GeoViQua
QUAlity aware VIsualisation for the
Global Earth Observation system of systems

Final achievements and scenarios
www.geoviqua.org

SEVENTH FRAMEWORK PROGRAMME (nº 265178)
THEME [ENV.2010.4.1.2-2]
Integrating new data visualisation approaches of earth Systems into GEOSS development
GeoViQua. QUAlity aware VIsualisation for the Global Earth Observation system of systems. Final achievements and scenarios.
Designed by CREAF Communication Team.
Cover photograph: Earth Communications by Donkey Hotey.
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What is GeoViQua

GeoViQua has attained several scientific and technical achievements. The most significant ones are:

The release of a complete quality model. GeoViQua’s major conceptual contributions are its producer quality framework, based on existing metadata standards such as ISO 19115 and UncertML, and its innovative user feedback model for geospatial data.

The provision of innovative visualisation solutions to represent quality in 2D and 3D geo web portals and their formalization into existing standards such as WMS and KML.

The development of the GEOLabel. GeoViQua has fully developed the concept of the GEOLabel in close collaboration with the ID-03 GEO task. A carefully designed consultation on user requirements has converged on a clear and objective

GeoViQua has contributed to augment GEOSS Common Infrastructure (GCI) with innovative quality-aware visualization tools and geosearch capabilities, providing to the user community with enhanced and advanced tools available through the GEOSS Portal and other end-user tools.
design for a dynamic label that is easy to generate, compare and understand. A Web service generates up-to-date labels for all datasets in the GCI.

The harmonization, exploitation and dissemination of project outputs has been ensured by close work with the GEOSS communities of practice and other EC research projects. GeoViQua has worked with standards bodies and GEOSS tasks to maximize its outreach. GeoViQua has also collaborated with two OGC Architecture Interoperability Pilots.

GeoViQua has been supported by the participation of 11 partners:

CREAF: Centre for Ecological Research and Forestry Applications (Spain)
UAB: Universitat Autònoma de Barcelona (Spain)
52° North GmbH (Germany)
Fraunhofer Institut Graphische Datenverarbeitung -IGD- (Germany)
Consiglio Nazionale delle Ricerche (CNR). IIA - Istituto sull’Inquinamento
Aston University (UK)
University of Reading (UK)
Commissariat a l’Energie Atomique (CEA). LSCE -Laboratoire des Sciences du Climat et de l’Environnement (France)
ESA: European Space Agency (France)
S&t Corporation (The Netherlands)
Open Geospatial Consortium (Europe) Limited (OGCE)
The EU agri-environmental measures (Regulation CEE 1257/1999) consist of a subsidy that farmers receive to support agricultural practices that favour the conservation of ecosystems, e.g. keeping their rice crops flooded during the period when the birds visit the area. In Catalonia, the local government monitors the farmers’ practices by means of a fair decision support system based on remote sensing imagery, replacing time-consuming and expensive field surveys.

The Ebro Delta regions are too big for in situ verification. A sophisticated remote sensing algorithm has been implemented, based on Landsat imagery. Farmers’ flooding practices are extracted by combining image classification procedures with rigorous statistical quality assessments. Both the Landsat imagery and a sample of the classified maps are available through the GEOSS portal.

The GeoViQua developments integrated in this platform enable discovery of, and access to, the quality indicators and traceability embedded in metadata, GEO Label and scientific reports. They also provide smart quality visualization at pixel level (Quality enriched Web Map services [WMS-Q] visualized in Greenland) and at feature level (Quality enriched [KML-Q] visualized in Google Earth).
A sudden failure of the Landsat TM/ETM+ sensor occurs during a monitoring critical period, thus an alternative has to be found as quickly as possible. Time is critical to find a suitable alternative dataset for this specific application without compromising the quality of the farm assessment. Through the **Producer Quality Model (PQM)** developed in GeoViQua, a discovered issue is found, which includes a reference to a paper comparing Landsat with other imagery. This allows potential alternatives to be selected, based on the documented operative quality parameterization and accuracy measures.

The Producer Quality Model extends ISO 19115-1, 19115-2 and 19157 standards to include richer information such as discovered issues, new and better formalized quality indicators (reference datasets used for quality evaluation, traceability, and statistical summaries of quantified uncertainty), citations to publications, pixel level quality and more.

**ADDITIONS IN THE METADATA QUALITY MODEL**

[http://schemas.geoviqua.org](http://schemas.geoviqua.org)

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The government technicians can search for these alternative datasets through the **GEOSS Portal quality-aware component (DAB-Q)**. Searching by location (Ebro Delta area) and/or keyword, date (the critical period without Landsat images) and also by specifying quality parameters which the data must fulfil, they can identify available data from a range of different platforms.

The Quality-enabled Discovery and Access Broker (DAB-Q) is an extension of the GEO-DAB that implements the Producer Quality Model (and also a User Quality Model) 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.

**QUERY BY QUALITY INDICATOR**
http://geoviqua.essi-lab.eu/dabq-demo/gi-portal/index.jsp
The metadata of the possible alternative datasets can be compared to facilitate the choice of the right product, using the visual and graphical tools developed in the GeoViQua project. The most fit-for-purpose dataset is identified through metadata comparison, which offers a vision of the attributes of the datasets and also a rating of the accuracy values.

Finally, some SPOT imagery is selected and the monitoring process can continue.

METADATA COMPARISON
http://geoportal.geoviqua.org

The metadata comparison tool presents datasets in columns, with attributes and metadata parameters aligned in rows. It also offers graphical plots of some numerical parameters. The quality metadata section not only compares the values of the attributes, but emphasizes the most accurate dataset using a green color.
At the end of the campaign the local government releases **KML-Q** with a summary of the season (a layer which displays the compliant and non-compliant parcels with a binary palette over Google Earth). This publication informs landowners as to whether they will receive the subsidies, and an allegation period starts. More informative presentations using bivariate representation are also provided.

On this binary map, the service overlays a visualization of the quality (purity) of the estimate, (e.g., green/red fading colors for lower purity values), thus showing both the category and the uncertainty of that category.

GeoViQua has provided a tool that can be used by wildlife managers to quickly obtain datasets with specific quality and characteristics, as well as provide them with alternative datasets when needed.

Quality can be described at dataset level (overall indicator in the metadata) or at pixel level and feature level (a quality value for each pixel or feature). GeoViQua has incorporated into the ncWMS innovative symbolization methods that allow presentation of pixel quality and data in the same frame.

**KML-Q AND WMS-Q**

http://www.ogc.uab.es/geoviqua/wmsq
In the process of updating the emission thresholds and mitigation strategies for the Kyoto protocol, the generation of carbon cycle products (in particular carbon flux products) provides scientific data for decision makers.

Through the Carbon Atlas web, sufficient material is provided to derive both technical reports and dissemination material for the media, general public and, most importantly, inputs for national policy makers who ultimately agree on the emission market rules. This provides an actionable scientific base to decide the best strategy for different countries, with a global understanding of the carbon fluxes, their associated uncertainties, and regional budget knowledge. The Global Carbon Atlas is able to return datasets in several visualization styles (e.g., legends, layers styling, etc) through GetMap WMS requests. The user is able to compare carbon flux models.

http://www.globalcarbonatlas.org
Flux models can be compared and analyzed, detecting trends, anomalies and calculating statistics related to the quality and performance of the models. This process allows for model choice. Quality-aware visualization of such products is available in the Carbon Atlas portal. When several models are selected, a model ensemble is attempted. In this way, carbon products are generated, including models, and can be visually compared. When a scientist detects an anomaly in model results for some regions he/she can send their feedback with a detailed report and can thus contribute to improve the accuracy of the models on the basis of local studies. Also a scientist can rate and comment on the model that they find most convenient for their application.

The user feedback model offers a framework for storing and querying user comments, ratings, expert reviews, metadata overrides and other feedback elements. The user feedback component allows introduction of new feedback items, while the DAB-Q is able to search in the user feedback database and integrate the response in its search results page. The integration in the GEOSS Portal facilitates creation of rich feedback about a dataset.
User feedback and expert reviews can be accessed by means of a **GEO label**. In the carbon atlas, each dataset is associated with a GEO label. This dynamic label facilitates comparison of the datasets.

The GEO label of the Carbon Atlas product changes with the addition of a new user feedback item, showing that there has been an improvement in the completeness of the metadata.

The GEO label is a graphic representation which visually summarizes the availability of quality information for the dataset it represents, comprising 8 informational facets: producer profile, producer comments, lineage information, standards compliance, quality information, user feedback, expert review and citations information. The information availability states are expressed through varying the appearance of the facet icons.

The GEO label is also dynamic, giving access to more information by hovering or clicking over its facets. Integrated in the GEOSS portal, an individual GEO label is provided for each dataset based on its available quality information. The generated GEO labels serve as quality indicators, and assist in dataset search and selection.
In the carbon atlas, a scientist wants to compare two types of carbon flux models, but they have different geographic projections and a different averaging period. They can use the **GECA Toolset**, which assists in the inter-comparison of datasets. Data are preprocessed such that the two datasets that need to be compared end up having the same temporal/spatial grid, same data format/structure, and same physical unit.

At the end of the process, the user gets a set of data files that can be directly compared in IDL or MATLAB and a detailed report on the intercomparison of the values.

**DATA COMPARISON TOOL: GECAaaS**

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. GECA has been integrated in the GEOSS portal and it is available by enabling checkboxes next to two of the resources in the results page and clicking “Data Intercomparison”. A request is sent to an online processing service (a WPS) which compares the two datasets. The intercomparison result is shown either within the GEOSS Portal or in a pop-up window.
SCENARIO 2

The WPS utilized by the GECA Toolset can also be queried directly to generate a ZIP file that contains the inter-comparison report and collocated values. A user can upload this file to the Quality Emitter and select the reference and observed datasets. Quality indicators will then be computed, validated and presented as an online report. PQM metadata describing these results is automatically generated.

Computing Data Quality: Quality Emitter

A challenge with many existing data sets is that they do not have reliable quantitative quality indicators available to them. To address this, GeoVi-Qua has developed a tool to combine reference data with collocated measurements to compute dataset-level quality indicators.

These quality indicators, such as the mean (bias), variance, or quantiles of the uncertainties can then be added to XML in the extended producer quality model. The additional XML includes a description of the lineage of the quality indicators.

The quality emitter tool also provides a validation of the quality indicators (often referred to as meta-quality descriptors) which allow the user to judge the reliability of the quality indicators, and to easily access information on how these indicators were computed.
Conclusions

The Global Earth Observation System of Systems (GEOSS) brings together existing observing systems around the world while supporting the development of new systems where gaps currently exist. The network interoperability is ensured by a common set of standards so that data from different instruments can be combined into coherent datasets.

GeoViQua formalizes quality providing two integrated metadata models: an evolution of the ISO metadata model and a new geospatial user feedback model. GeoViQua improves the GEOSS Common Infrastructure by enhancing Discovery and Access Broker with quality queryables and by incorporating a new user feedback database.

GeoViQua also integrates several improvements into the GEOSS Portal such as quality search, data intercomparison, metadata graphical representation, user feedback input and the GEO label.

The GEO Label service is another addition into the GCI that dynamically generates easy-to-compare data labels, allowing increasing user trust in GEOSS data.

The user feedback service implements the user feedback model allowing sharing user comments and rates, and also expert reviews. The user feedback service is integrated into the Discovery and Access Broker that provides producer metadata and user feedback. Those results are shown together in the GEOSS Portal.

The generic CAL/VAL (GECA) is wrapped in a WPS that elicits quality from existing data intercomparison. Finally, quality indicators are derived by the quality emitter component and included into producer metadata.
GeoViQua components address a variety of strategies for visualising data, together with its quality information, in the GEOSS Portal - particularly at a pixel and feature level. Data is represented with its quality indicators through innovative symbology techniques.

The components comply with existing standards and are ready to deploy in the GEOSS portal as well as mass-market geo-browsers and geo web tools (such as GeoNetwork, WMS Greenland, Google Earth...).

Some of the publications derived from the project:


This leaflet presents the final achievements of the GeoViQua (QUAlity aware VIsualisation for the Global Earth Observation system of systems) project described in terms of two demonstration scenarios. The scenario 1 is related to agriculture flooding practices control, and the scenario 2 talks about the Global Carbon Atlas. For each page, the upper part framed in background color describes the scenario stories and the lower part describes components developed by GeoViQua.

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