2016 CAPACITY BUILDING

NASA Earth Science Applied Sciences Program
2016 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, Climate, Energy, Oceans, and Weather.

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), the Committee on Earth Observation Satellites (CEOS), and the Coordinating Group for Meteorological Satellites (CGMS), as well as identifying partnership opportunities to reach new end-users. The program supports three Elements, including Applied Remote Sensing Training (ARSET), DEVELOP, and SERVIR, along with an initiative focused on building capacity to use Earth observations of indigenous peoples in North America.

Element 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/](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/](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 climate risks and land use. SERVIR empowers decision makers with tools, products, and services to improve awareness and increase access to 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/.

II. 2016 Overview

Throughout 2016, the Capacity Building Program continued to refine and strengthen its many contributions to the Agency. CBP achieved the following impacts “by the numbers” in 2016:

- **4,259**: Individuals Engaged
- **1,684**: Organizations Engaged
- **55**: Trainings Given
- **77**: Feasibility Studies Conducted
- **35**: Multi-year Projects Conducted
- **65**: Earth Observation Assets Applied
- **8**: Application Areas Addressed
- **50**: U.S. States Impacted
- **9**: U.S. Territories & Holdings Impacted
- **142**: Countries Impacted
- **23**: Publications
- **103**: Conferences & Meetings Attended

The Capacity Building Program’s global impact can also be shown “by the map” for 2016:

Black denotes the 142 countries impacted by CBP; gray denotes the 53 not impacted

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

III. Accomplishments & Highlights

**Programmatic Accomplishments**

Throughout 2016, 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.

New additions included a SERVIR hub in West Africa, a DEVELOP node in Tempe, Arizona, more application area training topics offered by ARSET, and a completed study of needs of North American indigenous peoples for Earth observations and how those needs are currently being addressed. Key indicator tracking by the three CBP Elements was strengthened through organizational and reporting system improvements to further the depth and quality of projects,
partnerships, and trainings. CBP indicators show that the program’s geographic reach continued to grow with impact in all 50 U.S. states and nine U.S. territories, and a global impact across 142 countries, where reach is mapped by including project study areas and locations of end-users and individuals engaged in CBP activities. The Capacity Building Program engaged 4,259 individuals and 1,684 organizations through 55 trainings, 77 feasibility studies, and 35 multi-year projects. The number of individuals and institutions engaged set new records with a total of 4,259 individuals (an increase of 155 from 2015) and 1,684 institutions (an increase of 315).

Overall, CBP participated in a total of 103 conferences and meetings – 74 science and policy conferences and 29 NASA meetings – and published 23 articles and features in 2016, both increases from 2016.

Collectively, the program utilized 65 Earth-observation assets in trainings and projects (Appendix C), furthering the goal to enable sustained use of existing NASA Earth observations and the ability to incorporate new observations and applications as they become available, e.g. the use of HICO in the new ARSET coastal monitoring training. SERVIR’s selection of 16 new Applied Science Team members will contribute to this goal over the next three years by bringing in innovative applied science to meet end user decision needs sustainably across the SERVIR network.

ARSET contributed significantly 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 through their new webinar series on training best practices. SERVIR has been developing a service planning framework that includes iterative end-user needs definition and co-development of applications to build capacity, with ways to assess impact included as well. As a contribution to CEOS WGCapD, CBP team members led a session and synthesized training best practices of WGCapD member agencies.

To improve feedback of lessons learned through capacity building to the broader Earth science community, CBP continued to grow a community of practice of Earth observation use capacity building practitioners through a focused session and lunch at the American Geophysical Union fall meeting. CBP also shared lessons informally at the Applied Science Program’s Associate meeting. CBP continues to participate in NASA Earth Science Division mission Science Teams to hear the latest results and provide feedback from capacity building activities.

Program elements had a strong year in 2016. Accomplishments and highlights are summarized below.

ARSET had a record breaking year having conducted the most trainings (15), trained the most individuals (3,277), engaged the highest number of organizations (1,392), and impacted the most countries (130). The program set a record for most participants trained in one day on June 9th, 2016 when it had 1,023 people engaged in its trainings, and hosted the largest webinar in its history when 768 attendees attended the “Applications of Remote Sensing to Soil Moisture & Evapotranspiration”. ARSET also expanded its offering of trainings into new thematic areas such as oceans & coastal management, carbon monitoring, NDVI time series, and training best practices.

DEVELOP had a dynamic year engaging 359 participants and 125 partner organizations through 77 projects that took place at 13 nodes and impacted 42 U.S. states and 55 countries (44 through project study areas and 19 by means of individuals participating in the program). DEVELOP expanded its reach in the southwestern U.S. with the addition of a node in Tempe, Arizona, in collaboration with the Maricopa County Department of Public Health and Arizona State University. In support of the National Park Service (NPS) Centennial in 2016, DEVELOP
partnered with NPS on a campaign of 17 projects that explored the use of NASA Earth observations to enhance monitoring and decision making in national parks and monuments across 25 states. The program presented project results and participated in 59 science and policy conferences and meetings, co-chaired a session at the AGU Fall Meeting, and served as a key note speaker at two conferences. The program also continued its video series highlighting the use of Earth observations in decision making, with a record 32,509 YouTube views in 2016. Four DEVELOPers and two DEVELOP project teams were recognized for their outstanding work through multiple awards including AGU’s Data Visualization Storytelling Contest, NASA’s Silver Achievement Medal, and NOAA NCEI Employees’ Choice Award for Innovative Product.

In 2016, SERVIR was active in 40 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 in Bangkok, Thailand, and through a collaboration of Agriculture, Hydrology and Meteorology Regional Center (AGRHYMET), the Comité permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel (CILSS), Tetra Tech Incorporated and multiple consortia members in Niamey, Niger. The program conducted 35 projects and 39 trainings in 2016. In 2016, SERVIR developed, provided oversight for, enhanced, or launched, 23 applications and tools, including geportals 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 21 different satellite instruments. A total of 623 people were trained in the use of SERVIR tools, technologies, data, and methodologies, with a total of 298 institutions engaged. With SERVIR’s help, an estimated 122 institutions saw improvements in their capacity to address issues relating to changing climates.

**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 2016:

In September, ARSET provided a five-week webinar series on access and applications of soil moisture and evapotranspiration data products. There were 768 attendees from 479 organizations and 81 countries. The high demand and participation broke all previous ARSET records, and accounted for nearly a quarter of the individuals trained in 2016. Survey responses from the attendees who completed the survey (about 30 percent) indicate the training was highly successful.

ARSET initiated a collaboration with the Indian Space Agency (ISRO) and the Indian Institute of Remote Sensing (IIRS). The group held discussions on future joint training activities and exchange of capacity building best practices. ARSET also received an invitation from the U.S. Department of State to tour four Indian cities and participate in panel discussions on air quality challenges in India and the role of remote sensing, providing high visibility for NASA and ARSET. In 2017, ARSET and ISRO will collaborate on a training and continue working together.
In celebration of the National Park Service (NPS) Centennial, DEVELOP conducted 17 projects over the course of the year that focused on monitoring change and threats to America’s national parks and highlighting the use of Earth observations to support our national treasures. These projects spanned multiple NPS regions across 25 states and partnered with parks, monuments, and inventory and monitoring networks to support the integration of NASA Earth observations in decision making throughout the park system.

DEVELOP published two peer-reviewed articles, one each in the Bulletin of American Meteorological Society and AGU’s Eos, two programmatic articles on Earthzine and the LP DAAC website, and two project overviews in The Earth Observer. The program’s people and projects were featured in 18 articles in venues ranging from local media, university newspapers, AGU’s Thriving Earth Exchange, and NASA’s Earth Observatory and social media postings.

DEVELOP’s people and projects were recognized through a series of awards including its Pacific Water Resources project winning the NOAA NCEI Employee’s Choice Award for Innovative Product, DEVELOP’s Karen Allsbrook receiving NASA’s Silver Achievement Medal for her many contributions to the Agency’s mission, DEVELOP’s Allison Daniel and Dr. Sara Lubkin winning two of five grand prizes of AGU’s 2016 Data Visualization Storytelling Contest, and the Chaco Canyon Cross-Cutting project won 1st place in the Physical & Liberal Sciences category of the Wernher von Braun Memorial Symposium’s student competition.

Through the NASA ROSES peer review process, 16 proposed projects were selected for the new SERVIR 2016 AST. 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 will meet needs identified by the four regional SERVIR hubs in Eastern and Southern Africa, West Africa, Hindu Kush-Himalaya (HKH), and the Lower Mekong region of Southeast Asia. Each project was developed in collaboration with a regional SERVIR hub based on the needs identified for that region.

SERVIR launched its newest hub – SERVIR-West Africa – on July 14th, 2016. This hub is implemented by the Agriculture, Hydrology and Meteorology Regional Center (AGRHYMET), a specialized agency of the Comité permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel (CILSS) (the Permanent Inter-State Committee against Drought in the Sahel), headquartered in Niamey, Niger; Tetra Tech Incorporated, headquartered in Pasadena, California; and a consortium of partners serving the West Africa region. The hub will serve Ghana, Burkina Faso, Senegal, and Niger. Helping policy makers and other officials make more
informed decisions in four areas: food security and agriculture; water and disasters; weather and climate; and land use, coastal zones, and forest management.

SERVIR developed a tool in 2016 called ClimateSERV. Using ClimateSERV, development practitioners, scientists/researchers, and government decision-makers can readily analyze historical rainfall for the past 30 years and compare it with the best available forecasts for the next 180 days for their defined area of interest to improve understanding of, and make improved decisions for, issues related to agriculture and water availability. ClimateSERV can help those decision-makers assess and monitor large-scale rainfall patterns, analyze how those patterns may have changed over time, determine likelihood of drought, and infer crop condition.

During 2016, a SERVIR AST project led by Amy Thomas of Battelle successfully completed their planned activities. This project developed a satellite-derived high resolution regional aerosol products and visualization system for national air quality modeling systems for the Ministry of Environment and Natural Resources El Salvador and Costa Rica. The project team worked with El Salvador MARN to develop a visualization system for the MODIS-based Aerosol Optical Depth product. The system, installed on MARN computers, is being upgraded by MARN for broader use. The project team also gave several training sessions on use of the satellite data and air quality modeling system to create actionable information. In Costa Rica, the project team worked with the National Meteorological Institute (IMN) to understand the needs of the agency and designed a blend of modeling and satellite-derived products. The result was development of a finely tuned CMAQ model. The project team trained IMN staff members, who are now confident in use of the tools in their operations.

Another successfully completed AST project was led by Dalia Kirschbaum (GSFC). This project developed a Central American landslide hazard forecasting system (LHASA) using satellite data to assess regional landslide hazards. The system provides probabilistic landslide assessments for real-time and forecasted landslide activity. It has been transferred to CentroClima, a regional portal for environmental data. The project team also trained MARN colleagues on use of this system. The project truly engaged the stakeholders during the development process, and provided significant training on it. Even though this project lacked a formal SERVIR engagement in the region, it made significant progress through collaborations with end users. The SERVIR Science Coordination Office has developed infrastructure cloud based solutions to continue providing technical support from NASA Marshall Space Flight Center in Huntsville. The project team has made significant progress in providing similar capabilities in Nepal, where the SERVIR hub is actively engaged in uptake of the methodology.

Cindy Schmidt led an effort to better understand the needs and data gaps in the use of geospatial data within Indigenous communities in North America. Indigenous peoples in North American are place-based and depend on natural resources to sustain their economies and cultural and spiritual practices. The study was completed in 2016 and summarizes: 1) How federal agencies are currently working with Indigenous communities; 2) What NASA is currently doing with indigenous communities; 3) The key natural resource management needs of indigenous communities and 4) The extent that indigenous communities are currently using remote sensing/geospatial technology. This study will inform plans for 2017.

**IV. Community Engagement**

**Community Leadership**

In 2016, 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-leads the U.S.’s participation in the regional initiative called AmeriGEOSS. She is 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 Bogota, Colombia, in June 2016 and the 5th annual WGCapD meeting in Hampton Roads, Va., in March 2016.

CBP chaired a session at the AGU Fall Meeting in San Francisco, Calif., entitled: “Building Sustained Capacity to Use Earth Observations to Enhance Environmental Management Decisions, Actions, and Policy”. The session brought together a broad community of Earth observation capacity-building groups to discuss best practices for improving workforce skills to use Earth observations in environmental management and policy and how to grow a community of practice. An outcome of the meeting was the establishment of a periodic newsletter to bolster communication of the community of practice and distribute news and best practices.

ARSET hosted five in-person training workshops in conjunction with conferences to leverage attendance and enhance Earth observation skill development. These workshops included a water quality monitoring workshop at the National Water Quality Monitoring Conference, May 5, in Tampa, Fla., an air quality monitoring workshop August 28-29, as a pre-conference event for the 17th IUAPPA World Clean Air Congress and 9th Clean Air Asia Better Air Quality Conference, a conservation management workshop at the IUCN World Conservation Congress in Honolulu, Hawaii, on September 4, an air quality workshop ahead of the Atmospheric Optics: Aerosols, Visibility, and the Radiative Balance Conference in Jackson Hole, Wyo., September 26, and another air quality monitoring training on November 14 at the 2nd International Smoke Symposium in Long Beach, Calif.

DEVELOP joined and led the science and policy communities in a variety of activities in 2016. The program co-chaired a session at the AGU Fall Meeting. DEVELOPers gave two key note speeches at conferences focused on Great Lakes water management in Niagara Falls, N.Y., and another focused on gender and GIS inclusion in disaster response and resilience in Bangkok, Thailand. The program engaged policy makers through informative visits to Congress in August and participated in two Aerospace Days in Virginia and Idaho. In celebration of the National Park Service Centennial, DEVELOP led NASA's engagement with the NPS by conducting 17 projects that focused on the use of Earth observations to support management of the nation’s national parks and monuments. DEVELOP also began engagement with AGU’s Thriving Earth Exchange to explore how NASA and AGU could support local communities with their decision making.
In 2016, SERVIR's Science Coordination Office (SCO) pursued increased collaboration with regional initiatives such as the Working Group on Land Cover for Africa and AfriGEOSS by co-chairing its Working Group and serving as the chair of its technical meetings. SERVIR’s NASA Program Manager, Dan Irwin, gave the distinguished 2016 Schermerhorn Lecture at the Opening of the Academic Year 2016-2017 of the University of Twente in Enschede, Netherlands, as well as attended and presented at the 22nd Conference of the Parties (COP 22) to the UN Framework Convention on Climate Change (UNFCCC) in Marrakech, Morocco. An RCMRD hub team member participated as a trainer in an SRTM workshop organized by CEOS in Kathmandu, Nepal. SERVIR also engaged with the International Institute for Geo-Information Science and Earth Observation, originally known as ITC, to explore potential avenues of cooperation.

**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 has built skills to acquire and use Earth observations for decision support. In 2016, ARSET demonstrated or presented 99 instruments, missions, and web tools (see Appendix). Through these capacity building activities, ARSET facilitated access to satellite data hosted by NASA and other organizations, including NOAA, USDA, USFS, private sector, and nonprofits. The program is deeply engaged with multiple NASA data centers, serving as a formal member of six of the user working groups (ASDC, GES DISC, LAADS DAAC, LANCE, LP DAAC, and ORNL DAAC) in order to share the perspectives and needs of the end-user community with the 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 2016, the program had NASA’s Software Release Authority approve the release of four tools for public dissemination including: Surface Aquatic Vegetation Detection Tool (SAVDT) that generates shapefiles from recently acquired satellite data where water hyacinth is most likely present, Land Surface Temperature MODIS Visualization (LaSTMoV) that creates heat vulnerability maps using satellite data, Detecting Realtime Increased Precipitation / Sudden Landslide Identification Product (DRIP-SLIP) that identifies landslides and extreme precipitation monitoring software, and the Drought Severity Assessment Tool (DSAT) that calculates periodical Standardized Precipitation Index (SPI) values cell by cell from monthly precipitation rasters. DEVELOP also used Google Earth Engine in 13 projects to harness cloud computing for running analyses, simplification of processing for project partners, and increase utility of DEVELOP products.

The SERVIR SCO prepared 36 time-series datasets produced by AST members, extracted from the Distributed Active Archive Centers (DAACs) or generated through modeling processes, for inclusion in decision support systems such as ClimateSERV and the SERVIR Global Data Catalog, enabling broader and more user-friendly utilization in different scenarios. These datasets contain valuable observed and forecast information about rainfall, soil moisture, runoff, Normalized Difference Vegetation Index (NDVI), and more. The geographical extents of these datasets vary from global to specific regions (e.g., watersheds in the lower HKH).

**V. 2016 CBP Portfolio**

The Capacity Building Program engages in two types of activities within its portfolio: projects and trainings. In 2016, the program conducted 106 projects (77 feasibility studies, 35 multi-year projects) and 55 trainings (10 online, 45 in-person). CBP activities covered a broad range of themes in alignment with eight of the Applied Sciences’ Application Areas: Agriculture, Climate, Disasters, Ecological Forecasting, Health & Air Quality, Oceans, Water Resources, and Weather.
More information about individual projects and trainings can be found on ARSET, DEVELOP, and SERVIR websites.

<table>
<thead>
<tr>
<th>Application Area</th>
<th>Projects</th>
<th>Trainings</th>
<th>Portfolio %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>18 (9 Feasibility / 9 Multi-Year)</td>
<td>1 (1 Online / 0 In-Person)</td>
<td>11%</td>
</tr>
<tr>
<td>Climate</td>
<td>14 (7 Feasibility / 7 Multi-Year)</td>
<td>8 (0 Online / 8 In-Person)</td>
<td>13%</td>
</tr>
<tr>
<td>Disasters</td>
<td>9 (6 Feasibility / 3 Multi-Year)</td>
<td>7 (2 Online / 5 In-Person)</td>
<td>10%</td>
</tr>
<tr>
<td>Eco Forecasting</td>
<td>26 (20 Feasibility / 6 Multi-Year)</td>
<td>15 (3 Online / 12 In-Person)</td>
<td>24%</td>
</tr>
<tr>
<td>Health &amp; AQ</td>
<td>10 (8 Feasibility / 2 Multi-Year)</td>
<td>8 (2 Online / 6 In-Person)</td>
<td>11%</td>
</tr>
<tr>
<td>Oceans</td>
<td>3 (3 Feasibility / 0 Multi-Year)</td>
<td>0 (0 Online / 0 In-Person)</td>
<td>2%</td>
</tr>
<tr>
<td>Water Resources</td>
<td>26 (19 Feasibility / 7 Multi-Year)</td>
<td>9 (1 Online / 8 In-Person)</td>
<td>21%</td>
</tr>
<tr>
<td>Weather</td>
<td>2 (1 Feasibility / 1 Multi-Year)</td>
<td>1 (0 Online / 1 In-Person)</td>
<td>2%</td>
</tr>
<tr>
<td>Cross-Cutting</td>
<td>4 (4 Feasibility / 0 Multi-Year)</td>
<td>6 (1 Online / 5 In-Person)</td>
<td>6%</td>
</tr>
</tbody>
</table>

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 2016 through USGEO, GEO, CEOS, and program element activities.

ARSET online and in-person trainings reached individuals in 130 countries, an increase from 2015 (128 countries impacted). In 2016, training attendees were comprised of 35 percent U.S. and 65 percent international, consistent with 2015 totals.

DEVELOP’s primary focus is domestic capacity building and in 2016, the project portfolio consisted of 73 percent of projects addressing issues in 42 U.S. states and 88 percent of participants were U.S. citizens from 37 states, with a total of 44 U.S. states impacted. The program virtually conducts a limited number of projects with international study areas and engages international participants already studying in the U.S. In 2016, and 27 percent international projects addressed issues in 44 countries and international participants from 19 countries were 12 percent of the individuals engaged on teams, with a total of 55 countries impacted.
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 climate risks and land use. SERVIR was able to directly engage 40 countries through the support of the regional hubs in 2016. Domestically, SERVIR’s Science Coordination Office and Applied Sciences Team (AST) engaged 24 U.S. states and six countries in Mesoamerica.

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 35 countries in the Americas caucus region through:

- ARSET – 1,764 individuals through 5 in-person and 9 online trainings
- DEVELOP – 323 individuals through 65 feasibility studies and 1 in-person training
SERVIR – 139 individuals and 3 multi-year projects and 1 online & 9 in-person trainings

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.

**Applications of Satellite Products for Air Quality Monitoring, Analysis, Forecasting, and Visualization in the SERVIR Mesoamerica and Himalaya Regions (ROSES 2011 - SERVIR AST) [Mesoamerica & Himalaya Regions]**

*Principal Investigator:* Amy Thomas, Battelle Memorial Institute
*ASP Application Area:* Health and Air Quality
*Thematic Service Area:* Weather and Climate

*Description:* This project, successfully completed in 2016, developed satellite-derived high resolution regional aerosol products and visualization system for national air quality modeling systems for MARN El Salvador and Costa Rica. The project team trained National Meteorological Institute (IMN) staff members, who are now confident in use of the tools in their operations.

**Landslide Hazard Assessment and Forecasting System using Near Real-Time Remote Sensing Information over SERVIR-Mesoamerica (ROSES 2011 - SERVIR AST) [Mesoamerica & Himalaya Regions]**

*Principal Investigator:* Dalia Kirschbaum, NASA Goddard Space Flight Center
*ASP Application Area:* Disasters
*Thematic Service Area:* Water Resources and Hydroclimatic Disasters

*Description:* This project, successfully completed in 2016, developed a Central American landslide hazard forecasting system (LHASA) using satellite data to assess regional landslide hazards. The system provides probabilistic landslide assessments for real-time and forecasted landslide activity. The system has also been piloted in Nepal and is providing very useful results there as well.

**Asia and Oceania**

CBP reached 37 countries in the Asia & Oceania caucus region through:
ARSET – 811 individuals through 1 in-person and 9 online trainings
DEVELOP – 27 individuals through 7 feasibility studies
SERVIR – 263 individuals and 13 multi-year projects and 15 in-person trainings

Black denotes the 37 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 subseasonal 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.

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.

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 will enable them to prepare for and warn the public of impending floods and related disasters and promote resilience and recovery after flood events.
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.

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.

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 Program on the dangerous rise of Lake Imja in Nepal. Based on this analysis, UNDP provided assistance to the Nepal Army to lower the dam by over 10 feet, substantially reducing the risk from a lake outburst flood.

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.

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.

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.

Monitoring and Forecasting Drought and Crop Yield for the Lower Mekong Basin (ROSES 2015 - SERVIR AST)
Principal Investigator: Stephanie Granger, NASA Jet Propulsion Laboratory
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.

Africa
CBP reached 37 countries in the Africa caucus region through:
- ARSET – 298 individuals through 9 online trainings
- DEVELOP – 5 individuals through 6 feasibility studies
- SERVIR – 209 individuals and 21 multi-year projects and 13 in-person trainings

Black denotes the 37 countries in Asia & Oceania 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.

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.

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.

**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.

**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.

**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 is supporting 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 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.

**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 aims to demonstrate 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.

**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.

**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 sets (1981 to present) using a variety of available satellite data and model products. The data are being used by the SERVIR-Eastern and Southern Africa hub in helping countries in their region with water resources and agriculture analysis.

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 in 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, and flood modeling and forecasting.

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.

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.

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 in order to improve the wellbeing and resilience of pastoralist and agropastoralist communities in West Africa.

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.

Europe
CBP reached 27 countries in the Europe caucus region through:
- ARSET – 369 individuals through 9 online trainings
- DEVELOP – 2 individuals and 2 feasibility studies
Black denotes the 27 countries in Europe impacted by CBP

**Commonwealth of Independent States (CIS)**

CBP reached 7 countries in the CIS caucus region through:
- ARSET – 29 individuals through 9 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 2016, 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 Assessment study was led by Dr. Cindy Schmidt, BAERI at ARC.
**Strategic Planning**

Capacity Building continues to strengthen through enhancement of programmatic assessment methods and tools. In late March of 2016, CBP management and Element teams gathered in Hampton, Va., to conduct a Strategic Planning Workshop. Participants reviewed the pilot results framework and finalized the set of indicators to collect, enhanced methods of collaboration within the program, strategic partnerships and activities for 2016.

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 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.

Two of the three program Elements, ARSET and SERVIR, held strategic meetings in 2016, while DEVELOP’s retreat is scheduled for January 2017. In addition, the Indigenous Peoples Assessment study was completed in 2016 to inform 2017 CBP plans.

ARSET held its third annual retreat the first week of November at GSFC, with all 15 team members in attendance. The team revised its mission and vision, discussed current trainings, and identified key training criteria and new initiatives for 2017. ARSET added six new team members, both trainers and students, to support training in Water Resources, Disasters, and Health & Air Quality, as well as communications and database management. In 2017, ARSET will consider new training approaches through the use of a learning management system.

The 3rd annual SERVIR Joint Working Group (JWG) meeting took place in Washington D.C., in May 2016 among USAID and NASA HQ Earth Science Division leadership and SERVIR SCO leadership. The JWG reviewed Lessons Learned and reaffirmed strategic directions for SERVIR and expansion of the SERVIR network. The JWG discussed SERVIR Hub expansion and the demand from South America, Central Asia, and other emerging/strategic regional priorities. The SERVIR program also hosted the SERVIR Annual Global Exchange (SAGE) October 24-28 in Pokhara, Nepal. The meeting resulted in agreement on the service planning process, which efficiently links the needs from end users in SERVIR regions to product and intervention development and evaluation of intervention efficacy. SAGE was also critical for AST PIs and SERVIR hubs to address integration and co-development of services for the upcoming year.

**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**

A new 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. After challenges in collection during a pilot test, an updated timeline for collection has begun on a quarterly system beginning in the 4th quarter of 2016, with a set of shared indicators compiled for CBP as a whole.

**2016 4th Quarter Aggregated Indicators:**

<table>
<thead>
<tr>
<th>IR-1: Improved Awareness of – and Access to – Earth observation Data, Products, and Tools</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sub-IR 1.1: Awareness Increased in New Geographic Regions &amp; Different Sectors</strong></td>
</tr>
<tr>
<td>1.1.1 The Number of States &amp; Countries Reached through CBP Trainings &amp; Projects</td>
</tr>
<tr>
<td>Total: 268 – Academic Institution (83); Research Institution (14); Local Government (4); State/Provincial Government (11); Federal/Central Government (98); Intergovernmental Organization (9); Consortium (9); Private Sector (For-Profit) (19); Private Sector (Non-Profit)/Voluntary OR NGO (16); Tribal Entity (1); Miscellaneous/Other (4)</td>
</tr>
<tr>
<td>38 states; 76 countries</td>
</tr>
<tr>
<td>1.1.2 The number of Partners [by type] Reached through Trainings &amp; Projects</td>
</tr>
<tr>
<td><strong>Sub-IR 1.2: Individual &amp; Institution Needs Identified</strong></td>
</tr>
<tr>
<td>1.2.1 The number of front end engagement activities (pre-assessments/needs assessments)</td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td><strong>Sub-IR 1.3: Access to Data, Products, Tools &amp; Trainings Enhanced</strong></td>
</tr>
<tr>
<td>1.3.1 The number of CBP trainings &amp; projects by ASP National Application Area</td>
</tr>
<tr>
<td>Total: 56 – Agriculture (9); Climate (10); Disasters (4); Ecological Forecasting (9); Energy (0); Health &amp; Air Quality (4); Oceans (0); Water Resources (15); Weather (1); Cross-Cutting (1)</td>
</tr>
<tr>
<td>1.3.2 The number of CBP products posted online</td>
</tr>
<tr>
<td>21</td>
</tr>
<tr>
<td>1.3.3 The number NASA Earth observation platforms &amp; sensors utilized in projects &amp; highlighted in trainings</td>
</tr>
<tr>
<td>37</td>
</tr>
</tbody>
</table>

**IR-2: Strengthened Capacity to Use Earth Observation Data, Products & Tools**

<table>
<thead>
<tr>
<th><strong>Sub-IR 2.1: Individuals Engaged &amp; Trainings Delivered</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>2.1.1 The number of trainings &amp; workshops given or facilitated by CBP Elements</td>
</tr>
<tr>
<td>10</td>
</tr>
<tr>
<td>2.1.2 The number of individuals engaged in CBP activities</td>
</tr>
<tr>
<td>381</td>
</tr>
<tr>
<td><strong>Sub-IR 2.2: Tailored Products &amp; Tools Co-developed</strong></td>
</tr>
<tr>
<td>2.2.1 The number of products developed by/with support from CBP</td>
</tr>
<tr>
<td>46</td>
</tr>
<tr>
<td><strong>Sub-IR 2.3: Increased Number of Organizations Using NASA Earth Observations in Their Decision Making Process</strong></td>
</tr>
<tr>
<td>2.3.1 The number of end-users integrating Earth observations in their decision making process</td>
</tr>
<tr>
<td>6</td>
</tr>
<tr>
<td><strong>Sub-IR 2.4: Science Policy Exchanges Enhanced</strong></td>
</tr>
<tr>
<td>2.4.1 The number of policy &amp; science conferences attended</td>
</tr>
<tr>
<td>20</td>
</tr>
<tr>
<td>2.4.2 The number of science policy exchanges involving CBP engagement</td>
</tr>
<tr>
<td>0</td>
</tr>
</tbody>
</table>

**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           |
| 0 *                                                                                     |
3.1.2 The number of outreach events for CBP activities

7

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 (**); DEVELOP (**); SERVIR (**)

3.2.2 The percent of individuals who completed post-training/project surveys & project assessments

ARSET (22%); DEVELOP (89%); SERVIR (**)

3.2.3 The number of projects that achieved yearly ARL goal

**

3.2.4 The annual average PSI score for feasibility projects

**

Sub-IR 3.3: Feedback to Earth Science Community Delivered

3.3.1 The number of presentations at Science Team Meetings

0

3.3.2 The number of DAAC feedback activities

0

* An ARSET training was conducted highlighting best practices for creating trainings and the CBP has contributed to a CEOS WGCapD best practices document currently in progress.

** To be measured in 2017.

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, then piloted in 2015 and 2016.

ARSET

<table>
<thead>
<tr>
<th>Activity</th>
<th>Target</th>
<th>2016 Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. States Impacted</td>
<td>40</td>
<td>50</td>
</tr>
<tr>
<td>Countries Impacted</td>
<td>90</td>
<td>130</td>
</tr>
<tr>
<td>Total # of Participants</td>
<td>1,500</td>
<td>3,277</td>
</tr>
<tr>
<td>Total # of Organizations</td>
<td>500</td>
<td>1,392</td>
</tr>
<tr>
<td>Application Areas Covered</td>
<td>4</td>
<td>7</td>
</tr>
</tbody>
</table>

DEVELOP

<table>
<thead>
<tr>
<th>Activity</th>
<th>Target</th>
<th>2016 Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>U.S. States Impacted</td>
<td>35</td>
<td>42</td>
</tr>
<tr>
<td>International: Domestic Project Ratio</td>
<td>1:4</td>
<td>~1:4 (27%)</td>
</tr>
<tr>
<td>Total # of Participants</td>
<td>250</td>
<td>359</td>
</tr>
<tr>
<td>Total # of Partner Organizations</td>
<td>75</td>
<td>125</td>
</tr>
<tr>
<td>Total # of Projects</td>
<td>60</td>
<td>77</td>
</tr>
<tr>
<td>Application Areas Covered</td>
<td>9 (All)</td>
<td>8</td>
</tr>
</tbody>
</table>

SERVIR

<table>
<thead>
<tr>
<th>Activity</th>
<th>Target</th>
<th>2016 Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Countries Directly Served</td>
<td>38</td>
<td>40</td>
</tr>
</tbody>
</table>
**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 2016:

<table>
<thead>
<tr>
<th>Metric</th>
<th>ROSES 2011</th>
<th>ROSES 2015*</th>
</tr>
</thead>
<tbody>
<tr>
<td>SERVIR AST ARL Range</td>
<td>6-9</td>
<td>1 - 6</td>
</tr>
<tr>
<td>SERVIR AST ARL Mean</td>
<td>7.5</td>
<td>3.0</td>
</tr>
<tr>
<td>SERVIR AST ARL Mode</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td># of Projects with ARL 1-3:</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td># of Projects with ARL 4-6:</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td># of Projects with ARL 7-9:</td>
<td>10</td>
<td>0</td>
</tr>
<tr>
<td>% of Projects Advanced 1+ ARL in past 12 months</td>
<td>100% (11 of 11)</td>
<td>N/A**</td>
</tr>
</tbody>
</table>

*: Note—ARL information for two of the 16 ROSES-2015 AST projects are still pending

**: ROSES-2015 AST projects, having recently confirmed their ARLs, are still at their start ARLs.

For the 11 AST projects selected through ROSES-2011, the average ARL advanced from 6.4 to 7.6 over the calendar year. As of November 2016, 10 of the 11 projects had reached an ARL of 7 or higher, and 6 had reached 8 or higher. For the 16 AST projects selected through ROSES-2015, initial and goal ARLs have been defined, and begun reporting progress.

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 2016, 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 DEVELOP’s spring 2016 projects, using the previous PSI metrics, 4 percent of projects ended in Stage 1, 15 percent in Stage 2, 46 percent in Stage 3, and 35 percent in Stage 4. Through Part I of the PSI, the summer projects resulted in 7 percent in Stage 2, 83 percent in Stage 3, and 10 percent in Stage 4. After the Part II follow-up, 63 percent of those projects increased in their final stage, including two projects assessed as Stage 5. For the fall projects, 14 percent were in Stage 2, 76 percent in Stage 3, and 10 percent in Stage 4. 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 2016, the program continued collaboration between the elements in the following ways:

- ARSET team members served as mentors to multiple DEVELOP projects.
- 53 DEVELOPers and 2 people from SERVIR participated in ARSET trainings, with DEVELOPers attending all nine online trainings offered by ARSET.
- DEVELOP and SERVIR continued their collaboration on four international projects that applied NASA Earth observations to regional issues in Africa and Southeast Asia.
- ARSET and DEVELOP collaborated to represent CBP at the 2016 InterAction Forum to increase engagement of NGOs.
- SERVIR and ARSET began planning a collaborative training to be held in 2017 focusing on the Variable Infiltration Capacity (VIC) hydrologic model and bias correction of satellite precipitation data.
- SERVIR began conversations with the Indigenous People initiative to identify synergies and future collaborative activities.
- DEVELOP supported the Indigenous Peoples-focused activities by supporting a project hand-off and engagement meeting with the Navajo Nation.

**VIII. Looking Ahead**

In 2017, 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 interagency and international engagements, leveraging engagement of boundary organizations to help increase reach to key end-user groups, engaging with the broader NASA Earth Sciences community, through its three Elements: ARSET, DEVELOP, and SERVIR, and through pilot Indigenous Peoples activities.

ARSET will explore new online training formats, the inclusion of SAR data into trainings, and host trainings on the use of remote sensing and the United Nations Sustainable Development Goals. DEVELOP plans to expand its reach in the U.S. northeast through the establishment of a new node in Boston, Massachusetts, increase its projects’ use of socioeconomic data, and pilot a new interactive mapper to visualize the program’s impact. SERVIR will begin to implement 16 new AST projects in SERVIR hub regions, increase the internal capacity to process and use SAR imagery, enhance ClimateSERV and AgriSERV through incorporation of additional datasets and user interfaces, and enter into a planning phase for the future SERVIR-Amazonia hub. In 2017, work will begin to address the needs of Indigenous Peoples through pilot activities focused on incorporating traditional ecological knowledge and Earth observation information.

Collectively, the program will use existing and new Earth-observation assets in trainings and projects, furthering the goal to enable sustained use of existing NASA Earth observations and the ability to incorporate new observations and applications as they become available, DEVELOP will continue to conduct feasibility projects using under-utilized assets with potential for applications, ARSET will continue to interact with Early Adopter programs for upcoming missions, and SERVIR will bring the latest research using these assets to SERVIR hubs to enable sustained use.

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 through their new webinar series on training best practices. SERVIR’s
service planning framework may be shared more broadly as its application matures. As a contribution to CEOS WGCapD, CGMS, and GEO, CBP team members will continue to provide thought leadership and share best practices with the broader community engaged in building capacity to use Earth observations for societal benefit.

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, 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 continue their mission to do great work and to integrate and benefit from each other’s work.
IX. Appendix

A. Abbreviations and Acronyms

ADPC: Asian Disaster Preparedness Center
AGHYSMET: Agriculture, Hydrology and Meteorology Regional Center
AGU: American Geophysical Union
ARC: Ames Research Center
ARL: Application Readiness Level
ARSET: Applied Remote Sensing Training
ASDC: Atmospheric Science Data Center
ASP: Applied Sciences Program
AST: Applied Sciences Team
BAERI: Bay Area Environmental Research Institute
CAA: Clean Air Asia
CBP: Capacity Building Program
CDC: Centers for Disease Control
CEOS: Committee on Earth Observation Satellites
CHIRPS: Climate Hazards Group InfraRed Precipitation with Station
CILSS: Comité permanent Inter-Etats de Lutte contre la Sécheresse dans le Sahel
CMAM: Community Climate System Model
CMS: Composite Mesoscale Air Quality
COI: Conference on International Issues
DAACs: Distributed Active Archive Centers
DCE: Digital Elevation Model
DSD: Distributed Groundwater Models
DMSP: Defense Meteorological Satellite Program
DNA: Data North America
DWD: Deutscher Wetterdienst
E&SA: Eastern & Southern Africa
ET: Evapotranspiration
FAO: Food and Agriculture Organization
FCCT: Forest Conservation Targeting Tool
FCET: Forest Conservation Evaluation Tool
FFWC: Flood Forecasting and Warning Center
FRA: Forest Resources Assessment
GDP: Gross Domestic Product
GEE: Google Earth Engine
GEO: Group on Earth Observations
GES DISC: Goddard Earth Sciences Data and Information Services Center
GIS: Geographic Information System
GLOFs: Glacial Lake Outburst Floods
GRACE: Gravity Recovery and Climate Experiment
GRASP: Great Apes Survival Project
GSFC: Goddard Space Flight Center
GVF: Green Vegetation Fraction
HICO: Hyperspectral Imager for the Coastal Ocean
HKH: Hindu Kush-Himalaya
IADB: Inter-American Development Bank
ICIMOD: International Centre for Integrated Mountain Development
ICPAC: Intergovernmental Authority on Development (IGAD) Climate Prediction and Applications Centre
IDEA: Infusing Satellite Data into Environmental Applications
IIRS: Indian Institute of Remote Sensing
IMN: Instituto Meteorológico Nacional
INETER: Instituto Nicaraguense de Estudios Territoriales
ISRO: Indian Space Research Organization
IUAPPA: International Union of Air Pollution Associations
IUCN: International Union for Conservation of Nature
IWM: Institute for Water Modeling
JPL: Jet Propulsion Laboratory
JWG: Joint Working Group
KWS: Kenya Wildlife Service
LANCE: Land, Atmosphere Near real-time Capability for EOS
LaRC: Langley Research Center
LPC: Land Processes Distributed Active Archive Center
MaMaSe: Mau Mara Serengeti (Sustainable Water Initiative)
MARN: Ministerio de Medio Ambiente y Recursos Naturales
MET: Model Evaluation Tool
MOAD: Ministry of Agricultural Development
MODIS: Moderate Resolution Imaging Spectroradiometer
MRC: Mekong River Commission
MSFC: Marshall Space Flight Center
MWAR LAC: Managing Water Resources in Arid and Semi-Arid Regions of Latin America and the Caribbean
NASA: National Aeronautics and Space Administration
NDVI: Normalized Difference Vegetation Index
NEX-GD: NASA Earth Exchange Global Daily Downscaled Projections
NMME: North American Multi-Model Ensemble
NOAA: National Oceanic and Atmospheric Administration
NPS: National Park Service
ORNL DAAC: Oak Ridge National Laboratory Distributed Active Archive Center
PCRWR: Pakistan Council of Research in Water Resources
PI: Principal Investigator
PM2.5: Particulate Matter (PM2.5 are fine particles 2.5 micrometers in diameter or smaller)
PSI: Project Strength Index
RCCP: Regional Climate Change Program
B. Publications


C. Earth Observation Assets Employed by CBP

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<td>SMAP L-Band Radiometer</td>
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<td>SMOS MIRAS</td>
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<td>NASA King Air B200 AirSWOT</td>
<td>SRTM</td>
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<td>NOAA-11 AVHRR</td>
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D. ARSET 2016 Trainings: Instruments, Web Tools, Missions, and Satellites Covered

- Advanced Rapid Imaging and Analysis (ARIA)
- Aeronet
- Aerostat/Multi-sensor Aerosol Products Sampling System (MAPPS)
- AIRS
- Atmospheric Land Exchange (ALEXI)
- Aqua
- Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER)
- Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO)
- Carbon Mapper
- Centers for Disease Control National Environmental Public Health Tracking Network
- Consultative Group for International Agricultural Research (CGIAR)
- CORal Reef Airborne Laboratory (CORAL)
- Dartmouth Flood Dual Precipitation Radar (DPR)
- EarthEnv
- Earth Explorer
- Earth Observatory
- Earthdata Search
- EASTWeb
- Extreme Rainfall Detection System (ERDS)
- Enhanced Thematic Mapper Plus (ETM+)
- Evaluation (E-Decider)
- Evaporative Stress Index (ESI)
- Firecast
- Fire Information for Resource Management Systems (FIRMS)
- Geodetic Data Exploration (GEOGateway)
- Goddard Earth Observing System Model, Version 5 (GEOS-5)
- Global Flood Mapping System (GFMS)
- Global Inventory Modeling and Mapping Studies (GIMMS)
- MODIS
- Giovanni-4
- Global Land Data Assimilation Systems (GLDAS)
- Global Agricultural Monitoring (GLAM)
- Global Data Explorer (GDEX)
- Global Forest Watch
- Global Land Cover Facility (GLCF)
- Global Landslide Catalog
- Global Learning and Observations to Benefit the Environment (GLOBE)
- Global Navigation System Satellites (GNSS)
- Global Visualization Viewer (GloVIS)
- Google Earth Engine Evapotranspiration Flux (EEFlux)
- Geostationary Operational Environmental Satellite (GOES)
- GOES Evapotranspiration and Drought (GET-D)
- Global Precipitation Measurement (GPM)
- Gravity Recovery and Climate Experiment (GRACE)
- Himawari 8
- Hyperspectral Imager for the Coastal Ocean (HICO)
- Infusing Satellite Data into Environmental Applications (IDEA)
- Integrated Multisatellite Retrievals for GPM (IMERG)
- International Charter
- International Space Station
- Level-1 and Atmosphere Archive and Distribution System
- Web Interface (LAADSweb)
- LANCE-MODIS
- Land Ecosystem Disturbance Adaptive Processing System (LEDAPS)
- Landsat
- Map of Life
- MERRA
- METRIC
- Mirador
- MISR
- MODIS
- MODIS Active Fire and Burned Area Product
- MODIS NRT Global Flood Mapping
- MODSCAG
- MOPITT
- MRTWeb
- The National Map (Digital Elevation Data)
- National Snow & Ice Data Center
- North American Land Data Assimilation Systems (NLDAS)
- NOAA CoastWatch
- NOAA Coral Reef Watch
- NOAA Harmful Algal Blooms Forecasting
- NOAA Hazard Mapping System (HMS)
- NOAA/NESDIS Volcanic Alert System
- NOAA Whale Watch
- NPP
- OceanColor Web
- OLI
- OMI
- Plankton, Aerosols, Clouds, ocean Ecosystems (PACE)
- PPS/STORM
- Precipitation Radar (PR)
- RECOVER
- Reverb/ECHO
- Roffer’s Ocean Fishing Forecasting Service
- SAR
- SeaDAS
- SERVIR
- Short-Term Prediction Research and Transition (SPoRT)
- SNAP
- Snow Data System Portal
- SRTM
- TEMPO
- Terra
- Tagging of Pelagic Predators (TOPP)
- TRMM
- VIIRS
- VIIRS Active Fire Mapper
- Web-Enabled Landsat Data (WELD)
- Worldview
E. Organizations Engaged
In 2016, CBP engaged 1,684 organizations through trainings, feasibility studies and multi-year projects. Below you can see organizations classified by sectors:

**PARTNERS BY TYPE**

- **Academic Institution**: 34%
- **Federal/Central Government**: 22%
- **Private Sector (For-Profit)**: 12%
- **Private Sector (Non-Profit)/ Voluntary OR NGO**: 7%
- **Research Institution**: 6%
- **State/Provincial Government**: 7%
- **Tribal Entity**: 0%
- **Consortium**: 4%
- **Local Government**: 3%
- **Intergovernmental Organization**: 3%
- **Miscellaneous/Other**: 2%