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These are Dublin Core metadata elements. See for more details and examples http://www.dublincore.org/

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ACRONYMS AND ABBREVIATIONS

Abbreviation	Name
AOC	Advanced Operating Capacity
APAAT	African Protected Areas Assessment Tool
APM	Area Production Model
CEN	European Committee for Standardization
CHE	Ebro River Basin Authority
CIFOR	Center for International Forestry Research
CNIG	Centro Nacional de Información Geográfica
CSW	Catalog Service for the Web
DCMSEE	Center for drought management in Southeastern Europe
DOPA	Digital Observatory of Protected Areas
EDO	European Drought Observatory
EFDAC	European Forest Data Centre
EFFIS	European Forest Fire Information System
EFICP	European Forest Information and Communication Platform
ENM	Ecological Niche Model
EU	European Union
FAO	Food and Agriculture Organization
FGUA	Fundacion General de la Universidad de Alcala
FP7	Seventh Framework Programme
GBIF	Global Biodiversity Information Facility
GEO	Group on Earth Observations
GeoRM	Geo Rights Management
GeoRSS	Geospatially-enabled RSS and Atom feeds
GEOSS	Global Earth Observation System of Systems
GMES	Global Monitoring for Environment and Security
GSCB	Ground Segment Coordination Body
IBA	Important Bird Area
IDEE	Spanish Spatial Data Infrastructure, Infraestructura de Datos Espaciales de España
INSPIRE	Infrastructure for Spatial Information in Europe
IOC	Initial Operating Capacity
IR	Implementing Rules
IUCN	International Union for Conservation of Nature

ISO	International Organization for Standardization
JRC	Joint Research Centre
LUCC	Land Use and Cover Change
MARM	Ministerio de Medio ambiente Y Medio Rural Y Marino
MCPFE	Ministerial Conference on the Protection of Forests in Europe
MS	Member State
NDVI	Normalize Difference Vegetative Index
NFI	National Forest Inventory
NGO	Non-Governmental Organization
NSDI	National Spatial Data Infrastructure
O&M	Observation and Measurement
OFAC	Observatory for the Forests of Central Africa
OGC	Open Geospatial Consortium
OSE	Observatorio de la Sostenibilidad en España
OWS	OGC Web Services
RSPB	Royal Society for the Protection of Birds
SAIH	Automated Hydrology Information System
SEIS	Shared Environmental Information System
SIA	Integrated Water Information System of Spain
TREES	United Nations Environment Programme
ULBF	University of Ljubljana Biotechnical Faculty
UNEP	United Nations Environment Programme
WBDB	World Biodiversity DataBase
WCMC	World Conservation Monitoring Centre
WCS	Web Coverage Service
WCS-T	Web Coverage Service, Transactional
WDPA	World Database on Protected Areas
WFS	Web Feature Service
WFS-T	Web Feature Service, Transactional
WMS	Web Map Service
WPS	Web Processing Service
WP	Work Package

1 INTRODUCTION

The goal of WP2 (Santoro et al., 2010) is to enable multidisciplinary interoperability between the three thematic areas (WPs 3-5). Figure 1 gives an overview of the starting points (rounded boxes), tasks (light blue/grey) and dependencies to other work packages (dark blue/grey).

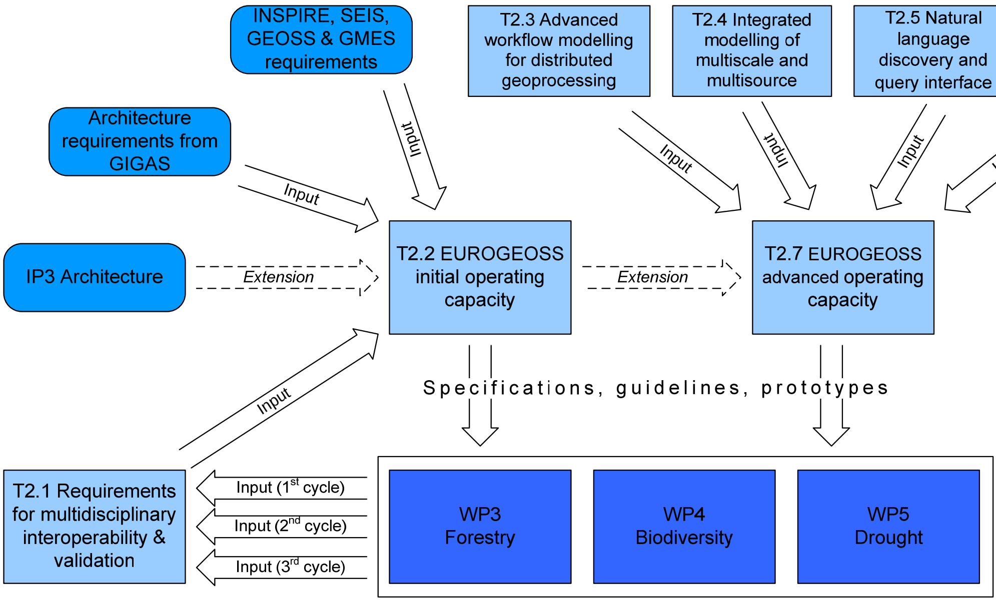

Figure 1. Overview of WP 2

As illustrated in Figure 1, in order to collect and address the requirements for multidisciplinary interoperability and validation, WP2 provides different tasks. One of these tasks as we can see in Figure 1 is T2.6 which deals with research about the integration of Web 2.0 resources and alternative search mechanisms to enrich EuroGEOSS scenarios. This document analyses and summarized the first outcomes from the EuroGEOSS WP2 regarding this task.

2 SCOPE

This document describes the research tasks being carried out within the task 2.6 included in WP2 of the EuroGEOSS project. We describe this task split into two blocks. Each of these blocks addresses one issue relevant to the discovery of geospatial resources.

1. Discovery and integration of Web 2.0 resources
2. Assisted content publication for improving geospatial resource discovery.

These two blocks are described in the remaining sections of the document. First, in section 3 we address the availability of a big amount of resources available through Web 2.0 services and we propose mechanisms to discover and integrate them into Geospatial Infrastructures being used in the EuroGEOSS project, always taking into account the interaction with the EuroGEOSS discovery broker. We present a collection of Web 2.0 services providing geographical contents, and analyses whether they are a feasible as new geodata sources in an integrated scenario. We introduce the OpenSearch interface and its 'geo' extension, and presents some OpenSearch-enabled components developed by UJI: A collection of Web 2.0 connectors and a web client component that supports OpenSearch. Details on how these components interact with the EuroGEOSS discovery broker are also shown. Finally, the 'semantic' OpenSearch extension is proposed as a method to enhance searches with EuroGEOSS thesauri.

Section 4 covers a mechanism for assisted content publication. We address the publication of geospatial content in Geospatial Infrastructures. In this block we propose a mechanism to assist EuroGEOSS users to integrate and publish content in their infrastructures to maintain them up to date. With this mechanism we pretend to improve discovery of resources by improving the provision and availability of content through standard services already registered in EuroGEOSS.

The main focus of this document is to provide advanced discovery and publication functionalities required to implement the Advanced Operating Capacity (AOC). Proposed AOC ideas in sections 3 and 4 connect when possible to other components and ideas exposed in previous documents developed by other partners within WP2.

3 DISCOVERY AND INTEGRATION OF WEB 2.0 RESOURCES

With the emergence of Web 2.0, ordinary citizens have begun to produce and share Geographic Information (GI) on the Internet. These Web 2.0-based geospatial activities show that users are willing to engage more actively in the production and provision of contents. This gives rise to a new phenomenon, which has been variously named 'neogeography' (Turner 2006), 'cybercartography' (Tulloch 2007), or 'voluntary geographic information (VGI)' (Goodchild 2007).

The aim of this section is to analyze those web services offering volunteered geographic content (usually as tagged resources with a geographic reference such as a city name, place name, and country), and analyze which ones can be considered in the EuroGEOSS project in particular to become potential data sources by the discovery broker component. We describe how Web 2.0 content can be searched and potentially integrated in a Spatial Data Infrastructure (SDI). From now on, in this document, we use the term 'Web 2.0 services' to refer to the user-generated content services.

The rest of this section is organized as follows. First, SDI and Web 2.0 service features are briefly compared, identifying their respective strengths and weaknesses, and which of them are worth keeping when constructing an integrated scenario. A group of Web 2.0 services is also analyzed using some indicators to evaluate if they are suitable as data sources for an SDI. Second, the OpenSearch specification is proposed as the common interface that provides search and retrieval functionality. We describe the implementation of a generic OpenSearch client which is used to access to several Web 2.0 services, providing integration to some extent. The retrieval of resources is closely related with the document "User-Driven Requirements for Resource annotation" (see References), since the same taxonomy should be used to annotate and search resources. Finally, we describe the implementation of a brokering engine to extend the EuroGEOSS Broker to access these Web 2.0 services.

3.1 SDI vs. Web 2.0

The data contained in an SDI is usually produced and maintained by official providers like scientific or government institutions that guarantees data quality and completeness. Such providers also register metadata descriptions of data and resources in standard catalogue services. In this way, common tasks of SDI users like data search, discovery and evaluation for a particular purpose are performed against these catalogue services, since they contain metadata descriptions that should point to the resource itself or the data service serving it.

Web 2.0 services are meant to be easily accessible, via specific web sites or APIs to integrate them in different applications. The Web 2.0 service contents are mainly user generated and are being continuously updated by non experts. There is then a lack of authoritative indicators regarding completeness, accuracy, or even veracity of data, but in the other hand it can be easily rated, improved and updated by users. Due to the easy deployment and publication mechanisms the rate of participation is high and then resources are also quite up-to-date. In contrast, SDI publication mechanisms are still complex and users do not have the knowledge to publish easily new content.

An SDI is built on services implementing OGC standard interfaces. OGC provides interoperable and open, consensus-based interfaces and specifications promoted by industry and academia. Interoperability is reached by applying the same standard to the different components deployed in the infrastructure to be used in as many use cases as possible, at the cost of certain abstraction level and format complexity. The use of OGC standard is beneficial in terms of integration and interoperability, though, these can be rather complex when compared to the Web 2.0 services, which are built upon simple application-level protocols (the so-called APIs) and lightweight data formats.

Web 2.0 services rely on simplicity, ease of implementation and fast adaptation to user’s needs. Open standards are used where they serve the keep-it-simple principle (not reinventing the wheel). Each service has to offer some differential functionality over its competitors, so each one provides its own public API. But some common functionality (search interface, geographic content data types) could benefit from simple standards as OpenSearch, GeoRSS, GeoJSON or KML, thus increasing interoperability to some extent.

SDI and Web 2.0 also have common features: Both worlds use open interfaces and formats, in the sense that they are publicly documented and freely implementable. They are part of the web, relying mainly on the HTTP protocol. And both use XML-based formats extensively.

Three concepts are key in this context: interoperability, simplicity and openness. OGC is focused on interoperability, and the Web 2.0 on simplicity. Both worlds use and produce open standards and interfaces. When simplicity and interoperability meet, integration arises. For example, WMS is a simple OGC standard, widely known and used in web mapping mashups, and KML is an interoperable format adopted by OGC.

3.2 Web 2.0 services overview analysis

This section describes the analysis methodology to assess the list of candidate Web 2.0 services as potential geospatial sources in the realm of EuroGEOSS. First, we introduce the criteria used in our analysis, to describe then each of the initial set of Web 2.0 service considered. Finally we discuss the final selection.

3.2.1 Criteria

Popular Web 2.0 services that give access to geographic content without using OGC standards have been analyzed. To doing so, the following list of criteria and indicators have been defined to study and evaluate whether they are suitable as additional SDI data sources:

- Web service name.
- Data nature: What kind of data is it?
- API documentation: Is API documented? Where?
- Data license terms: Can contents be reused in other applications?
- Rate restrictions: Is there a limited number of requests per user?
- Retrieved content: Are query results exhaustive and repeatable?
- Full text search: Can results be searched by any textual content?

- Geographic filtering (especially BBOX, as agreed in last meeting).
- Time filtering.
- Libraries: Is there a java library or API wrapper?
- Scoring: Are data elements rated?
- Request protocols.
- Response formats.

The existence of a well documented, stable API to access the data is essential. Other legal or technical restrictions and constraints have to be studied as well.

Full text search and basic BBOX geographic filtering is the desirable minimum requirement to restrict content to a certain topic or area and allow for specific use scenarios. Time filtering can be used for analyzing historical data, and for real-time and emergency management applications, where the most updated data is necessary.

Data results can be ranked automatically by the search engine supported by the service, or results can be scored based on user's voting. Some APIs allow for alphabetical sorting, paged results, or can limit the maximum response items. All these issues should be taken into account in our analysis.

3.2.2 Candidate Web 2.0 services

The goal of this analysis is to evaluate the relevance and feasibility of existing Web 2.0 services in order to be used as new data sources to be integrated in EuroGEOSS scenarios. Table 1 lists the nine web 2.0 services considered initially in our analysis.

Service Name	Available content type
Twitter	short texts
Google Search API	Vector data (KML format)
Panoramio	Multimedia content (photographs)
Picasa	Multimedia content (photographs)
Flickr	Multimedia content (photographs)
OpenStreetMap	Vector data (OSM format)
Wikimapia	Text (place names & descriptions)
Geonames	Text (place names)
Geocommons	Raster and vector data (maps)

Table 1 Web 2.0 services analized

Following is a brief discussion on these services, in particular we discuss about their features regarding content discovery. A more detailed discussion and a summarizing table can be found in annex I.

Twitter

Twitter has recently added geotagging. It has some format inconsistencies (inverse coordinate ordering in GeoJSON), and lacks usual geographic filtering (BBOX parameter not present), but can be used despite these limitations.

Google Services

Services owned by Google (Google Search API, Panoramio and Picasa), cannot be used because of license restrictions: geographic data can only be presented over Google Maps technology. Wikimapia service, despite of its name, is not open at all, lacking an API to access the geographic data directly. Thus these services have been discarded in the further interoperability scenarios.

Flickr

Flickr provides a mature and solid API with all the required functionality.

OpenStreetMap

OpenStreetMap has many APIs, each one offering some of the needed functionality. Integrated use could be very powerful, but is not straightforward. We have used the Nominating API for integration experiments, as it was designed for simple and effective placename searches.

Geonames

Geonames provides a wide collection of simple search services (up to 34). For further experimentation we have considered two of them: The one that provides access to the core Geonames database, and one that allows for searches across the Wikipedia geo-referenced articles.

Geocommons

Geocommons service offers the standard OpenSearch-geo interface natively, so it will be used “as is”.

After our analysis (as discussed in Annex I), the selected set of Web 2.0 services has been the following: Twitter, Flickr, OpenStreetMap, Geonames and Geocommons. In the next section we explain how these services can be integrated with traditional SDI resources.

3.3 Integration of Web 2.0 resources into classical SDIs

Every Web 2.0 service publishes its own API, so clients have to deal with each API because each one is slightly different: specific request parameters, response formats, etc.

In our architecture, we propose to expose a simple common query interface and common response formats for all Web 2.0 services, which provides interoperability across the services, increased data accessibility, and makes much easier client implementations. Therefore we have developed an adapter for each service, converting requests from the common format to the concrete syntax of each API specification. Similarly, the response from every service is serialized into the common format and forwards it to the client as a unique response. To some extent, this set of adapters play the same role of a broker or mediator.

Figure 2 illustrates the data flow and interfaces used in an integrated scenario. The adapters act as a mediator between client applications and the Web 2.0 services in the backend. All adapters expose a common query interface to communicate with client applications, which could be for instance lightweight clients or the EuroGEOSS discovery broker. In the latter case, all of the Web 2.0 services can be consumed also by EuroGEOSS clients.

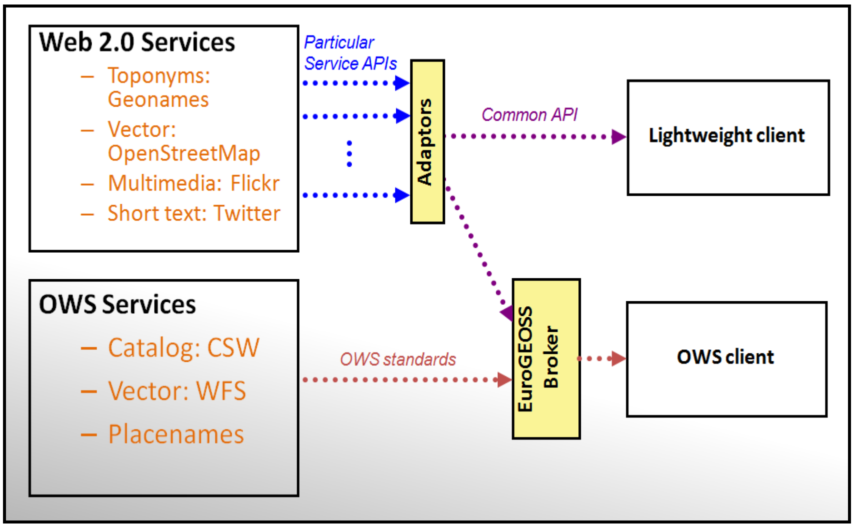

Figure 2 Use of a common interface (purple) to connect Web 2.0 services and SDI resources

3.4 Web 2.0 Broker component: Opensearch as integration protocol

As we mentioned Web 2.0 services offer different functionality and provide their own public API. In our approach we look for a mechanism to access common functionality (search interface, geographic content data type) by experimenting with simple standards as OpenSearch, GeoRSS, GeoJSON or KML.

OpenSearch (Gonçalves 2010; Clinton, 2010) and its geo extension (Turner et al. 2010) is proposed as the minimal query interface that can be used to access geographic content, both for Web 2.0 services and for SDI services. In this sense, OpenSearch becomes the "common query interface" mentioned in Figure 2. This would allow for easy client implementations that could search and integrate all data sources regardless of their origin. In addition, the use of the OpenSearch as a common interface to access to all of the Web 2.0 services alleviates greatly the integration with the discovery broker. This approach implies the development of OpenSearch adapters for each Web 2.0 service. The Web 2.0 broker encompasses all the adapters for the selected services for the integration scenario, which would be: Twitter, Flickr, OpenStreetMap and Geonames. Geocommons already supports natively an OpenSearch interface. The rest of this section is centred on the design and implementation details of the OpenSearch web client functionality and the Web 2.0 adapters.

3.4.1 Functionality

The OpenSearch specification defines a minimal interface to query a search engine (service provider, etc.) over the web. Only one parameter (*{searchTerms}*) is mandatory. The remaining parameters (*{count}*, *{startIndex}*, *{startPage}*) are optional and allow for paged results. Response data formats are not limited by the standard, but usually are bound to common web and syndication data formats: Atom, RSS, HTML or JSON.

OpenSearch is extensible by adding extra parameters that define other filtering criteria. Such extensions include the 'time' extension (see References), with *{start}* and *{end}* parameters, the semantic extension (see References), and the 'geo' extension (see References). The latter allows for multiple location filters: bounding box, circle, polygon and placename. OGC is contemplating other parameters as WKT geometry, geometric operation and unique identifier (Gonçalves 2010).

OpenSearch-geo extension provides a radically simple search interface that can be used as a convenient way to access a wide range of geographic information repositories. These repositories may range from official and scientific resources, such as the EuroGEOSS discovery broker and SDI catalogs, to VGI-oriented services related with citizen and mass market information.

To the best of our knowledge, there was no reference implementation of a general-purpose, ‘geo’ client that could be used to perform tests. Therefore a generic client based on OpenLayers is being developed. At the time of writing, the client uses only two core parameters: *{searchTerms}* (text for keywords) and *{box}* (bounding box), and understands four response formats. This core functionality covers the wide majority of use cases. Figure 3 shows common data formats for the OpenSearch (in black) and also the ‘geo’ formats for the ‘geo’ extension (in red).

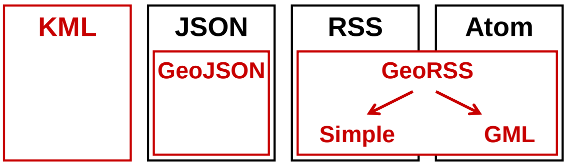

Figure 3. The four ‘geo’ response formats read by OS web client

3.4.2 Architecture

From a component perspective, the OpenSearch Web client component can be integrated in any web mapping client (for instance OpenLayers), enabling it with multiple OpenSearch connections (see Figure 4).

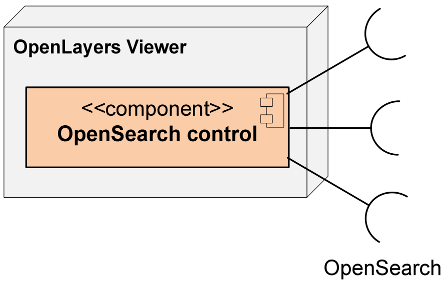

Figure 4. The OpenSearch Web client component

In order for the client to be tested we need to find OpenSearch-enabled service providers. There are few known public OpenSearch-geo services: Geocommons and GENESI-DR. Geonetwork support few OpenSearch capabilities, but it has been recently patched to support some ‘geo’ parameters. Besides these, the GI-Cat and EuroGEOSS discovery broker (developed by CNR) also offer support for OpenSearch interface. Figure 5 shows these three service providers. It is worthwhile to note that the OpenSearch support for Geonetwork has been partially added by UJI (orange colour denotes development made by UJI). These improvements are available in the lastest stable release, 2.6.0.

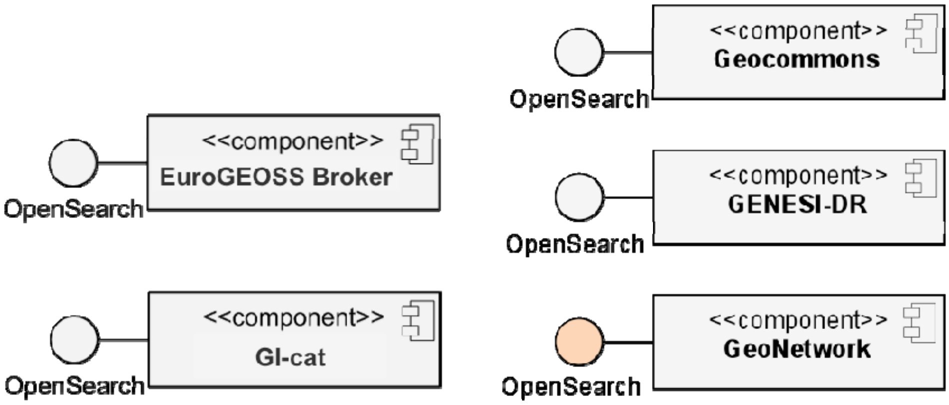

Figure 5. Existing native OpenSearch-geo services

The current OpenSearch capabilities supported by these service providers are the following:

- Geocommons:
  - HTML, Atom, KML and JSON (not GeoJSON) response formats.
  - Text search and bounding box filtering.
  - Support paged results.
- GENESI-DR:
  - HTML, Atom, KML, and XML/RDF response formats.
  - Text, bbox, unique id, and time filtering.
  - Support paged results.
- GeoNetwork (2.6.0):
  - HTML and GeoRSS response formats.
  - Text, placename, bbox and geometry filtering.
- •GI-cat and EuroGEOSS discovery Broker
  - HTML, Atom, KML, and XML/RDF response formats.
  - Text, bbox, unique id, and time filtering.
  - Support paged results.

Rather than exposing a multitude of particular APIs, many Web 2.0 services would benefit from OpenSearch capabilities, so that they offer a standard, common search interface. To demonstrate this, we have developed a collection of OpenSearch-geo interface adapters (or proxies) for the selected Web 2.0 services (see section 3.2). Figure 6 shows the adapters developed (in orange) for each Web 2.0 service.

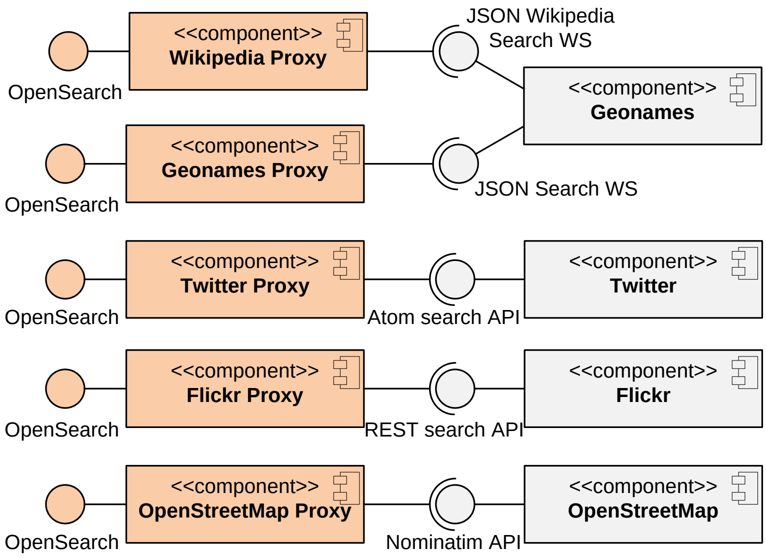

Figure 6. Web 2.0 APIs and developed OpenSearch proxies

Table 2 lists of the adapters developed so far and their capabilities. Table 3 lists the URLs to the service description documents published so far. All these URLs are publicly available for testing by other EuroGEOSS partners, and especially for the Brokering component.

Web 2.0 Service	Features
Wikipedia	through Geonames JSON Wikipedia Search Web Service: • KML and Atom response formats. • Text search. • Configurable number of results.
Geonames	through JSON Search Web Service: • KML and Atom response formats. • Text search. • Paged results.
Twitter	through search API: • KML and Atom response formats. • Text search. • Paged results. • Geographic filtering by centre & radius.
Flickr	through REST search API: • KML and Atom response formats. • Text search. • Geographic bbox filtering. • Geographic filtering by center & radius.

		• Paged results.
OpenStreetMap	through *nominatim* API:	• KML and Atom response formats. • Text search. • Geographic bbox filtering.

Table 2. OpenSearch capabilities supported by all the OpenSearch adapters

Service name	Description document URL
Geocommons	**http://core.geocommons.com/opensearch.xml**
GENESI-DR	**http://dr-site.esrin.esa.int/genesi/envisat_meris/mer_rr__1p/description/**
Wikipedia	**http://geoportal.dlsi.uji.es/OpenSearch/services/wikipedia/opensearch.xml**
Geonames	**http://geoportal.dlsi.uji.es/OpenSearch/services/geonames/opensearch.xml**
Twitter	**http://geoportal.dlsi.uji.es/OpenSearch/services/twitter/opensearch.xml**
Flickr	**http://geoportal.dlsi.uji.es/OpenSearch/services/flickr/opensearch.xml**
OpenStreetMap	**http://geoportal.dlsi.uji.es/OpenSearch/services/osm/opensearch.xml**
EuroGEOSS discovery broker	**http://217.108.210.73/broker/services/opensearch?getDescriptionDocument**

Table 3. URLs to OpenSearch-geo service descriptions (native and proxies).

3.4.3 Design

From the design perspective, we build on top of existing functionally to create new components, that is, exploiting the reusability principle. In particular, the OpenSearch web client benefits from existing OpenLayers classes. The client contains only three classes which in turn extend from the OpenLayers base classes. Figure 7 shows a UML class diagram where blue boxes represents OpenLayers base classes, and red ones are extensions.

The aim of these extended classes is:

- The `OpenLayers.Format.OpenSearchDescription` class reads the service description document, and chooses automatically the better response format that will be used.
- The `OpenLayers.Strategy.OpenSearch` is the controller class. It updates the request parameters, constructs the query URLs, fires the appropriate network events, and adds the response geometries to a vector layer. There is one independent 'strategy' controlling each search engine. But one layer can have many strategies, so results from different origins can be rendered in the same layer.
- The `OpenLayers.Control.OpenSearch` class controls the user interface and events, and orchestrates (activates/deactivates) the different strategies.

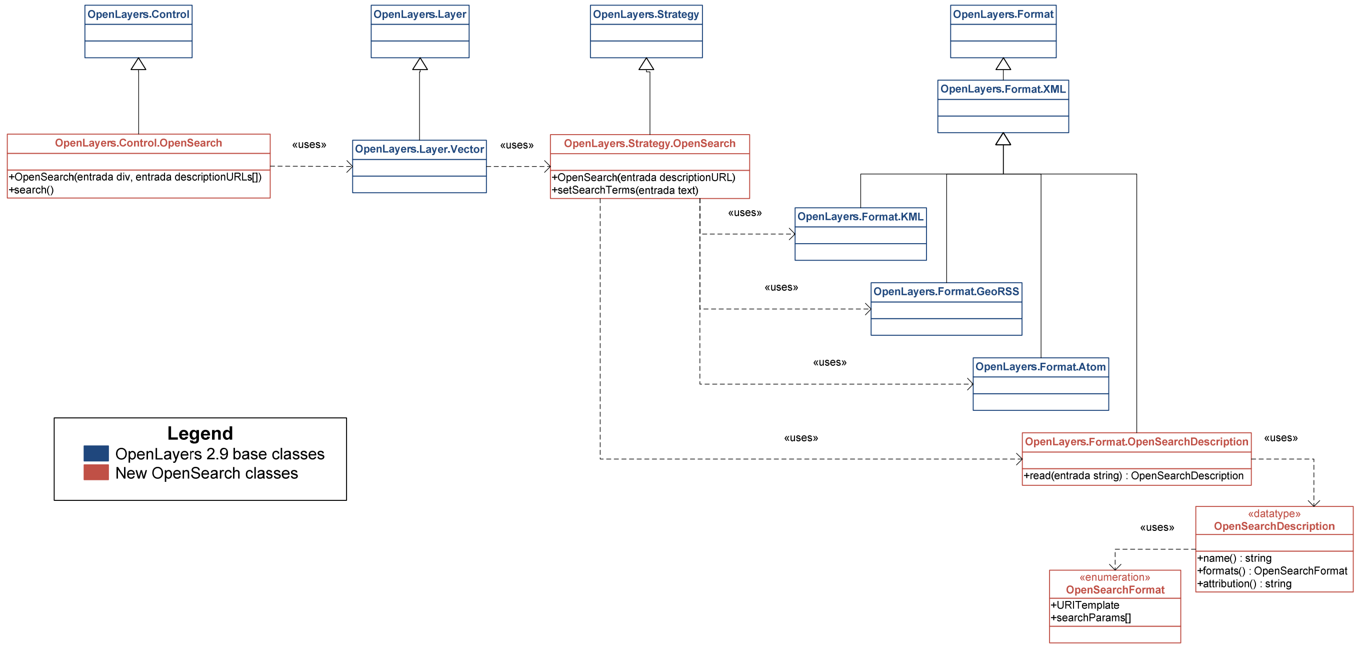

Figure 7. OpenSearch client class diagram.

These three classes are open source and can be downloaded from a sandbox in the OpenLayers SVN repository at (http://svn.openlayers.org/sandbox/oscar.fonts/opensearch/). Even, one can setup a working local copy just by adding these three classes to the 2.9 branch in OpenLayers.

3.4.4 Execution scenario

The adapters have been used in an integrated scenario with the OpenSearch Web client. Figure 8 shows the left panel of the web client. The client knows *a priori* all the adapters available, that is, all the Web 2.0 services that expose the OpenSearch interface. As each adapter makes the URL pointing to the service description document public (See Table 3), the client can parse these documents and register the corresponding search engines. If the service is up and registration is successful, the search engine is added in the list box as depicted in Figure 8.

Once selected a search engines (e.g. OpenStreetMap), the user can type search terms (*{searchTerms}*) in the text box to find resources in OpenStreetMap related with “JRC, Italy”.

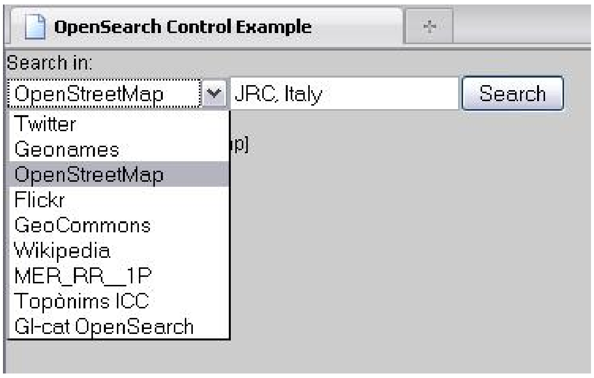

Figure 8. User interface for multiple search services

The search result is shown in table-based format on the left and map-based format on the right. Figure 9 shows the result (feature) found in OpenStreetMap displayed on the map viewer.

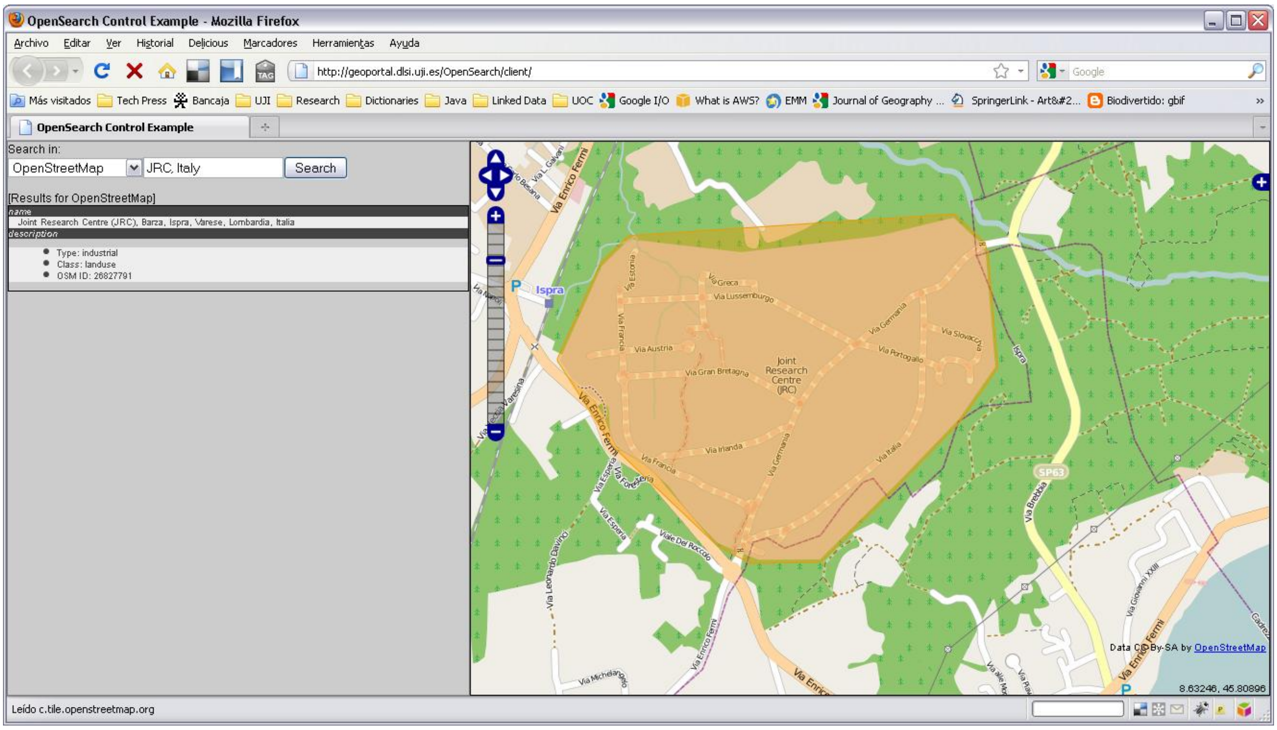

Figure 9. Search results displayed in the map viewer

From an operational perspective, the step represented in Figure 8 consists of obtaining the service description document from the proxy or adapter services. This document is a public file stored in the proxy service. Figure 10 shows a sequence diagram for this step.

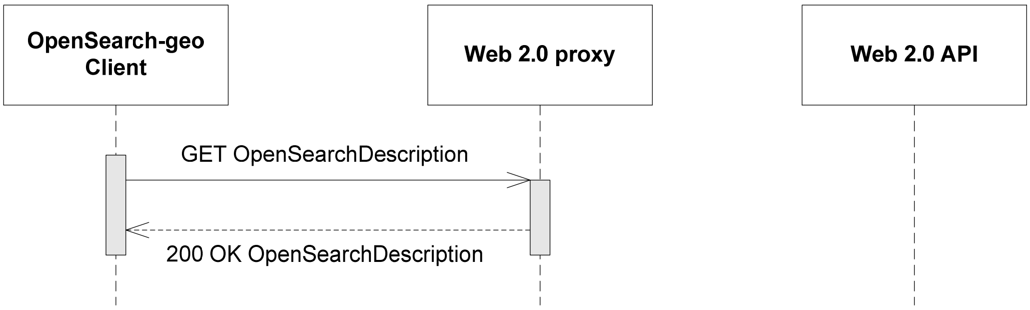

Figure 10. Get description document operation (step 1)

Once the description document is obtained, the next step is to perform the query as illustrated in left side of Figure 9. Figure 11 represents the sequence diagram for the step 2. At the beginning, the client sends a HTTP GET request with the OpenSearch-geo search parameters. The proxy service adapts the query to the concrete API syntax and makes the query against the corresponding Web 2.0 service. The response is transformed to a standard format in accordance with the description document, and forwarded to the client for visualization (right side Figure 9).

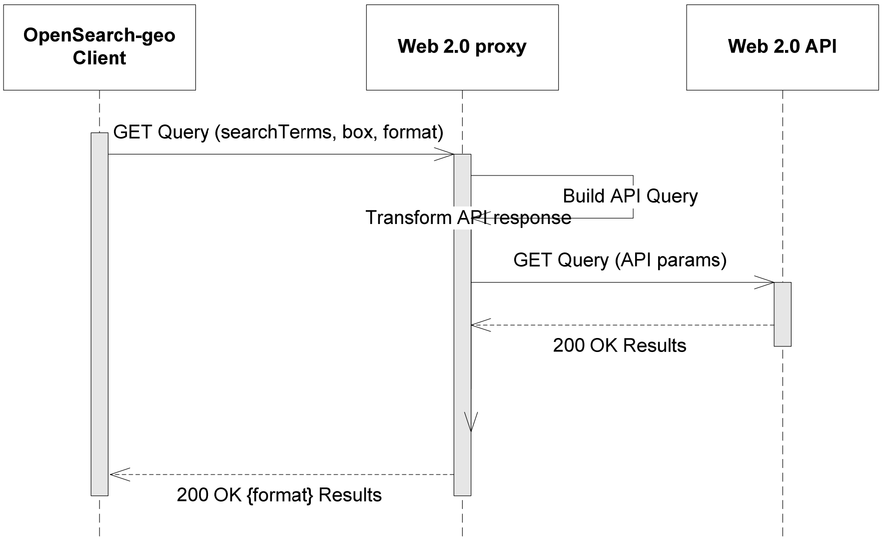

Figure 11. Web 2.0 search query operation, through OpenSearch proxy (step 2)

The OpenSearch web client is available online at http://geoportal.dlsi.uji.es/OpenSearch/client/ for testing purposes.

3.4.5 Integration with EuroGEOSS discovery broker

The scenario described so far connects a user agent (OpenSearch web client) to a collection of OpenSearch services (natively or via proxy). Figure 12 (top) represents this scenario. In this section, we split this component in their contained components (Web client and proxy services) so that we can accommodate the EuroGEOSS discovery broker in the middle (see Figure 12 bottom).

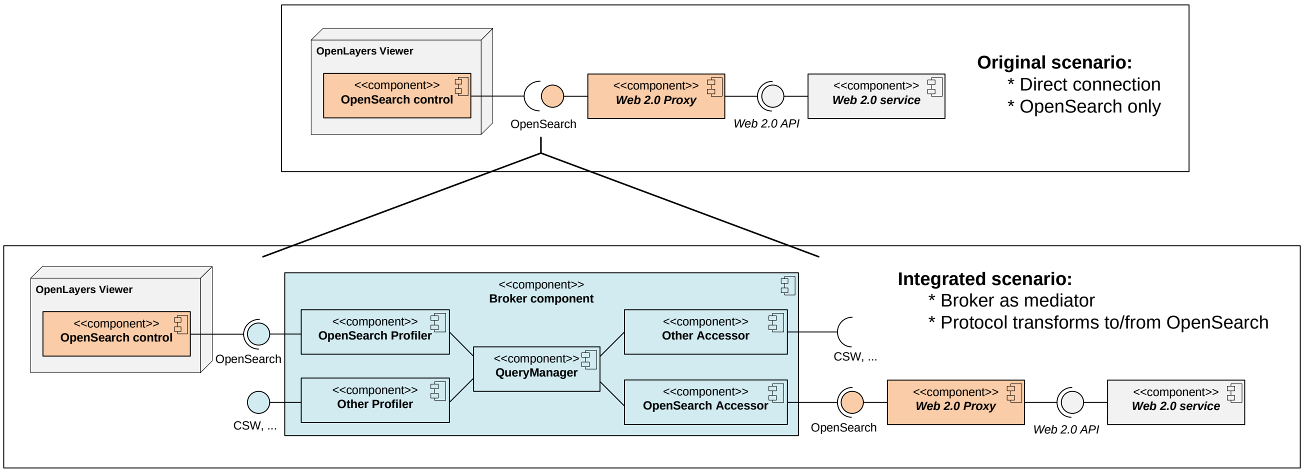

Figure 12. Integration scenario with EuroGEOSS broker

Figure 12 shows how EuroGEOSS broker components and proxy services are integrated. The EuroGEOSS broker provides an *OpenSeach Accessor* component, to which all the mentioned proxy services can be connected and tested against. The discovery broker also offers an *OpenSearch Profiler* interface, which can be accessed through the OpenSearch Web client described previously.

The integrated scenario proposed here offers many benefits. As the EuroGEOSS brokering component has an OpenSeach *Accessor* and an OpenSearch *Profiler*, many other protocols can be transformed to or from OpenSearch-geo interface. A scenario where the discovery broker component acts as a mediator is possible, enabling new use cases:

- Web 2.0 services can be accessed through other protocols thanks to discovery broker *Profilers* components.
- The OpenLayers thin client can access other EuroGEOSS services thanks to discovery broker *Accessors* components.

3.4.6 Experiments with profilers and accessors

A Gi-cat OpenSearch profiler has been added as a new search engine to OpenLayers client (see last items listed in Table 3 and Figure 8). This integration showed up some interoperability issues which have been resolved. Details of the interoperability tests conducted are summarized in Annex III, along with the corrective actions taken.

3.4.7 Roadmap

Figure 13 summarizes the OpenSearch client and proxy services, and shows their current capabilities (green) and the potential functionality (red).

In short, the generic client currently supports text and bounding box filtering. It is planned to support paged results. Geocommons and GENESI-DR are third party OpenSearch services, so they are taken as is. GeoNetwork OpenSource developers are incorporating time indexation and filtering, so it will be studied whether it can be exposed in the form of OpenSearch ‘time’ extension.

All proxy services actually support both KML and Atom response formats. Support for paged results and time filtering has been added when possible. Service functionality is limited to each API native functionality.

OpenSearch tools capabilties Rev. 4 (2010.10.25)	Data Formats: HTML	KML	Atom (+GeoRSS)	GeoRSS	Base params: searchTerms (text)	count (paging)	startIndex (paging)	startPage (paging)	Geo extension: box	geometry	lat, lon, radius	name	relation	uid	Time extension: start	end
Clients																
OpenLayers Control		Current	Current	Current	Current	Potential	Potential	Potential	Current							
Native OpenSearch services																
Geocommons	Current	Current	Current		Current	Current		Current	Current							
GENESI-DR	Current	Current	Current		Current	Current	Current	Current	Current					Current	Current	Current
Catalog servers & brokers																
GeoNetwork	Current	Potential	Potential	Current	Current	Current	Potential		Current	Current		Current	Potential	Potential	Potential	Potential
GI-cat / discovery broker			Current		Current	Current	Current		Current							
CatalogConnector	Current	Current	Current		Current	Current	Current		Current							
Web 2.0 proxies																
Wikipedia		Current	Current		Current	Current										
Geonames		Current	Current		Current	Current	Current									
Twitter		Current	Current		Current	Current		Current			Current				Potential	Potential
Flickr		Current	Current		Current	Current		Current	Current		Current				Potential	Potential
OpenStreetMap		Current	Current		Current				Current							

Current capabilities
Potential capabilities

Figure 13. Current status of Web 2.0 services (& other OpenSearch tools)

4 ASSISTED CONTENT PUBLICATION IN GEOSPATIAL INFRASTRUCTURES

Traditional GII (Geographic Information Infrastructures), like those describe in the EuroGEOSS Systems, focus their efforts in providing services with functionality to address most of the steps in the geospatial user workflow like discovery, access, visualization and processing. However they do not provide services with the functionality to assist users in the publication of new content. The lack of this functionality challenges the implementation and maintenance of these systems. Publication of content remains a complex task turning GII into top-down infrastructures without any user participation contrary to the general trend in our information society. In this section we describe how to extend these GII with a new type of web service that assists in content publication. This service will be used to extend the middleware layer of the CGI (Common GEOSS Infrastructure).

This section proposes a service component to provide an integral view that comprises several publication capabilities useful for EuroGEOSS. This component provides EuroGEOSS/GEOSS users an integrated service with functionality to perform publication actions over the EuroGEOSS services, components, and data sources, and then increasing the availability of content to exploiting the operating capacity of EuroGEOSS.

4.1 Context

INSPIRE (Infrastructure for Spatial Information in Europe) is a Directive by the European Commission, that set the legal framework for the establishment and operation of an Infrastructure for Spatial Information in Europe (INSPIRE, 2007). To ensure that GII are compatible and usable in a Community and cross-boundary context, the Directive requires that common Implementing Rules are adopted in a number of specific areas.

Network Services Drafting Team provide a Network Service Architecture (NSA) document (INSPIRE, 2008) that helps to the process of developing the Implementing Rules for each of the INSPIRE Network Services. It defines a network based on discovery, view, download, transformation and invocation services.

As mentioned GII currently follow a top-down building methodology oriented to produce and provide information only top-down, i.e., from higher levels. The rises of collaborative philosophies applied to the effective management of information have introduced a new flow that follows a bottom-up approach. This means that users acquire a new role of content provider. A set of emerging experimental proposals have appeared, such as Service Framework (Díaz et al, in press) (Gil et al, in press), GeoNode (Benthall and Gill, 2010) or GeoCat Bridge (Ticheler, 2010), which allow users to publish information and generate an easy way services within the GII.

4.2 Architecture

Next we present an integrated view of the different components. The conceptual architecture illustrated in Figure 14 represents a modification based on the proposal from the NSA document. Now the Service layer is extended with a new functionality, since it acquires a new publication transaction profile (arrow filled in gray) with the objective of integrating new content generated by the user in the Application layer. This way we create a collaborative GII.

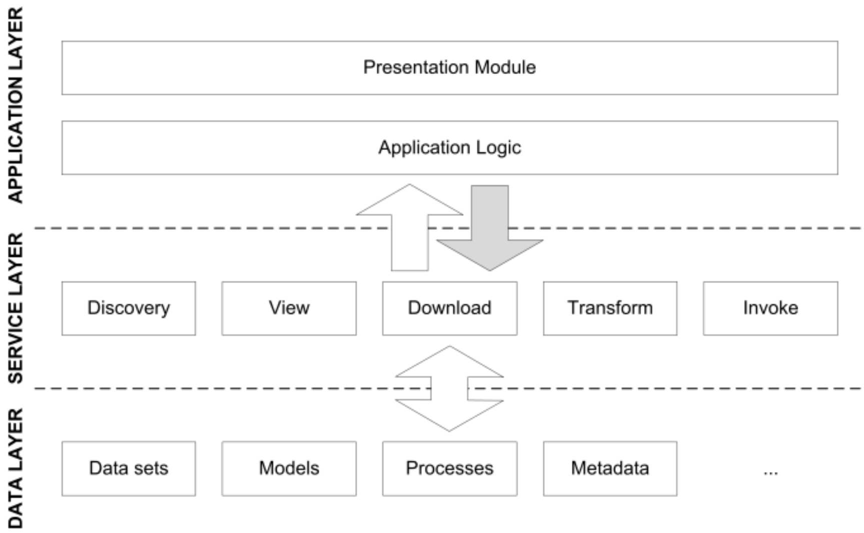

Figure 14. Conceptual architecture overview

We propose a mechanism to assist users in the publication of content. The realization of our proposal is called GEOSS Service Factory (GSF). GSF implements the Abstract Factory pattern (Gamma et al, 1994) to publish content by creating new entries in existing standard service instances. In this way we facilitate content sharing, preparing a channel to hide complexity, while remaining loyal to the geospatial initiatives agreements and standards to reach the required level of interoperability. This work extends and generalizes over our previous activities on a GII Service Framework (Díaz et al, in press).

GSF deals with automatic generation and provision of standards-based services. Its aim is to facilitate the creation, deployment and publication of geospatial data resources into geospatial information infrastructures following the OGC, INSPIRE specifications and standards in order to deploy GEOSS components and services.

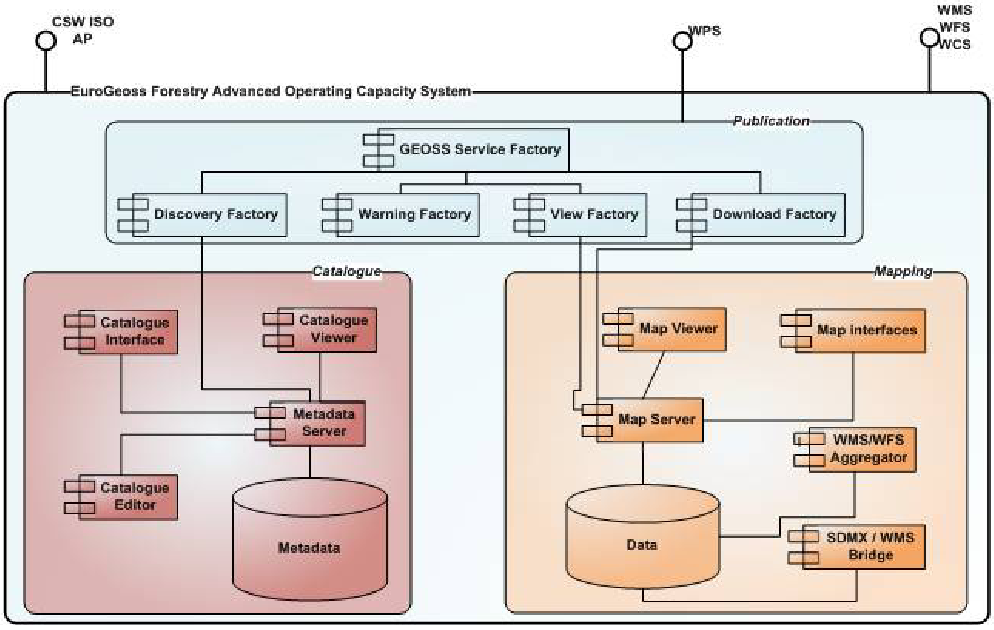

Figure 15. Detail on EFFIS extended with GSF

Our proposal is to provide users with mechanisms to publish content in the same way that GII provide users with mechanisms in the form of Web Service to perform the rest of tasks included in their daily workflow like discovery, access or download. This mechanism is defined as an additional component, which is integrated in GII architectures. Figure 15 shows partially the IOC EFFIS system extracted from (EuroGEOSS D3.1, 2009; EuroGEOSS D3.2, 2010) where we can appreciate the catalogue and mapping functionality offered by some services deployed in the system. We have extended it by adding a new service. This service is GSF which adds to the system content publication capacity. The GSF acts as a mediator to facilitate the publication of new content in GII like EuroGEOSS systems. GSF can be described as a Publication Service, i.e. a Service providing the functionality of publishing new content. GSF is designed as a standard and scalable publication service.

4.3 GEOSS Service Factory

The GSF implements the Abstract Factory pattern to group different types of geospatial service factories. As a creational pattern, the GSF creates or updates, through its *Publish* operation, new content in existing standard services.

4.3.1 Design

The GSF is designed to be implemented as a service component with a standard interface to be re-used in different scenarios. Since the WPS (Web Processing Service) specification is used to reach processing interoperability, it is the standard of choice to implement the GSF as a service. WPS GSF implementation acts then as a middleware for services and the ultimate goal is to manipulate an OGC Service instance to publish new content entries.

As a first approach the WPS-GSF offers a single process called *Publish*. The Publish process execution needs the following parameters:

- Content: Only this input parameter is mandatory. This content can be passed by value or by reference, where a URL to the content can be used.
- ServicePublicationProfile: XML encoded parameter that describes the publication policy. This parameter includes information regarding where each data type should be published within this GII.
- MD_URL: This parameter indicates that this content is already published in the GII and there are available metadata that should be reused when updating it.
- Keywords: The optional 'keywords' parameter provides an initial capability for metadata creation.
- DiscoveryLink: This is the only output parameter. This parameter contains the information needed to discover the content published in the system. In the case of the application being a traditional SDI where content is registered in Catalogue services, this parameter contains the end point to the metadata available in the Catalogue Service that contains the description of the content just being published. This metadata contains information about the data services end points serving the content.

4.3.2 Implementation

Offering a unique interface, GSF implements the functionality to publish different content types in a EuroGEOSS system. The content can differ in nature, like data content (raw data, processed data, discovered data), processing content, etc. Each content type will be published according the publishing policies of the concrete system. The content is published in the system to be available for different purposes, like visualization, download or discovery, GSF delegates the final publication to each concrete factory according to these purposes.

View and Download Service Factories: Automatic data content publishing

These factories offer the functionality to publish data content into standards-based data services, according to INSPIRE IR such as WMS, WFS, and WCS (Note these interfaces on the top-right side of Figure 15).

Discovery Service Factory: Automatic metadata content publishing

This factory is in charge of publishing metadata content for discovery purposes. One of its features is its ability to create semi-automatically (basic) service and data metadata to be published. This factory can be directly invoke by the GSF interface or it can be invoke automatically by GSF when the view and download factories have published data content.

However, the process of generating metadata associated with the Discovery service turns out to be a more complex process that requires an evaluation of the logic associated with its construction.

This is illustrated in Figure 16. When View and/or Download factories publish content, GSF can invoke Discovery Service Factory with some extra parameters like the end points to the Data Services. The discovery factory will generate some metadata by requesting information of this data services and merging it with the metadata received as parameter is that is the case. Afterwards, this factory will publish the metadata in a Discovery service, which nature and interface can vary depending on the system. Discovery Service can be implemented as a CSW service catalogs or other search engine. Publishing in some implementations of standard protocols like CSW-T like Geonetwork let users find the content also through other interfaces like OpenSearch.

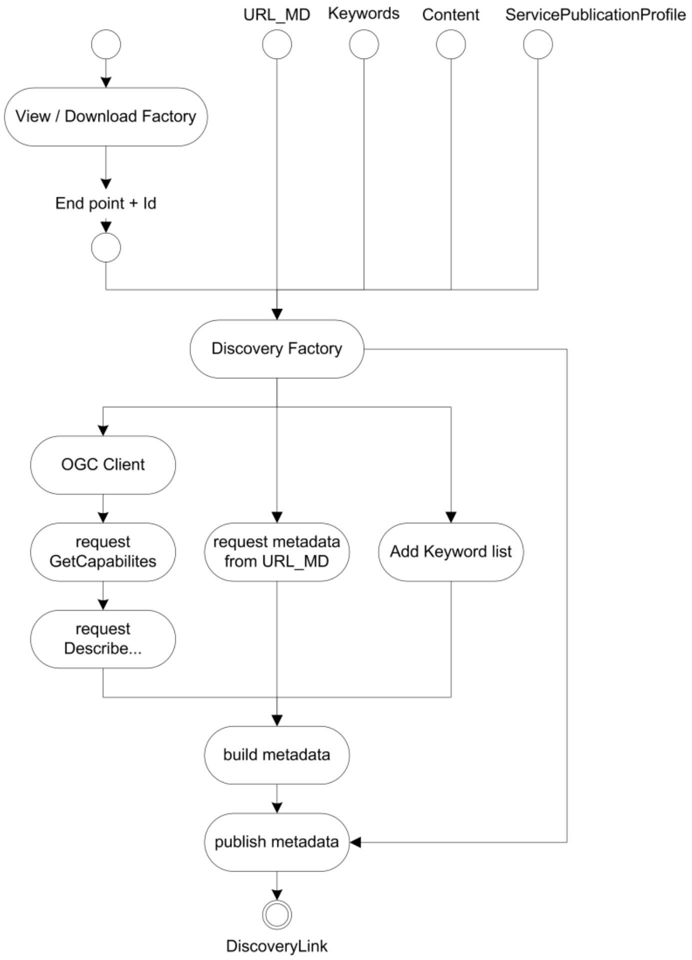

Figure 16: GSF process steps

The use of the mandatory input parameters by the Discovery Service is as follows:

End point + Id: represents the addresses path to access the viewing and downloads services for a particular resource (Id). With these data and using an OGC client, it proceeds to make request in View and Download services for relevant information that it will use to build metadata

URLMD: represents an address associated with a specific metadata file.

And the optional parameters:

Keyword list: is a list of keywords with a high significance.

Depending on the number of input parameters, Discovery Factory builds a thread tree of different executions to generate metadata with the largest number of fields filled.

- If end point + Id parameters are provided, the process continues by requesting OGC services associated with the end point in search of general information. These requests are GetCapabilities for an overview of the service and Describe... associated with the specific resource (Id) that returns information about its features.
- If URLMD is provided, accessed and obtained directly from the metadata. If we not provide any other parameters, this step is equivalent to the simple transactional processing to insert metadata on the catalog.
- If keyword list is provided, as keywords are added to the resulting metadata.

By the end of the process is constructed from all the threads a resultant metadata is published in the catalog.

REFERENCES

Benthall, B., Gill, S. SDI Best Practices with GeoNode. In Proceedings of the 2010 Free and Open Source Software for Geospatial Conference (FOSS4G 2010). Barcelona, Spain, September 2010.

Clinton, D. (2010) Open Search 1.1 Specification, http://www.opensearch.org/Specifications/OpenSearch/1.1

Díaz, L., Granell, C., Gould, M., Huerta, J. Managing user generated information in geospatial cyberinfrastructures, Future Generation Computer Systems, In Press.

Duchesne, P. OpenSearch Semantic Extension 1.0 (draft 1) http://www.opensearch.org/Community/Proposal/Specifications/OpenSearch/Extensions/Semantic/1.0/Draft_1

Gamma, E., Helm, R., Johnson, R., Vlissides, J. (1995). Design Patterns. Addison-Wesley

Gil, J., Díaz, L., Granell, C., Huerta, J. Open Source based Deployment of Environmental Data into Geospatial Information Infrastructures. International Journal of Applied Geospatial Research. (accepted).

EuroGEOSS D3.1 (2009) D.3.1 Forestry operating capacity. Available at http://www.eurogeoss.eu/wp/wp1/Deliverables/EuroGEOSS_D3-1.pdf

EuroGEOSS D3.2 (2010) D.3.2: Design Specifications for EuroGEOSS Forestry Components and Interfaces. Available at http://www.eurogeoss.eu/wp/wp1/Deliverables/EuroGEOSS_D3-2.pdf

European Parliament and Council (2007). INSPIRE EU Directive. Retrieved January 28, 2009, from http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2007:108:0001:0014:EN:PDF

INSPIRE Network Services Drafting Team (2008). INSPIRE Network Services Architecture, from http://inspire.jrc.ec.europa.eu/reports/ImplementingRules/network/D3_5_INSPIRE_NS_Architecture_v3-0.pdf

Gonçalves, P. (editor) (2010) OpenGIS® OpenSearch Geospatial Extensions Draft Implementation Standard. Version 0.0.2. Open Geospatial Consortium Inc. Ref. OGC 09-084r3.

Goodchild, M.F. (2007) Citizens as voluntary sensors: spatial data infrastructure in the world of Web 2.0. International Journal of Spatial Data Infrastructures Research 2: 24–32.

Santoro, M., Boldrini, E., Papeschi, F., Baldini, A., Nativi, S. (2010) D.2.2.2. Specification of EUROGEOSS Initial Operation Capacity. EuroGEOSS, WP2.

Ticheler, J. GeoCat Bridge – One click data publishing. In Proceedings of the 2010 Free and Open Source Software for Geospatial Conference (FOSS4G 2010). Barcelona, Spain, September 2010.

Tulloch, D.L. (2007). Many many maps: Empowerment and online participatory mapping. First Monday.

Turner A. (2006). Introduction to Neogeography. O'Reilly Media Inc.

Turner et al. (2010). OpenSearch Geo Extension 1.0 (draft 2),

http://www.opensearch.org/Specifications/OpenSearch/Extensions/Geo/1.0/Draft_2,

Turner, A. Time Extension for Open Search.

http://www.opensearch.org/Specifications/OpenSearch/Extensions/Time/1.0/Draft_1

University of Nottingham. User-Driven Requirements for Resource Annotation (semantic annotation and ontology alignment user instructions v0.4.doc), NOTTS.

ANNEX I: ANALYSIS OF WEB 2.0 SERVICES.

This annex contains the results of our analysis, and discusses the pros and cons of each Web 2.0 service listed in the comparison Table 4.

Twitter

Twitter is a microblogging service. Users post short text messages (called statuses) that are immediately published to the web and received by following friends. Messages can contain links to other users or web pages. It is a popular service because its easiness allows for almost ubiquitous, near real-time communication.

The search API can be used freely unless abused, but there is a limit of requests per hour and host, and a limit of number of results (1500). Geographic filtering by centre and radius is possible, and time filtering as well.

Response formats include Atom and JSON. Details on each status message, including location, can be retrieved via REST API, which returns XML or JSON formats.

Twitter has recently introduced individual statuses geotagging, which can be used to draw a near real-time activity over a map, as points or labels.

Google Search

One of Google's searchers is "LocalSearch". LocalSearch is used for geocoding, for listing local businesses (returned as a list of points), and for retrieving KML files indexed by Google's geoindex.

It allows BBOX filtering along with text search. Results are scored according to Google's PageRank. Response format is JSON.

This search API is accessed in two flavours: AJAX, to be used inside a web browser, and REST, that can be used elsewhere.

The terms and conditions for Google Search state: "You will not, and will not permit users or other third parties to […] display Google Search Results for local search geospatially except by using the Google Maps service". So it isn't allowed to use Google search for an SDI.

Panoramio

Panoramio is a collection of georreferenced photographs. No text search is offered, but results can be ordered by popularity or recency, and filtered by BBOX.

Panoramio was acquired by Google on 2007, and the same restriction as Google Search API applies: they can only be represented over Google Maps. No SDI integration allowed.

Picasa

Picasa is another Google service, for photo album publishing. Its API lacks geotagging information, but this may change, as users can now geotag their photo albums. The same license policy as above may apply.

Flickr

Flickr is the most popular 2.0 photo repository service. Its API is free for non commercial use, but a paid commercial API is also available.

License restrictions also apply over individual photographs: Authors can decide to fully copyright or use a Creative Commons license. This information can be retrieved with Flickr API, and clients should respect it. For instance, the author name has to be displayed with the photograph.

Full text search and search based on tags is possible. Geographic and time filtering is also available. A user account is required for API access.

Request protocols include RPC, SOAP and REST. Additional response formats include JSON. Geotagging information in responses does not follow any standard.

Flickr has been already used in some web mapping applications and as a social tool in emergency situations (California wildfires, October 2007). It can be incorporated as a data source in the SDI, but special attention has to be taken on how to manage the mandatory Flickr account. One option is to create an account for the brokering component.

OpenStreetMap

OpenStreetMap is a huge social geodatabase whose aim is to build a free map of the world. The database atomic elements are points. Points can be grouped in ordered collections to construct polylines or polygons. These elements have an associated list of key-value pairs, used to tag each element without a predefined schema, but following some guidelines documented in a wiki.

OpenStreetMap license allows for redistribution, reuse and derivative works on the contents, as long as the same license terms apply: the Open Database License (ODbL).

The REST API allows for text search, BBOX and time selection. Due to the high amount of data, the API publishes a 'capabilities' document stating the maximum area (in square degrees) that can be requested, so the BBOX parameter is required and must cover a little area. Data downloading is slow.

There is an extended API (XAPI) that provides enhanced search and query capabilities, in read-only mode. The XAPI allows much larger BBOX requests (but not worldwide). Data is structured in XML, following an OpenStreetMap particular schema.

Finally, the Nominatim search API (from the latin 'search by name'), instead of returning the full data, returns a list of results containing the item ID and its bounding box. Results can be in XML, HTML or JSON formats.

A combination of XAPI and Nominatim APIs can be used to retrieve contents and use them in an SDI, provided that derived works can be redistributed with the same open license. Slow response times, data transformation and multiple API combined action, and the lack of a closed schema for feature attributes can make this integration a respectful technical challenge, depending on the desired final functionality.

Wikimapia

Wikimapia is a user-generated collection of geotagged elements drawn on top of Google Map's aerial imagery. Far from Wiki principles, it is not open at all. There is no API.

Geonames

Geonames is mainly a place name database, but also offers geocoding services, weather forecasts, or links to Wikipedia articles. Is an aggregation of public domain and user contributed data, under a creative commons license.

There is no unique API, but a large collection of simple web services with specific functionalities. There is no geographic BBOX filtering. The best integration strategy is to download the full database dump, load it in a geodatabase, and publish it through an OGC compliant map server. Incremental dumps are released periodically for mirror database updates.

Geocommons (Finder! & Maker!)

Geocommons is a collection of maps, with multiple layers and advanced symbolization. It supports natively OpenSearch. There is a poorly documented API based on REST.

	1. Twitter	2. Google Search AJAX API (local)	3. Panoramio	4. Picasa	5. Flickr	6. OpenStreetMap	7. Wikimapia	8. Geonames	9.Geocommons Finder! & Maker!
Data nature	Short texts	KML data, point	Photos	Photos	Photos	Vector	Georreferenced articles	Placenames, weather, wikipedia, (34 sources!)	Overlays
API docs	http://apiwiki.twitter.com/	http://code.google.com/intl/en/apis/ajaxsearch/documentation/reference.html	http://www.panoramio.com/api/	http://code.google.com/intl/es-ES/apis/picasaweb/overview.html	http://www.flickr.com/services/api/	http://wiki.openstreetmap.org/wiki/API_v0.6	No API	http://www.geonames.org/export/ws-overview.html	http://wiki.github.com/geocommons/api
License terms & restrictions (data, API)	Free, unless abused	When using the Service, You will not: […] use the Service in sites using map technology other than Google Maps	When using the Service, You will not: […] use the Service in sites using map technology other than Google Maps	N/A	Non commercial use (optional commercial API).	Free. CC-by-SA 2.0, transitioning to ODBL. Must attribute to OSM.		CC-by 3.0	N/A
Text filtering	Yes	Yes!	No	Tags & full text	Tags & full text	By attribute?		Text search	tag search
BBOX filtering	Center&radius	Weird format	Yes	No	Yes	Yes		No. Center&radius for reverse GC.	yes (see opensearch.xml)
Time filtering	& Streaming API!	No	'Recent'	Only 'recent'	Taken & upload	By edition date		No.	No
Exhaustive retrieval?	1500 max. Paged.	No	Chaining requests	Yes	Yes. Max. 500 results/page.	Yes. Slow.		Only text.	paged
Required key?	Optional	Optional	No	Not for read only	Yes	No		No	not for search
Rate restrictions	Limited	N/A	10.000 req/day	N/A	N/A	No		50.000 daily hits / IP. Or DB dump	N/A
Editable?	Yes	No	No	Yes	Yes	Yes		Yes	Yes (Maker!)
Java wrapper?	Twitter4J	Can do	No	Yes	flickrj, jicklr	Lots. Not trivial.		http://www.geonames.org/source-code/	No
Scoring/aggregating?	No	Google scoring	No	No	Interestingness	No		Hierarchy	Its own scoring
Request protocols	HTTP get (search)	HTTP get	HTTP get	REST	REST, RPC, SOAP	REST		HTTP get	REST, OpenSearch
Response formats	JSON, Atom	JSON	JSON	Atom feed (XML)	REST, RPC, SOAP, JSON, PHP	OSM (XML)		XML, JSON	KML, CSV, SHP, Atom, Json, Spatialite
Feasibility as data source	Yes	NO (license).	NO (license)	NO (lacks geo)	Yes	Loose schema	No API	Quite static. Simple services.	Yes, but lacks documentation

Table 4: Overview of Web 2.0 Services

ANNEX II: USE SCENARIOS

This annex describes use cases that involve heterogeneous services/components from SDI, Linked data and Web 2.0 services. We introduce the first impressions and discussions with some EuroGEOSS thematic partners.

GBIFThe first requirement is usability, that is, the proposed use cases should be useful and realistic for users/scientists in the context of EuroGEOSS. In this sense, we have contacted with GBIF people to know their needs. GBIF already offers a portal to search for protected areas (http://widgets.gbif.org/pa/index.html#/country/ES). When a user opens a protected area, a menu with additional layers (Flickr photos, panoramio, and Wikipedia) is available on the right site. For instance users can overlay gbif data and flicker photos in the same map viewer. According to GBIF people, this functionality is useful to some extent because filtering Web 2.0 content (flicker, panoramio) is a difficult task and some photos retrieved are irrelevant from the scientist standpoint.

Some use cases have been identified. For instance, given two forest fires, which of two should be a priority to assign proper resources? The answer involves a great variety of data but essentially (from EuroGEOSS perspective) forestry data and gbif data (species, wild animals living in that area). This sort of questions is actually demanded by decision makers, according to GBIF people.

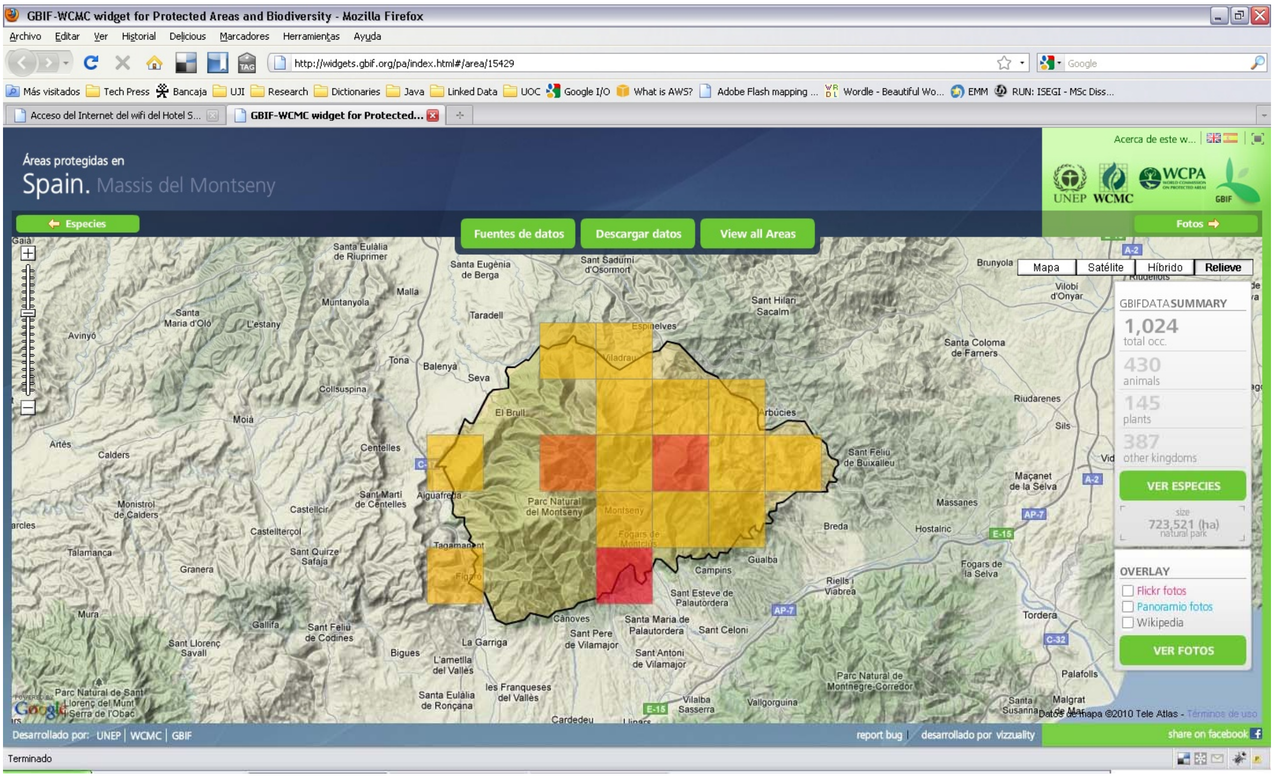

Figure 17. GBIF use case integrating Web 2.0 content

Geo-Wiki

The Geo-Wiki project (www.geo-wiki.org), presented by WP7, is a VGI application to collaboratively review global landcover maps with the help of volunteer's local knowledge, aerial imagery from Google Earth, and Panoramio as an additional web 2.0 layer, whose photographs can be used to determine the actual land use in a particular location. This project could benefit of other user-contributed data, such as additional geotagged images, from Flickr or Picasa, landcover information from OpenStreetmap, etc.

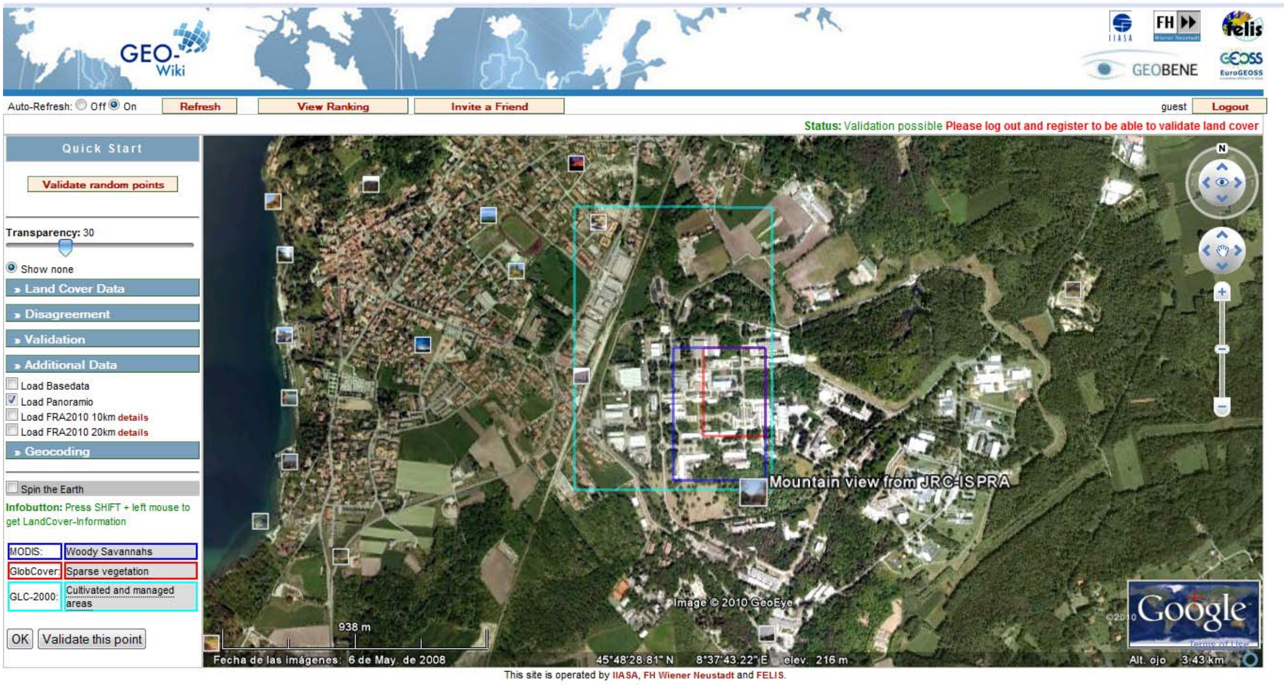

Figure 18. Geo-Wiki viewer with Panoramio layer and multiple Land Cover information

ANNEX III: TESTING IN THE EUROGEOSS BROKER

The following table summarizes the tests performed between the broker accessors and the web 2.0 adaptors. After a first run, some actions were taken to increase interoperability, which are detailed in the 'Actions taken' column. Mainly, the Atom format has been added to all services.

Service Name	Description Document	Discovery	Preview	Download	Notes	Actions taken
GeoCommons	http://core.geocommons.com/opensearch.xml	OK	OK	OK		Reported & corrected bug in Geocommons: http://getsatisfaction.com/geocommons/topics/search_atom_responses_with_wrong_georss_content
GENESI-DR	http://dr-site.esrin.esa.int/genesi/envisat_meris/mer_rr__1p/description/	OK	OK	OK		Updated URL: http://dr-site.esrin.esa.int/genesi/envisat_meris/mer_rr__1p/description/
OpenStreetMap	http://geoportal.dlsi.uji.es/OpenSearch/services/osm/opensearch.xml	OK	OK	OK	georss:polygon not supported by GI-cat/GI-go (only georss:box at the moment)	Added Atom response.
Twitter	http://geoportal.dlsi.uji.es/OpenSearch/services/twitter/opensearch.xml	OK	OK	OK	center and radius parameters not supported by GI-cat	Added searchTerms, count, startPage, lat, lon and radius parameters.
Flickr	http://geoportal.dlsi.uji.es/OpenSearch/services/flickr/opensearch.xml	OK	OK	OK		Added Atom response with link rel='enclosure'. Adding support to link rel='enlosure' in GI-cat
GeoNames	http://geoportal.dlsi.uji.es/OpenSearch/services/geonames/opensearch.xml	OK	OK	OK		Added Atom response.
Wikipedia	http://geoportal.dlsi.uji.es/OpenSearch/services/wikipedia/opensearch.xml	OK	OK	OK		Added Atom response.

Table 5. Evaluation of existing components

Legend: Green: OK Orange: OK with bug Red: NOT working