction Tool, and HydroViewer Nepal are now available through the SERVIR-HKH, SERVIR-Mekong, and SCO Tethys Apps. Current ARL is 7 for this ongoing project.

Supporting satellite-based national land-cover and land-use change monitoring systems in South-East Asian countries (Burma, Cambodia, Laos, Thailand, and Vietnam) (ROSES 2015 - SERVIR AST)
Principal Investigator: Peter Potapov, University of Maryland, College Park
ASP Application Area: Ecological Forecasting
Thematic Service Area: Land Cover and Land Use Change and Ecosystems
Description: This tool employs annual Landsat time-series data to create regionally consistent annual tree canopy cover and height layers at 30m spatial resolution for Southeast Asian Countries. The provided data and data analysis tools are designed to help develop regionally consistent annual forest extent and change maps and implement monitoring results in national and regional planning and management. The data layers are key contributors to SERVIR-Mekong's Regional Land Cover Monitoring System. During 2018, the project completed regional land cover/use, vegetation structure, and forest dynamics annual products for 2000-2015, and work on the regional forest monitoring portal is in progress in collaboration with SIG. Current ARL is 7 for this ongoing project.

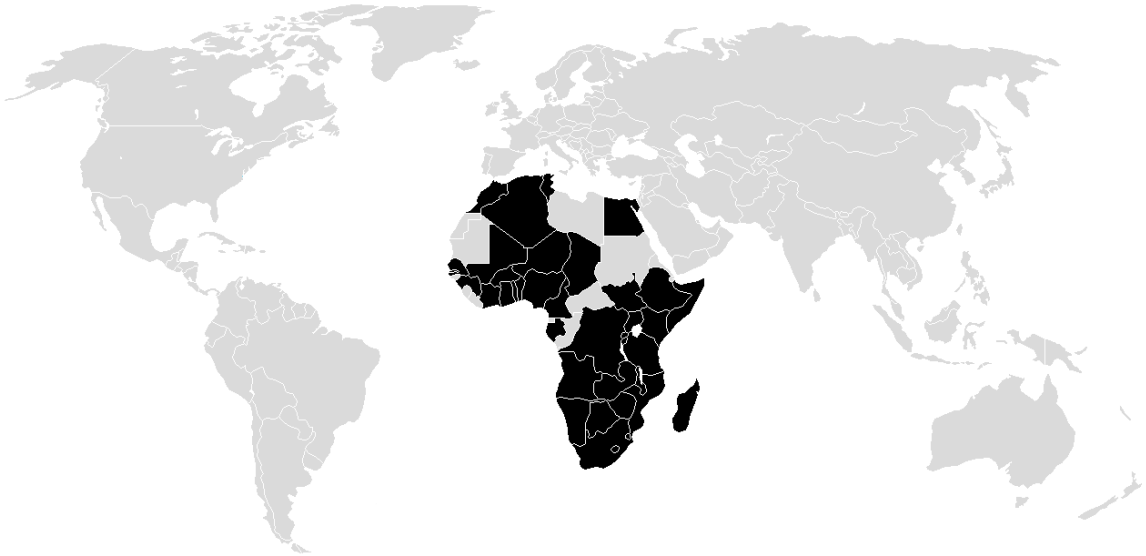
Seasonal Prediction of HKH Hydrological Extremes with the South Asia Land Data Assimilation System (ROSES 2015 - SERVIR AST)
Principal Investigator: Benjamin Zaitchik, Johns Hopkins University
ASP Application Area: Climate
Thematic Service Area: Weather and Climate

Description: This project generates sub-seasonal to seasonal (S2S) hydrological forecasts for the Hindu Kush Himalaya region, working with end-users to produce forecast products that describe the risk of drought or floods on time horizons of weeks to months. This project is helping the SERVIR-Hindu Kush Himalaya Hub with better compilation of different data layers to analyze regional drought. The South Asia LDAS Subseasonal to Seasonal Forecast System (SALDAS) now includes preprocessing scripts to automate bias correction and downscale GEOS-S2S seasonal forecasts using the NCAR GARD tool, and forecast capabilities have been transferred to ICIMOD. The project is implementing operational visualization capabilities for SALDAS, supporting ICIMOD's activities on a drought portal that will showcase the data and analyses. Current ARL is 7 for this ongoing project.

Africa

CBP reached 40 countries in the Africa caucus region through:

- ARSET– 452 individuals through 10 online trainings
- DEVELOP – 2 individuals (project participants)
- SERVIR – 1,070 individuals and 8 multi-year projects, 28 in-person trainings and 8 workshops



Black denotes the 40 countries in Africa impacted by CBP

More information for the multi-year projects:

Supporting National Agricultural Monitoring for Food Security (ROSES 2015 - SERVIR AST)
Principal Investigator: Inbal Becker-Reshef, University of Maryland, College Park
ASP Application Area: Agriculture
Thematic Service Area: Agriculture and Food Security
Description: This project builds capacity and develops remote sensing, smart phone, and collaborative internet technologies for the collection, analysis, and dissemination of data on the status of agricultural and crop conditions as a basis for decision-making, policy design, and agricultural development interventions in Eastern and Southern Africa. Data from this project served as inputs to Intergovernmental Authority on Development (IGAD) Climate Prediction and Application Centre's (*ICPAC's*) launch of the Eastern Africa Crop Monitor report at 49th GHACOF meeting, May13-14, since delivered quarterly, as well as to the Kenya National Crop Monitor report, delivered monthly since June of 2018 (reporting May 2018 data). Current ARL for this ongoing project is 5.

A West Africa LDAS for Forecasting Extreme Hydrological Events (WALFEHE) (ROSES 2015 - SERVIR AST)
Principal Investigator: Augusto Getirana, NASA Goddard Space Flight Center
ASP Application Area: Climate
Thematic Service Area: Water Resources and Hydroclimatic Disasters
Description: This project provides an improved land data assimilation system (LDAS) for integrated water management by Agriculture, Hydrology and Meteorology (AGRHYMET) Regional Center member nations, with a focus on hydrological modeling to provide meteorological, hydrological, and agricultural drought characterizations and forecasts, as well as flood modeling and forecasting. During 2018, the project held a LIS training at

AGRHYMET, February 20 – 22, and conducted streamflow evaluations of ESP and ESP+GRACE-DA forecasts and GEOS5 and GEOS5+GRACE-DA forecasts, Current ARL is 5 for this ongoing project.

Desertification or "re-greening"? Adaptation lessons learned in coping with late 20th century drought in West Africa (ROSES 2015 - SERVIR AST)
Principal Investigator: Alessandra Giannini, International Research Institute for Climate and Society (IRI), Columbia University
ASP Application Area: Climate
Thematic Service Area: Weather and Climate
Description: This project uses information from Earth observations and model simulations to develop climate information for decision-making in natural resources management, including water and landscapes, to improve agriculture and food security outcomes in West Africa. During 2018, production of seasonal predictions based on the NMME were enabled, and the project participated in the Climate Outlook Forum for the Sudano-Sahelian region of West Africa (PRESA-SS), April 30 – May 4. Current ARL is 6 for this ongoing project.

Supporting Pastoralist Livelihoods in West Africa Through Remote Sensing of Rangeland Vegetation Structure, Forage Production and Long-Term Trend Analysis (ROSES 2015 - SERVIR AST)
Principal Investigator: Niall Hanan, New Mexico State University
ASP Application Area: Agriculture
Thematic Service Area: Agriculture and Food Security
Description: This project assists SERVIR-West Africa in developing remote sensing-based applications relevant to rangeland vegetation structure and forage production to improve the wellbeing and resilience of pastoralist and agropastoralist communities in West Africa. This project collaborates with West Africa Consortium partner CSE to improve rangeland monitoring in West Africa. In early February, a Workshop on Automated Workflows for Retrieval-Processing of Sentinel Data was delivered by Julius Anchang in Niamey, Niger, to consortium partners and stakeholders such as FEWS NET and Burkina Faso's National Council for Sustainable Development (Conseil National pour le Développement Durable–CNDD). During 2018, Sahel-Sudan Savanna vegetation trend analysis was completed for this project, and the Global Hydrologic Soil Groups (HYSOGs250m) for Curve Number-Based Runoff Modeling was made available through daac.ornl.gov. Current ARL for this ongoing project is 5.

Enabling Local Monitoring of Landscape Change Across Eastern Africa (ROSES 2015 - SERVIR AST)
Principal Investigator: Sean Healey, U.S. Forest Service, Rocky Mountain Research Station
ASP Application Area: Ecological Forecasting
Thematic Service Area: Land Cover and Land Use Change and Ecosystems
Description: This project enables SERVIR-Eastern and Southern Africa/RCMRD to use cloud computing and the Landsat archive to deliver historical and continuously updated 30m land cover maps across Kenya, Malawi, Ethiopia, Zambia, Tanzania, Rwanda, and Uganda. This project has built the capacity of the SERVIR Hub to become the regional leader in Land Cover Monitoring, and is providing key annual updates to member countries. The project has been working in collaboration with Spatial Informatics Group (SIG) to fuse TimeSync (Landsat archive) and Collect Earth Online (high-res images), and this integration is nearly ready for testing. Current ARL for this ongoing project is 6.

Forecasting and Communicating Water-Related Disasters in Africa (ROSES 2015 - SERVIR AST)
Principal Investigator: Yang Hong, University of Oklahoma, Norman
ASP Application Area: Disasters
Thematic Service Area: Water Resources and Hydroclimatic Disasters
Description: This project uses the EF5 (the Ensemble Framework for Flash Flood Forecasting) hydrologic model to enhance decision-making for water and water-related disasters in Eastern and Southern Africa. Capacity has been strengthened at RCMRD and Kenya Meteorological Department (KMD) to use EF5 for hydrological assessments. In March of 2018, the project conducted a Capacity Building Training on Flood Monitoring Using EF5 in Kenya, and a Foundation Training and Technology Transfer in Uganda. The project acquired KMD's WRF model to analyze and create a case study for inundation modeling, and recently completed recording an EF5 Advanced Training. Current ARL is 7 for this ongoing project.

Enhancing Eastern and Southern Africa Climate Services by Increasing Access to Remote Sensing and Model Datasets (ROSES 2015 - SERVIR AST)
Principal investigator: Shraddhanand Shukla, University of California, Santa Barbara
ASP Application Area: Agriculture, Climate
Thematic Service Area: Agriculture and Food Security

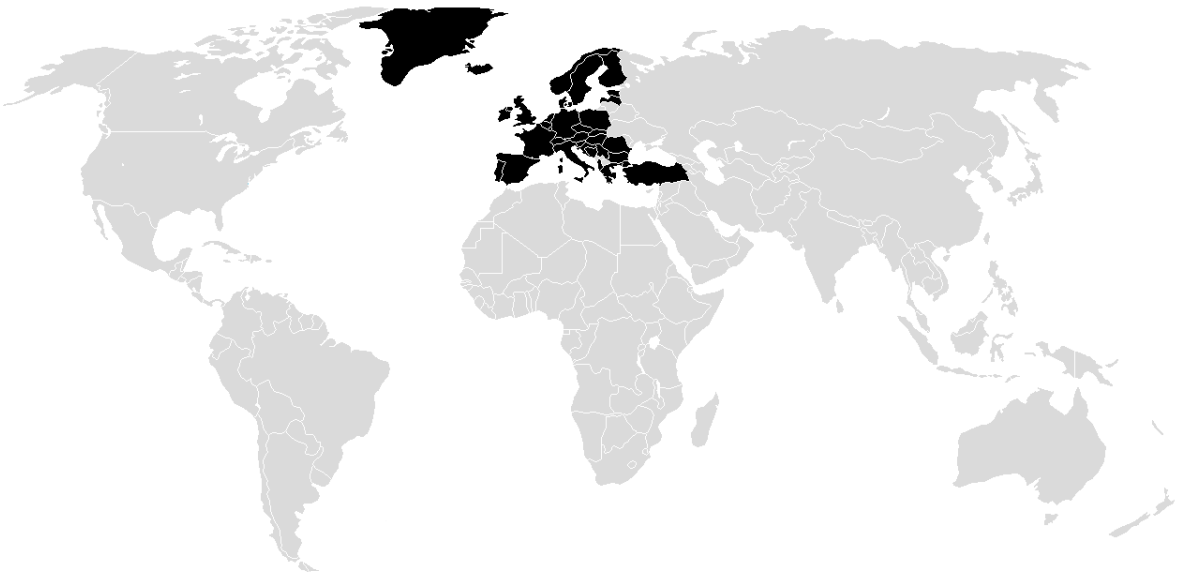
Description: This project enhances SERVIR-Eastern and Southern Africa/RCMRD's access to NASA and Famine Early Warning System Network (FEWS NET) Earth observations, datasets, models, forecasts, and web-services to support agricultural and water resources decision making by ministries and organizations in the region. The Early Warning Explorer (EWX) products, created as part of this project, are being used in several hub services, such as climate vulnerability assessments, and EWX has been fully transitioned to SERVIR-E&SA/RCMRD. Operational production of seasonal scale EDDI forecasts is now occurring, and development and validation of CHIRTSmax continues. A training workshop was held in Dar es Salaam, Tanzania, at the beginning of CY 2018, and a Regional Hydro-Climate Services Training Workshop took place in Lusaka, Zambia, in September. Current ARL is 7 for this ongoing project.

Monitoring and Projecting Environmental Change in Fragmented Tropical Forest Landscapes (ROSES 2015 - SERVIR AST)
Principal Investigator: Michael Wimberly, GISc Center of Excellence, South Dakota State University
ASP Application Area: Ecological Forecasting
Thematic Service Area: Land Cover and Land Use Change and Ecosystems
Description: This project integrates Landsat data and landscape simulation models to map historical forest degradation and project future impacts of climate and land use change on West African forests. This project has generated annual estimates of forest degradation from 2004-2014 in response to a request from the Forestry Commission of Ghana (FC). The West Africa Forest Degradation Dataset (WAForDD) version 1.0 was released in March of 2018, and WAForDD V. 2.0 is in development. Current ARL is 5 for this ongoing project.

Europe

CBP reached 33 countries in the Europe caucus region through:

- ARSET – 776 individuals through 10 online trainings
- DEVELOP – 1 individual (project participant) through 1 feasibility study (project with study area in region)



Black denotes the 33 countries in Europe impacted by CBP

Commonwealth of Independent States (CIS)

CBP reached 7 countries in the CIS caucus region through:

- ARSET – 38 individuals through 9 online trainings

Black denotes the 7 countries in CIS impacted by CBP

VII. GEO Projects

The **AmeriGEO** and **Human Planet projects** focus respectively on building and strengthening capacity in the use of Earth observations in the Americas, and strengthening the capacity to apply spatial data to understand human presence on the planet. Both sets of projects – seven altogether – are a subset of a broader group of NASA A.50 projects which represent a significant USGEO contribution to the GEO Work Programme for 2017-2019 and 2020-2022. Specifically, the four AmeriGEO projects contribute to the work of the AmeriGEO regional initiative, while the three Human Planet projects operate in the context of the GEO Human Planet initiative. While the Human Planet projects are mainly global in scope, the AmeriGEO projects focus particularly on various of the 16 GEO member countries in the Americas. For more information about the larger initiatives to which these projects are contributing, visit: https://www.amerigeoss.org and https://ghsl.jrc.ec.europa.eu/HPI.php.

In their first year of implementation, the GEO projects had noteworthy contributions to and engagement with the broader science community. The AmeriGEO projects were introduced to the broader community during the AmeriGEO Week Symposium in São José dos Campos, Brazil in August 2018, while there were presentations on the Human Planet projects at GEO Week 2018 in Kyoto, Japan in October 2018. The Human Planet projects also held a side meeting at the GEO Symposium in June 2018 in Geneva, Switzerland. Updates on the AmeriGEO projects' progress have been fixtures of the monthly AmeriGEO Coordination Working Group calls which involve the GEO Principals from across the region. The year 2018 was also rounded out by strong participation by the AmeriGEO and Human Planet project Principal Investigators and collaborators at the AGU Fall Meeting where all of the projects were featured in oral or poster presentations. The AmeriGEO projects were featured prominently in an Americas-specific poster session highlighting the role of Earth observation in environmental monitoring in the Western Hemisphere.

The AmeriGEO and Human Planet projects are internationally focused, contributing to GEO Work Programme activities in countries across the world. While the Human Planet projects have been developing products (e.g. NASA Black Marble) for the entire globe, some of the projects' activities have been focused on pilot countries, such as Colombia and Nigeria. In contrast, the AmeriGEO projects have engaged 16 countries in the Americas. The projects operate in close conjunction with the GEO initiatives

to which they contribute. In the case of AmeriGEO projects which seek to strengthen capacity particularly in GEO member countries across the Americas, the projects are largely being implemented along with specialized agencies of the governments where these projects are operating. In addition, the GEO Principals in these countries have been engaged. In the case of the EO4IM project which seeks to strengthen the capacity of indigenous communities in Ecuador and Peru to use Earth observations, the project is engaging the Achuar nation in Ecuador, and the Regional Office for the Development of Indigenous Peoples of San Martin in Peru.

More information for the multi-year projects:

SAR-CBC: A Capacity Building Center for the Use of SAR in Decision Making (ROSES 2017 - AmeriGEO)
Principal Investigator: Franz Meyer, University of Alaska-Fairbanks
ASP Application Area: Capacity Building
Thematic Service Area: Agriculture & Food Security, Biodiversity & Ecosystems, Water Resources and Hydroclimatic Disasters
Description: This project is developing targeted educational material, webinars, and on-site trainings that build capacity in the use of SAR-based Earth observation data in decisions-making. To sustain the use or SAR resources long term, the project is also developing innovative cloud-based data processing solutions that enable SAR data analysis without requiring expensive computing infrastructure. In 2018, the project conducted needs assessments with the 4 sets of stakeholders in Colombia (i.e. IDEAM), Ecuador (INIGEMM, UCE), and El Salvador (MARN), as well as developing the structure and curriculum for the capacity building center and activities which will be implemented in project years 2-3 (2019-2020).

Laying the Foundations of the Pole-to-Pole Marine Biodiversity Observation Network (MBON) of the Americas (ROSES 2017 - AmeriGEO)
Principal Investigator: Enrique Montes, University of South Florida
ASP Application Area: Capacity Building
Thematic Service Area: Biodiversity & Ecosystems
Description: This project is building a community of practice at the continental scale that serves the information needs of multiple national and international stakeholders for the conservation of marine living resources. In 2018, the project has been developing seascape biogeographic datasets and maps for both coasts of the Americas. The project also hosted a training workshop with stakeholders in South America during the AmeriGEO Week 2018 in Brazil. Data from biodiversity surveys for various countries in the Americas have also been collected and shared with the project, toward validation of some of the project outputs. Data from those surveys can be visualized via: https://marinebon.github.io/p2p/.

Harnessing Earth Observations to Support Indigenous-Led Land Management (ROSES 2017 - AmeriGEO)
Principal Investigator: Karyn Tabor, Conservation International
ASP Application Area: Capacity Building
Thematic Service Area: Biodiversity & Ecosystems
Description: This project is focused on strengthening the technical capacities of indigenous organizations in the Americas to harness the power of EO data for enhanced sustainable land management across indigenous lands. In 2018, where this project focuses on strengthening the capacity of indigenous communities in Ecuador and Peru to utilize Earth observation data, one of the project's first accomplishments was the execution of a participatory needs assessment methods workshop in Ecuador. Project personnel also participated in the Americas Regional Exchange of the Dedicated Grant Mechanism for Indigenous Peoples and Local Communities (DGM), highlighting the EO4IM project's upcoming activities.

Supporting the Vision for GEOSS in the Americas: Community Building and Capacity Development in Support of AmeriGEO's Food Security and Sustainable Agriculture Area (ROSES 2017 - AmeriGEO)
Principal Investigator: Alyssa Whitcraft, University of Maryland
ASP Application Area: Capacity Building
Thematic Service Area: Agriculture & Food Security
Description: This project seeks to: enhance national and regional capacity to monitor food supply using Earth observations; empower science-based decision making related to food security & agriculture; increase regional collaboration and cooperation around agriculture monitoring; create a sustainable model for within-region collaboration; guide future capacity development activities related to EO; and enhance the adoption of NASA instruments' data. In 2018, the project has been coordinating with stakeholders in Argentina, Brazil, and Chile, toward improvement of the existing GLAM systems in the first two countries, and development of a GLAM system

for Chile. The project also provided monitoring support to the Government of Argentina during a drought, after which a state of emergency was declared for 27 municipalities.

Population and Infrastructure on Our Human Planet: Supporting Sustainable Development Through Improved Spatial Data and Models for Human Settlements, Infrastructure, and Population Distribution Based on Earth Observations (ROSES 2017 - Human Planet)
Principal Investigator: Robert Chen, Columbia University
ASP Application Area: Capacity Building
Thematic Service Area: Water Resources and Hydroclimatic Disasters
Description: This project is being implemented in close collaboration with national statistical offices (NSOs) and related ministries and stakeholders in two countries, Nigeria and Colombia, to identify and address their needs for integrated settlement, infrastructure, and population data and models with respect to monitoring, planning, and decision making regarding the Sustainable Development Goals (SDGs) and associated targets and indicators. In 2018, toward implementing project pilot activities in focus countries of Colombia and Nigeria, the project focused on engaging stakeholder institutions in both countries, with workshops in both countries planned for 2019.

Mapping the Missing Millions: Developing a Global Database of Informal Settlement Location, Schema, and SDGs Indicators Using Crowdsourced Data, Machine Learning, and Multi-Sensor Satellite Imagery (ROSES 2017 - Human Planet)
Principal Investigator: Jamon Van Den Hoek, Oregon State University
ASP Application Area: Capacity Building
Thematic Service Area: Water Resources and Hydroclimatic Disasters
Description: This project is developing open, global-scale geospatial data to locate, characterize, and assess SDG indicators at informal settlements belonging to refugees, internally displaced populations, and forcibly displaced and resettled people: the “missing millions.” Using crowdsourced data, machine learning, and remotely sensed SDG indicator proxies, the project is developing a novel open, global-scale vector dataset representing “missing millions” informal settlements, attributed with information on schema, spatial typology, and enviro-climatic conditions to support sub-national SDGs assessment for the world’s most vulnerable. In 2018, as the project focuses on validation of the global nighttime lights and other products, one major accomplishment was the publication of the algorithm theoretical basis document (ATBD) for the project’s NASA Black Marble product suite. In addition, the utility of that Black Marble data for assessing disaster recovery was highlighted in news articles published by the BBC, *Bloomberg Business Week*, and *The Economist*. The project has also been involved in extensive benchmarking of the Black Marble data.

A Framework for Validation of Global Nighttime Environment Products (ROSES 2017 - Human Planet)
Principal Investigator: Virginia Kalb, NASA Goddard Space Flight Center (former PI was Miguel Roman)
ASP Application Area: Capacity Building
Thematic Service Area: Water Resources and Hydroclimatic Disasters
Description: This project, focused on the Human Planet initiative’s Nighttime Product Validation Task, is dedicated to the uncertainty assessment of NASA’s Black Marble product suite through validation – the process of comparing satellite-derived products to independent reference data. NPV seeks to facilitate international objective benchmarking and standardization techniques for satellite-derived nighttime lights products. In late 2018, Virginia Kalb took over PI duties for this project. In 2018, the project has engaged in the most comprehensive to date mapping of the distribution of informal settlements across the world. The project team has collaborated with the office United Nations High Commissioner for Refugees (UNHCR) to compile as well as validate data on the locations of the world’s informal settlements. Going into the next 2 years of project execution, the project will focus on using machine learning to locate and characterize informal settlements in an automated fashion.

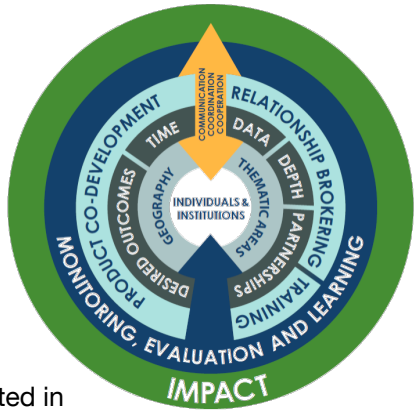
VIII. Program Management

Management Team

Capacity Building is led by Dr. Nancy Searby at NASA Headquarters. In 2018, the Program was supported by Christine Mataya, Georgina Crepps, and Lauren Childs-Gleason, who served as liaisons between the Elements and NASA Headquarters. Each Element was led by management teams at NASA Centers: ARSET – Dr. Ana Prados, UMD at GSFC; DEVELOP – Michael Ruiz, NASA LaRC; and SERVIR – Dan Irwin, NASA MSFC. The Indigenous Peoples Initiative is led by Dr. Cindy Schmidt, BAERI at ARC. Betzy Hernandez serves as Associate Program Manager for the AmeriGEO and Human Planet project portfolio.

Strategic Planning

The Capacity Building Program continues to grow and strengthen through enhanced communication, coordination, and cooperation. In October 2018, CBP management and Element teams gathered in Huntsville, AL to participate in a programmatic retreat. Participants focused their discussions using the lens of the programmatic capacity building framework (*image to right*) created the previous year while discussing topics such as partnering, integration of intiatives and Applied Sciences' thematic portfolios, innovative ideas, and strategic planning.



In addition to programmatic strategic planning, elements also participated in strategic activities at the element-level:

ARSET's strategic planning relies on feedback from program participants. This data is used by the program to help determine if program goals are being met and to make adjustments as needed. It is also used for end-user needs assessments and to determine future training topics. In 2019 ARSET will develop a 3-year plan that will outline the key themes and capacity building objectives for the next three years.

DEVELOP launched a survey in 2018 of past and present participants and end users to inform the program's future strategic planning efforts including participant & partner capacity building, the participant experience, end-user engagement, etc. The valuable feedback gathered in the survey will be critical to evaluating the participant and end-user experience and their ability to use and apply NASA Earth observations to decision making. In October, DEVELOP leadership participated in CBP's 2018 strategic planning retreat. The focus on increasing communication, coordination, & collaboration across program elements will help to direct DEVELOP's future planning activities. Additionally, DEVELOP continued to participate in strategic discussions with the Applied Sciences program areas where we shared how our feasibility projects are contributing to the application area portfolios and the end users we are engaging in the areas of Water, Disasters, Agriculture & Food Security, Ecological Forecasting, and Health & Air Quality.

The 5th Annual SERVIR Joint Working Group (JWG) meeting took place in Washington D.C., on March 31, 2018, with participation from USAID and NASA HQ Earth Science Division leadership and SERVIR SCO leadership. The JWG convened to discuss SERVIR's evolving value proposition and context, demonstrate the past year's accomplishments and results, and facilitate discussion between the two agencies. Topics discussed included 1) results in specific services leading to scale and replication, 2) growing partnerships and collaborations based on proven capabilities and stronger Hubs, especially partnership growth from 2012 to 2018, 3) empowering women to connect science and policy, and 3) progress toward more effective communications and thought leadership.

The SERVIR program also hosted the SERVIR Annual Global Exchange (SAGE) from November 11 – 16 in Lisbon, Portugal. As in previous years, sessions on the first day allowed participants including AST,

SCO and hub scientists to share regional activities and progress and exchange views on past, current and upcoming initiatives. With the theme 'Pathways To Mature Services', this year's meeting was designed to foster scientific and programming innovation, build the capacity of the network, and refresh strategic approaches to delivering services through the Service Planning Approach. Focusing on learning from SERVIR's mature services–those making a development impact–SAGE 2018 also initiated participation of a small group of development and humanitarian partners together with additional USAID bureau/sector experts.

Indigenous Peoples Pilot Project will primarily focus on building long-term relationships with the Indigenous community and the establishment of protocols for NASA's Applied Sciences Program when working with Indigenous groups. This will build from the experiences and lessons learned in the advisory workshop held in May. The team aims to bring in native leaders, such as Melanie Goodchild, from the University of Waterloo, who have experience in advising groups about individual informed consent and for sharing of indigenous knowledge. The Indigenous Peoples Pilot Project also aims to increase the native voice at NASA through the creation of an Ecological Forecasting E.2 proposal focused on Indigenous Knowledge.

CBP continues its programmatic goal to enhance activities that promote and improve engagement, entrepreneurism, and evaluation.

- **Engagement**. CBP pursues approaches that increase connectivity with current partners, reach out to potential end users, and engage Earth scientists who may be interested and skilled in applications. By improving programmatic understanding of key needs and user preferences, new communities are targeted and engaged.
- **Entrepreneurism**. Through experimentation and adoption of innovative methods for building capacity, CBP implements the Program's strategy to include creative approaches to data access, idea generation, brokering connections, funding of projects, use of social media and community challenges, and reporting of outcomes. This focuses on creative solutions that increase effectiveness and expand its reach.
- **Evaluation**. Monitoring and evaluation through the tracking of indicators across all Elements is performed. This activity includes the refinement of results frameworks for each Element and the program as a whole, as well as the identification and collection of shared indicators across all elements. Improved monitoring increases efficiency and assists with identification of highlights and successes.

Program Assessment

At the program level, CBP is building a robust network of engagement with other capacity building programs and initiatives in an effort to work towards its five strategic goals:

1. Expand the network of individuals and organizations aware of and able to access NASA Earth observations.
2. Increase the capabilities of individuals and organizations to use and apply NASA Earth observations in their management decisions and actions.
3. Enable sustained use of existing NASA Earth observations for decisions and actions, and the ability to incorporate new observations as they become available.
4. Build skills of Earth sciences community to define end user needs, collect and share robust feedback, build capacity and to assess impact of capacity building activities
5. Improve feedback of lessons learned through capacity building to Earth science research & analysis, applications, and data systems program management.

The program collects outcomes through success stories, highlights, ARSET surveys, and DEVELOP participant surveys. Indicators are used to track intermediate results. Strategic targets are annually assessed, along with ARL and PSI scores to track yearly progress.

Indicator Tracking

Programmatic performance tracking system was initiated in 2016 through results frameworks that identify unique indicators for each Element, with a refined number of program-wide indicators collected across all Elements.

2018 Aggregated Indicators:

IR-1: Improved Awareness of – and Access to – Earth-observation Data, Products, and Tools	
Sub-IR 1.1: Awareness Increased in New Geographic Regions & Different Sectors	
1.1.1 The Number of States & Countries Reached through CBP Trainings & Projects	50 states; 146 countries
1.1.2 The number of Partners (by type) Reached through Trainings & Projects	***Total***: 2,944 – Academic Institution (42%); Consortium (2%); Federal/ Central Government (26%); Intergovernmental Organization (3%); Local Government (3%); Miscellaneous/Other (4%); Private Sector (For-Profit) (8%); Private Sector (Non-Profit)/Voluntary or NGO (6%); Research Institute (1%); State/ Provincial Government (6%); Tribal Entity (~0%)
Sub-IR 1.2: Individual & Institution Needs Identified	
1.2.1 The number of front end engagement activities (pre-assessments/needs assessments)	109
Sub IR-1.3: Access to Data, Products, Tools & Trainings Enhanced	
1.3.1 The number of CBP trainings & projects by ASP National Application Area	***Projects*** *– 84 Total*: Agriculture (12); Disasters (10); Ecological Forecasting (12); Energy (1); Health & Air Quality (6); Transportation & Infrastructure (2); Urban Development (9); Water Resources (29) ***Trainings*** *– 85 Total*: Agriculture (8); Disasters (11); Ecological Forecasting (18); Energy (0); Health & Air Quality (5); Transportation & Infrastructure (2); Urban Development (6); Water Resources (24);
1.3.2 The number of CBP products posted online	141
1.3.3 The number NASA Earth observation platforms & sensors utilized in projects & highlighted in trainings	55
IR-2: Strengthened Capacity to Use Earth Observation Data, Products & Tools	
Sub-IR 2.1: Individuals Engaged & Trainings Delivered	
2.1.1 The number of trainings & workshops given or facilitated by CBP Elements	85
2.1.2 The number of individuals engaged in CBP activities	8,600
Sub-IR 2.2: Tailored Products & Tools Co-developed	
2.2.1 The number of products developed by/with support from CBP	211
Sub-IR 2.3: Increased Number of Organizations Using NASA Earth Observations in Their Decision-Making Process	
2.3.1 The number of end-users integrating Earth observations in their decision-making process	N/A
Sub-IR 2.4: Science Policy Exchanges Enhanced	
2.4.1 The number of policy & science conferences attended	52
2.4.2 The number of science policy exchanges involving CBP engagement	2
IR-3: Improved Capacity Building Practices & feedback to Earth Science Community	
Sub-IR 3.1: Best Practices & Lessons Learned Collected & Shared	
3.1.1 The number of best practice documents produced and/or presented by CBP	1
3.1.2 The number of outreach events for CBP activities	68
Sub-IR 3.2: Increased Capability to Monitor & Evaluate Impact of CBP Activities and Collect Feedback	

3.2.1 The percent of individuals who completed pre-training/project surveys & project assessments	ARSET (100%); DEVELOP (Partners – 73%; Participants – 98%); SERVIR (88%); IP (N/A)
3.2.2 The percent of individuals who completed post-training/project surveys & project assessments	ARSET (55%); DEVELOP (Partners – 32%; Participants – 97%); SERVIR (80%); IP (N/A)
3.2.3 The number of projects that achieved yearly ARL goal	14 out of 16
3.2.4 The annual average PSI score for feasibility projects	3
Sub-IR 3.3: Feedback to Earth Science Community Delivered	
3.3.1 The number of presentations at Science Team Meetings	6
3.3.2 The number of DAAC feedback activities	9

Strategic Targets & Growth

Each element addresses strategic goals and contributes to the objectives through specific targets and activities. Below shows tracking of targets and actuals over time.

ARSET

Activity	Target	2014	2015	2016	2017	2018
U.S. States Impacted	40+	44	50	50	50	50
Countries Impacted	90+	109	123	130	132	138
Total # of Individuals	1,500+	1,014	2,877	3,277	4,864	6,362
Total # of Institutions	500+	650	1,032	1,392	2,030	2,570
Application Areas	4	4	4	7	4	4
Trainings	Varies	11	11	15	18	17

DEVELOP

Activity	Target	2014	2015	2016	2017	2018
U.S. States Impacted	35+	46	50	42	49	46
Domestic: International	<1:4	N/A	1:4	1:4	1:6	1:5
Total # of Individuals	250+	379	393	359	342	308
Total # of Institutions	75+	160	157	125	128	121
Application Areas	All	9	9	8	9	8
Feasibility Studies	60	83	93	77	70	65

SERVIR

Activity	Target	2014	2015	2016	2017	2018
Countries Impacted	38	44	43	40	40	41
Custom Services	42	N/A	47	38	37	42
Total # of PI Leads	16	N/A	11	27	25	16
Total # of Individuals	283	425	834	623	1202	1,907
Total # of Institutions	27	159	128	143	150	249

Science Exchanges	25	10	6	5	28	18

Indigenous Peoples Pilot

Activity	**2017**	**2018**
US States Impacted	9	3
Total # of Participants	39	23
Total # of Organizations	19	12
Application Areas Covered	3	2

Project Progress Tracking

Capacity Building tracks projects through two measurements: SERVIR AST's long-term projects are tracked using the Application Readiness Level (ARL) scale which begins at 1 (basic research) and continues to a 9 (sustained use of tool); and DEVELOP feasibility projects are tracked using the Project Strength Index (PSI).

ARL Metrics for Multi-Year Projects in 2018:

Metric	**ROSES 2015 Projects**
SERVIR AST ARL Range	4 - 7
SERVIR AST ARL Mean	6.1
SERVIR AST ARL Mode	7
# of Projects with ARL 1-3:	0
# of Projects with ARL 4-6:	8
# of Projects with ARL 7-9:	8
% of Projects Advanced 1+ ARL in past 12 months	87.5% (14 of 16)

In terms of performance, out of the 2015 AST projects, 14 of 16 projects have advanced one or more ARLs. 12 projects advanced by two or more ARLs, 6 have increased by at least three levels, and one project advanced by four ARL levels. The initial mean ARL for these projects was 2.8, and the current mean is 6.1.

DEVELOP continued to track and assess its feasibility projects by means of its Project Strength Index (PSI). This scale takes into consideration both the scientific merit of the work as well as the project's applicability to decision making and partner capacity building. The PSI measures a project on two spectra: scientific merit and the applicability to decision making and capacity building of the project partners. The PSI tracks the progress of projects across a 5-point scale of 1) Basic Research, 2) Application Concept Complete, 3) Application Demonstration Successful, 4) Application Verified/End User Engaged, and 5) Transition to End User/Decision Enhanced. For the 65 feasibility projects conducting during 2018, the average PSI score was a 3.

Internal Collaborative Activities

The Capacity Building Program integrates and efficiently leverages activities between program Elements. In 2017, the program continued collaboration between the elements in the following ways:

- 38 DEVELOPers participated in ARSET trainings, with DEVELOPers attending all online trainings offered by ARSET.
- SERVIR and ARSET collaborated to design and provide a webinar training focusing on the Variable Infiltration Capacity (VIC) hydrologic model and NASA Earth observation data inputs used for hydrologic modeling in early 2018.

- SERVIR and ARSET collaborated on the *Advanced Webinar: Radar Remote Sensing for Land, Water, & Disaster Applications*, a September 2018 ARSET training.
- DEVELOP participated in the SERVIR/NASA Disasters and Red Cross Red Crescent Climate Centre workshop on Earth observations for disaster risk reduction.
- DEVELOP and SERVIR collaborated on an international project that applied NASA Earth observations to identify lightning exposure and risk Nepal and Bangladesh.
- ARSET, DEVELOP and SERVIR participated in the Indigenous Peoples Pilot Project /NASA Workshop with the Red Cliff Band of Lake Superior Chippewa in Red Cliff, WI from May 9–10, 2018.
- DEVELOP and SERVIR continue to collaborate on DEVELOP projects partnering with the Royal Thai Embassy.
- ARSET and DEVELOP collaborated to represent CBP at the 2018 InterAction Forum to increase engagement of NGOs.

IX. Looking Ahead

In 2019, the Capacity Building Program will continue to address the CBP strategic goals to expand the networks of individuals and institutions to be aware of, able to access, and able to use Earth observations in their decision making. CBP looks to solidify the use of common language and explore new approaches to capacity building. The program will enhance coordination through a shared training calendar, explore opportunities to share user feedback with the science community, and take over chair of the CEOS Working Group for Capacity Building and Data Democracy. Through its elements and initiatives, the program will engage with interagency and international consortiums, boundary organizations, and the broader NASA Earth Sciences community to further increase the number of individuals and institutions benefiting from NASA's investment in Earth science.

ARSET plans to include thematic, asynchronous on-demand trainings into its platform. ARSET will also continue its focus on Latin America, providing several dual language trainings and translating most online materials into Spanish. New training topics for 2019 include Disaster Risk Management and Remote Sensing for Freshwater Habitats. The program will also continue to build capacity in the use of SAR for disaster management. DEVELOP will review and implement feedback from the program's participant and end-user surveys and expand the role of Software Carpentry workshops into its approach to capacity building by conducting 3-4 trainings for participants in the summer term. SERVIR will launch the newest SERVIR hub, SERVIR-Amazonia; close out the second AST and initiate a new group of AST projects in 2019, and will continue to strengthen the network through co-development of services across multiple Hubs and partners. The Indigenous Peoples Pilot will pursue additional workshops and trainings, engagement with NASA's Minority University Research and Education Project (MUREP) and GLOBE, assisting in the development of strategy and guidelines for working with Indigenous groups. The AmeriGEO and Human Planet projects will continue to be fostered so they can succeed and look for broader connections across GEO activities.

All CBP elements will contribute to the CBP goal to build Earth sciences community capacity to define end-user needs, collect and share robust feedback, build capacity, and assess impact of capacity building activities. CBP will continue to collect, compile, and communicate lessons learned and best practices, with an increased focus on engagement of the NASA mission development community. CBP will continue to grow the community of practice of Earth observation use capacity building practitioners through science conferences like the American Geophysical Union fall meeting, through relationships with other program managers in Applied Sciences and in Research and Analysis, through participation in DAAC User Working Groups and Science Team meetings, through leading CEOS WGCapD and co-chair of GEO Capacity Building Coordination Working Group. and through broader engagement with the community.

Focused on its five strategic goals and strategic framework, CBP will continue to evolve and strengthen as it further refines methods for tracking progress and impact. Capacity Building management will continue to work with the program element teams to ensure that they have the resources to address user needs for Earth observations skills and to integrate and benefit from each other's work as well as the work of the capacity building networks acting through CEOS, GEO, and CGMS.

X. Appendix

A. Abbreviations and Acronyms

ADPC: Asian Disaster Preparedness Center
AGRHYMET: Agrometeorology, Hydrology and Meteorology (Regional Center)
AGU: American Geophysical Union
AmeriGEO: Americas Group on Earth Observations
ARL: Application Readiness Level
ARSET: Applied Remote Sensing Training
ASDC: Atmospheric Science Data Center
ASP: Applied Sciences Program
AST: Applied Sciences Team
BIA: Bureau of Indian Affairs
CHIRPS: Climate Hazard Group InfraRed Precipitation with Stations
CI: Conservation International
CMIP5: Coupled Model Intercomparison Project Phase 5
CY: Calendar Year
DAAC: Distributed Active Archive Centers
DSSAT: Decision Support System for Agro-technology Transfer
EF5: Ensemble Framework for Flash Flood Forecasting
EO: Earth Observations
ESI: Evapotranspiration Stress Indices
EWX: Early Warning eXplorer
FEWS NET: Famine Early Warning System Network
FY: Fiscal Year
GEE: Google Earth Engine
GEO: Group on Earth Observations
GEOSS: Global Earth Observation System of Systems
GES DISC: Goddard Earth Sciences (GES) Data and Information Services Center (DISC)
GHACOF: Greater Horn of Africa Climate Outlook Forum
GIS: Geographic Information Systems
GLAM: Global Agricultural Monitoring
GLDAS: Global Land Data Assimilation Systems
GMAO: Global Modeling and Assimilation Office
GRACE: Gravity Recovery and Climate Experiment
HKH: Hindu Kush Himalaya
ICIMOD: International Centre for Integrated Mountain Development
ICPAC: IGAD's Climate Prediction and Applications Centre
IGAD: Intergovernmental Authority on Development
IISD: International Institute for Sustainable Development
IITM: Indian Institute of Tropical Meteorology
IP: Indigenous Peoples
IRI: International Research Institute for Climate and Society
ITC: Faculty of Geo-Information Science and Earth Observation
JWG: Joint Working Group
KMD: Kenya Meteorological Department
LAADS DAAC: Level-1 and Atmosphere Archive and Distribution System Distributed Active Archive Center
LANCE: Land, Atmosphere Near real-time Capability for EOS
LDAS: Land Data Assimilation System
LIDAR: Light Detection and Ranging
LPDAAC: Land Processes Distributed Active Archive Center
MODIS: Moderate-resolution Imaging Spectroradiometer
MoNRE: Ministry of Natural Resources and Environment
NASA: National Aeronautics and Space Administration
NGO: Non-Governmental Organization
NOAA: National Oceanic and Atmospheric Administration
OPM: Office of the Prime Minister
ORNL DAAC: Oak Ridge National Laboratory Distributed Active Archive Center
PI: Principal Investigator
PSI: Project Strength Index
RAPID: Routing Application for Parallel computation of Discharge
RCMRD: Regional Centre for Mapping of Resources for Development
REDD: Reduced Emissions from Deforestation and Forest Degradation
RHEAS: Regional Hydrologic Extremes and Assessment System
ROSES: Research Opportunities in Space and Earth Sciences
S2S: Sub-seasonal to Seasonal
SAGE: SERVIR Annual Global Exchange
SAR: Synthetic Aperture Radar
SCAQMD: South Coast Air Quality Monitoring District
SCO: Science Coordination Office
SOCRATES: SERVIR Operational Cluster Resource for Applications – Terabytes for Earth Science
TEK: Traditional Ecological Knowledge
TEX: Thriving Earth Exchange
UNDP: UN Development Programme
UNDP: United Nations Development Program's
UNESCO: United Nations Educational, Scientific and Cultural Organization
USAID: United States Agency for International Development
USDA: United States Department of Agriculture
USFS: United States Forest Service
VIC: Variable Infiltration Capacity
WA: West Africa
WALFEHE: West Africa LDAS for Forecasting Extreme Hydrological Events

B. Peer-Reviewed Publications

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11. Markert, K., Schmidt, C., Griffin, R., Flores, A., Poortinga, A., Saah, D., Muench, R., Clinton, N., Chishtie, F., Kityuttachai, K., Paradis, S., Anderson, E., Aekakkararungroj. A. Ganz, D. 2018. Historical and Operational Monitoring of Surface Sediments in the Lower Mekong Basin Using Landsat and Google Earth Engine Cloud Computing. Remote Sensing. 10(6), 909. https://doi.org/10.3390/rs10060909. [SERVIR]
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C. Earth Observation Assets Employed by CBP

ALOS ALOS PALSAR
ALOS-2 PALSAR
Aqua AIRS
Aqua AMSR-E
Aqua MODIS
Aura OMI
AVHRR
CALIPSO CALIOP
CYGNSS
EO-1 ALI
EO-1 Hyperion
GeoEye-1
GOES
GPM DPR
GPM GMI
GPM IMERG
GRACE
UAVSAR
IKONOS
ISS CATS
ISS LIS
OSTM/Jason-2 AMR
Landsat 4 TM
Landsat 5 TM
Landsat 7 ETM+
Landsat 8 OLI
Landsat 8 TIRS
MeteoSat
NISAR
OCO-2
PERSIANN
Planet RapidEye
PlanetScope
Radarsat-2
SARAL/AltiKa
SeaStar SeaWiFS
Sentinel-1 C-SAR
Sentinel-2 MSI
SMAP
SMOS MIRAS
SRTM
Suomi-NPP VIIRS
TEMPO
Terra ASTER
Terra MISR
Terra MODIS
Terra MOPITT
TRMM LIS
TRMM PR
TRMM TMI
TRMM TMPA
TRMM VIRS
Worldview
Worldview-2
Worldview-3

D. ARSET 2018 Trainings: Instruments, Web Tools, Missions, and Satellites Covered

Advanced Baseline Imager (ABI) - GOES-R
Aeronet
AerosolWatch
Aerostat/MAPPS
AHI
AIRS
Alaska Satellite Facility (ASF) Sentinel Data Portal
Application for Extracting and Exploring Analysis Ready Samples (AppEEARS)
Aqua
ASTER
Aura
CALIOP
CALIPSO
Cloud-Aerosol Transport System (CATS)
Dartmouth Flood
Dual Precipitation Radar (DPR)
Earth Observatory
Earthdata Search
ERDS
ETM+
FIRMS
GEOS-5
Giovanni(-4)
Global Disasters Alert and Coordination System (GDACS)
Global Flood Mapping System (GFMS)
Global Learning and Observations to Benefit the Environment (GLOBE)
Global Wildfire Information System (GWIS) Copernicus
GMI
GOCI
GOES
GPM
GPM IMERG
Himarawi 8
Infusing Satellite Data into Environmental Applications (IDEA)
INSAT
International Space Station
Jason-2
LAADSweb
LANCE-MODIS
LANDFIRE
Landsat
LandLook Viewer
LPDAAC
MERRA or MERRA-2
MISR
MODIS
MODIS Active Fire and Burned Area Product
MODIS NRT Global Flood Mapping
MOPITT
Multi-Angle Imager for Aerosols (MAIA)
Multi-Sensor Aerosol Products Sampling System (MAPSS)
National Gap Analysis Program (GAP)
NASA-ISRO SAR Mission (NISAR)
NOAA Hazard Mapping System (HMS)
OceanColor Web
OCO-2

OLI
OMI
Precipitation Radar (PR)
Satellite Loop Interactive Data Explorer in Real-time (SLIDER)
SeaDAS
SeaWiFS
Sentinel
SMAP
Socioeconomic Data and Applications Center (SEDAC)
SRTM
Suomi National Polar-orbiting Partnership (S-NPP)
System for Earth Observations, Data Access, Processing, and Analysis for Land Monitoring (SEPAL)
TEMPO
Terra
TMI
TRMM
VIIRS
VIIRS Active Fire Mapper
Worldview