

National Aeronautics  
and Space Administration

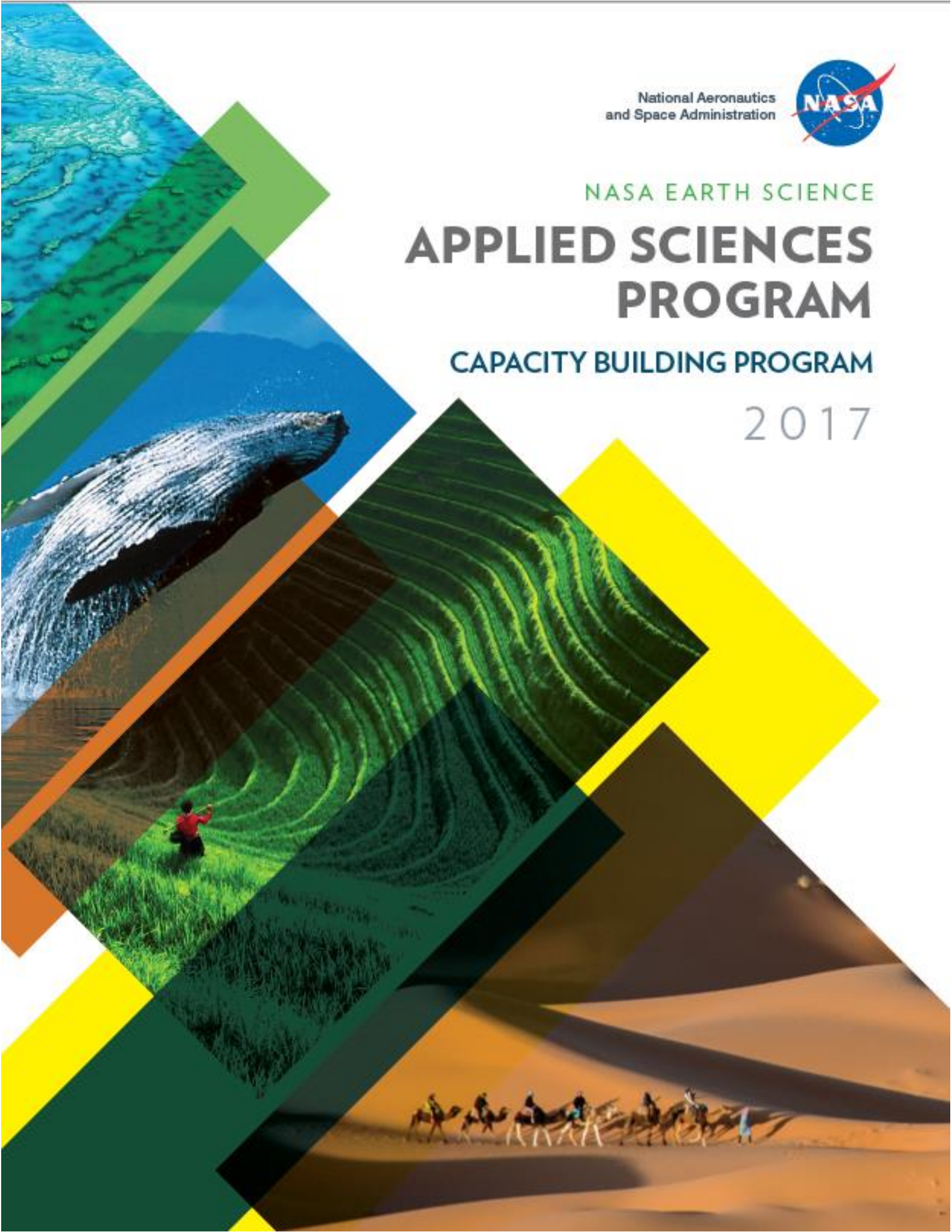


NASA EARTH SCIENCE

# APPLIED SCIENCES PROGRAM

CAPACITY BUILDING PROGRAM

2017



# 2017 Capacity Building Calendar Year Summary

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## 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 within the United States and the developing world to expand the Earth-observations user base, and increase the 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, and Health & Air Quality, as well as other application areas including Agriculture & Food Security, Energy, Urban Development, and Transportation & Infrastructure.

The Capacity Building Program works through both program and element activities. Program activities include participating in both 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. The program supports three Elements, including Applied Remote Sensing Training (ARSET), DEVELOP, and SERVIR, along with initiatives focused on building capacity to use Earth observations of indigenous peoples in North America and the creation of an interactive mapper for tracking and outreach activities.

### **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, please 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 around the globe. Bridging the gap between NASA Earth Science and society, DEVELOP provides workforce development opportunities for both participants and partner organizations to better prepare them to address the challenges that face our society and future generations. With the competitive nature and growing societal role of science and technology in today's global workplace, DEVELOP is fostering an adept corps of tomorrow's applied scientists and leaders. To learn more about DEVELOP, view previous projects, and propose a project idea, please visit <http://develop.larc.nasa.gov/>.

**SERVIR**, a joint development initiative of NASA and 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/](http://www.servirglobal.net/).

The **Indigenous Peoples Initiative** aims to provide remote sensing training, mentoring, and research opportunities to the indigenous community. A key programmatic goal is the co-production of place-based trainings where participants have the opportunity to address specific natural resource research and management issues facing their tribal lands. As the program continues to grow, we aim to increase our incorporation of Traditional Ecological Knowledge (TEK) into technical methods and to develop trainings tailored to thematic areas of interest to specific tribes. Engagement and feedback are encouraged to refine our approaches to increase capacity within the indigenous community to utilize NASA Earth Observations.

## II. 2017 Overview

Throughout 2017, the Capacity Building Program continued to refine and strengthen its many contributions to the Agency. CBP achieved the following impacts “by the numbers” in 2017:

<b>6,622:</b> Individuals Engaged	<b>50:</b> U.S. States Impacted
<b>2,369:</b> Institutions Engaged	<b>142:</b> Countries Impacted
<b>245:</b> Co-Developed Products	<b>18:</b> Peer-Reviewed Publications
<b>104:</b> Trainings Given	<b>10:</b> Application Areas Addressed
<b>65:</b> Earth Observation Assets Applied	<b>131:</b> Conferences & Meetings Attended

The Capacity Building Program’s global impact can also be shown “by the map” for 2017:



*Black denotes the 142 countries impacted by CBP; gray denotes countries not impacted*

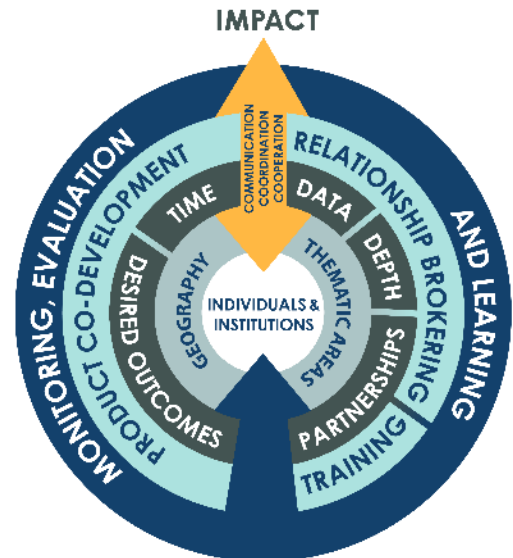
Read on to learn more about CBP’s accomplishments and highlights.

### III. Accomplishments & Highlights

#### Programmatic Accomplishments

Throughout 2017, the program continued 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. To further facilitate these activities, the program designed and adopted a new strategic framework focused around the needs of individual and institution end users.

The framework provides the program a common language for all program elements to support the capacity building of users. It facilitates the program's engagement planning process beginning with the user's individual and/or institutional needs. Those needs are organized by where their need is – geography – and what their need is – thematic area. The service design utilizes parameters including desired outcomes, time and depth required, applicable data, and partnerships involved to determine the best approach to a response: product co-development, training, or relationship brokering. Throughout each step of the process, the Capacity Building team monitors, evaluates, and collects lessons learned to inform each stage and support continuous improvement. The CBP team also actively communicates, cooperates, and coordinates amongst itself and partner organizations, including other capacity building networks, to strengthen and enable cohesive capacity building for users. The entire process works towards the outcome of impacting the user and increasing their ability to access and apply Earth observations to environmental decision making. The CBP has begun to implement the framework through simple actions such as communicating an integrated CBP planning with NASA thematic program managers.



2017 was a record-breaking year for CBP. The program engaged with 6,622 individuals and 2,369 institutions to reach all 50 U.S. states and 142 countries. Reach was mapped by including project study areas and locations of end-users and individuals engaged in CBP activities. In alignment with the new framework, the program provided 104 trainings and 245 product co-development opportunities which included 70 feasibility studies & 35 multi-year projects. CBP participated in a total of 98 events, including 52 science conferences, four policy meetings and 19 NASA science team meetings, along with publishing 18 peer-review journal articles in 2017.

Program elements had a strong year in 2017. Accomplishments and highlights are summarized below.

In 2017, ARSET built on its 2016 success, conducting 18 in-person and online trainings and producing 149 presentations and 91 documents. There were 4,864 instances of live participation and 10,199 views of recorded online trainings. ARSET engaged 2,030 organizations in its trainings, with more than 1,200 organizations (about half) being new to the program. The program reached attendees that work in 132 countries. The most popular ARSET training in 2017 was *Introduction to Synthetic Aperture Radar*, which had ARSET's highest number of live instances of participation ever: 984. The training, given entirely in Spanish in one session and in English in another, has also done well with online views. Since the live training, the sessions have been

viewed more than 3,800 times, with nearly 2,500 of them being viewings of the Spanish recordings.

DEVELOP had a dynamic year, engaging 342 participants and 128 partner organizations through 70 projects that took place at 12 nodes. These projects, and the participants that conducted them, impacted 50 U.S. states and 23 countries. The program launched its interactive mapper on the DEVELOP website that allows viewers the opportunity to visualize and locate the program's extensive portfolio of feasibility studies from 2016 to the present. The program presented project results and participated in 48 science and policy conferences and meetings, co-chaired sessions at four conferences (American Geophysical Union (AGU) Fall Meeting, 14th Biennial Conference of Science & Management on the Colorado Plateau & Southwest Region, American Association of Geographer's Annual Meeting, and the 19<sup>th</sup> George Wright Society Conference), and supported eight NASA review panels. The program also had six peer-reviewed journal publications and continued its video series highlighting the use of Earth observations in decision making, with a record 34,286 YouTube views from more than 170 countries in 2017.

In 2017, SERVIR was active in more than 45 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; 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. The program conducted 61 projects and 59 trainings in 2017. In 2017, SERVIR developed, provided oversight for, enhanced, or launched 26 applications and tools, including geoportals to improve data availability and sharing, online agricultural atlases to support food security, and vulnerability assessment tools to inform disaster-related decisions. These products and tools operate based on data from 27 different satellite instruments. A total of 1,202 people were trained in the use of SERVIR tools, technologies, data, and methodologies, with a total of 241 institutions engaged. With SERVIR's help, an estimated 150 institutions saw improvements in their capacity to address issues relating to changing environments.

In 2017, the indigenous people initiative (IP) team conducted three in-person trainings and also started to investigate working with international indigenous groups. These trainings focused on an introduction to remote sensing for land management, water resources, and climate change. The team trained 39 participants, from 19 different tribal groups and one federal agency (the Bureau of Indian Affairs (BIA)), and 9 U.S. states. The team successfully trained BIA trainers so that they can continue to provide the training in the future.

### **Highlight Events & Activities**

The Capacity Building Program's activities are best illustrated by highlighting events and activities that brought Earth observations to decision makers. The following are some of the top highlights for 2017:

ARSET has offered its materials in Spanish for many years, but in 2017 ARSET presented three different trainings in Spanish. *Introduction to Synthetic Aperture Radar* was presented in two sessions: one in English and one in Spanish. The *Disaster Risk Reduction Across the Americas Discussion Sessions* were conducted entirely in Spanish. *Application of Remote Sensing to Support the Management of Hydrographic Watersheds in Latin America and the Caribbean*, a six-day in-person training



held in Brazil in partnership with UNESCO, was conducted in English and Spanish with live-translation available for attendees.



DEVELOP launched its [interactive mapper](#) online – a resource for interested parties to visualize the impact and identify projects of interest based on their geographic locations. The mapper was the culmination of the fiscal year (FY) 17 Fellow Class project which self-organized to design, create, and launch the mapper within NASA protocols. The project not only built skills within the Fellow Class, but has enhanced the program’s communication of project methodologies and results.

DEVELOPers authored six peer-reviewed journal articles, fifteen articles on *Earthzine.org*, and two articles on the LPDAAC website. DEVELOP projects were also featured in media venues such as National Public Radio-affiliate KNAU, NASA’s *Earth Observatory*, National Broadcasting Company (NBC) affiliate KPVI Channel 6, the *Atlanta Journal-Constitution* and *Earthdata.gov*. DEVELOP’s people and projects were recognized through a series of awards including AGU’s Data Visualization Storytelling Contest, NASA’s Silver Achievement Medal, the Earth Science Information Partners (ESIP) 2017 Raskin Scholarship, and the National Park Service’s Intermountain Region Natural Resources Partnership Award.



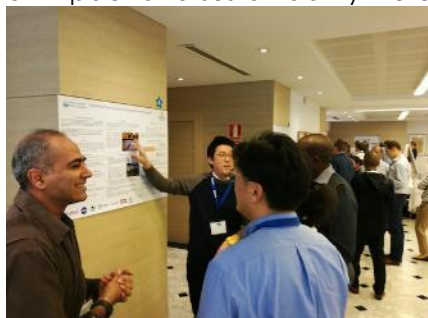
During 2017, the 16 projects selected for the NASA ROSES SERVIR 2015 Applied Sciences Teams made significant progress in achieving their Year One milestones. Each of the 16 projects is being accomplished in collaboration with a regional SERVIR hub (Eastern and Southern Africa, West Africa, Hindu Kush-Himalaya (HKH), and the Lower Mekong region of Southeast Asia), based on the needs identified for that region, as demonstrated by tools such as the Crop Monitor and TimeSync products described in this section and brief summaries by region below. Targeted toward a balanced portfolio in water and water-related disasters, food security and agriculture, weather and climate, and land use and ecosystems, the projects continue to become more integrated with the four SERVIR hubs. The AST projects had increased their ARL (Application Readiness Level) by an average of 1.25 levels by the end of calendar year (CY) 2017. The four projects focusing on HKH represent a strong example of integration with hub activities, as well as cross-project and even cross-hub

collaboration. These HKH AST projects provided trainings that were closely integrated into the ICIMOD AST/Stakeholder Workshop in April 2017. These projects are contributing key inputs to HKH services, for example, to portals and models providing early warning assessments for local decision makers. These projects also are actively engaged with several projects with similar foci at other SERVIR hubs, thus enhancing the productivity of the entire AST portfolio.



SERVIR continued to develop strategies for better integrating and implementing customer-focused service planning across all SERVIR activities throughout the year, while also looking at ways to ensure long-term impact and sustainability. Activities included a SERVIR Global Service Planning Exchange in Nairobi, Kenya in April, in which each of the hubs participated. This was the first SERVIR exchange focused primarily on this theme, as part of a multi-phased initiative to improve and enhance the practical application of the Service Planning Approach

by the SERVIR Hubs. The SERVIR Service Planning Approach was introduced during the first SERVIR Annual Global Exchange (SAGE) in 2015 as a way to holistically meet user needs through a set of services, and tools were subsequently developed to standardize processes. A key objective of the April 2017 exchange was to test and validate the tools in the Service Planning Toolkit and review initial lessons learned. The SERVIR Science Coordination Office (SCO) followed up with a Service Planning Overview Workshop at the end of May, and the SERVIR Planning Toolkit and themes of impact and sustainability were highlighted throughout the 3rd SAGE meeting--under the



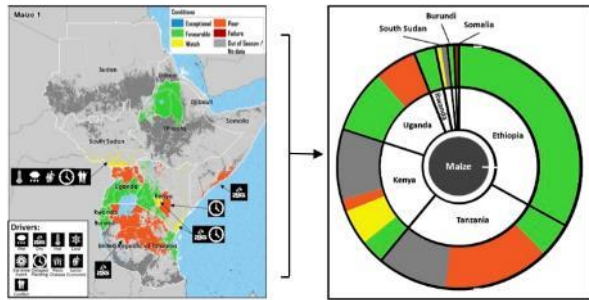
theme of *Achieving Lasting Impact*, where representatives from USAID, NASA and the SERVIR hubs gathered together October 9-13, 2017 in Bilbao, Spain, to discuss collaborations and to deepen SERVIR's integration of this process. SERVIR leadership shared the service planning approach through presentations at the Group on Earth Observations (GEO)-XIV Plenary and at AGU. Moving forward, the latest information and documentation on Service Planning and the Toolkit will be made available on the SERVIRGlobal website during 2018 so that others might benefit from this approach.

SERVIR launched a Capacity Building effort in early 2017 to gain an applied understanding of the use of Synthetic Aperture Radar (SAR) technologies for forest monitoring and biomass estimation. The initiative began with a Scoping Meeting on February 21-22, 2017, at the SCO offices in Huntsville, Alabama, USA, and was attended by representatives from SERVIR Hubs, USAID, the US Geological Survey, the US Forest Service, and NASA, along with subject matter experts from academia, government, and private industry. The objective of this Scoping Meeting was to agree on common needs and gaps to enhance forest monitoring systems, including assessment of forest biomass, through the application of new technologies, such as SAR. Outcomes of the meeting included the inception of a SAR Handbook Activity with hands-on and practical theoretical content, as well as a plan to hold a series of SAR Trainings at each of the hubs, led by subject matter experts. The first of these trainings will be held in Niamey, Niger, January 29 – February 2, 2018 on SAR Basics and for Mapping of Forest Degradation and



Deforestation. The next training will be in Kathmandu, Nepal on February 12-16, 2018 on the same topics. The purpose is for all SERVIR network and appropriate in-country partners to receive the initial basic training in preparation for additional advanced SAR trainings that are being planned.

A SERVIR 2015 AST project led by Inbal Becker-Reshef of University of Maryland, College Park, working closely with RCMRD/SERVIR-Eastern and Southern Africa, began bringing countries together and increasing their national and regional capacity for agricultural monitoring by developing the first monthly Crop Monitor product for the Greater Horn of Africa. Initially presented at the Greater Horn of Africa Climate Outlook Forum (GHACOF 47), the service

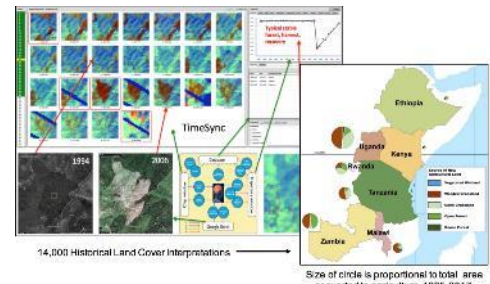


Crop conditions: maize map for ICPAC's 8 member countries.

provides timely and easily interpretable maps to national authorities, such as Ministries of Agriculture, and has also built the capacity of the Intergovernmental Authority on Development's (IGAD) Climate Prediction and Applications Centre (ICPAC) to produce regional crop monitor bulletins for improved agricultural decision making. A lack of timely and accurate information on crop conditions/prospects is a critical issue in much of eastern and southern Africa, undermining the

ability of national authorities to make decisions, particularly during agricultural droughts. More accurate data inform agricultural policies for end users, allowing for better decisions in response to severe crop conditions. Technical training workshops on the Crop Monitor were held, including a training on Global Agricultural Monitoring (GLAM) and Crop Monitor to Uganda's Office of the Prime Minister (OPM) in Kampala, Uganda in March of 2017, and a Crop Monitor Training to representatives from ICPAC and Ministries of Agriculture from the region, held at RCMRD in July of 2017. SERVIR will continue to support ICPAC in the production of the regional crop monitor bulletin, which will be released during each seasonal climate outlook meeting.

The TimeSync Tool allows easy access to all Landsat images to support land cover observations and assess change over time at specific locations of interest. TimeSync is being developed through a SERVIR 2015 AST Project led by Sean Healey of the US Forest Service. Existing land cover maps for Eastern Africa did not provide the annual land cover change information needed for higher-tier reporting by the Intergovernmental Panel on Climate Change. TimeSync has been used to quantify land cover trends in 7 countries, and TimeSync has been transferred to RCMRD, which has led three training workshops on the platform in the region.



In terms of performance, all eleven 2011 AST projects were completed except Allen Blackman's (extended to 3/19/18), with final reports/publications in work or submitted. Two of the 11 projects had been completed during CY 2016. Of these projects, five exceeded their ARL goal and five met their goal, while the 11th completed one level below the goal. For the 2015 AST projects, 14 of 16 projects have advanced one or more ARLs: four projects advanced by two or more ARLs and one project advanced by four ARL levels. The initial mean ARL for these projects was 2.8, and the current mean is 4.1.

The Indigenous Peoples Initiative successfully completed a train-the-trainers handoff of their *Introduction to Remote Sensing* course to the BIA partners. The BIA has now included this course in their upcoming offerings and now has the capacity to train tribes on not only Geographic Information Systems (GIS) but also on the use of NASA Earth Observations for land management.



## IV. Community Engagement

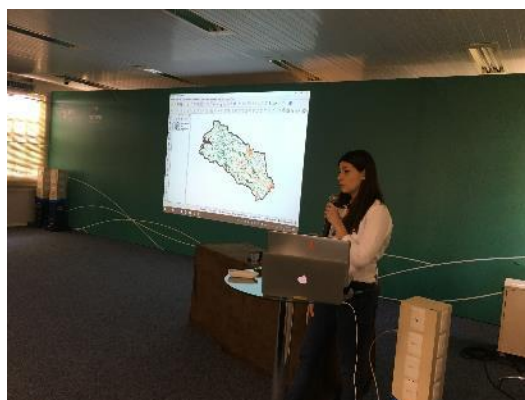
### **Community Leadership**

In 2017, Capacity Building participated, presented, and led sessions in national conferences, interagency, and international events. The CBP Program Manager, Dr. Nancy Searby, provides leadership in 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 initiative called AmeriGEOSS, as well served as a member of the GEO Capacity Building Coordination Working Group and the CEOS Working Group for Capacity Building and Data Democracy (WGCapD). Highlights of these broader activities include AmeriGEOSS Week in San Jose, Costa Rica in August 2017, the 6<sup>th</sup> annual WGCapD meeting in Oberpfaffenhofen, Germany in March 2017, assuming the Vice Chair role for WGCapD at the CEOS Plenary in Sioux Falls, South Dakota in October 2017, and sharing CBP highlights and approaches at the GEO-XIV Plenary Capacity Building Side Session in Washington, DC in October 2017.



CBP chaired two sessions at the AGU Fall Meeting in New Orleans, Louisiana, focused on building sustained capacity to use Earth observations to enhance environmental management decisions, actions, and policy. These sessions brought together multiple sectors including policy makers and Earth observation capacity-building groups 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 from a variety of sectors, conducted six in-person trainings in 2017. These include the Alaska Fire Service (state organization), Dewberry (private sector), South Coast Air Quality Management District (SCAQMD) (regional agency), Indian Institute of Tropical Meteorology (IITM), the Group on Earth Observations (GEO), and UNESCO. With community and stakeholder interests in mind, ARSET co-produced agendas tailored to provide attendees with the skills to access, interpret, and apply NASA data on local and global scales specific to the host organization or community's mission. One training was affiliated with a broader conference event (GEO Week 2017), while the remaining trainings were one to multi-day events conducted either partially or completely by ARSET team members.



DEVELOP joined and led the science and policy communities in a variety of activities in 2017. The program co-chaired a session at the 2017 AGU Fall Meeting, 14th Biennial Conference of Science & Management on the Colorado Plateau & Southwest Region, American Association of Geographer's Annual Meeting, and the 19<sup>th</sup> George Wright Society Conference. The program engaged policy makers through informative visits to Congress in August and participated in Virginia's Aerospace Days in Richmond, Virginia in February.

SERVIR's Science Coordination Office (SCO) pursued increased collaboration with regional initiatives such as AfriGEOSS and AmeriGEOSS. Along with the West Africa and Eastern & Southern Africa hubs, the SCO participated in the 2nd AfriGEOSS Symposium 2017, in Accra, Ghana, and two SERVIR trainings were held as part of the Symposium (AfriGEOSS Software Carpentry Training, led by AGRHYMET, and an Introduction to Google Earth Engine training led by the SCO). In July, the SCO also participated in the AmeriGEOSS meeting in San Jose, Costa Rica, where an SCO team member led a training on the Use of Synthetic Aperture Radar (SAR) imagery for disaster management. Collaborations with SilvaCarbon included the Scoping meeting and SAR Handbook activities as part of the SAR capacity building effort, as well as hosting of a SilvaCarbon/USFS online training on Forest Cover Change Detection, that is hosted on the SERVIRGlobal website and included introductory webinars for hub participants beginning in April of 2017.



The Indigenous Peoples Initiative's Dr. Cindy Schmidt, organized a session at the Disaster Risk Reduction Across the Americas Summit in Buenos Aires in September focused on how indigenous and local communities have developed disaster resilience strategies. This session brought together researchers and community leaders from multiple countries including Bolivia, Colombia, Peru, Mexico, Canada, and Argentina. The IP team has also been engaged in the Native American Advisory Committee (NAAC) at NASA Ames, which aims to help inform NASA Center leadership on inclusivity and engagement with the indigenous community.

### **Enhancing Data Accessibility**

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

ARSET helps training attendees build skills to acquire and use Earth observations for decision support. In 2017, ARSET demonstrated or presented on 109 instruments, missions, and web-based tools (see Appendix). Through these capacity building activities, ARSET facilitated access to satellite data hosted by NASA and other organizations, including NOAA, 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 (ASDC, GES DISC, LAADS DAAC, LANCE, LPDAAC, and ORNL DAAC) 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 2017, the program had NASA's Software Release Authority approve the release of twelve tools for public dissemination (an increase from four in 2016) including: Chesapeake Bay Chlorophyll Hotspot Identifier (CBCHI), Palm Oil Plantation Predictor (POPP), Move Away Superfluous Clouds (MASC),

Grand Canyon Regions of Drought Impact (GC-ReDI), Pixelwise Correlation-Based Landscape Classification (PICO), Elkhorn Slough Vegetation Imagery Assessment (ESVIA), Surface Water Indication Model (SWIM), Geographic Applications for Transitioning Everglades Regions (GATER), Flood Analysis Utilizing Landsat and ArcMap Tools (FAULT), Cover Crop Remotely Observed Performance (CCROP), Hydrologic Anomaly Index (HAE), and the Skyglow Estimation Toolbox. DEVELOP also used Google Earth Engine in 26 projects (increase from 13 in 2016) to harness cloud computing for running analyses, simplification of processing for project partners, and increase utility of DEVELOP products.

SERVIR SCO initiated the acquisition and implementation of a computer cluster (named SOCRATES), in order to provide the large computational capacity that's required for several of the data processing models that regional hubs are implementing with the AST Pls. This cluster will start offering services to the different teams in early 2018, and the datasets generated by these models will be made publicly accessible in different ways (e.g., cloud and on-premises, raw dataset access and custom applications). SERVIR is also exploring cloud-based pilots with Amazon, Google, and Microsoft to assess the best long-term approach to run data processing models and make products available across the network.

The SCO has also published applications and datasets to visualize data from various models and/or Earth observing instruments, such as Evapotranspiration Stress Indices (ESI), altimetry data from the GRACE mission, RHEAS and VSAT model outputs, and others. In parallel, the SCO continues to enhance the delivery of existing datasets through improvements to the metadata collections and metadata catalogs across the project.

In-person training activities conducted by the Indigenous Peoples Initiative have enhanced data access and use among tribal communities. In survey results from the two *Introduction to Remote Sensing* trainings, 100% of the respondents agreed that the training increased their ability to access remote sensing data products. These trainings have highlighted data portals such as LandsatLook Viewer, Earth Explorer, GloVis and data visualization viewers such as DroughtView, the Global Agricultural Monitoring (GLAM) website, VIIRS Active Fire Web Mapper, and Climate Explorer.

### **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 was able to bolster existing relationships and form new ones with organizations representing scientific and policy making communities. In the Non-Profit and NGO sectors, ARSET engaged exhibitors at the 2017 InterAction Forum, resulting in a better understanding of the issues facing humanitarian, development, and conservation organizations. In the conservation community, ARSET maintained its relationship with capacity building teams from the Wildlife Conservation Society and The Nature Conservancy.

ARSET also began actively engaging its attendees and new organizations around the UN Sustainable Development Goals (SDGs). The program conducted three SDG-related trainings that increased awareness around how remote sensing can support the implementation and monitoring of SDG targets and indicators. Participation included national statistics offices and other entities charged with curating and delivering on the SDGs. ARSET also contributed a session to GEO-XIV Plenary in October on water quality applications and SDG indicator 6.3.2. This also allowed ARSET to establish and further relationships within GEO and other organizations working with remote sensing to achieve the Sustainable Development Goals. In April,

International Institute for Sustainable Development (IISD) [featured an article on ARSET's PM<sub>2.5</sub> SDG training](#), published in its communications and knowledge portal.

For the second year, ARSET continued its partnership with UNESCO to host an in-person training in Brazil. ARSET also partnered with UNOSAT for an online training on the Global Disaster Alert and Coordination System (GDACS).

SERVIR began pursuing partnership agreements with three major cloud infrastructure providers -- Microsoft Azure, Amazon Web Services, and Google Cloud – to enable three of the hubs to engage with these companies in cloud pilot activities. The SCO will provide assistance in establishing and operating these pilot activities at ICIMOD, RCMRD and ADPC to advance their cloud management knowledge and increase their expertise to run dynamic, on-demand infrastructure using commercial clouds. While AGRHYMET will not be leading a cloud pilot, they will benefit from these findings to strengthen their capacity. This will also inform us whether a future cloud pilot should be initiated at AGRHYMET. Progress continues into 2018 in establishing these agreements, and contractual activities continue with organizations such as Digital Globe and Esri.

In partnership with the University of San Francisco, U.S. Forest Service, and SilvaCarbon, SERVIR-Mekong developed, tested, and delivered a Google Earth Engine (GEE) curriculum that served as the backbone for a regional training event in Bangkok in July of 2016 and, through a unique partnership with Google, continued to build capacity through a series of training events in 2017 as part of a GEE 'roadshow' in the Lower Mekong region.



Seeking to create unique and innovative opportunities between SERVIR scientists and ITC/University of Twente, the SCO is pursuing an agreement with the institute, based in Enschede, Netherlands, to forge a closer scientific collaboration between SERVIR and ITC. These collaborations will focus on improving, developing, accrediting and conducting relevant thematic education and training, as well as strengthening institutional and regional capacity and conducting relevant EO remote sensing science research and application, tool, and service development.

The Indigenous Peoples Initiative solidified relationships between federal and tribal organizations through visits, meetings, and conference calls with the 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.

## V. 2017 CBP Portfolio

The Capacity Building Program engages in two types of activities within its portfolio: co-developed products and trainings, and mid-year, added a new goal to focus on and determine ways to measure progress on brokering relationships. In 2017, the program created 245 co-developed products and 104 trainings (12 online & 92 in-person), as well as conducted 70 feasibility studies and 35 multi-year projects. CBP activities covered a broad range of 10 themes in alignment with the Applied Sciences' Application Areas including 8 of the 9 FY17 Application

Areas and 7 of 8 FY18 Applications Areas based on revised GEO societal benefit areas: Agriculture & Food Security, Climate, Disasters, Ecological Forecasting, Energy, Health & Air Quality, Oceans, Urban Development, Water Resources, and Weather.

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

<b>Thematic Area</b>	<b>Co-Developed Products</b>	<b>Trainings</b>	<b>Portfolio %</b>
<b>Agriculture &amp; Food Security</b>	<b>20</b>	<b>7</b>	<b>8%</b>
<b>Climate*</b>	<b>10</b>	<b>8</b>	<b>5%</b>
<b>Disasters</b>	<b>40</b>	<b>13</b>	<b>15%</b>
<b>Ecological Forecasting</b>	<b>38</b>	<b>28</b>	<b>19%</b>
<b>Energy</b>	<b>4</b>	<b>0</b>	<b>1%</b>
<b>Health &amp; Air Quality</b>	<b>65</b>	<b>5</b>	<b>20%</b>
<b>Oceans</b>	<b>6</b>	<b>0</b>	<b>2%</b>
<b>Urban Development**</b>	<b>2</b>	<b>0</b>	<b>1%</b>
<b>Water Resources</b>	<b>54</b>	<b>21</b>	<b>21%</b>
<b>Weather*</b>	<b>0</b>	<b>1</b>	<b>0%</b>
<b>Cross-Cutting</b>	<b>9</b>	<b>21</b>	<b>9%</b>

\* Application Areas retired at end of FY17

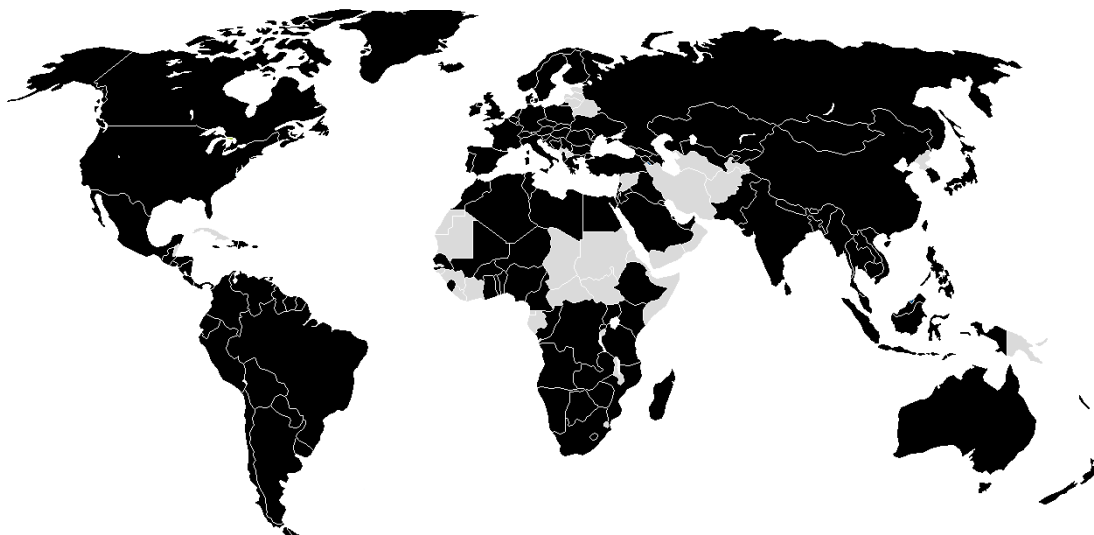
\*\* Application Area added in beginning of FY18

## VI. Geographic Reach

### Geographic Coverage of Activities

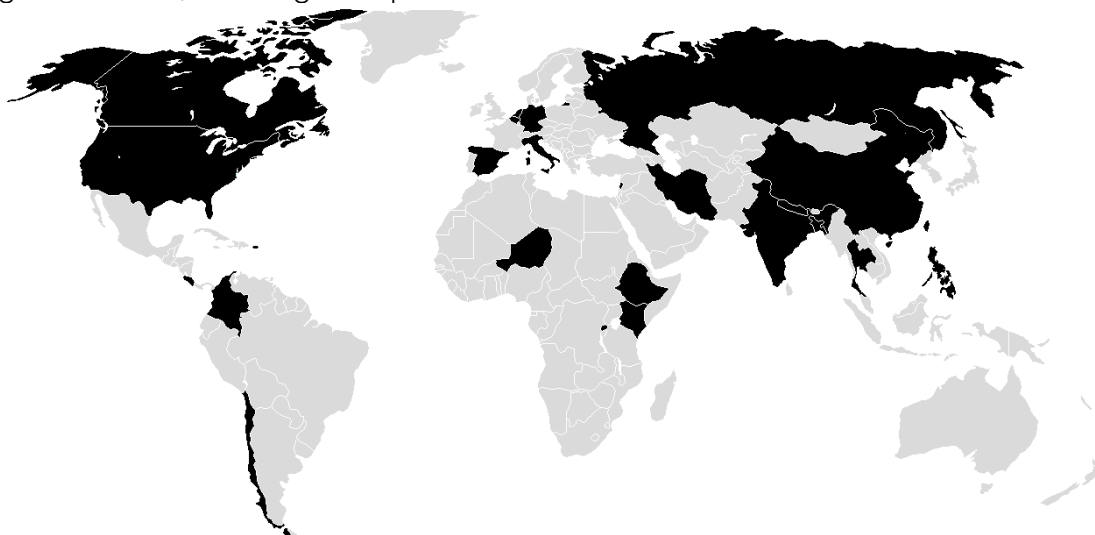
The Capacity Building Program actively participated in U.S. and international Earth observations and capacity-building activities in 2017 through USGEO, GEO, CEOS, and program element activities.

ARSET online and in-person trainings reached participants in 131 countries, a slight increase from 2016 (130 countries impacted). About 25 percent of the training participants were from the U.S. and 75 percent from outside the U.S.



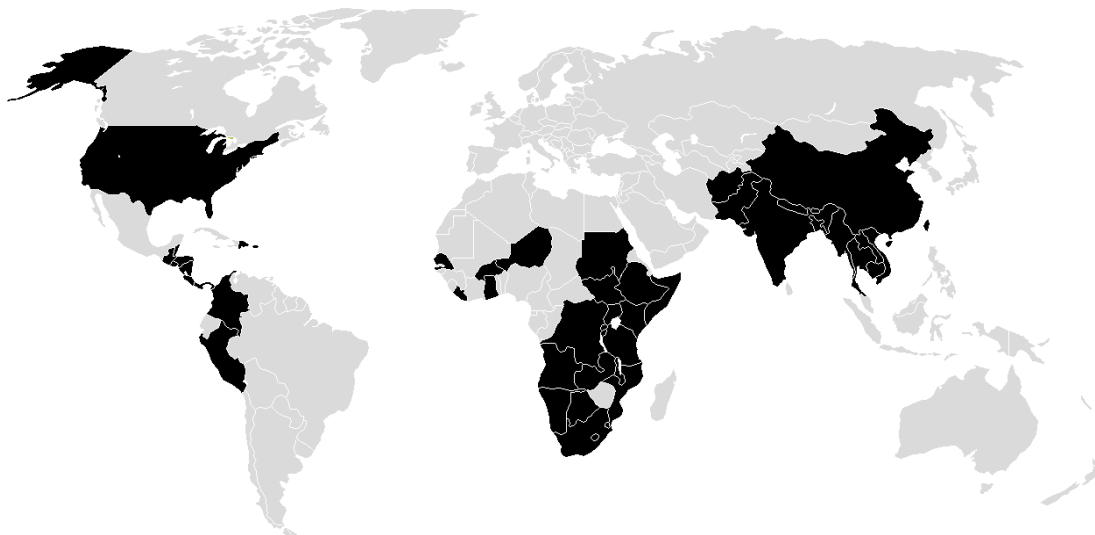
*Black denotes the 131 countries impacted by ARSET*

DEVELOP's primary focus is domestic capacity building and in 2017, the project portfolio consisted of 84 percent of projects addressing domestic issues. The program reached 48 U.S. states through project study areas and 90 percent of participants were U.S. citizens from 42 states, providing an impact to all 50 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 2017, 16% percent of projects addressed international issues in 12 countries and international participants from 11 countries were 10% percent of the individuals engaged on teams, meaning an impact to 23 countries.



*Black denotes the 23 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 with more than 45 countries through the support of the regional hubs in 2017. Domestically, SERVIR's Science Coordination Office and Applied Sciences Team (AST) engaged 14 U.S. states.



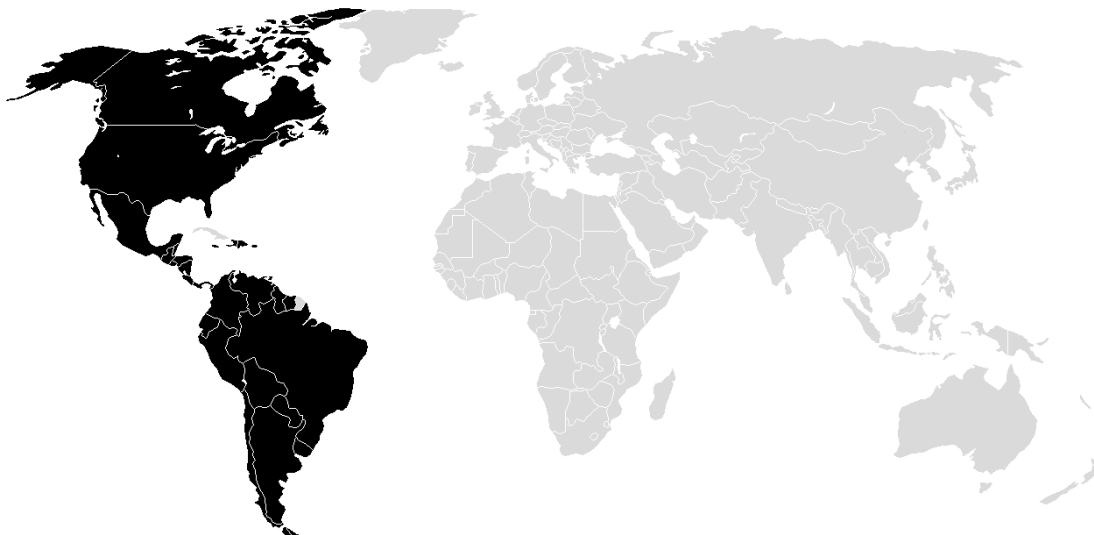
*Black denotes the 47 countries impacted by SERVIR*

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 29 countries in the Americas caucus region through:

- ▶ ARSET – 2,877 individuals through 3 in-person and 12 online trainings
- ▶ DEVELOP – 484 individuals through 62 feasibility studies and 5 trainings
- ▶ SERVIR – 56 individuals through 1 multi-year project, 6 in-person trainings and 4 workshops
- ▶ Indigenous Peoples – 39 individuals through 3 in-person trainings



*Black denotes the 29 countries in the Americas impacted by CBP*

*More information for the multi-year projects:*

#### **Using Earth Observation Data to Improve REDD+ Policy in Mesoamerica and the Dominican Republic (ROSES 2011 - SERVIR AST)**

*Principal Investigator:* Allen Blackman, Resources for the Future, Inc.

*ASP Application Area:* Ecological Forecasting

*Thematic Service Area:* Land Cover and Land Use Change and Ecosystems

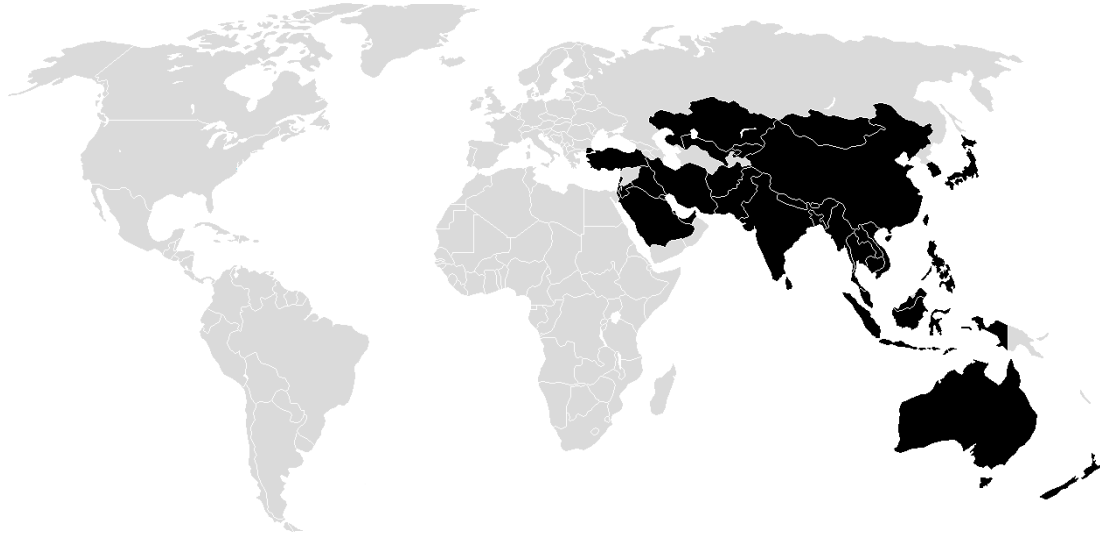
*Description:* This project is improving the efficiency and effectiveness of REDD+ policy making in Mesoamerican countries. The project developed Web-based decision tools that use Landsat and MODIS data to characterize forest cover change and combine this information with geophysical, socioeconomic, and ecological characteristics, enabling end users to prioritize interventions in their regions. For example, this tool was used by the Inter-American Development Bank to prioritize locations in which to distribute eco-friendly cook stoves based on highest benefit from an environmental and economic perspective. The project team is in the process of transitioning the tools to the SERVIR SCO, and therefore, activities are set to continue into early 2018, in order to complete this transition. Current ARL for this ongoing ROSES 2011 AST project is 7.

### Asia and Oceania

CBP reached 35 countries in the Asia & Oceania caucus region through:

- ▶ ARSET – 977 individuals through 1 in-person and 12 online trainings
- ▶ DEVELOP – 32 individuals through 5 feasibility studies
- ▶ SERVIR – 254 individuals and 12 multi-year projects, 27 in-person trainings and 12 workshops





Black denotes the 35 countries in Asia & Oceania impacted by CBP

More information for the multi-year projects:

**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 International Centre for Integrated Mountain Development, the hub organization for SERVIR- Hindu Kush-Himalaya, is working on a drought portal that will showcase the data and analyses. Current ARL is 4 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. Current ARL for this ongoing project is 2.

**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 Areas:* Water Resources and Hydroclimatic Disasters

*Description:* This project develops 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 them to prepare for and warn the public of impending floods and related disasters and promote resilience and recovery after flood events. Current ARL is 7 for this ongoing project.

**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 on-going activities in the region. Current ARL is 4 for this ongoing project.

**A Satellite-based Early Warning, Mapping and Post-Disaster Visualization System for Water Resources of Low-lying Deltas of the Hindu Kush-Himalayan Region (ROSES 2011 - SERVIR AST)**

*Principal Investigator:* Faisal Hossain, University of Washington

*ASP Application Area:* Water Resources, Disasters

*Thematic Service Area:* Water Resources and Hydroclimatic Disasters

*Description:* This effort focused on developing modular satellite-based water resources and water hazard mapping, early warning and post-disaster assessment visualization system for use by stakeholders in the Ganges-Brahmaputra-Meghna and Indus River basins. The satellite altimetry based datasets are in routine use by the Flood Forecast and Warning Center, an operational agency of Bangladesh government. This project ended in July of 2017, with an ARL of 9.

**Interdisciplinary Science Applications to Glacier and Alpine Hazards in Relation to Development and Habitation in the Hindu Kush-Himalaya: SERVIR Science Team Project (ROSES 2011 - SERVIR AST)**

*Principal Investigator:* Jeff Kargel, University of Arizona

*ASP Application Area:* Disasters

*Thematic Service Area:* Water Resources and Hydroclimatic Disasters

*Description:* This project created a satellite image time series of glacier lakes, conducted topographic and hydrological analysis, and performed field studies of glacier lakes for designing a warning system on glacial lake outburst flood. Kargel and his team provided analysis to the UN Development Programme (UNDP) on the dangerous rise of Lake Imja in Nepal. Based on this analysis, UNDP provided assistance to the Nepal Army to lower the lake level by lowering the dam by more than 10 feet, substantially reducing the risk from a lake outburst flood. This project ended in August of 2017, with an ARL of 7.

**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 develops 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. There have been several trainings on the hydrological modeling system offered at SERVIR-Mekong and to other partners in the region to increase capacity during CY 2017. Current ARL for this ongoing project is 4.

**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. Current ARL is 4 for this ongoing project.

**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 their water resource management decision-making and agricultural monitoring and forecasting capabilities. There have been several trainings on the hydrological modeling system offered at ADPC, to Vietnam's Ministry of Natural Resources and Environment (MoNRE), and to other partners in the region to increase capacity during CY 2017. Current ARL is 3 for this ongoing project.

### **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

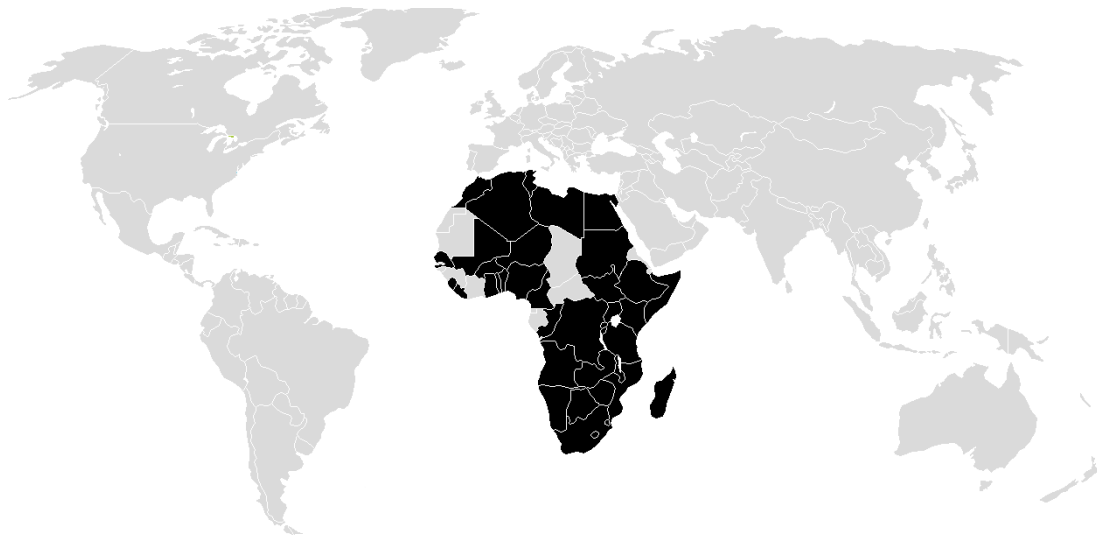
Thematic Service Area: Agriculture and Food Security

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. Current ARL for this ongoing project is 7.

## **Africa**

CBP reached 40 countries in the Africa caucus region through:

- ▶ ARSET – 372 individuals through 12 online trainings
- ▶ DEVELOP – 4 individuals through 2 feasibility studies
- ▶ SERVIR – 304 individuals and 14 multi-year projects, 22 in-person trainings and 5 workshops



*Black denotes the 40 countries in Africa impacted by CBP*

More information for the multi-year projects:

### **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. Several trainings have been conducted during CY17, and capacity has been strengthened at RCMRD and Kenya Meteorological Department (KMD) to use EF5 for hydrological assessments. Current ARL is 6 for this ongoing project.

### **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 agriculture and crop condition as a basis for decision-making, policy design, and agricultural development interventions in Eastern and Southern Africa. Data and methodology from this project are already serving as key inputs to Intergovernmental Authority on Development (IGAD) Climate Prediction and Application Centre's (ICPAC's) Regional Crop Monitoring efforts, as part of Greater Horn of Africa Climate Outlook Forum (GHACOF). Current ARL for this ongoing project is 4.

### **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 EWX products, created as part of this project, are being used in several hub services, such as climate vulnerability assessments. Current ARL is 5 for this ongoing project.

### **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 30-meter maps of land cover 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. Current ARL for this ongoing project is 3.

### **Development and Implementation of Flood Risk Mapping, Water Bodies Monitoring and Climate Information for Disaster Management and Human Health (ROSES 2011 - SERVIR AST)**

*Principal Investigator:* Pietro Ceccato, International Research Institute for Climate and Society (IRI), Columbia University

*ASP Application Area:* Health and Air Quality

*Thematic Service Area:* Water Resources and Hydroclimatic Disasters

*Description:* This project has developed the capacity to integrate NASA remotely-sensed products for establishing an improved vector-borne disease risk assessment tool for use by targeted stakeholders. The project team has developed water bodies mapping techniques and held several successful trainings with end users and ministries in East Africa. SERVIR-Eastern and Southern Africa is also looking at operationalizing the water body mapping for uses in rangeland pastureland management. This project was completed in August of 2017, with an ARL of 7, exceeding the project's goal ARL of 6.

### **East Africa Drought and Agricultural Productivity Assessment and Prediction System (ROSES 2011 - SERVIR AST)**

*Principal Investigator:* Stephanie Granger, NASA Jet Propulsion Laboratory

*ASP Application Area:* Agriculture, Water Resources

*Thematic Service Area:* Agriculture and Food Security

*Description:* This project developed a system to support farming practices in East Africa by helping farmers assess potential end of the season crop yields using crop and hydrologic models, Earth observations, and seasonal forecasts and outlooks. Since its inception, the project has coupled the Variable Infiltration Capacity (VIC) and Decision Support System for Agrotechnology Transfer (DSSAT) models for several crop type modules. The system is installed at the SERVIR-Eastern and Southern Africa hub, and several end users in Kenya, Ethiopia, and Zambia are trained on the use of the derived products. The SERVIR hub is

developing effective ways to disseminate these useful products. This project was completed in September of 2017, with an ARL of 8.

#### **Forest Carbon Assessment for REDD in the East Africa SERVIR Region (ROSES 2011 - SERVIR AST)**

*Principal Investigator:* Scott Goetz, Woods Hole Research Center

*ASP Application Area:* Ecological Forecasting

*Thematic Service Area:* Land Cover and Land Use Change and Ecosystems

*Description:* This project demonstrated that NASA Earth science products and derived models can assist stakeholders and decision makers with their terrestrial carbon assessment and forest conservation strategies. This project has built significant capacity in carbon accounting at the SERVIR-Eastern and Southern Africa hub. This project finished in June of 2017, with an ARL of 9.

#### **SERVIR Water Africa-Arizona Team (SWAAT) (ROSES 2011 - SERVIR AST)**

*Principal Investigator:* Juan Valdes, University of Arizona

*ASP Application Area:* Water Resources

*Thematic Service Area:* Water Resources and Hydroclimatic Disasters

*Description:* This project developed hydrologic modeling capabilities to monitor water resources in Africa. The outcome of this effort is provision of near-term streamflow forecasts in three key pilot basins (Mara, Tekeze, and Zambezi) and a quantitative assessment of seasonal outlook on water resources in these basins. Kenyan and Namibian water resources departments have used the derived datasets in making water allocation decisions. This project has enabled the capacity of SERVIR to transform real-time data streams into a Climate Hazards Group InfraRed Precipitation with Station data (CHIRPS)-based data product, to ensure data consistency and continuity. The project achieved an end ARL of 7, and was completed in August of 2017.

#### **A Long Time-Series Indicator of Agricultural Drought for the Greater Horn of Africa (ROSES 2011 - SERVIR AST)**

*Principal Investigator:* James Verdin, U.S. Geological Survey Sioux Falls/FEWS NET

*ASP Application Area:* Agriculture

*Thematic Service Area:* Water Resources and Hydroclimatic Disasters

*Description:* This project created a long time-series indicator of agricultural drought in the Greater Horn of Africa using remotely sensed observations. Since its inception, this project has generated a 30-year rainfall and drought indicator data set (1981 to present) using a variety of available satellite data and model products. The SERVIR-Eastern and Southern Africa hub is using the data to help countries in their region with water resources and agriculture analysis. Outcomes of this project contributed to initial successes of the EWX system (ROSES 2015). Completed in July of 2017, it exceeded the project goal ARL of 7 to achieve a final ARL of 9.

#### **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. Current ARL is 3 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. The project PI, in collaboration with SERVIR-West Africa, conducted a successful field campaign during CY17, which led to improved methodology and enhanced capacity in the region. Current ARL is 3 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. Current ARL is 3 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 collaborated with West Africa Consortium partner CSE to improve rangeland monitoring in West Africa. Current ARL for this ongoing project is 3.

**Leveraging CMIP5 and NASA / GMAO Coupled Modeling Capacity for SERVIR East Africa Climate Projections (ROSES 2011 - SERVIR AST)**

*Principal Investigator:* Franklin (Pete) Robertson, NASA Marshall Space Flight Center

*ASP Application Area:* Climate

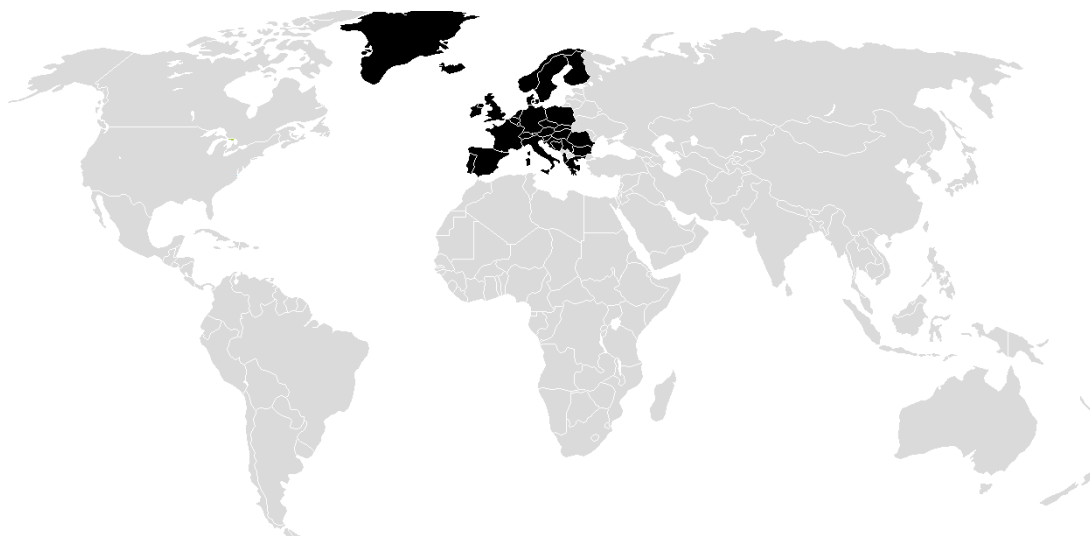
*Thematic Service Area:* Weather and Climate

*Description:* This project critically assessed and employed climate model projections of seasonal hydro-meteorological climate variability affecting SERVIR hub regions and developed spatially downscaled scenarios to enable other AST investigators to drive decision support systems on seasonal time horizons. The project's outputs have been used in several other AST projects and hub activities. These outputs continue to be produced and served through SERVIR's ClimateSERV portal. This project completed in August of 2017 with an ARL of 8, which exceeded the project goal ARL of 7.

**Europe**

CBP reached 31 countries in the Europe caucus region through:

- ▶ ARSET – 593 individuals through 12 online trainings
- ▶ DEVELOP – 4 individuals through 1 feasibility study

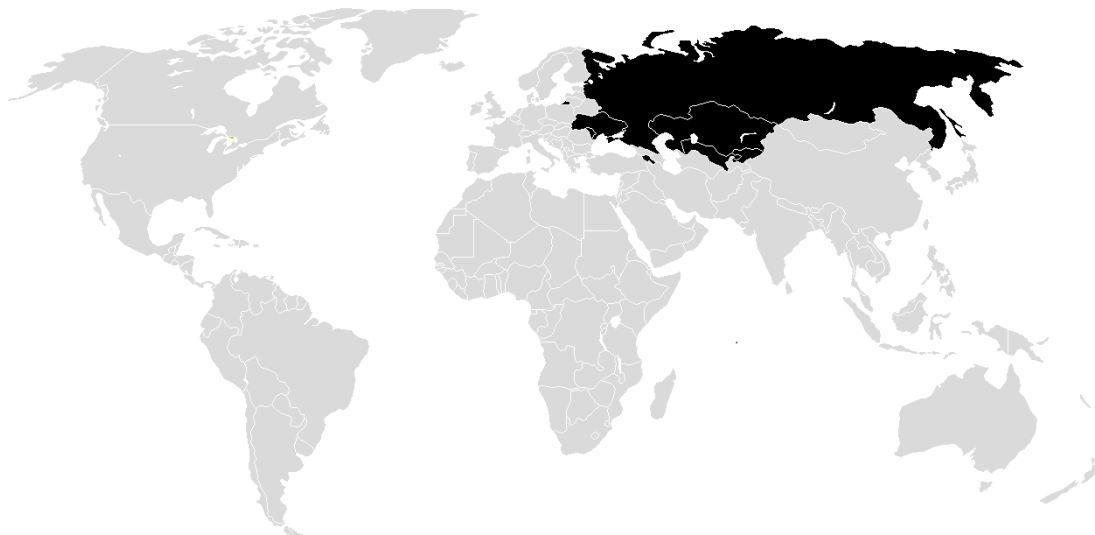


Black denotes the 31 countries in Europe impacted by CBP

## Commonwealth of Independent States (CIS)

CBP reached 7 countries in the CIS caucus region through:

- ▶ ARSET – 30 individuals through 12 online trainings
- ▶ DEVELOP – 2 individuals



*Black denotes the 7 countries in Europe impacted by CBP*

## VII. Program Management

### **Management Team**

Capacity Building is led by Dr. Nancy Searby at NASA Headquarters. In 2017, the Program was supported by Christine Mataya, Sarah Hemmings, 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.

### **Strategic Planning**

Capacity Building continues to strengthen through enhancement of programmatic assessment methods and tools. In June of 2017, CBP management and Element teams gathered in Greenbelt, Maryland to conduct a Strategic Planning Retreat. Participants constructed an effective operating model for CBP, as well as mapped powerful linkages and interdependencies within the program, with other ASP elements, and with broader Earth Sciences Division (ESD), Committee on Earth Observation Satellites (CEOS), and the Group on Earth Observation (GEO) communities.

Two of the three program Elements, DEVELOP and SERVIR, held strategic meetings in 2017, while ARSET's retreat is scheduled for January 2018.

In June 2017, ARSET participated in the larger Capacity Building retreat at GSFC, with several team members in attendance throughout the session. ARSET will hold its fourth annual meeting of all team members in January 2018. All team members will be in attendance, and the program will discuss accomplishments from 2017, strategies and best practices for moving forward, have continuing education opportunities for trainers, and further refine the workflow of the program.

ARSET will continue looking at new training approaches and topics, and will begin implementing a new learning management system for asynchronous trainings.

DEVELOP held three strategic meetings throughout 2017. In January, the program held its FY17 Fellow Class Strategic Planning & Leadership Retreat focused on organizing the Fellow Class project and identifying opportunities for improvements to the program which culminated in the creation of the DEVELOP Earth Science Collaborative (DESC) forum for improved Geoinformatics support and the program's interactive mapper. In May, the program held its 2018 Center Lead Strategic Planning & Leadership Retreat which focused on programmatic process improvements and professional development of leadership skills. In December, DEVELOP held its FY18 Strategic Planning & Leadership Retreat which brought both Center Leads, Fellows, and the National Program Office together to identify process improvements and participate in "soft skill" development.

The 4th Annual SERVIR Joint Working Group (JWG) meeting took place in Washington D.C., in May 2017, with participation from USAID and NASA HQ Earth Science Division leadership and SERVIR SCO leadership. The JWG reviewed progress since the last meeting, highlighting activities and accomplishments – particularly those supporting SERVIR's Strategic Goals, such as connecting more innovative and appropriate science through the ASTs and Technical Assessment Groups, and expanding the SERVIR network through strategic global partnerships and collaborations. Additional discussion topics included SERVIR hub expansion and how to best be responsive to changes in priorities of the current administration.

The SERVIR program also hosted the SERVIR Annual Global Exchange (SAGE) from October 9-13 in Bilbao, Spain. During the meeting, participants shared lessons learned and discussed strategies for better integrating the service planning process, which efficiently links needs from regional end users to SERVIR service planning, development and evaluation, to ensure services across the network are relevant and sustainable. In preliminary sessions on the first day, participants including AST, SCO and hub scientists shared regional activities and progress and exchanged views on past, current and upcoming initiatives.

For the IP initiative, a primary focus for future strategic planning activities in 2018 is the organization of a workshop of experts to explore lessons learned in the IP activities to date, user needs, gaps in addressing them, and how IP activities might proceed within the Capacity Building Program. The workshop aims to include Native American and First Nations members from academia and federal agencies that understand both traditional ecological knowledge and western science. Members could also include non-indigenous individuals that work closely with tribes.

CBP continues its programmatic goal to enhance activities that promote and improve engagement, entrepreneurship, 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 the reach of the program.



- **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 continues to work towards its five strategic goals, while building a robust network of engagement with other capacity building programs and initiatives. 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.

### 2016 4<sup>th</sup> Quarter Aggregated Indicators:

<b>IR-1: Improved Awareness of – and Access to – Earth-observation Data, Products, and Tools</b>	
<i>Sub-IR 1.1: Awareness Increased in New Geographic Regions &amp; Different Sectors</i>	
1.1.1 The Number of States & Countries Reached through CBP Trainings & Projects	50 states; 143 countries
1.1.2 The number of Partners (by type) Reached through Trainings & Projects	Total: 2369 – Academic Institution (36%); Consortium (2%); Federal/ Central Government (29%); Intergovernmental Organization (5%); Local Government (2%); Miscellaneous/Other (3%); Private Sector (For-Profit) (9%); Private Sector (Non-Profit)/Voluntary or NGO (8%); Research Institute (1%); State/ Provincial Government (5%); Tribal Entity (~0%)
<i>Sub-IR 1.2: Individual &amp; Institution Needs Identified</i>	
1.2.1 The number of front end engagement activities (pre-assessments/needs assessments)	89
<i>Sub-IR-1.3: Access to Data, Products, Tools &amp; Trainings Enhanced</i>	
1.3.1 The number of CBP trainings & projects by ASP National Application Area	<i>Projects – 105 Total:</i> Agriculture (12); Climate (11); Disasters (15); Ecological Forecasting (15); Energy (5); Health & Air Quality (9); Oceans (6); Water Resources (22); Weather (1); Cross-Cutting (7); Urban Development (2); Transportation & Infrastructure (0) <i>Trainings – 104 Total:</i> Agriculture (7); Climate (8); Disasters (13); Ecological Forecasting (28); Energy (0); Health & Air Quality (5); Oceans (0); Water Resources (21); Weather (1); Cross-Cutting (21); Urban Development (0); Transportation & Infrastructure (0)
1.3.2 The number of CBP products posted online	152
1.3.3 The number NASA Earth observation platforms & sensors utilized in projects & highlighted in trainings	65
<b>IR-2: Strengthened Capacity to Use Earth Observation Data, Products &amp; Tools</b>	
<i>Sub-IR 2.1: Individuals Engaged &amp; Trainings Delivered</i>	

2.1.1 The number of trainings & workshops given or facilitated by CBP Elements	104
2.1.2 The number of individuals engaged in CBP activities	6,622
<i>Sub-IR 2.2: Tailored Products &amp; Tools Co-developed</i>	
2.2.1 The number of products developed by/with support from CBP	245
<i>Sub-IR 2.3: Increased Number of Organizations Using NASA Earth Observations in Their Decision-Making Process</i>	
2.3.1 The number of end-users integrating Earth observations in their decision-making process	589
<i>Sub-IR 2.4: Science Policy Exchanges Enhanced</i>	
2.4.1 The number of policy & science conferences attended	47
2.4.2 The number of science policy exchanges involving CBP engagement	2
<b>IR-3: Improved Capacity Building Practices &amp; feedback to Earth Science Community</b>	
<i>Sub-IR 3.1: Best Practices &amp; Lessons Learned Collected &amp; Shared</i>	
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	49
<i>Sub-IR 3.2: Increased Capability to Monitor &amp; Evaluate Impact of CBP Activities and Collect Feedback</i>	
3.2.1 The percent of individuals who completed pre-training/project surveys & project assessments	ARSET (100%); DEVELOP (Partners – 69%; Participants – 98%); SERVIR (n/a); IP (n/a)
3.2.2 The percent of individuals who completed post-training/project surveys & project assessments	ARSET (47%); DEVELOP (Partners – 60%; Participants – 99%); SERVIR (83%); IP (100%)
3.2.3 The number of projects that achieved yearly ARL goal	13 out of 16
3.2.4 The annual average PSI score for feasibility projects	2.9
<i>Sub-IR 3.3: Feedback to Earth Science Community Delivered</i>	
3.3.1 The number of presentations at Science Team Meetings	18
3.3.2 The number of DAAC feedback activities	5

## Strategic Targets

Each element addresses strategic goals and contributes to the objectives through specific targets and activities. Targets were identified in 2015 at a strategic planning workshop.

### ARSET

Activity	Target	2017 Actual
U.S. States Impacted	40	50
Countries Impacted	90	132
Total # of Individuals	1,500	4,864
Total # of Institutions	500	2,030
Application Areas Covered	4	4

### DEVELOP

Activity	Target	2017 Actual
U.S. States Impacted	35	49

International: Domestic Project Ratio	1:4	~1:6 (16%)
Total # of Individuals	250	342
Total # of Institutions	75	128
Total # of Feasibility Studies	60	70
Application Areas Covered	All	9

**SERVIR**

Activity	Target	2017 Actual
Countries Directly Served	38	40
Products Developed	33	37
Total # of PI Leads	25	25
Total # of Individuals (Stakeholder Receiving Training)	283	1,202
Total # of Institutions with Improved Capacity	27	150
USG Science Expertise Connections	25	28

**Indigenous Peoples Initiative**

Activity	Target	2017 Actual
US States Impacted	9	9
Total # of Participants	39	39
Total # of Organizations	19	19
Application Areas Covered	3	3

**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 2017:*

Metric	ROSES 2011	ROSES 2015
<b>SERVIR AST ARL Range</b>	7 - 9	2 - 7
<b>SERVIR AST ARL Mean</b>	7.9	4.1
<b>SERVIR AST ARL Mode</b>	7.5	3
<b># of Projects with ARL 1-3:</b>	0	7
<b># of Projects with ARL 4-6:</b>	0	7
<b># of Projects with ARL 7-9:</b>	11	2
<b>% of Projects Advanced 1+ ARL in past 12 months</b>	36% (4 of 11)	87.5% (14 of 16)

For the 11 AST projects selected through ROSES-2011, all but one of the 11 projects were completed as of end of CY 2017 and reached ARLs between 7 and 9. For the 16 AST projects

selected through ROSES-2015, 7 have reached an ARL between 4 and 6, and 2 have reached an ARL between 7 and 9.

DEVELOP continued to track and assess its feasibility projects by means of its 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. In 2017, DEVELOP began a reformulation of the PSI, which 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. The new PSI is split into two parts, with one assessment being done after each project term, and a follow-up roughly 4-6 months after the completion of the project. The new system was implemented beginning in the summer 2016 term. For the 52 projects conducting during DEVELOP's 2017 spring and summer terms, 0 percent of projects ended in Stage 1, 6 percent in Stage 2, 36 percent in Stage 3, and 45 percent in Stage 4 and 12 percent in Stage 5 for final PSI scores. For the fall projects, which have only PSI part I calculated scores at this time, 0 percent of projects ended in Stage 1, 11 percent were in Stage 2, 89 percent in Stage 3, and 0 percent in Stage 4, and 0 percent in Stage 5. The PSI Part II assessments will be conducted in the upcoming months.

### **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:

- ARSET team members served as mentors to multiple DEVELOP projects.
- 25 DEVELOPers participated in ARSET trainings, with DEVELOPers attending all online trainings offered by ARSET.
- ARSET and DEVELOP collaborated to represent CBP at the 2017 InterAction Forum to increase engagement of NGOs.
- DEVELOP participated in SERVIR SCO's training session on the service planning toolkit.
- DEVELOP and SERVIR continued their collaboration on an international project that applied NASA Earth observations to aid in wetland identification using Google Earth Engine in Rwanda.
- DEVELOP and SERVIR continue to collaborate on DEVELOP summer projects with Thai scholars.
- 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.

## **VIII. Looking Ahead**

In 2018, 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. 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.

The CBP will continue to implement the CBP strategic framework with a focus on solidifying the use of common language and the operational model; synchronizing planning calendars and

creating longer-range training plans; integrating our understanding of user needs and approaches to gather them; connecting CBP to broader NASA Earth Sciences and other capacity building networks; and considering improved outcome monitoring and evaluation.

ARSET will begin implementing its asynchronous learning platform, allowing attendees to take self-guided trainings; introducing new disasters management-related topics; offer change detection trainings with applications for disasters and ecosystems; and, dedicate a training to geostationary satellite data. DEVELOP will be recognizing its 20<sup>th</sup> anniversary throughout 2018 with both regional and national events, expanding its network through the establishment of a new node in Boston, Massachusetts in January of 2018, and continue to increase its projects' use of socioeconomic data. SERVIR will increase capacity of the hubs to maximize use of high-performance computing for service development and delivery, continue to increase hub and SCO capacity to process and use SAR imagery and LIDAR, and select the newest SERVIR hub, SERVIR-Amazonia. The Indigenous Peoples Initiative will conduct trainings with the Samish and Sault tribes, organize a workshop with experts to suggest options for future IP activities, and continue to build relationships with federal agencies and the tribal community.

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's training best practices have been incorporated in the CEOS training best practices that will be released in 2018. CBP will continue to add chapters or publish subsequent methods and guidance documents to increase sharing of best practices in short and longer co-development projects. CBP will continue to learn and incorporate best practices from other capacity building contributors to CEOS WGCapD, CGMS, and GEO to continue to build the practice of building capacity to use Earth observations for societal benefit, thereby improving our ability to achieve our mission that everyone who wants to make a decision with Earth observations information has the skills to do so.

To improve feedback of lessons learned through capacity building to the broader Earth science community, CBP will continue to grow a 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, and through broader engagement with the community.

Focused on its five strategic goals and in implementing the CBP 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.

## IX. Appendix

### A. Abbreviations and Acronyms

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

VIC: Variable Infiltration Capacity

WA: West Africa

WALFEHE: West Africa LDAS for Forecasting Extreme Hydrological Events

## B. Publications

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11. Kumar, Abhishek, Patricia Stupp, Subash Dahal, Caren Remillard, Roger Bledsoe, Austin Stone, Christopher Cameron, Gurdeep Rastogi, Rabindro Samal, Deepak R. Mishra. Nov 22, 2017. A Multi-Sensor Approach for Assessing Mangrove Biophysical Characteristics in Coastal Odisha, India. *Proceedings of the National Academy of Sciences, India Section A: Physical Sciences*. pp 1-22. [DEVELOP]
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### C. Earth Observation Assets Employed by CBP

ALOS PALSAR	HyTES	Sentinel-1 C-SAR
Aqua AIRS	ICESat GLAS	Sentinel-2 MSI
Aqua AMSR-E	Terra MODIS	Sentinel-3 SRAL
Aqua CERES	Jason-1 JMR	SMAP Radiometer
Aqua MODIS	Jason-1 Poseidon 2	SMOS
Aura OMI	Jason-3 Poseidon 3B	SRTM
CALIPSO CALIOP	Landsat 4 TM	Suomi-NPP VIIRS
CryoSat-2 SIRAL	Landsat 5 TM	TEMPO
DHC6 AVIRIS-NG	Landsat 7 ETM+	Terra ASTER
Digital Globe constellation	Landsat 8 OLI	Terra CERES
DMSP SSMI	Landsat 8 TIRS	Terra MISR
Envisat MERIS	MASTER	Terra MODIS
EO-1	Meteosat	Terra MOPITT
ER-2 AVIRIS	OSTM/Jason-2 Poseidon 3	TOPEX/Poseidon TMR
GCOM-W1 AMSR2	OSTM/Jason-2 AMR	TRMM PR
Glenn Hyperspectral Imager II	PERSIANN	TRMM TMI
G-LiHT	PlanetScope 4-Band	TRMM VIRS
GOES-16	POES AVHRR	UAVSAR
GPM Dual Precipitation Radar	QuikSCAT	Worldview
GPM IMERG	Radarsat-2	Worldview-2
GRACE	Rapid	Worldview-3
HURSAT-B1	Saral AltiKa	

### D. ARSET 2016 Trainings: Instruments, Web Tools, Missions, and Satellites Covered

Aeronet	Dual Precipitation Radar (DPR)
Aerostat/MAPPS	Earth Explorer
AIRS	Earth Observatory
Alaska Satellite Facility (ASF) Sentinel Data Portal	Earthdata Search
AMSR-E	EO-1
AMSU-A	ERDS
Apex State and Transition Simulation Models	ESA PolSARpro
Application for Extracting and Exploring Analysis Ready Samples (AppEEARS)	ETM+
Aqua	FIRMS
ASTER	ForWarn
Atmospheric Land Exchange (ALEXI)	GEOS-5
Aura	Global Fire Emissions Database (GFED)
California Harmful Algae Risk Mapping System (C-HARM)	GIMMS MODIS
CALIOP	Giovanni(-4)
CALIPSO	GLDAS
CDC National Environmental Public Health Tracking Network	Global Data Explorer (GDEx)
CERES	Global Disasters Alert and Coordination System (GDACS)
ESA Climate Change Initiative (CCI)	Global Flood Mapping System (GFMS)
Climate Engine	Global Forest Watch
Cloud-Aerosol Transport System (CATS)	Global Land Cover Facility (GLCF)
Consultative Group for International Agricultural Research (CGIAR)	Global Learning and Observations to Benefit the Environment (GLOBE)
Cyanobacteria Assessment Network (CyAN)	GloVIS
Dartmouth Flood	GMI
	GOES
	Google Earth Engine EEFlux



GPM  
 GPM IMERG  
 GRACE  
 Infusing Satellite Data into Environmental Applications (IDEA)  
 International Charter  
 International Space Station  
 LAADSweb  
 LANCE-MODIS  
 Land Information System (LIS)  
 LANDFIRE  
 Landsat  
 LandsatLook Viewer  
 LPDAAC  
 Map of Life  
 MERRA  
 METRIC  
 Mirador  
 MISR  
 MODIS  
 MODIS Active Fire and Burned Area Product  
 MODIS Global Evapotranspiration Project  
 MODIS NRT Global Flood Mapping  
 MOPITT  
 Multi-Resolution Land Characteristics Consortium (MRLC)  
 Multi-Sensor Aerosol Products Sampling System (MAPSS)  
 National Gap Analysis Program (GAP)  
 National Snow & Ice Data Center  
 NLDAS  
 NOAA CoastWatch  
 NOAA Hazard Mapping System (HMS)

NPP  
 OceanColor Web  
 OCO-2  
 OLI  
 OMI  
 Plankton, Aerosols, Clouds, ocean Ecosystems (PACE)  
 PPS/STORM  
 Precipitation Radar (PR)  
 RECOVER  
 Reverb/ECHO  
 Satellite Mapping Coordination System (UNITAR)  
 SeaDAS  
 SeaWiFS  
 Sentinel (SAR)  
 SERVIR  
 Short-Term Prediction Research and Transition (SPoRT)  
 SMAP  
 SMAP ASF API  
 Socioeconomic Data and Applications Center (SEDAC)  
 SRTM  
 Suomi National Polar-orbiting Partnership (S-NPP)  
 TEMPO  
 Terra  
 TMI  
 TRMM  
 UAVSAR Data Search  
 U.S. Climate Resistance Toolkit (NOAA)  
 VIIRS  
 VIIRS Active Fire Mapper  
 Water Quality Portal  
 Worldview

### E. Organizations Engaged

In 2017, CBP engaged 2,369 organizations through trainings, feasibility studies and multi-year projects. Below you can see organizations classified by sectors:

