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systems**

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*Earth Science community and GEO CoPs, achievements and benefits***

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1. Abstract

GeoViQua's primary goal is to augment GEOSS Common Infrastructure (GCI) with innovative quality-aware visualisation tools and geo-search capabilities. More specifically, GeoViQua project has been created to provide a set of scientifically developed software components and services that facilitate creation, search and visualization of quality information related with earth observation data.

Indeed, one way to know if this goal is really achieved is to study the achievements and benefits that the GeoViQua project could have within the GEO CoPs and more generally within the Earth Science Community.

In order to have a more concrete idea of the initial impact of the achievements and benefits we made a survey and sent it to GEO CoPs and to the Science Community to have their opinion about some of the tools created within the GeoViQua project. Regarding the tools which are not mentioned in this survey a complete analysis was made to highlight what could be these achievements and benefits.

2. Introduction

The term of “Quality” can refer to many things. For example in climatology, the quality of a model can be interpreted as the degree of fidelity compared with natural/real mechanisms. Data quality could also be associated to the presence or lack of metadata information, to its completeness... Additionally, data users tend to take into account other user’s opinions and in many cases these opinions could be interpreted like quality information. Furthermore, quality information could be at dataset-level (generally contained in a metadata file which summaries the quality of a dataset) or a at pixel/feature level...

Consequently, it’s a complex but important information, especially for Earth Science Communities which have to deal with modelling, forecasting ...

GeoViQua's primary goal is to augment GEOSS Common Infrastructure (GCI) by adding innovative tools able to deal with “Quality information”. This document gives value to the success of the GeoViQua project studying achievements and benefits that this project could have within the GEO CoPs and more generally within the Earth Science Community.

Accordingly it is related with many Deliverables, with the following references: [D2.1-USERREQ], [D5.4-FVQUAVIS], [D6.4-COMPINT], [D7.2-REPONCURGCI], [D7.3-DATQUAPAR], [D7.4-GCIPILCAS], [D8.1-OGCISOSTAN] and [D8.5-GCITECINT].

After a short explanation of the terms and of the integration of these communities in GeoViQua and GEOSS, we analysed a survey that we sent to GEO CoPs and Earth Science Community members. The survey asked their opinions about three tools made by GeoViQua: the Producer Quality Model, the User Feedback Model and the GEO label. We used this survey in order to have concrete feedback regarding achievements and benefits. As the tools analysed in this survey were related to metadata information, this document is also intimately related to the [D3.2-USFEEDQU], [D6.1-QUALITYMDL] and [D6.2-GEOLABDES].

Regarding others tools created by the project, conclusions about the achievements and benefits are mainly based on direct conversations and indirect evidence. Accordingly description and explanation about these achievements and benefits are studied in another chapter.

2.1 Definition of GEOSS CoPs.

“A Community of Practice (CoP) is a user-led community of stakeholders, from providers to the final beneficiaries of Earth observation data and information, with a common interest in specific aspects of societal benefits to be realized by GEOSS implementation.”
(<http://www.earthobservations.org/cop.shtml>).

Consequently GEOSS CoPs and Earth Science Community in general are intimately related. That's why in this document we won't divide the two appellations but we refer to Earth Science Community (ESC) in general. GEOSS CoPs are listening in figure 1:

Figure 1: List of GEOSS CoPs and links to their portals.

CoPs name	Description (portals related)
Air Quality	http://wiki.esipfed.org/index.php/GEO_AQ_CoP
Atmospheric Chemistry	Under development
Biodiversity	http://www.earthobservations.org/geobon.shtml
Carbon	http://www.geocarbon.net/
Coastal Zone	http://www.czcp.org/
Cryosphere	Under development
Energy	http://www.geoss-ecp.org/
Forests	Under development
Geohazards	http://www.geohazcop.org/
Global Agricultural Monitoring	http://www.earthobservations.org/cop_ag_gams.shtml
Health and Environment	http://www.earthobservations.org/cop_he_henv.shtml
Water Cycle	http://www.earthobservations.org/wa_igwco.shtml

2.2 How is the Earth Science community integrated into GeoViQua and GEOSS?

In the GeoViQua project, 5 organizations have direct relations with some CoPs. In particular, 52N and S&T have relations with Air Quality CoP, CREA has relations with Biodiversity CoP, CEA-LSCE has relations with Carbon CoP, ESA has relations with Coastal Zone CoP and UAB has relations with Global Agricultural Monitoring CoP. Three organizations (52N, UAB and CEA-LSCE) have conducted some pilot cases in these communities.

- CEA and more specifically the LSCE are active members of the Global Carbon Project (<http://www.globalcarbonproject.org/>) which is the project related to Carbon GEOSS CoP. It should be noted in particular that the LSCE is leading 10 deliverables of this project (among 63).
- 52N and S&T are part of the Air Quality CoP because they participated in the GeoViQua “Air Quality Pilot Case” using ESA's data.

- CREAf is part of the Biodiversity CoP because it is the co-chair of the GEO task EC-01-C1: Global Standardized Ecosystem Classification, Map and Inventory (incl. characterizations of ecosystems in protected areas).
- ESA is part of the Coastal Zone CoP because it is the entity in charge of providing satellite data to allow coastal zone monitoring (http://earth.esa.int/applications/data_util/czm/).
- Global Agricultural Monitoring: UAB has actively participated in the Global Agriculture Monitoring CoP and the Agriculture Societal Benefit Area through the GEO Task IN-05 (GEOSS Design and Interoperability). The GeoViQua scenario (Monitoring flooding practices using remote sensing) has been presented in the context of the Architecture Implementation Pilot 5 sessions.

3. Survey study about GeoViQua metadata tools.

3.1 General study.

3.1.1 Survey justification

A good way to assess achievements and benefits of the GeoViQua project regarding ESC and GEO CoPs is to have their opinions. That's the reason why we conducted a survey that we sent to GEO CoPs and ESC members. In total, we sent this survey by mail to more than 200 individuals and we distributed surveys during the GEO Week in Geneva (13-18th of January).

In content terms it is worth to mention that this survey focuses specifically on 3 tools related with metadata (see section 3.1.2 for a global description of each). This can be explained by three reasons:

- -The first one is that metadata information appears to be very important quality information for most of users like it is mentioned in [D6.2-GEOLABDES]: *"Our participants stated that complete and well-documented metadata records are essential in the assessment of geospatial data quality and trustworthiness."*
- The second one is that metadata information is far to be complete in most of cases: *"Unfortunately, at present, users find metadata records are typically incomplete with a lot of essential data omitted"* [D6.2-GEOLABDES]. In our case this observation is all the more true because quality metadata information is even less well represented like it is mentioned in [D7.2-REPONCURGCI]: *"the overall number of metadata records with quality indicators is 19107 (which represent 19.66% of the total sample)."*
- The third one is that they are not really good visualisation metadata tools: *"Our interviews revealed a need for more sophisticated tools for visualisation of metadata records, with users commenting that, at present, metadata records are not only incomplete but are also typically not easy to examine and assimilate."*: [D6.2-GEOLABDES].

3.1.2 Global description

The survey is structured in 4 parts:

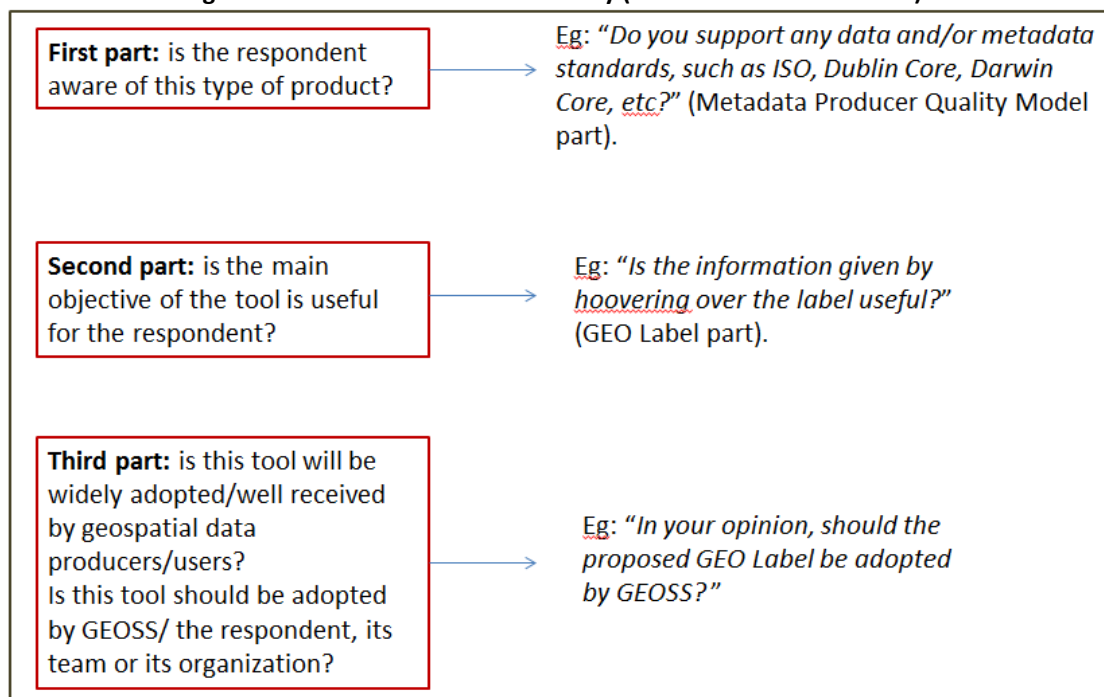
- The first part was used to identify the respondents. It consists in three questions about their role and field study.

Each of the three others parts are related to a tool related to metadata. These are the following:

- The Metadata Producer Model part.
- The User Feedback Model part.
- The GEO label part.

Global structure of these three parts is similar. It consists in 3 different parts (see figure 2):

Figure 2: Global structure of the survey (related to metadata tools):



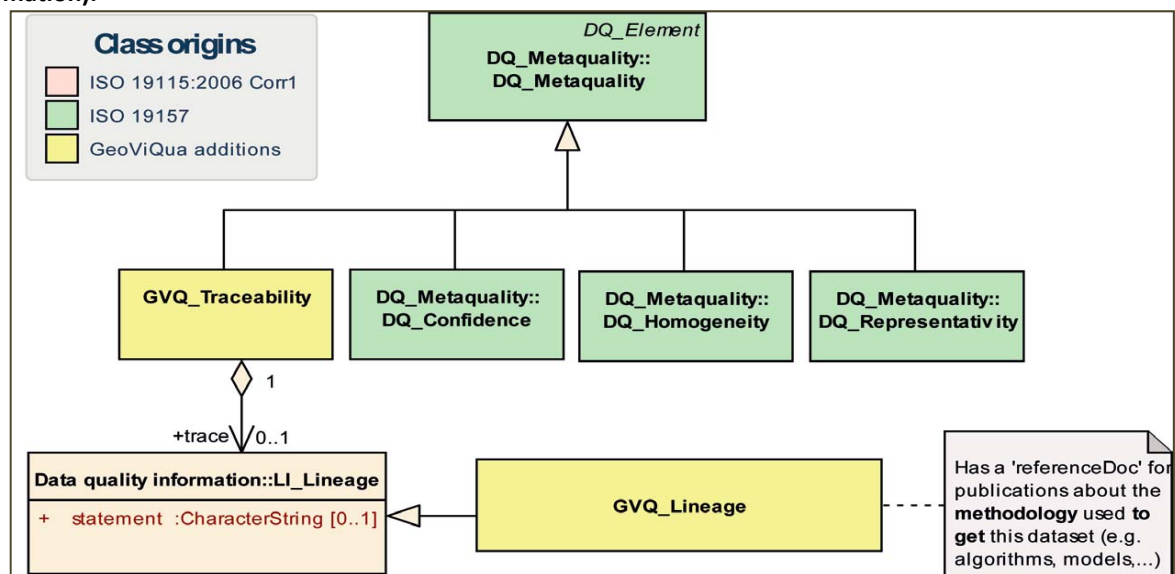
Each of these tools is described in a video tutorial about three minutes long each (<http://tutorial.geoviqua.org/>). To respond to the questions the respondents were invited to see the video tutorials before.

The Quality Producer Model (PQM, ASTON University):

The objective was to create a new and specific metadata editor complete and easy to use. For more details, see [D6.1-QUALITYMDL].

It appeared important for the GeoViQua team and more specifically for the University of Aston to create such tool because, despite metadata standards existence for geospatial data, these standards are not complete, especially regarding quality metadata information. This can be verified by the fact that *“The data producer explained that his organisation is currently using ad hoc standards to include information which seems most relevant.”*: [D6.2-GEOLABDES]. That’s the reason why this PQM extends ISO 19115-1, 19115-2 and 19157 standards to include information such as discovered issues, new and better formalized quality indicators (reference datasets for quality evaluation, traceability, and statistical summaries of uncertainty), citations to publications, pixel level quality and more. Figure 3 below shows an example of one of these extensions.

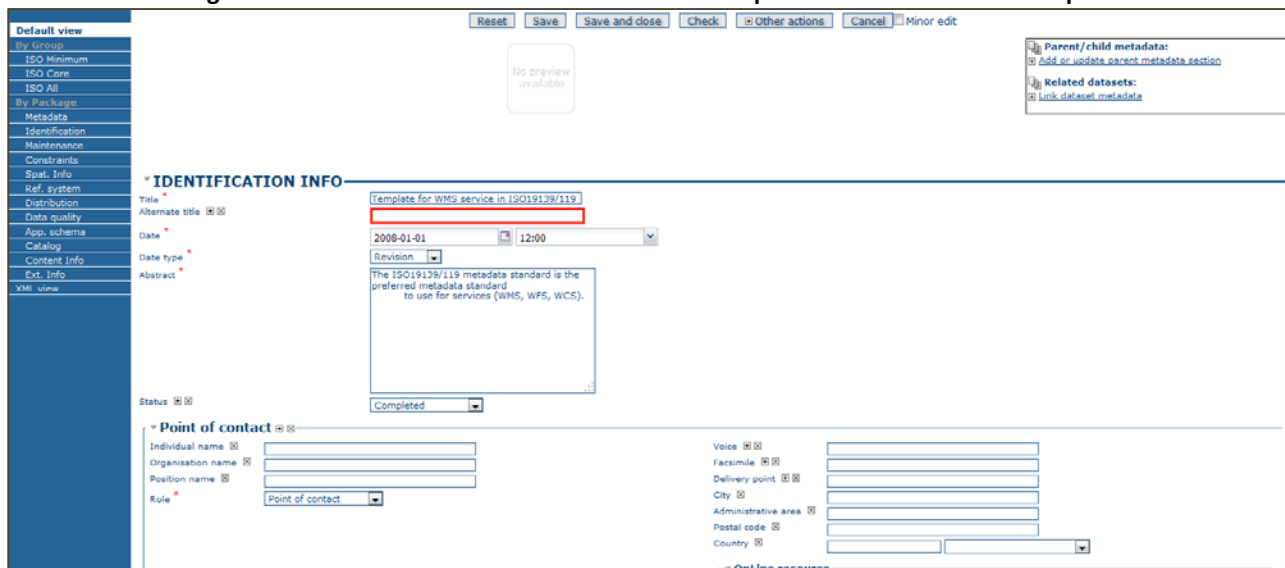
Figure 3: Extensions of the DQ-Metaquality element (the GeoViQua team add the “Traceability” and the “Lineage” information).



To give an easy access to this tool, the GeoViQua team chose to create and integrate a plugin in the GeoNetWork portal (figure 4). The Geonetwork metadata editor tool is a schema plugin for Geonetwork that allows creating, editing, saving and exporting GeoViQua QMs format metadata. Moreover, the Geonetwork tool is being connected to a Quality Indicator emitter that in turn is a client of the GECA toolset WPS (see 4.3.3 section) component and enables the transmission of a quality parameter to the Geonetwork plugin.

The Geonetwork component is connected to the DAB-Q (see 4.1 section) and plays a role as an internal catalogue integrator.

Figure 4: How to edit metadata with the Metadata producer?: A concrete example.



The screenshot shows the 'Metadata producer' web interface. On the left is a sidebar with a 'Default view' section containing links like 'By Group', 'ISO Minimum', 'ISO Core', 'ISO All', 'By Package', 'Metadata', 'Identification', 'Maintenance', 'Constraints', 'Spal. Info', 'Ref. system', 'Distribution', 'Data quality', 'App. schema', 'Catalog', 'Content info', 'Ext. Info', and 'XML some'. The main content area is titled 'IDENTIFICATION INFO' and contains several form fields: 'Title' (with a red box around the text 'Template for WMS service in ISO19139/119'), 'Alternate title', 'Date' (set to '2008-01-01' and '12:00'), 'Revision', 'Date type', 'Abstract' (with a text area containing 'The ISO19139/119 metadata standard is the preferred metadata standard to use for services (WMS, WFS, WCS)'), 'Status' (set to 'Completed'), 'Individual name', 'Organisation name', 'Position name', 'Rule' (set to 'Point of contact'), 'Voice', 'Facsimile', 'Delivery point', 'City', 'Administrative area', 'Postal code', and 'Country'. At the bottom right, there is a link for 'Online resource'. On the far right, there is a sidebar with links for 'Parent/child metadata' (including 'Add or update parent metadata section') and 'Related datasets' (including 'Link dataset metadata').

To offer more complete quality information the PQM is related to another tool: the User Feedback Model.

The User Feedback Model (S&T):

The idea was to “improve the ways in which geospatial experts perceive, assess and judge the quality of geospatial data. In the context of GEOSS, leveraging expert user feedback is an excellent opportunity to improve data quality assessment in practice, as has been indicated to us in various user interviews conducted to collect requirements for the project.” ([D6.2-GEOLABDES]).

It was an important point because in the original GEO portal design the only feedback was about the GEO Portal itself, not about the services and datasets it contains. To facilitate exchange of user feedback, GeoViQua has been working on three complementary subjects.

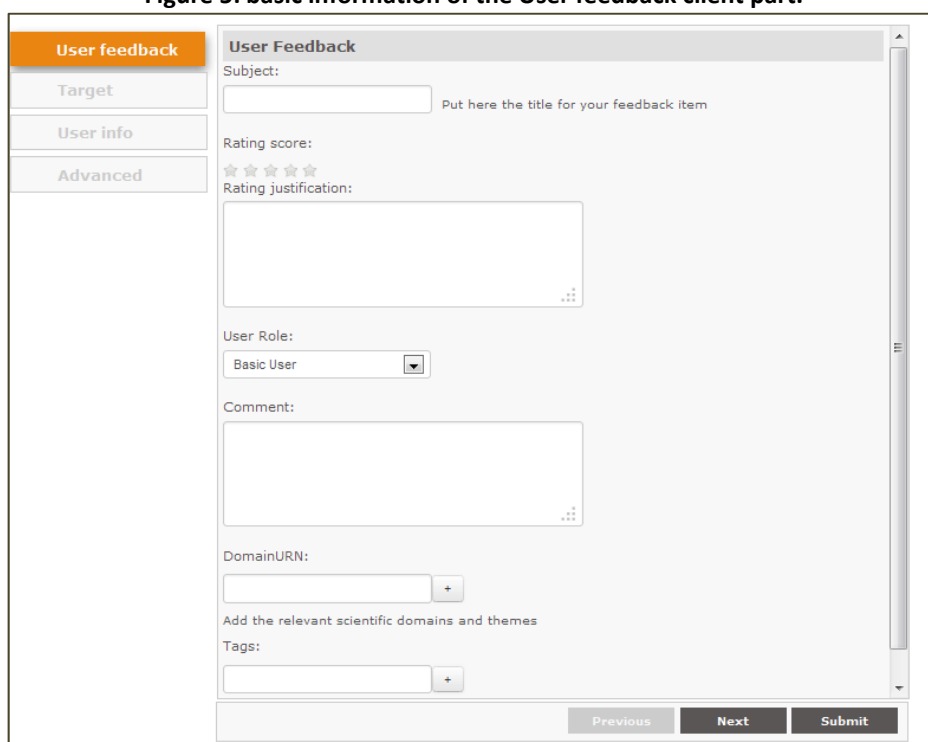
- A feedback model to support and structure focused expert communication.
- A feedback server to facilitate this communication with a database, an API and a user interface
- Integration into the GEO Portal.

We won't describe here all these elements because it's not the goal of this document. To have more details about the architecture and the technical parts of the User feedback, see [D3.2-USFEEDQU]. But we have to explain the possibilities that such tools give to ESC.

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. Consequently client application of the User feedback has been designed in an interactive way to be able to fit to the complexity of the User feedback information (see figures 5 and 6). In fact, two cases that could exist are:

- A user without much time will only use a simple form without a request for details.
- A user that wants to add more details can go to other tabs and fill everything in as desired.

Figure 5: basic information of the User feedback client part.

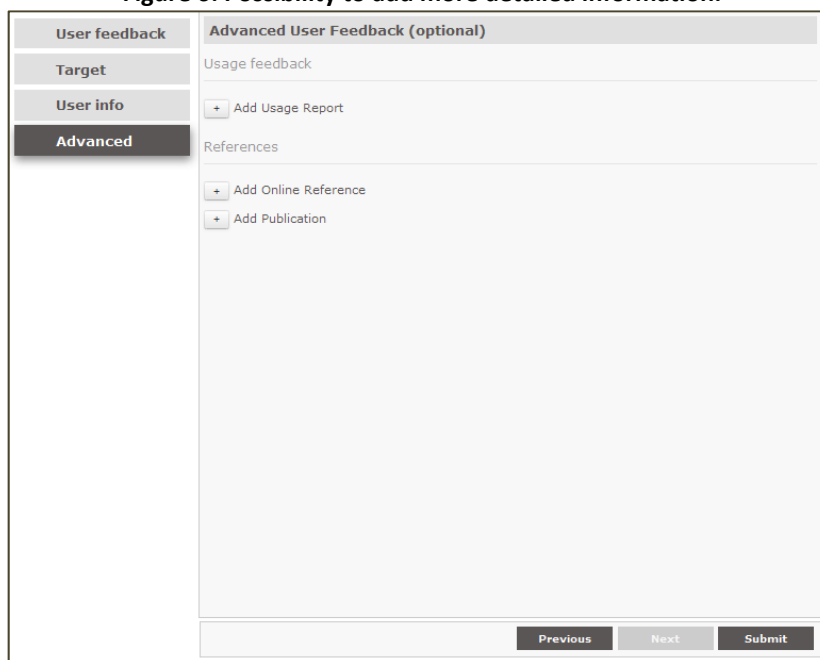


The screenshot shows a web application interface for user feedback. On the left is a vertical sidebar with four tabs: 'User feedback' (highlighted in orange), 'Target', 'User info', and 'Advanced'. The main content area is titled 'User Feedback' and contains the following fields:

- Subject:** A text input field with a placeholder text 'Put here the title for your feedback item'.
- Rating score:** A row of five stars, with the first three stars filled.
- Rating justification:** A large text area for providing details on the rating.
- User Role:** A dropdown menu currently showing 'Basic User'.
- Comment:** A large text area for additional comments.
- DomainURN:** A text input field followed by a '+' button.
- Tags:** A section with the text 'Add the relevant scientific domains and themes' and a text input field followed by a '+' button.

At the bottom right of the main content area are three buttons: 'Previous', 'Next', and 'Submit'.

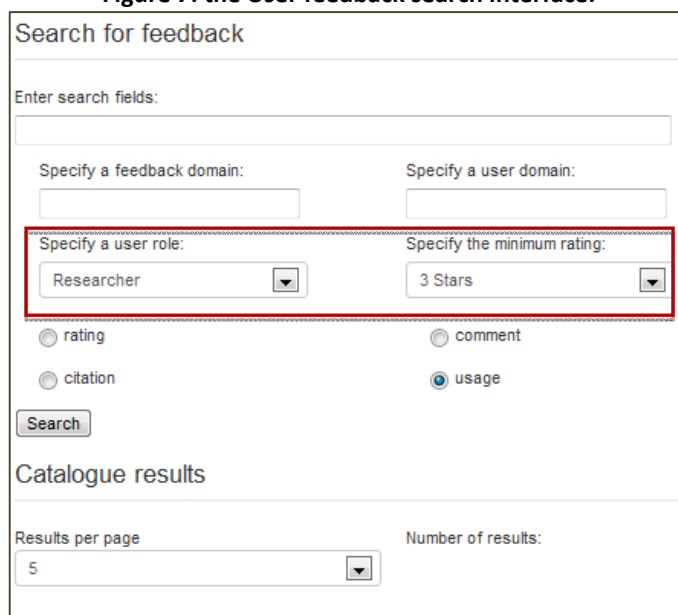
Figure 6: Possibility to add more detailed information.



The figures 5 and 6 show the possibility to adapt the User feedback complexity response. It should be noted that this possibility exists inside each of the four parts as well (“User feedback”, “Target”, “User Info” and “Advanced”). Indeed, each of these parts presents some “adjustable” and optional parts.

To support searching for feedback a search page has been developed (see figure 7).

Figure 7: the User feedback search interface.



This allows a new type of queries for Earth Science Communities (e.g: *Show me the summaries of all the feedback items done by a researcher with a minimum rating of 3 stars, like showed in red in the figure 7*).

Additionally the User feedback model information is thinking to integrate metadata information in a friendly and synthetic way thanks to the tool described below.

The GEO label (Aston University):

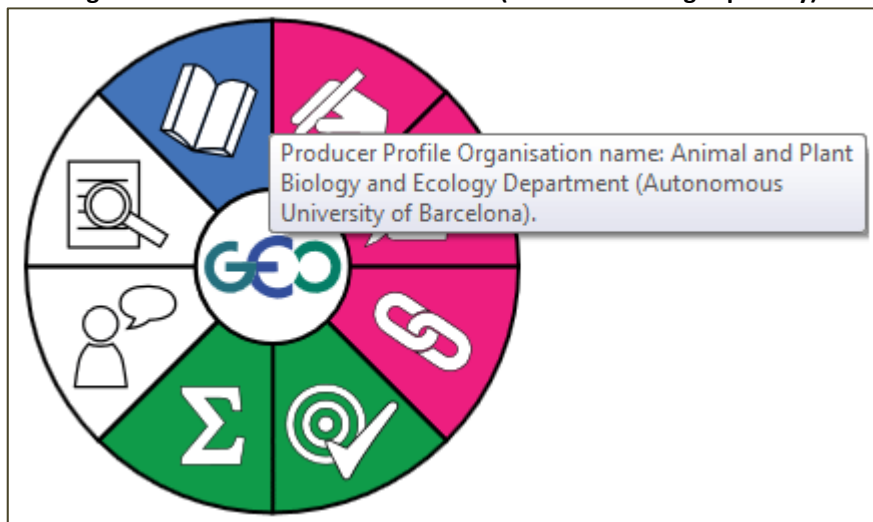
The GEO label component is a graphic representation which visually summarizes the availability of quality information for the dataset it represents. Producer and feedback metadata documents are being used to dynamically assess information availability and generate a label. The GEO label representation comprises eight informational facets: producer profile, producer comments, lineage information, standards compliance, quality information, user feedback, expert review and citations information.

Because the GEO label is intended to convey the availability of quality information for a given dataset, each informational facet can represent one of three availability states: 'available'; 'not available'; and 'available only at a higher level' (indicating that information is not immediately available for the dataset, but is available for a parent dataset). These three information availability states are expressed through varying the appearance of the facet icons.

The GEO label not only visually summarizes information availability but also provides hover-over (for summary information) and drilldown functionalities. Hovering over an individual facet in the GEO label displays a summary of the information related to the facet for the associated dataset – e.g., producer comments, the name of the standard to which the dataset complies, etc. The drilldown function displays styled structured information extracted from the associated dataset's metadata record when a facet is clicked (see Figure 8 for an example).

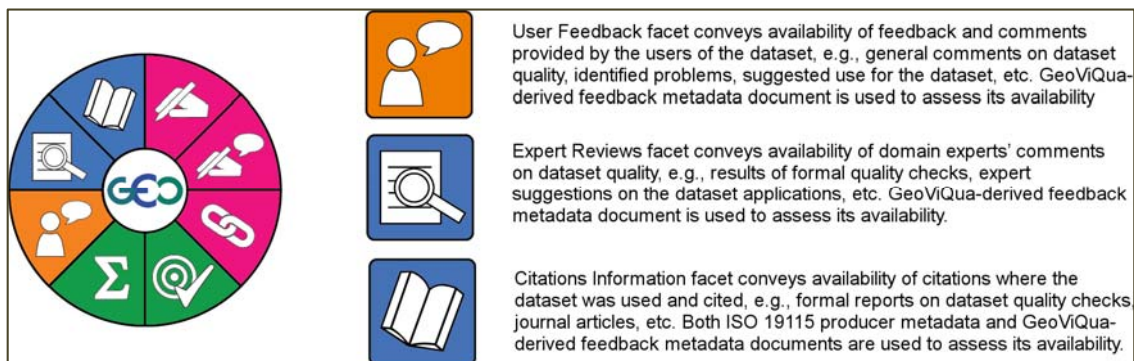
When integrated in the GEOSS, an individual GEO label will be provided for each dataset in the GEOSS clearinghouse based on its available quality information. The generated GEO labels will serve as quality indicators assisting in dataset searching and selection activities by providing users with visual cues of dataset quality and possibly relevance.

Figure 8: what looks like the GEO label (and the hovering capability):



It should be noted that among these facets, three convey availability of information recorded in the GeoViQua feedback metadata documents (Figure 9).

Figure 9: GEO label facets conveying availability of information recorded in GeoViQua feedback metadata documents.



3.1.3 Global results and limits.

70% of the individuals who started to fill in this survey¹ abandoned it after this question. This finding shows that despite the importance granted to the metadata information

¹ From France, Spain, Italia, United State, Germany, Japan, Austria and Sweden.

previously mentioned, in general terms, Earth Science Communities are not used to metadata information and/or are not used to provide metadata records.

For this reason, we think that the sample results cannot allow a generic interpretation but nevertheless, there are still very valuable comments that are worth recording and considering.

The next section will study the results regarding each tool.

3.2 Detailed results form the survey

We made the choice to not describe every answer of the survey but to synthesize them.

3.2.1 The Producer Quality Model

The first question: *“Do you provide metadata records or any others supporting information with the datasets that you produce?”*, permitted us to filter the people that had no previous experience in producing or understanding metadata.

The people who responded the questions appreciated the current metadata editor tool created in GeoViQua and recognized that it simplifies the metadata creation process but they provided us with important observations about the whole metadata process: First recommendation was to include more contextual help and some dropdown lists to avoid having to check frequently on the documentation. Elaborate a good metadata document still involves too many steps and it is a time consuming process. Indeed, some people consider that metadata creation is a process that needs more assistance from the tools that create data (including metadata management into the Geosoftware (GIS desktop, etc) instead of forcing the producer to having to document every single detail manually. Additionally, responders recommended extending the tool in a way that other metadata standards could be used and brokered into the catalogue. Finally, there were concerns about opting for GeoNetwork as a catalogue instead of using a more generic approach or even to include a metadata editor directly into the DAB.

Respondents answered positively to the question: *Is the extensions of the “classic” metadata (i.e. ISO 19115 & 19157) useful for geospatial data, i.e. does it capture valuable information?*, In this case, the achievements and benefits of such tool regarding the ESC is clearly positive and concord with the interviews done in [D6.2-GEOLABDES] (i.e. the need to enhance the metadata information).

Users valued positively most of the additions into the model (i.e.: Pixel and dataset level uncertainty, citations, discovered issues, reference dataset citation, traceability) being the favourite one the contributions to express the traceability and lineage better.

Unfortunately, the responders were uncertain about producers introducing the GeoViQua quality model into the *geospatial data chains*". In contrast, GeoViQua achieved its objectives in this matter because responders think that if the model was adopted, this would be a very important step for them. In particular, they mention that it allows *"a more appropriate and intelligent usage of the geospatial data"* and enables *"data users to understand what they are dealing with better"*. It is worth mentioning that users are still worried about the difficulties that different communities face in dealing with quality indicators emphasizing that *"Data quality process is related to data domain."* and more work is needed to create an abstract definition of data quality."

Responders think that the proposed Producer Quality Model should be adopted by GEOSS. In particular, they mentioned that it will *"Clearly improve geosearch activities"* and that *"There are already many efforts that touch on these ideas"*. A responder was worried about how long the GEO community would have to wait to see GeoViQua results applied and asked for accelerating the process of adoption (*"it is long and winning road towards acceptance and adoption."*).

Finally the responders were in favour of continuing the GeoViQua work in the direction of bringing the GeoViQua results into the standardization process (*"If the extension becomes a standard, my institution will adopt it."*). Some individuals had even started to think about the costs of applying GeoViQua results in their domain (*"We have to test it and see if it fits. We have to know what efforts, added value and costs are"*).

To conclude about the Metadata Producer Quality Model part of this survey:

Indeed, ESC is interested in having metadata information even if there are still concerns on the exact process to create metadata information. Furthermore, they received the ISO .19115 and 19157 improvements as real achievements and benefits. GeoViQua tools represent a step in the right direction.

3.2.2 The User Feedback Model

We started this part of the questionnaire with a very simple question: "Are you aware of any feedback/review system that can be used to provide feedback on geospatial data and/or metadata records?" All the respondents answered "No". This was already known by GeoViQua, so it justifies the idea of creating a user feedback option, as an innovative way to integrate metadata information.

Most of the participants think that such a tool captures valuable information. They mentioned that it's a *"Good idea"* and that *"the feedback about dataset and metadata are very valuable data"* and express the idea that *"Producers could be easily aware of flaws in their maps. Non-expert users could see the opinion of expert-users."* Nevertheless, one respondent specifies that *"Some level of moderation is necessary"*.

These positive responses are reflected in the answers *"In your opinion, how useful is the feedback server presented in the tutorial?"*, where majority of individuals answered positively.

Participants were more uncertain about producers introducing the GeoViQua quality model into the geospatial data chains. Their doubts were about the fact that *"Most producers think that their system covers it all"*. Additionally one participant mentioned that it *"should be implemented in established systems"*, which is in fact already the case.

Regarding if the Feedback Model can be adopted by geospatial data USERS, most of the participants think that it could be well received. They mentioned that *"some users can inform other users"* and that *"It's a good feedback for data producers in order to set their data creation process."* Nevertheless a participant expresses the fact that *"the reward for filling the user feedback information is a little bit nebulous (...). The user has to spend some time when it is the producer who sees on self-benefiting."*

Participants also think that proposed User Feedback Model should be adopted by GEOSS. In particular, they mentioned that it *"Improves geosearch"*.

With regards to adopting the User Feedback System in their work, participants are more hesitant. But one person mentioned that it is more related with the degree of responsibility than with the tool itself: *"I cannot decide this on my own and we need to know all aspects"*.

To conclude about the User Feedback Model part of this survey:

User feedback information is a new approach and a new way to bring metadata information and this approach receives positive opinions from the Earth Science Community, even if there are still concerns about the exact process to create it. In fact, to the question *"Please describe any modifications or improvements that you would apply to the proposed User Feedback Model"*, participants mentioned that it is necessary to *"Define a more robust and flexible user interaction"* and in particular to think about the *"moderation"* aspect. Accordingly like in the Metadata Producer Quality Model, the User Feedback represents a step to a better and more complete metadata approach.

3.2.3 The GEO label

The first question *“Do you understand the label concept?”* is important because it partly determines the quality of the following responses. Fortunately, most of the participants responded positively.

Users think that information given by hovering over the label is useful. This is reflected by their comments mentioning that it's a *“good overview about the dataset”*. More specifically a participant mentioned that it allows for *“Graphically displaying the PQM-USQ info”*.

The next question (*“Is the information given by clicking on faced (drill-down functionality) useful?”*) allows to specify other modality of the GEO label. One more time, responses are very positive and mention that it's a *“Good impact”* and a *“Good overview about the dataset”*.

In general terms, participants think that label facets information (User feedback, Expert review, Citation information, Producer profile, Producers comments, Lineage information, Standards compliance, Quality information) usefulness is similar although Quality information appears the more useful.

These positive responses are reflected in the questions about possible applications.

To the question *“In your opinion, how useful is the GEO label presented in the tutorial?”*, participants think that the GEO label is useful or even extremely useful. Furthermore, at the question *“In your opinion, could the proposed GEO label be adopted by geospatial data PRODUCERS?”*, respondents answered positively and they point that *“It allows the user community to learn more about the value and quality of the data”* and that *“It's a firstly impact about datasets.”* Nevertheless, one participant mentioned the fact that *“There could be producers that do not want to deal with some of the facets of the GEO label”*.

Regarding the geospatial data users reception, respondents also think that the proposed GEO label could be well received. In addition they think that it should be adopted by GEOSS. One respondent even mentioned that *“It is vital for a global initiative to do this”*. Finally the participants were in favour of continuing the GeoViQua work in the direction of bringing the GeoViQua results into the standardization process (*“My institution will adopt it, if it became a standard”*).

To conclude on the GEO label part of this survey:

It's important to mention that the objectives of these tools are achieved. Indeed, for the Earth Science Community, this tool appears as a good way to have clear and quick metadata information and this community is agreeing to adopt and use it.

In addition, the fact that participants think that Quality information is the more useful information of the GEO label brings even more value to the GeoViQua project in general. For all these reasons, the GEO label appears to bring real and concrete achievements and benefits for Earth Science community. One more time, GeoViQua tools represent a step in the right direction.

3.3 General conclusions.

The three tools studied respond to the interest of the ESC to have metadata information. GeoViQua Quality Model is confronted with the creation of metadata information process, which is a really complex issue. Nevertheless, the GeoViQua contributions (expend quality metadata information and create the metadata via the GeoNetwork plugin) is well received by the Earth Science Community. The two other tools (User Feedback Model and GEO label) are innovative tools, which have a very good reception from part of the Earth Science Community. To illustrate this, a respondent mentioned that if the three tools become a standard, his organisation would adopt it.

To conclude we can say that these GeoViQua tools represent improvements and benefits for the Earth Science Community.

4. Achievements and benefits related to other tools.

It's very difficult to know how the ESC perceives concrete and real achievements and benefits of the other tools created by the GeoViQua project because most of them were released at the very end of the project. Nevertheless, an important effort was done to fit these tools to the Earth Science Community's needs².

This section presents and explains these tools.

4.1. Concrete example of search and visualisation of quality data: DAB-Q portal and KML-Q.

4.1.1 Portal quality-aware component (DAB-Q)

The portal quality-aware component (DAB-Q) allows enhancing the GEOSS Common Infrastructure (GCI) and especially the GEO Discovery and Access Broker (DAB). Indeed the DAB has been extended to support quality information (DAB-Q). The DAB-Q implements the Producer and User Quality Models as quality extensions of the OGC Catalogue Service For the Web (CSW-ISO-Q) interface. This component also supports searches filtered by a user's quality requirements. For more details, see [D4.2-INTCOM].

This use of the DAB-Q portal is based on the *Agriculture flooding practices* scenario created by the GeoViQua and especially the CREAM team to take into account needs of the ESC. This scenario is itself based on the EU agri-environmental measures (Regulation CEE 1257/1999) which consist of a subsidy that farmers receive to support agricultural practices that favour the conservation of ecosystems. The Ebro Delta regions (Catalonia, Spain) are places with a specific ecosystem combined with intensive agriculture (mainly rice). Consequently, farmers of these places can receive the subsidy mentioned above. That's the reason why the CREAM designed a sophisticated remote sensing algorithm based on Landsat imagery, which is actually used by the local government of Catalonia to monitor farmer's practices instead of time-consuming and expensive field surveys.

² In particular thanks to the users cases which allowed the use of real data and feedback from various ESC.

Given the aforementioned, if a researcher goes to the DAB-Q portal (<http://geoviqua.essi-lab.eu/dabq-demo/gi-portal/index.jsp>) and enters “flood control” in the keyword items, specifying the area that he wants to apply (simply by drawing a square on the world map), and limits his search to data with “domain consistency” (i.e “Adherence of values to the values domains”³) above 90%, he would get the following result: (figure 10):

Figure 10: a concrete utilisation of the DAB-Q example.



Achievements and benefits of this tool are highlighted by figure 10. Indeed, it allows retrieving files and information present in the GEO portal taking into account quality information parameters. Furthermore, it offers the possibility to visualize metadata and quality information related to the selected dataset and to add feedback (respectively red and blue circles in the figure 10: see figure 11). Consequently the DAB-Q is also able to search in the user feedback database and integrate the response in its search results page.

³ More explanation at <http://qualityml.geoviqua.org/>

Figure 11: Quality information visualisation thanks to the DAB-Q (note the possibility to access to the Dataset's GEO label).



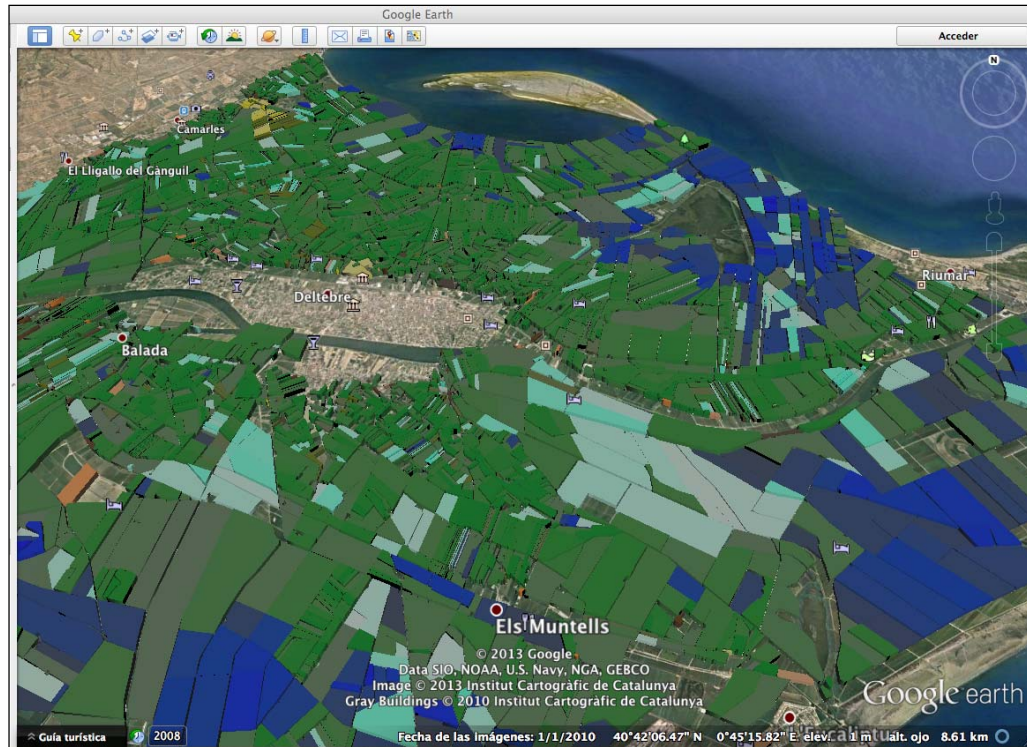
The DAB-Q allows retrieving and visualising quality information at dataset level. To visualize the quality information at pixel or feature level, GeoViQua has created an innovative visualisation tool that fits particularly with the data related with the *Agriculture flooding practices*. The description of this tool is explained below.

4.1.2 Data quality visualisation with KML-Q standard.

The KML-Q standard use KML (and consequently Google Earth) format combined with the possibility to change the “intensity” of the colour. This allows a binary map used to add quality information. See section 4.2.1 for more explanations.

In the case of the *Agriculture flooding practices* scenario, the type of colour is used to represents the category and colour intensity is used to represent the uncertainty of this category. Figure 12 shows how data from the *Agriculture flooding practices* scenario are visualised thanks to this application.

Figure 12: KML-Q allowing visualisation on the same map of categories and uncertainties related to flooding agriculture in the Ebro delta.



Consequently, GeoViQua provides a tool that can be used to associate and visualize quality information to vector datasets. It should be noted that the KML-Q protocol is actually used by the local government of Catalonia and therefore represents a real and concrete achievement and benefits for the Earth Science community.

But to be really useful for Earth Science Communities this tool has to be integrated in the protocols used by the OGC and especially with the WMS protocol. That's the reason why efforts have been done to integrated quality information in the OGC-WMS protocol. The next section explains how it was done.

4.2. Standards-based approach using OGC WMS (WMS-Q) and client visualization tool.

This section describes and explains the methods used by the GeoViQua team to integrate into the WMS OGC standard the possibility to retrieve quality information. Secondly it describes the client visualisation tool that has been created especially to visualise this information.

4.2.1 WMS-Q standard and visualizations methods.

Description and purpose:

The purpose was to develop and apply conventions for conveying information about data quality through the OGC Web Map Service specification. The WMS 1.3.0 currently did not correctly support the integration of quality information into WMS. Hence, the GeoViQua team proposed a WMS-Q specification to address these limitations. This specification was approved by the OGC-OWS-9 and became an OGC public engineering report ([ING-REP]).

This WMS-Q profile was proposed as far as possible within the bounds of the WMS 1.3.0 specification, not requiring any extension. It's a specialisation of this specification, not a modification or event extension. Consequently it can be used with any server WMS compliant which represents achievement and benefits for Earth Science Communities.

We mentioned in the introduction of this document that "Quality" concept is complex and heterogeneous. It could mean for example completeness, consistency, accuracy, lineage ... The WMS-Q focused on two main aspects of data quality:

- Visualizing thematic accuracy, expressed as uncertainties.
- Linking to further information recorded in metadata documents (dataset level).

It should be noted that the WMS-Q was initially thinking for raster data but the KML-Q specification introduced the possibility to integrate vector data. Consequently, thematic accuracy (expressed as uncertainties) could be represented at pixel or feature level.

Referring to dataset level quality information, the profile used the layer's MetadataURL tag to link to quality document. Of course the MetadataURL endpoint was extended to the ISO metadata (extends ISO 19157) created by the GeoViQua project. Furthermore, it was also extended to the GeoViQua "user quality model" (feedback) and to the GEO label.

Referring raster data, pixel-level uncertainty information can be encoded using NetCDF-U; a convention which defines some conventions for encoding the uncertainty information (see [NETCDFU]). The basic idea is to use layer nesting coupled with keywords from the UncertML vocabulary (for more detail see <http://www.uncertml.org/>). Figure 13 shows the methods used to encode pixel level uncertainties as a WMS Capabilities document.

Figure 13: a fragment from a WMS-Q Capabilities document, illustrating the use of layer nesting and UncertML terms to convey the semantic relationship between layers.

```

<Layer>
  <Title>Some Dataset</Title>
  ...
  <Layer queryable='1'>
    <!-- Parent layer, analogous to NetCDF-U "concept without values" -->
    <Title>Sea Surface Temperature</Title>
    <!-- The Name is only included if this parent layer is displayable -->
    <Name> sea_surface_temperature</Name>
    <KeywordList>
      <Keyword vocabulary='http://www.uncertml.org/distributions/'>
        normal
      </Keyword>
    </KeywordList>

    <!-- Now the child layers represent the elements of the distribution -->
    <Layer queryable='1'>
      <Name>sea_surface_temperature_mean</Name>
      <Title>SST mean</Title>
      <KeywordList>
        <Keyword vocabulary='http://www.uncertml.org/distributions/'>
          normal#mean
        </Keyword>
      </KeywordList>
    </Layer>

    <Layer queryable='1'>
      <Name> sea_surface_temperature_variance</Name>
      <Title>SST variance</Title>
      <KeywordList>
        <Keyword vocabulary='http://www.uncertml.org/distributions/'>
          normal#variance
        </Keyword>
      </KeywordList>
    </Layer>
  </Layer>
</Layer>

```

Referring vector data, feature level uncertainty information encoding is slightly different. KML-Q extends KML format to include data quality information and describes how to associate quality information to contained and referenced geometries and data. It also describes how to visualize quality information along the data it characterizes.

We saw in the section 4.1.2 that the quality information was integrated with the possibility to adapt the colour's intensity. Figure 14 show an example using these rules to encode feature level uncertainties as a KML document.

Figure 14: a fragment from a KML-Q document, illustrating the integration of styles to adapt color's intensity and therefore to integrated within the KML file uncertainties information.

```
<kml xmlns="http://www.opengis.net/kml/2.2">
  <Document>
    <name>Portrayal of Quality data</name>

    <!-- These would be autogenerated or selected from a
well-known scale -->
    <Style id="veryBadQuality">
      <LabelStyle>
        <color>ff0000ff</color>
      </LabelStyle>
    </Style>
    <Style id="reasonableQuality">
      <LabelStyle>
        <color>00ffffff</color>
      </LabelStyle>
    </Style>
    <Style id="veryGoodQuality">
      <LabelStyle>
        <color>00ff00ff</color>
      </LabelStyle>
    </Style>
    <!-- Apply data to referenced dataset -->
    <NetworkLink>
      <styleUrl>#veryGoodQuality</styleUrl>
      <Link>
        <href>
          http://somedata.set/34542352.kml
        </href>
      </Link>
    </NetworkLink>
  </Document>
</kml>
```

Achievements and benefits:

The approach explained above represents several achievements and benefits for ESC:

- It allows integrating in a standard protocol and in the same document quality information both at pixel/feature level and dataset level. Accordingly quality information is easily accessible by external users: quality information is not scattered in a server machine. Furthermore, managing of this information is improved (e.g: the GetFeatureInfo request is greatly simplified).
- It extends the classical quality information (NetCDF-U improves the classical "*Climate and Forecast Conventions*" which have a basic means of modelling uncertainty and integrates the ISO extensions done by the GeoViQua project)

Concrete developments and applications:

Two different WMS servers have been adapted by the GeoViQua project. Each brought improvements to the way of visualizing quality information via the WMS protocol.

The first one is the MiraMon server from CREAM (<http://www.ogc.uab.es/geoviqua/wmsg/>)

The main contribution of the MiraMon Map Browser is its capability to connect to WMTS-Q servers in addition to WMS-Q ones. This capability has been implemented within the scope of the project while making the required modifications in the MiraMon server engine to accept and properly respond WMS-Q and WMTS-Q requests.

The second one is the ncWMS-Q server which is an extension of the ncWMS server done by the University of Reading. Consequently the quality integration has been done for a specific format; the netCDF format which is a format widely used in the Earth Science Communities. Main contribution of the ncWMS-Q server (beside a specific focus on netCDF format) is explained as follows.

The GeoViQua team and particularly the University of Reading have associated to a new way of representing quality information via WMS innovative symbolisation methods. WMS provides three visualisation methods: named Styles (simple but inflexible), SLD (Styled Layer Descriptors) and Symbology Encoding which are more flexible but still rather basic for raster data. Furthermore, none of these visualisation methods meet the use cases for visualization of uncertainty. Hence the University of Reading through the ncWMS-Q has developed a new XML language for specifying styles for raster data. The figure 15 shows one of these new visualisations quality methods.

Figure 15: ncWMS-Q associate to new symbolization methods capacity. Property show (i.e parent layer) is sea surface temperature.

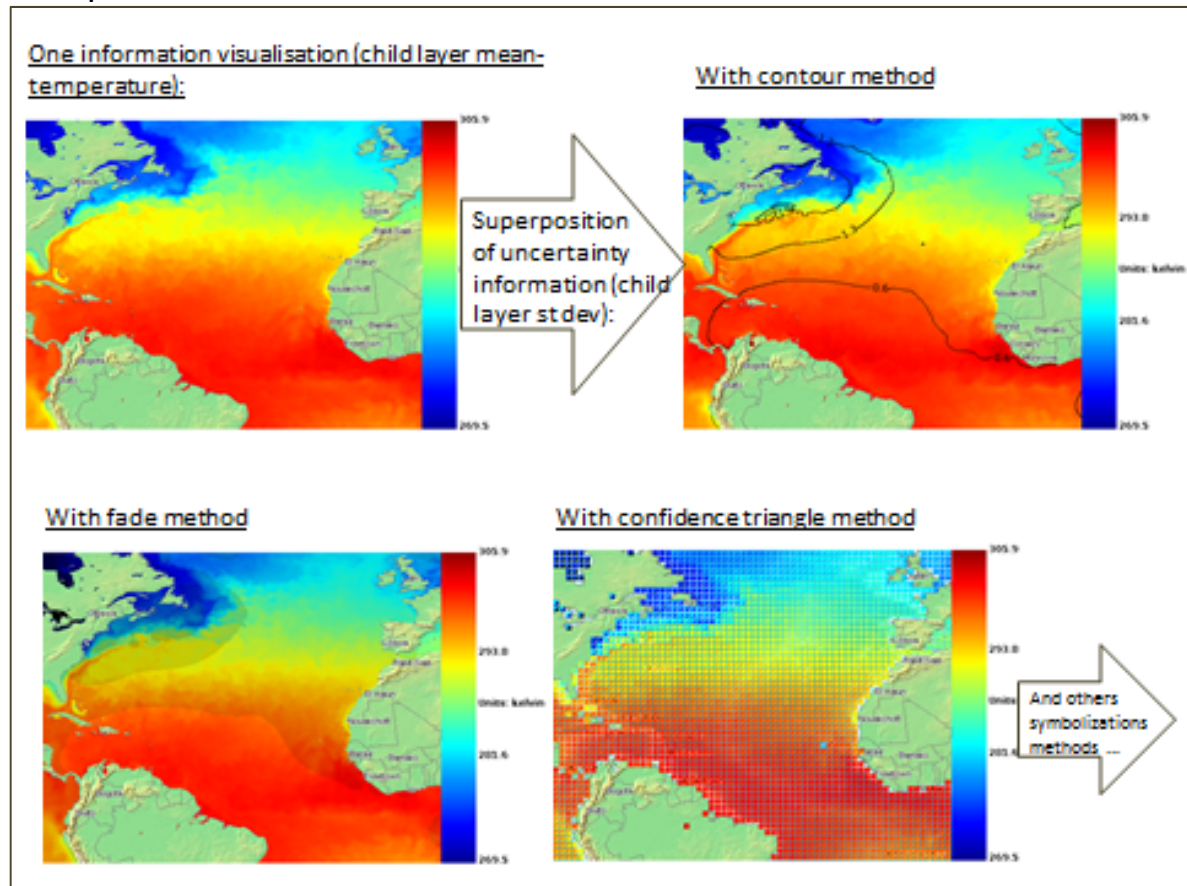


Figure 15 emphasizes the possibilities that offer the association between the WMS-Q protocol and the new symbolisations methods. In fact, it's possible to visualise one quantity separately or to associate quality information associated. Furthermore, the quality information may be visualised in different ways. It should be noted that the choice of the visualisations methods has been done in association with the Earth Science Community. For example the stipples method was chosen because it was well adapted to the carbon scenario. Indeed in this scenario spatial resolution is very low (one degree X one degree)⁴.

Accordingly GeoViQua project created tools which allow to retrieve quality information (at dataset or feature/pixel level) via WMS-Q and WMTS-Q protocol and furthermore created new ways to visualize this quality information for both vector and raster data.

⁴ Consequently real data of carbon fluxes models (among others) were used to construct these symbolizations.

To allow ESC to visualise on the same client qualities information mentioned above, GeoViQua team created a specific client.

4.2.2 Client quality visualisation tool: Greenland.

Greenland is a WMS javascript client interface used by GEOSS to visualise data via the WMS-Q and WMTS-Q protocols. It was done by the *52 North* team in GeoViQua. Consequently the GeoViQua WMS-Qs servers studied previously are integrated in the 52N Greenland client and therefore accessible to the DAB-Q component. The figure 16 shows the interface of this “Quality WMS-WMTS client”:

Figure 16:Greenland interface (the quantity represented is temperature). On the right: mean, on the left: variance.

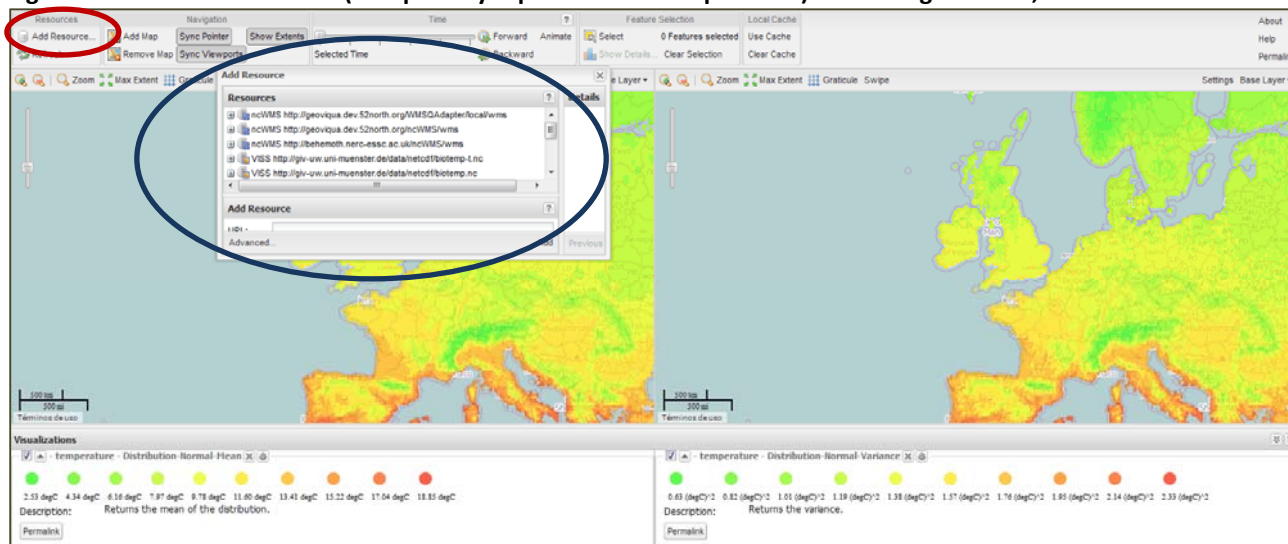


Figure 16 shows the WMS-Qs servers integration (with add resource we access to data present in different servers). It shows also a design adapted to quality visualisation. Indeed, this client allows to visualise X maps on the same screen and consequently to easily compare different variables. It should be noted that for a better comparison maps can be shown side by side synchronized.

4.3 Improve the dataset choice: metadata intercomparison, Rubric tool and GECA.

Besides the possibility to search and visualise data and datasets with qualities criteria, GeoViQua team created tools that allow ESC to provide data and metadata intercomparison functionality to GEOSS and therefore to improve the choice between different datasets. We present below these three tools.

4.3.1 Metadata intercomparison tool

The purpose is to allow users to easily compare the main metadata elements side by side facilitating the selection of the best dataset for their purpose⁵. It is now being extended to include the graphic comparison of metadata elements in the form of statistical plots (see [D4.1-GRAINTREP] for more details).

Concretely, this metadata comparison tool presents datasets in columns, with attributes and metadata parameters aligned in rows (figure 17).

Figure 17: Application of the metadata intercomparison tool. In this case, the most accurate dataset appears in green.

HOME ABOUT HELP SEARCH GEOSS MAP VIEWER			
Metadata comparison			
Bounding Box			
Identifiers	Dataset 1	Dataset 2	Dataset 3
Id (fileIdentifier):	RiceFlooding2006-10-29to2007-03-22	mttri2an1ib	LCL12_BcnGrn_2005_07
uuid MD_Metadata/GVQ_Metadata			
id MD_Metadata/GVQ_Metadata			
uuid MD_DataIdentification/GVQ_DataIdentification			
Element Results			
Positional Accuracy			
Absolute External Positional Accuracy	0.5	11.3	0.015625
Relative Internal Positional Accuracy			
Gridded Data Positional Accuracy			

⁵ It's worth to mention that it was introduced in the AIP-5 Quality Session (see [D8.1-OGCISOSTAN]).

Figure 17 highlights the possibility to compare datasets with quality parameters (in this case these quality parameters are related to the positional accuracy). These quality parameters are in accordance with the ISO 19115

Of course, this comparison does not apply only to the quality parameters. We can compare easily the bounding box of each dataset, the abstract, the lineage, the date...

4.3.2 Rubric tool

The rubric tool is based on the Rubric project under NOAA (National Geodetic Survey, National Ocean Service, NOAA, U.S. Department of Commerce) development. The objective of this tool is to compare goodness of metadata information between files.

Concretely, the information is represented in tables divided in main metadata information parts (for example "Lineage"). These parts are themselves divided in their metadata information parts (figure 18).

Figure 18: goodness metadata information visualization via the Rubric tool (we can access to the metadata information thanks to the bottom menu). These metadata belong to the Landcover Bcn-Girona 12 categories file.

Total Spiral	14	Distribution	1	Description	2
Identification	6	Distributor Contact	0	Purpose	1
Metadata identifier	0	Online Resource	1	Resource Extent Description	1
Resource title	1	Resource Distribution Format	0	Lineage statement	0
Resource date	1	Browse Graphic	0	Quality	0
Abstract	1	Content	0	Positional Accuracy	0
Topic Category	1	Content Type	0	Thematic Accuracy	0
Theme Keywords	1	Band Name	0	Temporal Accuracy	0
Theme Keyword Thesaurus	0	Band Definition	0	Lineage	0
Metadata Contact	0	Band Units	0	Statement	0
Resource Contact	1	Feature Types	N/A	Source	0
Extent	2	Feature Catalogue Citation	N/A	Process Step	0
Resource Spatial Extent	1	Connection	3	Usage	0
Temporal Extent	0	Online Resource URLs	1	Usage	0
Vertical Extent	0	Online Resource Functions	1	Date and Time	0
Place Keywords	1	Online Resource Names	0	Limitations	0
Place Keyword Thesaurus	0	Online Resource Description	1	Contact	0

[Total Spiral](#) | [Spiral details](#) || [Identification](#) | [Extent](#) | [Connection](#) | [Distribution](#) | [Description](#) | [Content](#) | [Quality](#) | [Lineage](#) | [Usage](#) || [ISO Core](#)

Total ISO Core Score: 10/22

One more time this tool offers a new way to select datasets. Indeed, it takes into account the quality of the metadata and not the quality of the data in itself. This approach complements the metadata intercomparison approach and improves the geosearch tool capacity of the GEOSS portal.

Detailed information on the purpose and algorithm used in the Rubric tool can be found in the following article:

<http://ieeexplore.ieee.org/xpl/articleDetails.jsp?tp=&arnumber=6514679>

4.3.3 GECA toolset as a WPS.

The GECA Toolset is based on the ESA GECA project (see [GECA-PUB]). The idea was to use the intercomparison methodology contained in this project and to combine it with a Web Processing Interface (WPS) to expose intercomparison functions to the GEO Portal user (see [D7.3-DATQUAPAR] for more details).

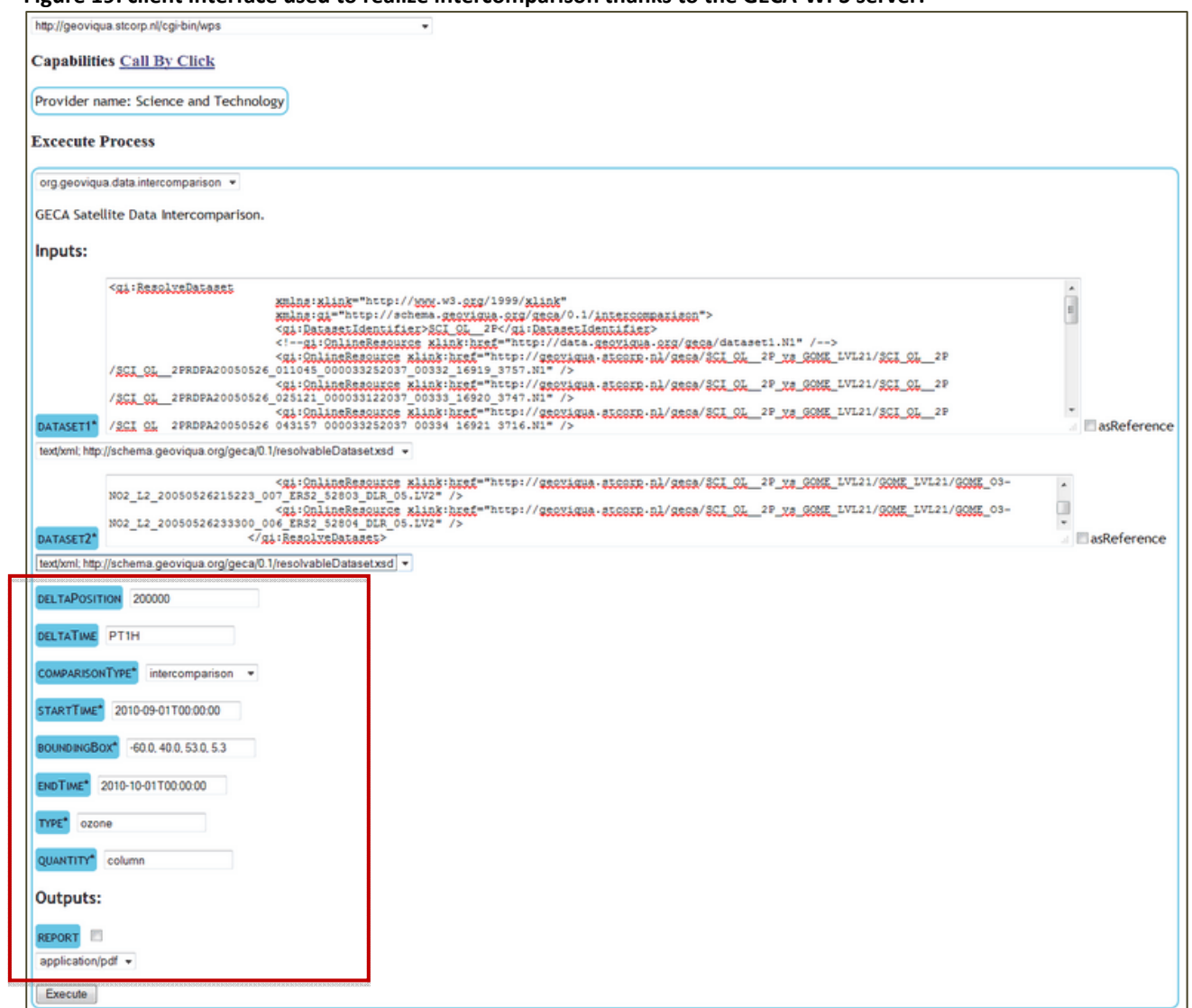
Concretely, *“The GECA Toolset is a toolkit for ingesting, processing and inter-comparing satellite data against correlative data, which can be either in-situ data or other satellite*

data. It is composed of command lines and a library of analysis functions. In the inter-comparison the satellite and correlative data are processed and the two datasets that are to be compared end up having the same temporal/spatial grid, data format, and same physical unit": [D7.4-GCIPILCAS].

To assess ESC applicability, the S&T team used atmospheric data provided by ESA.

The figure 19 show the client interface used to realize an intercomparison between 2 satellites data.

Figure 19: client interface used to realize intercomparison thanks to the GECA-WPS server:



The screenshot displays the GECA client interface. The 'Execute Process' section is active, showing the 'org.geoviqua.data.intercomparison' process. The 'Inputs' section contains two XML snippets for 'DATASET1' and 'DATASET2'. A red box highlights the parameter section below the XML, which includes the following fields:

- DELTAPOSITION**: 200000
- DELTA TIME**: PT1H
- COMPARISON TYPE**: intercomparison
- START TIME**: 2010-09-01T00:00:00
- BOUNDING BOX**: -60.0, 40.0, 53.0, 5.3
- END TIME**: 2010-10-01T00:00:00
- TYPE**: ozone
- QUANTITY**: column

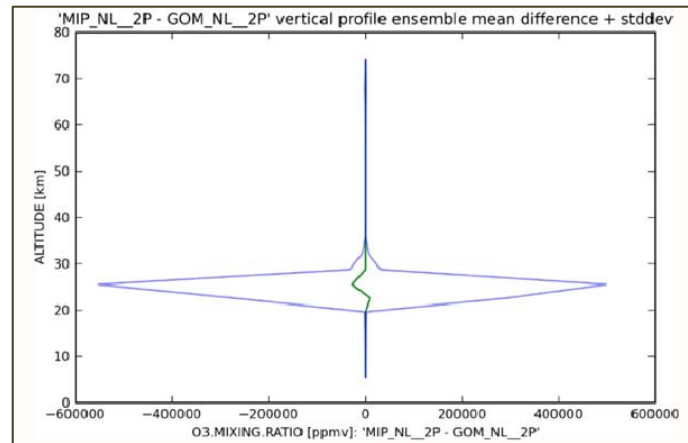
The 'Outputs' section shows a 'REPORT' checkbox and a dropdown menu set to 'application/pdf'. An 'Execute' button is located at the bottom of the interface.

Figure 19 highlights how to construct a valid request via the GECA client application to the GECA-WPS server. It should be note that the user have to precise several parameters (red square) which are:

- ID of dataset 1 – The first dataset for the intercomparison.
- ID of dataset2 – The second dataset for the intercomparison.
- deltaPosition (optional) – The maximum spatial offset between both datasets in meters
- deltaTime (optional) – The maximum time offset between both datasets in hours
- comparisonType – This parameter acts as a switch between “intercomparison” and “collocation”
- startTime, endTime – a referenced dataset might have a wide coverage over time. These parameters are used to restrict the intercomparison to the provided times
- boundingBox – similar to the temporal extent, a dataset might have a wide spatial coverage. This parameter is used to restrict the intercomparison to the spatial area defined by provided bounding box
- type – The quantity of interest used in the intercomparison (e.g. ozone concentration, methane)
- quantity – The quantity used in the intercomparison (e.g. parts per million, total column density, volume mixing_ratio)
- report – the type of report generated

To fill in this information the GEOSS portal interacts with the user to find easily the proper parameters for the intercomparison. For example, once the users has chosen its two datasets (thanks to the DAB-Q, the metadata intercomparison and Rubric), the GEOSS portal can display a list of available type for the quantity to intercompare (e.g. column, mixing ratio, ...) depending on the quantity and dataset selected. Finally, upon acceptance of the job by the WPS service, it offers a hyperlink to the user that enables monitoring progress and fetching results after completion. Figure 20 shows one comparison results done by the request describe in figure 19.

Figure 20: Example report plot showing the relation between altitude and differences in Ozone volume mixing ratio (green line is average difference, blue line is standard deviation of difference).



Accordingly this tool offers to the ESC more than comparison possibilities: it can be used as well as a real analysis data tool.

To conclude about the sections 4.1, 4.2 and 4.3, it's important to show the integration of these tools within the GEOSS portal (figure 21):

Figure 21: GEOSS portal integration of the comparison metadata tools done by GeoViQua (the use of these tools is very easy: users just have to select dataset which have been search by key words and select them before apply the desired tool).



Notice the presence of the GEO label and the possibility to access to the global metadata's dataset information (click to read more).

4.4 Global Carbon Atlas.

4.4.1 General description and global GeoViQua project integration.

The Global Carbon Atlas (GCA) is a platform to explore and visualize the most up-to-date data on carbon fluxes resulting from human activities and natural processes. It's also a community effort under the umbrella of the Global Carbon Project (<http://www.globalcarbonproject.org/>) based on the contributions of many research institutions and individual scientists around the world who make available observations, models, and interpretation skills. It is led by the *CEA-LSCE* and the *Global Carbon Project* teams and supported by the *Fondation BNP Parisbas*.

Consequently, it's important to note that this initiative wasn't created for the GeoViQua project, unlike the others. Nevertheless one part of the Carbon Atlas portal (the "Flux maps" part, which belongs to the "Research component" of the portal) is related to the GeoViQua project because it integrates some of the GeoViQua tools⁶.

First of all, the "Flux maps" application, that displays maps of the carbon fluxes from different products, is based on a client interface using OpenLayers and on a server using the ncWMS capabilities (the data used are in netCDF format). The main idea of this application is to compare carbon fluxes models (from different approaches, including land/ocean models and atmospheric CO₂ inversions) so the client interface offers the possibility to spatially synchronize several carbon flux model maps (see figure 22).

⁶ GeoViQua's tools integration was promoted by the fact that the CEA-LSCE belongs to GeoViQua partners (it's the entity in charge of the Carbon Use Case).

Figure 22: Client interface of the “Flux maps” part of the GCA showing the capacity to easily compare different carbon fluxes models.

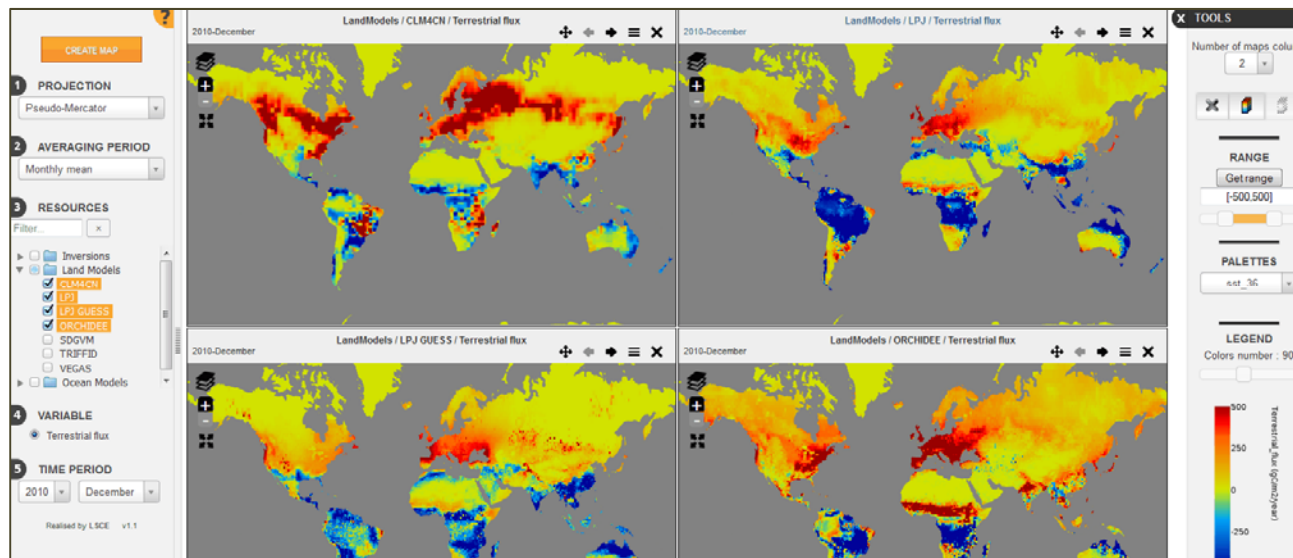


Figure above highlights similarities with the Greenland interface (these two interfaces allow to compare different maps). However, the interface developed for the CarbonAtlas is specifically adapted to the display of surface carbon flux data⁷.

Besides the utilisation of the ncWMS server and the comparison maps capacity, this application is related to the GeoViQua project with the integration of specific GeoViQua's tools (see below).

4.4.2 GeoViQua's tools integration.

Producer Quality Model.

Carbon flux data providers (all coming from different research institutes around the world) are invited to use the Producer Quality Model to fill in metadata information about their own carbon flux model (land/ocean models or atmospheric inversions). The interest for the GCA team is to benefit from an easy tool to ask metadata information to each provider and to have complete and ISO compliant metadata information.

⁷ One of the values of the GCA is to present several carbon fluxes models from different countries and research institutes.

GEO label and User Feedback

The GCA integrates the GEO label tool to present metadata information (figure 23).

Figure 23: integration of the GEO label tool in the GCA portal.

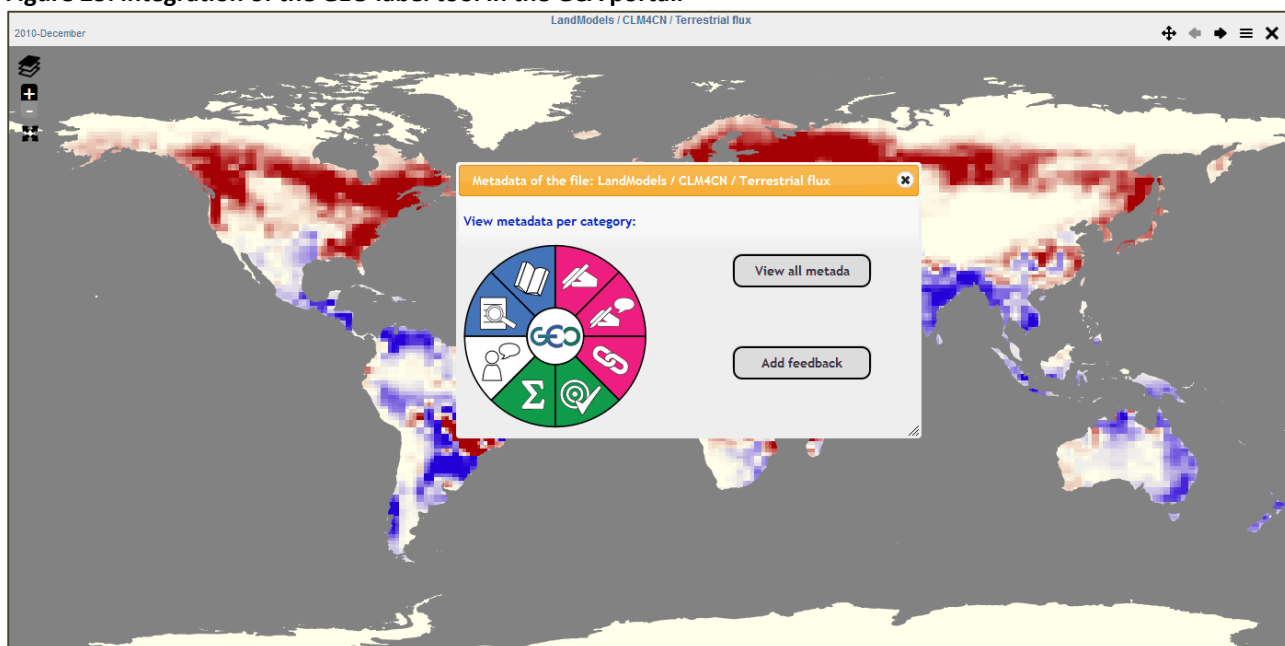


Figure above shows also the integration of the User feedback tool.

WMS-Q

The objective is to use WMS-Q extension to retrieve metadata information for each model and to overlay an uncertainty⁸ layer to a given product, like it is currently done in the **Godiva2** interface (<http://ncwms.geoviqua.org/godiva2.html>), which is the Reading client application based on the ncWMS-Q server.

Overall, the “carbon flux application” though the GCA portal represents an important and concrete valorisation of few tools developed within GEOVIQUA and directly benefits the Earth Science Communities and more specifically the carbon cycle community. The application illustrates the benefit of deriving generic tools that can be used by specific communities around Earth Science.

Note finally that other groups related to Earth Science Communities have started to use GeoViQua’s tools. Among them, the George Mason University (GMU) have used the GEO label and the User Feedback tool in the following portal: <http://gis.csiss.gmu.edu/GADDFS/>.

⁸ In this case the uncertainty layer is the result of the difference between one model layer and the mean of all the models layers related with this model.

5. Conclusion

Tools created by the GeoViQua team are innovative and have been designed to be easy to use and related with ESC needs. Concretely, these tools add much functionality to the GEOSS portal (see figure 24).

Figure 24: functionalities add to the GEOSS portal thanks to the GeoViQua project.

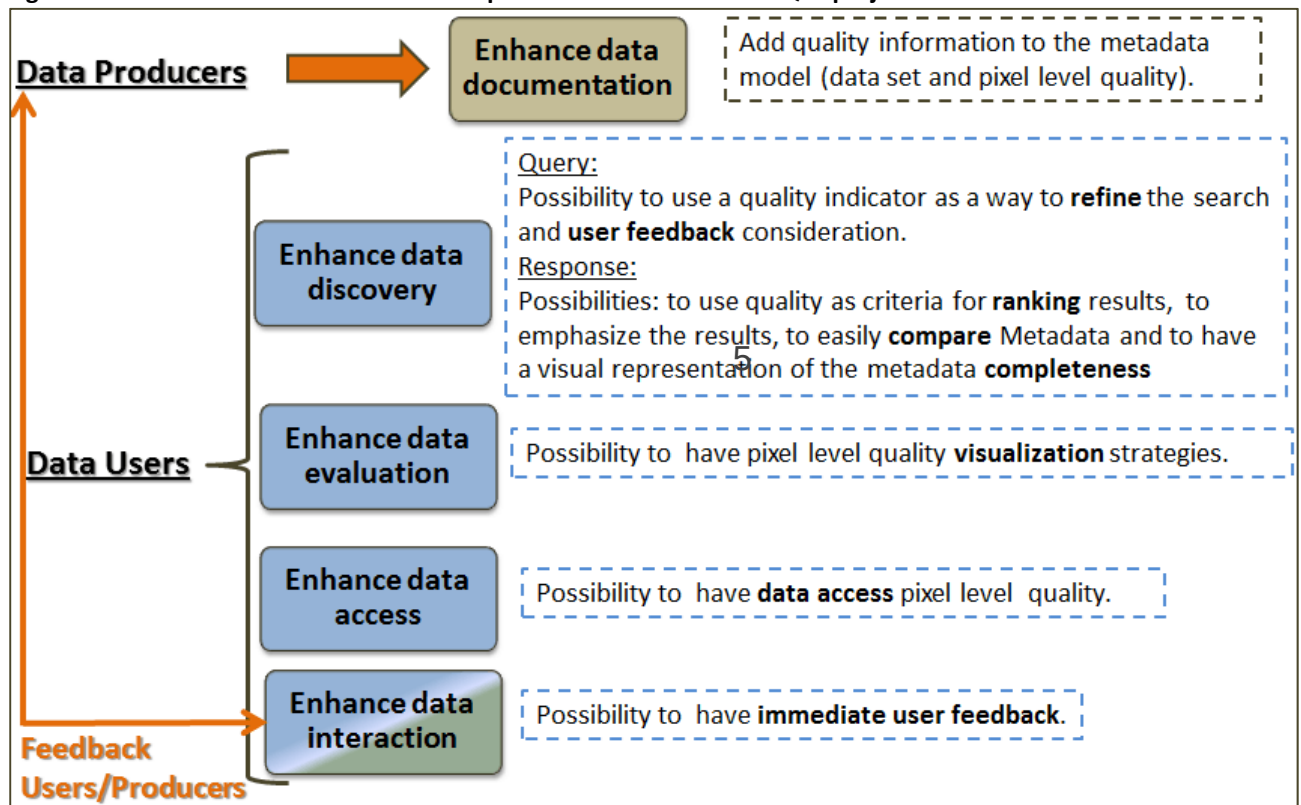


Figure 24 highlights and summarizes achievements and benefits of the GeoViQua project regarding to ESC. It should be noted that a huge effort has been done in this project to combine all these tools/elements together. To illustrate this effort we can mention the User feedback tool which is used to complete GEO label and Producer Quality Model tools using one of the metadata ISO extensions which allow taking into account user feedback information. Additionally, this User feedback information could be used to refine search.

Nevertheless all the tools that we have studied depend on the quality information content in datasets and actually few documents in the GCI have good quality information but GeoViQua dissemination efforts are still ongoing to increase the number of producers that create and maintain quality enable data and metadata. Accordingly this deliverable shows the importance of the tools developed for the immediate applicability for the ESC.

Of course some things have to be done to improve these tools. For example, actually, the ncWMS-Q doesn't implement GetFeatureInfo capacity. Its future implementation will allow for example to generate probability density functions for a pixel based on uncertainty metadata.

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ACRONYMS:

CoP. Community of Practice (GEOSS)

CSW. Catalogue Service for the Web

DAB. Discovery and Access Broker

EC. European Commission.

EGIDA. FP7 Project. Coordinating Earth and Environmental cross-disciplinary projects to promote GEOSS (Global Earth Observation System of Systems). <http://www.egida-project.eu/>

EGU. European Geosciences Union. <http://www.egu.eu/>

EuroGEOSS. FP7 Project. <http://www.eurogeoss.eu/default.aspx>

GECA. Generic Environment for Calibration/validation Analysis

GIF. Graphics Interface Format

GEO. Group on Earth Observations.

GEOSS. Global Earth Observation System of Systems.

GeoViQua. QUALity aware Visualisation for the Global Earth Observation system of systems

GCI. GEOSS Common Infrastructure

ISO. International Organization of Standardization. <http://www.iso.org/iso/home.html>

KML. Keyhole Markup Language.

OGC. Open Geospatial Consortium <http://www.opengeospatial.org/>

OWS. OGC Web Services

PQM. Producer Quality Model

QM. Quality Model

ncWMS. Web Map Service for geospatial data that are stored in CF-compliant NetCDF files.

netCDF. network Common Data Form

SLD/SE. Styled Layer. Descriptor (SLD) and Symbology Encoding (SE) standards

TDS THREDDS Data Server

UncertML. <http://www.uncertml.org/>.

URL. Uniform Resource Locator

WMS. Web Map Service

WMTS. Web Map Tile Service

WPS. Web Processing Service

- **GeoViQua partners:**

52N. 52° North GmbH (Germany)

AST. Aston University (UK)

CEA. Commissariat à l’Energie Atomique et Aux Energies Alternatives (France).

CNR. Consiglio Nazionale delle Ricerche (Italy).

CREAF. Centre for Ecological Research and Forestry Applications (Spain)

ESA. European Space Agency (Italy)

FRAUN. Fraunhofer Institut Graphische Datenverarbeitung -IGD- (Germany)

OGCE. Open Geospatial Consortium (Europe) Limited

S&T. S[&]t Corporation (The Netherlands)

UAB. Universitat Autònoma de Barcelona (Spain)

UREAD. University of Reading (UK)



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