Connecting Space to Village
Since its launch in 2005, SERVIR has grown into a global network of regional hubs that support analysis and capacity building to connect satellite data to development challenges in South America, West Africa, Eastern and Southern Africa, the Hindu Kush Himalaya, and Lower Mekong regions.
SERVIR: Executive Summary

SERVIR connects space to village by helping developing countries use satellite data to address critical challenges in food security, water resources, weather and climate, land use, natural disasters, and air quality. A partnership of NASA, USAID, and leading technical organizations around the world, SERVIR develops innovative solutions to improve livelihoods and foster self-reliance in Asia, Africa, and the Americas.

The last few years have been an exciting time for growth and improvement. SERVIR welcomed a new hub and expanded to the Amazon region, integrated a new Applied Sciences Team, continued building capacity of the network and partner stakeholders, shared knowledge throughout the network through multiple exchanges, strengthened external partnerships, and improved service delivery. These have also been exciting times for impact: this report highlights some important services including SERVIR’s key contribution to scaling up a crop insurance program in Kenya, the results of SERVIR’s work with governments and institutions in the Mekong region for improved drought resilience and flood forecasts, and SERVIR’s multi-pronged efforts across the network to monitor, map, and support improved forest and land management.

SERVIR continues to lead the field in building lasting capacity to apply geospatial technology, data and solutions to pressing development challenges. SERVIR’s successful approach to the design and delivery of geospatial information services is anchored in a user-centric, co-design process. This process is embodied in the SERVIR Service Planning Toolkit, a practical guide oriented around users’ needs to achieve meaningful development impact. Importantly, in all the work underway across the network, SERVIR has embraced gender equality, women’s empowerment, and social inclusion. SERVIR is committed to reducing the gender gap in science technology, and innovation so that women and girls have equal access to investments in technology and knowledge transfer, with improved access to information in ways that equally benefit all people, thus giving women greater influence in society.

SERVIR is moving into the new decade with strategic emphasis on three goals:

1. strengthen regional and national capacity and commitment;
2. demonstrate greater development impact of SERVIR services; and
3. enhance the SERVIR network’s global leadership and influence.

SERVIR looks forward to continued collaboration with partner governments, technical institutions, the private sector, academic researchers, and a broad set of partner shareholders, all working together to advance sustainable, inclusive development.
Since its launch in 2005, SERVIR has grown into a network of hubs with leading technical organizations and consortium members that are turning world-class research and data into meaningful insights to help people across Africa, Asia, and South America better manage complex development and environment challenges. SERVIR builds capacity of regional, national, and local partners through services that empower decision makers to better address critical issues related to food security, water resources, disasters, land use, and climate change.

A joint development initiative of the National Aeronautics and Space Administration (NASA) and the United States Agency for International Development (USAID), SERVIR works in partnership with leading regional organizations worldwide to help developing countries use information provided by Earth observing satellites and Earth science to address development challenges. SERVIR builds capacity of regional, national, and local partners through services that empower decision makers to better address critical issues related to food security, water resources, disasters, land use, and climate change.

Here are a few examples of SERVIR’s many activities and collaborations with local partners:

- In the Hindu Kush Himalaya region, scientists and development practitioners have collaborated with government ministries to develop a new glacier inventory for Afghanistan, which will help decision makers better understand how temporal changes in glaciers impact the availability of water and inform the sustainable development of this vital resource.
- In Senegal, satellite data is being used to help guide pastoralists and their livestock to water during the dry season thanks to a service that sends the location of watering holes to local populations via text messages and local radio broadcasts.
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In 2018, USAID set out to reorient its strategies, partnership models, and program practices to achieve greater development outcomes and work towards a time when foreign assistance is no longer necessary. The approach is called the Journey to Self-Reliance, and it involves building a country’s capacity to plan, finance, and implement solutions to local development challenges, while ensuring that there is a commitment to see these solutions through effectively, inclusively, and with accountability.

The Journey to Self-Reliance perfectly captures the SERVIR approach to supporting African, Asian, and Latin American institutions to generate locally led solutions to their regions’ development challenges. SERVIR’s institutional and human capacity strengthening model fosters stable, resilient, and prosperous countries with reinforced regional cooperation.

SERVIR invests in strong regional organizations as hub and consortium partners. These organizations have deep roots that provide a strong base for the journey to self-reliance. Partnering with SERVIR has a positive impact on hubs, helping them attract additional resources and replicate, scale, and adapt their capabilities to meet evolving regional needs.

SERVIR promotes open data and the transfer of science and technology, ensuring sustained access to science and technology, data, and products. This allows people to innovate, instead of receiving one-off data and analyses from outside experts.

SERVIR invests in women and youth through training, fellowships, and outreach programs. Increased engagement and representation of women and youth in science and technology are critical to inclusive development and services that meet the needs of all people.

SERVIR’s Service Planning Approach emphasizes consultation, co-development, and capacity building. These are good practices for ensuring local ownership, integration into decision-making processes, and the capacity building needed to sustain services by users.

Read more: The Journey to Self-Reliance Country Roadmap is USAID’s standardized analytical tool for measuring country progress across dimensions of commitment and capacity.
SERVIR: By the Numbers
Results Around the Globe

Training and Information Sharing
- **8,400** individuals trained
- **500** institutions with improved capacity

Custom Tools Developed
- **45+** countries directly served by SERVIR services or trainings
- **70+** custom tools developed

Partnerships
- **6** partnerships with U.S. technology companies

Custom Services and Applied Research
- **31** custom services in development or delivery stages
- **500K+** SAR handbook downloads in over 179 countries (as of August 2020)
- **35** satellites and sensors used by SERVIR
- **19** U.S.-based collaborating universities and research centers across 21 states

*cumulative, not annual
Current SERVIR Hub Network

Network of Hubs

SERVIR brings together a variety of specialists from diverse backgrounds to create a unique global team. SERVIR’s global network of hubs includes the Regional Centre 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; the Agrometeorology, Hydrology and Meteorology (AGRHYMET)* Regional Center in Niamey, Niger; and the International Center for Tropical Agriculture (CIAT) in Cali, Colombia—as well as consortium members and other partners dedicated to the SERVIR vision. In addition to the hubs, the SERVIR team includes the SERVIR Science Coordination Office (SCO), NASA headquarters and centers in the United States, USAID headquarters and missions around the world, 19 U.S.-based universities, and other institutions across the globe.

* A subsidiary of the Permanent Inter-State Committee for Drought Control in the Sahel (CILSS) and its consortium partners.

Focus Countries

Additional Reach
SERVIR: Service Approach

It is one thing for a researcher to generate an analysis of land cover and biomass that is posted online or published in a journal, and an entirely different thing for a land management authority to integrate land cover analysis and biomass estimation tools into their planning. SERVIR aims to bring powerful scientific data and tools to influential decision makers where improved information can make a real difference for people and the environment.

Through SERVIR, diverse stakeholders work together to identify local development problems and co-design solutions that use satellite data, Earth sciences, and geospatial technologies. The goal is to integrate these solutions into decision-making processes in order to better achieve development outcomes. The resulting solutions are tailored, need-based, decision support tools, data sets, and capacity-building activities. SERVIR calls these packages of support "services." Services are developed with a user in mind, tailored to the users’ capacities, needs, and feedback, and are accompanied by comprehensive support activities. While services may take longer to develop than one-off products, they are more likely to be adopted and sustained, owing to the collaborative, user-centric design process. In most cases, SERVIR expects the solution to be available and evolve as a long-term service offered by SERVIR hubs or sustained by regional or national partners.

Service Planning Toolkit

The service approach is documented in the SERVIR Service Planning Toolkit, a practical guide for designing geospatial information services oriented around users’ needs to achieve meaningful development impact. The toolkit includes guidance for identifying a development problem, analyzing opportunities for linking decision-making to satellite data analysis, and delivering a service—all through collaborative and results-oriented processes.

The SERVIR Service Planning Toolkit contains four tools:

1. CONSULTATION & NEEDS ASSESSMENT
   - Tools for engaging stakeholders to identify and prioritize development challenges. These steps establish a dialogue between stakeholders and satellite and geospatial data experts to explore potential solutions based on identified challenges.

2. STAKEHOLDER MAPPING
   - An approach to help SERVIR and partners refine their understanding of existing and potential stakeholders and their roles in using, enabling, benefitting from or sustaining a service. Stakeholder mapping reduces redundancies and supports strategic partnership building for increased uptake of a service.

3. SERVICE DESIGN
   - Guidance and templates for collaborating with implementing partners on the design of a service and the development of the products, tools, data sets, capacity building, and outreach necessary for success. This process documents the context and niche for a service and ensures a common understanding among partners.

4. MONITORING, EVALUATION & LEARNING
   - Guidance and templates to help SERVIR and partners effectively identify measures of success, monitor progress, adapt and learn from experience, and measure impact.

The SERVIR Service Planning Toolkit contains practical guidance on how to engage users at each phase, how to develop a theory of change, sample agendas and activities for consultations, and guidance for visualizing and reporting information.

IMPACT

What do hubs have to say about the service approach? The service approach helps SERVIR design and deliver demand-driven, inclusive, and sustainable services. Experiences from across the SERVIR network speak to the value of the service approach:

- SERVIR-West Africa’s application of stakeholder mapping helps the team form strategic partnerships from the start and ensures that SERVIR builds on ongoing work in the region.
- SERVIR-Hindu Kush Himalaya is conducting more inclusive stakeholder engagement—going beyond government to consider other partners and users so that service impact and sustainability are increased.
- For both SERVIR-Mekong and SERVIR-Eastern & Southern Africa, the service approach helps articulately a vision for designing and delivering services in a way that builds allies and demonstrates broader impact.
- For SERVIR-Amazonia, women from public offices, indigenous organizations, and NGOs represented 44% of participants at user consultation workshops in Peru and Colombia, which ensures that their needs, initiatives and proposals are considered in the design and delivery of services.
- SERVIR Applied Sciences Team members (NASA-funded scientists) see their methods and tools continue to be actively used in SERVIR regions through services, beyond their initial project lifetimes.

Discover the SERVIR Service Planning Toolkit and explore its applications.
SERVIR: Regional Hubs and Networks

Amazonia

SERVIR-Amazonia empowers actors across the region to track environmental changes in near real-time, evaluate climatic threats, and improve resource management.

SERVIR-Amazonia was established in 2019, and is implemented by a consortium led by the Alliance of Biodiversity International and the International Center for Tropical Agriculture (CIAT), along with a network of local and international partners serving the Amazon region—primarily the Spatial Informatics Group (SIG) Conservación Amazónica (ACCA), and the Institute for Forest and Agriculture Management and Certification (IMAFLORA).

The SERVIR-Amazonia hub works with regional partners to understand needs and then to translate these needs into the development of tools, products, and services that will allow countries of the Amazon basin to improve evidence-based decision-making that also incorporates the voices of women, indigenous peoples, and their communities.

Primary services
- Ecosystem services modeling in the Amazon’s forest-agriculture interface
- Monitoring and evaluation of mangroves in Guyana
- Quantifying the effects of forest changes on provisioning and regulating ecosystem services
- Deforestation monitoring and reporting in Ecuador
- Monitoring of gold mining in the Peruvian Amazon
- Radar for detecting forest change
- Forecasting seasonal to sub-seasonal fire and agricultural risk from drought
- Improving resilience and reducing risk of extreme hydrological events
- Monitoring forest dynamics from space to enable sustainable livelihoods and biodiversity conservation in the Amazon

Learn more at: https://servir.ciat.cgiar.org
Created in 1974, AGRHYMET is a specialized agency of the Permanent Inter-State Committee against Drought in the Sahel (CILSS) serving 13 member countries in West Africa. The SERVIR-West Africa hub and its five consortium partners promote the use of publicly available satellite imagery and related geospatial decision support tools and products to help key stakeholders make more informed decisions in SERVIR’s four thematic areas.

SERVIR-West Africa

In 2016, USAID and NASA launched SERVIR-West Africa implemented by the Agrometeorology, Hydrology and Meteorology (AGRHYMET) Regional Center, a subsidiary of the Permanent Inter-State Committee for Drought Control in the Sahel (CILSS), and its consortium partners,* with support from Tetra Tech, Inc.

Primary Services

- Surface water body mapping
- Ground water monitoring and modeling
- Charcoal production monitoring
- Locust infestation monitoring
- Monitoring of artisanal mining (galamsey) in Ghana
- Support for commune-level development planning in Burkina Faso

*Centre de Suivi Ecologique (CSE), based in Senegal; Center for Remote Sensing and Geographic Information Services (CERSGIS), based in Ghana; African Regional Institute for Geospatial Information Science and Technology (AFRIGIST), based in Nigeria; International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), based in Mali; and, African Centre of Meteorological Application for Development (ACMAD), based in Niger

Learn more at: http://servir.cilss.int/en
Founded in 1975, RCMRD is a leading intergovernmental African organization that currently has 20 contracting member states in the Eastern and Southern Africa regions. RCMRD’s aim is to promote sustainable development through the generation, application, and dissemination of geo-information and related IT products and services in their member states and beyond.

SERVIR–Eastern & Southern Africa builds upon RCMRD’s mission to promote sustainable development through the generation, application, and dissemination of geo-information and related IT products and services in their member states and beyond.

SERVIR-Eastern & Southern Africa

In 2008, NASA and USAID partnered with the Regional Centre for Mapping of Resources for Development (RCMRD) based in Nairobi, Kenya, to establish SERVIR’s Eastern & Southern Africa hub.

Primary Services
- Drought monitoring and assessments
- Frost monitoring
- Streamflow and flood forecasting
- Land cover mapping
- Climate vulnerability, impacts, and assessment
- Crop area estimation

Learn more at: http://servir.rcmrd.org
The forces of globalization and climate change are impacting the stability of fragile mountain ecosystems and the livelihoods of mountain people. Earth observations are critical for building resilience in this vast and remote region.

SERVIR-Hindu Kush Himalaya

SERVIR–Hindu Kush Himalaya (SERVIR–HKH) was established in 2010 at the International Centre for Integrated Mountain Development (ICIMOD) in Kathmandu, Nepal. Founded in 1983, ICIMOD is a regional intergovernmental learning and knowledge sharing center serving the eight regional member countries of the Hindu Kush Himalaya—Afghanistan, Bangladesh, Bhutan, Burma (Myanmar), China, India, Nepal, and Pakistan.*

The forces of globalization and climate change are impacting the stability of fragile mountain ecosystems and the livelihoods of mountain people. ICIMOD works to help mountain communities understand these changes, adapt to them, and make the most of new opportunities, while also addressing upstream-downstream issues. SERVIR–HKH strengthens ICIMOD’s capabilities as an established regional resource center on geospatial information and Earth observation applications for the countries in this region. Stakeholders range from decision makers at the regional level addressing trans-boundary issues, to national governments, scientists, students, the general public, and development practitioners working in the region.

Primary Services
- Crop area estimation
- Regional drought monitoring and outlook system
- Regional land cover monitoring system
- Forest monitoring and biomass estimation
- Support for early warning information on floods and other high-impact weather events

Learn more at: https://servir.icimod.org

*SERVIR–HKH supports Afghanistan, Bangladesh, Burma (Myanmar), Nepal and Pakistan.
Since its establishment in 1986, ADPC has developed strong relationships with national governments in the region, and with support from its development partners provides more than 20 countries with technical services and capacity building to bolster resilience against natural hazards in one of the most disaster-prone regions of the world.

SERVIR–Mekong works in Burma (Myanmar), Cambodia, Lao PDR, Thailand, and Vietnam to promote the use of publicly available satellite imagery and related geospatial decision support tools and products to help key stakeholders and decision makers to monitor changes in land cover and better forecast and manage floods, drought, and other disasters.

In 2014, USAID and NASA launched SERVIR–Mekong, primarily implemented by the Asian Disaster Preparedness Center (ADPC)—a recognized leader in strengthening disaster resilience in Asia. Three other consortium partners assist in implementing the SERVIR–Mekong program, bringing exceptional capabilities to help deliver services to the region.

**SERVIR-Mekong**

SERVIR–Mekong promotes the use of publicly available satellite imagery and related geospatial decision makers to monitor changes in land cover and better forecast and manage floods, drought, and other disasters.

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**Primary Services**

- Enhancing drought resilience and crop yield security
- Supporting improved riverine and flash flood forecasting
- Improving regional land cover monitoring
- Supporting transboundary water resource planning and management in the Lower Mekong
- Supporting management of the agriculture, forestry, and other land use sectors through air quality monitoring
- Developing a protected area alerts system for Cambodia
- Data monitoring and evaluation dashboard for landscape improvement in Cambodia

Learn more at: [https://servir.adpc.net](https://servir.adpc.net)
SERVIR: Collaborating Scientists and Partnerships

Role of Collaborating Scientists

SERVIR is part of NASA’s Earth Science Division Applied Sciences Program, which uses NASA’s unique view from space to address real-world issues, inform decision-making, and enhance quality of life. Within the Applied Sciences Program’s Capacity Building Program, NASA brings innovative and appropriate science to meet SERVIR user needs through the Applied Sciences Team (AST).

The team includes scientists based out of NASA research centers and private and public academic institutions across the United States. Each principal investigator leads a separate project, supported by co-investigators and hub-based researchers. Project proposals are selected across thematic service areas, balancing needs identified by each hub in topics such as water scarcity, food security, land cover monitoring, and disaster preparedness. The project teams work directly with the hubs, drawing on regional expertise to help to build capacity in using cutting-edge tools and data.

After a multi-round solicitation process, NASA selected 20 new projects comprising the 2019 SERVIR Applied Sciences Team, funded through the NASA Research Opportunities in Space and Earth Sciences (ROSES). This will be the third iteration of the SERVIR Applied Sciences Team, with previous selections in 2011 and 2015. A collection of SERVIR AST principal investigators (Pis), hub researchers, and NASA Science Coordination Office (SCO) staff are highlighted in this report as “collaborating scientists” at the top of the success stories.

20 new projects selected by NASA comprise the 2019 SERVIR Applied Sciences Team, funded through the NASA Research Opportunities in Space and Earth Sciences (ROSES)

A complete list of past and current projects can be found here: www.servirglobal.net/SERVIR-AST

SERVIR Applied Sciences Team member Catherine Nakalembe (right) instructs a Village Knowledge Extension Agent in electronic field data collection in Iringa, Tanzania.
SERVIR:  
Innovation Through Partnership

Partnerships and collaborations are important to successful, sustainable development— we can do more by working together than we can alone. As such, the SERVIR network fosters new and old partnerships to effectively tap into the expertise, resources, and innovations of a diverse array of organizations across the public, private, and nonprofit sectors. These collaborations and partnerships are critical to sustaining and strengthening our ability to bring cutting-edge solutions to our hub regions’ development challenges. Below are a few highlights from SERVIR’s key partnerships with the U.S. government, private sector, and academic community.

SilvaCarbon
Drawing on the strengths of multiple U.S. agencies and a global network of partners, the SilvaCarbon Program provides targeted technical assistance to build country capacities for measuring, monitoring and managing forest and terrestrial carbon. SERVIR is collaborating with SilvaCarbon to strengthen the capacity of hubs on forest mapping and monitoring, including biomass estimation, by capitalizing on currently underutilized Earth observation resources, such as Synthetic Aperture Radar (SAR) datasets, (a type of radar that can ‘see’ through clouds to gather data) in developing new products. In addition, SERVIR and SilvaCarbon are partnering with the U.S. Forest Service, Spatial Informatics Group, and the Food and Agriculture Organization (FAO) of the United Nations to jointly develop a free-and-open online version of Collect Earth (a tool that enables data collection through Google Earth Engine). Called Collect Earth Online, it includes new features, capabilities, and functionality to collect ground validation data for improved land cover analysis. This new global tool leveraging the SERVIR network, will assist SilvaCarbon and the GEO Global Forest Observation Initiative by adding value to existing platforms and supporting countries to reduce emissions from land use and land use change.

Esri
Through a partnership between USAID, SERVIR, and Esri—an international supplier of geographic information system software—hubs are provided with lower-cost access to a wide range of Esri products and services, including software, educational resources, and technical support. SERVIR hubs develop many of their products and tools through GIS processes and applications to meet the needs of their regional users. To be effective, these tools must be affordable, reliable, and supported by a committed development and support staff. The hubs also need access to educational and reference materials that guide them on how to build solutions—or even help them discover previously built solutions that solve a similar problem. Finally, they need to collaborate with a broad community of peers that are using similar tools to solve problems. Through this partnership with Esri, SERVIR benefits from the latest geospatial software and practices.

Google Earth Engine
Tracking the Earth’s rapidly changing landscapes efficiently and accurately is critical to protecting lives and livelihoods. Satellite technology provides a unique vantage point for observing our land, rivers, atmosphere, and many other elements of the environment. For decades, access to this technology for effective decision-making has been a strenuous endeavor for scientists and development practitioners across the globe requiring high processing computers, access to trays of images, and technical expertise in advanced algorithm development, all of which require significant financial and technical resources. Now through a unique partnership with Google, SERVIR-Mekong is changing this reality for scientists and development practitioners across the Lower Mekong region by leveraging Google’s cloud-based, high computing platform called Google Earth Engine (GEE) in partnership with the University of San Francisco, U.S. Forest Service, and SilvaCarbon. SERVIR-Mekong developed, tested, and delivered a GEE curriculum that has served as the backbone for several regional trainings. At SERVIR hubs, the curriculum has been reused and customized for additional national and regional level trainings in South and Southeast Asia, Eastern and Southern Africa, and West Africa. These trainings are empowering scientists with state-of-the-art skills that directly guide decision makers in their environmental management and sustainable development planning.

ITC
SERVIR through NASA, has an existing agreement with the University of Twente’s Faculty of Geo-Information Science and Earth Observation (ITC) based in Enschede, Netherlands. The goals of this partnership are to focus on joint development training strengthening institutional and regional capacity building and conducting research in SERVIR hub regions. Collaborations between SERVIR scientists and ITC focus on improving, developing, accrediting, and conducting relevant thematic education and trainings, strengthening institutional and regional capacity, and conducting relevant Earth observation remote sensing science research, and application tool and service development.

This partnership creates unique and innovative opportunities for ITC and SERVIR scientists to learn, interact, and collaborate in the areas of continuing education training and service planning development and implementation, which allows for greater societal impacts in the developing regions serviced by SERVIR hubs. For example: in 2019 two employees of SERVIR-Mekong enrolled in the ITC PhD program. They will continue to support SERVIR-Mekong while working towards their degrees with dissertation topics that complement SERVIR-Mekong activities, not only furthering their own education but also improving the capacity of science activities at SERVIR and in the region. Additionally, by virtue of their association SERVIR hubs, the SERVIR Applied Sciences Team (AST), and regional institutions also become beneficiaries of this agreement through the opportunities extended to them through this collaboration.

Nguyen Thien Hoa, PhD student and researcher at Can Tho University, Vietnam, participates in Google Earth Engine training at SERVIR-Mekong.
Building and relying upon a growing network of partners is fundamental to SERVIR. Beyond the sponsorship and active participation of NASA and USAID, SERVIR collaborates with other U.S. government agencies and projects, as well as partner government agencies and institutions in SERVIR regions. The SERVIR network also works together with a diverse set of stakeholders—including universities, non-governmental organizations, and private sector partners—to improve capacity in the use of geospatial data to address development challenges.
As demand grows for geospatial tools and services, SERVIR supports a broad range of institutions through its small grants program.

Small grants encourage innovation by building partnerships with a wide range of organizations that are using Earth observations to solve national, regional, and local development challenges. Grantees include non-governmental organizations, universities, and local government entities.

SERVIR currently implements competitively awarded grants through two of its regional hubs, SERVIR-Eastern & Southern Africa and SERVIR-Mekong. Products and services developed through grant activities will be integrated into SERVIR’s service catalogue, and data layers generated by grantees will be integrated into SERVIR’s data catalogue.

The vulnerability impact assessment study conducted by E-Link Consult in Chalinze District (Tanzania) results indicated that villages in Talawanda ward were the most vulnerable to climate change impacts. E-Link conducted training in five villages on agriculture, livestock, land, water, forests, natural resources, environment and community development in relation to climate change impacts and adaptation measures. Beekeeping was selected as one of the adaptation measures due to its affordability and capacity of community groups. A total of 108 persons (35 women and 73 men) from 10 community groups participated in the capacity building sessions and were provided 30 beehives. These community groups comprised of youth, elders and special need persons.

Geospatial vulnerability impact assessment catalyzed a beekeeping activity for improved climate adaptation in Talawanda, Tanzania (credit: E-Link Consult).
## SERVIR

### Eastern & Southern Africa Grants

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<thead>
<tr>
<th>Country</th>
<th>Project</th>
<th>Organization</th>
</tr>
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<tbody>
<tr>
<td>Tanzania</td>
<td>Integrating hydraulic modeling with participatory GIS to assess flood risk in Dar es Salaam, Tanzania to enhance community resilience</td>
<td>Ardhi University</td>
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<tr>
<td>Kenya</td>
<td>Bringing coral reef and coastal-ecosystem data into country decision-making in Kenya</td>
<td>Coastal Ocean Research and Development: Indian Ocean (CORIDIS) East Africa</td>
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<tr>
<td>Uganda</td>
<td>Building the capacity of National Agricultural Research Organization institutes in integrating geospatial tools for climate-smart precision agriculture</td>
<td>Earth Consult (U) Ltd</td>
</tr>
<tr>
<td>Tanzania</td>
<td>Conducting an assessment of climate change vulnerability using GIS tools and enhancement of community adaptive capacity in Chalinze District, Tanzania</td>
<td>E-Link Consult</td>
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<tr>
<td>Kenya</td>
<td>Enhancing the technical capacity of researchers to use satellite data on land use/land cover through an Unmanned Aerial Vehicle (UAV) to improve the accuracy of classification and validation processes</td>
<td>Naresuan University</td>
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<tr>
<td>Kenya</td>
<td>Leveraging citizen science in invasive species data collection and management in northern Kenya rangelands.</td>
<td>Laikipia Wildlife Forum</td>
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<tr>
<td>Uganda</td>
<td>Using remote sensing products to predict aquatic habitat conditions and fish communities for Lake Victoria</td>
<td>National Fisheries Research Institute [NaFIRRI]</td>
</tr>
<tr>
<td>Rwanda</td>
<td>Applying Earth observation technology to improve water resource management in the upper Nyabarongo and Mukungwa catchments</td>
<td>Rwanda Water and Forest Authority</td>
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<td>Wetlands International Kenya</td>
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### Mekong Grants

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<tbody>
<tr>
<td>Vietnam</td>
<td>Strengthening the capacity of academia and researchers to utilize geospatial data for natural resource management</td>
<td>Vietnam National University (VNU); University of Science</td>
</tr>
<tr>
<td>Thailand</td>
<td>Enhancing the technical capacity of researchers to use satellite data on land use/land cover through an Unmanned Aerial Vehicle (UAV) to improve the accuracy of classification and validation processes</td>
<td>Naresuan University</td>
</tr>
</tbody>
</table>
Gender Overview

Commitment to Gender Inclusion

Women and girls are often underrepresented at all stages of science and technology activities—from participating in science and technology careers and voicing their needs in consultation workshops, to benefiting from science and technology services. To achieve inclusive development, SERVIR takes a holistic view of gender integration: applying a variety of strategies tailored to each regional context.

Integrating gender into the design, delivery, and use of Earth observation services for development challenges improves and sustains resilience in key economic sectors, strengthens results for agricultural production, water supply and management, and ensures that disaster preparedness and risk reduction efforts are inclusive of issues facing vulnerable populations. In order to achieve development goals where societies thrive, women, girls, men, and boys must have equal rights and opportunities, including equal access to technology and information.

The SERVIR network made a commitment in 2018 to become more gender responsive, inclusive, and equal. Using a common methodology, each SERVIR hub, as well as the NASA/SERVIR Science Coordination Office, drafted gender strategies to actively integrate gender work into their annual work plans.

SERVIR shares four objectives to ensure that our work is gender responsive, inclusive, and equal:

1. Build women leadership and gender champions in SERVIR and create a working environment that gives equal opportunity regardless of gender
2. Empower women and girls to explore STEM fields in the countries and regions where we operate
3. Integrate gender considerations within the service planning approach
4. Use remote sensing and GIS to address development issues in a way that is intentionally inclusive of:
   a. women, taking into account how their experience is shaped by ethnicity, class, gender, sexual orientation, and other social signifiers
   b. other social groups characterized by gender, ethnicity, age, and/or disadvantaged social status

The SERVIR network’s gender strategies to date include:

- SERVIR-Mekong: Developing a user-friendly application to visualize and monitor gender gaps at the sub-national level in Cambodia and Vietnam paired with support to women’s organizations who use GIS to promote gender equality.
- SERVIR-Eastern & Southern Africa: Has participated in the WISE STEAM camps for girls from Africa and the USA since 2017, organizing an interactive lesson on how to use Earth observations to address development challenges.
- SERVIR-West Africa: Partner CILSS/AGRHYMET launched the “Kamya Yan Mata,” which means “girls and science” in the Hausa language, mentoring girls project in 2019 to empower secondary and high school girls in STEM in Niger.
- SERVIR-Hindu Kush Himalaya: Organized Empowering Women in Geospatial Information Technology (GIT) in 2018 and 2019 and supported the professional development of 124 women in this field.
- SERVIR-West Africa: Partner CILSS/AGRHYMET launched the “Kamya Yan Mata,” which means “girls and science” in the Hausa language, mentoring girls project in 2019 to empower secondary and high school girls in STEM in Niger.
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**SERVIR:** Satellites and Sensors

**SERVIR Uses Data from 35 Satellites and Sensors**

<table>
<thead>
<tr>
<th>Satellite/Sensor Name</th>
<th>Data Collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALlos (PALSAR) 1 and 2 (Japan)</td>
<td>Vegetation structure, water</td>
</tr>
<tr>
<td>ALlos-2 (PRISM) (Japan)</td>
<td>Vegetation structure, elevation</td>
</tr>
<tr>
<td>AltKa (France, India)</td>
<td>River heights</td>
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<tr>
<td>AMSR-E on Aqua (NASA)</td>
<td>Soil moisture</td>
</tr>
<tr>
<td>Sentinel-1 and -2 (ESA/Copernicus)</td>
<td>Forests, biomass, vegetation, water, crops, disasters</td>
</tr>
<tr>
<td>Sentinel-3 (ESA/Copernicus)</td>
<td>Altimetry, vegetation</td>
</tr>
<tr>
<td>Terra-ASTER (NASA)</td>
<td>Vegetation properties, glaciers</td>
</tr>
<tr>
<td>Digital Globe constellation</td>
<td>High-resolution visible imagery and near-IR</td>
</tr>
<tr>
<td>ED-1 ALI and Hyperion (NASA)</td>
<td>Disasters, vegetation change, water quality</td>
</tr>
<tr>
<td>GOES-E (NOAA/NASA)</td>
<td>Atmospheric composition, cloud formation, air mass characteristics</td>
</tr>
<tr>
<td>GPIM (NASA/Japan)</td>
<td>Precipitation</td>
</tr>
<tr>
<td>GRACE* (NASA/Germany)</td>
<td>Gravity, groundwater</td>
</tr>
<tr>
<td>GRACE-FO (NASA/Germany)</td>
<td>Gravity, groundwater</td>
</tr>
<tr>
<td>Himawari 8 (Japan)</td>
<td>Weather forecasting</td>
</tr>
<tr>
<td>ICESat (GLAS) (NASA)</td>
<td>Altimetry, vegetation</td>
</tr>
<tr>
<td>ICESat-2 (NASA)</td>
<td>Altimetry, vegetation</td>
</tr>
<tr>
<td>GEDI (NASA)</td>
<td>Vegetation</td>
</tr>
<tr>
<td>Jason-2 and -3 (NASA/NOAA)</td>
<td>Water and sea surface elevation</td>
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<tr>
<td>LANDSAT 7, 8, and 9 (NASA/USGS)</td>
<td>Vegetation properties, agriculture</td>
</tr>
<tr>
<td>LIS on IIS (NASA)</td>
<td>Lightning imaging</td>
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<tr>
<td>Meteosat (European)</td>
<td>Atmospheric composition, cloud formation, air mass characteristics</td>
</tr>
<tr>
<td>Planet constellation (USA)</td>
<td>High-resolution visible imagery and near-IR, high temporal frequency</td>
</tr>
<tr>
<td>QuikSCAT* (NASA)</td>
<td>Scatterometer (vegetation structure)</td>
</tr>
<tr>
<td>Radarsat-2 (Canada)</td>
<td>Vegetation, surface water</td>
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<tr>
<td>SMOS (French)</td>
<td>Soil moisture, ocean salinity</td>
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<tr>
<td>SRTM (NASA)</td>
<td>Elevation</td>
</tr>
<tr>
<td>Terra and Aqua MODIS (NASA)</td>
<td>Land surface temps, vegetation, water resources, fire, light at night</td>
</tr>
<tr>
<td>TRMM (NASA/Japan)</td>
<td>Precipitation</td>
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<tr>
<td>SMAP (NASA)</td>
<td>Soil moisture</td>
</tr>
<tr>
<td>VIIRS on Suomi-NPP (NASA/NOAA)</td>
<td>Land surface temps, vegetation, water resources, fire, light at night</td>
</tr>
</tbody>
</table>

* Satellite/sensor no longer producing data
* Commercial Satellites in use through a unique data use agreement

Note: U.S.-affiliated satellites and sensors are bolded

More information about these satellites and sensors can be found here: [http://www.eohandbook.com/](http://www.eohandbook.com/)

**Examples of SERVIR Services Developed with Satellites and Sensors**

**Moderate Resolution Imaging Spectroradiometer (MODIS) Sensor on Terra/Aqua (NASA)**

**Using Sentinel-1 and -2 to Monitor Crops**

**Tool:** Wheat mapping application for Afghanistan

**Description:** Wheat is a major crop and staple food covering 80% of the total cereal plantation area in Afghanistan. Despite being a significant producer of wheat, Afghanistan still imports the cereal from other countries. The timely forecast of wheat production is highly important for planning and ensuring food security in cases where shortages are predicted. Using synthetic aperture radar data from Sentinel 1 and optical data from Sentinel 2, this tool produces accurate estimates of total wheat areas during the growing season to support decision makers in national-level planning for formulation and implementation of policies related to food procurement and advance planning. The satellite-derived wheat area estimates are vetted against reference sample points provided by field staff from the country’s Ministry of Agriculture, Irrigation, and Livestock.

**Hub:** SERVIR-Hindu Kush Himalaya

**LANDSAT 8 (NASA/USGS)**

**Using Landsat for Land Cover Monitoring**

**Tool:** Land Use Land Cover and Change Mapping Service

**Description:** This service draws on the immense catalogue of Earth observation data for monitoring land use and land cover change, including the 40-year Landsat archive, and commercial imagery such as WorldView and GeoEye. Together, these satellites provide a comprehensive picture of the landscape in ten countries. To support the service, SERVIR employed state-of-the-art methodologies to develop land use land cover maps and products, greenhouse gas accounting information data, supporting REDD+ apps to enhance data collection processes, and visualization tools to increase awareness and access to available data.

**Hub:** SERVIR-Eastern & Southern Africa
Synthetic Aperture Radar (SAR) Handbook: Monitoring and Protecting Forests Worldwide

More than 40% of the world’s forests are in tropical regions. Deforestation and forest degradation are common threats that are difficult to detect in these areas with regular optical remote sensing methods, due to constant cloud-cover.

Earth observations from Synthetic Aperture Radar (SAR) sensors are uniquely able to assess threats to forest health by examining vegetation structure. For example, Colombia’s Institute of Hydrology, Meteorology, and Environmental Studies has identified illegal roads and deforestation hotspots in areas constantly covered by clouds with SAR imagery.

With the wealth of freely and openly available SAR datasets, such as Sentinel-1 and ALOS PALSAR, as well as upcoming missions with open data policies, such as NISAR and BIOMASS, there is an immense need for resources that effectively explain how to use and process these powerful datasets for specific applications.

However, a gap has existed in freely available training materials and related case studies for these relatively new uses of SAR technology. SERVIR and SilvaCarbon, a U.S. government program partnering with the Global Forest Observation Initiative working to enhance capacity around the world in monitoring and managing forests, developed a train-the-trainer vision to build global capacity in the use of SAR.

Working with world-renowned SAR experts, and the various hubs from across SERVIR’s global network, SERVIR developed a series of applied documents, tutorials, and quick reference guides explaining key SAR concepts. These materials culminated in the April 2019 release of the first edition of the SAR Handbook: Comprehensive Methodologies for Forest Monitoring and Biomass Estimation. The handbook translates very technical SAR training materials into a format more easily used by applied science audiences and the forestry community—empowering users across government agencies, academia, research centers, and other groups to implement SAR data into routine workflows and account for the state of forest resources around the world. This Handbook aligns with SERVIR and SilvaCarbon missions to improve environmental management and resilience in critical landscapes, such as forests. The aim of this effort is to support decision makers in the forestry community in leveraging the power of SAR technology to better protect and manage forest resources.

Co-authored by six experts from the NSAR Science Team US Forest Service and academia, the chapters contain applied content and hands-on self-guided trainings with step-by-step tutorials. The topics addressed in the SAR Handbook have been driven by the needs of the applied SERVIR community. The SAR handbook is a “living” document, freely available online as an e-Book hosted on the SERVIR Global website. As part of the handbook project, complementary quick reference guides, as well as an animated video series explaining in straightforward language how SAR can capture information for forest monitoring were created.

Since its release, the full SAR Handbook and associated training materials have been accessed more than 500,000 times across 179 countries. The project has also enabled an increase in the use of SAR technologies across SERVIR hub regions, including SERVIR Amazonia’s work monitoring mangroves in Guyana—helping to improve environmental management and resilience in forests and other critical landscapes around the world.

“"The SAR Handbook is perhaps the most comprehensive guide available for learning how to use SAR for forest applications. It will require handbooks like this to ensure that the capacity to collect, analyse and interpret SAR data is available everywhere, and not condensed into a small number of laboratories or institutes.”

— Dr. Iain Woodhouse, author of Introduction to Microwave Sensing

"The SAR Handbook leveraged the power of the global SERVIR network, all working towards the same goal of filling knowledge gaps in applying SAR science and technology for forestry monitoring and management."

— Africa Flores, Handbook lead editor and SERVIR Land Use Thematic Lead
SERVIR: Global Tools

Collect Earth Online: Regionally Developed Tool Expands to Support Global Forest Monitoring

A land cover tool originally developed for southeast Asia is now being expanded globally.

“Land cover mapping in the Lower Mekong has been challenging in the past, based primarily on outdated maps using different criteria,” said Dr. David Saah, Professor at the University of San Francisco, Managing Principal of the Spatial Informatics Groups (SIG). Competing objectives, priorities and resource limitations, in the Mekong and beyond, often mean differential treatment and sometimes omission of key land cover features. For example, forest ministries focus on mapping forest biodiversity, structure, condition, and use. Agriculture departments typically mask out forest cover, displaying features like irrigation treatments, crop type, and yield. In both cases, critical land cover categories such as water and urban areas are missed. Even identical features like orchards often are mapped using different methods, preventing easy comparison and complicating landscape-level analysis.

To address these challenges, SERVIR began developing a regional land cover mapping service in 2016 to support countries with food security, forest management, water management, and more. Saah and the SERVIR-Mekong team soon hit a familiar roadblock with respect to monitoring land cover and land use change: a lack of consistent, accurate reference data. To resolve this, a massive amount of data was needed—and quickly. After looking at existing collection platforms and not finding a service able to do this type of landscape-level mapping, they set out to create something new.

The team realized their ideal platform had similarities to the UN Food and Agriculture Organization’s (FAO) desktop Collect Earth system, used to monitor global forest cover. “We found out a lot of our initiatives and priorities fell in line with FAO, not just Collect Earth. The whole idea of things being open-source, distributed for people to use, ties into the way FAO does land management and governance consultations,” said Saah. Identifying a collaboration opportunity, SERVIR and FAO partnered to create a joint, web-based system, known as Collect Earth Online (CEO).

Three years and three iterations later, CEO now has a much broader geographic reach. Integrating high-resolution satellite imagery and big-data analysis tools, the platform allows users to collect reference data and images from anywhere in the world to create more accurate land cover maps. In addition, its open-source and cloud-based design makes CEO especially crucial for regions with limited internet and local computing infrastructure capabilities. Integrating TimeSync, led by Sean Healey of US Forest Service, allows analysis of land cover change over time within CEO.

“On the NASA side, we’re good at product development, data, and science, whereas FAO understands the users, the landscape, what data is needed, and how people are collecting data for forests,” said Kel Markert, SERVIR Research Scientist. “With the technical knowledge from our team, and the on-the-ground knowledge from FAO, we’re able to make something that’s really meaningful,” said Markert.

In 2019, the Forest Survey of India used CEO for its first high-level collection campaign in Dehradun. The results of this assessment will be incorporated into the 2020 Global Forest Resources Assessment (FRA), covering more than 100 countries. CEO’s collaborative origins and support from Google Earth Engine, the U.S. government’s SilvaCarbon program, and others have made the platform a first-of-its-kind repository for global land cover reference data.

“With the technical knowledge from our team, and the on-the-ground knowledge from FAO, we’re able to make something that’s really meaningful.”

— Kel Markert, SERVIR Research Scientist

Collect Earth Online can be accessed at: https://collectearth.org
While artisanal mining is a major source of income for many rural people in Ghana, the increase in unregulated galamsey activities in recent years has resulted in severe land degradation, biodiversity loss, and the pollution of water bodies due to the use of toxic chemicals, including mercury and cyanide. Between 2015-2018, illegal mining increased from 13,000 hectares to 29,000 hectares and is steadily encroaching into Ghana’s protected forest preserves.

In order to address this challenge, the Ghana-based Centre for Remote Sensing and Geographic Information Services (CERSGIS), a consortium partner of SERVIR-West Africa, developed a satellite-based monitoring service to provide accurate information about the location and scale of these illegal mining sites. The collected data provides critical intelligence to government officials and local non-governmental organizations that can be used to identify areas requiring increased law enforcement and environmental restoration.

A key component of this service is a user-friendly mobile phone app that can be freely downloaded and used to collect information on the location and scale of illegal mining activities. Once detected, a user can take a snapshot of a mining site, upload its coordinates, and report on the state of the activity.

A web-based geospatial platform was created to consolidate and analyze all the collected data and provide a visual representation of the extent and distribution of illegal mining sites across forested areas in Ghana, annually from 2015 to 2018. Additional datasets on regional and district boundaries, forest reserves, and communities have been overlaid to aid orientation, provide background detail, and generate yearly statistics of mining sites and the scale of their impacts.

CERSGIS will continue to share information with national and local decision makers and work with them to further develop this monitoring service to better assess and develop effective strategies to combat the negative impacts of illegal small-scale mining on Ghana’s precious forest resources.
**Finding the Ephemeral:**

**Satellite Data Guide Pastoralists to Water**

The Ferlo region of north-central Senegal is a vast expanse of dry savannah covering over a third of the country’s total area. With only a few small, scattered settlements, the region is almost exclusively reserved for pastoralism, both by tradition and government policy. Inhabited primarily by the Serer and Fulani peoples, the region is characterized by an extremely dry climate with a long dry season—up to nine months of the year.

During the rainy season from July to September, water and forage are fairly abundant for livestock. But when the dry season comes, pastoralists sustain their animals by relying on ephemeral water bodies—temporary ponds that hold remnants of water left over from the rainy season. As a result of their importance in the life of pastoralists, ponds that retain water for a quite long time (5-6 months) all bear a name and are known by most pastoralists who move locations based on the change of seasons,” explained Demba Ba, President of Entente des Groupements Associés pour le développement à la Base, a consortium of village community development associations in the region. In the past, local populations could rely on historical knowledge passed on from generation to generation, to find these watering holes during the dry season. However, climate change has made the historical knowledge of weather patterns less reliable, requiring a different approach. “Having reliable [surface water] information to better manage them [livestock] would be of great help to us,” Demba Ba said.

After a series of consultations with key stakeholders, the SERVIR-West Africa consortium partner Senegal-based Centre de Suivi Ecologique (CSE) and Dr. Niall Hanan, NASA Applied Sciences Team principal investigator at New Mexico State University, developed an innovative solution to help address this problem. Using free and open source satellite imagery from NASA’s Landsat suite and the European Space Agency’s Sentinel-2, SERVIR launched a new service that provides accurate and timely information concerning the availability of water in all parts of the Ferlo throughout the dry season. SERVIR is exploring the utility of high-resolution commercial imagery (such as Planet and Digital Globe) in detecting water in the ponds.

This service monitors the location of watering holes and produces high-resolution maps with sufficient accuracy to assist local authorities in natural resource management. The information generated by this system is disseminated directly to affected populations through cell phone text messages and local radio broadcasts. Improvements are currently underway to integrate information on vegetation condition—this will facilitate the consideration of both food and water in livestock management decision making.

The SERVIR-West Africa consortium will continue to work with local stakeholders and beneficiaries to improve the accuracy and availability of this service to strengthen the resilience of agropastoral systems in response to regional climate change. This service is a great example of how SERVIR truly connects space and the utility of high-resolution commercial imagery to the ground—providing critical information on all parts of the Ferlo region to help pastoralists have year-round access to water and forage for their livestock.

This service monitors the location of watering holes and produces high-resolution maps with sufficient accuracy to assist in locally-led natural resource management.
SERVIR: Success Stories

West Africa/Eastern & Southern Africa

SERVIR partners with UN FAO on New Data Fusion Product to Improve Desert Locust Monitoring

With remote sensing observations helping improve soil moisture modelling, researchers are tracking how environmental conditions influence locusts—hoping to stop outbreaks before they spread.

The Desert Locust (Schistocerca gregaria) is one of nineteen species of short-horned grasshoppers known to form swarms of adults or bands of hoppers. These resulting swarms can be dense and highly mobile, devouring vegetation. The result is devastation of crops and grasslands, given that one square kilometer of a dense swarm can consume as much vegetation as 35,000 people in a single day.

Following an unusual pattern of cyclones in the Arabian Peninsula, locust swarms have inundated East Africa—threatening food supplies for millions of people. Kenya is facing its worst locust event in 70 years, and Ethiopia and Somalia have seen their worst locust infestations in 25 years.

One of the greatest difficulties in combating the locust threat across its vast habitat—stretching from Mauritania to Bangladesh—is targeting swarms in a timely fashion to mobilize control measures. To have an impact on population numbers, it is best to find, track, and treat the immature ‘hoppers’ that move across the ground before they take flight.

Locusts prefer moist, sandy soil for laying eggs, which offers important clues for targeting surveillance and early action. Working with UN’s Food and Agriculture Organization (FAO), SERVIR expects that the integration of higher resolution satellite and soil moisture data will help pinpoint locations of these gregarious hoppers before they take flight, so targeting eradication efforts can be conducted with pesticide, bio-pesticide, or mechanical means. Improved capabilities to direct survey and control efforts can be derived at depths relevant to ideal locust egg habitats.

SERVIR’s West Africa and Eastern & Southern Africa hubs, Science Coordination Office, NASA SPoRT, NASA Applied Sciences Disasters program, and SERVIR Applied Sciences Team experts are working with the FAO to improve locust monitoring systems globally. Most current monitoring systems use rainfall as a proxy for soil moisture. However, higher resolution satellite—and model-derived soil moisture data can increase the accuracy of such monitoring systems.

Using SERVIR soil and moisture maps in combination with vegetation data and broader locust monitoring, scientists can forecast where the potential for invasion exists (i.e. if the locust will land and breed or keep moving) and help the FAO and national governments plan accordingly.

Working with the UN’s Food and Agriculture Organization (FAO), SERVIR is integrating higher resolution satellite and soil moisture data to create maps identifying where locusts are most likely to breed. This information is proving critical to the efforts of ground survey teams, especially in areas where there is little national capacity or institutional memory to address swarms.

Overlapping locusts’ optimal soil moisture with their preferred soil type to identify where the next invasion may occur.

One square kilometer of a dense locust swarm consumes as much vegetation as 35,000 people in a day.
Through a partnership between SERVIR-Eastern & Southern Africa and the Kenya Ministry of Agriculture, a new satellite-based crop mapping system and sampling methodology has been developed to support the Kenya Crop Insurance Program. In the past, ministry employees developed a crop yield sample size – used to determine risk – through extensive fieldwork. This sample-based approach measured crop yields from 15-20 representative plots. However, this process was time consuming, expensive, subject to bias, and did not capture the range of variation across all farm plots. Using satellite-generated crop maps, Ministry of Agriculture employees can now go directly to where maize is grown and measure crop yields in pre-identified sample plots. Further helping to remove bias, all samples are used to create average yields to be compared to historical yields. If yields fall below historical average thresholds, insurance is paid out on a sliding scale based on the size of plots.

Using this innovative approach, instead of taking a week to complete, crop insurance assessments can now be processed in one day. By empowering smallholder farmers to manage their risks, they are more resilient to climate shocks and stresses.

Remote Earth observation data incorporated into the insurance program has increased efficiencies, allowing the Kenya Crop Insurance Program to expand from 900 insured farmers in 10 counties in 2015 to more than 425,000 insured farmers in 27 counties today.

In June 2019, about 12,000 insured farmers were paid around $100 each to compensate for crop losses resulting from adverse weather conditions. This transfer of risk has helped farmers avoid financial crisis.

With methodological improvements using remote Earth observations, the insurance program is more accessible and allowed the insurance program to significantly expand from 900 insured farmers in 2015 to more than 425,000 insured farmers today.

As Earth observation data becomes more integral to insurance and risk financing programs around the world, SERVIR’s partnership with the Kenya Ministry of Agriculture has demonstrated the importance of building local capacity to integrate science and technology into key decision-making. SERVIR-Eastern & Southern Africa hopes to expand this approach beyond Kenya, reaching farmers in neighboring countries by helping to strengthen other crop insurance programs. Along the way, AST principal investigators Shrad Shukla from the University of California, Santa Barbara, and Inbal Becker-Reshef from the University of Maryland have provided additional insight on using satellite data to inform index insurance and disaster risk financing.
Smartphone App Simplifies Invasive Species Mapping in Kenya’s North Rangelands

For many years, pastoralists in Northern Kenya have been negatively affected by Opuntia stricta, an invasive cactus native to the Caribbean region and commonly referred to as prickly pear. This invasive species not only has overtaken the landscape and shrunk the forage space for both wildlife and livestock, but it also produces purple-reddish fruits that are highly toxic to animals.

Mr. Sepeika, a livestock farmer in Laikipia, Kenya, says the plant has invaded large tracts of his grazing land and even thrives during dry spells. He adds that domestic and wild animals suffer either sickness or death as none are spared by the wild fruit. “The cactus has small spines on the surface of its fruits that can lodge in the throat, stomach or intestines of any animal that eats it, oftentimes causing a slow death.”

For Sepeika and his fellow pastoralists, livestock are everything because they provide food, income, as well as status. Thus, the invasive prickly pear threatens the livelihoods for pastoralists in the region.

As with many invasive plant species, large-scale eradication of prickly pear is expensive and time-consuming. It requires a combination of herbicides, manual cutting, burning, and even the introduction of a specific sap-sucking bug that heavily infests the prickly pear leaves, gradually destroying the plant until it finally dies. Adding to this challenge is the lack of accurate mapping of the areas with the highest concentrations of this plant, which is necessary to effectively mobilize limited resources in eradication plans.

Seeking to address these shortcomings, SERVIR – Eastern & Southern Africa at the Regional Centre for Mapping of Resources for Development (RCMRD) developed the Invasive Species Mapper—a smartphone application that facilitates the collection of data on the current distribution of prickly pear and other invasive species in Kenya. Using satellite data and geospatial technologies, this app was designed to accurately map invasive species hotspots where particular plants are concentrated which is important in prioritizing and planning both financial and human resources to eradicate invasive plant species.

Once downloaded, the app is customized with a comprehensive list of local invasive plants to aid in identification. Livestock farmers and local community leaders can easily mark the precise location of prickly pear clusters by taking a photo with their smartphone, which is uploaded with GPS coordinates and transmitted directly to RCMRD’s database for processing. This app can also work offline when there is limited internet connectivity. Once data collected in the field are sent to RCMRD for analysis, a predictive model is applied to produce maps of current and future distributions of the invasive species under different climate scenarios.

John Letai, Deputy Director, Environment and Natural Resources of the Laikipia County Government, welcomed the new mapping tool, noting that the plant spreads remarkably fast, especially when baboons and elephants move across the landscape, carrying seeds or other sprouting plant parts.

“The negative impact to our lands from the prickly pear is undeniable. We are looking at additional ways to reduce the effects of the plant on our grasslands, our livestock, and our livelihoods. It is for this reason that additional solutions such as this Invasive Species Mapper must be implemented to increase the rate at which the plant is destroyed.”

—John Letai, Deputy Director, Environment and Natural Resources of the Laikipia County Government
CHAPTER SIX

Afghanistan’s First Glacier Inventory

Satellite Data Helps Launch Afghanistan’s First Glacier Inventory

Glaciers serve as natural, renewable, solid reservoirs of freshwater and are the primary source of freshwater in the high mountains during the dry season. They are also impacted by climate change, which is putting freshwater resources at risk in high mountain regions. Studying past and present behavior of glaciers and analyzing long-term changes helps governments better manage their water resources and understand how they are impacted by climate change.

Across the Hindu Kush Himalaya region—an area that extends over eight countries from Afghanistan in the west to Myanmar in the east—scientists have observed that most glaciers are melting faster than in the past, creating new challenges in managing local and regional water resources, natural hazards, and geopolitical stability.

In a region where water is already a scarce commodity, the retreat of glaciers is affecting millions of people, but the magnitude of this impact is not precisely known. For example, in Afghanistan, where most glaciers are found in the narrow northeastern Wakhan Panhandle of the country—wedge between Pakistan, China, and Tajikistan—glaciers serve as the headwaters of the Amu Darya River basin and contribute to the Indus River basin. However, the lack of historical data makes it difficult to understand how changes in glaciers over time impact water resources, and even more difficult to quantify how communities and their livelihoods are affected today, or how they should plan for the future. With accurate spatial and temporal data, government officials will be able to make better informed decisions on water management, agriculture, land use, and long-term planning.

Out of more than 50,000 glaciers in the region, only a few are consistently monitored on site. Physically challenging terrain and inaccessibility make field-based investigations to map and monitor glaciers and glacial lakes impractical and dangerous.

To address this data gap, SERVIR-Hindu Kush Himalaya (SERVIR-HKH) at the International Centre for Integrated Mountain Development (ICIMOD), is collaborating with the Afghanistan Ministry of Energy and Water in the development of the first-of-its-kind inventory of glaciers and glacial lakes using remote sensing data from satellites to map and monitor glaciers. This collaboration is important because data generated will serve as a baseline for reliable scientific information to support water resources management in Afghanistan, which will help the country prepare for the future, both agriculturally and industrially.

"Mapping and monitoring glaciers in Afghanistan using GIS (Geographic Information System) and remote sensing techniques has been a breakthrough for us to collect reliable data. Prior to ICIMOD's study, we only had some historical data and we were not aware about glaciers and their trends in Afghanistan. Today, we have an exact number and an estimated volume of glacier water reserves," said Daud Gazizada, Deputy Minister of Energy and Water.

In addition, four Afghanistan-based ICIMOD research assistants worked closely with ministry staff to develop and analyze the glacier inventory and have built a database of glaciers from the years 1990, 2000, 2005, 2010, and 2015 to study decadal changes in glaciated areas. Out of more than 50,000 glaciers in the region, only a few are consistently monitored on site. Physically challenging terrain and inaccessibility make field-based investigations to map and monitor glaciers and glacial lakes impractical and dangerous.

"Mapping and monitoring glaciers in Afghanistan using GIS (Geographic Information System) and remote sensing techniques has been a breakthrough for us to collect reliable data. Today, we have an exact number and an estimated volume of glacier water reserves."— Daud Gazizada, Deputy Minister of Energy and Water
Developers Improve Land Use Monitoring from Space

Monitoring land cover and land use change is important for land resource planning, forest monitoring and management, maintaining ecosystem services, and for building resilience to climate shocks and stresses. However, in many cases, land cover maps are produced and updated infrequently and are often not accurate enough for local planning.

In order to address these shortcomings, SERVIR-Mekong developed a new state-of-the-art Regional Land Cover Monitoring System (RLCMS) that uses remote sensing, open data, and the power of cloud computing (Google Earth Engine) to develop high-quality maps across the Lower Mekong region. Incorporating consistent and high quality tree and forest cover data from the Landsat archive produced by AST principal investigator Peter Potapov and team from the University of Maryland, the system helps address challenges to land management, including difficulties in accessing up-to-date data, limited financial and staff resources, lack of transparency in methodologies, and inconsistencies in land cover maps.

RLCMS: Transforming the Process for Generating Land Cover Maps and Analysis

- Higher spatial resolution (30 meter)
- Higher temporal resolution (yearly)
- High accuracy—up to 94%
- Transparency—all codes and all methods are open source
- Lower cost—no need to buy hardware or cloud credits, human resource cost for labor intensive tasks such as downloading, storing, and processing data is eliminated
- Consistency—all maps are created using the same methodology and definitions
- Peer-reviewed and published in leading scientific journals

SERVIR-Mekong collaborated with SilvaCarbon, to build capacity of Vietnam’s Forest Inventory and Planning Institute (FIPI) in utilizing the RLCMS approach and Google Earth Engine for improving forest monitoring in Vietnam.

Land cover map of Lower Mekong region.

Myanmar developed good quality time series maps of land cover from 1990 to 2017 for the first time through a partnership with SERVIR-Mekong.

—Dr. Myat Su Mon, Deputy Director of Myanmar’s Forest Department, Ministry of Natural Resources and Environmental Conservation

COLLABORATING FOR IMPACT

SERVIR-Mekong, RLCMS, and Google Earth Engine

SERVIR-Mekong developed a new state-of-the-art tool called the Regional Land Cover Monitoring System (RLCMS) that uses remote sensing, open data, and the power of cloud computing through Google Earth Engine to develop high-quality maps and land cover change analysis across the Lower Mekong region. Using RLCMS, SERVIR-Mekong is supporting countries to monitor their land resources and estimate greenhouse gas emissions, building capacity to monitor and analyze forest landscapes, land cover change, and land use change.

FOREST MONITORING/MAPPING

The cloud-based computing and machine learning approach of the RLCMS from SERVIR-Mekong is an innovative approach in forest mapping and calculating land-based sources and sinks of greenhouse gases.

LAND MANAGEMENT/DATA ACCESSIBILITY

RLCMS helps address challenges to land management, including difficulties in accessing data, limited financial and staff resources, lack of transparency in methodologies, and inconsistencies in land cover maps.

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CHAPTER SIX

SERVIR: Success Stories

Developers Improve Land Use Monitoring from Space (continued)

The cloud-based computing and machine learning approach of the system from SERVIR-Mekong is an innovative approach in forest mapping. We have learned a lot and are going to integrate it in our fifth forest monitoring cycle project.”

— Pham Ngoc Hai, an officer at FPI’s Training and International Cooperation Division

SERVIR-Mekong is currently collaborating with the Forest Department of Myanmar to build a national land cover monitoring system, which can generate data to develop a detailed greenhouse gas emissions inventory to support national policy and enable reporting to the United Nations Framework Convention on Climate Change.

This was a milestone for the country, “Myanmar developed good quality time series maps of land cover from 1990 to 2017 for the first time through a partnership with SERVIR-Mekong,” said Dr. Myat Su Mon, Deputy Director of Myanmar’s Forest Department, Ministry of Natural Resources and Environmental Conservation.

In addition, SERVIR-Mekong collaborated with SilvaCarbon, to build capacity of Vietnam’s Forest Inventory and Planning Institute (FPI) in utilizing the RLCMS approach and Google Earth Engine for improving forest monitoring in Vietnam.

“The cloud-based computing and machine learning approach of the system from SERVIR-Mekong is an innovative approach in forest mapping. We have learned a lot and are going to integrate it in our fifth forest monitoring cycle project,” said Pham Ngoc Hai, an officer at FPI’s Training and International Cooperation Division.

Following the successful launch of RLCMS in 2018, developers are releasing an upgraded version made possible through a collaborative effort between SERVIR-Mekong and SERVIR-Hindu Kush Himalaya (HKH). In this new version, users will have the ability to more accurately measure different land cover types using LANDSAT satellite imagery, an expanded time span will be applied so users can access land cover data from 1987 through 2017, where previous versions only extended to 2000. In addition, the new RLCMS will now update its land cover maps annually rather than the previous five-year time step, allowing for annual analysis. SERVIR-HKH will apply this upgraded version in its work with the Forest Research and Training Centre in Nepal to develop a land cover monitoring system to use in the Centre’s official reporting.

Both SERVIR hubs will continue to work with government agencies throughout the region — including adopting this methodology in Afghanistan, Nepal, and Bangladesh — and across the SERVIR network in utilizing this state-of-the-art system to further strengthen local capacity for improved land, forest, and natural resources policy, planning, monitoring, and reporting.
To help address this need, SERVIR-Mekong is supporting the Mekong River Commission (MRC) in using a new generation of satellite-derived precipitation products to increase flood forecast accuracy. The MRC is the only inter-governmental organization that works directly with the governments of Cambodia, Laos, Thailand, and Vietnam to jointly manage the shared water resources and sustainable development of the Mekong River.

By collaborating with SERVIR-Mekong, the MRC is now able to improve its flood forecasting system using new satellite data to estimate rainfall. This improved system will help to overcome the region’s existing challenges of insufficient ground rain gauge stations and inaccurate rainfall data that hinder the collection of accurate transboundary river flow data.

Building upon the MRC’s current use of precipitation datasets developed under a partnership between NASA and the Japan Aerospace Exploration Agency (JAXA), SERVIR-Mekong introduced updated Global Precipitation Measurement (GPM) data and performed regional bias-correction. This data has been integrated into the Virtual Rain and Stream Gauge Information Service co-developed with AST principal investigator Hyongki Lee of University of Houston.

“Bias corrections with the global rainfall product from the GPM will significantly improve our flood forecasting and warning system for better accuracy,” said Dr. Lam Hung Son, Head of the MRC Secretariat’s Regional Flood and Drought Management Center. “We want to continue our cooperation with SERVIR-Mekong to include deeper efforts towards a holistic plan, which includes monitoring for both floods and droughts.”

The accuracy of MRC’s hydrologic model will be strengthened by integrating precipitation data with higher spatial and temporal resolution information to aid in flood forecasting efforts.

MRC’s Mekong Flood Forecasting System integrated SERVIR-Mekong satellite-based precipitation data, improving accuracy and increasing lead time from 6 to 10 days.

SERVIR-Mekong will continue to support the governments in the region, as well as regional institutions and other key stakeholders in Lower Mekong countries, to utilize publicly available satellite imagery and geospatial tools to improve environmental management and help build greater resilience to the negative effects of climate change.
Enhancing Drought Resilience in Vietnam

Droughts are slow-onset disasters that trigger significant environmental and economic impacts, including loss in agricultural productivity and decreased food and water security. The Lower Mekong region is not immune to the impacts of drought. Recently, Vietnam contended with droughts and resulting damages. The 2015 drought was especially acute—the worst drought Vietnam has seen in 90 years—caused by the El Niño event that affected 52 out of 63 provinces. Vietnam suffered heavy losses, particularly in rice crop yields.

To better understand and plan for future droughts in the region, SERVIR-Mekong partnered with the Vietnam Academy for Water Resources (VAWR) to co-develop a web-based drought monitoring service. Following several rounds of consultations incorporating SERVIR’s service planning approach, a wide range of stakeholders—from farmers to local government officials—provided feedback identifying the Ninh Thuan and Binh Thuan provinces as the most promising pilot sites for testing the Regional Drought and Crop Yield Information System (RDCYIS). In addition, during these stakeholder consultations, SERVIR-Mekong and its consortium partner the Stockholm Environment Institute (SEI) identified various gaps—including social and gender inequities—with affected stakeholders to better understand how drought may impact people differently depending on gender or ethnicity.

The service provides comprehensive drought monitoring and forecasting, plus crop yield information, to assist local governments and non-government users to make better-informed decisions related to environmental remediation, water allocations, and sustainable approaches for planting and harvesting crops. This service also gives users essential information to implement short- and long-term mitigation measures both in advance of and during droughts.

The service uses a satellite-based crop yield model called the Regional Hydrological Extremes and Assessment System (RHEAS) led by AST principal investigator Narendra Das from the NASA Jet Propulsion Laboratory. This model produces drought indices, both from real-time monitoring and up-to-three-month forecasting time frames. Drought indices indicate the severity of the drought in any location in the region and have been incorporated into national and provincial climate and agricultural decision support systems used by a diverse set of stakeholders, ranging from policy makers to farmers. For example, the government drought bulletin is used as guidance to the provincial irrigation management company to better plan for water allocation in the Ninh Thuan province. Also important is that RHEAS uses freely available data and open-source software. These are key features that enable service sustainability and co-development of this technology in Vietnam.

By comparing satellite data with available on-the-ground crop reports, the models in the RHEAS framework have undergone a calibration and validation process, helping to build consensus on current crop conditions. Based on the successful co-development of this model, VAWR now features these results in their monthly drought bulletins—used by policy makers and growers—and it has led to an official agreement with SERVIR-Mekong to begin tracking rice crop yield outputs. Through collaboration on this service, SERVIR-Mekong enhances collaboration with the VAWR to improve drought forecasting at national level and provincial scale and their relationship is strengthened.

Collaboration between SERVIR-Mekong and VAWR in developing the RHEAS model has led to an official agreement with SERVIR-Mekong to begin tracking rice crop yield outputs.

Droughts in the Lower Mekong region cause significant environmental and economic impacts, including loss in agricultural productivity and decreased food and water security. These impacts are exacerbated by climate change, further highlighting the need for improved governance and local decision-making across many sectors.
As SERVIR celebrates its first 15 years, USAID and NASA have identified the following three strategic goals to guide the program over the next five years by reflecting on progress to date, changes in the wider landscape, as well as strengths, weaknesses, opportunities, and threats identified across the network. The following strategic goals establish areas of emphasis to improve or accelerate SERVIR’s ability to realize the program’s theory of change and achieve the overall goal of empowering regional and national actors to use Earth observations and Earth science for development gains through 2025.

**GOAL 1:**
Strengthen regional and national capacity and commitment, reflects the imperative of local ownership and leadership for long-term sustainability of SERVIR. SERVIR will assist regional hubs and partners to institutionalize Earth observations and Earth science services tailored to the needs of decision makers, and help build the necessary capacities, tap into available resources, and foster international collaborations to empower our partners.

**GOAL 2:**
Demonstrate greater development impact of SERVIR services, reflects the need to go beyond innovative technical solutions to ensure that wider audiences understand the relevance of SERVIR services, the results generated, and can take them forward. Actions in the focus areas will acknowledge SERVIR’s regional technical niche and reinforce strategic engagement of development actors like USAID’s field programs and opportunities to scale or replicate services for wider impact.

**GOAL 3:**
Enhance the SERVIR network’s global leadership and influence, reflects the incredible knowledge and experience generated by the program’s network of partners, and the growing internal and external audiences for this knowledge that have the potential to multiply our impact. Actions focus on widening participation in the network’s technical exchange program, investing in thought leadership to reach wider audiences, and supporting individuals to build their leadership potential.
CHAPTER SEVEN

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