MSFC-296

SERVIR: From Space to Village
A Regional Monitoring and Visualization System For Environmental Management Using Satellite Applications For Sustainable Development

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Introduction:

NASA is committed to providing technological support and expertise to regional and national organizations for earth science monitoring and analysis. This commitment is exemplified by NASA's long-term relationship with Central America. The focus of these efforts has primarily been to measure the impact of human development on the environment and to provide data for the management of human settlement and expansion in the region. Now, NASA is planning to extend and expand this capability to other regions of the world including Africa and the Caribbean. NASA began using satellite imagery over twenty-five years ago to locate important Maya archeological sites in Mesoamerica and to quantify the affect of deforestation on those sites. Continuing that mission, NASA has partnered with the U.S. Agency for International Development (USAID), the World Bank, the Water Center for the Humid Tropics of Latin America and the Caribbean (CATHALAC) and the Central American Commission for Environment and Development (CCAD) to develop SERVIR (Sistema Regional de Visualizacion y Monitoreo), for the Mesoamerican Biological Corridor. SERVIR has become one of the most important aspects of NASA's geospatial efforts in Central America by establishing a common access portal for information that affects the lives, livelihood and future of everyone in the region.

SERVIR, most commonly referred to as a regional visualization and monitoring system, is a scientific and technological platform that integrates satellite and other geospatial data sets to generate tools for improved decision-making capabilities. It has a collection of

data and models that are easily accessible to earth science managers, first responders, NGO's (Non-Government Organizations) and a host of others. SERVIR is currently used to monitor and forecast ecological changes as well as provide information for decision-support during severe events such as forest fires, red tides, and tropical storms. Additionally, SERVIR addresses the nine societal benefit areas of the Global Earth Observation System (GEOSS): disasters, ecosystems, biodiversity, weather, water, climate, health, agriculture and energy.

Data Sources:

SERVIR, as is the case with most earth science geospatial database and Decision Support Systems (DSS), incorporates data layers from a variety of sources in order to provide an extensive overview of a geographic region or study area. One example is topographic information that depicts transportation arteries, streams and elevation contours. Another is a Digital Elevation Model (DEM) that is derived from elevation contours and single-point data highlighting slope, aspect and surface elevation. Still more information is added from fieldwork and aircraft sensors. However, it is satellites that have provided some of the most important and exciting information to date. Geospatial satellite data made its first real impact in Central America when Dr. Tom Sever, NASA's only archeologist, used Landsat TM (Thematic Mapper) satellite data to assist in his efforts to locate critical Maya historic sites and to demonstrate the negative effect deforestation was having on those areas. In August of 1989, the results of his analysis motivated the presidents of Mexico and Guatemala to shake hands along the border to demonstrate a new era of cooperation between the two countries to curtail the loss of those valuable natural assets.

In fact, a Landsat TM satellite image depicting clear-cutting along the Mexican border encroaching into Guatemala appeared in the October, 1989 edition of National Geographic Magazine (along with a photo of the presidents of the two countries shaking hands). This satellite image of the border was a direct factor in the Guatemalan government setting up the Maya Biosphere Reserve in 1990—Central America's largest

protected area. TM satellite imagery has been widely used for years in natural resource management as a basis for land use and land cover change detection. The scanners on the TM and the later ETM (Enhanced Thematic Mapper) satellites have eight spectral bands, including panchromatic and thermal bands, and scan across the entire surface of the earth every 16 days in a near-polar, sun-synchronous orbit. The latest in the Landsat series of satellites, the Landsat 7, was launched in April 1999 and although its ETM+ instrument was designed to last only five years is still transmitting images on a limited basis.

Now, NASA is providing even more dynamic information from space using the MODIS (Moderate Resolution Imaging Spectoradiometer) instruments aboard the Terra and Aqua satellites. Terra MODIS and Aqua MODIS view the entire earth surface every 1 to 2 days, acquiring data in 36 spectral bands from 620 nm to 14.385 micrometers with spatial resolution ranging from 250 to 1000 meters. Each spectral band is carefully defined to provide specific data ranging from temperature of land, clouds and atmosphere; to atmospheric water vapor and ozone; to cloud altitude; properties and boundaries between land, clouds and aerosols; and to ocean bio-chemistry. Data from these instruments are used for monitoring fire, flood and hurricane impact and are helping first responders coordinate efforts to save lives.

SERVIR'S GLOBAL PERSPECTIVE:

SERVIR is also taking a global approach to environmental challenges. It is supporting the ten-year plan for implementation of the Global Earth Observation System of Systems (GEOSS) which was adopted by the European Commission and over 60 governments worldwide. This plan was the culmination of an effort initiated in 2002 when the World Summit on Sustainable Development highlighted the urgent need for coordinated observations relating to the state of the Earth. The plan defined nine societal benefit areas that could be addressed with a coordinated global observation system. These are:

- Reducing loss of life and property from natural and human-induced disasters.
- Understanding environmental factors affecting human health and well-being.

- Improving management of energy resources.
- Understanding, assessing, predicting, mitigating and adapting to climate variability and change.
- Improving water resource management through better understanding of the water cycle.
- Improving weather information, forecasting and warning.
- Improving the management and protection of terrestrial, coastal and marine ecosystems.
- Supporting sustainable agriculture and combating desertification.
- Understanding, monitoring and conserving biodiversity.

Mesoamerica is a prime example of a multi-national region with natural and human induced stresses that can benefit from information provided by observation systems as defined by GEOSS. The region is severely threatened by extensive deforestation, illegal logging, water pollution and uncontrolled slash and burn agriculture. Additionally, Mesoamerica's distinct geology and geography result in disproportionate vulnerability of its population to natural disasters such as earthquakes, hurricanes, drought and volcanic eruptions. For example, SERVIR has provided decision makers with critical support tools such as algae maps during severe red tides along the El Salvadoran coast in the June of 2004, flood maps and landscape change maps during floods in Panama in November, 2006, and current and predicted wind and precipitation maps covering northern Central America during the approach and landfall of Hurricane Stan in October, 2005. SERVIR Africa will address some of the same issues as those in Mesoamerica along with others that can benefit from critical information required to manage natural resources and support sustainable development.

Case Studies:

NASA satellite imagery provides a critical resource of information used for applications that address issues as diverse as tracking the spread of infectious diseases to measuring the impact and devastation of hurricanes. Some examples of these projects used in the

SERVIR DSS (Decision Support System) are the Red Tide Alert, Fire Extent Product and the Mesoamerican Climate Modeling System.

MODIS Red Tide Alert

A red tide is a naturally occurring harmful algal bloom which poses serious health risks to humans and consequently can cause significant economic loss to local fishing industry as well as tourism. To avoid red tide events, the governments of El Salvador, Guatemala and Nicaragua requested the development of a MODIS Ocean Color product to meet their requirements for better detection and location of red tide events off the Pacific coast of these countries. The El Salvadoran and Guatemalan governments especially benefited by saving millions of dollars for their fisheries' industry.

MODIS Fire Extent Product

During 2003, the fire season in Guatemala was particular severe – challenging the Guatemalan Park Service's ability to respond. Their reliance on visual and oral reports limited their ability to effectively evaluate fire breakout locations and potential severity. The MODIS based information generated by SERVIR proved valuable because it provided a better means of reporting and evaluating fire locations.

Mesoamerican Climate Modeling System

Landsat 7 ETM+ (Enhanced Thematic Mapper) provides land cover data sets that produce updated land use/land cover maps for input into the MM5 (Mesoscale Model). This model was used to develop climate change scenarios for the region (years 2005, 2010, 2020. 2025, 2050, and 2100) which include, for example, precipitation, temperature, soil moisture and vegetation index measurements.

Summary

SERVIR has become a high-profile project with a host of success stories at the local and regional Mesoamerican level. This accomplishment can be attributed to NASA's long-standing commitment to using technology it has developed in-house, combined with off-the-shelf products, to provide access to solutions for those decision makers most in need of critical geospatial information. SERVIR will be a good fit for Africa because it has the flexibility to grow and adapt to challenges that require a constant flow of these timely data. This formula will allow NASA and its partners to continue to bring global technology to the grass roots level.