

# PROJECT FINAL REPORT

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## 4.1 Publishable summary

### 4.1.1 Executive summary

GeoViQua aimed to contribute significantly to integrating quality-aware visualisation of Earth Observation systems into GEOSS developments at the European and international level, bringing together key partners from academia, industry and the broader scientific community. In particular, GeoViQua has provided consistent, high quality specifications, protocols and components allowing scientists and decision makers to access easily to a range of EO information including complete, flexible quality information. GeoViQua components and services are made available within the GCI, complemented by a GEO Portal with enhanced visualisation technologies, which also communicate data quality. This aim was been achieved by means of a range of tools and components that have been provided to allow users seeking data/imagery and associated quality indicators to access the information through modern visualisation environments via the GEO Portal:

- GeoViQua analyzed the CGI catalogues being proved that enough quality indicators and provenance information are already present in those. Extraction of quality information from the main EO metadata formats was done. Effort has been put into data extraction and conversion into individual layers that can be combined in GIS tools or WMS services. Impact of these activities has been ensured by the release of the results as scientific publications.
- Graphical representation of the metadata, GEO Label, was developed to allow increasing user trustworthiness over GEOSS data and services delivery. Efforts to maximize its impact continue in the form of a cluster service that can be operationalized, contacts in the GEO and standardization activities.
- Models for quality enhanced producer metadata, and for user feedback input are published at <http://schemas.geoviqua.org/> in the form of XSD schema documents (accompanied by UML models and examples). The producer model builds on existing ISO standards (19115 and 19157) to permit the encoding of reference dataset information, citations, traceability of quality statements and discovered issues within metadata documents. The user model will inform the database structure for a feedback server from which comments, citations, discovered issues, ratings and reports of usage may be retrieved.
- A user feedback system has been developed. An standardization process in OGC has been initiated to maximize the impact.
- A search broker filtering by quality parameters and sorting result by quality indicator values was performed. Query by location with metadata, quality statistical charts, and quality representations through symbology are some of the techniques developed. The components use existing standards to allow direct implementation in the GEO Portal as well as mass-market geo-browsers and mapping tools (such as Google Earth) and other 3D viewers. The catalogue is able to harvest quality aware WMS-Q, SOS-Q, KML-Q, etc. Impact is guaranteed by the integration in the DAB.
- Quality metadata visualization techniques, quality metadata completeness rubric (punctuation) system, and metadata inter-comparison templates are as well tools included in the GEOSS Portal Efforts to maximize its impact continue by contacts in the GEO and standardization activities and ESA funding to operationalize this components in the official GEOSS portal.
- A standard-based visualization approach for the visualization of quality/uncertainty information in 2D developed using OGC Web Map Service (WMS). A similar approach was done for 3D visualization based on KML-Q. Impact is maximised by the release of an OGC public engineering report.
- Tools to help provide the formal uncertainty estimates have been developed, integrating the INTAMAP and GECA projects results as starting point. SMEs can maximize the impact of this approach in the future.

Agriculture, Air Quality and Carbon-cycle selected scenarios have been present all along the different phases of the project, from the iterative collection and documentation of first user and technical requirements



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Theme title: Integrating new data visualisation approaches of earth Systems into GEOSS development

through the stages of system design and development, and tutorial and instructions later up to the final system integration.

GeoViQua team will continue the effort to maximize the impact of the project by several means including, smooth integration in the GCI, conducting careful collaboration with a number of CoPs and standards committees dialog and reuse of the components in other projects and activities.

## 4.1.2 Summary description of project context and objectives

### 4.1.2.1 Context

The Global Earth Observation System of Systems GEOSS aims to be a global and flexible network of content providers allowing decision makers to access an extraordinary range of information directly on their desk. It brings together existing observing systems around the world while supporting the development of new systems where gaps currently exist. The network interoperability is ensured by a common set of standards so that data from different instruments can be combined into coherent datasets. This network is supported by the GEOSS Common Infrastructure (GCI) that provides catalogue, search engines and a GEO Portal that offers a single Internet access point for users search and discovery of data, imagery and analytical software packages to all parts of the globe.



GeoViQua is in line with the two major directions given by GEO ministers in the GEO Cape Town Declaration (GEO WP 2010), namely: (1) Continued research and development activities necessary for future observation systems; (2) Upgrading and expanding of Earth Observations, and building the capacity of individuals, institutions and systems, particularly in developing countries. GEO has established four Committees to guide the implementation of the 10-Year Plan: Architecture and Data, Capacity Building, Science and Technology and User Interface.

The Architecture and Data committee coordinates the GEOSS Common Infrastructure (GCI) that provides clearinghouses and portals to allow the integrated discovery and visualisation of data. These standardised components facilitate interactive, informed evaluation and selection of information by the scientific community when representing and modelling Earth Systems. GCI is composed of standardised components tested in the Architecture Implementation Pilots (AIP) harmonizing interoperable systems. GeoViQua has significantly contributed to this activity by adding rigorous data quality representations to existing search and visualisation geo-portal functionalities, prioritising interoperability at all times.

The GCI is subject to continuous development and improvement of its functionality, from infrastructure and backend services to context-driven applications and human-computer interfaces. A major driver for this development is the wide variety of Societal Benefit Areas (SBAs) that GEOSS addresses, and in particular the deep interconnections of distributed systems. This broad user community has offered rich challenges and opportunities for user-driven development within GeoViQua.

GeoViQua has scientifically explored methodologies for extending this basic infrastructure adding rigorous data quality in search and visualisation geo-portal functionality. GeoViQua has provided innovative components for augmenting the GEOSS and the adoption of GEOSS by the community; contributing to catalyzing research and development (R&D) activities on GEO.



### 4.1.2.2 General objectives of the project

GeoViQua has 3 major scientific and technical objectives:

- a) Provision of innovative tools to enhance the current infrastructure capability. GeoViQua's major technical innovation will be searching and visualising tools for the community which communicate and exploit data quality information from GEOSS catalogues. The activities required to deliver this major objective are as follows:
  1. Derive, extract and collect information about data quality from data, metadata, CAL/VAL processes including *in-situ* observations, provenance and end-users' feedback
  2. Encode and embed information on data quality and link it to data themselves. This process will include interfacing with standards and protocols, quality metrics and storage catalogues
  3. Develop context-driven smart visualisation of information on data quality (e.g., reveal information and detail progressively) in 2D and 3D. A prototype has to be developed
  4. Enable search and discovery over GEO Portal using information on data quality.
  5. Enable the developed functionality over low bandwidth transmission and small screen devices (smart phones and PDA components).
- b) Contribution to the GEO Label development. With its technical and scientific achievements, GeoViQua will significantly contribute to the definition design, prototype development, and evaluation of a strong GEO Label, which will allow users to query, explore and contribute to data quality information within a flexible and interoperable framework. GEO Label requirements will be defined (Work Package WP2), the label will be integrated with the components (WP6) and validated and applied in pilot cases (WP7) and disseminated to the community will be done (WP8). It will be completed in collaboration with the GEO task ST-09-02. The GEO Label deliverable will mature during the project and will crystallize on a final report about this.
- c) Harmonization, exploitation and dissemination of project outputs. GeoViQua will secure lasting impact for its deliverables through continuous and direct interaction with a number of relevant GEO tasks and user communities. A careful validation process will be conducted in collaboration with a number of communities of practice and standards committees to ensure that the project contributes effectively to the GEOSS GCI architecture. Collaboration with AIP will be on going. The solution will be transferred to the GCI.

### 4.1.2.3 Specific objectives of the project

The GeoViQua's primary goal is *to augment the GEOSS Common Infrastructure with innovative quality-aware visualisation tools and geo-search capabilities, providing the user community with enhanced and advanced tools available through the GEO Portal and other end-user tools*. All work done is contributing to this objective.

Here we present a list of the specific objectives, using the same sentences extracted from the first section of the Annex I but arranged as enumerated bullets, sorted by topic and with redundancies removed. This gives us a clearer list of the initial objectives of the project.

#### Derive, Encode and Catalogue

- 1.1 Derive, extract and collect information about data quality from data, metadata, CAL / VAL processes including *in-situ* observations, provenance and end-users' feedback. A prototype will be ready at month 18 (milestone MS04) and the component will be ready for integration in month 24 (milestone M 3.2). WP3

- 1.2 Encode and embed information on data quality and link it to data themselves. This process will include interfacing with standards and protocols, quality metrics and storage catalogues. The solution will be provided at month 15 (milestone MS11). WP3
- 1.3 Provide a data quality encoding that can be parsed, interpreted and applied in a wide variety of scenarios considering ISO, QA4EO and UncertML (deliverable D6.1 month 18). WP6
- 1.4 Develop tools and procedures to allow users of datasets to provide feedback about the utility of datasets for their purpose. WP3

### Search and discovery

- 2.1 Enable search and discovery best dataset for their purpose over GEO Portal using information on data quality. A prototype will be ready at month 18 (milestone MS06) and the component will be ready for integration in month 24 (milestone M 2.2). WP4

### Visualize

- 3.1 Catalogue current methods for visualising quality information and uncertainty. WP5
- 3.2 Develop context-driven smart visualisation of information on data quality (e.g., reveal information and detail progressively) in 2D and 3D. A prototype will be ready at month 18 (milestone MS08) A prototype will be ready on month 18 (milestone M 5.1) and the component will be ready for integration in month 24 (milestone M 5.2). WP5
- 3.3 Visualization tools which provide links to textual quality information. WP5

### Validate and Integrate

- 4.1 Contribute to the definition of a strong GEO Label by allowing users to query, explore and contribute to data quality information within a flexible and interoperable framework. GEO Label requirements will be determined (WP2). WP6
- 4.2 Follow the evolving directives on standards as given by the Open Geospatial Consortium (OGC) and the IEEE's Standards Interoperability Forum (SIF). WP8
- 4.3 A careful validation process will be conducted in collaboration with a number of communities of practice and standards committees to ensure that the project contributes effectively to the GEOSS GCI architecture. Collaboration with AIP will be continuous (reported in deliverables D 8.3 month 19, WP7, D 8.4 month 32)
- 4.4 The solution will be transferred to the GCI in month 35 (milestone M 6.2)

## 4.1.3 Description of the main S&T results/foregrounds

The GeoViQua project has 3 main kinds of results: scientific publications, standards participation and components (and its documentation) for the GEOSS common infrastructure.

### 4.1.3.1 Scientific publications

In this report we highlight the main 3 **scientific papers** produced during the project:

X. Yang , J. D. Blower , L. Bastin , V. Lush , A. Zabala , J. Maso , D. Cornford , P. Diaz , J. Lumsden (2013) An integrated view of data quality in Earth observation. **Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences** Vol. 371/Issue 1983 Royal Society of London, United Kingdom , 28/01/2013.

In this paper GeoViQua the team exposes that data quality is a difficult notion to define precisely, and different communities have different views and understandings of the subject. This causes confusion, a lack of harmonization of data across communities and omission of vital quality information. For some existing data infrastructures, data quality standards cannot address the problem adequately and cannot fulfil all user needs or cover all concepts of data quality. In this study, we discuss some philosophical issues on data quality. We identify actual user needs on data quality, review existing standards and specifications on data quality, and propose an integrated model for data quality in the field of Earth observation. It also proposes a practical mechanism for applying the integrated quality information model to a large number of datasets through metadata inheritance. While our data quality management approach is in the domain of EO, we believe that the ideas and methodologies for data quality management can be applied to wider domains and disciplines to facilitate quality-enabled scientific research.

The paper addresses the problem of EO data quality from a number of different angles, including (i) clarifying concepts and terminology, (ii) reviewing existing relevant international standards, (iii) establishing unfulfilled user needs, and (iv) surveying the current state of the GEOSS. The paper proposes the GeoViQua model as an expanded model for representation of EO data quality and described how it can be applied to large data holdings through a metadata inheritance mechanism. Although specifically aimed at the EO community, this study is relevant to many other areas of e-Science, particularly where data need to be provided to a diverse user community. Many of the concepts (e.g. UncertML) are entirely general and can be much more widely applied. Conversely, the EO informatics community will benefit from innovations occurring in other communities, particularly concerning the linking of information from different sources. We note that, for these linkages to be effective, GEOSS requires a robust mechanism for globally, uniquely and permanently identifying datasets, something that is currently lacking. The paper concludes that a strong need was also identified to help users to understand the provenance of datasets. The W3C provides a generic provenance model for data on the Internet, and there is an almost one-to-one correspondence between this model and the ISO 19115 Lineage model. There is therefore strong potential for interoperability with other communities.

6 citations of this paper has been detected so far:

Mobasheri, A. (2013). Exploring the Possibility of Semi-Automated Quality Evaluation of Spatial Datasets in Spatial Data Infrastructure. *Journal of ICT Research & Applications*, 7(1).

Feng, C. C. (2013). Mapping Geospatial Metadata to Open Provenance Model.

Blower, J., Alegre, R., Bennett, V. L., Clifford, D., Kershaw, P. J., Lawrence, B., ... & Phipps, R. (2013). Understanding climate data through commentary metadata: the CHARMe project.

Zabala, A., Riverola, A., Serral, I., Díaz, P., Lush, V., Maso, J., ... & Habermann, T. (2013). Rubric-Q: Adding Quality-Related Elements to the GEOSS Clearinghouse Datasets.

Townend, P., Xu, J., & Austin, J. (2013). e-Science—towards the cloud: infrastructures, applications and research. *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences*, 371(1983), 20120082.

Leibovici, D. G., & Jackson, M. J. Copula metadata est. Agile conference 2013

Alaitz Zabala , Anna Riverola , Ivette Serral , Paula Diaz , Victoria Lush , Joan Maso , Xavier Pons , Ted Habermann (2013) Rubric-Q: Adding Quality-Related Elements to the GEOSS Clearinghouse Datasets . **IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing**. Vol. 6/Issue 3, Institute of Electrical and Electronics Engineers Inc., United States, 01/06/2013 pp1676-1687.

In this paper GeoViQua the team that geospatial data have become a crucial input for the scientific community for understanding the environment and developing environmental management policies. Metadata in the GEOSS Clearinghouse are often not easily understood by users, especially when presented in ISO XML encoding. Data quality included in the metadata is basic for users to select datasets suitable for them. The work aims to help users to understand the quality information held in metadata records and to provide the results to geospatial users in an understandable and comparable way. Thus, we have developed an enhanced tool (Rubric-Q) for visually assessing the metadata quality information and quantifying the degree of metadata population. Rubric-Q is an extension of a previous NOAA Rubric tool used as a metadata training and improvement instrument. The paper also presents a thorough assessment of the quality information by applying the Rubric-Q to all dataset metadata records available in the GEOSS Clearinghouse. The results reveal that just 8.7% of the datasets have some quality element described in the metadata, 63.4% have some lineage element documented, and merely 1.2% has some usage element described.

Paula Díaz Redondo, Joan Masó, Eva Sevillano, Miquel Ninyerola, Alaitz Zabala, Ivette Serral, Xavier Pons (2012) Analysis of quality metadata in the GEOSS Clearinghouse, **International Journal of Spatial Data Infrastructures Research**. Vol 7, pp 352-377

In this paper GeoViQua the team explores the GEOSS Clearinghouse records where users often try to find the fit-for-use data. Quality indicators and provenance are included in the metadata and are potentially useful variables that allow users to make an informed decision avoiding to download and to assess the data themselves. However, no previous studies have been made on the completeness and correctness of the metadata records in the Clearinghouse. The objective of this paper is to analyze the data quality information distributed by the GEOSS Clearinghouse. The aim is to quantify its completeness and to provide clues on how the current status of the Clearinghouse could be improved and how useful quality aware tools could be. The methodology used in the current analysis consists in first harvesting of the Clearinghouse and then quantify the quality information found in 97203 metadata records, by using a semi-automatic approach. The results reveal that the inclusion of quality information on metadata records is not rare: 19.66% of the metadata records contain some quality element. However, this is not general enough and several aspects could be improved. For instance, 77.78% of quantitative measures lack measure units. When quality indicators are not sufficient, the lineage metadata information could be used to mitigate this situation by analysing the process steps and sources used to create a dataset. However, even though lineage is reported in 15.55% of the records, only 1.27% of the cases return a complete list of process steps with sources.

In this paper, GeoViQua team also provides some indications on what is lacking in the current producer metadata model and, detected a gap in usage or user feedback metadata in GEOSS. Moreover, information extracted from GeoViQua interviews with users indicates that they value informal comments and user feedback on datasets as a complement of the more formal producer-oriented metadata description of the data. Although, many efforts within the scientific community and the Quality Assurance Framework for Earth Observation (QA4EO) group have been invested in describing how to parameterize data quality and uncertainty, we conclude that still extra work can be done to provide complete quality information in the metadata catalogues. In brief, since the GEOSS Clearinghouse references data from the most important agencies and research organizations, the results presented in this paper provide a perspective on how well quality is disseminated in the Earth observation community in general.

### 4.1.3.2 Standards participation

In this report we highlight main **contributions to the standard process: 3 public engineering reports** and the start of **2 new standard groups** to develop standards.

Stefano Nativi, and Joan Masó, (2014) **GCI Research and GeoViQua Integration Engineering Report**. GEOSS AIP-6 Engineering Reports. [http://www.ogcnetwork.net/pub/ogcnetwork/GEOSS/AIP6/documents/Technical/GCIResearch/GEOAIP6\\_GCIResearch\\_GeoViQuaIntegration\\_ER.pdf](http://www.ogcnetwork.net/pub/ogcnetwork/GEOSS/AIP6/documents/Technical/GCIResearch/GEOAIP6_GCIResearch_GeoViQuaIntegration_ER.pdf)

This document summarizes two main activities that took place in AIP6. In the Agriculture group a methodology to integrate both GEO label API and the User feedback system API was tested in the GMU drought portal. In the GCI research, several GeoViQua quality improvements were incorporated into the DAB. The system is related to GEO SBA Task AG-01 Global Agricultural Monitoring and Early Warning. The system to be integrated into is its Component C1 - A Global Operational Monitoring System of Systems for Agricultural Production, Famine Early-warning, Food Security and Land-use Change.

Jon Blower, Xiaoyu Yang, Joan Masó and Simon Thum (2013) OGC® **OWS 9 Data Quality and Web Mapping Engineering Report** OGC 12-160r1. [https://portal.opengeospatial.org/files/?artifact\\_id=52884](https://portal.opengeospatial.org/files/?artifact_id=52884)

This Engineering Report specifies conventions for conveying information about data quality through the OGC Web Map Service Standard (known hereafter as the “WMS-Q conventions”), OGC Web Map Tile Service Standard (known hereafter as the “WMTS-Q conventions”), OGC KML (known hereafter as the “KML-Q conventions”) and OGC Augmented Reality Markup Language. Some problems and details were found in the implementation phase and a new version of this ER was released by GeoViQua. Details on the identification of pixel level layers and how the description of these layers can be converted into ISO metadata descriptions in the DAB can be seen in the document WMS-Q version 2.0 that can be found in the documentation area of the GeoViQua website.

Matthes Rieke, Benjamin Pross and Joan Masó (2013) **OWS-9 CCI Conflation with Provenance Engineering Report** OGC 12-159. [https://portal.opengeospatial.org/files/?artifact\\_id=51818](https://portal.opengeospatial.org/files/?artifact_id=51818)

This OGC® Engineering Report describes the architecture of a WPS capable of conflating two datasets while capturing provenance information about the process. The report also provides information about defining and encoding conflation rules and about encoding provenance information. This Engineering Report was created as a deliverable for the OGC Web Services, Phase 9 (OWS-9) initiative of the OGC Interoperability Program.

**Creation of OGC Geospatial User Feedback Standards Working Group Charter** (OGC 14-020). February 21, 2014

The creation of a new OGC Geospatial User Feedback Standards Working Group has been approved in the last OGC TC in Washington DC. The formation of the new group will soon start. The SWG proposal has initially been written in an official charter. The Geospatial User Feedback SWG is established with the following proposed activities:

1. Review the GeoViQua User Feedback Model (UFM; sometimes referred as Consumer Quality Model or User Quality Model) UML and XML schema that is currently included in the version 4 of the

GeoViQua General Quality model (<http://schemas.geoviqua.org/GVQ/4.0/>) and determine the best way to bring it into the OGC process.

2. Reach out to experts in online collaboration (e.g. on the topic of wikis) and scientific peer review processes to harvest existing research and experiences.
3. Refine which feedback items are more useful for users, producers and distributors, and discern what concepts can be easily understood by users and what others are less attractive as feedback items due to their descriptive and technical complexity.
4. Investigate how to best incorporate the UFM into the OGC standards framework (and the ISO 19115 Metadata model) including identifying places where there may be common elements in existing standards. Identify required best practices for data owner to allow users to comment on the metadata accessible through OGC data services such as WFS, WCS, and SOS.
5. Develop a UFM standard.
6. Assist the current implementations of the GeoViQua Quality model in the migration to the final agreed UFM standard.
7. Investigate the need for a revision of the OGC abstract model to include the User Feedback concept for Geospatial information.
8. Consider the standardization of a User Feedback query API or service interface and its relation to the CSW standards and impact on the GEO label concept.
9. Interact with other DWGs about challenges of globally identifying datasets and multilingual metadata.
10. Support upcoming research projects and implementers in taking up the GeoViQua UFM and the existing software implementations.

User feedback has been identified by GeoViQua interviewees as one of the quality components that GEOSS users appreciate during the project's requirements gathering phase. Quality information is often too abstract and difficult to understand alone and users like to complement this information with how the dataset has to learn from other people's experiences, e.g. difficulties found. With the explosion of geospatial digital data and particularly Earth observation data, there is a need for ranking and comparing mechanisms. This concurs with a continuing move towards a social web, user reviews as a generally accepted component of online shopping, and mainstream developments such as "social search". Including user-generated metadata into geospatial data services has the potential to improve the available metadata, increase usability of datasets, extend the appropriate usage/uptake/adoption of published datasets, give data producers a chance to alter the data collection or publishing methods, and ultimately improve the quality of the data as well as the quality of the analysis based on a dataset.

By OGC adopting a Geospatial User Feedback Model and Catalogue profile, the user community will be assured of a formal process for maintaining, improving, documenting and in fact, formalizing the standard. This will lead to a greater confidence in the use of the standard and new opportunities for integration with other related OGC standards.

### **IEEE standardization of the GEO label**

The GEO Label, developed by the GeoViQua project, is both a graphical representation of 8 facets of data quality, as well as an application that assess metadata completeness. Mechanisms for capturing user feedback on data sets, and reflecting this in the label are also part of the concept. More details on the GEO Label are available [here](#). The purpose of this process is to ask the SCC40 in IEEE to consider the GEO Label concept suitable as potential standard to be developed by IEEE, and if we would be willing to sponsor a



project around it. Members of the GEOSS Standards and Interoperability Forum will be asked to prepare a draft Project Authorization Request. The IEEE-SA process is explained at <http://standards.ieee.org/develop>. Once the group will start to work will decide how to proceed and which part of the work of the GEO label can be adopted or adapted in the IEEE geospatial label standard can and which part will be changed to fulfill the requirements of the IEEE membership needs. This is part of the outreach activities that GeoViQua has started to continue the live of the outcomes after the end of the project.

#### **4.1.3.3 Components for the GEOSS common infrastructure**

The most important outcomes of the GeoViQua project are its components. The following components have been released to GEOSS for its integration in the GCI or for its use in other projects. The new components are: The GeoViQua model, DAB-Q, User Feedback system, GEO label API, Quality emitter, The GICA as a Service, WMS-Q instances and Greenland client, KML-Q services, Metadata comparison, Rubric Q, Provenance viewer

##### The GeoViQua Quality model

The producer quality model introduces elements to record qualitative and quantitative quality information, and to identify resources (i.e., datasets) in order to relate metadata in hierarchical or other ways. The model extends ISO 19115, 19115-2 and 19157, adding means to report publications, discovered issues, reference datasets used for quality evaluation, traceability, and statistical summaries of quantified uncertainty.

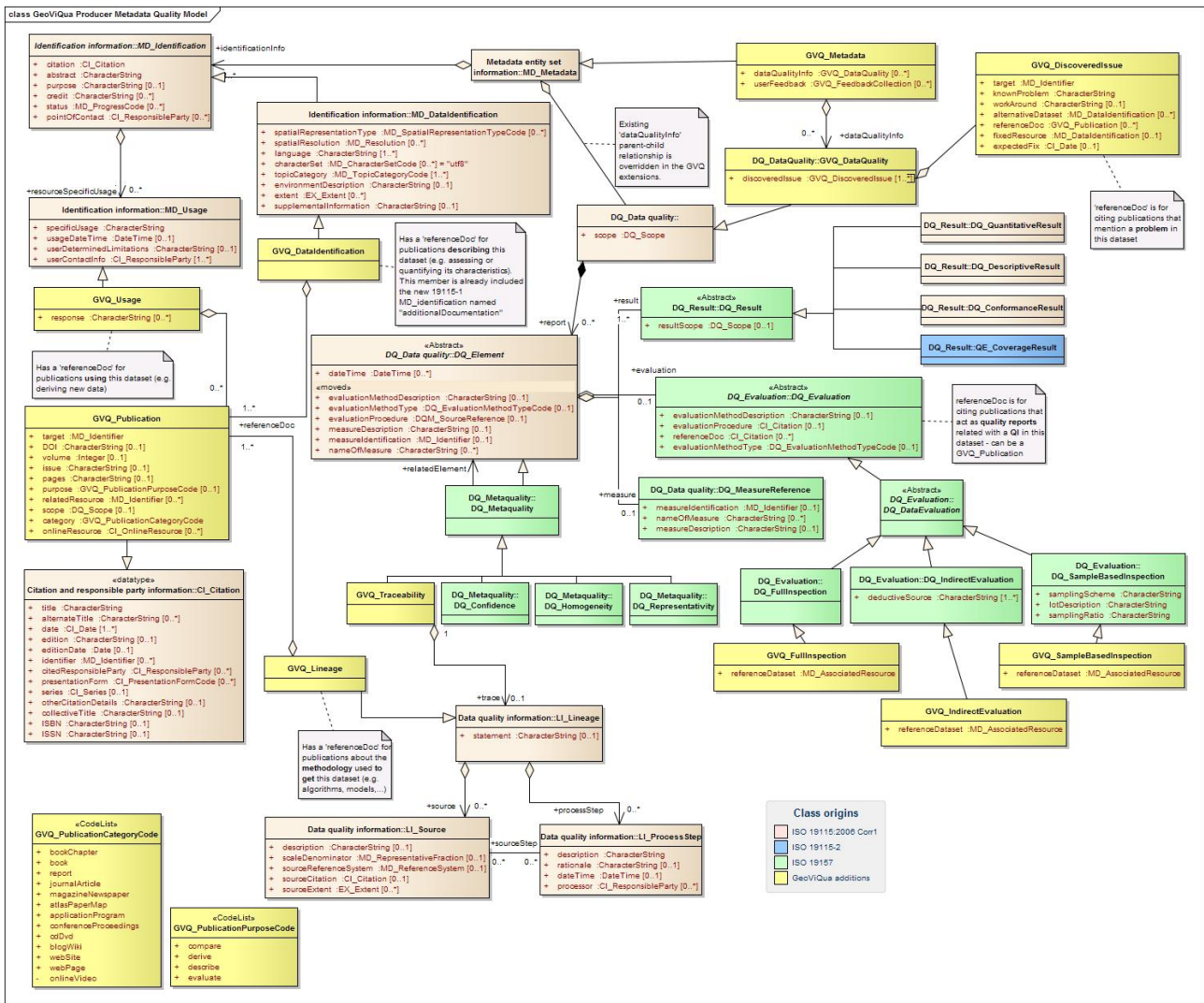


Figure 1: The GeoViQua producer quality model

The user quality model is shown in Figure 2. It re-uses some ISO quality and metadata elements, and elements of the producer model, but is far less strictly bound to existing ISO schemas. The root element of the schema is the `FeedbackCollection`, which can hold zero or more `FeedbackItems`. An empty `FeedbackCollection` indicates, for example, a search for feedback where no relevant data was found.

A 'FeedbackItem' may 'own' or 'hold' for example any combination of:

- (optional) rating;
- one or more user comments;
- one or more reports of usage (including reports of any discovered issues);
- citation of one or more publications;
- a text description of the feedback subject;
- text tags which might assist with topic-based search and linking;
- one or more quality overrides.

It must 'own':



- one or more sets of details on the focus of the feedback;
- a reference to at least one target of the feedback (a dataset, resource, etc.);
- one user information describing the submitter of the feedback.

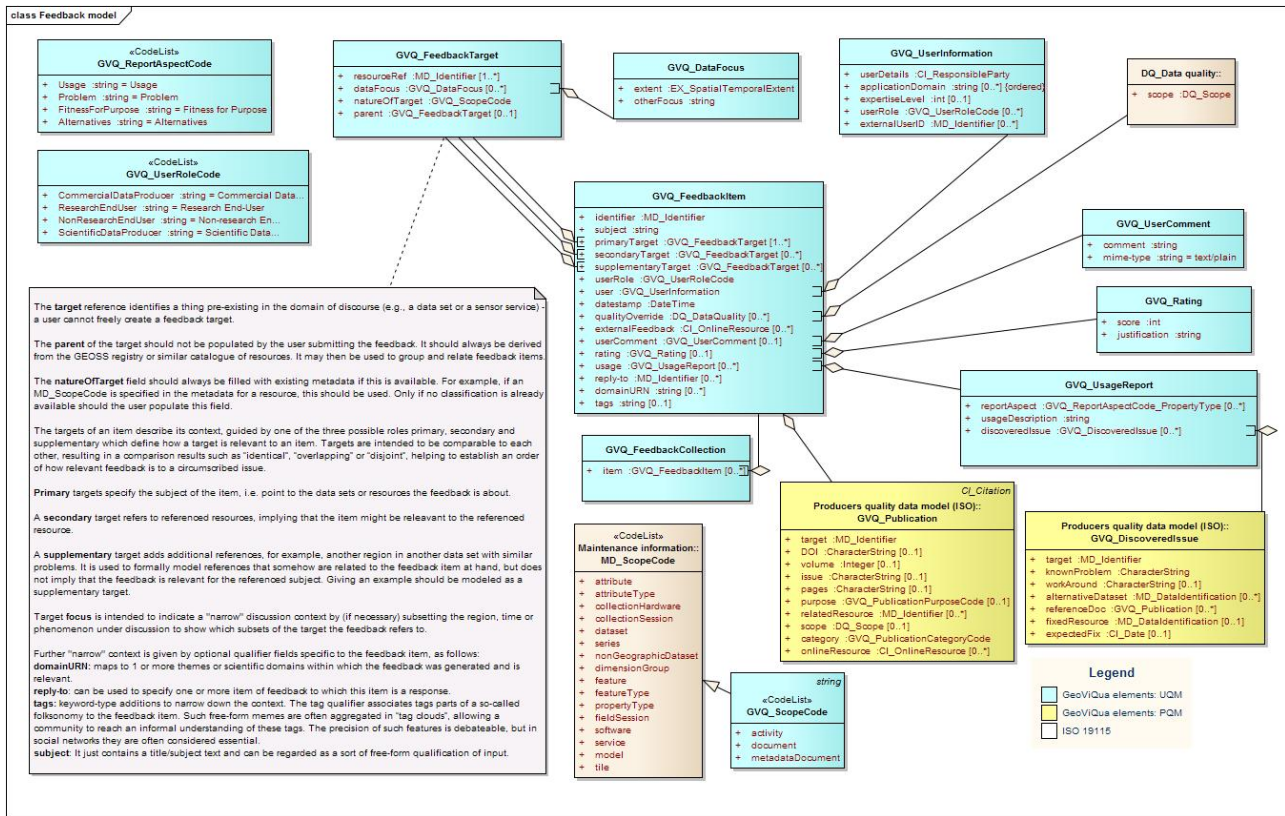


Figure 2: The GeoViQua user quality model.

Both the producer and user quality model have been formulated as UML diagrams which, as well as being viewable as online images (see above) may also be accessed using Enterprise Architect. A file containing both models, as well as all supporting schemas, may be downloaded from the following URL.

[http://schemas.geoviqua.org/GVQ/4.0/UML/ISO\\_19115-1-2\\_and\\_19157\\_Metadata\\_and\\_GeoViQua\\_v4.EAP](http://schemas.geoviqua.org/GVQ/4.0/UML/ISO_19115-1-2_and_19157_Metadata_and_GeoViQua_v4.EAP)

This UML defines all cardinality, extensions and relationships to existing ISO standards.

### DAB-Q

The GeoViQua Broker is a Quality-enabled Discovery and Access Broker (DAB-Q) service, developed in the context of GeoViQua project. The DAB-Q is an extension of the GEO DAB (formerly known as EuroGEOSS Broker) and enables smart search and discovery functionalities using parameters relevant to GEO products (date, scale/detail, bounding box, SBA, etc.) extended to include quality information.

Quality information can be stated both by data producers and by data users, resulting in two conceptually distinct data models, the Producer Quality Model (PQM) and the User Quality Model (UQM) (also known as User Feedback model). These models together form the GeoViQua Quality Model, now in its final version 4.0 (<http://schemas.geoviqua.org>).

The DAB uses the CSW/ISO-Q that is an extension of the standard OGC Catalog Service for the Web 2.0.2 ISO Application Profile (CSW ISO AP) to support quality-constrained queries. Following the standard CSW behavior, the CSW/ISO-Q interface requires explicit quality statements in order to match query constraints. In other words, datasets without quality statements will never be returned as a result of a quality-constrained query.

The Capabilities document of the CSW/ISO-Q interface is available at the following endpoint:

<http://geoviqua.essi-lab.eu/dabq-demo/services/cswisoq?service=CSW&version=2.0.2&request=GetCapabilities>

Quality-constrained discovery is enabled by query constraints based on the above quality indicators. Such quality constraints are expressed against queryable properties (also referred to as “queryables”), which are selected concrete expressions of quality parameters/indicators both for the Producer Quality Model and User Feedback model.

The DAB-Q includes new several accessos. The WMS-Q accessor maps the WMS-Q Layers into ISO datasets according to specific requirements described in the WMS-Q version 2.0. The current WMS accessor of the DAB maps all the Layers of the Capabilities document. The bottom-level Layers are mapped into the ISO concept of dataset and all the Layers above in the hierarchy are mapped to the concept of dataset collection. The WAF accessor simply reads the XML files in the folder and tries to map them into the ISO 19115 standard. In the context of GeoViQua the WAF contains metadata based on the PQM, which will be mapped into a uniform data model implementing ISO 19115, based on official ISO 19139 schemas (<http://essi-lab.eu/gvq/waf>).

This component can be tested using the GI client (see Figure 3): <http://geoviqua.essi-lab.eu/dabq-demo/gi-portal/index.jsp>.

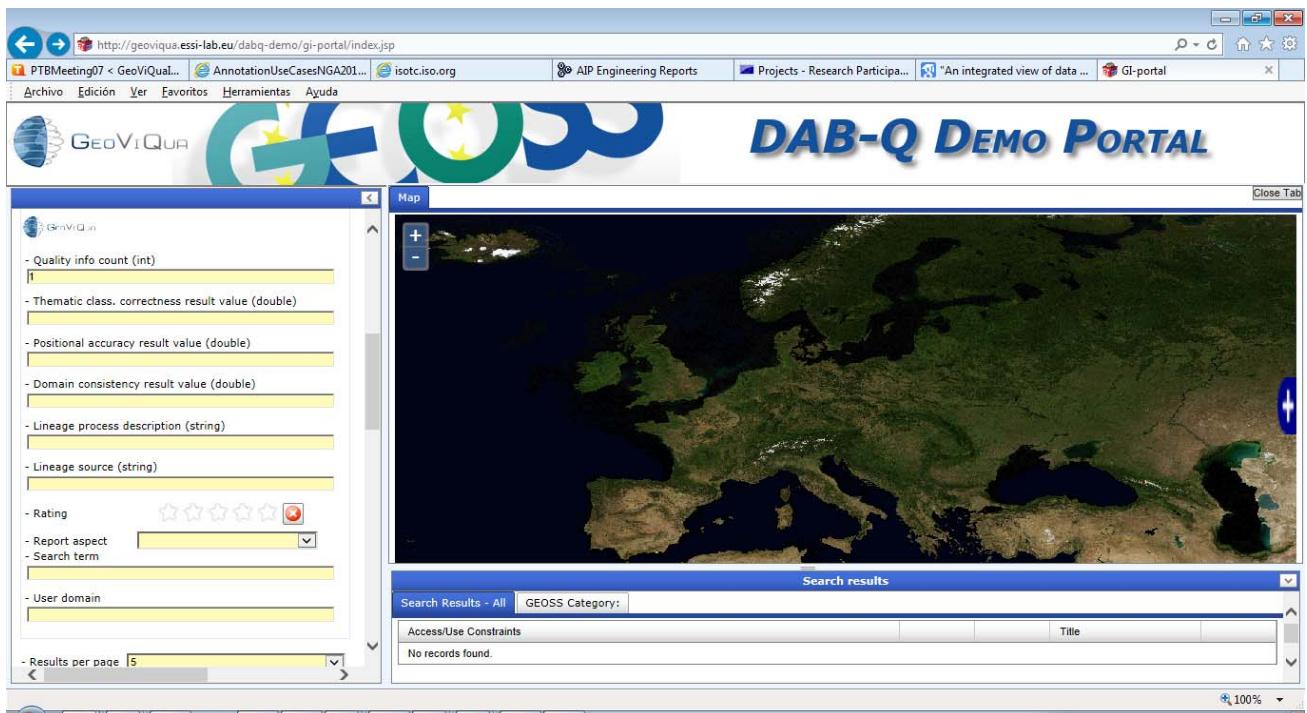


Figure 3: GI test portal

### User Feedback system,

The user feedback system is composed by several independent components: The user feedback database, the user feedback API and the user feedback interface.

The user feedback database stores the feedback items in a relational database. An advantage of using a relational database is the support for complex search queries. Since the feedback data is highly relational it makes sense to use a relational database. A disadvantage is that it is more difficult to create the highly complex XML output. The feedback catalogue uses the Django framework with a PostgreSQL database as backend.

The user feedback API is the query language to the catalogue allows the users to provide information about the different datasets present on the portal. The API framework Tastypie is used to construct a RESTful interface. Via this interface feedback items and collections can be requested and searched and feedback items can be posted. The feedback catalogue has an API that is used by the DAB to request all the feedback items that refers to a producer metadata document instance and it links both together in a single response.

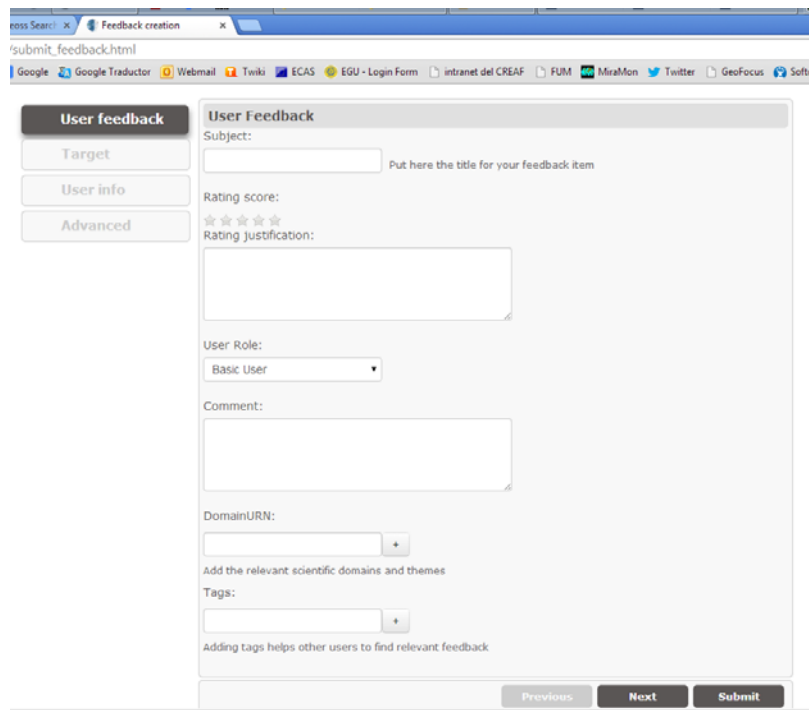
In the GeoViQua Geoportal mirror, the link to the feedback of each dataset has been placed on the dataset description page, and easily allows checking if any feedback has been submitted providing a feedback count on the button

Documentation and access to the about the API can be found here: <http://geoviqua.stcorp.nl/devel/api/v1>, <http://geoviqua.stcorp.nl/api/v1>

Record	
<b>File identifier</b>	LCL12_BcnGrn_2005_07
<b>Date stamp</b>	2013-06-14
<b>Reference system info</b>	EPSG:23031

Figure 4: Example of feedback button in a database description page.

To integrate the feedback client into the current and future portal we chose approach is to keep the client as simple as possible and independent of the server. This can be done by writing HTML pages, which only use JavaScript and do not require any server information, besides of course the path to POST to. The GEOSS user community is assumed to consist of researchers who are used to complex data, but also of users who are looking to find a dataset on which they can do a simple analysis and use the results e.g. for showing on a map on a tablet or phone application. When a researcher has worked extensively with a dataset he might want to be able to provide another researcher with information such as references and detailed information on a certain region. Since the dataset is of importance to him, he will probably take some time to provide his/her feedback. Someone who uses the dataset as-is might just be able to quickly provide a rating with justification and perhaps to add some comments and tags. To be able to satisfy both user groups several design concepts have been used. This interface was designed following the following principles: Wizard-style input, 'Add more' button for elements and Collapsible elements. The user feedback input interface can be tested here: [http://feedback.geoviqua.org/submit\\_feedback.html](http://feedback.geoviqua.org/submit_feedback.html)



The screenshot shows a web browser window with the URL `/submit_feedback.html`. The page has a navigation menu on the left with 'User feedback' selected. The main form is titled 'User Feedback' and contains the following fields:

- Subject:** A text input field with a placeholder: 'Put here the title for your feedback item'.
- Rating score:** A star rating system with five stars.
- Rating justification:** A large text area for providing reasons for the rating.
- User Role:** A dropdown menu currently set to 'Basic User'.
- Comment:** A text area for additional feedback.
- DomainURN:** A dropdown menu.
- Tags:** A text input field with a dropdown arrow, with a note: 'Adding tags helps other users to find relevant feedback'.

At the bottom of the form are three buttons: 'Previous', 'Next', and 'Submit'.

Figure 5: User feedback interface

User Feedback system has been released as an open source development available here: <https://github.com/GeoViQua/geo-userfeedback>. More information can also be found here: <http://geoviqua.stcorp.nl/home.html>.

### GEO label API,

The GEO label generator can be easily integrated through a script added to the webpage source code. To do it, the GEOSS portal only needs to know how to use the GEO label API that converts metadata and user feedback XML documents into an image mosaic that ends up composing the GEO label, see Figure 6. The GEO Label Service is a RESTful API that allows generating a SVG and JSON representation of the label from supplied metadata records. The documentation of the API can be found here: <http://www.geolabel.net/api.html> and [http://twiki.geoviqua.org/twiki/bin/view/GEO\\_SIF/SifGeoLabel](http://twiki.geoviqua.org/twiki/bin/view/GEO_SIF/SifGeoLabel).



Figure 6: GEO label showing all the facets filled in but the one about user feedback.

This API can be summarized as the following URL template:

<http://www.geolabel.net/api/v1/geolabel?metadata={ProducerMetadataRecord}&feedback={UserFeedbackItems}&format={format}&size={size}>

- {ProducerMetadataRecord} is an URL pointing to the PQM in the form of an XML file
- {UserFeedbackItems} is an URL to the corresponding XML feedback resource
- {format} stands for SVG or JSON
- {size} corresponds to the output size of the GEOLabel bounding box in pixels

Based in this API there are two implementations developed during the project that can be used and can be found here: <http://www.geolabel.net> and <http://geoviqua.dev.52north.org/glbservice/api/svg>



## REST API v1 Resources

/api/v1/geolabel

Operations to retrieve GEO label SVG representations.

Query parameters			
Name	Required	Data Type	Description
metadata*	optional	URL	Encoded URL of producer metadata document. Metadata document must be ISO19115, ISO19157, FGDC or GVV-PQM compliant.
feedback*	optional	URL	Encoded URL of feedback document. Feedback document must be GVV-UQM compliant.
parent_metadata	optional	URL	Encoded URL of parent dataset's producer metadata document. Metadata document must be ISO19115, ISO19157, FGDC or GVV-PQM compliant.
parent_feedback	optional	URL	Encoded URL of parent dataset's feedback document. Feedback document must be GVV-UQM compliant.
size	optional	int	Required size of the GEO label SVG in pixels. If not specified, the default size is 200x200 pixels.

\* Although optional, at least one of these parameters must be provided.

Figure 7: GEO label API documentation as shown in [www.geolabel.net](http://www.geolabel.net)

The Aston implementation has been released as open source and can be found here: <https://github.com/lushv/geolabel-service>.

### GECAaaS WPS (S&T)

Several other functionalities have been integrated in the GEOSS portal. One of the most innovative integrations is the capability to assess quality using reference data in the GEOSS portal. To illustrate the methodology, a web form or "Data Intercomparison" allow for selecting a satellite image and a collection of in-situ data that are send to the GECA Toolset (a toolkit for ingesting, processing and inter-comparing satellite data against correlative data) as a request to an online web processing service (a WPS). The intercomparison result is shown either within the GEOSS Portal or in a pop-up window. If accepted by the user, the results can be transformed into a quality indicator as explained below.

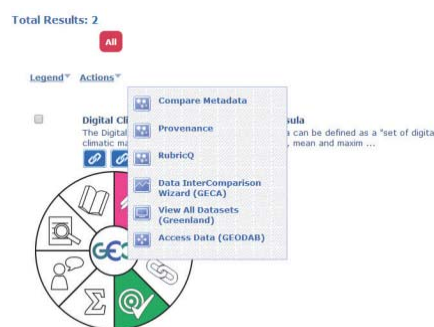


Figure 8: GECA as a service integrated in the GEOSS Portal

### Quality emitter

A challenge with many existing datasets is that they do not have reliable quantitative quality indicators available to them. To address this, GeoViQua has developed a tool to combine reference data with collocated measurements to compute dataset-level quality indicators. These quality indicators, such as the mean (bias), variance, or quantiles of the uncertainties can then be added to XML in the extended producer

quality model. The additional XML includes a description of the lineage of the quality indicators. The quality emitter tool also provides a validation of the quality indicators (often referred as meta-quality descriptors) which allow the user to judge the reliability of the quality indicators, and to easily access information on how these indicators were computed. More information can be found here: <https://github.com/GeoVIQua/computeqi-web> and <https://github.com/GeoVIQua/emulatorization-api>

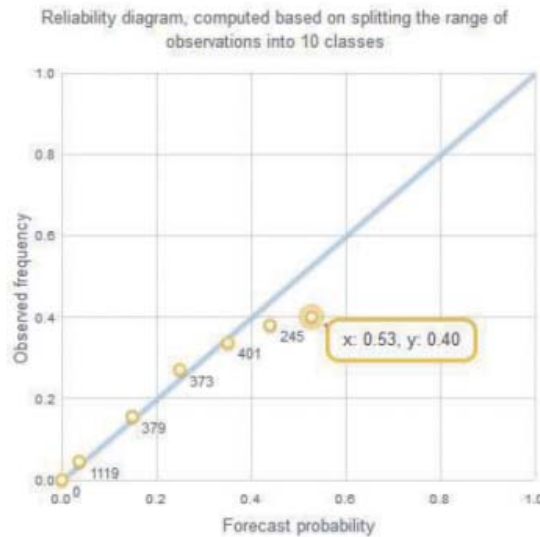


Figure 9: Quality emitter intermediate graphic.

### WMS-Q instances,

The WMS-Qs are Web Map Services following the standard defined by the OGC which are aware that some of its layers describe quality parameters of certain variables. Thus, instead of each layer corresponding to one variable like in regular WMS, in WMS-Q some layers are just statistical descriptors that inform about the quality and ensemble describe one variable. These instances are connected to the DAB-Q from where the portal is able to gather them. Each server is presented in the DAB as a metadata record for the services plus a number of metadata records corresponding to each of its served datasets (each dataset is compound of different variables which at same time are described by different quality components). The DAB-Q does not generate a record for each uncertainty component but just for the dataset level layers.

It is worth to note that WMS-Q also recommends the use of MetadataURL as a way to expose the dataset level metadata. This way a WMS service can act as a small metadata catalogue for providers that do not want to expose their catalogue (see Figure 10).

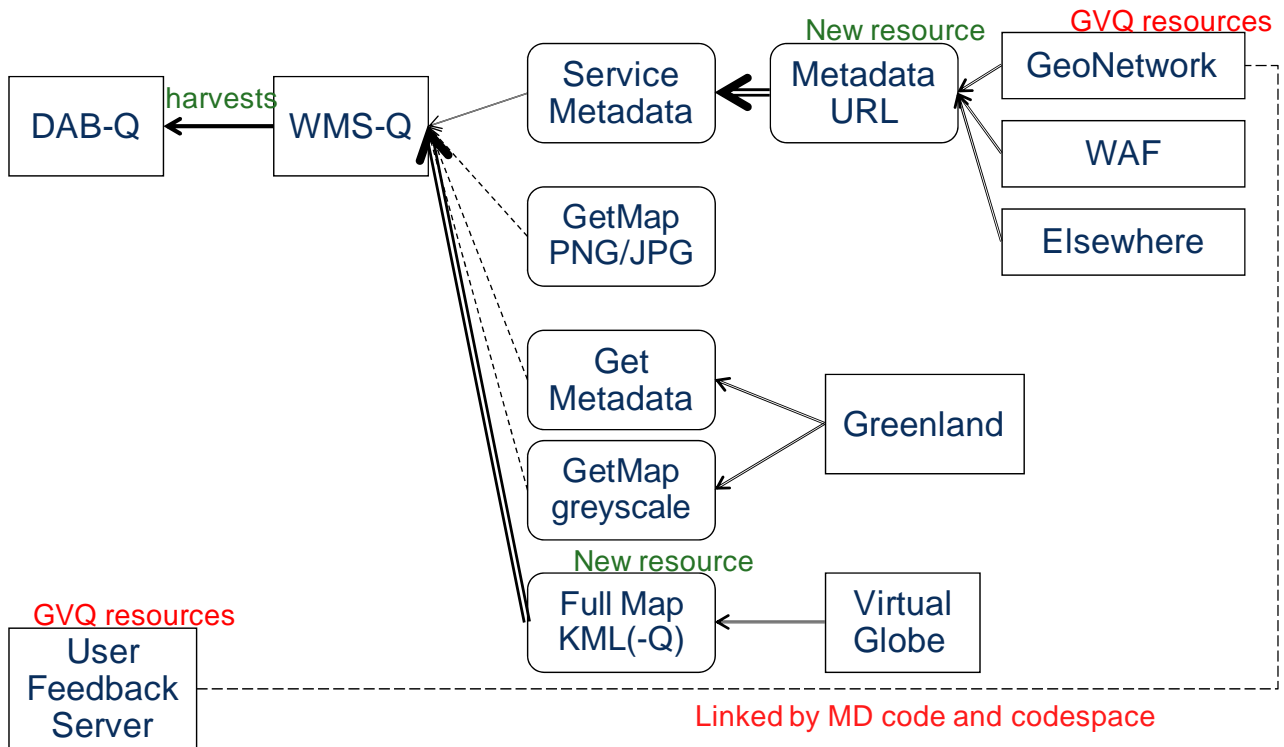


Figure 10: WMS-Q used as small metadata catalogue that the DAB can discover.

Same exercise has been done for Web Map Tile Services (WMTS) creating the WMTS-Q convention.

Several WMS and WMTS services resulted from the GeoVIQUA work: the UREAD WMS-Q can be found here <http://ncwms.geoviqua.org:8080/edal-ncwms> and <http://lovejoy.nerc-essc.ac.uk:8080/edal-ncwms> the CREAM WMS-Q service can be found here: <http://mmwms-q.geoviqua.org/cgi-bin/GeoVIQUA/WMSQ/MiraMon.cgi?> And the CEA carbon WMS can be found here: [http://webportals.ipsl.jussieu.fr/thredds/wms/CARBON/fco2\\_lmdz\\_pyvar\\_frederic\\_1988-2008.nc?](http://webportals.ipsl.jussieu.fr/thredds/wms/CARBON/fco2_lmdz_pyvar_frederic_1988-2008.nc?)

To query this services some clients were adapted during the GeoVIQUA and the results are available as components. The CREAM WMS-Q client can be found here (see ): <http://wms-q-demo.geoviqua.org/geoviqua/wmsq> <http://www.ogc.uab.es/geoviqua/wmsq>, the UREAD ncWMS-Q, can be found here: <http://ncwms.geoviqua.org/godiva2.html> and the Greenland WMS client (see ): <http://greenland.geoviqua.org/greenland>



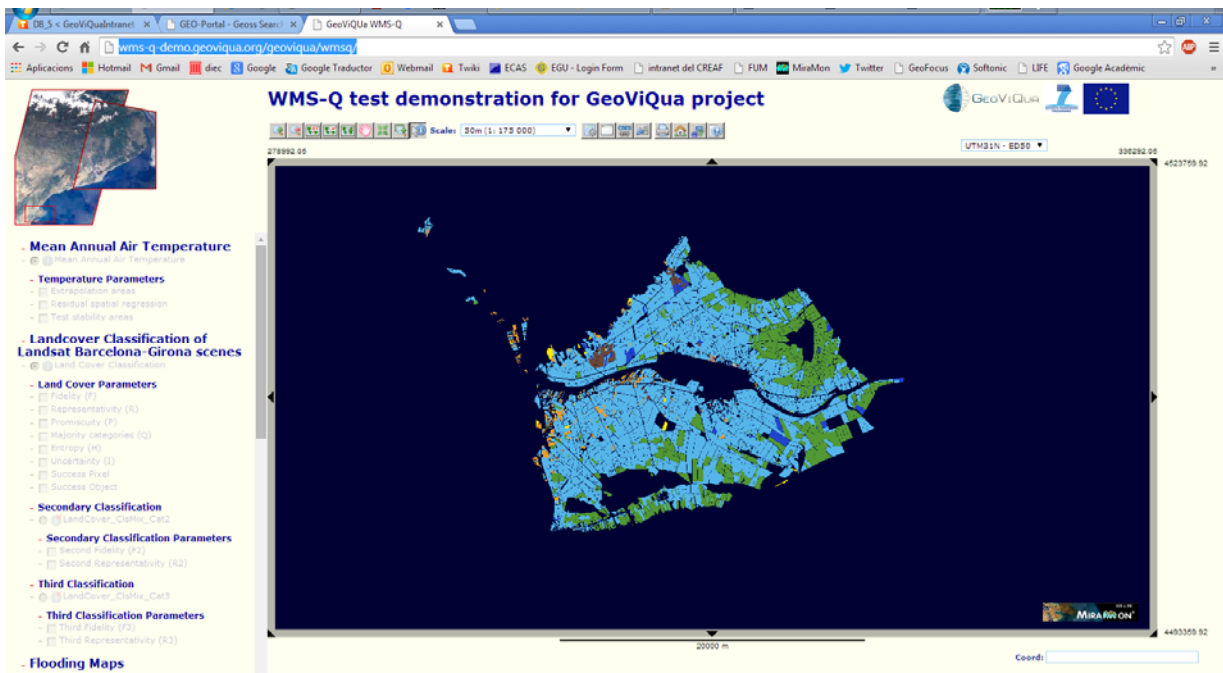


Figure 11: CREAM WMS-Q client

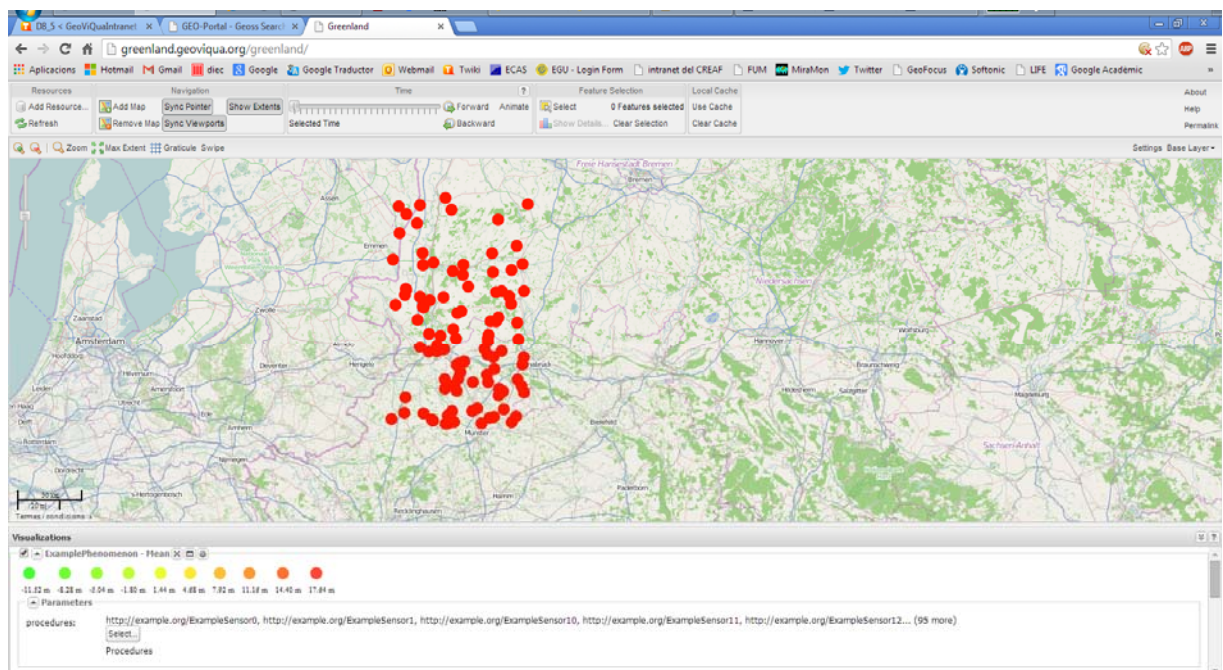


Figure 12: Greendland WMS-Q client

### KML-Q services

This implementation of KML-Q is a service that conforms to the OGC WMS-Q standard. It is based on the CityServer3D technology developed by Fraunhofer IGD (<http://www.cityserver3d.de>). The KML emitted contains machine-processible quality information as well as quality visualization. An extrusion and a shaded colour palette indicating category and quality have been implemented. The KML-Q features are exposed as styles. This component can be found here: <http://kml-q.geoviqua.org:8081/cs3d/Controller?do=wsc>.

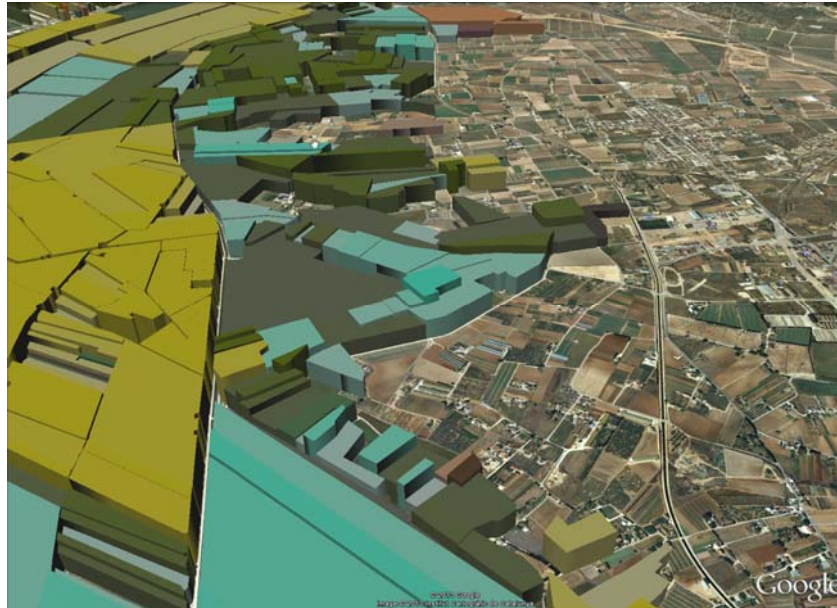


Figure 13: KML-Q representation of the Ebro Delta data set

### Metadata comparison

A metadata comparison tool presents dataset descriptions in columns, with attributes and metadata parameters aligned as rows marking with a colour the optimum dataset in each case. It also offers graphical plots for visual comparison. Additionally, a system for scoring the quality metadata is also introduced as a way to stimulate producers to include more information about quality and uncertainties. It also includes parallel coordinate' plot that uses different vertical axes to rank the values of each attribute in one axis and their display together in parallel in order to make easy the comparison between the attributes and facilitate the choice of the right set of data for the purposes of the. In addition, star plots are included. Star plots similar to the parallel coordinate' plots, but in this case the axes are centred in the same point and extending in all directions. In these axes the values of the different attributes are represented, resulting in a kind of radial plot with different volumes according to the datasets (see Figure 14).

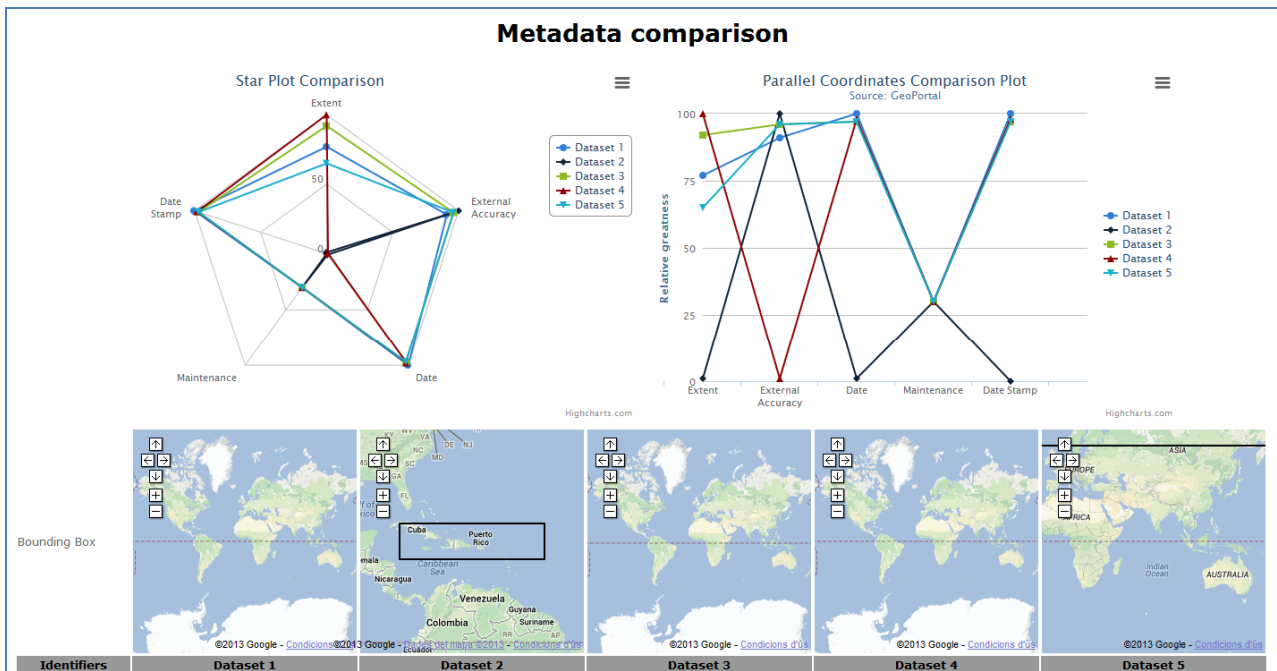


Figure 14: Implementation of the statistical plots in the metadata comparison interface

### Rubric Q,

The rubric extension of the Ted Habermann's Rubric (<http://www.ngdc.noaa.gov/metadata/published/NOAA/NESDIS/CLASS/iso/>) that originally included eight information groups depicted in the NOAA rubric tool (Identification, Connection, Extent, Distribution, Description, Content, Lineage and Acquisition Information). Two new information groups related with ISO quality have been added to the initial sheet, they are Quality and Usage. These two groups have been designed to increase the information available for users and producers, to be represented and consequently visualized in the rubric tools. Other addition made in rubric tool is related to lineage information. In ISO 19115:2003 standards the lineage information is a class pending from DQ\_DataQuality, thus we have extended the rubric previous information to include all the lineage details related with data quality. All the original and new information is fully summarized at the top of the HTML page.

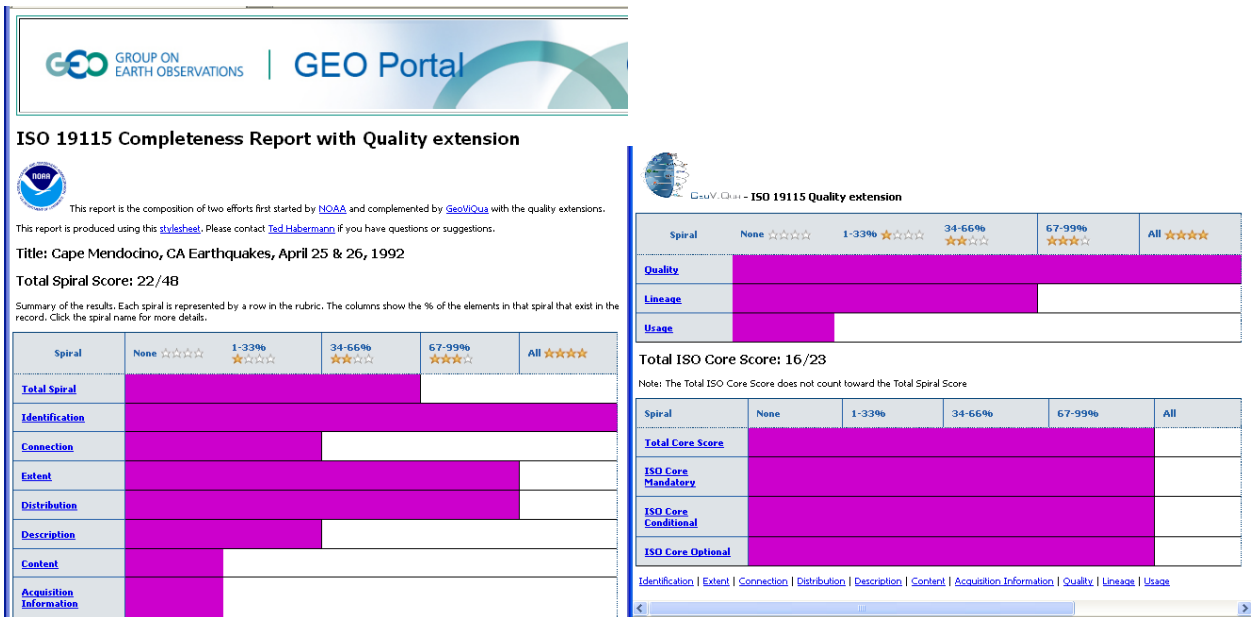


Figure 15: Rubric tool quality extension

Provenance viewer:

The Provenance component provides a detailed visualization of the documented description of processes used to obtain the data on its current state. The processes and source data used on each step are related using hypertext links, and buttons to collapse the information presented.

In the GeoViQua Geoportal mirror the solution has been reusing the selection boxes required for the metadata comparison component, adding a global button in the search page to launch the Provenance component (see Figure 16). This component is also based on a XSL transformation of the XML metadata files to HTML.

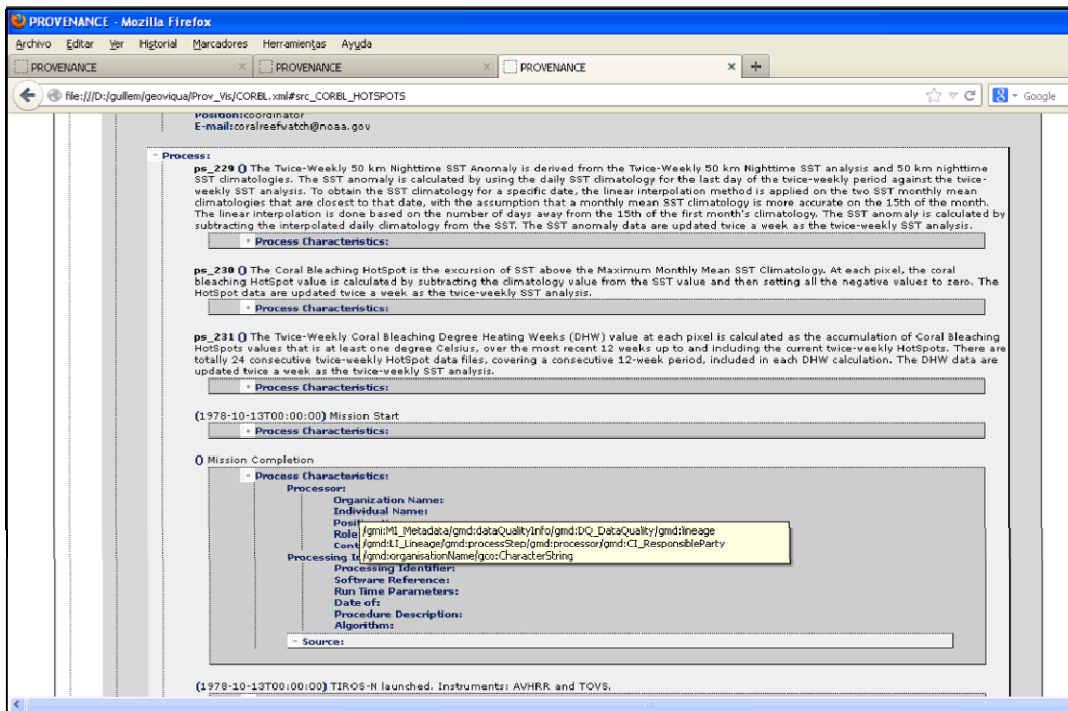


Figure 16: Provenance visualization integrated into the GEOSS Portal

### GEOSS Portal Mirror

This component is a replica of the GEOSS portal that demonstrates how all client components can be integrated in the official GEO portal at [www.geoportal.org](http://www.geoportal.org). This process was already exemplified with on the GeoViQua project (see Figure 17).

Most of these components are based on java Portlets that can be integrated into a Liferay portal. Therefore, a web page must be created for each of them at portal level, and the corresponding Portlet added to that page. Launch buttons or links for the components can be then linked to the appropriate new page. Because the components are based on technologies fully supported by current versions of main modern browsers, they can be easily integrated to other kinds of portal frameworks or plain HTML web pages.

The GEOSS portal mirror can be found at: <http://geoportal.geoviqua.org> or at <http://scgeoviqua.sapienzaconsulting.com>.





Figure 17: Multiple selection of entries and compare metadata launch button.

#### 4.1.3.4 Components Documentation

The project compiled a lot of documentation about the components and standards used. Some of this documentation was collected in the public deliverables that are available in the project website and in the CEN projects results repository. Here we emphasise on some extra resources that will be able after the project.

##### GEO label services demo

The url <http://www.geolabel.net> contains documentation an examples on how to use the GEO label API.

The url <https://github.com/igd-geo/pcolor> contains information about how to use the colour schemas used in the KML-Q, implementation.

The url <https://github.com/GeoViQua/geoviqua-geonetwork-plugin> contains information and the GeoNetwork plugin to store information using the GeoViQua producer quality model in GeoNetwork.

All the GeoViQua schemas for the producer and user quality model are available at <http://schemas.geoviqua.org>

The extended QualityML vocabulary developed based on the UncertML and some clues on how to use QualityML and UncertML for feature level and pixel level quality can be found here: <http://qualityml.geoviqua.org>



Figure 18: GeoViQua QualityML website

Tutorials on how to use the Producer Quality model in the GeoNetwork implementation, how to input user feedback for a dataset, how to use the GEO label API and how to publish a WMS-Q service can be found here: <http://tutorial.geoviqua.org>. The tutorial is not just a collection of documents to read but contains interactive exercises allowing readers e.g. to create metadata documents in a GeoNetwork catalogue, introduce new feedback items in the feedback database and create their own GEO labels based on their own metadata. This tutorial was shown by the first time in the INSPIRE Conference 2013 in Florence.



Figure 19: GeoViQua tutorials first page.

### Data Quality Tutorial for GEOSS Providers

This tutorial is published as a documentation resource for the Global Earth Observation System of Systems (GEOSS). The purpose of this tutorial is to assist the GEOSS providers and GEOSS users in understanding the various ways in which GEOSS can be used to provide and use Earth observation data and services. The contents of this tutorial are provided free of any intellectual property rights and offered into the public domain for the common good.

This tutorial can be found directly at the GEOSS Best Practices Wiki (BPW) (<http://wiki.ieee-earth.org>). It can also be found indirectly via a search at the Geo Web Portal (GWP) (<http://www.geoportal.org>). If registered at the BPW, and logged in, a reader of this tutorial can submit comments on each page of the tutorial. These comments can serve to point out ways in which this tutorial can be improved upon.

More information:

<http://wiki.ieee->

[earth.org/Documents/GEOSS\\_Tutorials/GEOSS\\_Provider\\_Tutorials/Data\\_Quality\\_Tutorial\\_for\\_GEOSS\\_Providers](http://wiki.ieee-earth.org/Documents/GEOSS_Tutorials/GEOSS_Provider_Tutorials/Data_Quality_Tutorial_for_GEOSS_Providers)

### 4.1.4 Potential impact

GeoViQua main impact is the significantly contribution to integrate quality-aware visualisation of Earth Observation systems into GEOSS developments (in particular, make progress on the GEOSS Common Infrastructure) at the European and international level, bringing together key partners from academia, industry and the broader scientific community.

In particular, GeoViQua has provided consistent, high quality specifications, protocols and components allowing scientists and decision makers to access easily to a range of EO information including complete, flexible quality information. GeoViQua components and services have been made available for the GCI to



incorporate, complemented by GEOSS Portal enhanced visualisation technologies, which also communicate data quality.

GeoViQua has provided a range of tools and components to allow users seeking data/imagery and associated quality indicators to access the information through modern visualisation environments via the GEO Portal. Particular emphasis has been done on intuitive and easy-to-use tools, providing components, which enable data providers and users to derive, attach and mine quality indicators for existing datasets using both classical CAL/VAL quality indicators and user opinions. GeoViQua has also provided components integrated in the DAB to allow the discovery of data (using quality indicators in the search process) and components to allow easy visualisation of the resulting data and its reliability in modern 2D and 3D visualisation settings. All this components has been demonstrated and need to be moved into the IIB and the IDB Boards to be included in the future GEOSS Common Infrastructure revision. GeoViQua will continue working with this boards find ways to include these components. In the server side, CNR will continue moving these aspects forward. In the client side, client side, ESA is looking on ways (and funding) to move client components from the GEOSS portal mirror into the operation one.

GeoViQua in working to maximize the impact of its components with the following actions

- Components list is published in the GeoViQua website
- Components are published in the Components and Services Registry
- Most of the components are available as open source and have a Github page. Examples of this are the user feedback system, the GEO label API, the colour schemas used in KML-Q, etc.
- Tutorials of some of the components have been published in the internet.
- Components has been integrated and demonstrated in the GEO-X Plenary.
- Some components that require services are hosted on services that will live after the end of the project. This is particularly true for the
- Some components were developed by SME's. In particular, S&T Corp can support the deployment of an operational user feedback system or the intercomparison module. In the same way, 52North can support the deployment of client components and the GEO label in GEOSS and in other systems.
- Some of the developed components will be included in the new versions of the MiraMon software.

Participation in GEO boards, components and in Communities of Practice (CoP) workshops has been facilitated by CEA in the Global Carbon Project and ESA in the industry (such as CEOS Working Group on Calibration and Validation, QA4EO and the European Association of Remote Sensing Companies [EARSC]) and the European Commission representation in GEO. Thanks to this collaboration, GeoViQua has leaded a strategy for the implementation of the GEO Label. This was based on adding richer structured quality indicators to datasets, together with considerations about how to convey trust to users that will contribute to the development and 'brand identity' of a GEO dataset. We are continuously pushing for the GEO label idea in as many forums as possible including IEEE standardization process. GeoViQua has engaged with key bodies (QA4EO, DDQ, CEOS, OGC) and user communities in the EO domain. Through the project outcomes

and the sustainable dissemination strategy GeoViQua has achieved a long lasting impact on both data providers and consumers, providing tools and a framework for easily discovering, accessing and visualising EO data and associated quality information.

ESA provided through the Sapienza Consulting subcontracting a Virtual Machine of the GeoPortal. This is a replica of the GeoPortal and was used to test developments in the project and make sure that the developments were done in the same web technology that the GeoPortal uses so it that can be immediately incorporated on them one validated by ESA and GEO.

In terms of direct impact within GEO tasks, GeoViQua has had considerable impact, as follows:

- GeoViQua outputs and recommendations has included QA4EO implementation to GEOSS, has impacted the way QA4EO and DDQ addresses the requirements for data registration to GEO, has contributed to the dissemination of QA4EO implementation.
- GeoViQua quality model and concept has been included in the DDQ best practice document.
- GeoViQua tutorial has been developed for the Best practice wiki and SIF is constantly helping in the process of pushing GeoViQua components into the operation phase.
- ID-01 “Advancing GEOSS Data Sharing Principles”: GeoViQua has contributed to the development of working data sharing policies and procedures for GEOSS by ensuring data access for capacity building;
- ID-03 “Science and Technology in GEOSS”: involving the scientific community to collaborate within GEO to address interactions between the components of the global integrated Earth system, and connect natural and socioeconomic sciences, GeoViQua is highly relevant to this task’s target of “engaging the research community in GEOSS to achieve breakthroughs in the understanding of the Earth’s changing environment and global integrated Earth system”.
- IN-03 “GEOSS Common Infrastructure”: GeoViQua has contributed to the GEOSS Best Practices Registry with best practices deliveries;
- EC-01 “Global Ecosystem Monitoring”: GeoViQua has helped to create a globally agreed global classification scheme for ecosystems covering terrestrial, freshwater, and ocean ecosystems. In particular project’s achievements have contributed to ease the integration of newly available global ecosystems product with existing ecosystem maps and databases. Therefore support ecosystem (GEO Trends Analysis Network) regarding conservation (habitat loss, degradation, increase of invasive species...) which are some of the main objectives of the LandPC pilot case study. Finally GeoViQua has also supported biodiversity GEOBON monitoring approaches;
- CL-01-C1 “Extension and Improvement of the Climate Record”. Climate reanalysis efforts require observations to be provided with quality and uncertainty parameters. The consortium (particularly UREAD) had take advantage of existing close links with ECMWF to ensure that GeoViQua developments were useful to this community;

To demonstrate the impact, and further motivate the usage of GeoViQua solutions a series of pilot case studies which had been carefully selected have illustrated the usage of the standards, protocols and tools in a real world setting. These pilot case studies were the key to bridge a powerful link between S&T and daily needs of CoP, other activities from GEO and geodata users in general. Thanks to GeoViQua, science and management related to agriculture, climate, fishery, land cover, carbon cycle and air quality have newest resources and quality data. These pilot cases have demonstrated the usability of the GeoViQua solutions and will help to promote their uptake.

GeoViQua team has made some efforts to get more funding to continue GeoViQua work. The more successful of these attempts was the CHARMe project that aims to allow users to view or create annotations that describe how climate data has been used and what has been learned. This information can include Citations that reference a particular dataset, results of assessments - reanalysis, quantitative error assessments, provenance - processing algorithms and chain data source, external events that may affect the data - volcanic eruptions, El Nino, sensor failure; supplementary dataset quality information - maturity, discontinuity, updates. Some of these items were already addressed by the GeoViQua model. The coordinator of CharMe is the University of Reading that at the same time is partner in GeoViQua. The intentions of the University of Reading and the coordinator, Jon Blower, are to take advantage and use of the GeoViQua developments and continue in the same direction extending the GeoViQua model when needed. Some partners in the GeoViQua team are also targeting other opportunities in the new Horizon 2020 call.

Meanwhile, GeoViQua results are expected to be used in other active projects such as GEOWOW, and COBWeb. GEOWOW is a project, co-funded under the European Community's Seventh Framework Programme in response to call ENV.2011.4.1.3-1 "Interoperable integration of Shared Earth Observations in the Global Context". It is implemented by a consortium of 15 partners from Europe, Brazil and Japan and is coordinated by the Italian establishment of the European Space Agency (ESA-ESRIN) in Frascati. GEOWOW benefited by the advances and solutions that GeoViQua proposed on data quality search and visualization. Quality-aware search functionality, user-rating capability following the web 2.0 trend, metadata standards enhancements, low bandwidth and quality visualisation techniques are a few of GeoViQua's objectives that were considered for in the forthcoming architectural design of GEOWOW. The collaboration between the two projects was possible by the participation in the AIP initiatives where GeoViQua regularly introduced and share its components and results, especially regarding the Unique and Universal identifier for the GEOSS tutorial; or by direct communication. On the other hand, COBWeb brings together expertise from 13 partners and 5 countries. The main context for the project is the Global Earth Observation System of Systems (GEOSS) and the UNESCO World Network of Biosphere Reserves (WNBR). Concentrating on Biosphere Reserves in Wales, Germany and Greece, the main aim is to create a testbed environment which will enable citizens living within Biosphere Reserves to collect environmental data using mobile devices. Information of use for policy formation and delivery will be generated by quality controlling the crowdsourced data and aggregating with Spatial Data Infrastructure (SDI) type reference data from authoritative sources. In the process the project aims to build up shared expertise in these new and developing technologies and understand how crowdsourcing/citizen science techniques combined with SDI-like initiatives can deliver both societal and commercial benefits. Chris Higgins, the COBWeb coordinator, offered the possibility to organize one of the project meetings in the in EDINA facilities in Edinburgh, September 9th and 10th. The meeting was co-located with a COBWEB project meeting in a way that project members of both projects

could talk during the coffee and lunch breaks. In the afternoon of both days, both project meet together and exchange presentations. In the first afternoon, the presentations where focused on CobWeb activities and needs. In second afternoon, GeoViQua partners presented what GeoViQua could offer to CobWeb. These are the agendas of both meeting parts. In a more generic GeoViQua was present in the last previous editions of the GEOSS European projects workshop, GEPW-5 (London) and in GEPW-6 (Rome), and The European Commission and the GeoViQua coordinator team organized the last GEPW-7 in Barcelona on 15-16th April 2013. GeoViQua is well known in the GEOSS European community.

Another important impact is the efforts in the standardization process that has been described in the previous section both with the OGC and the IEEE. The consortium as a whole has assumed the responsibility to support these standardization activities in the near future. Some of these efforts will continue in the near future. Additionally, GeoViQua has collaborated with the CEN (European Committee for Standardization) in a formal way by signing a Memorandum of Understanding. GeoViQua applied for “project liaison” with CEN/TC 287 "Geographic information". We strongly believed that by joining forces in this Pan-European forum, GeoViQua Project efforts to create practical and effective standards will benefit both the industry and the user. As we have exposed, GeoViQua deliverables and outcomes will be registered in the CEN repository. Also, GeoViQua has participated in the standardization groups for ISO 19115-1 and 19157 in ISO/TC 211 meetings Toulouse and Delft. Some of this comment were considered and influenced the recently approved 19115-1 and 19157.

The GeoViQua team members that are in the academic and research sector will continue working on the release of new scientific publications as a continuation of the ones already published and exposed in the previous section. The GeoViQua team estimated in its final meeting that the possible paper number that are potentially publishable in highly indexed publications is around 8.

#### 4.1.5 Address of the project public website

For further information and access to all project documentation and reports, please see [www.geoviqua.org](http://www.geoviqua.org). For further information, contact Joan Masó, CREA, [joan.maso@uab.cat](mailto:joan.maso@uab.cat).

Several other important URLs to get more information about this project has been provided all over the document.

GeoViQua partner name	Acronym
Centre de Recerca Ecologica i Aplicacions Forestals	CREAF
Universitat Autònoma de Barcelona	UAB
52°North Initiative for Geospatial Open Source Software GmbH	52N
Fraunhofer-Gesellschaft zur Foerderung der Angewandten Forschung E.V.	Fraunhofer
Consiglio Nazionale delle Ricerche	CNR
Aston University	AST
The University of Reading	UREAD

Commissariat A L Energie Atomique Et Aux Energies Alternatives	CEA
European Space Agency	ESA
Science and Technology B.V	S&T
Open Geospatial Consortium (Europe) Limited	OGCE