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**Caribbean Flood Pilot Sensor Web**  
**GEO Architecture Implementation Pilot – Phase 2 (AIP-2)**

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**Table of Contents:**

<b>1</b>	<b>Overview .....</b>	<b>3</b>
<b>2</b>	<b>Proposed Contributions .....</b>	<b>4</b>
<b>3</b>	<b>Societal Benefit Area Alignment and Support.....</b>	<b>8</b>
<b>4</b>	<b>Component and Service Contributions .....</b>	<b>9</b>
<b>5</b>	<b>Architecture and Interoperability Arrangement Development .....</b>	<b>14</b>
<b>6</b>	<b>Description of Responding Organizations .....</b>	<b>15</b>
6.1	CEOS and CEOS Disaster SBA Team .....	15
6.2	NASA Sensor Web/SERVIR Collaboration.....	16
6.3	UNOOSA/UN-SPIDER .....	16
6.4	CDERA .....	17
6.5	CATHALAC .....	18
6.6	West Indies University .....	18
6.7	Caribbean URISA Chapter .....	18
6.8	Other participants .....	19
6.9	Collaborating Proposals.....	20
	<b>Annex A. Letters Responding Organizations .....</b>	<b>23</b>

## NASA-CEOS-CDERA-CATHALAC-UNOOSA Response to the GEOSS AIP-2 CFP

## 1 Overview

This proposal (herein after referred to as the ‘Caribbean Flood Pilot’) is a response to the Call for Participation (CFP) in the Architecture Implementation Pilot (AIP) of the Global Earth Observation System of Systems (GEOSS) and proposes to conduct a region-specific flood disaster management pilot project in the wider Caribbean (see domain in **Figure 1** below). The overall goal of the Caribbean Flood Pilot is threefold:

- (i) to provide information on which flooding disaster relevant data and models are available already for the Caribbean region,
- (ii) to produce a one year flooding composite image from various satellites, and
- (iii) to make the relevant data and services accessible via the GEO Portal.



**Figure 1: Geographic Domain of Proposed Pilot**

The wider Caribbean region is home to some 115 million inhabitants and was chosen for this pilot because of its intrinsic vulnerability to disasters (source: Oakridge National Laboratory). The region is defined as the countries bordering the Caribbean Sea and therefore includes – which includes all of the island nations of the insular Caribbean, most of Central America (with the exception of El Salvador), and the countries in northern South America. The region is particularly vulnerable to recurring extreme events, including droughts, earthquakes, fires, floods, landslides, tropical cyclones, and

volcanic eruptions. In 2007 alone, some 2,000 earthquakes were registered, approximately 93,000 hotspots were detected by the MODIS sensors, and some seventeen tropical cyclones impacted the region (sources: NASA, NOAA, USGS).

A number of the extreme events affecting the Caribbean can nevertheless be both observed and monitored from space. Hence the current proposal seeks, in the framework of existing international cooperation initiatives, to build regional capacity to utilize space-based information for disaster preparedness and response. In terms of the disasters that can be remotely observed and monitored, this pilot will focus on the phenomena of flooding as this is seen both as a priority among the other types of disasters and is also often the most devastating consequence of the annual tropical cyclones which ravage the region. By developing regional capacity in this area, it is therefore expected that this initiative will have significant multiplier effects (??) in terms of providing societal benefit to the region's 115 million inhabitants.

## **2 Proposed Contributions**

The Flood Pilot will provide Caribbean Disaster Management agencies and other support groups in the region with access to an array of satellite data, flood models, in-situ sensors, and baseline data sets through a common web-based interface available on internet browsers and hand-held wireless devices. It is proposed that this common web-based interface will be harmonized with the existing SERVIR system which currently serves Mesoamerica. By implementing this pilot, regional capacity in the application of satellite-based disaster products will be enhanced by fulfilling the objectives of the Global Earth Observation System of Systems (GEOSS).

Access to civilian satellites that will be utilized during the Pilot is being coordinated through the Committee on Earth Observation Satellites (CEOS), an international group of civilian space agencies, which includes the U.S. National Aeronautics and Space Administration (NASA), the European Space Agency (ESA), the Japanese Space Agency (JAXA), the Canadian Space Agency (CSA), and many others.

Model data showing flood extent and inundation levels will be provided by numerous sources such as the Dartmouth Flood Observatory, the University of Maryland, Columbia University, the U.S. National Oceanic and Atmospheric Administration (NOAA), the U.S. Geological Survey (USGS), and others.

Access to in-situ sensors and background data sets will be provided by participants in the Global Earth Observation System of Systems (GEOSS) Architecture Implementation Pilot (AIP) Phase 2 activity which is scheduled to occur from September 2008 to September 2009. Participants from across the globe will register their components and services in the GEOSS registry and provide interoperable availability to the entire group through discovery using the GEOSS Portal.

### **CARIBBEAN FLOOD PILOT CONTEXT**

GEOSS is a system, as envisioned by the intergovernmental Group on Earth Observations (GEO), which will provide standardized access to data and information

products in support of nine global societal benefit areas (SBAs). The SBAs are Disasters, Health, Energy, Climate, Water, Weather, Ecosystems, Agriculture, and Biodiversity.

GEO consists of over 70 nations and 40 international organizations. The GEO Architecture and Data Committee has been assigned a set of tasks to define and build capacity for GEOSS. CEOS is being leveraged as a forum for coordinating current and future observations from civilian satellites.

### **AIP CFP RESPONSE FOR FLOOD PILOT**

This proposal is being submitted so that the Flood Pilot can commence and the demonstration in the Caribbean can be conducted under official auspices of the GEOSS AIP. The AIP CFP describes a flood scenario under the SBA for Disaster Management and this response provides specific scenario descriptions for the Caribbean coverage. Our team will support implementation of the Caribbean Flood Pilot as part of the AIP flood scenario by demonstrating the GEOSS Core Architecture Interoperability capability integrated with the NASA SERVIR/Sensor Web collaborative in the Caribbean flood mitigation and response context.

Our team will work with the organizers of the GEOSS AIP who will assign a person to lead the flood scenario from the perspective of the GEOSS AIP Interoperability Program team. End users and infrastructure providers enlisted under this response include a number of agencies from within and outside the region, including:

- the Caribbean Disaster and Emergency Response Agency (CDERA),
- the Water Center for the Humid Tropics of Latin America and the Caribbean (CATHALAC),
- the University of the West Indies (UWI), and
- the United Nations Platform for Space-based Information for Disaster Management and. Emergency Response (UN-SPIDER) program of the United Nations Office for Outer Space Affairs (UNOOSA).

This proposal describes the components and services being orchestrated for use in the Caribbean Flood Pilot and specific commitments from CEOS and other organizations to support the AIP flood scenario demonstration.

### **REGIONAL SUPPORT FOR FLOOD PILOT**

In the context of disaster management, under the auspices of the Caribbean Disaster and Emergency Response Agency – an umbrella agency for Caribbean disaster management agencies – there are already a number of ongoing initiatives in the region related to disaster preparedness, mitigation, and response. The proposed Caribbean Flood Pilot activity will leverage the support provided by such activities, which already include personnel time, travel, accommodations, and meals to support coordination activities across the nations of the region as well as within each country. As such, this project will piggyback on already planned and emerging conferences, workshops, and splinter group meetings to accomplish face-to-face coordination (e.g. the upcoming 2<sup>nd</sup> GEOSS of the Americas Symposium in Panama where a side session for this Pilot is being planned).

Other coordination activities will be accomplished through teleconferences and email correspondence.

All integration planning and status reporting will be primarily the responsibility of the GEOSS AIP Pilot Team who will provide the interface to the GEOSS pilot activity. The GEOSS Pilot Team will support coordination planning and status reporting to the Caribbean entities.. The Caribbean regional participants will examine the GEOSS data offerings and assess the utility of the interface.

### **CAPACITY BUILDING AND FUTURE ACCESS**

The GEOSS Pilot exercises are intended to support persistent components and services that will be available for at least one year with the goal of evolving a set of on-going assets that will include sensor data from future platforms. Future civilian satellite mission requirements are being coordinated through CEOS and individually within member agencies, such as NASA within the U.S., to address the GEOSS needs.

The GEO organization conducts workshops in numerous venues to coordinate activities across nations and international organizations (such as the Institute for Electrical and Electronics Engineers - IEEE) for planning and capacity building.

The limited availability of data, processing facilities and trained scientists in developing countries is a major problem. Strategies are urgently needed to provide low-income countries with free data and software – as well as training - for mapping and monitoring geohazards, physical vulnerability and disaster risk.

The School of Earth & Environmental Sciences at the University of Portsmouth, UK, can provide a free set of distance-learning tutorials for Disaster Risk Reduction utilizing satellite imagery, using free image processing and GIS software. Training materials are being developed that use geospatial data and crisis management experience from flooding earlier this year around the Trinidad region of Bolivia. The remote sensing datasets will be MODIS, ASTER, Landsat ETM+ and SRTM (and probably a RadarSat or ERS radar image). Two tutorials are being developed:

1. Introducing the types of data, image processing and GIS software.
2. A disaster risk reduction case study, based on the 2008 Bolivia flooding. It is hoped that disaster management centers in the Caribbean region will assist with developing further tutorials, based on their own case study datasets.

### **FLOOD PILOT BACKGROUND**

The CEOS Disaster SBA Team is promoting activities that will culminate in the GEO Disaster Management Pilot Project for Flooding in the Caribbean under GEO Task AR-07-02 with the support of the CEOS under the action DI-06-09. The intent of the CEOS Disaster SBA Team is to promote the Caribbean Flood Pilot Project and obtain the support of CEOS members to provide data for the Pilot. The Pilot was proposed to the UN-SPIDER workshop in Barbados in July 2008, organized by the United Nations Office for Outer Space Affairs, the United Nations Development Programme (UNDP), the Caribbean Disaster Emergency Response Agency (CDERA) and the Department of Emergency Management of the Government of Barbados.

It is apparent that CEOS, the GEO Architecture and Data Committee, CDERA, the Open Geospatial Consortium (OGC), the UNOOSA/UN-SPIDER, and the NASA SERVIR/Sensor Web collaborative want to see a robust demonstration of our capacity to support the disaster management functions of not only the Caribbean nations, but also globally. The GEOSS AIP presents a significant opportunity to leverage the broadest range of capabilities for the Caribbean flood effort by using assets that have global reach provided through CEOS members and other participating organizations.

These activities will certainly support regional efforts for improving flooding disaster mitigation and warning but also will set a benchmark for coping with these tasks in other tropical regions. It is the mandate of the UN-SPIDER Programme to provide universal access to all types of space-based information and services relevant to disaster management (General Assembly A/RES/61/110). Therefore, by UN-SPIDER being a gateway to space information for disaster management support, this access will be a relevant content of the UN-SPIDER Knowledge Portal which is under development.

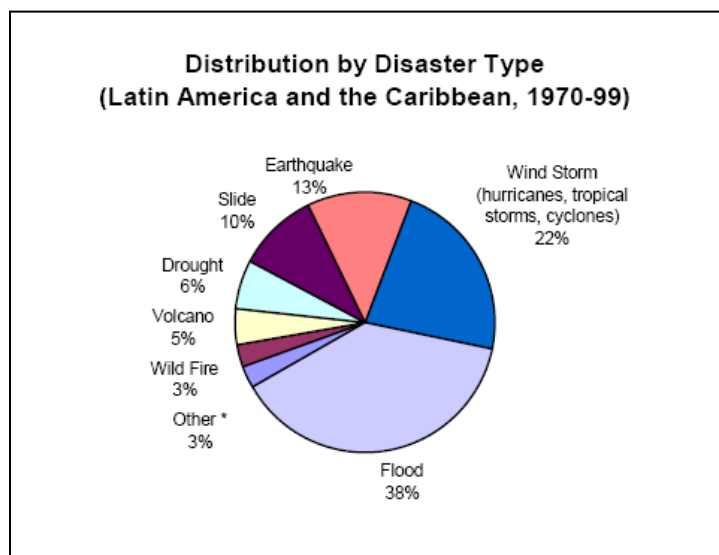
Additionally, in terms of helping to build GEOSS, this project will play an extremely significant role in building regional capacity to make use of satellite-based products for disaster preparedness and response. In addition to developing the virtual infrastructure for receiving satellite-based disaster products, this Pilot will also develop the human infrastructure through its involvement of key agencies working in disaster response in the region. The key agencies capacities will be enhanced over the project's implementation, ultimately augmenting their ability to respond to disasters. These regional agencies include CDERA (representing the national disaster management agencies), CATHALAC (the operational node for SERVIR which is already involved as a project manager for the International Charter on Space and Major Disasters), and the Centre for Geospatial Studies of the University of the West Indies (which plays a key role in training of geospatial personnel in the insular Caribbean). Other agencies will be invited to participate in the Pilot as deemed necessary.

It is recognized that developing the region's human capacity in the application of satellite-based technologies is absolutely crucial to the success of this Pilot and to the enhancement of the Group on Earth Observations' intergovernmental mandate. It is being proposed that the first such capacity-building activity be executed at a side session of the upcoming September-October 2008 GEOSS of the Americas Symposium in Panama where, among other activities, technical personnel from the end-user organizations will be trained in tasking of some of the available satellite resources. This preliminary activity will both endow the Pilot with considerable momentum as well as serving as a pilot for other capacity-building activities to be accomplished throughout the project's life. It is anticipated that in addition to organizing in-person training sessions with end users, capacity-building will also be conducted using virtual means, as well as enhanced through a "training of trainers" approach to produce a multiplier effect regionally.

### 3 Societal Benefit Area Alignment and Support

The Caribbean Flood Pilot project addresses one of GEO's core societal benefit areas: the reduction of loss of life and property through improved disaster management. In recent decades, both the frequency and impact of great natural disasters has been increasing. Great disasters are those that overtax the ability of regional authorities to respond, requiring international assistance.

The Caribbean region is faced with a multiplicity of natural hazards. Disaster losses have been increasing as a result of rapid population growth in hazard prone areas, environmental exacerbation of vulnerable sites, and increasing occurrence and intensity of weather-related natural hazards. Natural disasters have caused an estimated 464,000 fatalities in the Latin American and Caribbean region, over the last century. Nearly 5 million people in the region are affected annually by disasters, resulting in an average of 7,500 deaths per year. The increase in economic cost of disasters over the last two decades has outgrown GDP growth by a factor of five in the region. Floods and windstorms rank second and third as the cause of disaster related fatalities.<sup>1</sup>



**Figure 2: Distribution by Disaster Type in Latin America and the Caribbean.**

Satellites offer the largest potential for improving current practices for every aspect of flood risk management, from mitigation through response and recovery. Weather satellites have for many years made well-recognized contributions to disaster warning and prevention, particularly hydrological disasters. More recently, other Earth observation satellites are being brought to improve the management of a broader range of natural disasters. This can be achieved through better assessment of risk before events take place, by providing accurate warnings of where disasters will occur, by assessing the situation of critical infrastructure after an event or supporting the recovery process long

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<sup>1</sup> **Source:** Natural Disasters in Latin America and the Caribbean: Inter-American Development Bank



after the disaster is over. Dozens of Earth observation satellites orbit the world collecting imagery to provide information about the effects of hazards derived from low and high resolution data. These data can be integrated into disaster warning systems to improve their accuracy, or may be used to generate maps that assist responders in determining the most affected areas and status of the infrastructure.

One of the main objectives of the Caribbean Flood Pilot is to improve access to these unique data sets for disaster managers and ensure that critical observations are sustained over the long-term.

The Pilot scenarios will aim to be user driven and use existing space assets with targeted acquisition programs to specifically address problems of concern. They will address the need of the following users.

1. The decision maker who needs to affect resources;
2. Regional civil protection agencies preparing to face a natural disaster or looking for information on a daily basis to react;
3. The public looking for information either to face the situation or to find out what can be done to help.

#### **International Charter “Space and Major Disasters”**

Following the UNISPACE III conference in July 1999, the European and French space agencies (ESA and CNES) initiated the International Charter “Space and Major Disasters” (the Charter), whose membership now includes the Canadian Space Agency and 8 other leading space organizations. The Charter provides a unified system of space data acquisition and delivery to emergency authorities affected by natural or man-made disasters. This system has been activated over 150 times, with more than 30 calls in 2007 alone. In parallel, a number of regional initiatives have been undertaken to better coordinate access to satellite data, including the Global Monitoring for Environment and Security (GMES) programme in Europe, Sentinel-Asia’s 18 nation operational system and SERVIR, a Mesoamerican visualization and monitoring portal. UNOOSA has worked with UN Members States to define a United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN SPIDER), which was approved by the UN General Assembly in 2006. The Caribbean Pilot scenarios will be built on the lessons learned from these systems and extensive consultations by CEOS and the Integrated Global Observing Strategy Partnership (IGOS-P) over the past decade.

## **4 Component and Service Contributions**

The pilot will support the deployment of services as well as the development of a virtual infrastructure to support such services.

### ***Data Inputs***

Of primary importance are the data inputs which will feed the Caribbean Flood Pilot, and these can be divided into satellite-based and non-satellite-based inputs. As such, a

preliminary inventory of satellite assets being proposed for use under this response includes the following:

- the MODerate-resolution Imaging Spectro-radiometer (MODIS) onboard NASA's Terra and Aqua satellite platforms,
- the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) on the Terra platform,
- the Enhanced Thematic Mapper Plus (ETM+) of Landsat 7,
- the Advanced Microwave Scanning Radiometer – EOS (AMSR-E) on Aqua,
- the Tropical Rainfall Measuring Mission (TRMM),
- RADARSAT,
- the Advanced Land Observation Satellite (ALOS),
- the Advanced Land Imager (ALI) and the Hyperion sensors on NASA's Earth Observing One (EO-1) platform, and
- ENVISAT.

Other datasets required by this Pilot include, but are not limited to:

- Administrative boundaries
- Populated places
- Cadastral data (property boundaries)
- Transportation networks, including roads and bridges
- Population density (e.g. the 1km-resolution Landsat dataset)
- Land cover (e.g. the 300m GlobCover 2005-06 land cover dataset from ESA)
- Digital Elevation Models (DEMs) (e.g. the 90m elevation model of the Shuttle Radar Tomography Mission, SRTM)
- Existing water bodies to assess nominal and peak annual averages of water levels (e.g. the SRTM Water Body Dataset (SWBD) or water bodies derived from available land cover data)
- Catchment boundaries (e.g. national watershed maps where available or the SRTM-derived HydroSHEDS dataset)
- Local flood susceptibility maps (where available)
- Local topographic maps of varying scales (e.g. 1:5,000, 1:12,500, 1:50,000, 1:250,000)
- Historic precipitation data (e.g. TRMM-based precipitation product, NOAA CMORPH precipitation data)

- Precipitation forecast data (e.g. outputs from regional MM5 runs by CATHALAC, and NOAA GFS runs)

The SERVIR Data Portal ([www.servir.net](http://www.servir.net)) serves as a data clearinghouse where a number of these data inputs (e.g. digital elevation model, Landsat imagery) can already be obtained, whereas much of the rest of the data can be obtained from the public domain or from among the project's participating agencies (e.g. the sizable data holdings of UWI (??) or CATHALAC). For the purpose of sustainability, non-sensitive data obtained during the Pilot will be lodged within the SERVIR Data Portal, where they will be publicly accessible to users across and outside of the Caribbean.

### ***Satellite Tasking Capability***

The proposed effort will create a geo-spatially enabled campaign manager that provides a coverage visualization of what data products are available and will be available for any given area of interest of all assets. Also, the campaign manager will task satellites automatically or retrieve archived data of the relevant region of interest. Tasking and data processing via web service workflows will be vetted through the OGC and CEOS Working Group on Information Systems and Services (WGISS).

### ***Flood Products***

The Pilot will use the University of Maryland (Bob Adler's) global flood potential product from TRMM data and the Dartmouth Flood Observatory (Bob Brankinridge's "River Watch") Satellite-based Flood Detection and Flood Risk Assessment in some combination to create satellite tasking triggers. Flood extent maps will likewise be developed using data from TERRA, AQUA, RADARSAT, ALOS, ENVISAT, LANDSAT, and EO-1 satellites, taking into consideration the resources' technical limitations. For instance, while MODIS on Terra and Aqua can image the same area on earth twice per day, as an optical sensor it is limited by its inability to detect floods beneath clouds. ALOS (JAXA – contact Satoko Muira) can see through clouds but can only be available every 2 days for any given area. ENVISAT's ERS (ESA – contact Natalia Kussul) can see through clouds and is available every 2 days also. Seeing through clouds and under tree canopy requires C-band and/or L-band radar. Thus, the development of composite products using various satellites will provide the timeliest and most complete picture. It will be a mosaic over time that is automatically assembled, never complete, but improves over time for an area and a given event. For instance, for a baseline of current extents of water bodies, in addition to the existing SWBD,, we will also collaborate with the MODIS team that is creating a global water mask over a one year period (University of Maryland – contact Rob Sohlberg). One year's worth of images will be used to provide a cloud free composite baseline. These activities will demonstrate the CEOS Constellation concept for ad hoc fusion of assets to accomplish theme-based goals.

For some areas, floods occur seasonally and do not need to be attended, so decision support models needed to correlate rainfall anomalies with actual problematic flooding are being developed under the NASA ROSES Decisions grants. By using flood models such as those developed by the Dartmouth Flood Observatory, Ukraine Space Research Institute (Natalia Kussul), and Columbia University, our Pilot team will construct the

high resolution flood basin descriptions and decision support tools, tools which can in turn be incorporated into the other components of the existing SERVIR platform. These models will be used to correlate precipitation anomalies and form the basis of determining what can be a flood event versus a nominal event using higher precision DEMs, such as from the SRTM and other radar maps as they become globally available from the CEOS Working Group on Calibration and Validation (WGCV). Another data source will be the United Nations Operational Satellite Applications Programme (UNOSAT).

Part of the decision support loop will be to correlate historical nominal and annual flood levels in the context of the regional/local precipitation anomalies to derive triggers for observation gathering and possible development of flood alerts. Additionally, the University of Puerto Rico has been tasked to experiment with plant distress to determine if salt water flooding has occurred. The reason to do remote sensing of salt vs. fresh water is so aid agencies can determine whether to send fresh water for the salt water contaminated case or water purifier's for the fresh water contaminated case.

### ***Delivery of Services***

Services such as (i) data warehousing and (ii) the streamlined provision of data products and model results will be implemented in cooperation with existing information platforms such as SERVIR ([www.servir.net](http://www.servir.net)) and the International Charter on Space and Major Disasters (<http://www.disasterscharter.org>). This, for instance, will bring to light and demonstrate the need for extending the Charter deliveries to include mitigation data as well as response data. This extension will direct the Charter mechanism towards the disaster management cycle phases other than only response. This aspect for the Charter needs to be discussed as well as the range of Authorized Users as proposed by GEO. Likewise, while UN-SPIDER is not a data provider per se, it provides meta-information on data, products, and services. Hence, we will explore how to provide access to our metadata and pull metadata for correlative data sets from the UN-SPIDER Knowledge Portal (<http://www.unoosa.org/oosa/unspider/>). We will further explore the complimentary nature of the GEO Portal and the UN-SPIDER Knowledge Portal following the initial discussions that are being conducted at the Davos Conference 25-29 August 2008, the GEOSS in the Americas Workshop 30 September – 3 October 2008, and the UN-SPIDER Bonn Workshop 13-15 October 2008.

### ***Additional Leveraged Cooperation***

We will work with our partners at USGS and the U.S. Agency for International Development (USAID) to build additional inroads with the organizations participating in the International Charter and UN-SPIDER. Collaborations with the U.S. Department of Defense (DoD) and the U.S. Geological Survey (USGS), may enable the acquisition of additional high resolution data from satellites such as GeoEye-1 and IKONOS, depending on the severity of the disasters. Through the DoD's U.S. Africa Command (USAFRICOM), DoD plays a humanitarian assistance role in Africa and they have expressed interest in providing needed data during disaster events by leveraging the Cross Domain Sensor Web that could build on the Caribbean Pilot assets to provide coverage in Africa. The Cross Domain Sensor Web is an effort to provide seamless access for DoD to

civilian observations and for the civilian community to unclassified DoD observations within a common architecture.

Members of our team are working with the Futures Lab at the National Reconnaissance Office (NRO) to integrate our civilian sensor web with their classified side to flow tasking requests and data products in both directions for mutual support of the U.S. Africa Command (USAFRICOM), the International Federation of Red Cross/Red Crescent (IFRC) and the Regional Center for Mapping of Resources for Development (RCMRD) – a regional intergovernmental agency in Africa which works in disaster support and home to the SERVIR node that is being implemented for Africa. The DoD assets provide declassified data through the National Geospatial-Intelligence Agency (NGA) and additional DoD Sensor Web components and services will be provided through the Defense Intelligence Agency (DIA). The Cross Domain Sensor Web will also be demonstrated during the Empire Challenge 2009 activity (a DoD interoperability exercise).

Due to resource constraints on ENVISAT for orbits corresponding to the Caribbean region, ESA has set up collaboration with University of Miami (Hans Grabe). This is a Category 2 project (negotiated by University of Miami with Eurimage, distributing entity for ESA ENVISAT data). Since ENVISAT will not use its onboard recorder for these orbits, the University of Miami will receive ASAR instrument data over the region for flood disaster events. Therefore, the University of Miami may be a good partner for the Pilot. ESA suggested setting up a quick repatriation mechanism with the University.

### ***Interoperability with the GEO Portal***

Out Flood Pilot team will demonstrate interoperability with the GEO Portal by registering our components and services with the GEOSS registry and showing access to our services through GEO Portal. As previously detailed, our data products and model results will be made available through discovery via the clearinghouse linkages with our catalog services. All data products and web services will be provided in web service standard formats that are specified within the GEOSS standards registry.

## 5 Architecture and Interoperability Arrangement Development

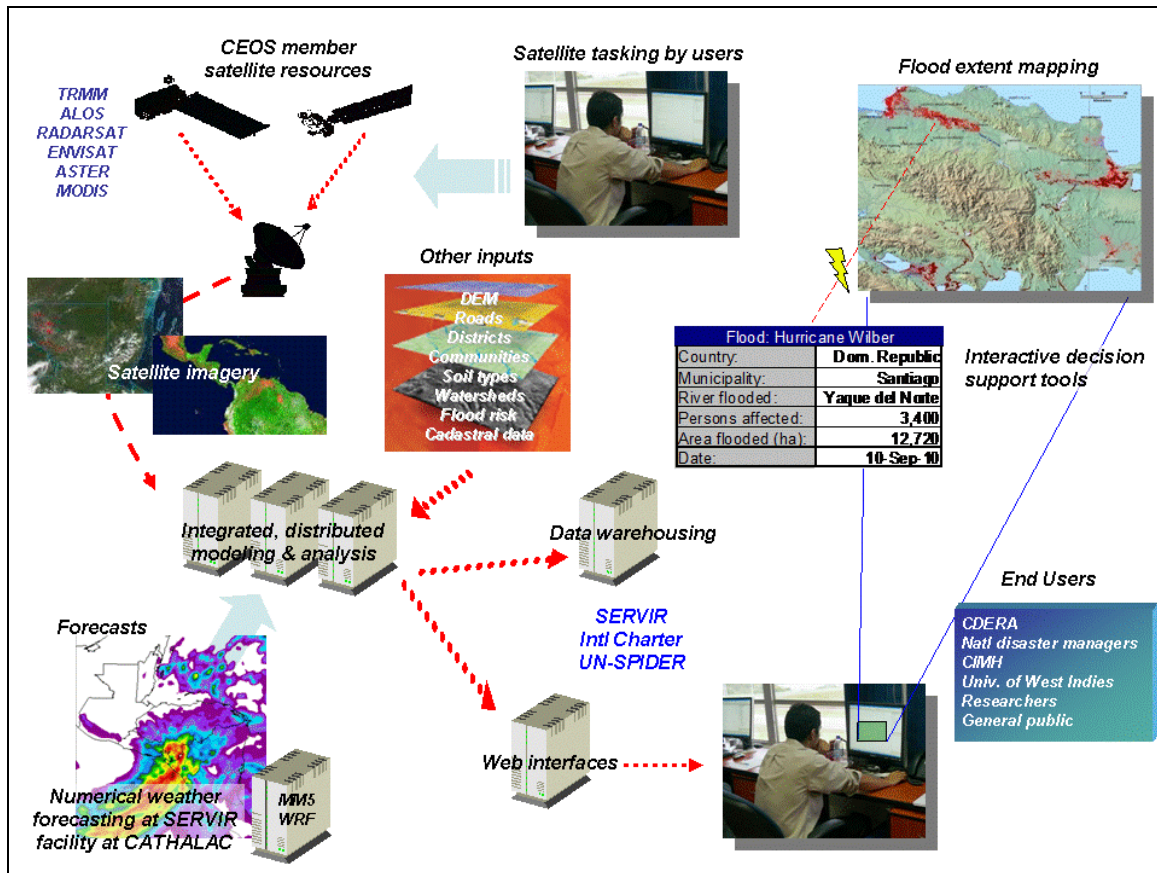


Figure 3: Architecture of Caribbean Flood Pilot

## 6 Description of Responding Organizations

### 6.1 CEOS and CEOS Disaster SBA Team

#### Committee on Earth Observation Satellites (CEOS)

The Committee on Earth Observation Satellites (CEOS) is an international coordinating mechanism charged with coordinating international civil spaceborne missions designed to observe and study planet Earth. CEOS is recognized as the major international forum for the coordination of Earth observation satellite programs and for interaction of these programs with users of satellite data worldwide.

CEOS consists of 26 Members (most of which are space agencies) and 20 Associates (associated national and international organizations)

The main goal of CEOS is to ensure that critical scientific questions relating to Earth observation and global change are covered and that satellite missions do not unnecessarily overlap each other.

Members of CEOS are actively involved in supporting global change/climate and environmental research and monitoring efforts of the international scientific community, as well as pursuing other uses of Earth observations data such as local/regional research, operational environmental monitoring, and commercial.

CEOS re-organized its contributions to GEO to ensure coordination within each Societal Benefit Area and the **CEOS Disaster SBA Team** was formed in November 2007. The Team coordinates all inputs to Disaster management (DI) tasks of GEO workplan and focuses on three main activities:

- Development of architecture to meet user needs;
- Technology demonstrations to increase user awareness; and
- Pilot projects development and support to demonstrate operational feasibility.

CEOS Disaster SBA Team will promote and support implementation of the Caribbean scenario under the Societal Benefit Area for Disaster Management as part of the GEOSS AIP and ensure contributions from space agencies towards this Pilot project.

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## 6.2 NASA Sensor Web/SERVIR Collaboration

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## 6.3 UNOOSA/UN-SPIDER

UNOOSA/UN-SPIDER - The United Nations General Assembly established in 2006 the "United Nations Platform for Space-based Information for Disaster Management and Emergency Response - UN-SPIDER" as a United Nations programme under the United Nations Office for Outer Space Affairs, with the following mission statement: "Ensure that all countries and international and regional organizations have access to and develop the capacity to use all types of space-based information to support the full disaster management cycle".



The UN-SPIDER programme is achieving this by focusing on being a gateway to space information for disaster management support, by serving as a bridge to connect the disaster management and space communities and by being a facilitator of capacity-building and institutional strengthening, in particular for developing countries. UN-SPIDER is being implemented as an open network of providers of space-based solutions to support disaster management activities.

As a collaborator on this study and potential promoter of a future operational version of the system, we will support in the definition of requirements and in providing an evaluation of the prototype products within the context of the programme activities of the United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER).

Furthermore UNOOSA is a Participating Organisation of GEO and co-chairs two GEO tasks including DI-06-09 which this proposal will support.

#### **6.4 CDERA**

CDERA is a regional inter-governmental agency established in September 1991 by an Agreement of the Conference of Heads of Government of CARICOM to be responsible for disaster management. There are presently sixteen Participating States within CDERA's membership.

CDERA's main function is to make an immediate and coordinated response to any disastrous event affecting any Participating State, once the state requests such assistance.

Other functions include:

- Securing, collating and channeling to interested governmental and non-governmental organizations, comprehensive and reliable information on disasters affecting the region;
- Mitigating or eliminating as far as possible, the consequences of disasters affecting Participating States.  
Establishing and maintaining on a sustainable basis, adequate disaster response capabilities among Participating States; and,
- Mobilizing and coordinating disaster relief from governmental and non-governmental organizations for affected Participating States.

#### ***CDERA Team members:***

<b>Name</b>	<b>Organization</b>	<b>Email</b>
Nicole Alleyne, POC	CDERA	nicole.alleyne@cdera.org
Roche Mahon	CDERA	roche.mahon@cdera.org

## 6.5 CATHALAC

Established in 1992, the Water Center for the Humid Tropics of Latin America and the Caribbean (CATHALAC, in Spanish) is a non-profit inter-governmental organization based in Panama which promotes sustainable development through applied research and development, education and technology transfer on water resources and the environment, in the humid tropical regions of Latin America and the Caribbean. Since 2004, CATHALAC has been hosting the Regional Visualization & Monitoring System (SERVIR), a virtual satellite-based platform for environmental monitoring and disaster response whose pilot implementation in Mesoamerica has been recognized as a regional model for the implementation of GEOSS. SERVIR is implemented jointly with NASA, USAID, and is also being expanded to Africa. In this context, since 2007, CATHALAC has served as a project manager for the International Charter on Space and Major Disasters, and is also a participating organization in the Group on Earth Observations.

### *CATHALAC Team members:*

Name	Organization	Email
Emil Cherrington	CATHALAC	emil.cherrington@cathalac.org

## 6.6 West Indies University

### *West Indies University Team members:*

Name	Organization	Email
Jacob Opadeyi, POC	University of West Indies	jopadeyi@hotmail.com
Maurice Mason	University of West Indies	Maurice.mason@uwimona.edu.jm

## 6.7 Caribbean URISA Chapter

The Caribbean Urban and Regional Information Systems Association (URISA) Chapter is a non-profit organization that provide members with a forum to share real experiences in implementing Geoinformatics/GIS technology in organizations, to present ones work, get constructive criticism, discuss concepts and ideas of how Geographical Information Systems (GIS) can make meaningful contribution to society in general and the Caribbean region in particular.

**Mission:** To promote partnerships and teamwork with users of GIS concepts and technology. This will be geared towards the sustainable development of the Caribbean region. Caribbean URISA would strive to be an organization relevant to the needs of GIS professionals in the region with a dynamic committed membership. This organization would also strive to be the leading medium of The Caribbean Geospatial Community providing

Geospatial professionals with opportunities for educational development, networking, leadership, coordination and representation.

- Goals:** The main objectives are to:
- i. be a GIS knowledge network across the Caribbean.
  - ii. provide a wealth of professional services for its members
  - iii. assist in the development of innovative professionals prepared for the future of GIS.
  - iv. promote the use of GIS and facilitate the expansion of GIS use within the region
  - v. influence government policy on the effective and efficient use of GIS in the region

#### **The Disaster Management Committee**

At the recent UNSPIDER regional workshop held in Barbados July 8-11, 2008, Geospatial professionals and disaster managers discussed how to use space technology to enhance disaster management. Following the workshop the Caribbean URISA Chapter has formed a technical group of GIS professionals who will assist regional disaster agencies with GIS processing and analysis following a disastrous event. This committee will also be charged with the responsibility of collaborating with CDERA, UNDP and other stakeholder organizations to move action items resulting from the meeting forward.

#### ***Caribbean URISA Chapter Team members:***

<b>Name</b>	<b>Organization</b>	<b>Email</b>
Valrie Grant-Harry	President of Caribbean URISA Chapter	valgharry@yahoo.com

### **6.8 Other participants**

<b>Name</b>	<b>Organization</b>	<b>Email</b>
Elizabeth Klute	Government of Anguilla, Director of Disaster Management	Elizabeth.Klute@gov.ai
Tricia-Anne Mclean	GIS Special Projects Manager, Spatial Data Management Division, Office of the Prime Minister	tnmclean@moa.gov.jm
Quinta Ana Pérez Sierra	Instituto Tecnológico de Las Américas, ITLA, Research Professor	qperez@itla.edu.do
Richard Teeuw	University of Portsmouth, UK, Senior Lecturer in the School of Earth & Environmental Sciences	Richard.Teeuw@port.ac.uk

Name	Organization	Email
Nikolai Thomas	Planning Analyst Office of Disaster Preparedness and Emergency Management	nthomas@odpem.org.jm

### **6.9 Collaborating Proposals**

Several organizations that are planning to respond to the AIP CFP with their own proposals expressed their willingness to collaborate with the Caribbean Flood Pilot initiative. Below is a short description of these initiatives. The Caribbean Flood Scenario Pilot Team is also eager to collaborate with organizations involved in the proposals listed below by sharing data, expertise and experience.

#### ***JAXA. Disaster Scenario with Catalogue Server (ALOS)***

JAXA will offer catalog services and on-line access (WMS) for JAXA Earth observation satellite data. The catalogue server and the WMS server will be registered for the GEOSS registry. Users can be provided the services via portal/GEOSS clearinghouse. The catalogue server will support CSW2.0. This enables an ISO19115 (19139) compliant view of the various collections (dataset series) of satellite data and also provides WMS 1.0.0 to show Earth Observation images.

#### ***NGMS. Disaster Response Scenario for Hurricane Victoria***

As part of a dual scenario Northrop Grumman Corporation (NGC) response, NGC Mission Systems (NGMS) is participating in GEOSS AIP Phase II by collaborating with other SBA working groups, developing a Disaster Response scenario with realistic features and events, and augmenting GEOSS Phase I capabilities with persistent data and product providers. By executing the Disaster Cycle depicted in the CFP for a hurricane and flooding scenario, that incorporates multiple user communities, we will demonstrate how communities of practice may be applied to extend information sharing in response to disasters. NGMS will collaborate with other scenario developers, especially the Pilot Project in the Caribbean.

NGMS will also integrate data and product providers into GEOSS as persistent exemplars to comprise the operational building blocks necessary for the system-of-systems GEOSS concept. In order to enhance the disaster response scenario depicted in the CFP, all phases of the Disaster Cycle are used to step through the events of a Category 4 hurricane strike on the Port of Houston; as well as, flooding events left in the wake of the storm.

#### ***Ukraine Space Research Institute and Columbia University, Sensor Web, for Global Flood Applications.***

The scenario will exploit up-to-date information technology and standards, in particular Sensor Web, for global flood applications.

The detailed possible scenario for the flood application could be as follows:

1) We operationally obtain forecasts of meteorological parameters (including precipitation) from Global Forecasting System (GFS) using the Sensor Observation Service (SOS). Under certain conditions, e.g. when precipitation exceeds some limit, we may consider the territories as potentially caused by flooding.

The output of the SOS service: locations of regions with high precipitations that could potentially result in flooding.

Other predictive data sources should be used for triggering the event such as IRI anomaly rain map and TRMM flash flood potential (using predicted rainfall as input).

There can be also alerts from local authorities or emergency organizations considering flood events.

2) After triggering the flood event, we use the Sensor Planning Services (SPSs) to request satellites to acquire images of the specific territory for flood assessment. In parallel, International Charter is activated by authorized parties (e.g. IFRC) to acquire necessary data. These data can be both optical and microwave. In particular, we can concentrate on the following:

- Radar (Envisat, ALOS)
- EO-1
- MODIS mapping world now for existing water and can provide water mask (250m)
- Daily rapid delivery of MODIS data (daily) overlaid with MODIS water mask to show flood extent
- Detect plant distress with microwave or spectral instrument as proxy to detect salty water inundation within 1-2 days (Proposed by City College, NY)

The output of this step: we acquire satellite data from different sources in order to produce flood and risk analysis maps.

3) The data acquired on previous steps are then processed using OGS's Web Processing Services (WPS) in order to produce necessary flood products.

4) Processed data are used to generate Web Map Service (WMS) and therefore Google's KML files. These data (precipitation, temp, etc estimations and satellite-derived products with flood maps) are overlaid and integrated through a Web interface (e.g. using OpenLayers and Google Earth).

## Annex A. Letters of Support from Participating Organizations

1. Letter of Support from CEOS Disaster SBA Team



August 27, 2008

Letter of Support from the **CEOS Disaster SBA Team**.

The GEOSS AIP presents a perfect opportunity to provide a demonstration for multi-hazard management in the Caribbean region with an emphasis on floods produced by tropical storms, using assets that have global reach provided through CEOS members and other participating organizations.

The CEOS Disaster SBA team was formed after the November 2007 CEOS plenary session. In its reformulation of its workplan to support the development of GEOSS, CEOS has identified an action, DI-06-09\_3, to promote the demonstration of the management of the all phases of a disaster. The Caribbean region was chosen to initiate a Pilot project to promote demonstration of the four phases of Flood Management.

The CEOS Disaster SBA team wishes to promote and support implementation of the Caribbean flood scenario under the Societal Benefit Area for Disaster Management as part of the GEOSS AIP.

The CEOS Disaster SBA Team presented its proposal at the UN-SPIDER workshop in Barbados, organized by the United Nations Office for Outer Space Affairs, the United Nations Development Programme (UNDP), the Caribbean Disaster Emergency Response Agency (CDERA) and the Department of Emergency Management of the Government of Barbados. The proposal was received with optimism and a list of participants interested in the Caribbean Flood project was identified. It is expected that a broad range of participants including CEOS member Space Agencies, UNOOSA/UN-SPIDER, SERVIR, CDERA, CATHALAC take part in this project.

The main source of space data is expected to come from the International Charter during disaster events. The CEOS Disaster Management SBA team will seek additional contribution from some CEOS members including JAXA, ESA, NASA, DLR and CSA to cover mitigation, warning and recovery phases of flood management.



Dr. Guy Seguin

CEOS Position: Coordinator, Disaster SBA Team

Organization: Canadian Space Agency

Position: Director, Earth Observation Projects

Email: [guy.seguin@space.gc.ca](mailto:guy.seguin@space.gc.ca)

Tel: (450) 926-4614

Address: 6767, route de l'Aéroport, Saint-Hubert (Québec) J3Y 8Y9

2. Letter of Support from NASA Sensor Web



September 1, 2008

TO: Stuart Frye/SGT

FROM: Earth Observing 1 Mission Manager

Re: Support for Architecture Implementation Pilot

I, Daniel J. Mandl, as Principal Investigator and EO-1 Mission Manager acknowledge on behalf of the NASA Sensor Web collaborative, that our collaborative effort is in full support of the proposed Flood Pilot in the Caribbean activity defined in the Response to the Call for Participation under the Global Earth Observation System of Systems (GEOSS) Architecture Implementation Pilot phase 2. Our collaborative team stands ready to support the Sensor Web activities defined in the proposal by providing access to satellite observations, derived data products, and model results using components and services that conform to the GEOSS Architecture. I have read the entire proposal and agree that it accurately describes our commitment to the proposed effort.

A handwritten signature in cursive script that reads "Daniel Mandl".

Daniel Mandl

NASA/GSFC

3. Letter of Support from United Nations Office for Outer Space Affairs



**UNITED NATIONS**  
**Office for Outer Space Affairs**

26 August 2008

**Support to Caribbean Flood Pilot Sensor Web**  
**GEO Architecture Implementation Pilot – Phase 2 (AIP-2)**

This letter is to confirm our support to the pilot project titled “**Caribbean Flood Pilot Sensor Web**” in response to the GEOSS AIP Call for Participation (CFP).

As detailed in the proposal, UNOOSA will through its United Nations Platform for Space-based Information for Disaster Management and Emergency Response (UN-SPIDER) stand ready to collaborate in the pilot project by ensuring access by end users to the capabilities developed by the project and by supporting assessment and evaluation activities as to the effectiveness of the Pilot in satisfying the needs of end users in developing countries.

We confirm that Dr. Jörg Szarzynski, Senior Expert of the UN-SPIDER Programme in Bonn, Germany will be the contact person and UN-SPIDER expert for this support. Tel: +49-228-815-0677, [joerg.szarzynski@unoosa.org](mailto:joerg.szarzynski@unoosa.org).

We fully support this proposal and we look forward to the successful outcome should this proposal be selected.

Yours sincerely,

A handwritten signature in black ink, appearing to read 'David Stevens'.

David Stevens  
Programme Coordinator  
UN-SPIDER  
Office for Outer Space Affairs



4. Letter of Support from CATHALAC



**Water Center for the Humid Tropics of Latin America & the Caribbean**  
Science, Education and Policy for People: Putting Knowledge into Practice

CA 645/08

**FROM:** Emil A. Cherrington, Senior Scientist, Division of Applied Research and Development,  
Water Center for the Humid Tropics of Latin America and the Caribbean (CATHALAC),  
Panama City, Panama

**TO:** Stuart Frye, Goddard Space Flight Center, U.S. National Aeronautics and Space  
Administration (NASA), Greenbelt, Maryland 20771

**RE: Statement of Commitment for Flood Pilot Project for the Caribbean**

I, Emil Alexander Cherrington, acknowledge on behalf of the Water Center for the Humid Tropics of Latin America and the Caribbean (CATHALAC) that our Center is in full support of the proposed effort to conduct a Flood pilot project in the Caribbean. In the context of the Regional Visualization & Monitoring System (SERVIR), which CATHALAC is jointly implementing with NASA, USAID and other partners, CATHALAC stands ready to collaborate in this pilot project. Specifically, CATHALAC will be making available the SERVIR infrastructure to support the various infrastructure needs of the project in the Caribbean and Mesoamerica region to deliver observational data from the NASA Sensor Web and CEOS satellites to the region's users. I intend to carry out all responsibilities identified for me in the proposal as technical point of contact within CATHALAC.

I have read the entire proposal and I agree that the proposal correctly describes my commitment to the proposed effort.

Signed this 22<sup>nd</sup> day of August, 2008:

**Emil A. Cherrington**



5. Letter of Support from West Indies University



**THE UNIVERSITY OF THE WEST INDIES**

ST. AUGUSTINE, TRINIDAD AND TOBAGO, WEST INDIES

FACULTY OF ENGINEERING

DEPARTMENT OF SURVEYING AND LAND INFORMATION

Telephone (868) 662 2002 ext 2108, 2109; Fax: (868) 663-7383

Web Site: <http://www.eng.uwi.tt> Email: [jacob.opadeyi@sta.uwi.edu](mailto:jacob.opadeyi@sta.uwi.edu)

August 21, 2008

**Flood Pilot Project in the Caribbean: Letter of Support**

I, Jacob Opadeyi, acknowledge that I support the proposed effort to conduct a Flood Pilot project in the Caribbean. The University of West Indies through the Department of Surveying and Land Information stands ready to collaborate in the pilot project by acting as knowledge integrator for the capabilities to be developed by the project and by supporting assessment and evaluation activities as to the effectiveness of the Pilot in satisfying Caribbean flooding disaster needs. I intend to carry out all responsibilities identified for me in the proposal as point of contact with the University. I will also ensure the incorporation of the knowledge gained into our undergraduate and post-graduate academic programmes.

I have read the entire proposal and I agree that the proposal correctly describes my commitment to the proposed investigation.

Yours sincerely,

Jacob Opadeyi, PhD  
Head, Department of Surveying and Land Information  
Email: [jopadeyi@hotmail.com](mailto:jopadeyi@hotmail.com)



6. Letter of Support from Caribbean URISA Charter



**CARIBBEAN URISA CHAPTER**

[www.urisacaribbean.org](http://www.urisacaribbean.org)

August 29, 2008

The Caribbean URISA Chapter offers our support to the initiative to conduct a Caribbean Flood Management Pilot Project and stands ready to collaborate on the pilot project by providing technical geospatial assistance where necessary through our Disaster Management Committee.

Recognizing that the Caribbean is increasingly beset by natural disasters and more so tropical storms and hurricanes, and that much of the population lives in coastal and low lying areas that are vulnerable to flooding, it is our conclusion that there is an immediate need for the development of flood hazard information so as to ensure that regional planning and risk management officials have access to the most accurate information so as to make more informed decisions. This information is also critical in assessing the social and economic impact of from flood related disastrous events.

The Caribbean URISA Chapter will support the project by providing image processing, geoprocessing, analysis and spatial modelling through the Disaster Management Committee.

I also agree to be the point of contact for the Caribbean URISA Chapter.

Sincerely,

A handwritten signature in blue ink, appearing to read 'V. Grant-Harry'.

Valrie Grant-Harry, GISP

President, Caribbean URISA Chapter