

WMS-Q version 2.0

Contributors: Jon Blower, Joan Masó, Daniel Díaz, Lucy Bastin

Date of issue: 28th November 2013

Table of contents

WMS-Q version 2.0	1
Contributors: Jon Blower, Joan Masó, Daniel Díaz, Lucy Bastin	1
Table of contents	1
Requirements.....	2
1 Introduction	3
2 Intended audience	4
3 What is the scope of WMS-Q?	4
3.1 Future work.....	4
4 Identifying a WMS-Q.....	4
5 Layer nesting and displayability	5
5.1 Variables and components in WMS-Q.....	5
5.2 Mapping of Layers to datasets and collections in the DAB-Q.....	5
6 Recognising “quality-enabled” Layers in WMS-Q.....	5
6.1 Types of MetadataURL documents linked to “quality-enabled” Layers.....	6
6.2 Variable-level quality information	6
6.3 Pixel-level quality information	6
6.3.1 Adding semantic information about variables and components	7
6.3.2 How to express an UncertML or QualityML URI as a Keyword.....	8
7 Additional requirements	8
8 WMS-Q sources in ISO metadata.....	8
8.1 Quality descriptions in ISO metadata	10
9 Examples (informative)	11
9.1 Sample WMS-Q Capabilities document	11
9.2 Sample of the ISO 19115 metadata document representing the data of a variable also depicted in WMS-Q layers	12
9.3 Sample of the ISO 19119 metadata document representing the WMS-Q service	14
10 Rules for recognising “quality-enabled” Layers in practice (informative)	14

Requirements

- Requirement 1** A WMS-Q service shall advertise itself as such by including a top-level Keyword with the value “WMS-Q” in the vocabulary “<http://www.geoviqua.org/def/conventions>”. 4
- Requirement 2** An ISO 19119 service metadata representing this WMS-Q service shall advertise a top-level Keyword with the value “WMS-Q” in the vocabulary “<http://www.geoviqua.org/def/conventions>” 5
- Requirement 3** A variable in a WMS-Q shall *always* map to an ISO dataset metadata. If that variable has pixel-level quality information (i.e. if it contains components) its components shall be ignored by a harvesting catalogue (since we believe there is little value in a catalogue user discovering an individual components and those will be described in the ISO metadata document at the variable level). 5
Section 8 will describe how this layer will have a MetadataURL referencing an ISO metadata document. 5
- Requirement 4** A variable that is quality-enabled only at the **variable level** (without pixel level quality components) shall be represented as a layer at the bottom level of the Layer hierarchy that is displayable **and** has an attached MetadataURL pointing to a quality document. 6
- Requirement 5** Layers may have many MetadataURLs, and so a client shall inspect the “type” of the MetadataURL to determine whether or not this represents a quality document. 6
- Requirement 6** A variable with pixel level quality components shall be represented by a Layer at the second-bottom level of the Layer hierarchy. This layer is **not** displayable **and** contains the Keyword “qualityCollection” of “<http://qualityml.geoviqua.org/1.0/>” vocabulary. 6
- Requirement 7** All components of a variable that has pixel-level quality shall be represented as direct children of the Layer in Requirement 6 (at the bottom level of the hierarchy, i.e. each component is a leaf node in the tree of Layers). These child Layers shall be displayable. 6
- Requirement 8** The first child Layer shall represent the variable as a whole. It represents the same concept as its parent and therefore replicates all Keywords that are held by its parent except “qualityCollection” and adds a “qualityComposition” of “<http://qualityml.geoviqua.org/1.0/>” one. WMS server implementers can use this first child Layer to provide a portrayal of the whole variable as a single image (for example, a raster map of a mean field overlain by contours representing variance). Because this Layer is displayable, it contains information about the Layer’s spatio-temporal domain: clients can use this to read this metadata, which will usually not be present on the parent. 6
- Requirement 9** The remaining child Layers shall represent the various quality components that together comprise the total amount of information contained in the variable. The valid quality parameter depend on the type of grouping: see Table 1 below. 7
- Requirement 10** The ordering of these remaining child Layers is up to the server, but the second child shall contain the component with the semantics closer to the variable’s actual values. E.g. In a normal distribution it will be the mean and in QualityML it will be identified as <http://qualityml.geoviqua.org/1.0/values>..... 7
- Requirement 11** In addition to the “qualityCollection” Keyword, the two Layers representing the variable, both the non-displayable parent Layer and the displayable first child Layer (see Requirement 8), shall be able to contain additional Keywords that represent more specific quality groupings from the UncertML and QualityML vocabularies. See Table 1 below. 7

Requirement 12 Each Layer representing quality components (see Requirement 7) shall, where possible, be tagged with a Keyword that describes the quality properties that it represents, preferably using URIs from the UncertML or QualityML vocabularies as explained in subsection 6.3.2.

7

Requirement 13 An ISO 19119 service metadata representing this WMS-Q service shall advertise the formats available by this service. 8

Requirement 14 All WMS layers shall be documented in the <gmd:distributionInfo> of the file. A <gmd:distributorTransferOptions> shall be defined for each WMS layer. These elements shall be identified so xml:id shall contain a unique name for this layer that is declared on its corresponding <gmd:MD_DigitalTransferOptions id="layer_id"> element (this identifier does not have to be the *layer name* but it could be useful to use it). 8

Requirement 15 All mandatory parameters of a WMS request shall be included on the <gmd:linkage> element so even clients not WMS aware are able to obtain a default image. 9

Requirement 16 The <gmd:name> shall have the actual WMS layer name. 9

Requirement 17 The measure shall be included in a <gmd:MD_Identifier> or <updated19115:MD_Identifier> that relates to an id in the form of a URL that explains the measure used. These ids can be found visiting the appropriate link under the “Quality measure” column of the QualityML table 1. As for the name of the measure, found in the same column, it shall be included in the <gmd:19157:nameOfMeasure> tag of the measure. 10

Requirement 18 The metrics type in use, it is documented in the result property of the DQ_Element, adding a “xlink:href” to the <gco:RecordType> tag of valueType that points to the metric id. That id is in the form of a URI obtained from the metric page in the “Metrics” column of the QualityML table 1. The descriptive name of the metric is written within the <gco:RecordType> tag. 10

Requirement 19 The metric values shall be documented in a <gco:Record> using either a UncertML xml encoding or QualityML encoding. 10

Requirement 20 For the values of the parameters at the pixel level, they are too many to be included in the metadata as a value list. Instead, a reference to the corresponding MD_DigitalTransferOptions id element (e.g. a MD_DigitalTransferOptions containing a WMS-Q service that for visualizing the actual values at pixel-level) shall be included using the href tag attribute inside the corresponding child tags where it better fits (e.g. <un:values>, <qml:count>,...).

10

1 Introduction

This document specifies a set of conventions for conveying data quality information using Web Map Services. It supersedes the current WMS-Q specifications as defined in, following further research and discussions within the GeoViQua project.

In this document, when we refer to the “WMS specification” we mean OGC 06-042 OpenGIS Web Map Service (WMS) Implementation Specification version 1.3.0

(http://portal.opengeospatial.org/files/?artifact_id=14416) that is also ISO 19128:2005 Geographic information -- Web map server interface.

2 Intended audience

The current version of this document is intended to be read by members of the GeoViQua project, prior to formal publication. It is particularly relevant to the developers of the DAB-Q component, which must access and parse information from WMS-Q services.

This document presents a set of requirements for “WMS-Q servers”, “catalogues harvesting the WMS-Q layers” (and particularly to the DAB-Q adaptor for WMS-Q) and “ISO metadata documents describing data used in WMS-Q layers”.

3 What is the scope of WMS-Q?

The original WMS-Q specification applied only to layers that are based on continuous raster data, i.e. data in which each pixel is associated with a numeric value that represents some kind of field (in the mathematical sense of the word “field”, e.g. temperature). However, this updated version can apply to any layer based on any type of data (continuous or categorical, raster or vector).

WMS-Q is primarily concerned with conveying quality information at the level of variables representing fields or categorical values and also individual pixels (or features for the vector case).

This specification describes how the ServiceMetadata document (GetCapabilities response) has to be created when including quality-enabled layers and how this document has to be interpreted by clients (e.g. WMS enhanced viewers, catalogues harvesting WMS layers, etc). Additionally it includes recommendations on how an ISO metadata document describing a layer in the WMS-Q service has to be produced.

3.1 Future work

More work is expected in a style language that allows for better description of combined styles for uncertainty layers. Additionally, future version of this document could describe the behaviour of the GetFeatureInfo operation when requesting pixel level quality enable layers (quality aware queries).

4 Identifying a WMS-Q

Requirement 1 A WMS-Q service shall advertise itself as such by including a top-level Keyword with the value “WMS-Q” in the vocabulary “<http://www.geoviqua.org/def/conventions>”.

Requirements target: a WMS-Q server

as in the following Capabilities document fragment:

```
<?xml version='1.0' encoding="UTF-8"?>
<WMS_Capabilities version="1.3.0" ... >
  <Service>
    <Name>WMS</Name>
    <Title>GeoViQua Web Map Service</Title>
    <KeywordList>
      <Keyword vocabulary="http://www.geoviqua.org/def/conventions">WMS-Q</Keyword>
    </KeywordList>
```

...

Requirement 2 An ISO 19119 service metadata representing this WMS-Q service shall advertise a top-level Keyword with the value “WMS-Q” in the vocabulary “<http://www.geoviqua.org/def/conventions>”.

Requirements target: a catalogue harvesting the WMS-Q layers

5 Layer nesting and displayability

The WMS specification permits Layers to be arbitrarily nested. Layers that have a <Name> property are *displayable* (i.e. can be requested in a GetMap operation). Layers that are not displayable do not have a <Name>. WMS permits any Layer to be displayable, even if that Layer contains child Layers.

5.1 Variables and components in WMS-Q

In WMS-Q, when considering pixel-level quality measures, we consider that *variables* can be comprised of *components* representing measurements and associated quality measures and metrics. For example, a continuous variable may be made up of two components such as “mean” and “variance”. A categorical variable may have several components: the “most likely” category plus information about the probability of other categories. In a WMS-Q a variable is associated with a layer and may have children layers representing the components of the variable. For more details see subsections 6.2 and 6.3.

5.2 Mapping of Layers to datasets and collections in the DAB-Q

The current WMS adaptor for the DAB-Q maps bottom-level Layers onto the ISO concept of a “dataset”. All levels above this are mapped to the concept of a “dataset collection”. In WMS-Q this should be modified.

Requirement 3 A variable in a WMS-Q shall *always* map to an ISO dataset metadata. If that variable has pixel-level quality information (i.e. if it contains components) its components shall be ignored by a harvesting catalogue (since we believe there is little value in a catalogue user discovering an individual components and those will be described in the ISO metadata document at the variable level).

Requirements target: a catalogue harvesting the WMS-Q layers

Section 8 will describe how this layer will have a MetadataURL referencing an ISO metadata document.

6 Recognising “quality-enabled” Layers in WMS-Q

In WMS-Q, not all Layers will necessarily have quality information (at the variable or pixel level or both) attached. It is permissible to mix “quality-enabled” and “regular” Layers in the same WMS service instance. The following mechanisms shall be used (e.g. by a harvesting catalogue) to recognize whether a Layer is quality-enabled or not.

6.1 Types of MetadataURL documents linked to “quality-enabled” Layers

Possible MetadataURL document “type” values for both cases: variable level quality and pixel level quality layers.

1. If type is “ISO19115:2003”, then the metadata document is assumed to be a valid ISO document. The document must be downloaded by the client and parsed to determine whether it contains quality information. An ISO metadata document has quality information if there is a correctly populated element at the following xpath:
/gmd:MD_Metadata/gmd:dataQualityInfo/gmd:DQ_DataQuality/gmd:report.
2. If the type is “ISO19115:GEOVIQUA”, then the metadata document is a GeoViQua Producer Quality Model document (which is essentially an extension to an ISO19115 document). A GeoViQua PQM document has quality information if there is a correctly populated element at the following xpath:
/gvq:GVQ_Metadata/gvq:dataQualityInfo/gmd19157:DQ_DataQuality/gmd19157:report

The information in the linked metadata document can be aligned with the information in the WMS-Q Capabilities document as described in section 8 below.

6.2 Variable-level quality information

Requirement 4 A variable that is quality-enabled only at the **variable level** (without pixel level quality components) shall be represented as a layer at the bottom level of the Layer hierarchy that is displayable **and** has an attached MetadataURL pointing to a quality document.

Requirements target: a WMS-Q server

Requirement 5 Layers may have many MetadataURLs, and so a client shall inspect the “type” of the MetadataURL to determine whether or not this represents a quality document.

Requirements target: a catalogue harvesting the WMS-Q layers

6.3 Pixel-level quality information

Requirement 6 A variable with pixel level quality components shall be represented by a Layer at the second-bottom level of the Layer hierarchy. This layer is **not** displayable **and** contains the Keyword “qualityCollection” of “<http://qualityml.geoviqua.org/1.0/>” vocabulary.

Requirement 7 All components of a variable that has pixel-level quality shall be represented as direct children of the Layer in Requirement 6 (at the bottom level of the hierarchy, i.e. each component is a leaf node in the tree of Layers). These child Layers shall be displayable.

Requirement 8 The first child Layer shall represent the variable as a whole¹. It represents the same concept as its parent and therefore replicates all Keywords that are held by its

¹ In an earlier version of WMS-Q the parent Layer representing the variable was allowed to be displayable and fulfilled this purpose. However, this causes problems with Styles. The parent Layer representing the variable typically requires special Styles (e.g. “contour upon raster”); by WMS rules, these Styles are inherited by child Layers, where they would not make sense. However, it is still necessary to provide a single Layer to represent the whole variable, since some portrayals of uncertainty (e.g. bivariate colour maps) cannot be constructed by compositing separate child Layers.

parent except “qualityCollection” and adds a “qualityComposition” of “<http://qualityml.geoviqua.org/1.0/>” one. WMS server implementers can use this first child Layer to provide a portrayal of the whole variable as a single image (for example, a raster map of a mean field overlain by contours representing variance). Because this Layer is displayable, it contains information about the Layer’s spatio-temporal domain: clients can use this to read this metadata, which will usually not be present on the parent.

Requirement 9 The remaining child Layers shall represent the various quality components that together comprise the total amount of information contained in the variable. The valid quality parameter depend on the type of grouping: see Table 1 below.

Requirement 10 The ordering of these remaining child Layers is up to the server, but the second child shall contain the component with the semantics closer to the variable’s actual values. E.g. In a normal distribution it will be the mean and in QualityML it will be identified as <http://qualityml.geoviqua.org/1.0/values>

Requirements target: a WMS-Q server

The Layer representing the variable **may** also have a MetadataURL pointing to a quality document as described in subsection 6.2. However, since it is not displayable, it may not have other information such as its spatial or temporal extent. This information can be found by examining the first child of this Layer (see below).

6.3.1 Adding semantic information about variables and components

Further information about the semantics of the grouping can optionally be provided. The general principles are these:

Requirement 11 In addition to the “qualityCollection” Keyword, the two Layers representing the variable, both the non-displayable parent Layer and the displayable first child Layer (see Requirement 8), shall be able to contain additional Keywords that represent more specific quality groupings from the UncertML and QualityML vocabularies. See Table 1 below.

Requirement 12 Each Layer representing quality components (see Requirement 7) shall, where possible, be tagged with a Keyword that describes the quality properties that it represents, preferably using URIs from the UncertML or QualityML vocabularies as explained in subsection 6.3.2.

Requirements target: a WMS-Q server

The child Layers (i.e. those representing the components) may be portrayable in any number of Styles. These Styles are likely to be simple but should allow the client to create custom composite maps by overlaying layers (e.g. asking for a raster of the mean field and a contour plot of the variance field). The styles of the first layer are expected to convey some of the other child information combined in a single view.

Type of quality collection	Keyword for variable	Keywords for components
Probabili	Any URI in the collection	URIs representing the mathematical

ty Distributi on Function	http://www.uncertml.org/distributions/*	parameters of the distribution, as appropriate to the distribution. Use URI fragments to denote the parameter, e.g. http://www.uncertml.org/distributions/normal#mean
Statistics Collectio n	http://www.uncertml.org/statistics/statistics-collection	URIs representing individual statistics as required, e.g. http://www.uncertml.org/statistics/mean
Samples	Any URI in the collection http://www.uncertml.org/samples/*	Always http://www.uncertml.org/samples/realisation
Quality collectio ns	Any URI in the collection http://qualityml.geoviqua.org/1.0/metrics-collection (many QualityML metrics cannot be grouped so in many cases no additional keyword will be added at this level)	Appropriate URIs representing individual metrics or statistics as required, see: http://qualityml.geoviqua.org/1.0/metrics http://www.uncertml.org/statistics Second child contains the actual values of the variable. In the QualityML http://qualityml.geoviqua.org/1.0/values

Table 1: UncertML and QualityML Keywords to apply to Layers representing variables and components

6.3.2 How to express an UncertML or QualityML URI as a Keyword

In the WMS (and WMS-Q) Capabilities document, Keywords are terms taken from vocabularies.

- The URI of the UncertML vocabulary is <http://www.uncertml.org/>
- The URI of the QualityML vocabulary is <http://qualityml.geoviqua.org/1.0/>

The Keywords are then the remainder of the full URI. For example:

```
<Keyword vocabulary="http://www.uncertml.org/">distributions/normal</Keyword>
<Keyword vocabulary="http://www.uncertml.org/">distributions/normal#mean</Keyword>
<Keyword vocabulary="http://qualityml.geoviqua.org/1.0">metrics/items</Keyword>
```

7 Additional requirements

WMS-Q does not define formats extra requirements but WMS-Q clients need to discover and know if they support those formats.

Requirement 13 An ISO 19119 service metadata representing this WMS-Q service shall advertise the formats available by this service.

Requirement target: a catalogue harvesting the WMS-Q layers

8 WMS-Q sources in ISO metadata

ISO metadata documents can be used in WMS-Q as metadataURL links as described in section 6.1 or can be catalogued in a metadata catalogue as descriptions to variables depicted in a WMS or distributed by other means. Emphasis is done on how to advertise the quality enable layers served by a WMS-Q and its relation to UncertML or QualityML descriptions of them.

Requirement 14 All WMS layers shall be documented in the <gmd:distributionInfo> of the file. A <gmd:distributorTransferOptions> shall be defined for each WMS layer. These elements shall be identified so xml:id shall contain a unique name for this layer that is declared on its corresponding <gmd:MD_DigitalTransferOptions id="layer_id"> element (this identifier does not have to be the *layer name* but it could be useful to use it).

Requirement target: ISO metadata documents describing data used in WMS-Q layers

Defining the connection at the gmd:distributorTransferOptions level allows for having more than one online service (or data file URL) providing the same layer data resource, while it is still possible to have more than one layer defined in the metadata file (something not possible with the tag <gmd:transferOptions>).

Requirement 15 All mandatory parameters of a WMS request shall be included on the <gmd:linkage> element so even clients not WMS aware are able to obtain a default image.

Requirement 16 The <gmd:name> shall have the actual WMS layer name.

Requirements target: ISO metadata documents describing data used in WMS-Q layers

The following is a simplified example for one service and one layer:

```
<gmd:distributionInfo>
<gmd:MD_Distribution>
  <gmd:distributor>
    <gmd:distributorTransferOptions>
      <gmd:MD_DigitalTransferOptions id="Layer_id">
        <gmd:onLine>
          <updated19115:CI_OnlineResource>
            <gmd:linkage>
<gmd:URL>http://s.org/srv.cgi?SERVICE=WMS&VERSION=1.3.0&REQUEST=GetMap&CRS=EPSG:230
31&BBOX=330565,4561231,534765,4705631&WIDTH=1021&HEIGHT=722&LAYERS=MeanAnnualSometh
ing&FORMAT=image/png&STYLES=</gmd:URL>
            </gmd:linkage>
            <gmd:protocol>
              <gco:CharacterString>urn:OGC:serviceType:WebMapService:1.3.0:HTTP-
GET</gco:CharacterString>
            </gmd:protocol>
            <gmd:name>
              <gco:CharacterString>MeanAnnualSomething</gco:CharacterString>
            </gmd:name>
            <gmd:description>
              <gco:CharacterString>This is the mode for Ebro river
crops</gco:CharacterString>
            </gmd:description>
            <gmd:function>
              <gmd:CI_OnLineFunctionCode
codeList="http://schemas.geoviqua.org/ISO/19139/20130610_INSPIRE/resources/codelist
/gmxINSPIRECodeLists.xml#CI_OnLineFunctionCode"
codeListValue="mapDigital">mapDigital</gmd:CI_OnLineFunctionCode>
              </gmd:function>
            </updated19115:CI_OnlineResource>
          </gmd:onLine>
        </gmd:MD_DigitalTransferOptions>
      <gmd:distributorTransferOptions>
        <gmd:MD_DigitalTransferOptions id="Another_layer_id">
```

```
</gmd:MD_DigitalTransferOptions>
</gmd:distributorTransferOptions>
</gmd:MD_Distribution>
</gmd:distributionInfo>
```

More details about this section will be provided later.

8.1 Quality descriptions in ISO metadata

UncertML distribution parameters and QualityML quality metrics, will be documented in the element `<gvq:dataQualityInfo>`. Within that tag at least two types of quality levels can coexist:

- **Variable-level:** Those parameters are relate to the layer as a whole
- **Pixel-level:** Those parameters the values of which are not provided directly in the metadata but in external services (e.g. a WMS-Q service) or files specified in the `gmd:distributorTransferOptions`.

As for pixel-level, this is the kind of parameters that are linked to the WMS-Q services layers documented in the `<gmd:distributionInfo>` section using the `gmd:MD_DigitalTransferOptions/@id`. They are enclosed into a `<gmd:report>` or `<gmd19157:report>` (GeoViQua Producer Quality Model) and developed inside a `gmd:DQ_Element`. These elements can use UncertML distribution elements or QualityML the full list of which, along with correspondence to the specific metrics is detailed in the “Quality measures matrix” table on <http://qualityml.geoviqua.org/> (QualityML table 1 for now on). Each of these `DQ_Elements` requires a *measure* and *result* properties which define the quality measure and the metrics (equivalent to an UncertML statistic).

In order to go further, it is important to fully understand how QualityML understands the three concepts used to document quality indicators:

- **Measure:** This is a certain quality concept that was measured
- **Measurement field:** The raw data used to estimate the value of quality indicator
- **Metric:** The statistical summary or metrics summary used express or quantify the quality indicator

Requirement 17 The measure shall be included in a `<gmd:MD_Identifier>` or `<updated19115:MD_Identifier>` that relates to an id in the form of a URL that explains the measure used. These ids can be found visiting the appropriate link under the “Quality measure” column of the QualityML table 1. As for the name of the measure, found in the same column, it shall be included in the `<gmd19157:nameOfMeasure>` tag of the measure.

Requirement 18 The metrics type in use, it is documented in the result property of the `DQ_Element`, adding a “xlink:href” to the `<gco:RecordType>` tag of value type that points to the metric id. That id is in the form of a URI obtained from the metric page in the “Metrics” column of the QualityML table 1. The descriptive name of the metric is written within the `<gco:RecordType>` tag.

Requirement 19 The metric values shall be documented in a `<gco:Record>` using either a UncertML xml encoding or QualityML encoding.

Requirement 20 For the values of the parameters at the pixel level, they are too many to be included in the metadata as a value list. Instead, a reference to the corresponding

MD_DigitalTransferOptions id element (e.g. a MD_DigitalTransferOptions containing a WMS-Q service that for visualizing the actual values at pixel-level) shall be included using the href tag attribute inside the corresponding child tags where it better fits (e.g. <un:values>, <qml:count>,...).

Requirement target: ISO metadata documents describing data used in WMS-Q layers

More detailed information on how to include UncertML or QualityML XML encodings and examples to document the <gco:Record> tag maybe obtained in the QualityML homepage and from the metrics webpage for each of the metrics defined on the UncertML and QualityML projects.

9 Examples (informative)

9.1 Sample WMS-Q Capabilities document

The following XML represents an incomplete fragment of a WMS-Q Capabilities document, illustrating the above concepts. The parent Layer representing the variable is shown in blue; the displayable child Layer that also represents the variable is shown in green and the Layers representing the properties are shown in red. The DAB-Q should only record a single ISO dataset, representing the variable, ignoring the child properties. Note that this example uses a statistics collection with components of mean and variance. This is semantically distinct from a normal distribution (because one can generate mean and variance from any sample, no matter what the underlying distribution is).

```
<?xml version='1.0' encoding="UTF-8"?>
<WMS_Capabilities version="1.3.0" ... >
  <Service>
    <Name>WMS</Name>
    <Title>GeoViQua Web Map Service</Title>
    <KeywordList>
      <Keyword
        vocabulary="http://www.geoviqua.org/def/conventions">WMS-Q</Keyword>
    </KeywordList>
    ...
  </Service>
  <Capability>
    ...
    <Layer>
      <Title>GeoViQua Web Map Service</Title>
      <CRS>CRS:84</CRS>
      <Layer>
        <!-- Non-displayable parent layer representing a variable. Each pixel in
the variable has uncertainty values recorded as mean and variance statistics -->
        <Title>Sea Surface Temperature</Title>
        <!-- Link to GVQ PQM document -->
        <MetadataURL type="ISO19115:GEOVIQUA">
          <Format>text/xml</Format>
          <OnlineResource
            xlink:href="http://www.geoviqua.org/pqm/sst.xml" />
        </MetadataURL>
        <KeywordList>
          <Keyword
            vocabulary="http://qualityml.geoviqua.org/1.0/">qualityCollection</Keyword>
```

```

        <Keyword vocabulary="http://www.uncertml.org/">statistics/statistics-
collection</Keyword>
    </KeywordList>
    <Layer>
        <!-- Represents the whole variable as a displayable Layer -->
        <Title>Sea Surface Temperature</Title>
        <Name>sst</Name>
        <EX_GeographicBoundingBox/>
        <KeywordList>
            <Keyword
vocabulary="http://qualityml.geoviqua.org/1.0/">qualityCollection</Keyword>
            <Keyword vocabulary="http://www.uncertml.org/">statistics/statistics-
collection</Keyword>
        </KeywordList>
    </Layer>
    <Layer>
        <Title>SST Mean field</Title>
        <Name>sst-mean</Name>
        <EX_GeographicBoundingBox... />
        <KeywordList>
            <Keyword
vocabulary="http://www.uncertml.org/">statistics/mean</Keyword>
        </KeywordList>
    </Layer>
    <Layer>
        <Title>SST Variance field</Title>
        <Name>sst-variance</Name>
        <EX_GeographicBoundingBox... />
        <KeywordList>
            <Keyword
vocabulary="http://www.uncertml.org/">statistics/variance</Keyword>
        </KeywordList>
    </Layer>
</Layer>
</Capability>
</WMS_Capabilities>

```

9.2 Sample of the ISO 19115 metadata document representing the data of a variable also depicted in WMS-Q layers

The following XML represents an incomplete fragment of a ISO metadata document, illustrating the above concepts. The example shows a pixel-level metrics description in a <gco:Record> element and how href="#TemperatureConfidenceInterval " is used to link to the corresponding <gmd:MD_DigitalTransferOptions id="TemperatureConfidenceInterval">

```

<gmd:MD_Metadata>
    ...
    <gmd:distributionInfo>
        <gmd:MD_Distribution>
            <gmd:transferOptions>
                <gmd:MD_DigitalTransferOptions id="TemperatureConfidenceInterval">
                    <gmd:onLine>
                        <gmd:CI_OnlineResource> <!-- Any service that allow to retrieve
the data values or a visualization of them -->
                            <gmd:linkage>

```

```

<gmd:URL>http://www.server.bob/wms.cgi?REQUEST=GetMap&VERSION=1.3.0&SERVICE
=WMS&LAYERS=TemperatureConfidenceInterval&STYLES=</gmd:URL>
  </gmd:linkage>
  <gmd:protocol>
    <gco:CharacterString>serviceType:WebMapService:1.3.0:HTTP-
GET</gco:CharacterString>
  </gmd:protocol>
  <gmd:name>

<gco:CharacterString>TemperatureConfidenceInterval</gco:CharacterString>
  </gmd:name>
  </gmd:CI_OnlineResource>
  </gmd:onLine>
  </gmd:MD_DigitalTransferOptions>
  </gmd:transferOptions>
  </gmd:MD_Distribution>
</gmd:distributionInfo>
<gmd:dataQualityInfo>
  <gmd:DQ_DataQuality>
    <gmd:report>
      <gmd:DQ_CompletenessOmission>
        <gmd:nameOfMeasure>
          <gco:CharacterString>
            Missing
          </gco:CharacterString>
        </gmd:nameOfMeasure>
        <gmd:measureIdentification>
          <gmd:MD_Identifier>
            <gmd:code>
              <gco:CharacterString>
                http://qualityml.geoviqua.org/1.0/measures/QuantitativeAttributeError
              </gco:CharacterString>
            </gmd:code>
          </gmd:MD_Identifier>
        </gmd:measureIdentification>
      <gmd:result>
        <gmd:DQ_QuantitativeResult>
          <gmd:valueType>
            <gco:RecordType>
              xlink:href="http://qualityml.geoviqua.org/1.0/metrics/metrics/Half-
lengthConfidenceInterval">
                Half-length Confidence Interval
              </gco:RecordType>
            </gmd:valueType>
            <gmd:valueUnit/>
            <gmd:value>
              <gco:Record>
                <qml:HalfLengthConfidenceInterval level="0.683">
                  <un:values href="#TemperatureConfidenceInterval"/>
                </qml:HalfLengthConfidenceInterval>
              </gco:Record>
            </gmd:value>
          </gmd:DQ_QuantitativeResult>
        </gmd:result>
      </gmd:DQ_CompletenessOmission>
    </gmd:report>
  </gmd:DQ_DataQuality>
</gmd:dataQualityInfo>

```

</gmd:MD_Metadata>

9.3 Sample of the ISO 19119 metadata document representing the WMS-Q service

10 Rules for recognising “quality-enabled” Layers in practice (informative)

In the DAB-Q the requirements stated before has been implemented as a set of rules that a layer has to validate. Once the input is recognized as WMS-Q, only the variable layer is mapped. To identify a variable layer, two set of rules must be checked:

A variable Layer with pixel level components has the following rules:

- *Keyword* element “qualityCollection” for vocabulary "http://qualityml.geoviqua.org/1.0/";
- *metadataURL* element pointing to ISO or GeoViQua extension quality documents;
- children layers (representing the components);
- NO *Name* element available (non displayable layer).

A variable Layer without pixel level components has the following rules:

- NO *Keyword* element “qualityCollection” for vocabulary "http://qualityml.geoviqua.org/1.0/";*metadataURL* element pointing to ISO or GeoViQua extension quality documents;
- NO children;
- *Name* element available;
- NO parent being a variable Layer (NO parent has keyword “qualityCollection”).