Agriculture/Disaster Societal Benefit Areas Scenario Engineering Report
GEOSS Architecture Implementation Pilot Phase 6

Version 0.5

Revision History

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Table of Contents

Agriculture/Disaster Societal Benefit Area Scenario

1. Introduction

1.1 Scope of this document

This document captures the demonstration work and scenarios in the combined Agricultural Societal Benefit Area (SBA) and Disaster SBA during GEOSS AIP Phase 6. In this phase, two disaster applications have been demonstrated. One is the remote-sensing-based flood crop loss assessment. Another is global drought monitoring based vegetation indices. The application portals are an aggregation or mashup of functions or Web services by reusing standard OGC-compliant Web services.

Both portals have been registered into the GEOSS Component and Service Registry (CSR) () hosted and maintained at the Center for Spatial Information Science and Systems, George Mason University. It is harvested by GEOSS Clearinghouse. These portals can be searched through GeoPortal.

1.2 GEOSS AIP

The GEOSS Architecture Implementation Pilot (AIP) task develops process and infrastructure components for the GCI and the broader GEOSS architecture as a means of coordinating cross-disciplinary interoperability deployment. The AIP Task provides phased delivery of components to GEOSS operations, with each phase consisting of: architecture refinement based on user interactions; component deployment and interoperability testing; and SBA-focused demonstrations. An international collaboration enabled the use of GeoLabel to better manage and visualize metadata and quality of service for the Global Agricultural Drought Web services.

This Engineering Report (ER) is a key result of the sixth phase of AIP. AIP-6 was conducted from May 2013 January 2014. A separate ER describes the overall process and results of AIP-6 and thereby provides a context for this Community SBA ER.

1.3 Summary of SBA development

This phase develops and enhances a Remote-Sensing-based flood crop assessment. With the monitor, the following are specific products to be produced routinely and operationally using time series satellite observations:

(1) Remote-sensing-based flood-induced crop loss assessment geospatial community portal

(2) Global agricultural drought monitoring

1.4 Future work

The following are to be explored in future phases:

(1) Crowd source is thriving in many sectors. It can be also helpful in growing ideas surround a community like crop condition and disaster monitoring. Added information channel from people report and information injection in field would help in validating and enhancing the accuracy of disaster assessment in timely fashion while providing decision support.

(2) Agricultural disaster generally affects a large area. It requires the handling of extremely large volume of data. Efficiency on large data handling is one of the performance areas to be studied. In the cloud or cyberinfrastructure environment, efficient balancing on transportation of data, information product, and/or workflows (programs/algorithms) may be examined to seek best timely performance.

2. Community SBA Objectives

Disasters affect all sectors. Agriculture is not immune to disasters. The damage to agriculture is often large scale. At different stages of a disaster, different type of information is expected. In pre-disaster, forecasting of imminent disasters and their likelihood would help in preparing for disasters. During disaster, distribution and degree of disaster damage are crucial for efficient allocating resources and providing needed aids in emergency response. After disaster, the recovery and related decision requires information about area and degree of damage and their sustaining effect.

In the phase, the community united together to focus on two scenarios: post-flood crop loss assessment and pre- and during drought agricultural drought monitoring. Earth Observations have been proved to be efficient technologies to monitor land cover and land use at large area. They are efficient in monitoring vegetation conditions (specifically crop monitoring for agriculture). The damage of crop due to disasters, like flooding and drought, can be estimated or monitored through monitoring their health indices derived from Earth Observations. Earth Observations used in the two scenarios are mainly observations and products from Moderate Resolution Imaging Spectroradiometer (MODIS). Moderate resolution allows the quick monitoring and mapping of disaster and their severity in a manageable time while accuracy and performance are desirable with current technology.

Community information sharing and exchange is important to collaborate around a specific task that require synergy from different fields. In modern Web environment with maturing cyberinfrastructure, geospatial processing and data have been migrating into online cyberinfrastructure. Interoperation between different components and services is required to maximize the information sharing and exchange in times of disasters, to make better and proper decision to mediate the damage of disasters. Open standard and specifications are the backbone to allow such open interoperation among different venders, facilities, and institutions. Well-recognized OGC geospatial specifications and ISO/TC 211 standards are selected to support such interoperations in this phase.

The following are questions and study themes facing agricultural/disaster communities. Therefore, they are deemed as the major focus of demonstration and collaboration during this phase.

(1) How to efficiently use open standards and specifications to enable the extensive interoperation in supporting decisions for pre-, during, and post-disaster planning, preparation, responding, and assessment?

(2) How to better enable discovery, access, and updating of metadata and quality of service to meet user requirements?

3. Scenario: Global Agricultural Drought Monitoring and Forecasting

3.1 Actors

The actors can be grouped into several groups.

Table 1. Actors for the Global Agricultural Drought Monitoring and Forecasting

Name	Description	Examples
Farmers	Producers of crops that may be affected by agricultural drought.	Corn farm, soybean farm, rice farm
Risk analyst	These are end users who need information on disasters like agricultural drought to determine risks and/or insurance policy in agricultural production.	Agricultural insurance policy risk analyst
Agricultural Drought Policy Maker	These are end users who need information on agricultural drought estimate to make macro policy to respond to agricultural drought at national level or even international level.	USDA, FAO
Integrated Desktop Client	These are software package or desktop application that connects to the agricultural drought information system/server through interoperable, standard interfaces and application programming interface.	ArcGIS, SAP, Quantum GIS, PYXIS
Business Logic Middleware	These are middleware or Web services that interact with the agricultural drought information system/server for accessing and retrieving information dynamically.	Agricultural Drought Planning Web services
Agricultural Drought	These are the modelers that produce the useful agricultural	Agricultural drought analyst, Agricultural drought forecaster,

Information Producer	drought information.	Meteorologist, Climatologist
Web Service and Server System Administrator	These are administrators who maintain the daily operation of the system.	Web administrator, Information Technology Help Desk
Earth Observation Data Provider	Producer of the raw Earth Observations and their derived products.	NASA, ESA

3.2 Context and pre-conditions

The use cases will show ability to produce agricultural drought information and risk warning with live feed from EEO data and how decision makers use the agricultural drought information and forecasting for preparation and planning to counter agricultural drought disasters and mitigate its damage.

A portal to aggregate agricultural drought information is developed and implemented. The portal is be based on Earth Observations. It also provide mechanism to support updating and reviewing Quality of Service. The following list the pre-conditions for the system to be running:

- **Earth Observation**: Earth observation is the base for the system to derive information in real-time or near-real-time. These EO data are primarily MODIS and its derived products including surface reflectance and vegetation index.
- **Vegetation Index**: This is a level 3 product from MODIS. It is the base to 8-day/16-day Vegetation Condition Index (VCI) and other indices.

The portal supports the collaboration with different agencies in the world. The following lists the aspects of collaboration.

- **Data sharing**: Geographically, EO data will be shared and used in the monitoring system.
- **Web Processing Services**: Agricultural drought indices, such as VCI and drought levels, are the basic indices derived from MODIS product - NDVI. The Web Processing Service to derive these indices and other crop monitoring models can be re-used by different regional systems to derive the intermediate products.
- **Portals**: Portals can be accessed worldwide. The crop monitoring results can be shared worldwide.

3.3 Scenario Events

Scenario events are listed in Table 2 that covers all the steps in deriving the agricultural drought and eventually arriving at the final decision on preparation for agricultural drought risks.

Table 2 – Steps in the Agriculture EO-based Crop Condition Monitor Scenario

Step	Description	Trans. Tech Use Case	Specialized Use Case
0	Set up and configure the Global Agricultural Drought Monitoring and Forecasting System (GADMFS). This involves configuration of data sources, especially those data sources from Earth Observations for real-time or near-real-time automatically triggering of processing processes.	A2. Access files (new)	
1	Search GEO-Portal for data resources, including MODIS Vegetation Index Products, and administrative boundaries	D1. Search for Resources (AIP-3 ER: 4)	
2	Download and access data discovered through GEO-Portal	A3. Access data via services (AIP-3 ER: 5&6)	
2.1	MODIFS 16-day NDVI data download	A2. Access files (new)	
2.3	Administrative boundaries WFS	A3. Access data via services (AIP-3 ER: 5&6)	
3	VCI WPS calculates the VCI on 16-day NDVI	W1. Execute Processing Service (AIP-3 ER: 11)	
4	Register 16-day VCI in GEOSS CSR	P1. Register Resources (AIP-3 ER: 1)	
5	VCI WPS calculates the drought risk level on 16-day VCI	W1. Execute Processing Service (AIP-3 ER: 11)	
5.1	Register bi-weekly agricultural drought product in GEOSS CSR	P1. Register Resources (AIP-3 ER: 1)	
5.2	Register GADMFS Portal GEOSS CSR	P1. Register Resources (AIP-3 ER: 1)	
7	Interactively discovery and access of selective information from the Portal	D5. Launch Enabler App (AIP-4)	SUC3 GADMFS Portal
7.1	VCI data access via WCS	A3. Access data via services (AIP-3 ER: 5&6)	
7.2	VCI data access via WMS	A1. Web Mapping	

		(new)	
7.3	Agricultural Drought level virtual WCS	A3. Access data via services (AIP-3 ER: 5&6)	
7.4	Agricultural drought level virtual WMS access	A1. Web Mapping (new)	
7.5	Visualizing data in preferred clients, such as Google Earth	D5. Launch Enabler App (AIP-4)	
8	Statistical summarization and graphic generation for user's interest dataset geospatially	D5. Launch Enabler App (AIP-4)	SUC3 GADMFS Portal

3.4 Post-Conditions

New MODIS NDVI data source will trigger the workflow to generate the intermediate VCI products and agricultural drought risk map. Mainly, the following products will be updated when new NDVI data are available.

(1) Daily vegetation critical index (VCI)

(2) Agricultural drought classification

3.5 Special Requirements

The scenario is a general one with decision making related to agricultural drought. All components and services are made available through standard geospatial Web services. This opens an array of opportunities and flexibilities for users to use their preferred tools and clients as long as the client software is standard-aware. User can choose their preferred tools. The decision on which tool to be used would be up to end users.

Data and services produced in the community are encouraged to be released in both WCS and WMS. In other words, release of data should be open. This may be difficult in some cases when the production units are not able to share the data in great details due to policy and privacy constraints. In such cases, aggregated data may be released and shared.

4. Scenario: Remote Sensing Based Flood Crop Loss Assessment

4.1 Actors

The actors can be grouped into several groups.

Table 3. Actors for the Earth Observation Based Crop Condition Monitor

Name	Description	Examples
Policy risk analyst	These are end users who need information on flood risk and their potential crop damage to determine insurance rating for given agricultural area.	Crop Insurer, Crop Insurance Policy Analyst
Agricultural	These are end users who need information on flood risk	USDA, USDA Risk Management

Insurance Policy Maker	and potential crop loss to make macro policy to guide agricultural insurance policy at state level or national level.	Agency
Integrated Desktop Client	These are software package or desktop application that connects to the agricultural information system/server through interoperable, standard interfaces and application programming interface.	ArcGIS, SAP, Quantum GIS, PYXIS
Business Logic Middleware	These are middleware or Web services that interact with the agricultural information system/server for accessing and retrieving information dynamically.	Flood Risk Assessment Web services
Crop Information Producer	These are the modelers that produce the useful crop information.	Crop modeler, Crop analyst, Statistician, Image Analyst
Web Service and Server System Administrator	These are administrators who maintain the daily operation of the system.	Web administrator, Information Technology Help Desk
Earth Observation Data Provider	Producer of the raw Earth Observations and their derived products.	NASA, ESA

4.2 Context and pre-conditions

The use cases will show ability to integrate multiple EO data and Social economic data for post-flood crop loss assessment to support decision making in flood risk management and crop insurance policy.

The Portal will be based on Earth Observations. The following list the pre-conditions for the system to be running:

- **Earth Observation**: Earth observation is the base for the system to derive information in real-time or near-real-time. The primary EO data are MODIS.
- **Surface Reflectance**: This is a level 3 product from the EO. It is the base to calculate daily NDVI, VCI, RMVCI, MVCI, and other indices.
- **Cropland Data Layer (CDL)**: These are accurate crop area maps. They may be derived from very high resolution satellite images, such as SPOT, AWiFS. They may also be based on survey.

The Portal demonstrate the aspects of collaboration.

- **Data sharing**: Geographically, EO data will be shared and used in the monitoring system.
- **Web Processing Services**: Vegetation indices, such as NDVI and VCI, are the basic indices derived from EO. The Web Processing Service to derive these indices and other crop monitoring models can be re-used by different regional systems to derive the intermediate products. Crop condition profiles are generated on-the-fly by crop condition profile generator WPS process.
- **Portals**: Portals can be accessed worldwide. The flood crop loss assessment decision support tool and their results can be shared worldwide.

4.3 Scenario Events

Scenario events are listed in Table 4 that covers all the steps in deriving the crop condition evaluation and eventually arriving at the final evaluation of flood-induced crop loss.

Table 4 – Steps in the Agriculture EO-based Crop Condition Monitor Scenario

Step	Description	Trans. Tech Use Case	Specialized Use Case
0	Set up and configure the Remote-sensing-based flood crop loss assessment (RF-CLASS) system. This involves configuration of data sources, especially those data sources from Earth Observations for real-time or near-real-time automatically triggering of processing processes. Gather CDL and other basic information once a year.	A2. Access files (new)	
1	Search GEO-Portal for data resources, including MODIS Surface Reflectance Products, CDL, and administrative boundaries	D1. Search for Resources (AIP-3 ER: 4)	
2	Download and access data discovered through GEO-Portal	A3. Access data via services (AIP-3 ER: 5&6)	
2.1	MODIS Surface Reflectance data download	A2. Access files (new)	
2.2	CropScape CDL data discovery	A3. Access data via services (AIP-3 ER: 5&6)	SUC1 CropScape Portal
2.3	Administrative boundaries and agricultural statistical districts (ASD) WFS	A3. Access data via services (AIP-3 ER: 5&6)	
3	NDVI WPS processes the EO surface reflectance data and calculate daily NDVI.	W1. Execute Processing Service (AIP-3 ER: 11)	
3.1	Register Daily NDVI in GEOSS CSR	P1. Register Resources (AIP-3 ER: 1)	
3.2	Register Weekly NDVI in GEOSS CSR	P1. Register Resources (AIP-3 ER: 1)	
3.3	Register Bi-Weekly NDVI in GEOSS CSR	P1. Register Resources (AIP-3 ER: 1)	
4	Maximum value composite WPS to calculate weekly and/or bi-weekly NDVI from daily NDVI.	W1. Execute Processing Service (AIP-3 ER: 11)	
5	VCI WPS calculates the VCI on daily, weekly, and bi-weekly NDVI	W1. Execute Processing Service (AIP-3 ER: 11)	

5.1	Register weekly VCI in GEOSS CSR	P1. Register Resources (AIP-3 ER: 1)	
5.2	Register bi-weekly VCI in GEOSS CSR	P1. Register Resources (AIP-3 ER: 1)	
6	Register RF-CLASS Portal GEOSS CSR	P1. Register Resources (AIP-3 ER: 1)	
7	Interactively discovery and access of selective information from the Portal	D5. Launch Enabler App (AIP-4)	SUC5 RF-CLASS Portal
7.1	Crop condition data access via WCS	A3. Access data via services (AIP-3 ER: 5&6)	
7.2	Crop condition data access via WMS	A1. Web Mapping (new)	
7.3	Change ratio to previous year virtual WCS	A3. Access data via services (AIP-3 ER: 5&6)	
7.4	Change ratio to previous year virtual WMS access	A1. Web Mapping (new)	
7.5	Change ratio to median of previous years virtual WCS	A3. Access data via services (AIP-3 ER: 5&6)	
7.6	Change ratio to median of previous years virtual WMS	A1. Web Mapping (new)	
7.7	Change ratio between any two year on-demand WCS	A3. Access data via services (AIP-3 ER: 5&6)	
7.8	Change ratio between any two year on-demand WMS	A1. Web Mapping (new)	
7.9	Cop condition profile generation on-demand WCS	A3. Access data via services (AIP-3 ER: 5&6)	
7.9	Visualizing data in preferred clients, such as Google Earth	D5. Launch Enabler App (AIP-4)	

8	Statistical summarization and graphic generation for user's interest dataset geospatially	D5. Launch Enabler App (AIP-4)	SUC5 RF-CLASS Portal
9	Time series on-demand analysis and visualization and flood crop loss summary	A1. Web Mapping (new)	

4.4 Post-Conditions

New EO data source will trigger the workflow to generate the intermediate products. Mainly, the following products will be updated when new EO data are available.

(1) Daily Normalized Difference Vegetation Index (NDVI)

(2) Daily vegetation critical index (VCI)

(3) Crop condition profiles

(4) Flood coverage

4.5 Special Requirements

The scenario is a general one with decision making related to flood –induced crop loss assessment. Flood coverage is made available through the collaboration with the Dartmouth Flood Observatory.

5. System Model of the Scenario

5.1 Context Diagram

Disasters happen to every sector. Agricultural sector is not immune to disasters. In this phase, two representative agriculturally-related disasters, drought and flooding, have been chosen to demonstrate the use of GEOSS resources to help in decision making. Figure 1 shows the generic context diagram of using EO data and their product in different disaster preparation, prevention, and mediation use cases.

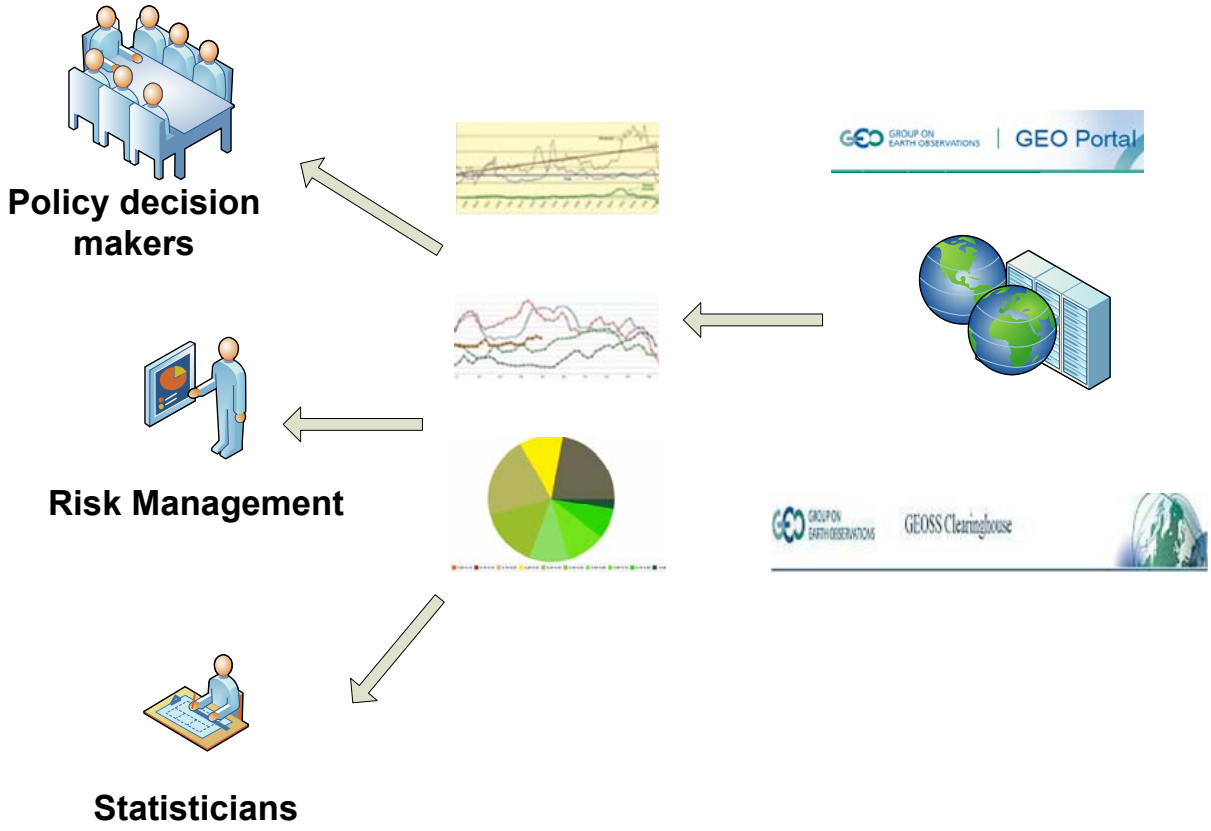

Figure 1. Agricultural Infomration requirements from policy difdecision-makers, risk analysts, and statsiticsions

5.2 Enterprise Specification Diagram

To enable geospatial production and services for disaster respondents and decisions makers in dealing with agricultural disasters in need of crop condition and agricultural drought information, the community should extensively use satellite based Earth Observations for achieving timely response, open geospatial standards for achieving seamless integration, and Web service-oriented computing for reaching users with short latency. Figure 2 shows the overall architecture that uses Earth Observations in combination with open geospatial standards in serving crop condition and progress information.

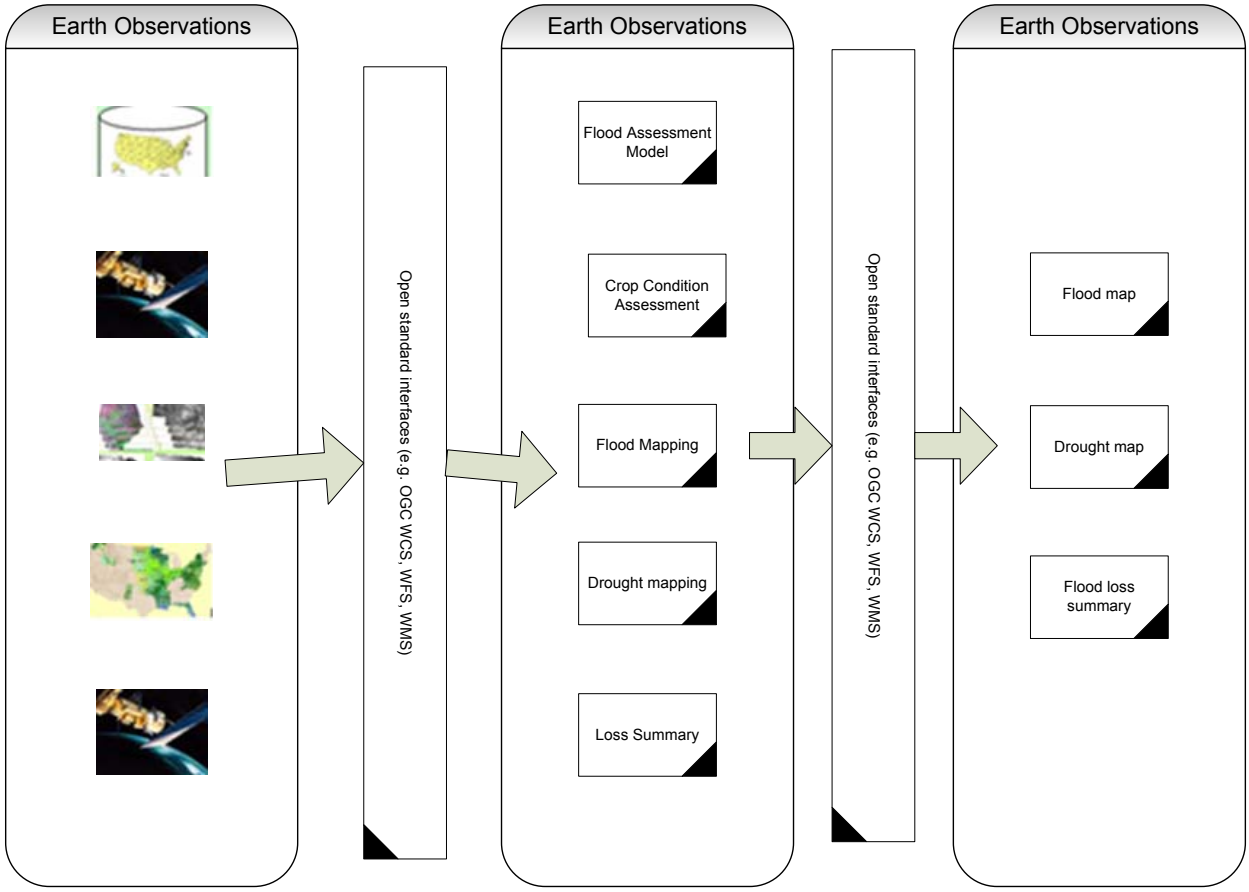

Figure 2. Agricultural Disaster Decision Support System Enterprise Architecture

5.3 Enterprise Activity Diagrams

Users of crop condition can be decision makers in insurance policy makers, risk analysts, and agricultural statisticians. Figure 3 shows activities that consume crop condition and agricultural drought information.

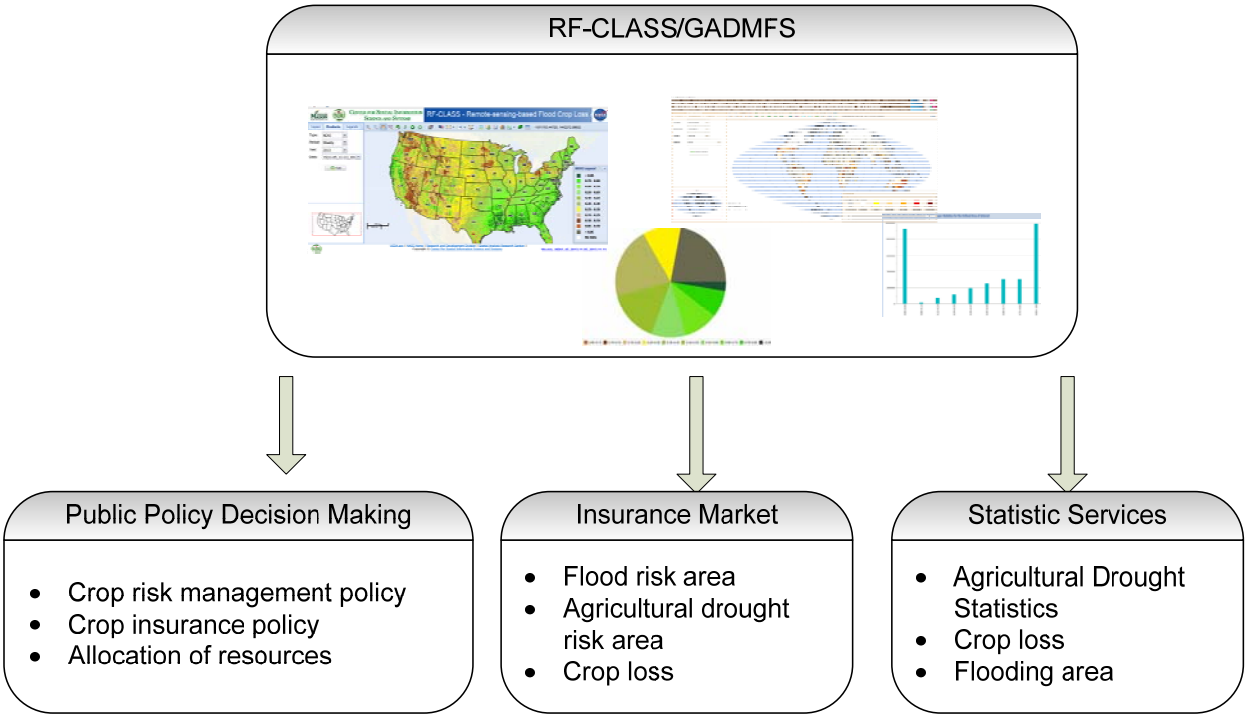

Figure 3. Activities related to agricultural drought and flooding

5.4 Information View

Earth Observations are used in achieving timely and accurately monitoring crop conditions at a large scale. The most useful Earth observations for the large scale crop progress and production monitoring are moderate resolution satellite observations, considering the tradeoff of spatial resolution and processing time. Therefore, MODIS, Landsat, SPOT , AWiFS, or the like, are used to derive different products for evaluating and representing crop conditions.

Intermediate data products and crop condition data products have been computed and served through standard geospatial Web services. The data products served through the systems are as follows.

(1) NDVI and VCI data derived from MODIS via GMU WMS and GMU WCS.
(2) Agricultural statistic district (ASD) and administrative boundaries (state and county) served through GMU/NASS WFS.
(3) Copland Data Layer (CDL) of major crops in the US served through GMU/NASS WMS and GMU/NASS WCS.
(4) Global agricultural drought maps based on MODIS via GMU WMS and GMU WCS.
(5) Flood map of Contiguous US

5.5 Computational View

The overall system design is based service oriented architecture constructed on standard geospatial Web services, mostly following OGC geospatial specifications. Open geospatial specifications have been proved to be very useful in achieving interoperation and scalability. Data services can be harmonized as OGC Web Coverage Service (WFS), Web Feature Service (WFS), and Sensor Observation Service (SOS). Processing services can be enabled and encapsulated in OGC Web Processing Service (WPS). Presentation and dissemination can be enabled with OGC data services and Web Map Service (WMS).

In this phase, the following standard data services are made available and accessible to GEOSS community.

(1) GMU WCS
(2) GMU WMS
(3) GMU/NASS WCS
(4) GMU/NASS WMS

6. Use Cases

6.1 AIP Engineering Use Cases

The GEOSS AIP Architecture approach supports the several SBA communities with a reusable process of SBA Scenarios and Engineering Use Cases.[1] Scenarios are implemented by use cases. Use cases describe reusable functionality of the GEOSS service oriented architecture implemented through Interoperability Arrangements.

A summary of GEOSS AIP Use Cases is shown in Figure 4 with details provided in the following tables. In addition to the actors shown in Figure 4 the GEOSS Actors involved in GEOSS use cases are listed in Table 5.

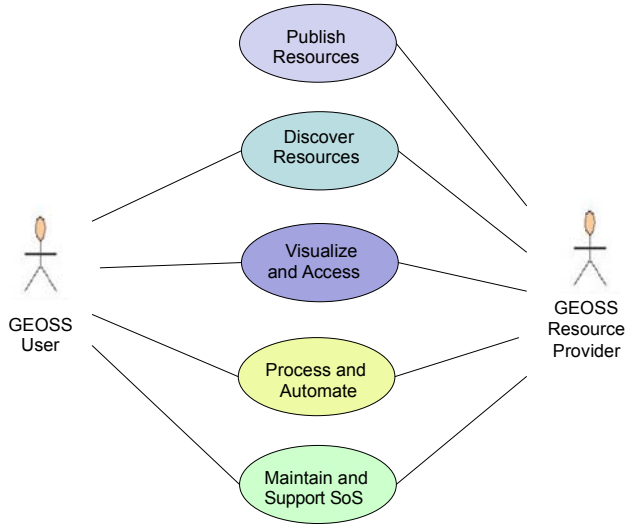

Figure 4 – GEOSS AIP Use Case Summary Diagram

Table 5 – GEOSS Actors

Actor	Description	Role Type
GEOSS User	Discovers, consumes, and exploits GEOSS resources	Principal
GEOSS Resource Provider	Deploys, operates, registers GEOSS resources	Principal
SBA Integrator	Builds network of organizations and components to achieve objectives on an SBA community	Secondary
GCI Operator	Operates GCI components and approves registrations	Administrative

[1] For details, see "AIP Development Process," http://earthobservations.org/documents/cfp/201202_geoss_cfp_aip5_development_process.pdf

Table 6 – Publish Resources Use Cases

Name	Description	Actors (may be optional)
P1. **Register Resources** (AIP-3 ER: 1)	Register resources in GEOSS Components and Services Registry (CSR) or Community Catalog	• GEOSS Resource Provider • SBA Integrator – optional • GCI Operator – optional
P2. **Deploy a Service** (AIP-3 ER: 2)	Deploy services for use in GEOSS.	• GEOSS Resource Provider • SBA Integrator – optional
P3. **Test a Service** (AIP-3 ER: 09)	Service Provider tests its deployed service using a proper Test tool discovered in the GEOSS CSR.	• GEOSS Resource Provider • SBA Integrator – optional
P4. **Develop SBA network** (AIP-3 ER: 14)	Identify resources in particular services relevant to an SBA. Promote concerted use on a larger-scale	• SBA Integrator • GEOSS Resource Provider

Table 7 – Discover Resources Use Cases

Name	Description	Actors (may be optional)
D1. **Search for Resources** (AIP-3 ER: 4)	Search for resources of interest. Variations: user initiated (e.g. GWP), process initiated, searching data sharing conditions.	• GEOSS User
D2. **Aggregate Metadata**[2] (AIP-3 ER: 3)	Harvesting and/or query metadata from community catalogs or services via GEOSS Clearinghouse	• GEOSS Resource Provider • SBA Integrator • GCI Operator
D3. **Conduct semantic search** (AIP-3 ER: 13)	Utilize mediated vocabularies to extend GEOSS search queries across disparate domains or communities.	• GEOSS User
D4. **Semantic mapping** (AIP-3 ER: 12)	Register, mediate, and map between disparate vocabularies used to describe GEOS resources.	• SBA Integrator • GEOSS Resource Provider • GCI Operator
D5. **Launch Enabler App** (AIP-4)	Associated with resources discovered in GCI are enabler applications, e.g., clients. User launches help application including context from previous search.	• GEOSS User

[2] See also the Catalogue Use Case in "OGC Engineering Report: Water Information Services Concept Development Study," OGC Document 11-013r6, 2011-07-012.

Table 8 –Visualize and Access Use Cases

Name	Description	Actors (may be optional)
A1. **Web Mapping** (new)	Access web maps services and display a composite map to the user. Allow user to modify map layers. Variation: include use of portrayal service	• GEOSS User
A2. **Access files** (new)	Retrieve a file from an access server using FTP. Variations include: user-initiated, process-initiated.	• GEOSS User if user initiated.
A3. **Access data via services** (AIP-3 ER: 5&6)	Access data from using a service that allows for user selection of data returned based on content. Variation: use of Access Broker	• GEOSS User if user initiated
A4. **User Authentication** (new)	User login with single sign-on (SSO). May used with Use Cases: A2, A3, W1. Variations: user-initiated, process-initiated.	• GEOSS User
A5. **Access with Acknowledgement** (new)	May used with Use Cases: A2, A3, W1. Variations: user-initiated, process-initiated.	• GEOSS User
A6. **Exploit Data** (AIP-3 ER: 7)	Exploit - visually and analytically- in Client Applications using information retrieved through access use cases.	• GEOSS User

Table 9 – Process and Automate Use Cases

Use Case	Description	Actors
W1. **Execute Processing Service** (AIP-3 ER: 11)	Invoke a processing service, to produce new derivative data resources. Variations: user-initiated, process-initiated	• GEOSS User
W2. **Construct and Deploy Workflow** (AIP-3 ER: 8)	Design, deploy and execute a workflow. Described in Business Execution Language (BPEL) or any other script language.	• SBA Integrator • GEOSS User
W3. **Process with Waiver or License** (new)	Use metadata containing information about the waiver or license to handle aggregation of data, derived data, re-use of data, and layered data.	• GEOSS User if user initiated

Table 10 – Maintain and Support Use Cases

Use Case	Title	Actors
M1. **Register Interoperability Arrangements** (AIP-3 ER: 10)	Register Interoperability Arrangements in the GEOSS SIR	• GEOSS Resource Provider • SBA Integrator • GCI Operator
M2. **Share Best Practices** (AIP-3 ER: 15)	Create a Best Practice relevant to GEOSS in the GEOSS BP Wiki	• GEOSS User • GEOSS Resource Provider • SBA Integrator • GCI Operator
M3. **Monitor Services** (AIP-3 ER: 10)	Services registered with GEOSS are routinely monitored for network connectivity and application response.	• GCI Operator
M4. **User Registration** (new)	User information is provided to a centralized authentication server to support single sign-on (SSO) with GEOSS providers.	• GEOSS User • GCI Operator
M5. **Metrics Management** (new)	GEOSS data provider, or GCI, gathers access and use metrics and stores information for reporting to the GCI. Variations: reports pushed, reports available for query	• GEOSS User • GEOSS Resource Provider • GCI Operator

6.2 Specialized Use Cases

6.2.1 SUC1 Using CropScape Cropland Data Layer

This use case describes the conditions and steps for visually and interactively exploiting Cropland Data Layer served through CropScape – an online portal.

Overview	
Title	Using CropScape Cropland Data Layer
Description	This use case describes the conditions and steps for visually and interactively exploiting Cropland Data Layer through the online portal CropScape as used within GEOSS. This is relevant to general use case Exploit Data (AIP 3. ER: 7).
Actors and Interfaces	# GEOSS User # GEOSS GEO-Portal # GEOSS Components and Services Registry (CSR) #GEOSS Providers #CropScape – the portal
Initial Status and Preconditions	# GEOSS User searched “CropScape” through GEOSS GEO-Portal and identified the link to CropScape # CropScape Web site was located and opened in browsers (tested for Internet Explorer 8/9 and FireFox 10/11/12) # Google Earth was installed on user’s computer.
Basic Flow	
Step 1: In browser, user opens CropScape found through GEO-Portal.	

Step 2: Use radiate choice to select Cropland Data Layer by year. Step 3: Use toolbar to select area of interest by state, county, ASD or hand-drawn area of interest. Step 4: Use toolbar to activate the download menu to retrieve data through WCS. Optional Step 4.1 View data in Google Earth by accessing WMS. Step 5: Use toolbar to enable the tool to statistically summarize and analyze data by different crop and aggregation unit areas.
Post Condition
GEOSS Users have Cropland Data Layer for them to further analysis in their preferred client software # GEOSS Users have rendered map of Cropland Data Layer # GEOSS user can optionally publish and register their processed data as GEOSS resources in the CSR and share them across the community

6.2.2 SUC2 Using DEM Explorer

This use case describes the conditions and steps for visually and interactively DEM served through DEM Explorer – an online portal.

Overview	
Title	Using DEM Explorer
Description	This use case describes the conditions and steps for visually and interactively exploiting Cropland Data Layer through the online portal CropScape as used within GEOSS. This is relevant to general use case Exploit Data (AIP 3. ER: 7).
Actors and Interfaces	# GEOSS User # GEOSS GEO-Portal # GEOSS Components and Services Registry (CSR) #GEOSS Providers #DEM Explorer – the portal
Initial Status and Preconditions	# GEOSS User searched "DEM Explorer" through GEOSS GEO-Portal and identified the link to DEM Explorer # DEM Explorer Web site was located and opened in browsers (tested for Internet Explorer 8/9 and FireFox 10/11/12) # Google Earth was installed on user's computer.
Basic Flow	
Step 1: In browser, user opens CropScape found through GEO-Portal. Step 2 : Define the interested area using specifying location name by clicking  or  , dragging rectangle or polygon by clicking  or  , or inputing coordinates by clicking  . Step 3 : Click  , specify data name, projection, format, etc, then submit the request of data customization. Step 4 : Download  the output data (except ASTER DEM *), or perform DEM analysis like contours  , aspect  , slope  etc. Optional Step 4.1 View data in Google Earth by accessing WMS.	

Post Condition
GEOSS Users have DEM data of their choice for them to further analysis in their preferred client software # GEOSS Users have rendered map of DEM # GEOSS user can optionally publish and register their processed data as GEOSS resources in the CSR and share them across the community

6.2.3 SUC3 Using GADMFS Global Agricultural Drought Monitoring and Forecasting System

This use case describes the conditions and steps for visually and interactively exploiting agricultural drought data served through Global Agricultural Drought Monitoring and Forecasting System (GADMFS) – an online portal.

Overview	
Title	Using Global Agricultural Drought Monitoring and Forecasting System (GADMFS)
Description	This use case describes the conditions and steps for visually and interactively exploiting agricultural drought data through the online portal Global Agricultural Drought Monitoring and Forecasting System (GADMFS) as used within GEOSS. This is relevant to general use case Exploit Data (AIP 3. ER: 7).
Actors and Interfaces	# GEOSS User # GEOSS GEO-Portal # GEOSS Components and Services Registry (CSR) #GEOSS Providers #GADMFS – the portal
Initial Status and Preconditions	# GEOSS User searched "GADMFS" or "Global Agricultural Drought Monitoring and Forecasting System" through GEOSS GEO-Portal and identified the link to GADMFS # GADMFS Web site was located and opened in browsers (tested for Internet Explorer 8/9 and FireFox 10/11/12) # Google Earth was installed on user's computer.
Basic Flow	
Step 1: In browser, user opens GADMFS found through GEO-Portal. Step 2: Use drop selection combo to select data type and year. Step 3: Use toolbar to select area of interest by state, county, or hand-drawn area of interest. Step 4: Use toolbar to activate the download menu to retrieve data through WCS. Optional Step 4.1 View data in Google Earth by accessing WMS.	
Post Condition	
# GEOSS Users have chosen agricultural drought data for them to further analysis in their preferred client software # GEOSS Users have rendered agricultural drought map # GEOSS user can optionally publish and register their processed data as GEOSS resources in the CSR and share them across the community	

6.2.4 SUC4 VegScape Crop Condition Explorer

This use case describes the conditions and steps for visually and interactively exploiting crop condition data served through VegScape – an online portal.

Overview	
Title	Using VegScape Crop Condition Explorer
Description	This use case describes the conditions and steps for visually and interactively exploiting crop condition through the online portal VegScape as used within GEOSS. This is relevant to general use case Exploit Data (AIP 3. ER: 7).
Actors and Interfaces	# GEOSS User # GEOSS GEO-Portal # GEOSS Components and Services Registry (CSR) #GEOSS Providers #VegScape – the portal
Initial Status and Preconditions	# GEOSS User searched "VegScape" through GEOSS GEO-Portal and identified the link to VegScape # VegScape Web site was located and opened in browsers (tested for Internet Explorer 8/9 and FireFox 10/11/12) # Google Earth was installed on user's computer.
Basic Flow	
Step 1: In browser, user opens VegScape found through GEO-Portal. Step 2: Use drop-down selection lists to select vegetation condition or related products by year. Step 3: Use toolbar to select area of interest by state, county, ASD or hand-drawn area of interest. Step 4: Use toolbar to activate the download menu to retrieve data through WCS. Optional Step 4.1 View data in Google Earth by accessing WMS. Step 5: Use toolbar to enable the tool to statistically summarize and analyze data by different crop and aggregation unit areas.	
Post Condition	
# GEOSS Users have crop condition data for them to further analysis in their preferred client software # GEOSS Users have rendered crop condition map # GEOSS user can optionally publish and register their processed data as GEOSS resources in the CSR and share them across the community	

6.2.5 SUC5 RF-CLASS Portal

This use case describes the conditions and steps for visually and interactively conducting flood crop loss assessment through RF-CLASS – an online portal.

Overview	
Title	Using RF-CLASS Flood Crop Loss Assessment Portal
Description	This use case describes the conditions and steps for visually and interactively exploiting flood crop assessment related tools and data through the online portal RF-CLASS as used within GEOSS. This is relevant to general use case Exploit Data (AIP 3. ER: 7).
Actors and Interfaces	# GEOSS User # GEOSS GEO-Portal # GEOSS Components and Services Registry (CSR) #GEOSS Providers #RF-CLASS – the portal
Initial Status and Preconditions	# GEOSS User searched "RF-CLASS" through GEOSS GEO-Portal and identified the link to RF-CLASS # RF-CLASS Web site was located and opened in browsers (tested for Internet Explorer 10/11 and FireFox 10/11/12) # Google Earth was installed on user's computer.
Basic Flow	
Step 1: In browser, user opens RF-CLASS found through GEO-Portal. Step 2: Use drop-down selection lists to select vegetation condition or related products by year. Step 3: Use toolbar to select area of interest by state, county, ASD or hand-drawn area of interest. Step 4: Use toolbar to activate the download menu to retrieve data through WCS. Optional Step 4.1 View data in Google Earth by accessing WMS. Step 5: Use toolbar to enable the tool to statistically summarize and analyze data by different crop and aggregation unit areas.	
Post Condition	
# GEOSS Users have crop condition data for them to further analysis in their preferred client software # GEOSS Users have rendered crop condition map # GEOSS user can optionally publish and register their processed data as GEOSS resources in the CSR and share them across the community	

7. Implementation

7.1 Deployed Components

In the designed crop condition monitor system, users can have choices of different clients to access and visualize the data and information served through geospatial Web services. Figure 5 shows the possible connections, activities, and clients. Users can access data through aggregated portals - GAMDFS and RF-CLASS. Users can derive maps, summary tables, or graphs from on-demand mapping, processing, and analyzing processes.

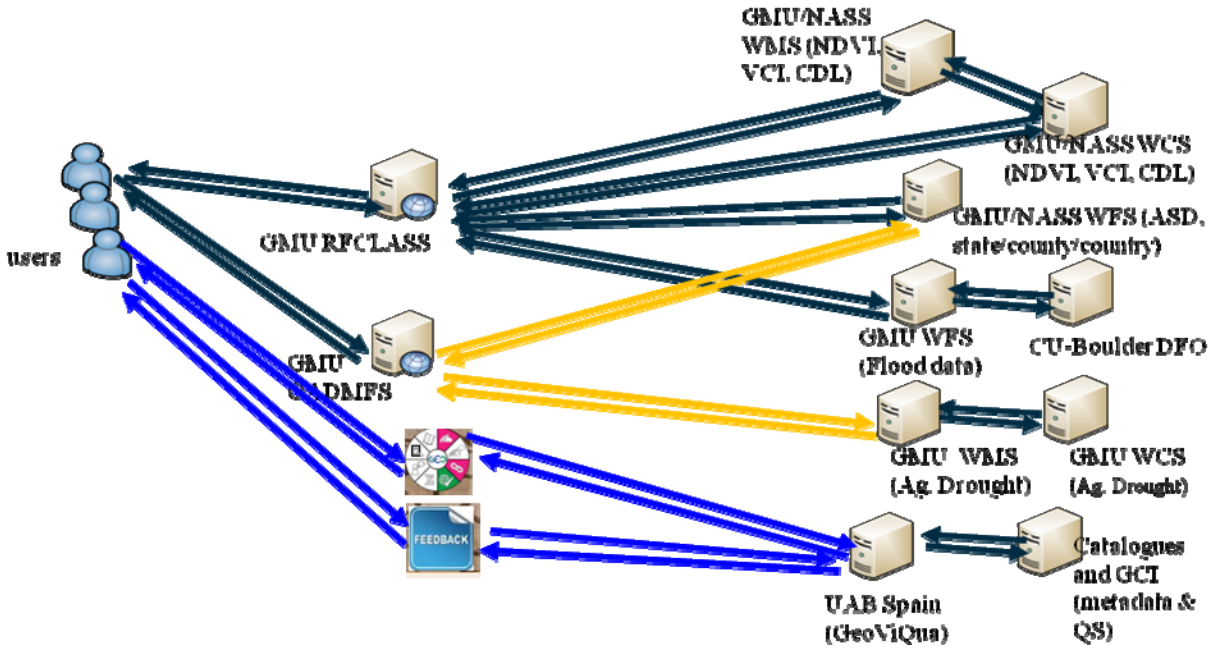

Figure 5. Wiring Diagram

The following are deployed and registered components:

(1) GMU WCS for 16-day global agricultural drought maps since 2001.

(2) GMU WCS for rendering 16-day drought maps since 2001.

(3) RF-CLASS Flood Portal

(4) Global Agricultural Drought Monitoring and Forecasting

7.2 Interoperability Arrangements

The following specifications were followed in implementing and deploying data and Web processing services:

(1) OGC WCS 1.0[1]

(2) OGC WCS 1.1.1[2]

(3) OGC WMS 1.0[3]

(4) OGC WMS 1.1.1[4]

(5) OGC WPS 1.0[5]

(6) OGC WFS 1.0[6]

(7) OGC WFS 1.1.0[7]

7.3 Use of the GCI

GEOSS Component and Service Registry (http://geossregistries.info/) was used to register all deployed components, services, and data. GEO Portal (http://www.geoportal.org) was used to find components and services during the demonstration.

7.4 Demonstrations

Using of deployed component services and data was demonstrated in two scenarios: remote sensing based flood-induced crop loss assessment and global agricultural drought monitoring. One use case is also included to demonstrate metadata and Quality of Service for allowing the discovery, access, and visualizing of agricultural drought information. The demonstration videos are available through the following links –

(1) Long version (roughly 7 minutes before credits) is at http://dss.csiss.gmu.edu/demo/geoss_aip6_2014-short/geoss_aip6_2014-short.html and the direct link to download the MP4 file is at http://dss.csiss.gmu.edu/demo/geoss_aip6_2014-v5/geoss_aip6_2014-v5.mp4.

(2) Short version (roughly 2:20minutes before credits) is at http://dss.csiss.gmu.edu/demo/geoss_aip6_2014-short/geoss_aip6_2014-short.html and the direct link to download the MP4 file is at http://dss.csiss.gmu.edu/demo/geoss_aip6_2014-short/geoss_aip6_2014-short.mp4.

7.5 Future plans for deployment

In next phase of AIP, the agricultural and disaster SBA community expects to continue on expanding the coverage of other cases beyond drought and flooding. The following are possible enhancements:

(1) Extending the adoption of updated Web service specifications, such as WCS 2.0[8] and WFS 2.0[9].

(2) Flood crop loss assessment with extension to work globally.

8. References

[1] J. D. Evans, "Web Coverage Service (WCS), Version 1.0.0," Open Geospatial Consortium Inc., Wayland, MA, USA, OpenGIS® Implementation Specification OGC 03-065r6, Aug. 2003.

[2] J. D. Evans, "Web Coverage Service (WCS) Implementation Specification," Open Geospatial Consortium Inc., Wayland, MA, USA, OpenGIS® Implementation Specification OGC 07-067r2, Jul. 2007.

[3] OGC, "OpenGIS® Web Map Server Interface Implementation Specification," Open Geospatial Consortium Inc., Wayland, MA, USA, OpenGIS® Implementation Specification OGC 00-028, Apr. 2000.

[4] J. de La Beaujardière, "Web Map Service Implementation Specification," Open Geospatial Consortium Inc., Wayland, MA, USA, OpenGIS® Implementation Specification OGC 01-068r3, Jan. 2002.

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[6] P. A. Vretanos, "Web Feature Service Implementation Specification," Open Geospatial Consortium Inc., Wayland, MA, USA, OpenGIS® Implementation Specification OGC 02-058, May 2002.

[7] P. A. Vretanos, "Web Feature Service Implementation Specification," Open Geospatial Consortium Inc., Wayland, MA, USA, OpenGIS® Implementation Specification OGC 04-094, May 2005.

[8] P. Baumann, "OGC® WCS 2.0 Interface Standard - Core," Open Geospatial Consortium Inc., Wayland, MA, USA, OpenGIS® Interface Standard OGC 09-110r3, Oct. 2010.

[9] P. (Peter) A. Vretanos, "OpenGIS Web Feature Service 2.0 Interface Standard," Open Geospatial Consortium Inc., Wayland, MA, USA, OpenGIS® Interface Standard OGC 09-025r1, Nov. 2010.