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QUAlity aware VIualisation for the Global Earth Observation system of systems

Deliverable D5.4
Final versions of quality-aware visualisation components

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<tr>
<td>1.0</td>
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**Institution** | **Contributors**
--- | ---
CREAF | JM_CREAF: Joan Masó
ASTON | VL_ASTON: Victoria Lush
UREAD | JB_UREAD: Jon Blower
FRAUN | ST_FRAUN: Simon Thum
CEA | PE_CEA: Pascal Evano

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1. Introduction
This document provides brief descriptions of the GeoViQua quality-aware visualization software components. The sections below contain descriptions of each component, URLs to relevant websites (of demonstrators and source code hosting), a brief outline of the capabilities of each system, and an indication of “future work” that is intended to be performed after the project, subject to further funding being available.
This document is an update to D5.3, which described an earlier stage of development of these components.

2. Status of prototypes

2.1 Server implementations

2.1.1 ncWMS-Q
Partner responsible: UREAD
URL of demonstrator website (if applicable): http://dexter.nerc-essc.ac.uk/ncWMS/godiva2.html
URL of developer website (including source code): http://ncwms.sf.net
Description: An implementation of the WMS-Q conventions for raster data, based upon the existing ncWMS software. It has been updated to be compatible with version 2 of the WMS-Q specifications.
Status of component:
The ncWMS-Q component is nearly complete. It implements version 2 (the latest version at the time of writing) of the WMS-Q specification (currently published at http://twiki.geoviqua.org/twiki/bin/view/GeoViQuaIntranet/WmsQDabQIntegration). This includes:

2. Use of Keywords from UncertML and QualityML to convey information about the nature of the quality information in the WMS.

Additionally, the server implements a sophisticated styling mechanism, giving the client very fine control over the styling of the data. Any field can be represented as colour maps, contours, patterns, glyphs, confidence triangles or other mechanisms. This is implemented using an enhanced version of the OGC Symbology Encoding specification. The new GeoViQua standard will be described in an update to deliverable D5.1 and will ultimately be published through the OGC, perhaps as a Best Practice report.

Future work:
1. Refine the behaviour of GetFeatureInfo. This currently returns basic information and graphics for each pixel in the images, but this needs modification to show uncertainty information in a more useful way.

2. Complete the integration of the “enhanced styling specification” that is under development in WP5.1. At the time of writing, this code is nearly ready for integration (it is being developed on a separate branch of the code) and will be completed before the end of the GeoViQua project.

3. Complete the publishing of metadata documents describing the sample data on this server, using the GeoViQua Producer Quality Model.

![Figure showing Sea Surface Temperature data from the European Space Agency’s Climate Change Initiative (data courtesy of Prof. Chris Merchant), portraying the mean field as colours and the uncertainty field (variance) as contours.](image)

2.1.2 CREAf WMS-Q
Partner responsible: CREAf
URL of demonstrator website (if applicable): http://www.ogc.uab.cat/cgi-bin/GeoViQUA/WMSQ/MiraMon.cgi?REQUEST=GetCapabilities&Service=WMS
**URL of developer website (including source code):** N/A

**Description:** The WMS server developed at CREAT in the MiraMon group has been enriched to support WMS-Q profile (see: D5.1 Integration of quality information with OGC visualisation services best practice report). It has been updated to be compatible with version 2 of the WMS-Q specifications. The MiraMon server technology requires a pre-rendering of the data into pictoric representation tiles (GIF, PNG, JPEG). The symbolic flexibility of the pre-rendering processes has been enriched with the capability of rendering 2 (or more) components in a single layer. This way the composite layer can be presented in a more understandable way.

The server content is registered in a catalog.mlc file where new sections were included to express the relations between layers and allow WMS-Q layer nesting requirements. For example the layer AnnualTemperature has a quality composition and 4 quality components, representing per pixel values, one for the main variable and the last 3 for quality components, all of them related as shown:

```
[Temes1]
Fills=MeanAnnualTemperature, LandCover, FloodingMonitoring;
Fills=TemperaturaMitjanaAnual, Ussol

[TEMA: AnnualTemperatureVar]
Title=Annual Air Temperature of Iberian Peninsula
Abstract=Annual climatic digital maps of air temperature of Iberian Peninsula. Maps have been generated by means of statistical techniques, Geographic Information Systems and spatial interpolation.
Keywords=qualityCollection
KW_TypeCode=1.0
KW_CodeSpace=http://qualityml.geoviqua.org
Metadata_Fitxer1=AtlesClimatic\md\DigitalClimaticAtlas_mt_an_currentVersion.xml
Metadades_Tipus1=TC211
Metadades_Exportacio1=XML1
Metadades_Idioma1=eng
```
Fills=Annual Temperature, Mean Annual Temperature, Extrapolation Areas, Residual Spatial Regression, Stability Test Areas

; ============= ATLES CLI MATIC ==============
[Annual Temperature: EPSG: 23030]
Fitxer = Atles Climatic\Temperatura\TemperaturaAnual.rel
Visible AGGetCapabilities = 1

[Mean Annual Temperature: EPSG: 23030]
Fitxer = Atles Climatic\TemperaturaMitjanaAnual.rel
Visible AGGetCapabilities = 1

[Extrapolation Areas: EPSG: 23030]
Fitxer = Atles Climatic\ZonesExtrapolacio\ZonesExtrapolacio.rel
Visible AGGetCapabilities = 1

[Residual Spatial Regression: EPSG: 23030]
Fitxer = Atles Climatic\EspacialitzacioResidusRegressio\EspacialitzacioResidusRegressio.rel
Visible AGGetCapabilities = 1

[Stability Test Areas: EPSG: 23030]
Fitxer = Atles Climatic\AreesTestEstabilitat\AreesTestEstabilitat.rel
Visible AGGetCapabilities = 1

When the capabilities document is requested this notation is translated into layer description in the WMS GetCapabilities standard response. The following XML fragment shows a simplified XML text the emphasises the layer relations, naming and mandatory keywords. It comes from the response of the following request:
http://www.ogc.uab.cat/cgi-bin/GeoViQUA/WMSQ/MiraMon.cgi?SERVICE=WMS&request=GetCapabilities

```xml
<Layer>
  <Title>CREAF-MiraMon WMS-Q WMTS-Q test demonstration</Title>
  <Layer>
    <Title>Annual Air Temperature of Iberian Peninsula</Title>
    <KeywordList>
      <Keyword vocabulary="http://qualityml.geoviqua.org/1.0/">qualityCollection</Keyword>
    </KeywordList>
    <Layer queryable="1" opaque="1">
      <Name>AnnualTemperature</Name>
      <Title>Annual Air Temperature of Iberian Peninsula</Title>
      <KeywordList>
        <Keyword vocabulary="http://qualityml.geoviqua.org/1.0/">qualityComposition</Keyword>
      </KeywordList>
      <Layer queryable="1" opaque="1">
        <Name>MeanAnnualTemperature</Name>
        <Title>Mean Annual Air Temperature</Title>
        <KeywordList>
          <Keyword vocabulary="http://qualityml.geoviqua.org/1.0/">values</Keyword>
        </KeywordList>
      </Layer>
    </Layer>
  </Layer>
</Layer>
```
The following WMS GetCapabilities fragment corresponds to the complete layer section for the exemplified variable (annual mean temperature).

```xml
<Layer>
  <Title>CREAF-MiraMon WMS-Q WMTS-Q test demonstration</Title>
  <CRS>EPSG:23031</CRS>
  <CRS>EPSG:4326</CRS>
  <CRS>EPSG:23030</CRS>
  <CRS>EPSG:27563</CRS>
  <Layer>
    <Title>Annual Air Temperature of Iberian Peninsula</Title>
    <Abstract>Annual climatic digital maps of air temperature of Iberian Peninsula. Maps have been generated by means of statistical techniques, Geographic Information Systems and spatial interpolation.</Abstract>
    <KeywordList>
      <Keyword vocabulary="http://qualityml.geoviqua.org/1.0/">qualityCollection</Keyword>
    </KeywordList>
    <Layer queryable="1" opaque="1">
      <!-- Layer content -->
    </Layer>
  </Layer>
</Layer>
```
<Layer>
  <Name>AnnualTemperature</Name>
  <Title>Annual Air Temperature of Iberian Peninsula</Title>
  <Abstract>Annual climatic digital maps of temperature. This layer is an aggregator for all the components of the temperature value. Maps have been generated by means of statistical techniques, Geographic Information Systems and spatial interpolation.</Abstract>
  <KeywordList>
    <Keyword vocabulary="http://qualityml.geoviqua.org/1.0/">qualityComposition</Keyword>
  </KeywordList>
  <EX_GeographicBoundingBox>
    <westBoundLongitude>-9.340148</westBoundLongitude>
    <eastBoundLongitude>3.858061</eastBoundLongitude>
    <southBoundLatitude>35.697178</southBoundLatitude>
    <northBoundLatitude>43.731057</northBoundLatitude>
  </EX_GeographicBoundingBox>
  <BoundingBox CRS="EPSG:23030" minx="-74000.00" miny="3969000.00" maxx="1052400.00" maxy="4865000.00" resx="100.00" resy="100.00"/>
  <MetadataURL type="ISO19115:2003">
    <Format>application/xml</Format>
  </MetadataURL>
</Layer>

<Layer queryable="1" opaque="1">
  <Name>MeanAnnualTemperature</Name>
  <Title>Mean Annual Air Temperature</Title>
  <Abstract>Annual climatic digital maps of mean temperature. Maps have been generated by means of statistical techniques, Geographic Information Systems and spatial interpolation.</Abstract>
  <KeywordList>
    <Keyword vocabulary="http://qualityml.geoviqua.org/1.0/">values</Keyword>
  </KeywordList>
  <EX_GeographicBoundingBox>
    <westBoundLongitude>-9.340148</westBoundLongitude>
    <eastBoundLongitude>3.858061</eastBoundLongitude>
    <southBoundLatitude>35.697178</southBoundLatitude>
    <northBoundLatitude>43.731057</northBoundLatitude>
  </EX_GeographicBoundingBox>
  <BoundingBox CRS="EPSG:23030" minx="-74000.00" miny="3969000.00" maxx="1052400.00" maxy="4865000.00" resx="100.00" resy="100.00"/>
  <MetadataURL type="ISO19115:2003">
    <Format>application/xml</Format>
    <OnlineResource xmlns:xlink="http://www.w3.org/1999/xlink" xlink:type="simple" xlink:href="http://localhost/cgi-bin/WMSQ/MiraMon.cgi?SERVICE=CSW&amp;REQUEST=GetRecordById&amp;OUTPUTSCHEMA=http://www.isotc211.org/2005/gmd&amp;ELEMENTSETNAME=full&amp;id=MeanAnn
ualTemperature:EPSG:23030&amp;LANGUAGE=eng&amp;OUTPUTFORMAT=application/xml
"/>
</Layer>
</Layer opaque="1">
<Name>ExtrapolationAreas</Name>
<Title>Extrapolation areas</Title>
<Abstract>Extrapolation areas of the regression model, these are uncertain areas and thus indicate the place where extrapolation of the regression model is applied (i.e. prediction of values without adjustment points within the range or area).</Abstract>
<KeywordList>
<Keyword vocabulary="http://qualityml.geoviqua.org/1.0/measures">ExtrapolatedAreas</Keyword>
</KeywordList>
<EX_GeographicBoundingBox>
<westBoundLongitude>-9.340148</westBoundLongitude>
<eastBoundLongitude>3.858061</eastBoundLongitude>
<southBoundLatitude>35.697178</southBoundLatitude>
<northBoundLatitude>43.731057</northBoundLatitude>
</EX_GeographicBoundingBox>
<BoundingBox CRS="EPSG:23030" minx="-74000.00" miny="3969000.00" maxx="1052400.00" maxy="4865000.00" resx="100.00" resy="100.00"/>
</Layer>
</Layer opaque="1">
<Name>ResidualSpatialRegression</Name>
<Title>Residual spatial regression</Title>
<Abstract>Detection of cells that have different weather from the predicted averages conditions. Integrates both the uncertainty caused by the unsatisfactory modeling as well as the natural uncertainty of areas with particular climatic conditions.</Abstract>
<KeywordList>
<Keyword vocabulary="http://www.uncertml.org/statistics">ResidualAccuracy</Keyword>
</KeywordList>
<EX_GeographicBoundingBox>
<westBoundLongitude>-9.340148</westBoundLongitude>
<eastBoundLongitude>3.858061</eastBoundLongitude>
<southBoundLatitude>35.697178</southBoundLatitude>
<northBoundLatitude>43.731057</northBoundLatitude>
</EX_GeographicBoundingBox>
<BoundingBox CRS="EPSG:23030" minx="-74000.00" miny="3969000.00" maxx="1052400.00" maxy="4865000.00" resx="100.00" resy="100.00"/>
</Layer>
</Layer opaque="1">
<Name>StabilityTestAreas</Name>
<Title>Map of test stability areas (discrete standard deviation)</Title>
<Abstract>Map of areas obtained from a stability test in which 12 maps have been generated using different sets of tuning (60%) and test (40%) stations, and it has also been obtained
a discretized standard deviation where the value 1 represents areas with less deviation and value 2 represents areas of greater deviation.\</Abstract>\<KeywordList>\  \<Keyword vocabulary=\"http://www.uncertml.org/statistics\">deviation</Keyword>\</KeywordList>\<EX_GeographicBoundingBox>\  \<westBoundLongitude>-9.340148</westBoundLongitude>\  \<eastBoundLongitude>3.858061</eastBoundLongitude>\  \<southBoundLatitude>35.697178</southBoundLatitude>\  \<northBoundLatitude>43.731057</northBoundLatitude>\</EX_GeographicBoundingBox>\</Layer>\</Layer>\</Layer>\Additionally, each layer in the MiraMon data model can have a metadata document ready to be shared. These documents are exposed in the Capabilities document as a MetadataURL’s. This metadata documents contain quality indicators that are global for the complete layer. This is the example for the Climatic atlas layer:\<MetadataURL type=\"ISO19115:2003\">\  \<Format>application/xml</Format>\  \<OnlineResource xmlns:xlink=\"http://www.w3.org/1999/xlink\" xlink:type=\"simple\" xlink:href=\"http://www.ogc.uab.cat/cgi-bin/GeoViQUA/WMSQ/MiraMon.cgi?SERVICE=CSW&REQUEST=GetRecordById&OUTPUTSCHEMA=http://www.isotc211.org/2005/gmd&ELEMENTSETNAME=full&id=MeanAnnualTemperature:EPSG:23030&LANGUAGE=eng&OUTPUTFORMAT=application/xml\" /\</MetadataURL>\Here, MiraMon server uses the CSW syntax for the GetRecordByld operation only to simulate the behaviour of a catalogue service for the web that uses the layer names as records id’s.\In fact, the returned metadata record contains some global quality indicators such as:\<gvq:dataQualityInfo>\  \<gmd19157:DQ_DataQuality>\  \<gmd19157:scope>\  \<gmd19157:DQ_Scope id="datasetScope">\  \<gmd19157:level>\  \<gmd:MD_ScopeCode codeListValue="dataset"/>\</gmd19157:level>\</gmd19157:DQ_Scope id="datasetScope">\</gmd19157:scope>\</gmd19157:DQ_DataQuality>\</gvq:dataQualityInfo>
Status of component: Status of component:

This component is nearly complete. It implements version 2 (the latest version at the time of writing) of the WMS-Q specification (currently published at [http://twiki.geoviqua.org/twiki/bin/view/GeoViQualIntranet/WmsQDabQIntegration](http://twiki.geoviqua.org/twiki/bin/view/GeoViQualIntranet/WmsQDabQIntegration)). This includes:

2. Use of Keywords from UncertML and QualityML to convey information about the nature of the quality information in the WMS.

Future work:

1. Refine the behaviour of GetFeatureInfo. This currently returns basic information and graphics for each pixel in the images, but this needs modification to show uncertainty information in a more useful way; probably a graph.

2.1.3 **CREAF WMTS-Q**

**Partner responsible:** CREAF
URL of demonstrator website (if applicable): http://www.ogc.uab.cat/cgi-bin/GeoViQUA/WMSQ/MiraMon.cgi?REQUEST=GetCapabilities&Service=WMTS

URL of developer website (including source code): N/A

Description: WMS MiraMon services are able to expose the same layers as WMTS layers using the same data preparation. We have added the development of the WMTS Capabilities document. There were no modifications in the WMTS-Q specification.

This results in the following WMS GetCapabilities fragment that describes the layer names and properties.

```xml
<Layer>
  <ows:Title>Mean Annual Air Temperature</ows:Title>
  <ows:Abstract>Annual climatic digital maps of mean temperature. Maps have been generated by means of statistical techniques, Geographic Information Systems and spatial interpolation.</ows:Abstract>
  <ows:Keywords>
    <ows:Keyword>mean annual</ows:Keyword>
  </ows:Keywords>
  <ows:Type codeSpace="http://www.uncertml.org/statistics">mean</ows:Type>
  <TileMatrixSetLink>
    <TileMatrixSet>AtlesClimatic_UTM30N</TileMatrixSet>
  </TileMatrixSetLink>
</Layer>

<Layer>
  <ows:Title>Extrapolation areas</ows:Title>
  <ows:Keywords>
    <ows:Keyword>uncert areas</ows:Keyword>
  </ows:Keywords>
  <ows:Type codeSpace="http://www.uncertml.org/statistics">extrapolation</ows:Type>
  <TileMatrixSetLink>
    <TileMatrixSet>AtlesClimatic_UTM30N</TileMatrixSet>
  </TileMatrixSetLink>
</Layer>

<Layer>
  <ows:Title>Residual spatial regression</ows:Title>
  <ows:Keywords>
    <ows:Keyword>Residual regression</ows:Keyword>
  </ows:Keywords>
  <ows:Type codeSpace="http://www.uncertml.org/statistics">ResidualAccuracy</ows:Type>
  <TileMatrixSetLink>
    <TileMatrixSet>AtlesClimatic_UTM30N</TileMatrixSet>
  </TileMatrixSetLink>
</Layer>

<Layer>
  <ows:Title>Map of test stability areas (discrete standard deviation)</ows:Title>
  <ows:Keywords>
    <ows:Keyword>stability test</ows:Keyword>
  </ows:Keywords>
  <ows:Type codeSpace="http://www.uncertml.org/statistics">deviation</ows:Type>
  <TileMatrixSetLink>
    <TileMatrixSet>AtlesClimatic_UTM30N</TileMatrixSet>
  </TileMatrixSetLink>
</Layer>
```
The layers that contains the per pixel quality information are related to the “main” data by dependencies expressed in the <Themes> sections of the same capabilities document:

```xml
<Themes>
  <Theme>
    <ows:Title>Mean Annual Air Temperature of Iberian Peninsula</ows:Title>
    <ows:Abstract>Annual climatic digital maps of mean air temperature of Iberian Peninsula. Maps have been generated by means of statistical techniques, Geographic Information Systems and spatial interpolation.</ows:Abstract>
    <ows:Keyword>multivariate regression</ows:Keyword>
    <ows:Keyword>multivariate-normal</ows:Keyword>
    <ows:Identifier>MeanAnnualTemperature</ows:Identifier>
  </Theme>
  <Theme>
    <ows:Title>Temperature Parameters</ows:Title>
    <ows:Identifier>TempParam</ows:Identifier>
    <LayerRef>ExtrapolationAreas</LayerRef>
    <LayerRef>ResidualSpatialRegression</LayerRef>
    <LayerRef>StabilityTestAreas</LayerRef>
  </Theme>
  <LayerRef>MeanAnnualTemperature</LayerRef>
</Themes>
```

Metadata documents are exposed in the Capabilities document as ows:Metadata’s. This is the example for the Climatic atlas layer:

```xml
```

**Status of component:** This component is nearly complete in the WMTS-Q.

**Future work:** N/A

### 2.1.4 KML-Q server (FRAUN)

**Partner responsible:** Fraunhofer IGD (FRAUN)

**URL of demonstrator service:**

http://kml-q.geoviqua.org:8081/cs3d/Controller?do=wsc&service=WMS&version=1.3.0&request=GetCapabilities
Description:

A prototype implementation of KML-Q, i.e. the idea of enriching OGC KML with quality information. It conforms to the OGC WMS standard, with the foreseen addition of the WMS-Q convention adopted in the project. It is based on the CityServer3D technology developed by Fraunhofer IGD. The implementation is tailored for the Ebro Delta use case and demonstrates some unique features based on the data. The KML emitted contains machine-processible quality information as well as quality visualization. An extrusion and a shaded colour palette indicating category and quality have been implemented.

![Figure 1 KML-Q representation of the Ebro Delta data set](image)

Tool Status:

The tool is a prototype that uses and extends the CityServer3D infrastructure. It is server-based and the (currently) only KML-Q server. The KML-Q features are exposed as styles, which will be abandoned in favour of the WMS-Q convention.

Future work:

The functionality needs to be generalized, which is partly accomplished already. The target is for the visualization support in CityServer3D to support quality visualizations without requiring explicit program modification.

\[1 \text{ http://www.cityserver3d.de} \]
It would also be interesting to study the expected improvement in ease of understanding such category-quality colour maps for readers that “trickle through” by encoding through a colour appearance model, as opposed to existing approaches that rely on driving colour distance models (such as CIELuv or CIELab) beyond their design limits.

2.2 Client implementations

2.2.1 Greenland

Partner responsible: 52N

URL of demonstrator website (if applicable): http://geoviqua.dev.52north.org/greenland/

URL of developer website (including source code): https://wiki.52north.org/bin/view/Geostatistics/Greenland

**Description:** A Javascript client for explorative analysis of geospatial data, most importantly WMS-Q and particularly ncWMS-Q. Here we can see it with the CREF WMS-Q

**Status of tool:** Stable client software for (nc)WMS-Q, which features automatic visualisation of uncertainty based on the semantic information in a WMS-Q capabilities document.

**Future work:**

**Future work:**
Future work: The most important outstanding task is integration of test datasources and users testing Greenland for exploring these dataset. A potential task is the interaction between Greenland and ncWMS-Q with respect to styling mechanisms.

2.2.2 GeoAR

Partner responsible: 52N

URL of demonstrator website (if applicable):
https://play.google.com/store/apps/details?id=org.n52.geoar

URL of developer website (including source code):
https://wiki.52north.org/bin/view/Projects/GeoAR

Description: An Android mobile client for visualisation of geospatial data on mobile devices.

Status of tool: A prototype app is available in Google Play. The most important outstanding tasks (details found in the product backlog): integration of DAB-Q as a datasource, integration of WMS-Q as a datasource, visualisation of raster data in a map view (and in augmented reality), visualisation of sensor discovery quality information in augmented reality.

2.2.3 Carbon portal

Partner responsible: CEA
URL of demonstrator website: released the 20 of November.

URL of developer website (including source code):
http://research.globalcarbonatlas.org/rc/bobcat/

Description: A client implementation using OpenLayers and the ncWMS-Q server to visualize carbon fluxes data.

Status of tool: The idea is to apply to a WMS viewer the possibility to compare carbon fluxes models. Indeed, it's actually the easier solution to have uncertainty information related to these data.

Future work:

- Relate this application with the application to create Time Series (http://research.globalcarbonatlas.org/rc/woodpicker/) to be able to have pixel value and/or a time series when clicking on the map.

- Integrate uncertainty layer that will be the result of the models comparison. The idea is to place on top of the data layer these uncertainty layers which will use stipple symbolisation for each pixel (possible because the spatial resolution in this case is very low: about one degree*one degree).

- Integration of complete metadata information with the use of the GeoViQua metadata information tools.

2.3 Other components

2.3.1 Perceptual Colour Model

Partner responsible: FRAUN
URL of demonstrator website (if applicable): N/A

URL of developer website (including source code): https://github.com/igd-geo/pcolor

Description: A Java implementation of the CIECAM02 colour model

Status of prototype: The colour model can be used to design colour scales in 1D and 2D, as is required for quality visualization use cases. The model may help communicating quality information with a low "lie factor", i.e. it can be used to ensure the perceived graphical effect matches the underlying effect in the data, an otherwise frequent mistake. It will be used at least for categorical quality in the KML-Q prototype. The following illustration shows the effect of applying the colour model to 8 categories with colours that are modified depending on the quality of the classification of this particular parcel.

![Figure 2 Ebro Delta Color Legend (including quality information)](image)

![Figure 3 Parcels in the Ebro Delta as classified on 14.11.2006](image)

Future Work:

There are several possible directions. One possibility is exploiting the CIECAM02 model better, trying to address some of the questions attacked by its successor iCAM by exploiting spatial knowledge from the map itself, not its rendering as iCAM would.
However it is expected that this is very hard to do due to extensive verification, and it might be better to wait for a final iCAM before doing so.

Another is to extend the set of visualization and/or design problems that can be tackled with the tool. Here we concentrated on categorical quality, but the utility of CIECAM02 in general (geospatial) visualization is certainly greater. In combination with other research, such as on cognitive colour or colour harmony, many existing visualization approaches could be improved.

2.3.2 Prototype GEO label-based dataset discovery tool

**Partner responsible:** AST

**URL of demonstrator website (if applicable):** N/A

**URL of developer website (including source code):** [https://github.com/lushv/geolabel-comparison-tool](https://github.com/lushv/geolabel-comparison-tool)

**Description:** A PHP and JavaScript implementation of the GEO label-based dataset discovery tool

The GEO label-based dataset discovery tool is a prototype online system which is designed to support geospatial dataset intercomparison and selection. The system utilises the GEO label (see deliverable D6.2 for more details on the GEO label) and allows dataset filtering based on the informational aspects’ availability recorded in eight GEO label facets. Such novel approach of visualising metadata records allows for more efficient evaluation of datasets’ fitness for purpose and enables ‘at a glance’ intercomparison of large number of datasets which is not currently possible when using traditional dataset cataloguing systems and data discovery portals.

The proposed prototype system offers two major functions: 1) it allows users to search geospatial datasets by defining initial search criteria and 2) it offers interactive and visual way of filtering metadata records that match initial user requirements.

**Initial dataset search:**

The initial datasets discovery page (see Figure X1) provides an interface for discovering geospatial datasets through searching the metadata records available in the system catalogue. The **Query Constraints** tab is used to define the search criteria, it allows user to:

- a) specify query keywords (e.g., cloud cover, precipitation, sea surface temperature, etc.);
b) specify required spatial coverage by either selecting a predefined location option or selecting a custom area using an interactive map;
c) specify required temporal coverage by selecting the start and end dates; and
d) select dataset access and use constraints.

Figure X1: The GEO label-based dataset discovery tool (initial dataset discovery page).

Filtering search results:

After the search query has been submitted by clicking the **Search** button, the system returns the GEO label representations of all the datasets that match the defined search criteria (see Figure X2).
Figure X2: The GEO label-based dataset discovery tool (search results page).

With the search results being displayed, the **GEO Label Filtering** tab allows to apply information availability filtering based on the informational aspects’ availability recorded in eight GEO label facets. Using an interactive clickable label (located at the top of the **GEO Label Filtering** tab) or eight facet sliders, user can select one of three availability states (‘available’, ‘not available’ or ‘available only at a higher level’) for each GEO label facet. For instance, a user might only be interested in datasets that have producer information and producer comments immediately available (i.e., available for the dataset itself and not its parent dataset), therefore he/she would set producer profile and producer comments availability to ‘available’ to filter out all the datasets that do not contain this information. Figure X3 presents an example of producer profile and producer comments filtering being set to ‘available’ state. As can be noted from the example, when facet filtering is applied, the GEO labels that do not match the specified availability state are removed from the search results. Such interactive filtering of available datasets enables users to quickly narrow down their search to a manageable number of datasets that they can then inspect in more details.
Figure X3: The GEO label-based dataset discovery tool (producer profile and producer comments filtering applied).

The dataset discovery tool also offers additional filtering options for every GEO label informational aspect. These additional filtering options allow user to specify:

a) dataset source, i.e., name of the dataset producer;

b) producer comments’ type (supplemental information, known problems, or both supplemental information and known problems);

c) minimum and maximum number of process steps that have been applied to the data;

d) name of metadata standard to which the dataset complies;

e) quality information scope (dataset or pixel level);

f) average user rating and minimum number of user feedbacks;

g) average expert rating and minimum number of expert reviews; and

h) minimum number of citations which refer to the dataset.

Unlike the information availability filtering described above, the additional filtering does not remove the GEO labels that do not match the specified criteria. These filtering options alter the GEO labels’ size to indicate most relevant datasets. Figure X4 presents an example of additional filtering being applied. As can be noted from the example, the datasets’ label representations that match the specified filtering criteria are larger in size.
Figure X4: The GEO label-based dataset discovery tool (dataset source and comments type filtering applied).

**Obtaining detailed information about a dataset:**

The discovery tool also allows users to inspect detailed information about the datasets of interest. For instance, the dataset’s ID can be inspected by hovering over its GEO label representation and full information about a dataset can be accessed by clicking on its GEO label representation. The selected GEO label will be highlighted and the dataset’s title, abstract, producer details, link to a full metadata record, etc. will be displayed in the **Dataset Details** section of the discovery tool (see Figure X5).
Figure X5: The GEO label-based dataset discovery tool (dataset details are displayed).

The Dataset Details section will also provide an enlarged GEO label representation of the dataset which can also be used to obtain further details about the dataset it represents. Hovering over each facet of the enlarged dataset label will display a facet summary, e.g., name of the dataset producer, producer comments, number of process steps applied to the data, etc. The enlarged dataset label also offers drill-down functionality, i.e., when a facet is clicked, styled structured information extracted from the dataset’s metadata record will be displayed in a new browser window. Figure X6 shows a user feedback summary displayed after ‘user feedback’ facet was clicked.
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Figure X6: GEO label drill-down functionality (user feedback summary).

Highlighting the datasets of interest:

The datasets of interest can be highlighted for later reference by right-clicking on their GEO label representation and selecting the ‘Highlight’ option (see Figure X7). An outer glow will be applied to the highlighted GEO labels for a visual distinction.
When a dataset is highlighted, its detailed information is displayed in the **Highlighted Datasets** tab (see Figure X8). This allows users to keep track of datasets that closely match their requirements and also supports datasets intercomparison. The highlighted datasets can be removed from the highlighted list at any time by either clicking on a **Remove from List** button in the **Highlighted Datasets** tab or by right-clicking the dataset’s label representation in the **Search Results** tab and selecting **Undo Highlight**.

**Summary:**

The GEO label-based dataset discovery and intercomparison tool is designed to support more efficient visualisation of metadata records. By condensing large complex metadata records into a simple multi-faceted label, this tool allows users to capture visual cues of datasets’ quality and possibly relevance without having to inspect each dataset in great detail. At the same time, drilldown capabilities allow users to access and inspect detailed information about the datasets that potentially fit their needs to make an informed dataset selection.

**Future work:**

To date, we conducted a human subject study using observation, think-aloud, question-asking and interview techniques to elicit expert dataset users’ opinions on the usability and effectiveness of the proposed intercomparison and decision support tool. We are currently
analysing study data to verify system’s effectiveness and to identify areas of improvements. Initial study results however indicate that expert geospatial data users find the system intuitive and simple to use without having any previous experience of working with it. Initial observations further suggest overall effectiveness of the tool in metadata visualisation and dataset intercomparison.