Integrating new data visualisation approaches of earth Systems into GEOSS development

QUAlity aware VIualisation for the Global Earth Observation system of systems

Deliverable D8.5
GCI technology integration strategies of the final solution report

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1. Abstract
This document exposes the methodology to be followed for the integration of the GeoViQua client components into the GEOSS Portal (part of the GEOSS common infrastructure). It describes the relevant work done about the interaction of the project components in the scope of the integration work package (WP6) and provides instructions on how to get and deploy those components. This report also includes brief descriptions of the quality-aware developed client side tools. The experience gained in the integration through a GEO Portal mirror virtual machine environment provided by ESA has been crucial. This methodology will be submitted to the Infrastructure Implementation Board in GEOSS, who will be able to decide how to implement it.

2. Introduction
This document describes the methodology for deploying the GeoViQua components integrated in WP 6 and tested in WP7 pilot case activities. We enumerate the relevance of quality aware client elements and tools, and instructions on how to integrate them into the GEOSS portal. The integration in the GEOSS-GCI architecture is achieved by use of a set of protocols and extensions considered and developed in GeoViQua and applied in the components, as a set of standardized services providing quality aware discovery and visualization. This deliverable complements the deliverable D6.4 GeoViQua components integration within the GCI that focuses more on the server side and the integration into the GEOSS GCI services. This deliverable follows the same structure of D.7.4. “GCI pilot case perspective recommendations for enabling quality aware visualisation and search”. That one precedes this one and provides the description on how these components has been tested in the integrated testing environment that GeoViQua has deployed for this purpose. In opposition, this document focus on the actual integration in the client side

2.1 Introduction to the GeoViQua components
The client components are clearly identified in the right hand side of the following GeoViQua components UML schema shown in Figure 1.
Currently, producer and user encoding models (WP6), quality-aware queriables and geosearch linking data providers and user feedback information stored in catalogues (WP4), together with visualization tools (clients and servers) (WP5) are ready for its integration into de GCI. In addition, the GEO label component is part of the GeoViQua quality-aware contributions to GEOSS and can be integrated. Quality elicitation components, including intercomparison (WP3) are exemplary use cases that show the way for future components that help to generate quality indicators in the GCI.

2.2 Introduction to the GeoViQua clients in relation to their WP

GeoViQua provides a set of scientifically developed software client components that facilitate the creation, search and visualization of quality information of Earth Observation data integrated and validated in the GEOSS portal mirror.
2.2.1 WP2 User requirements

Covering the needs of both data producers and users is one of the main targets of the project. Accordingly, the scope of GeoViQua was delimited in WP2, as explained in D.2.1 “User requirements document” and D.2.2 “Technical requirements document”. User requirements have been taken into account in the development of the following work packages activities:

2.2.2 WP3 Quality elicitation

A first review of metadata elements, quality standards, quality indicators encoding in data and metadata formats can be found in D.3.1. “Metadata extraction quality component”.

Datasets compiled in the pilot cases selection (see D.7.1. “Document pilot case studies in a standard format”) were used in the quantitative and qualitative estimation of quality indicators. Those indicators where produced for both continuous and categorical variables at dataset level and sample level (sample including pixel level as the ultimate individual measurement in raster data models and object level in vector data models). This datasets metadata is useful as a controlled set that can be discovered in the GEOSS Portal mirror through the Data Access Broker (DAB) component, see Figure 2. More details are provided in the D.7.3 “Data quality parameterisation for the GeoViQua pilot case studies”.

Figure 2: Metadata View

In WP3 quality elicitation components have been developed (see QI emitter in the UML diagram). More details are provided in D.3.3 “Quality elicitation component for continuous and discrete valued variables” about how the QI emitter hides the complexity.
of the GECA process and offers an interface to easily compare a dataset with reference data and elaborates quality indicators that are later discoverable in the GEOSS portal mirror. More details are provided in D.3.3 “Quality elicitation component for continuous and discrete valued variables” and D.7.3 “Data quality parameterisation for the GeoViQua pilot case studies”. To name a few, geographic and attributes collocation, interpolation, modelling and classification processes have been considered in error estimation and validation, altogether leading to quality elicitation, uncertainty mapping and accuracy assessment reflected in quality parameterization, quality indicators and quality measures. Ongoing tasks in WP3 might introduce additional inputs for prototypes testing (e.g., integration of the GECA toolset for quality elicitation, collocation and data assimilation, with the corresponding derivation of quality indicators).

The models, and related components like the Geonetwork Metadata Editor and the User feedback editing tool, have been tested in WP7 activities, generating illustrative best practices reports and tutorials (http://tutorial.geoviqua.org/). In addition, the User Quality Model (UQM) editing tool is described in D.3.2. “User feedback quality elicitation tool”, see Figure 3 and Figure 4.

Figure 3: Schema Plugin: Metadata Creation and Editing
2.2.3 **WP4 Quality search**

New quality descriptions, fit for purpose dataset discovery using metadata intercomparison tools, quality labels and quality thresholds, or quality aware queriables for geosearch capabilities have been implemented in the GeoViQua solutions, as described in the D.4.1 “Graphical search interface report”. In fact the GEOSS portal mirror contributed by ESA to the project was adapted to perform requests to the new DAB-Q. This instance of GEOSS portal is capable of metadata comparison, which means that two or more metadata documents are presented side by side easily visualizing different information topic by topic. This representation is able to emphasize in green colour the numeric metadata properties that are better for the user and even present a graphical representation of 4-5 criteria using star plots and parallel coordinate plots. Those types of plots are easy to interpret allowing selecting the fit for purpose dataset rapidly. A future work on this tool could be to provide the user a way to choose its own criteria for a better plot comparison. Improved provenance visualization and metadata rubric assessments are other metadata visualization improvements incorporated in the client side. The DAB-Q demo portal client prototypes quality-constrained queries are possible both for the producer quality model and for the user feedback model. The user feedback is integrated in the query response page as well as the user feedback system that invites users to submit more feedback. Both clients are able to present GEO labels next to the query response page.
2.2.4 WP5 Quality visualization

Quality elicitation and encoding should be subsequently displayed using appropriate visualization techniques that enhance the product’s accuracy comprehension and are supported by widely used visualization standards suchlike WMS or KML. Therefore, GeoViQua visualization work package has used WMS and KML clients in international related initiatives. Outcomes are described in D.5.2. “Visualisation of quality information best practice report”, as well as D.5.3. “Prototypes of quality-aware visualisation components”.

After a sound review of usability studies and state-of-the art of quality visualisation methods, demo prototypes have been launched showing real datasets examples of the potential of the GeoViQua components. Different combinations of data and uncertainty have been tested and implemented in the ncWMS demo client, see Figure 5.

![ncWMS demo client](image)

Figure 5: ncWMS demo client

2.2.5 WP6 Quality Integration

The modular approach that we adopted in the client side has helped to integrate the results. The main strategies to facilitate the integration were the adoption of a RESTful architecture that makes the integration of different graphical user interfaces easier in a web browser and the use of several XSLT transformations between XML and HTML representations.
A quality framework that enhances producer metadata and proposes the addition of user feedback is embedded in the GeoViQua Quality Models. The Producer Quality Model (PQM), built as an extension over the existing standards ISO19115 and ISO19157, adds reference dataset information, citations traceability of quality statements and discovered issues. The User Quality Model (UQM) defines the database structure for a feedback server from which comments, citations, discovered issues, ratings and reports of usage may be stored and retrieved. These models are explained in D.6.1. “Data quality encoding as a best practice paper”. In the context of GEOSS, leveraging expert user feedback is an excellent opportunity to improve data quality assessment in practice, as was demonstrated in WP2 outcomes.

The link between the PQM and the UQM has been inserted in the WP4 architectural structures for GEOSS. In addition, the GEO label API is able to retrieve information from both models and generate a complete label for the dataset.

In sum, the outcomes of GeoViQua add rigorous data quality representations to state of the art search and visualization in the GEO Portal functionalities of GEOSS.

As one of the main challenges is the evolution of the GEOSS architecture and GEO Portal code, GeoViQua has been forced to adopt the approach of simulating the integration of the quality aware prototypes in the current GEO Portal through a virtual machine, specific portlets and a copy of the DAB.

2.3 Dissemination and integration efforts

Indeed, the main challenge that GEOSS poses regarding basic services and architecture is that whereas INSPIRE, being a European Directive, is to work with the same metadata standards, web services, and catalogues by specifying technical guidelines defining data topics and sharing data services, GEOSS, being a global and heterogeneous voluntary effort, must direct brokering efforts to harmonize differences in services and models, coping with the huge diversity of providers’ circumstances.

In such a context, besides establishing a sound quality framework, the success of GeoViQua requires dissemination and coordination with other geospatial projects. These innovative components have been introduced in relevant symposiums and tried outside the GeoViQua environment, with external datasets and user feedback. Tutorials and workshops have been carried out alongside the development of the tools in order to retrieve practical user feedback considerations. In the end, these initiatives contribute to the proper integration in the GEOSS CoPs and from the components point of view in the GEOSS infrastructure. Addressing this issue, the D.8.2. “Earth Science community and GEO CoPs, achievements and benefits” provides a description on some activities done to contact the CoP and transfer knowledge. The project has an exploitation plan, based on
testing findings, to address the extension of the project achievements beyond the funding period.
The following section describes the prototypes providing some examples from the pilot cases testing of the GeoViQua components at present.
3. Integration of generic service components into the GCI

3.1 DAB-Q

This service plays a key role integrating the GeoViQua quality model. The service harvests metadata from catalogue and map service instances that can be used to elaborate a catalogue of datasets automatically. Additionally, it allows translating the metadata from ISO to GeoViQua quality models in both directions.

The integration of the DAB-Q is performed on the search engine. This one connects to the service component asking for results that relates to the search string and filters provided by the user. Therefore, the GCI interface must provide a mechanism (see Figure 6) to allow users setting the following filters:

- Keyword search
- Location
- Area selection
- Date

Other filters specifically related to quality are:

- Quality info count (number of entries related to quality)
- Thematic classification correctness (to look for datasets with at least that percentage of pixels correctly classified)
- Positional accuracy (whether this is absolute or relative)
- Domain consistency (percentage of pixel values that belongs to allowed values)
- Lineage description and source (string based search of the name of a process or source from which the data has been derived)
- Rating (quality rated by users)
- Reported aspect
- Search term
- User domain
3.2 User feedback catalogue

This catalogue allows the users to provide information about the different datasets present on the portal. The feedback catalogue has a JavaScript 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, see Figure 7.

3.3 GEO label generator

The GEO label generator can be easily integrated through a script added to the webpage source code, see Figure 8 for the type of output. To do it, the GEOSS portal just has to know the URLs of the producer quality model record and the user feedback items related to the same dataset. For example, if the file resides here:
http://www.creaf.uab.es/temp/AgriculturalDrought19139.xml, to generate a dynamic GEO label associated with this metadata record the URL is:
This will only include the producer quality model facets. In order to include also the user feedback, it is necessary to know the code and codespace id of the file. If the code is GlobalAgriculturalDrought and the codespace is www.gmu.edu to add the feedback component, you just need to include the feedback URL:

![GEO label](image)

Figure 8: Example of GEO label result. The object can be split in different image pieces.

Since the return of this URL is in SVG format, to ensure maximum compatibility, you should use this html code:

```html
```

Alternatively, the GEOSS portal can look into the producer metadata document for a BrowseGraphic element that contains the link to the GEO label image.

### 3.4 Quality Indicators emitter

The Quality Indicators emitter is a set of web-based services and client interfaces to compute and validate quality indicators for continuously-valued data using reference values, see Figure 9. The client front-end tool is developed in Ruby on Rails and allows selecting inputs and viewing the results, see Figure 10. The outputs of the quality indicator emitter report are interactive statistics/graphs and a GeoViQua-compliant metadata.
Figure 9: Compute Quality Indicators interface using GECA

Figure 10: Selecting Inputs in the quality emitter

The integration into the GEOSS Postal is achieved by including a button that starts the query interface.

4. Integration of the providers components into the GCI

4.1 Catalogue instances

The integration of federated or harvested catalogues into the GEOSS portal is done by the DAB-Q and this does not require any client configuration and will be completely transparent to the user.
4.2 Web accessible folders

The integration of a web accessible folder into the GEOSS portal is done by the DAB-Q and this does not require any client configuration and will be completely transparent to the user.

4.3 WMS-Q instances

The WMS-Qs are Web Map Services following the standard defined by the OGC which are aware some of its layers describe quality parameters of certain variable.

These instances are connected to the DAB-Q from where the portal is able to gather them and no action is required to support them in the GEOSS portal during the discovery face. The GEOSS portal can identify that one of the results of a query contains a WMS-Q by analyzing the service metadata document that will reflect that the protocol used by the WMS uses the GeoViQua profile. This will result in a different icon in the GEOSS Portal results page that will allow for seeing the data in a WMS client. In our case, the WMS client is Greenland, as described later.

4.4 KML-Q instances

The project speculated with the possibility of creating a KML-Q extension that required a modified KML client. To favour interoperability, GeoViQua final decided to apply a ser of KML conventions to express quality by colouring changing or by changing the height of the objects. This way KML-Q instances, describing quality variables in KML format, can be integrated into the Geoportal creating links to the main URL of the service. These links can be included in the same way than WMS-Q is done. This links will generate a query to a KML client such as Google Earth or World Wind that need to be installed in the client computer in the form of an application or a plug-in.

For the GeoViQua Geoportal mirror, an icon similar to the Google Earth has been chosen to show the kind of source these links relates to, see Figure 11.
5. Integration of the client components into the GEOSS Portal

This chapter deals with requirements and recommendations on how to integrate the different components in the GEOSS Portal. In most cases this is exemplified with solutions tested on the GeoViQua Geoportal mirror developed during the project.

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 for the components can be then linked to the appropriate 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.

5.1 Metadata comparison

The metadata comparison component compares two different dataset metadata files on either ISO or GeoViQua model. Because of this, the user interface must allow to:

- **Select metadata entries** on the search result page. The component requires the user to specify which entries to compare.
- **Multiple selection of entries validation**. At least two metadata entries must be selected for this component to work and thus the user must receive feedback if none or only one has been selected.
- **Selection remembering**. So when the amount of results requires more than one page to present them to the user, he can choose entries from different pages.
Comparison **launch button** on the search result scope. Because placing the button on the entry level will be misleading as more than one entry is required to proceed with the comparison.

These strategies have already been adopted on the GeoViQua Geoportal mirror, and are exemplified in Figure 12, Figure 13 and Figure 14.

![Figure 12: Multiple selection of entries and compare metadata launch button.](image-url)
Figure 13: Datasets selection validation error message.

The Geoportal implementation requires the ability to transform XSL into HTML, because the component is based on an XSL transformation. In addition, an advanced characteristic that plots different metadata values into a figure requires the presence of jQuery for the use of highcharts.js (http://www.highcharts.com). Current tested version of jQuery is 1.10, but because the current Geoportal implementation already uses jQuery 1.6, an strategy to allow a different version of the library to be used concurrently has been implemented through the call to jQuery.noConflict().
An improvement to this tool could be to provide the user with the ability to choose what criteria to use in the star plot and the parallel plot that appear in top of the tool output for a fast dataset comparison.

### 5.2 Rubric-Q

The Rubric-Q component provides visual feedback about the completeness of metadata records, including the quality fields of the ISO and the GeoViQua models, see Figure 15.

It has been fully integrated into the GeoViQua Geoportal mirror by means of a geoportlet that handles the XSL transformation of the metadata files. Therefore, XSL support is the only technological requirement for Rubric-Q to work.

As for the user interface, it only requires a launch button to be integrated in the search results page, see Figure 12. Additionally, a button can be added to the metadata view page so the user can access a visual evaluation of the metadata from there.
5.3 Provenance

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, see Figure 16.

The interface requirements for this component are the same to those of the Rubric-Q component: a launch button to start the application and a search page metadata selection mechanism. 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 12 (page 15). However, a
different approach adding a local launch button directly to each dataset entry might be a good solution as well.

Similarly to the Rubric-Q component, it could be useful to add a Provenance button to the main metadata visualization page.

As for the technical requirements, this component is also based on a XSL transformation of the XML metadata files to HTML. Additionally, the maps depicting the spatial location of the metadata in the World, require the use of JavaScript and the Google Maps API. Therefore, a key to access the API from the domain where the component is finally installed requires to be generated and to be configured on the XSL file. This key might be of common use throughout the portal.

![Figure 16: Provenance visualization integrated into the GEOSS Portal](image)

5.4 GEO label visualization

The GEO label component is used to quickly visualize a summary of the metadata completeness for each dataset. The element, composed of different subsections that are filled with colour in case they are documented, is especially adequate to qualify the dataset entries on the search result page, see Figure 17.
In order to make the different icons in the label understandable, they require a minimal size, approximately 50 pixels diameter label (twice on high resolution screens). In case this is problematic on the intended insertion point, a solution might be to only enlarge the label when the cursor is placed over it, so the user can clearly see the label she wants to focus on. Colour and position of each section of the label seems enough for a fast situational scan of the results page.

5.5 Greenland

Greenland is a WMS client that works even better with ncWMS. It supports new features that allow an improved quality visualization experience such as personalized colour palettes, see Figure 18.
Figure 18 “Layer Settings” tool of the just added visualization in the legend section of Greenland.

Greenland has been also optimized to be able to show most of the different visualizations that ncWMS-Q can produce to better present data and uncertainty about the data such as contour lines, confidence interval triangles, whitening, etc, and it is able to present adjacent maps side by side, see Figure 19.
Figure 19: Data served as ncWMS(-Q) using the confidence triangles visualization

More information about Greenland and ncWMS integration here: https://wiki.52north.org/bin/view/Geostatistics/GreenlandExamples

Greenland has been introduced into the GEOSS Portal as a new portlet.

6. Conclusions

Though the document procedures on how to integrate the services described in the D6.4 “GeoViQua components integration within the GCI” in the new version of the GEOSS portal have been exposed.

The integration in the GEOSS Portal required adapting all the independently developed client components to make them compatible to the GEOSS portal. These efforts could be considered as out of scope of the GeoViQua project but de group considered important do demonstrate that the integration into the operational portal is possible with the minimum effort (taking the developments done by GeoViQua) in the GEOSS portal. To this end, ESA provided a copy of the current GEOSS portal and the client components where adapted to java, portlets and the LiveRay development environment.

The quality visualization components required the creation of launch buttons and hiperlinked texts on the search page, and in some cases selection checkboxes that allow comparison of one entry with another. Technical requirements are limited to common use
technologies such as JavaScript and XSL, currently supported by all major browsers. Some configuration effort is required at the GEOSS Portal level, adding pages for the components and configuring the corresponding portlets.
Annex 1
This annex contains a list of the URLs for most of the components (services or clients) developed in the GeoViQua project:

Services:

- CSW-Q interface
  - [http://dab-q.geoviqua.org/gvq-demo/services/cswisogvq?service=CSW&version=2.0.2&request=GetCapabilities](http://dab-q.geoviqua.org/gvq-demo/services/cswisogvq?service=CSW&version=2.0.2&request=GetCapabilities)

- UREAD WMS-Q service
  - [http://lovejoy.nerc-essc.ac.uk:8080/edal-ncwms](http://lovejoy.nerc-essc.ac.uk:8080/edal-ncwms)

- WMS-Q service from CREAf
  - [http://mmwms-q.geoviqua.org/cgi-bin/GeoViQUA/WMSQ/MiraMon.cgi](http://mmwms-q.geoviqua.org/cgi-bin/GeoViQUA/WMSQ/MiraMon.cgi)

- WMS Carbon CEA

- WMS-Q KML

- User feedback
  - [http://geoviqua.stcorp.nl/devel/api/v1](http://geoviqua.stcorp.nl/devel/api/v1)
  - [http://geoviqua.stcorp.nl/api/v1](http://geoviqua.stcorp.nl/api/v1)

- GEO label services
  - [http://www.geolabel.net](http://www.geolabel.net)
  - [http://geoviqua.dev.52north.org/glbservice/api/svg](http://geoviqua.dev.52north.org/glbservice/api/svg)

- WAF folder
  - [http://essi-lab.eu/gvq/waf](http://essi-lab.eu/gvq/waf)

Clients:

- GeoPortal Mirror:
  - [http://geoportal.geoviqua.org](http://geoportal.geoviqua.org)
  - [http://scgeoviqua.sapienzaconsulting.com](http://scgeoviqua.sapienzaconsulting.com)
• DAB-Q demo portal
  – http://geoviqua.essi-lab.eu/dabq-demo
  – http://dab-q.geoviqua.org/gvq-demo/gi-portal

• GreenLand:
  – http://greenland.geoviqua.org/greenland
  – http://geoviqua.dev.52north.org/greenland

• CREAT WMS-Q client:
  – http://wms-q-demo.geoviqua.org/geoviqua/wmsq
  – http://www.ogc.uab.es/geoviqua/wmsq

• User feedback
  – http://feedback.geoviqua.org/submit_feedback.html
  – https://geoviqua.stcorp.nl/submit_feedback.html

• GEO label services
  – http://www.geolabel.net/demo.html
Annex 2
This annex contains a list of the URLs for the public documentation and auxiliary files developed in the GeoViQua project:

- **DAB-Q CSW, GI-CAT (CNR) description and code**

- **GEO label services, API and code (ASTON+52N)**
  - [http://www.geolabel.net/api.html](http://www.geolabel.net/api.html)
  - [http://twiki.geoviqua.org/twiki/bin/view/GEO_SIF/SifGeoLabel](http://twiki.geoviqua.org/twiki/bin/view/GEO_SIF/SifGeoLabel)
  - [https://github.com/lushv/geolabel-service](https://github.com/lushv/geolabel-service)

- **WMS-Q, WMS, ncWMS, (UREAD)**
  - [http://ncwms.geoviqua.org/godiva2.html](http://ncwms.geoviqua.org/godiva2.html)

- **KML-Q, KML, code. Fraunhofer(FRAUN)**
  - [https://github.com/igd-geo/pcolor](https://github.com/igd-geo/pcolor)

- **GeoNetwork plugin (ASTON)**
  - [https://github.com/GeoViQua/geoviqua-geonetwork-plugin](https://github.com/GeoViQua/geoviqua-geonetwork-plugin)
  - For Geonetwork 2.8 use the 2.8.x-dev branch

- **User FeedBack system (S&T)**
  - [https://github.com/GeoViQua/geo-userfeedback](https://github.com/GeoViQua/geo-userfeedback)
  - [http://geoviqua.stcorp.nl/home.html](http://geoviqua.stcorp.nl/home.html)

- **Q emitter tool API, (ASTON+S&T)**
  - [https://github.com/GeoViQua/computeqi-web](https://github.com/GeoViQua/computeqi-web)
  - [https://github.com/GeoViQua/emulatorization-api](https://github.com/GeoViQua/emulatorization-api)

- **GECAaaS WPS (S&T)**
  - Contact S&T

- **Schemas (ASTON)**
  - [http://schemas.geoviqua.org](http://schemas.geoviqua.org)

- **Extended quality vocabulary (CREAF-UAB)**
  - [http://qualityml.geoviqua.org](http://qualityml.geoviqua.org)

- **Tutorial (ASTON)**
  - [http://tutorial.geoviqua.org](http://tutorial.geoviqua.org)
  - [http://uncertgeo.aston.ac.uk/INSPIRetutorial](http://uncertgeo.aston.ac.uk/INSPIRetutorial)