Instituto Geográfico Nacional

Raster national datasets transformation to INSPIRE specifications

Orthoimageries and Elevation

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❖Presentation

Intro (scope, INSPIRE, softwares, etc.)

Transformation step by step (OI & EL)

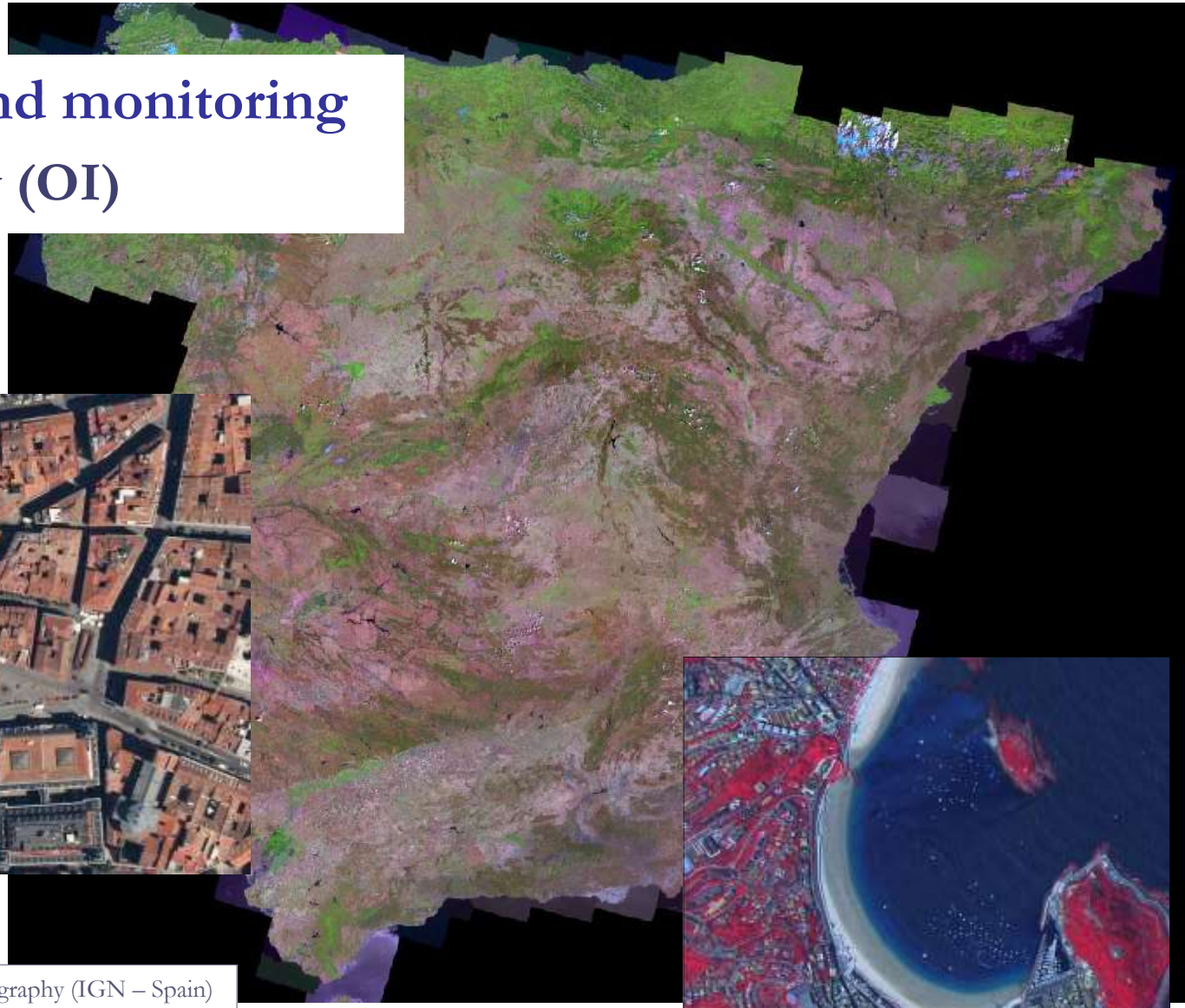
Conclusions

❖Objetive

- To generate **GMLs compliant to INSPIRE specifications for OI & EL** (raster)
- Design a process able to transform a **big raster data** (complete national datasets OI & EL) in automatic way
- To work directly with **published INSPIRE XSDs** without particular editions
- Results for:
  - **FME World tour**, Madrid venue
  - INSPIRE thematic clusters, **INSPIRE Conference** 2015
  - **European Environmental Agency** - EAGLE group
  - **EuroGeographics –** INSPIRE KEN
  - Spanish Council for INSPIRE implementation (CODIIGE - Consejo Directivo de la Infraestructura de Información Geográfica en España)

❖INSPIRE themes

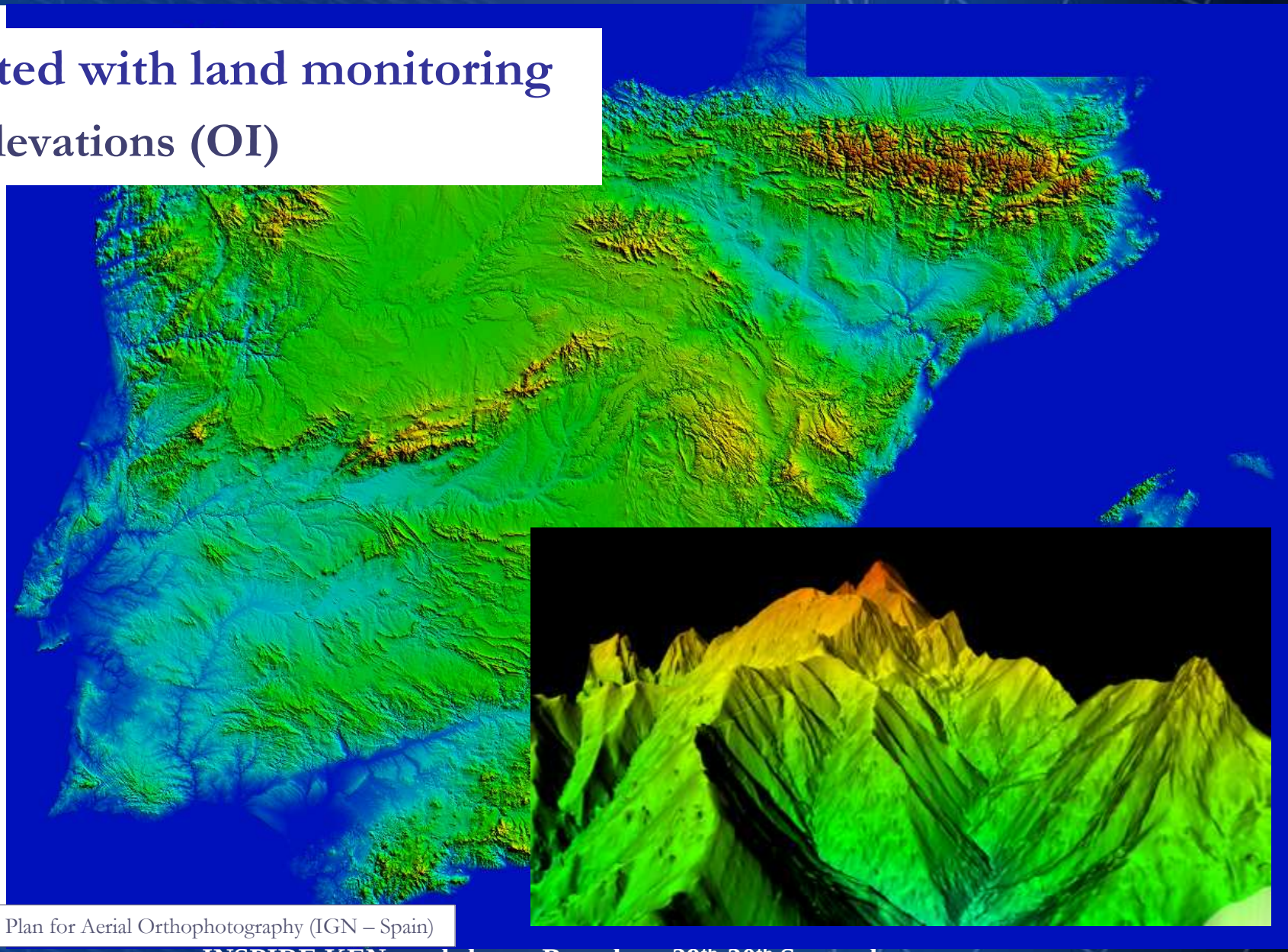
- Related with land monitoring
  - Orthoimagery (OI)



PNOA – National Plan for Aerial Orthophotography (IGN – Spain)
PNT – National Plan of Remote Sensing (IGN – Spain)

❖INSPIRE themes

- Related with land monitoring
  - Elevations (OI)



PNOA – National Plan for Aerial Orthophotography (IGN – Spain)

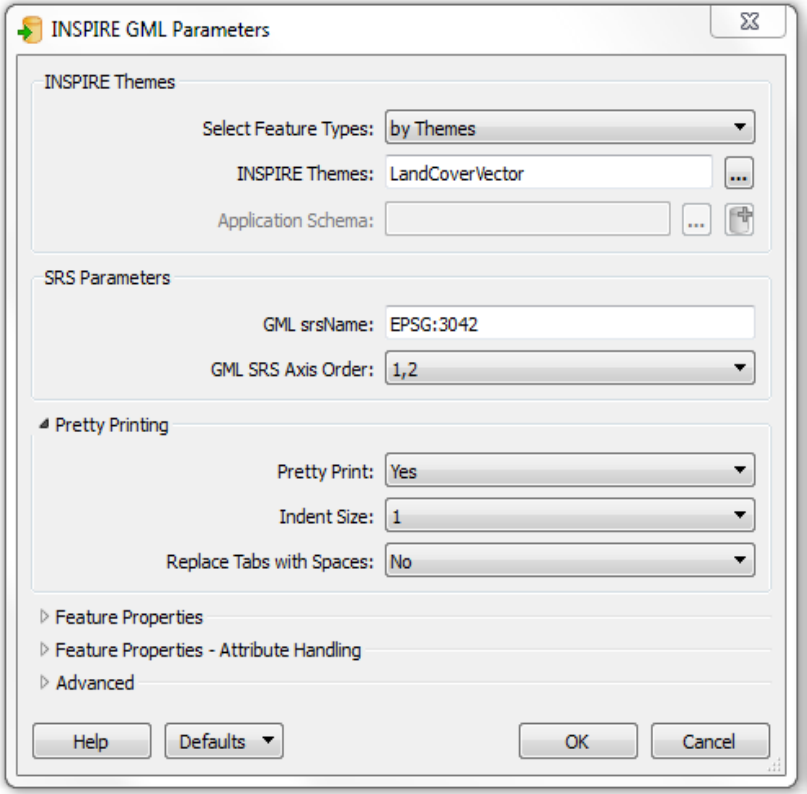
❖Softwares

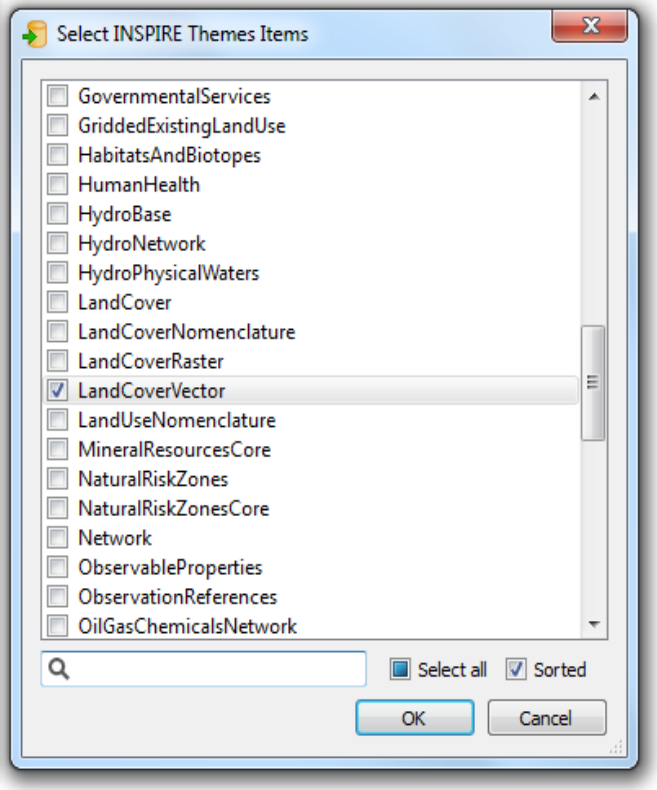
- For transformation **FME 2015**
  - Easy, powerful, automatic, able for massive data…

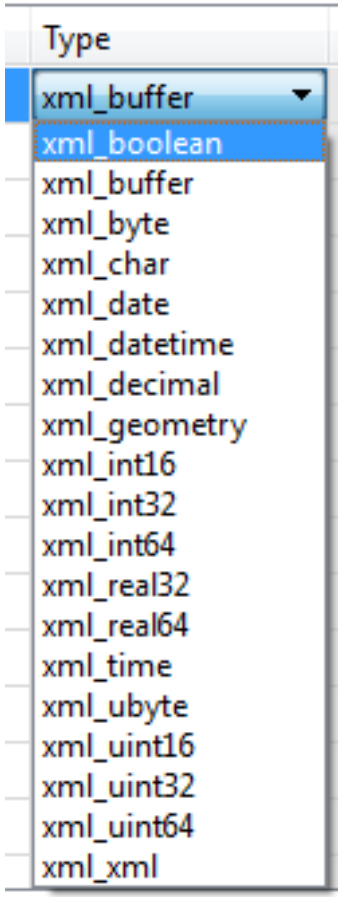
  … *but **not** perfect*

- **Others**

- Since FME 2014 there are reader/writer INSPIRE GML



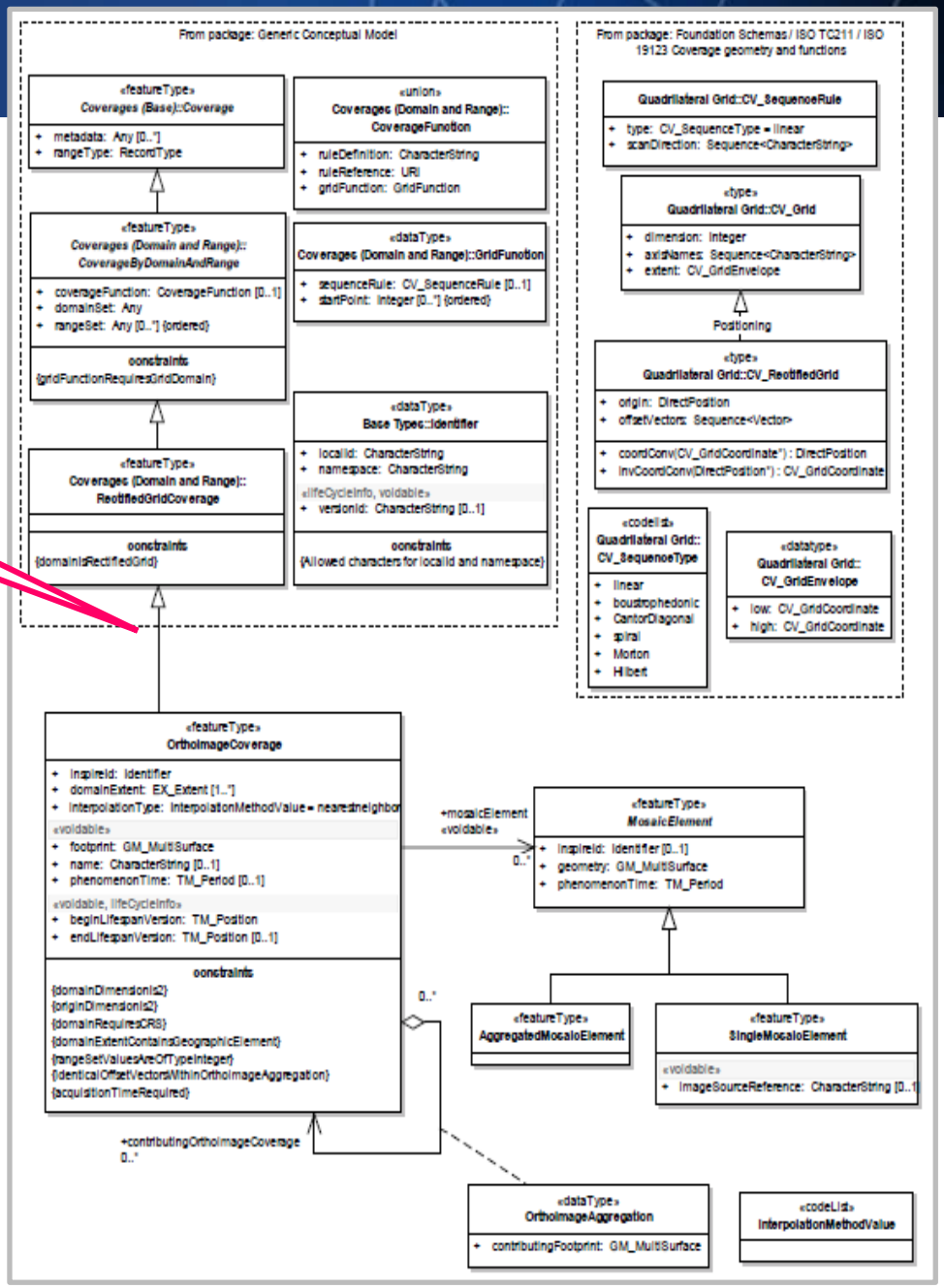




❖Specifications

Thematic attributes from OI can be obtained without problem with the previous tips/advices. The complicate ones are those attributes inherited from **ISO Coverages.**

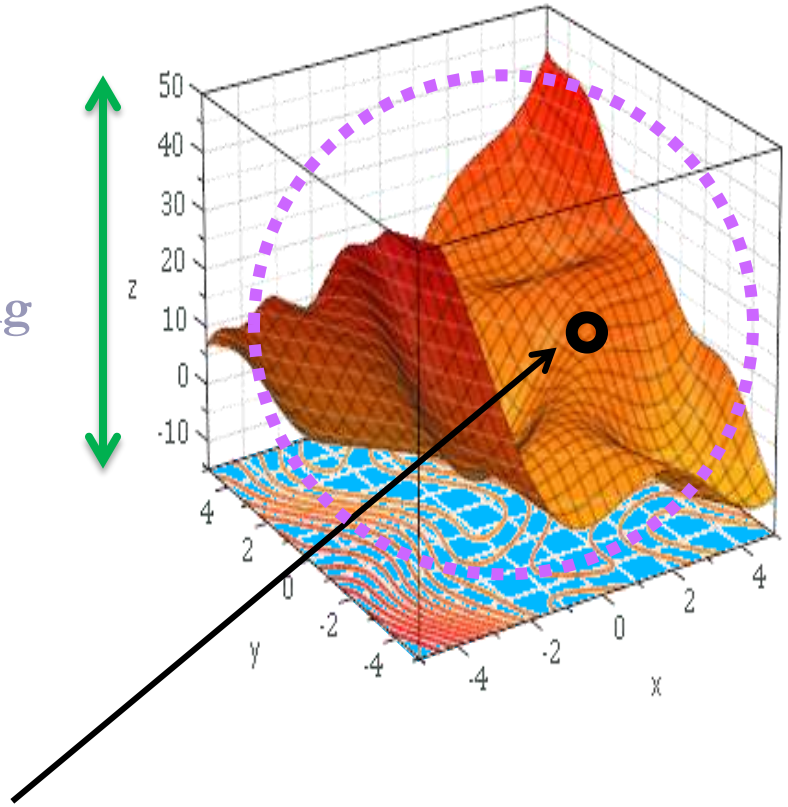
- **INSPIRE features types to obtain**
  - **OrthoimageAggregation**
    - Complete dataset
  - **OrthoimageCoverage**
    - Individual mosaicked image
  - **AggregatedMosaicElement**
    - Vector shapes of mosaic parts



❖Specifications

INSPIRE OI follows the ISO 19123 standard about Coverages. Their fundamental attributes are:

- ISO 19123 "Coverages"
  - *RangeType: RecordType*
    - Data values description (type of phenomenon described by the coverage, nº bits, etc.)
  - *CoverageFunction*
    - Description of grid function (ordering of file, origin point, etc.)
  - *DomainSet*
    - Description of grid nature (images coordinates, axis, resolution, etc.)
  - ***RangeSet***
    - Data values (pixels values)



❖Specifications

- ISO 19123 “Coverages”
  - *RangeSet*
    - Alternatives to encode data values:
      - *Type I) Multipart representation (OGC GML for coverages OGC 09-146r2)*
        - GML (except rangeSet) + rangeSet in binary format
      - *Type II) Reference to a external file*
        - GML with rangeSet as gml:FileElement that points to an external file in format *.tiff, *.geotiff, etc
      - *Type III) Encoding the range inline*
        - GML with range set as gml:DataBlock element (all pixel values inside GML file)
      - *Type IV*) WCS service*
        - rangeSet is obtained through a GetCoverage operation localized in DomainSet defined

OI example

EL example

- **INSPIRE does not allow image tiling [OI 5.3.1.1, Annex D]**
  - INSPIRE provide concepts to apply structured datasets
    - **OrthoimageAggregation** (complete dataset)
    - **OrthoimageCoverage** (individual mosaicked image)
    - **AggregatedMosaicElement** (mosaic part)

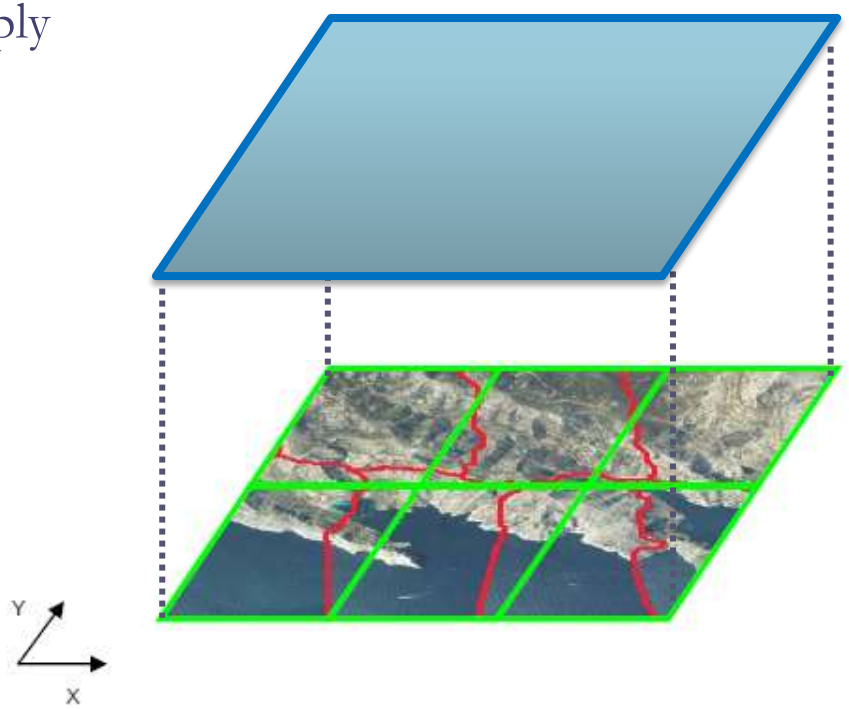


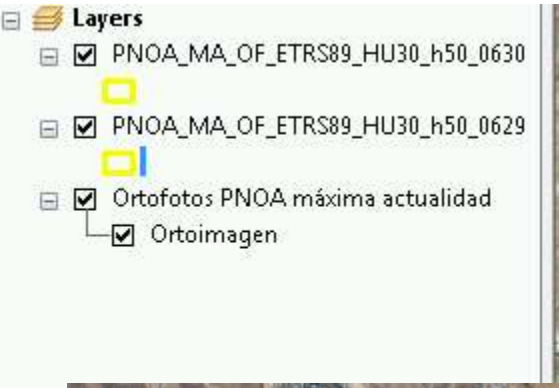
Figure 21 – mosaic with mosaic elements and tiling (tile extents in green)

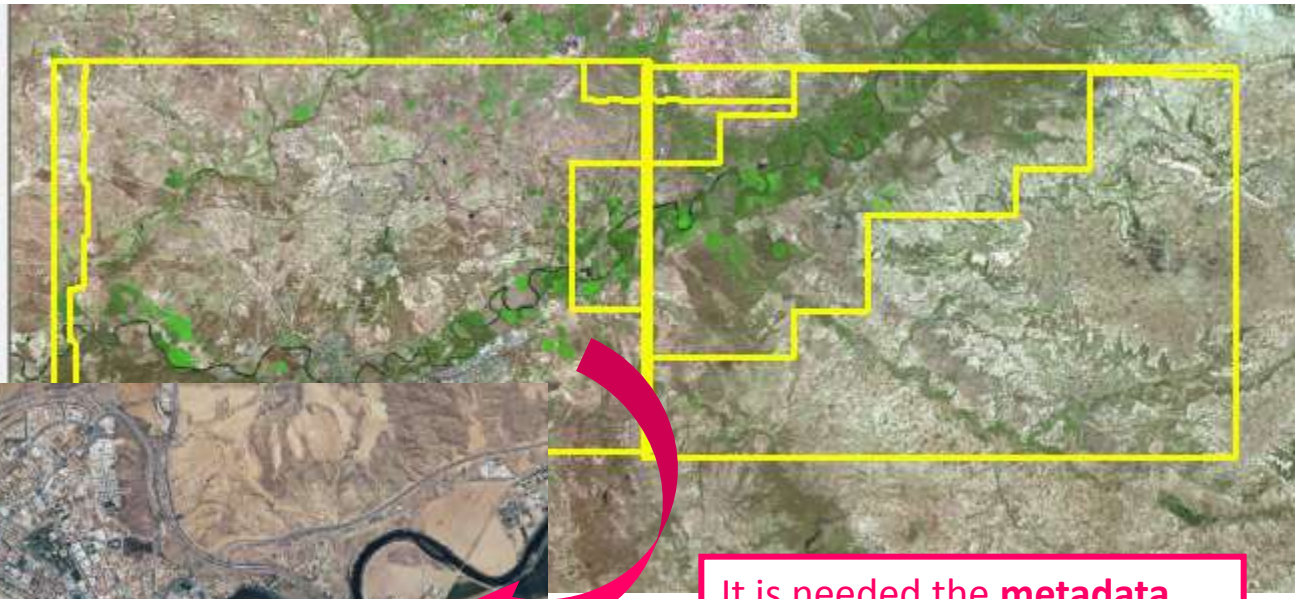
- Transformation example (OI & EL)
  - GML
  - Images

❖Orthoimageries

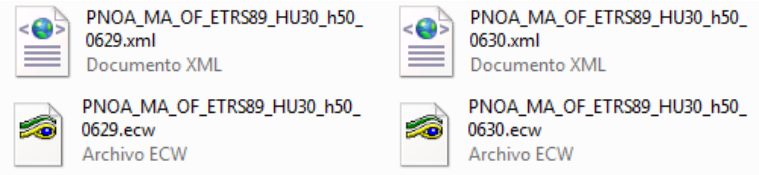
- National dataset
  - PNOA – National Plan of Aerial Orthophotography

- Test site
  - 2 images of 25 cm GSD
  - 8 mosaic parts
  - ≈ 1000 km2 for this example
  - http://pnoa.ign.es/



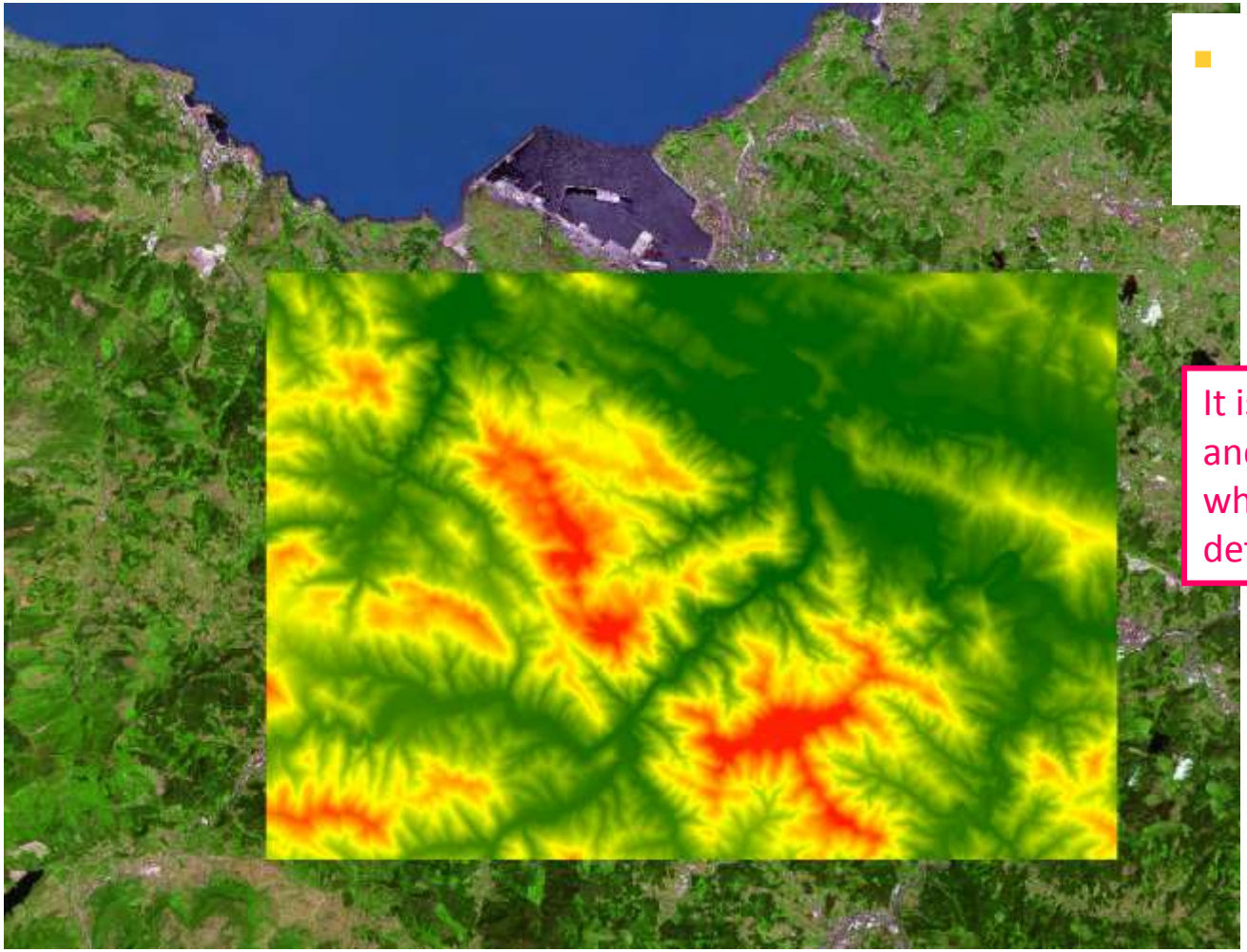


It is needed the **metadata** and **raster files**, because it is where the **coverage** definition is.



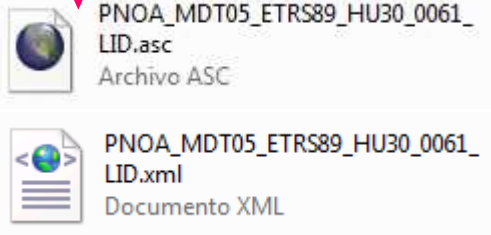
❖Elevations

- National dataset
  - PNOA – National Plan of Aerial Orthophotography

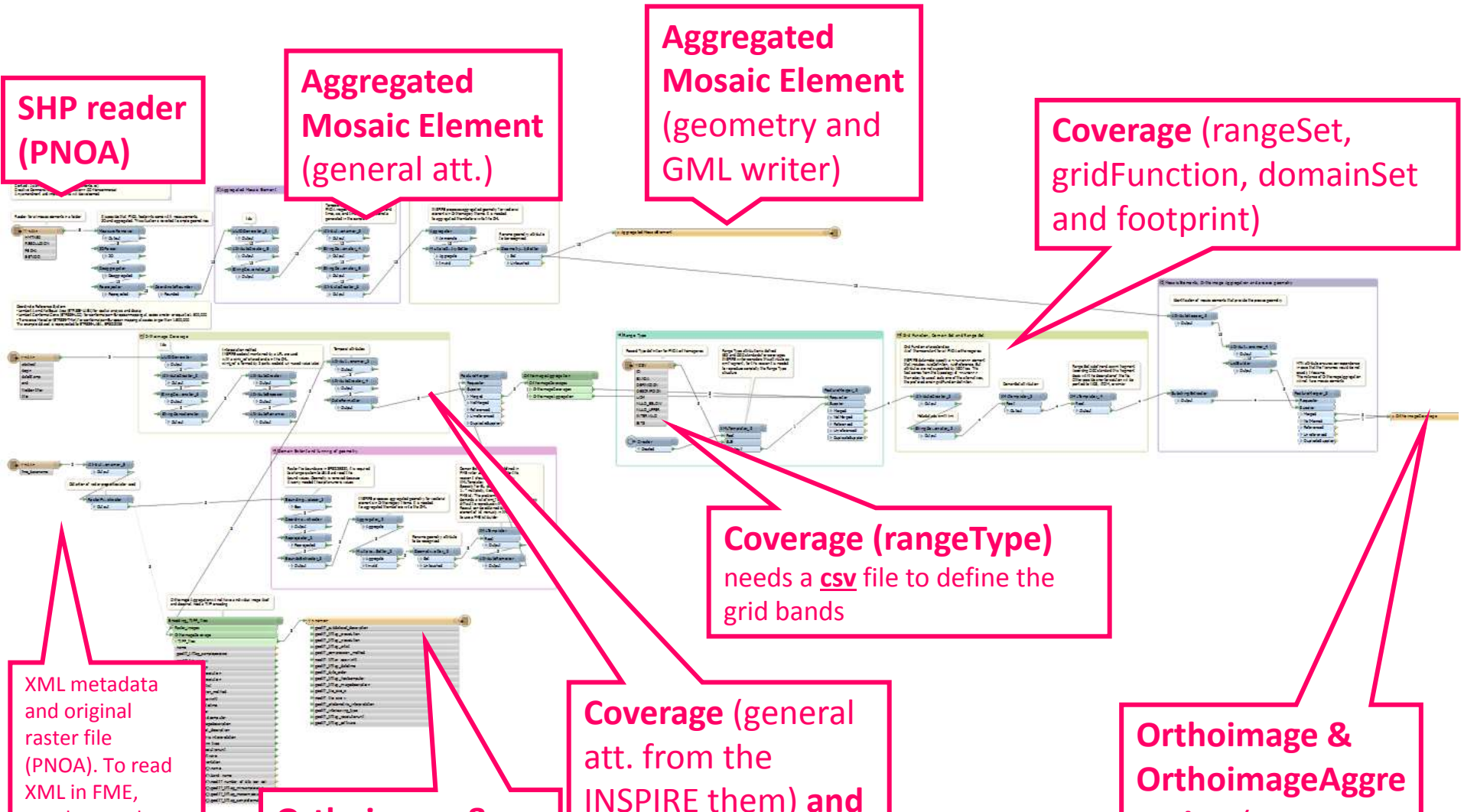


- Test site
  - 1 DEM 25m GSD
  - ≈ 200 km2
  - http://pnoa.ign.es/

It is needed the **metadata** and **raster files**, because it is where the **coverage** definition inside



❖Orthoimageries



SHP reader (PNOA)

Aggregated Mosaic Element (general att.)

Aggregated Mosaic Element (geometry and GML writer)

Coverage (rangeSet, gridFunction, domainSet and footprint)

Coverage (rangeType) needs a **csv** file to define the grid bands

XML metadata and original raster file (PNOA). To read XML in FME, needs a reader **configuration file xfMap**

Orthoimage & (TIFF writer)

Coverage (general att. from the INSPIRE them) **and domain extent**

Orthoimage & OrthoimageAggregation (geometry and GML writer)

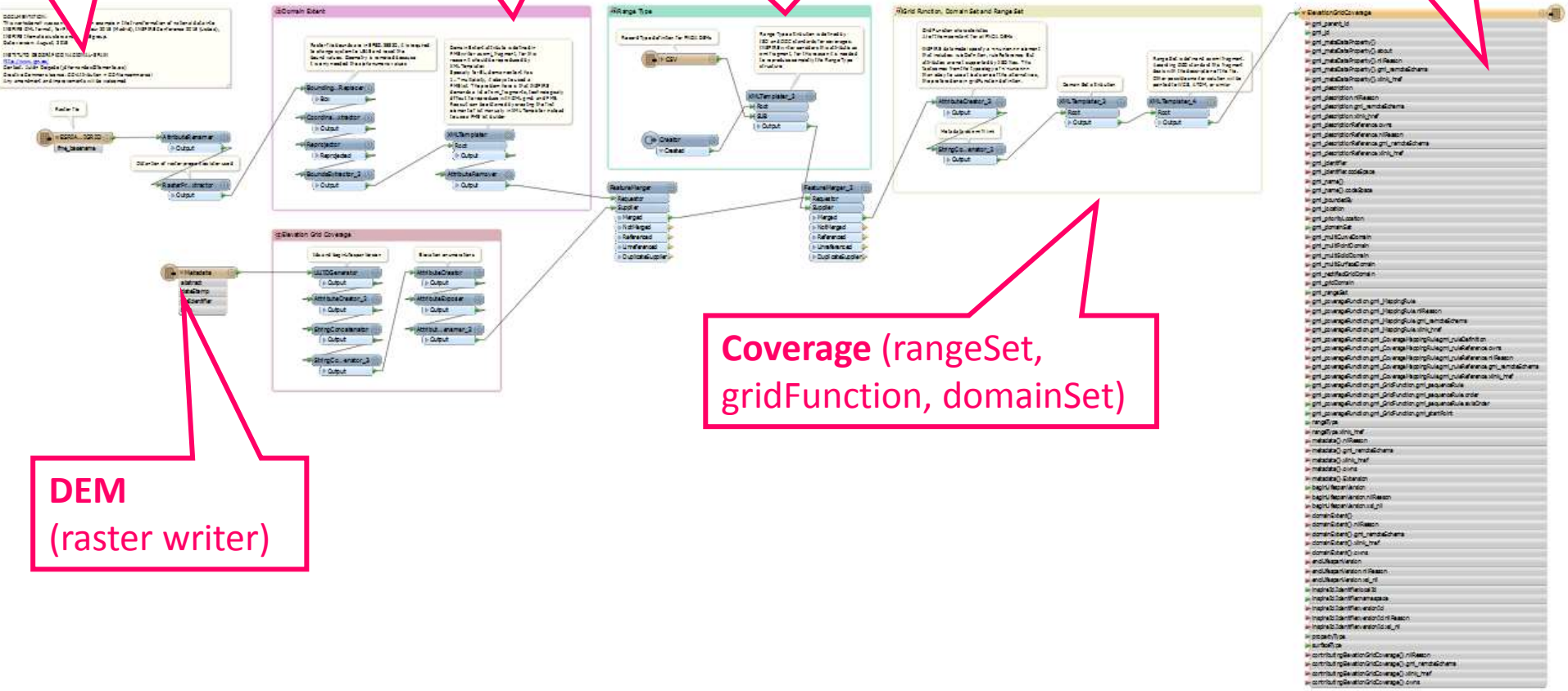
❖Elevations

XML metadata and original raster file (PNOA). To read XML in FME, needs a reader **configuration file xfMap**

Coverage (general att. from the INSPIRE them) **and domain extent**

Coverage (rangeType) needs a **csv** file to define the grid band (= height)

ElevationGridCoverage (GML writer)

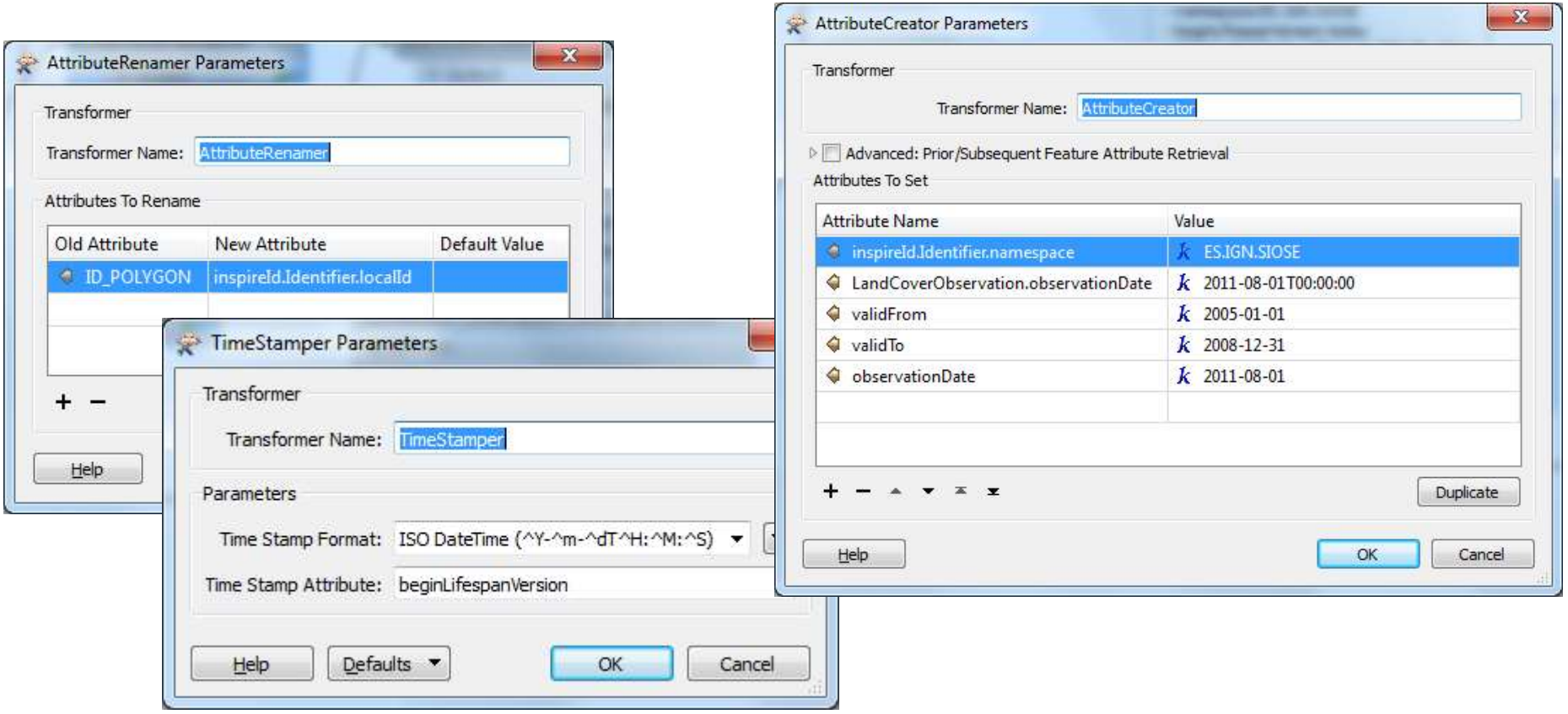


Coverage (rangeSet, gridFunction, domainSet)

DEM (raster writer)

❖General INSPIRE attributes with FME

- Direct creation or renaming according GML writer

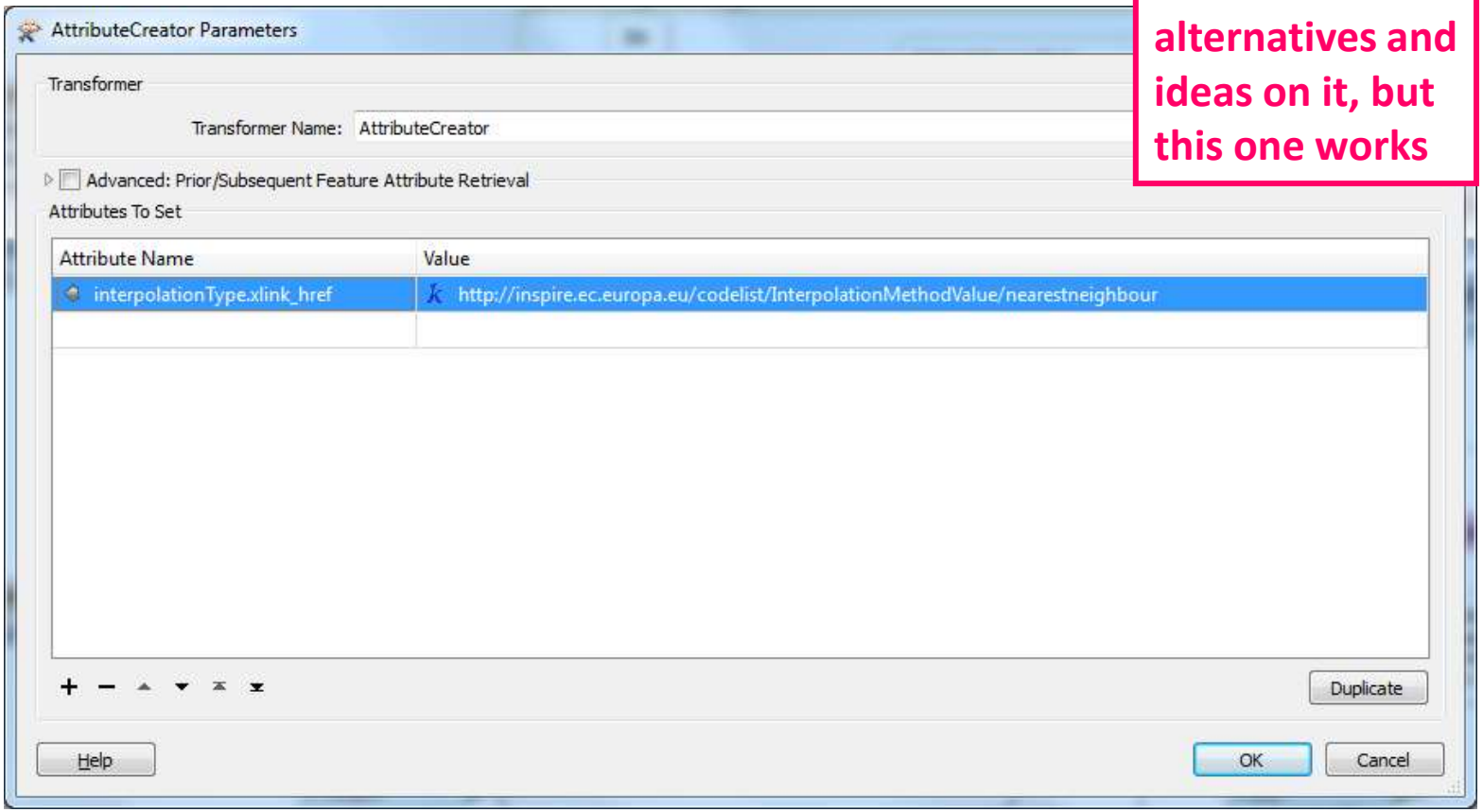


❖General INSPIRE attributes with FME

- Direct creation or renaming according GML writer

```
<gml:featureMember>
    <elu:ExistingLandUseObject gml:id="idbc11a82b-508b-4c6e-a018-6a523ed058d3">
        <elu:inspireId>
            <base:Identifier>
                <base:localId>bc11a82b-508b-4c6e-a018-6a523ed058d3</base:localId>
                <base:namespace>ES.IGN.SIOSE</base:namespace>
            </base:Identifier>
        </elu:inspireId>
        <elu:beginLifespanVersion>2015-04-07T07:54:26</elu:beginLifespanVersion>
        <elu:geometry>
        <elu:hilucsLandUse xlink:href="http://inspire.ec.europa.eu/codelist/HILUCSValue/5_ResidentialUse"/>
        <elu:hilucsPresence xsi:nil="true"/>
        <elu:specificLandUse xsi:nil="true"/>
        <elu:specificPresence xsi:nil="true"/>
        <elu:observationDate>2011-08-01</elu:observationDate>
        <elu:validFrom>2005-01-01</elu:validFrom>
        <elu:validTo>2008-12-31</elu:validTo>
        <elu:dataset xlink:href="idS2005"/>
    </elu:ExistingLandUseObject>
</gml:featureMember>
```

- Using an attribute with GML label xlink:href



There are other alternatives and ideas on it, but this one works

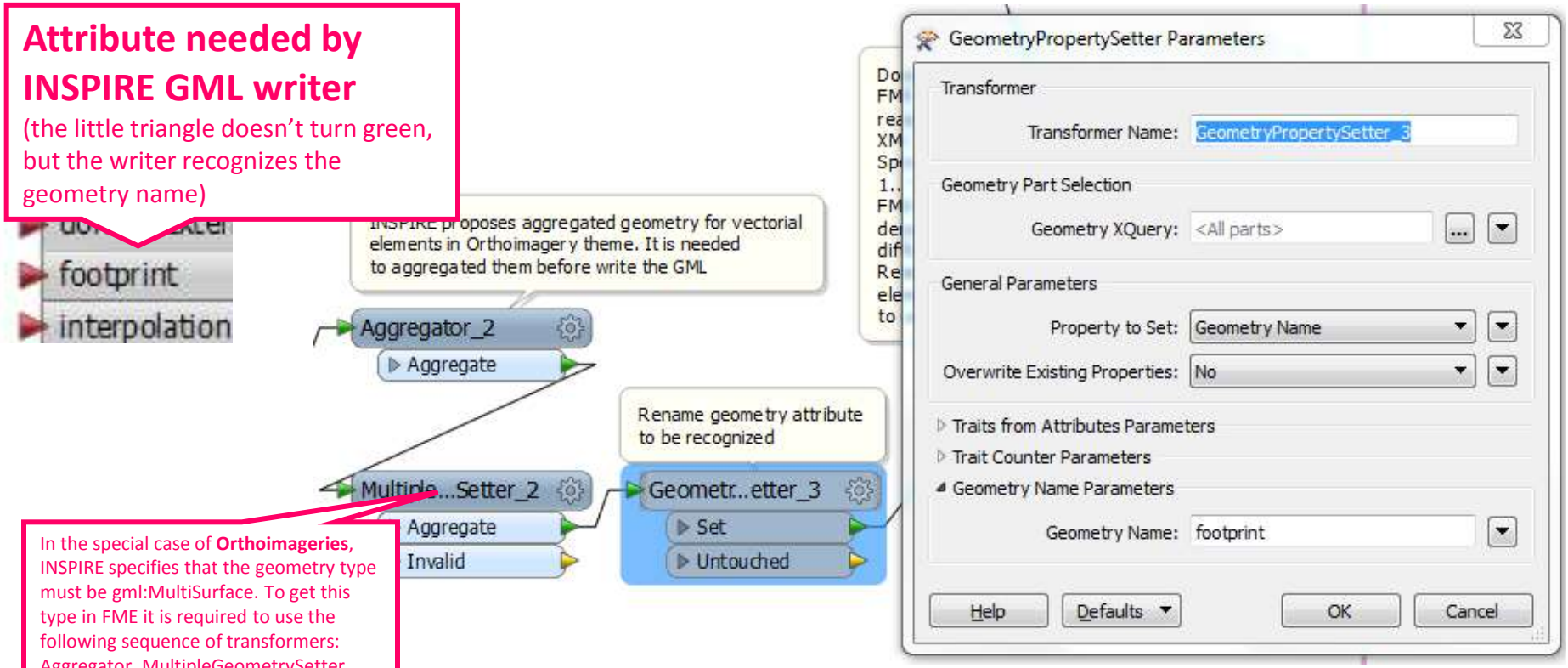
❖INSPIRE CodeLists with FME

- Using an attribute with GML label xlink:href

```
<oi:OrthoimageCoverage gml:id="id203449b8-5e8f-4511-9b58-7684b05e7b99">
    <gml:domainSet>
    <gml:rangeSet>
    <gml:coverageFunction>
    <gmlcov:rangeType>
    <gmlcov:metadata xlink:href="PNOA_MA_OF_ETRS89_HU30_h50_0630.xml"/>
    <oi:inspireId>
    <oi:domainExtent>
    <oi:footprint>
    <oi:interpolationType xlink:href="http://inspire.ec.europa.eu/codelist/InterpolationMethodValue/nearestneighbour"/>
    <oi:name>PNOA_MA_OF_ETRS89_HU30_h50_0630</oi:name>
    <oi:phenomenonTime>
    <oi:beginLifespanVersion>2015-03-09T00:00:00</oi:beginLifespanVersion>
    <oi:mosaicElement xlink:href="id5b9712a2-e769-4c5e-9631-466d8c6a3ab1"/>
    <oi:mosaicElement xlink:href="idb84c9dd6-d9a1-45f6-b32c-04317650649d"/>
    <oi:mosaicElement xlink:href="idc9707a84-64ad-4789-8e88-3d1e1e85f934"/>
    <oi:mosaicElement xlink:href="id712f03e2-0ec0-4405-82d1-4012223d92c0"/>
</oi:OrthoimageCoverage>
```

- FME geometry must be renamed according INSPIRE specifications, using GeometryPropertySetter

Attribute needed by INSPIRE GML writer
(the little triangle doesn't turn green, but the writer recognizes the geometry name)



In the special case of **Orthoimageries**, INSPIRE specifies that the geometry type must be gml:MultiSurface. To get this type in FME it is required to use the following sequence of transformers: Aggregator, MultipleGeometrySetter (value=no) and GeometryPropertySetter

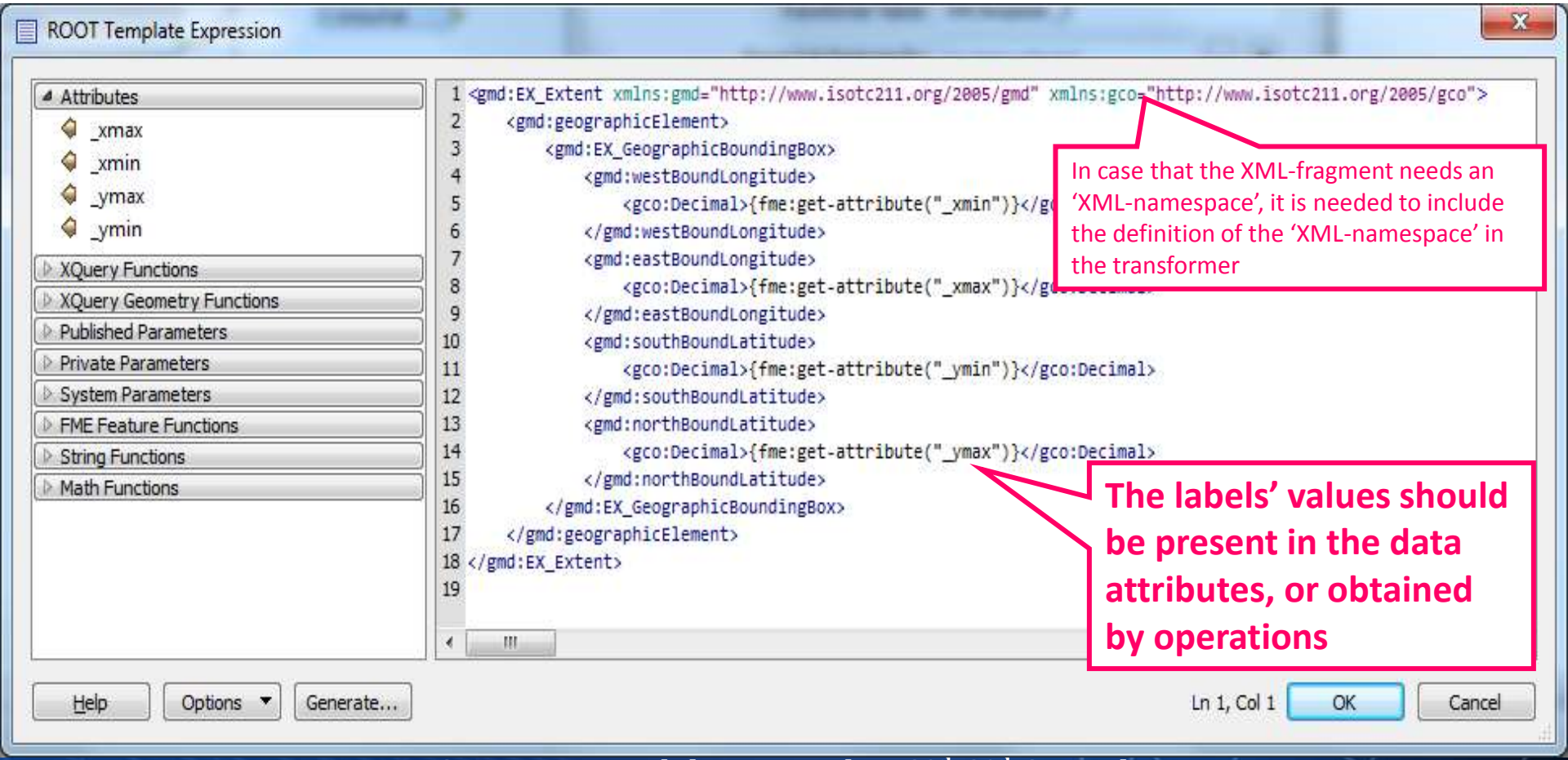
❖Geometry with FME

- FME geometry must be renamed according INSPIRE specifications, using GeometryPropertySetter

```
<oi:footprint>
    <gml:MultiSurface gml:id="id3894941c-9859-461e-885d-879a3ee8b5ef-0" srsName="EPSG:3035" srsDim
        <gml:surfaceMember>
            <gml:Surface gml:id="id3894941c-9859-461e-885d-879a3ee8b5ef-1">
                <gml:patches>
                    <gml:PolygonPatch>
                        <gml:exterior>
                            <gml:LinearRing>
                                <gml:posList>3135975.685 1968208.611 3138910.643 1986758.270 31673
                            </gml:LinearRing>
                        </gml:exterior>
                    </gml:PolygonPatch>
                </gml:patches>
            </gml:Surface>
        </gml:surfaceMember>
    </gml:MultiSurface>
</oi:footprint>
```

❖INSPIRE attributes with XML-fragment type

- It is needed to build manually the XML-fragment structure with XMLTemplater



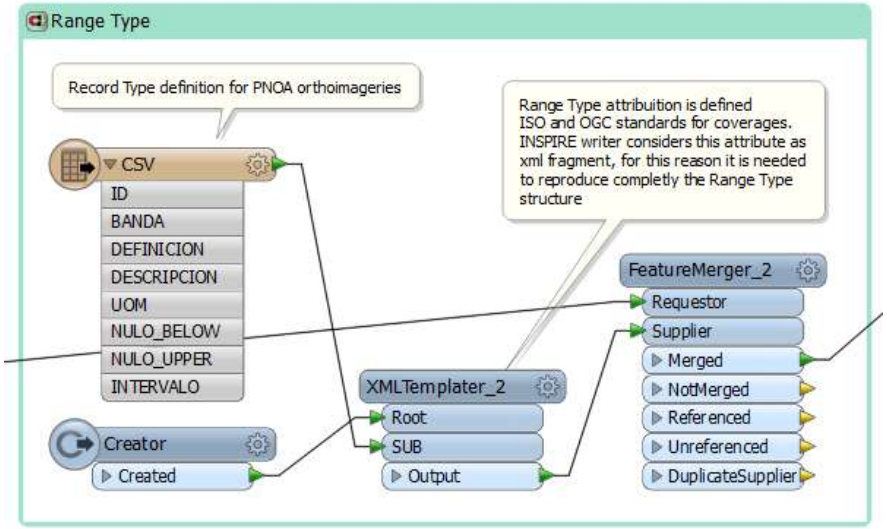
❖INSPIRE attributes with XML-fragment type

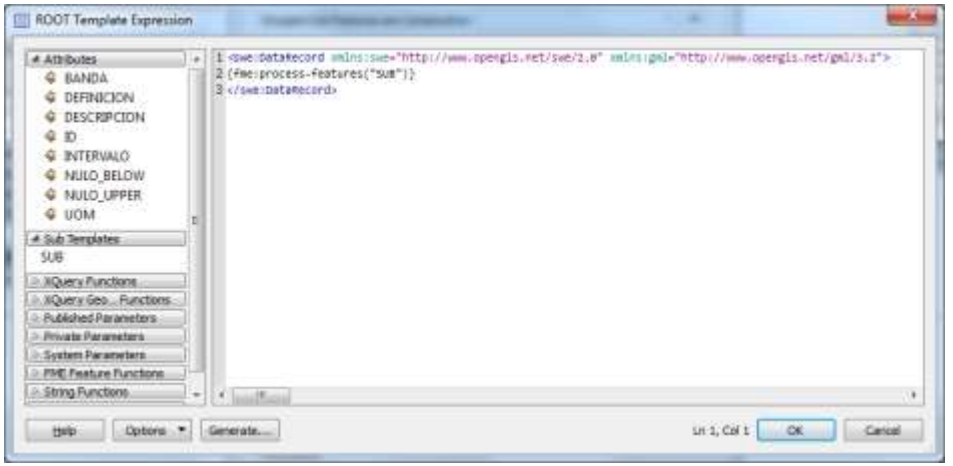
- It is needed to build manually the XML-fragment structure with XMLTemplater

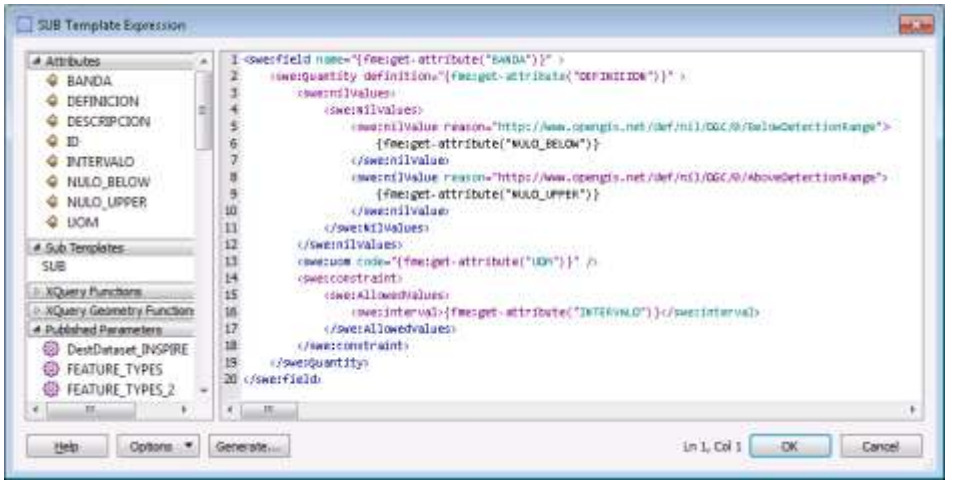
```
<oi:domainExtent>
    <gmd:EX_Extent>
        <gmd:geographicElement>
            <gmd:EX_GeographicBoundingBox>
                <gmd:westBoundLongitude>
                    <gco:Decimal>3107813.985</gco:Decimal>
                </gmd:westBoundLongitude>
                <gmd:eastBoundLongitude>
                    <gco:Decimal>3139238.855</gco:Decimal>
                </gmd:eastBoundLongitude>
                <gmd:southBoundLatitude>
                    <gco:Decimal>1968376.821</gco:Decimal>
                </gmd:southBoundLatitude>
                <gmd:northBoundLatitude>
                    <gco:Decimal>1992036.75</gco:Decimal>
                </gmd:northBoundLatitude>
            </gmd:EX_GeographicBoundingBox>
        </gmd:geographicElement>
    </gmd:EX_Extent>
</oi:domainExtent>
```

❖ISO 19123 attributes

- Range type







Orthoimagery.xsd | new 2 | coverage.xsd | PNOAtoINSPIRE-OI.gml | SIOSEtoINSPIRE-LC.gml | RecordType_PNOA-RGB.csv

```
ID;BANDA;DEFINICION;DESCRIPCION;UOM;NULO_BELOW;NULO_UPPER;INTERVALO
1;Red;http://opengis.net/def/property/OGC/0/Radiance;Measure of red band;W.m-2.sr-1.nm-1;0;255;0 255
2;Green;http://opengis.net/def/property/OGC/0/Radiance;Measure of green band;W.m-2.sr-1.nm-1;0;255;0 255
3;Blue;http://opengis.net/def/property/OGC/0/Radiance;Measure of blue band;W.m-2.sr-1.nm-1;0;255;0 255
```

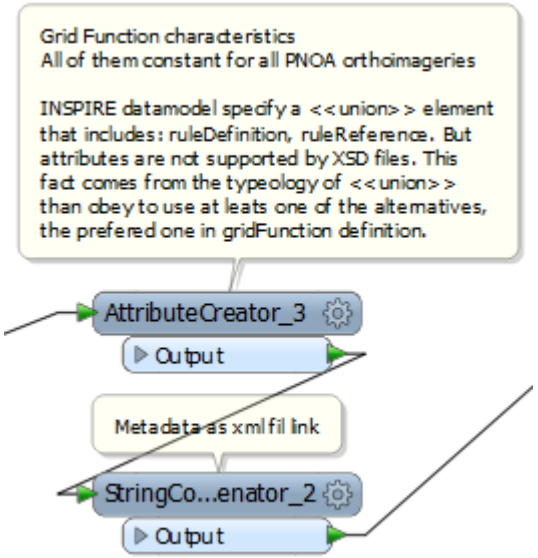
❖ISO 19123 attributes

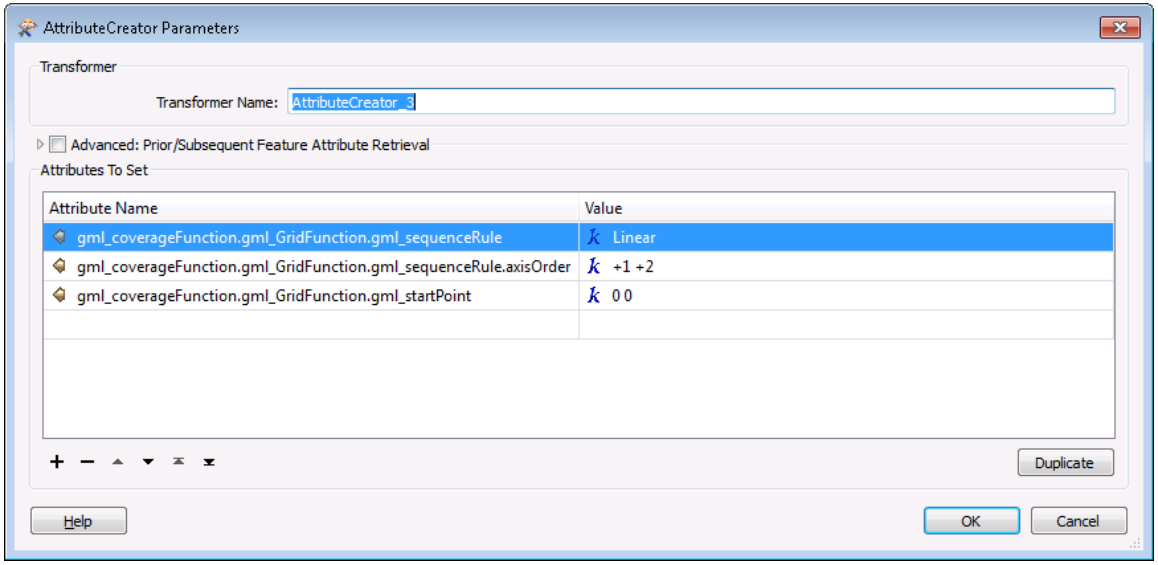
- Range type

```
<gmlcov:rangeType>
    <swe:DataRecord>
        <swe:field name="Red">
            <swe:Quantity definition="http://opengis.net/def/property/OGC/0/Radiance">
                <swe:nilValues>
                    <swe:NilValues>
                        <swe:nilValue reason="http://www.opengis.net/def/nil/OGC/0/BelowDetectionRange">0</swe:nilValue>
                        <swe:nilValue reason="http://www.opengis.net/def/nil/OGC/0/AboveDetectionRange">255</swe:nilValue>
                    </swe:NilValues>
                </swe:nilValues>
                <swe:uom code="W.m-2.sr-1.nm-1"/>
                <swe:constraint>
                    <swe:AllowedValues>
                        <swe:interval>0 255</swe:interval>
                    </swe:AllowedValues>
                </swe:constraint>
            </swe:Quantity>
        </swe:field>
        <swe:field name="Green">
        <swe:field name="Blue">
    </swe:DataRecord>
</gmlcov:rangeType>
```

❖ISO 19123 attributes

Coverage Function

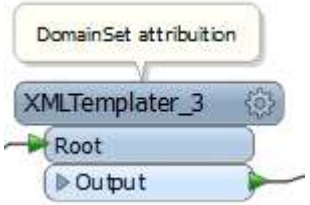





```
<gml:coverageFunction>
    <gml:GridFunction>
        <gml:sequenceRule axisOrder="+1 +2">Linear</gml:sequenceRule>
        <gml:startPoint>0 0</gml:startPoint>
    </gml:GridFunction>
</gml:coverageFunction>
```

❖ISO 19123 attributes

- Domain Set



ROOT Template Expression

Attributes

- _cell_origin_x
- _cell_origin_y
- _coordsys
- _lower_left_x
- _lower_left_y
- _lower_right_x
- _lower_right_y
- _max_x
- _max_y
- _min_x
- _min_y
- _num_bands
- _num_columns
- _num_rows
- _origin_x
- _origin_y

```
<gml:RectifiedGrid dimension="2" gml:id="gr{fme:get-attribute("gml_id")}" xmlns:gml="http://www.opengis.net/gml/3.2">
        <gml:limits>
            <gml:GridEnvelope>
                <gml:low>0 0</gml:low>
                <gml:high>{fme:get-attribute("_num_rows")} {fme:get-attribute("_num_columns")}</gml:high>
            </gml:GridEnvelope>
        </gml:limits>
        <gml:axisLabels>x y</gml:axisLabels>
        <gml:origin>
            <gml:Point gml:id="origin_{fme:get-attribute("gml_id")}" srsName="http://www.opengis.net/def/crs/EPSG/0/3035">
                <gml:pos>{fme:get-attribute("_origin_x")} {fme:get-attribute("_origin_y")}</gml:pos>
            </gml:Point>
        </gml:origin>
        <gml:offsetVector srsName="http://www.opengis.net/def/crs/EPSG/0/3035">{fme:get-attribute("_spacing_x")} 0</gml:offsetVector>
        <gml:offsetVector srsName="http://www.opengis.net/def/crs/EPSG/0/3035">0 -{fme:get-attribute("_spacing_y")}</gml:offsetVector>
</gml:RectifiedGrid>
```

Help | Options | Generate... | Ln 1, Col 1 | OK | Cancel

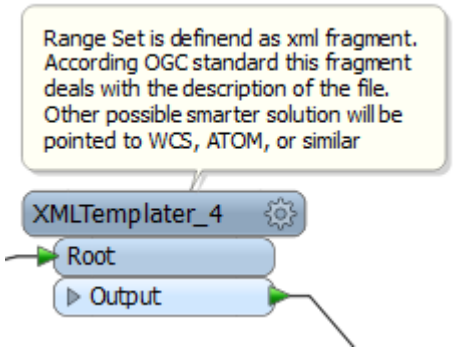
❖ISO 19123 attributes

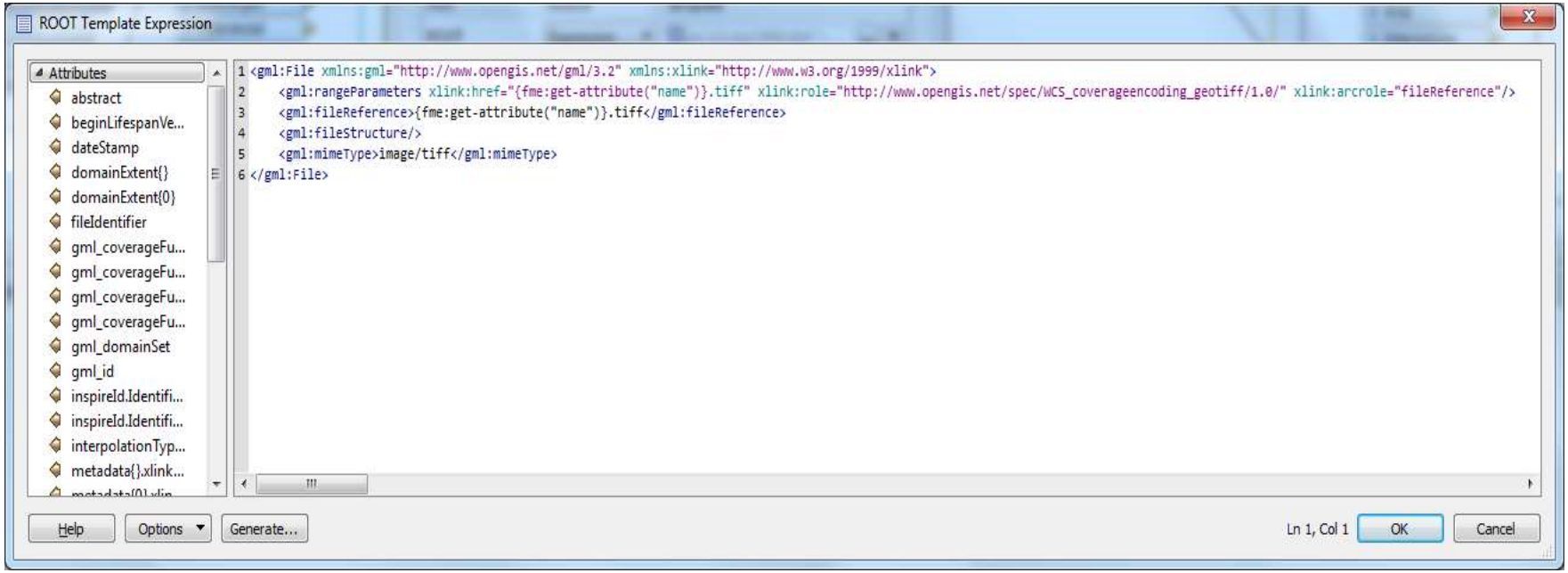
- Domain Set

```
<gml:domainSet>
    <gml:RectifiedGrid dimension="2" gml:id="grid203449b8-5e8f-4511-9b58-7684b05e7b99">
        <gml:limits>
            <gml:GridEnvelope>
                <gml:low>0 0</gml:low>
                <gml:high>75320 114960</gml:high>
            </gml:GridEnvelope>
        </gml:limits>
        <gml:axisLabels>x y</gml:axisLabels>
        <gml:origin>
            <gml:Point gml:id="origin_id203449b8-5e8f-4511-9b58-7684b05e7b99" srsName="http://www.opengis.net/def/crs/E
                <gml:pos>426860 4428160</gml:pos>
            </gml:Point>
        </gml:origin>
        <gml:offsetVector srsName="http://www.opengis.net/def/crs/EPSG/0/3035">0.25 0</gml:offsetVector>
        <gml:offsetVector srsName="http://www.opengis.net/def/crs/EPSG/0/3035">0 -0.25</gml:offsetVector>
    </gml:RectifiedGrid>
</gml:domainSet>
```

❖ISO 19123 attributes

- **Range Set**
  - ***Type II)*** Providing the pixels' values in a separate file (*.TIIF)





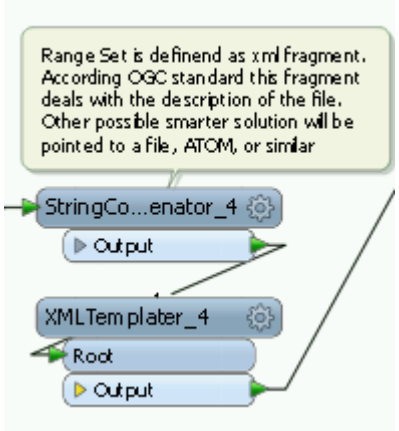
❖ISO 19123 attributes

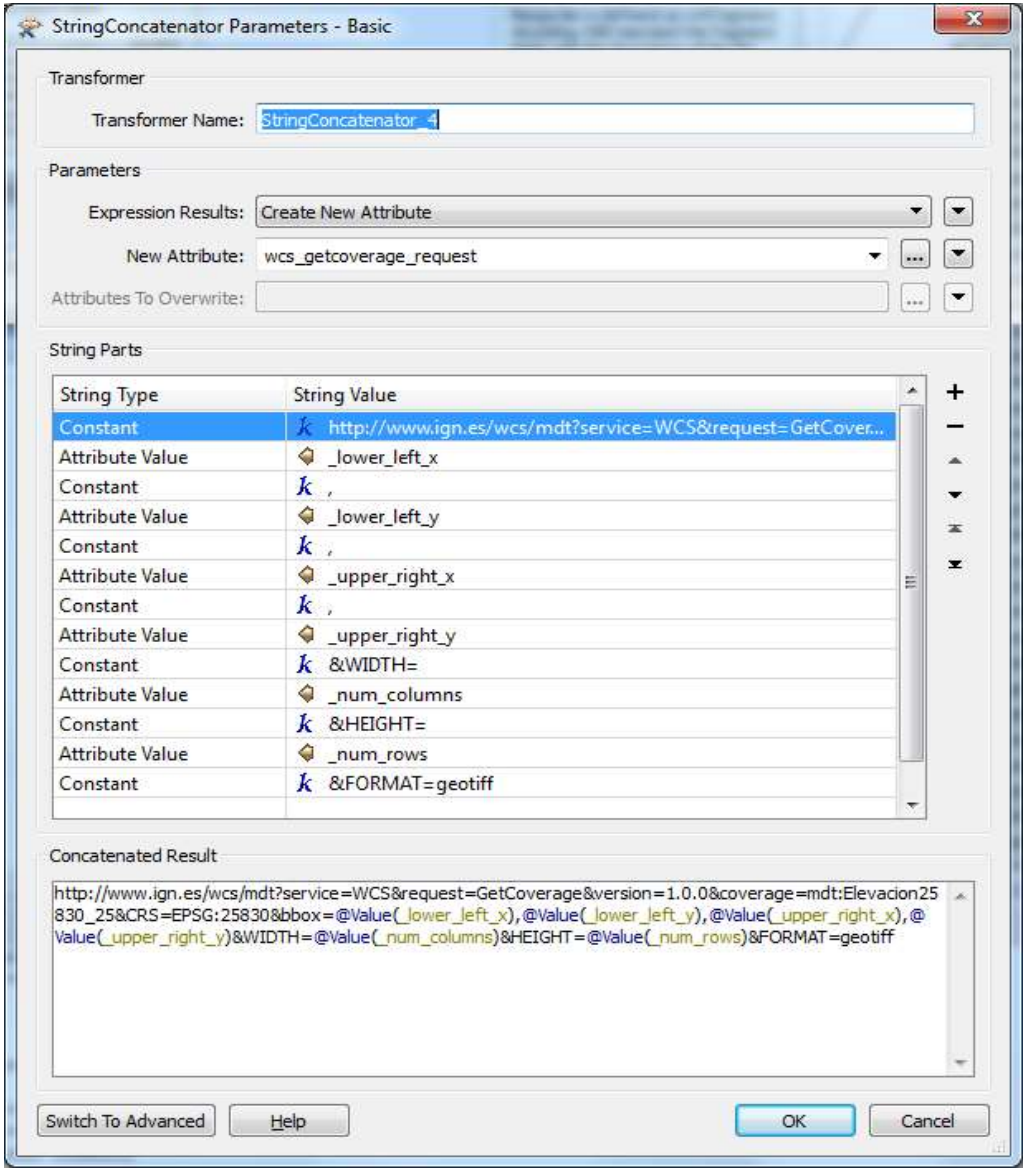
- **Range Set**
  - ***Type II)*** Providing the pixels' values in a separate file (*.TIIF)

```
<oi:OrthoimageCoverage gml:id="id203449b8-5e8f-4511-9b58-7684b05e7b99">
    <gml:domainSet>
    <gml:rangeSet>
        <gml:File>
            <gml:rangeParameters xlink:href="PNOA_MA_OF_ETRS89_HU30_h50_0630.tiff" xlink:role="http://www.opengis.net/s
            <gml:fileReference>PNOA_MA_OF_ETRS89_HU30_h50_0630.tiff</gml:fileReference>
            <gml:fileStructure/>
            <gml:mimeType>image/tiff</gml:mimeType>
        </gml:File>
    </gml:rangeSet>
```

❖ISO 19123 attributes

- **Range Set**
  - ***Type IV*)*** Providing area of the DEM through a WCS **getCoverage** request





❖ISO 19123 attributes

- **Range Set**
  - ***Type IV*)*** Providing area of the DEM through a WCS **getCoverage** request

```
<gml:rangeSet>
    <gml:File>
        <gml:rangeParameters xlink:href="http://www.ign.es/wcs/mdt?service=WCS&amp;request=GetCoverage&amp;version=1.0.
        <gml:fileReference>geoserver-GetCoverage.tiff</gml:fileReference>
        <gml:fileStructure/>
        <gml:mimeType>image/tiff</gml:mimeType>
        <!-- This encoding way is a proposal,
        required to be shared and validated with other encoding examples for coverages using WCS.
        Native CRS is used for data providing -->
        <!-- WCS provides the coverage in the native reference systems (EPSG:25830 and national altimetric system) -->
    </gml:File>
</gml:rangeSet>
```

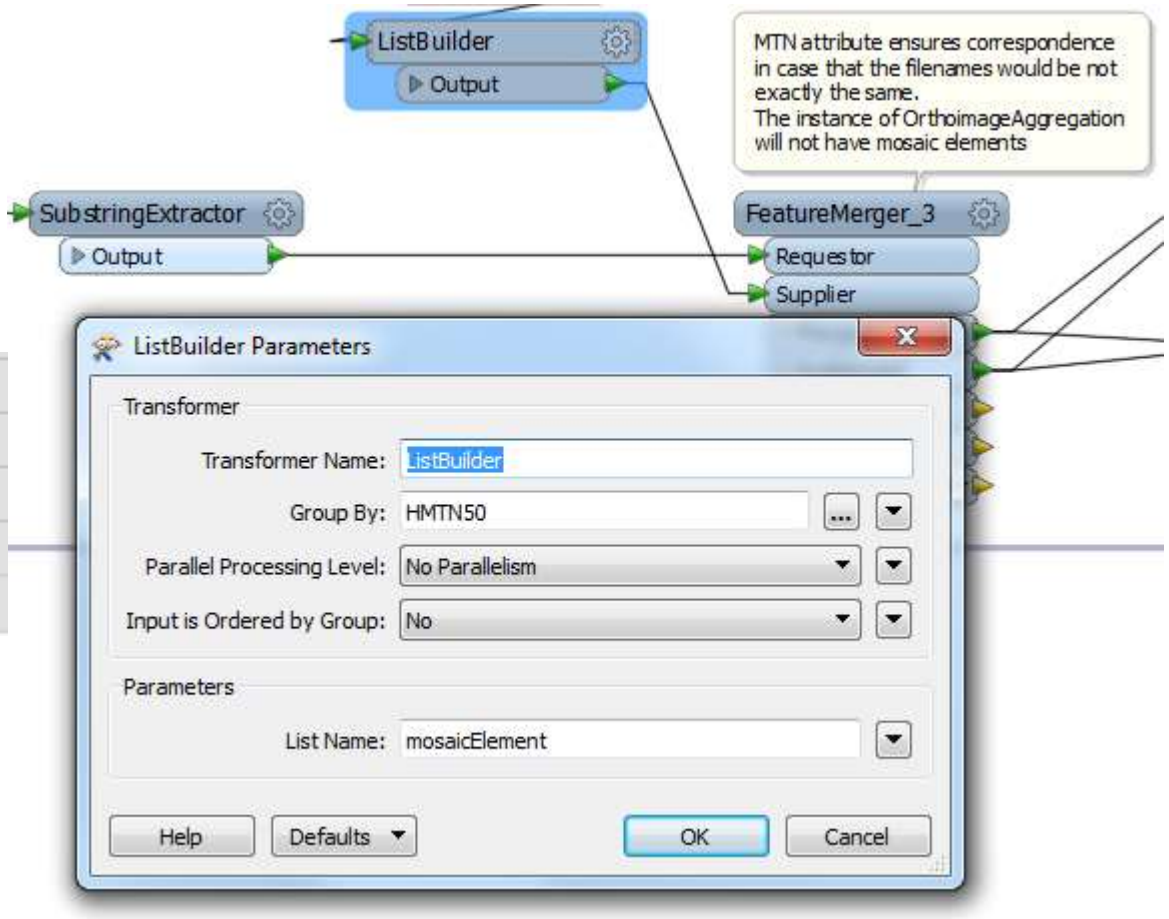
http://www.ign.es/wcs/mdt?service=WCS&request=GetCoverage&version=1.0.0&coverage=mdt:Elevacion25830_25&CRS=EPSG:25830&bbox=484387.5,4778987.5,512212.5,4798212.5&WIDTH=1113&HEIGHT=769&FORMAT=geotiff

❖Attributes' values with multiplicity 0..*

- Using FME lists

Attributes needed by INSPIRE GML writer

- mosaicElement{}.nilReason
- mosaicElement{}.gml_remoteSchema
- mosaicElement{}.xlink_href
- mosaicElement{}.owns
- mosaicElement{}.xsi_nil



❖MosaicElements and OrthoimageAggregation

- Represent attributes with multiplicity (0..*), recognized using FME lists

```
<gml:featureMember>
    <oi:OrthoimageCoverage gml:id="id127988fe-3f77-4080-91df-ccc1e55d4bca">
        <gml:domainSet>
        <gml:rangeSet>
        <gml:coverageFunction>
        <gmlcov:rangeType>
        <gmlcov:metadata xlink:href="PNOA_MA_OF_ETRS89_HU30_h50_0629.xml"/>
        <oi:inspireId>
        <oi:domainExtent>
        <oi:footprint>
        <oi:interpolationType xlink:href="http://inspire.ec.europa.eu/codelist/InterpolationMethodValue/nearestneighbour"/>
        <oi:name>PNOA_MA_OF_ETRS89_HU30_h50_0629</oi:name>
        <oi:phenomenonTime>
        <oi:beginLifespanVersion>2015-03-09T00:00:00</oi:beginLifespanVersion>
        <oi:mosaicElement xlink:href="id20380932-28fc-4f18-82e3-03d79abf2eba"/>
        <oi:mosaicElement xlink:href="id6ff19831-8cce-46ac-a1c5-aab463e4b860"/>
        <oi:mosaicElement xlink:href="id3f78d77d-b738-4f85-9367-42a4a525760e"/>
        <oi:mosaicElement xlink:href="id17162172-8f01-4066-8605-05f6c82168c9"/>
    </oi:OrthoimageCoverage>
</gml:featureMember>
```

Individual **Orthoimage** composed by 4 **MosaicElements**

❖MosaicElements and OrthoimageAggregation

- Represent attributes with multiplicity (0..*), recognized using FME lists

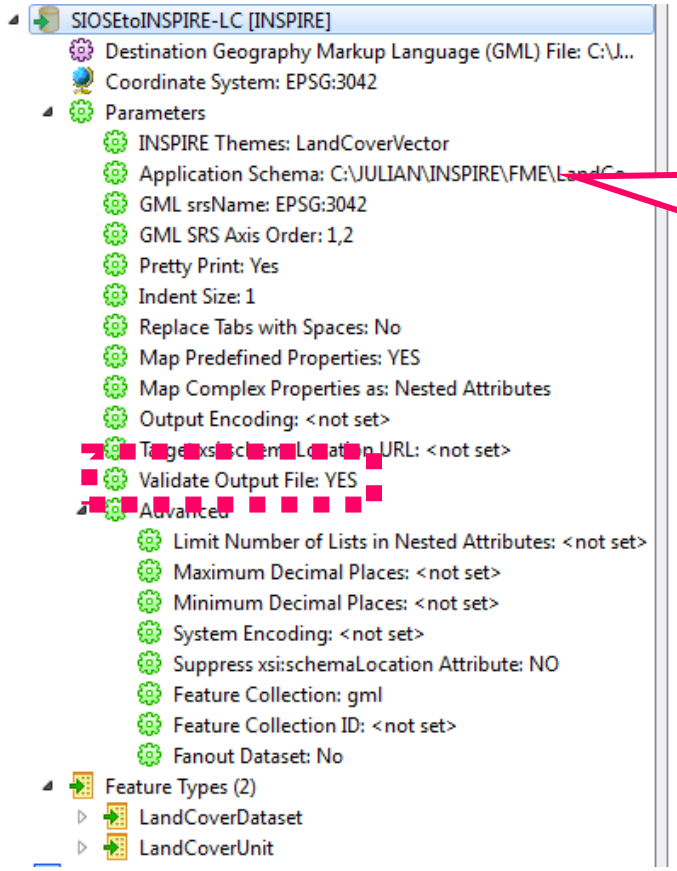
```
<oi:OrthoimageCoverage gml:id="idbf7d901f-d1c8-45e4-b334-bb23a86f89fb">
    <gml:domainSet>
    <gml:rangeSet>
    <gml:coverageFunction>
    <gmlcov:rangeType>
    <gmlcov:metadata xlink:href="Cobertura_PNOA_201
    <oi:inspireId>
    <oi:domainExtent>
    <oi:footprint>
    <oi:interpolationType xlink:href="http://inspire.ec.europa.eu/codelist/InterpolationMethodValue/nearestneighbour"/>
    <oi:name>Cobertura_PNOA_2012-14</oi:name>
    <oi:phenomenonTime>
    <oi:beginLifespanVersion>2015-03-08T00:00:00</oi:beginLifespanVersion>
    <oi:contributingOrthoimageCoverage>
    <oi:contributingOrthoimageCoverage>
</oi:OrthoimageCoverage>
```

An instance in the GML file to represent the complete national dataset

An **OrthoimageAggregation** that means the complete dataset composed by 2 **Orthoimages**

❖Validation with FME

- It is possible to use the default validation implemented in the INSPIRE GML writer, ensures only a **well format file against the XSD template**



Validation needs a reference 'application schema' to compare. It will be the downloaded **XSD file** from INSPIRE web. If this parameter is in blank, FME looks for directly in the **INSPIRE web**.

The validation only can be carried out over elements defined in the XSD file. XML-fragments attributes are omitted

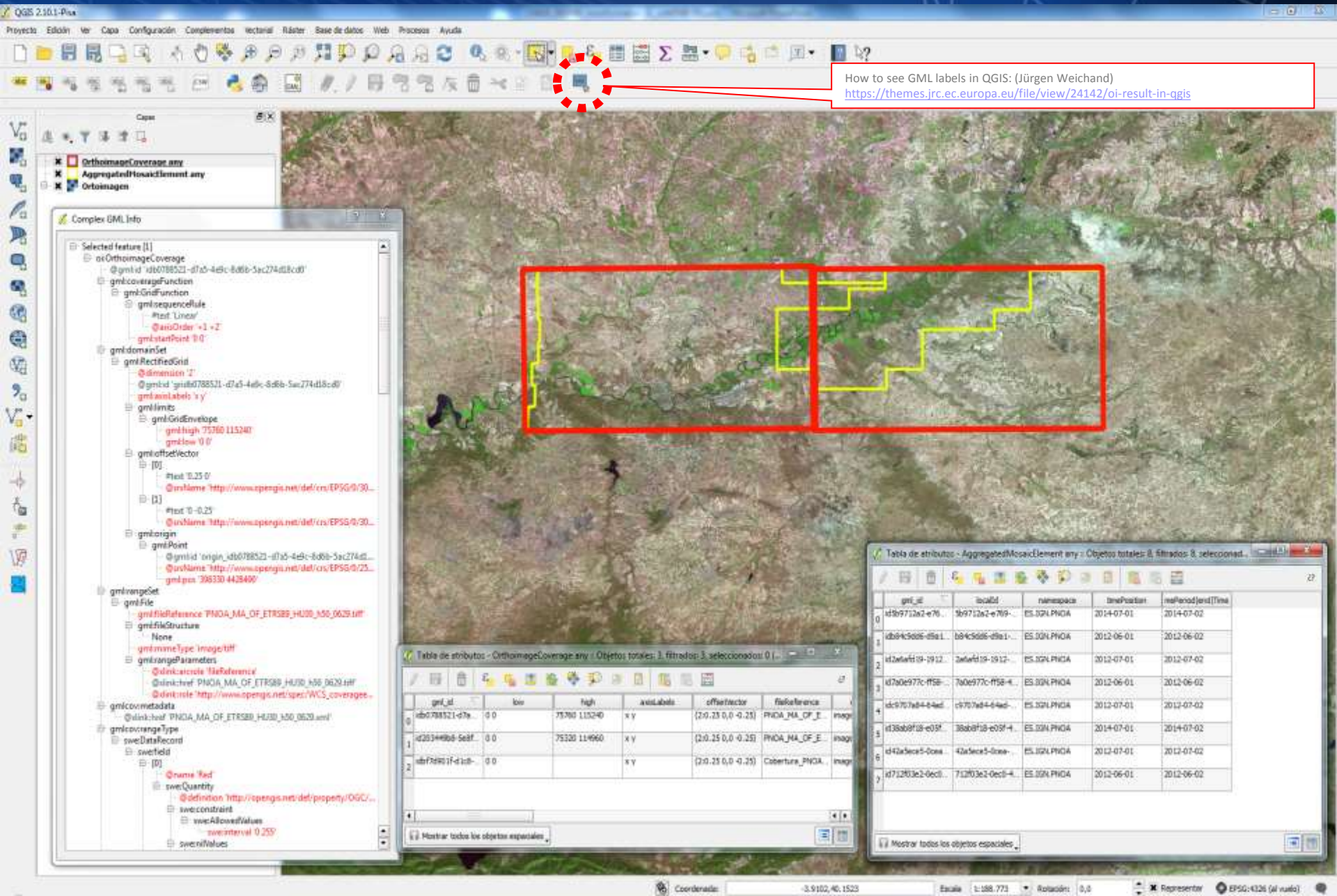
❖GML result Orthoimagery

8 MosaicElements

3 OrthoimageCoverage
(2 orthoimages
and 1 aggregation)

```
<?xml version="1.0" encoding="UTF-8"?>
<gml:FeatureCollection xmlns:gmlcov="http://www.opengis.net/gmlcov/1.0" xmlns:swe="htt
    <gml:boundedBy>
    <gml:featureMember>
        <oi:AggregatedMosaicElement gml:id="id5b9712a2-e769-4c5e-9631-466d8c6a3ab1">
    </gml:featureMember>
    <gml:featureMember>
        <oi:AggregatedMosaicElement gml:id="idb84c9dd6-d9a1-45f6-b32c-04317650649d">
    </gml:featureMember>
    <gml:featureMember>
        <oi:AggregatedMosaicElement gml:id="id2a6afd19-1912-485c-8627-5661247fa1a7">
    </gml:featureMember>
    <gml:featureMember>
        <oi:AggregatedMosaicElement gml:id="id7a0e977c-ff58-4b43-971b-aab5de70ee30">
    </gml:featureMember>
    <gml:featureMember>
        <oi:AggregatedMosaicElement gml:id="idc9707a84-64ad-4789-8e88-3d1e1e85f934">
    </gml:featureMember>
    <gml:featureMember>
        <oi:AggregatedMosaicElement gml:id="id38ab8f18-e05f-4d6a-8886-92b007b30ca0">
    </gml:featureMember>
    <gml:featureMember>
        <oi:AggregatedMosaicElement gml:id="id42a5ece5-0cea-44bd-96a6-2efd98491205">
    </gml:featureMember>
    <gml:featureMember>
        <oi:AggregatedMosaicElement gml:id="id712f03e2-0ec0-4405-82d1-4012223d92c0">
    </gml:featureMember>
    <gml:featureMember>
        <oi:OrthoimageCoverage gml:id="idb0788521-d7a5-4e9c-8d6b-5ac274d18cd0">
    </gml:featureMember>
    <gml:featureMember>
        <oi:OrthoimageCoverage gml:id="id203449b8-5e8f-4511-9b58-7684b05e7b99">
    </gml:featureMember>
    <gml:featureMember>
        <oi:OrthoimageCoverage gml:id="idbf7d901f-d1c8-45e4-b334-bb23a86f89fb">
    </gml:featureMember>
</gml:FeatureCollection>
```

❖GML result Orthoimagery

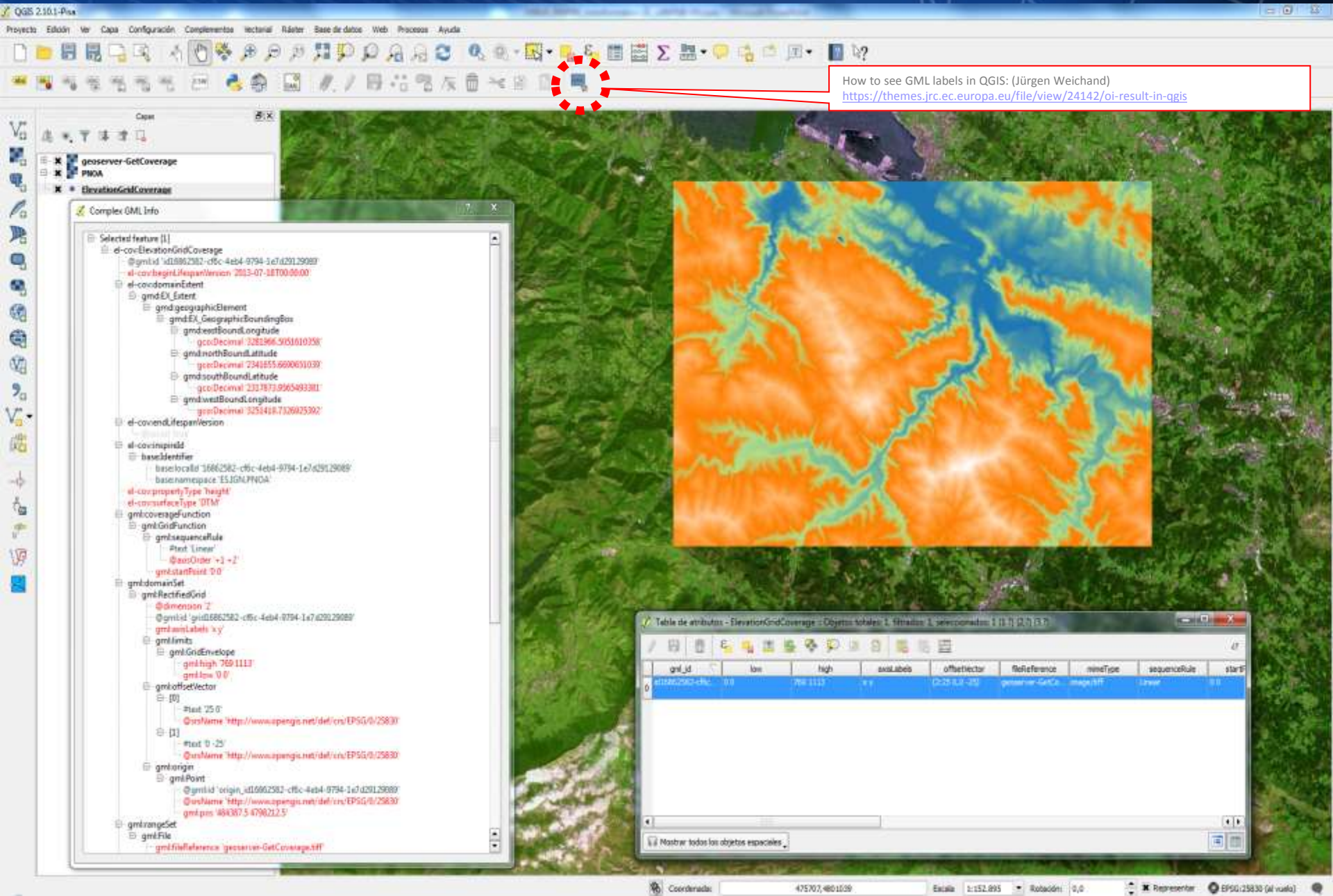


❖GML result Elevations

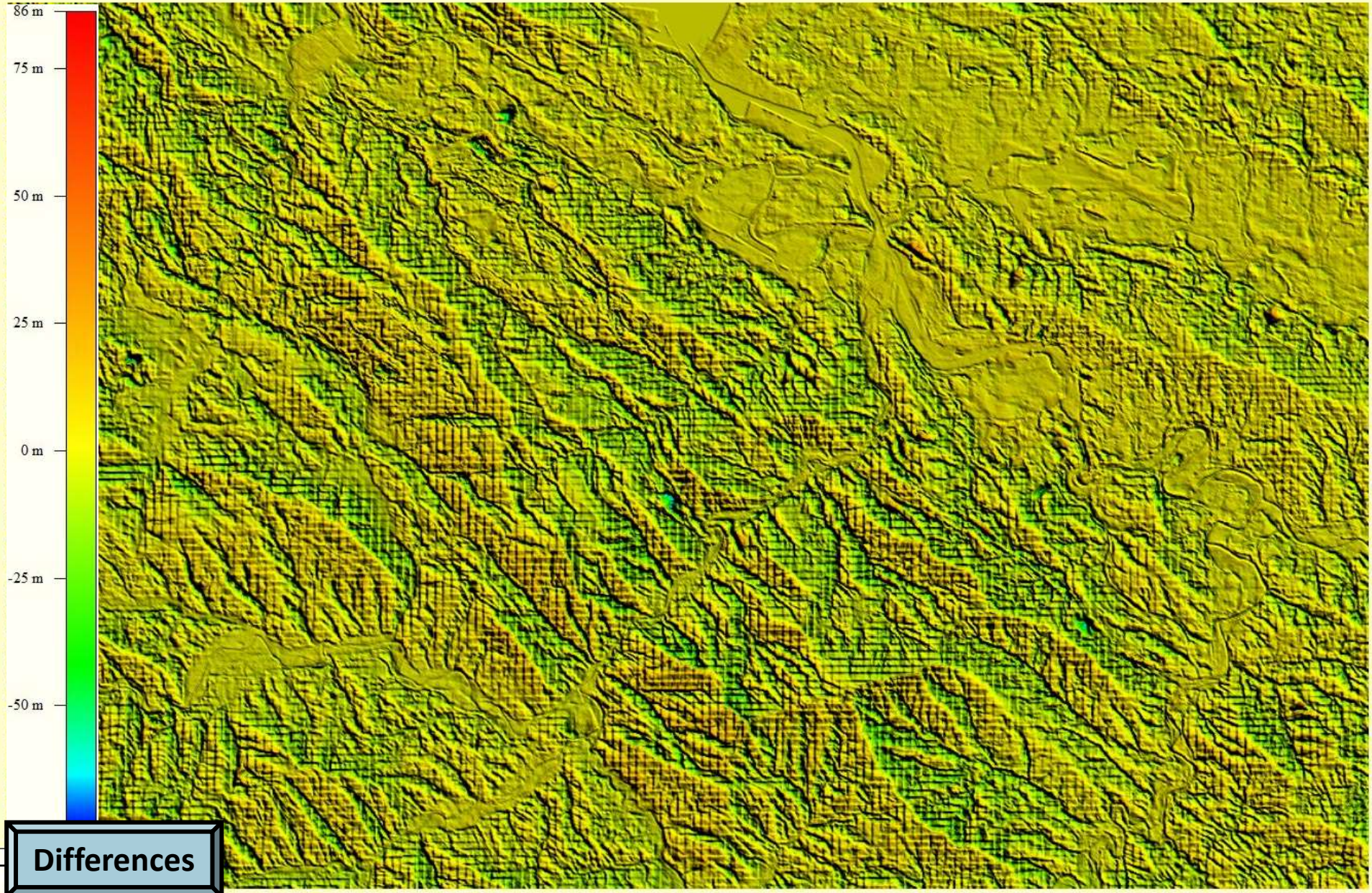
1 ElevationGridCoverage (without geometry)

```
<?xml version="1.0" encoding="UTF-8"?>
<gml:FeatureCollection xmlns:swe="http://www.opengis.net/swe/2.0" xmlns:ns1="http://inspire.ec.europa.eu/schemas/cvbas
    <gml:boundedBy>
    <gml:featureMember>
        <el-cov:ElevationGridCoverage gml:id="id16862582-cf6c-4eb4-9794-1e7d29129089">
            <gml:domainSet>
            <gml:rangeSet>
                <gml:File>
                    <gml:rangeParameters xlink:href="http://www.ign.es/wcs/mdt?service=WCS&amp;request=GetCoverage&amp
                    <gml:fileReference>geoserver-GetCoverage.tiff</gml:fileReference>
                    <gml:fileStructure/>
                    <gml:mimeType>image/tiff</gml:mimeType>
                    <!-- This encoding way is a proposal, required to be shared and validated with other encoding exam
                    <!-- WCS provides the coverage in the native reference systems (EPSG:25830 and national altimetric
                </gml:File>
            </gml:rangeSet>
            <gml:coverageFunction>
            <gmlcov:rangeType>
            <gmlcov:metadata xlink:href="PNOA_MDT25_ETRS89_HU30_0061.xml"/>
            <el-cov:beginLifespanVersion>2013-07-18T00:00:00</el-cov:beginLifespanVersion>
            <el-cov:domainExtent>
            <el-cov:endLifespanVersion xsi:nil="true"/>
            <el-cov:inspireId>
            <el-cov:propertyType>height</el-cov:propertyType>
            <el-cov:surfaceType>DTM</el-cov:surfaceType>
        </el-cov:ElevationGridCoverage>
    </gml:featureMember>
</gml:FeatureCollection>
```

❖GML result Elevations



❖Elevations comparision (Original file vs WCS result, both with same resolution and georeferenced)



❖Raster Images' Tags

- GMLs must be **accompanied by raster images** (geoTIFF or JPG2000). Raster images must be **tuned to allocate INSPIRE information inside**, using image **TAGs** (OI Recommendation 32 and Annex E)
  - Image tags should be modified/edited/written
  - 4 types of tags: Mandatory, Conditional, Optional, Inadequate

GeoTIFF Format Specification
GeoTIFF Revision 1.0

Click Here for Table of Contents

Authors:

Acknowledgments:

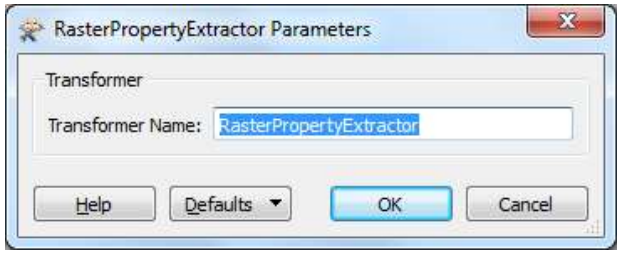
Table 10. Baseline TIFF implementation profile and Mapping between TIFF tags and the associated object elements from the Orthoimagery GML Application Schema

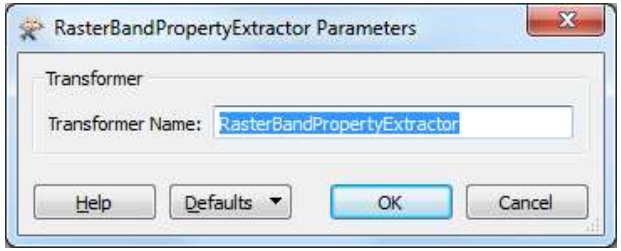
Tag name	Code	Type	Card.	Description	Obligation	Restricted values	Mapping to GML elements (including restrictions)
Artist	315	ASCII	1	Person who created the image	O	-	N/A
BitsPerSample	258	Short	SamplesPerPixel	Number of bits per component	M	1 for bi-level images For imagery, constrained to **8** or **16** bits-per-pixel-per-band (e.g. 8 8 8 or 16 16 16 for RGB images). For other gridded data, 8, 16 and 32 bits-per-pixel-per-band	For each band *i*, rangeType.field[*i*].constraint.interval = "0 *2^BitsPerSample[i]-1*"
CellLength	265	Short	1	The length of the dithering or halftoning matrix used to create a dithered or halftoned bilevel file.	I	This field should be never used	N/A
CellWidth	264	Short	1	The width of the dithering or halftoning matrix used to create a dithered or halftoned bilevel file.	I	This field should be never used	N/A
ColorMap	320	Short	3*(2**BitsPerSample)	A colour map for palette colour images	C	Only for palette colour images	N/A
Compression	259	Short	1	Compression scheme used on the image data	M	**1** for uncompressed data **5** for LZW compression **32773** for PackBits compression of greyscale and palette-colour data	N/A
Copyright	33432	ASCII	1..*	Copyright notice	O	-	N/A

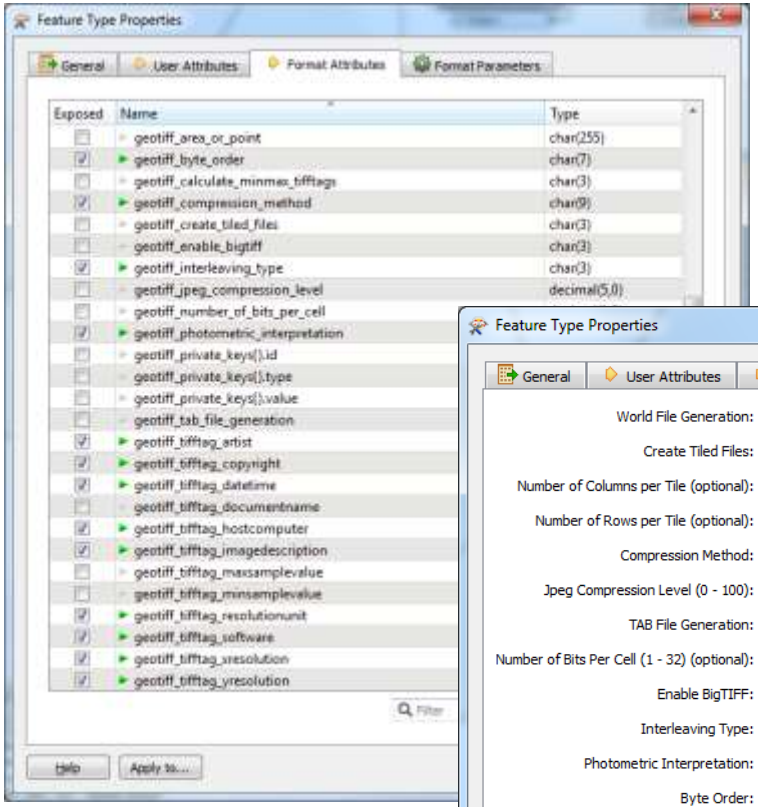
- **TIFF specifications**
  - http://www.remotesensing.org/geotiff/spec/geotiffhome.html
  - http://www.digitalpreservation.gov/formats/content/tiff_tags.shtml

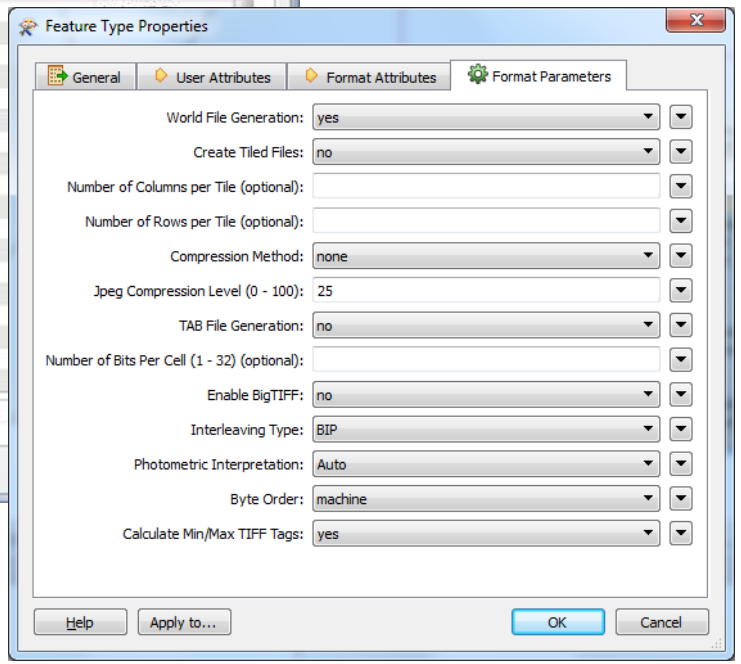
❖Raster Images TIFF Tags with FME

- It is possible to obtain and define TIFF tags with transformers and geoTIF writer









❖Raster Images TIFF Tags with FME

- It is possible to obtain and define TIFF tags with transformers and geoTIF writer

INSPIRE tags study for OI generated by FME 2015

INSPIRE specifications. Table 10. Baseline TIFF implementation profile and Mapping between TIFF tags and the associated object elements from the Orthoimagery GML Application Schema

INSPIRE classification of tags: The column Obligation informs if the tag is considered to be mandatory (M), conditional (C), optional (O) or inadequate (I).
Help with TIFF tags at: http://www.digitalpreservation.gov/formats/content/tiff_tags.shtml

Tag name	Code	Type	Card.	Description	Obligation	Restricted values	Mapping to GML elements (including restrictions)	Obligation	FME tag name	Ok	Comments
Artist	315	ASCII	1	Person who created the image	O	-	N/A	O	geotiff_tifftag_artist	ok	
BitsPerSample	258	Short	SamplesPerPixel	Number of bits per component	M	1 for bi-level images For imagery, constrained to 8 or 16 bits-per-pixel-per-band (e.g. 8 8 8 or 16 16 16 for RGB images). For other gridded data, 8, 16 and 32 bits-per-pixel-per-band	For each band *i*, rangeType.field[*i*].constraint.interval = "0 2^*BitsPerSample[i]*-1"	M	geotiff_number_of_bits_per_cell	ok	Editable in writer options, or automatic detection.
CellLength	265	Short	1	The length of the dithering or halftoning matrix used to create a dithered or halftoned bilevel file.	I	This field should be never used	N/A	I			
CellWidth	264	Short	1	The width of the dithering or halftoning matrix used to create a dithered or halftoned bilevel file.	I	This field should be never used	N/A	I			
ColorMap	320	Short	3*(2**BitsPerSample)	A colour map for palette colour images	C	Only for palette colour images	N/A	C			no tested
Compression	259	Short	1	Compression scheme used on the image data	M	1 for uncompressed data 5 for LZW compression 32773 for PackBits compression of greyscale and palette-colour data	N/A	M	geotiff_compression_method	ok	Editable in writer options, or automatic 'uncompressed'.
Copyright	33432	ASCII	1.. *	Copyright notice	O	-	N/A	O	geotiff_tifftag_copyright	ok	
DateTime	306	ASCII	20	Date and time of image creation	O	The Gregorian calendar should be used as a reference system for date values, and the Universal Time Coordinated (UTC) as a reference system for time values (local time is not recommended because offset from UTC can not be expressed in TIFF).	N/A NOTE the field DateTime should not be confused with the properties *phenomenonTime* and *beginLifespanVersion* that report other types of temporal information.	O	geotiff_tifftag_datetime	ok	
					C	Only when extra samples are present 1 for 4-bands RGB images with alpha channel	N/A	C			no tested
					O	1 (default)	N/A	O	geotiff_byte_order	¿?	Editable in writer options. Tag no checked.
					I	This field should be never used	N/A	I			

Summary of TIFF tags reproduced by FME 2015

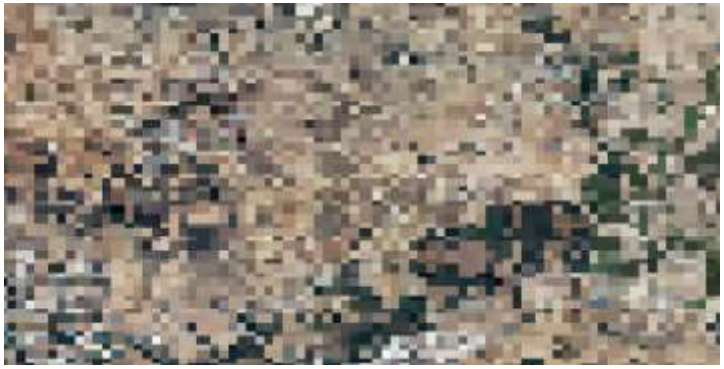
Obligation	Tags	Tested	Ok
Mandatory	12	12	12
Conditional	9	3	3
Optional	12	9	9
Inadequate	9	-	-
total:	42	24	24

❖Raster Images TIFF Tags with FME

- FME **collapses** converting original big raster files (ECW 1Gb, 500km2, GSD 25cm) to geoTIIF/BigTIFF
- → Resample original files to get practical solution in the exercise (GSD 1km)

TIFF tags (done by **FME2015**, readed by **AsTIFFtag viewer**). In blue tags independent from image resolution, some of them with same value than INSPIRE GML file. In red tags dependent on image resolution with different values than INSPIRE GML file.

```
SubFileType (1 Long): Zero
ImageWidth (1 Short): 315                    ← real values of original images are included in the GML file <domainSet> (114960)
ImageLength (1 Short): 237                   ← real values of original images are included in the GML file <domainSet> (75320)
BitsPerSample (3 Short): 8, 8, 8
Compression (1 Short): Uncompressed
Photometric (1 Short): RGB
ImageDescription (46 ASCII): Example PNOA image for INSPIRE transformation...     ← same than GML & metadata
StripOffsets (2 Long): 1230, 122190
Orientation (1 Short): TopLeft                                                    ← same than GML <coverageFunction>
SamplesPerPixel (1 Short): 3                                                      ← same than GML <recordType>
RowsPerStrip (1 Short): 128
StripByteCounts (2 Long): 120960, 103005
MinSampleValue (3 Short): 0, 0, 0                                                 ← same than GML <recordType>
MaxSampleValue (3 Short): 255, 255, 255                                           ← same than GML <recordType>
XResolution (1 Rational): 4,41377051277407E-5     ← real values of original images are included in the GML file <offsetVector> (1/25)
YResolution (1 Rational): 6,73683826037143E-5     ← real values of original images are included in the GML file <offsetVector> (1/25)
PlanarConfig (1 Short): Contig
ResolutionUnit (1 Short): Centimeter
Software (9 ASCII): FME 2015
DateTime (20 ASCII): 2015:03:09 00:00:00
Artist (71 ASCII): Instituto Geográfico Nacional - National Geog...
HostComputer (4 ASCII): N/A
SampleFormat (3 Short): 1, 1, 1
Copyright (14 ASCII): (C) IGN Spain
33550 (3 Double):
33922 (6 Double):
34735 (88 Short): 1, 1, 0, 21, 1024, 0, 1, 1, 1025, 0, 1, 1,...
34736 (7 Double):
34737 (94 ASCII): Lambert Azimuthal Equal Area (ETRS89-LAEA)|ET...
42112 (239 ASCII): <GDALMetadata>  <Item name="DESCRIPTION" sam...
```



- Conclusions

❖Conclusions

- **Open issues → steps forward**
  - Manage **GML+image** does not seem the best/smarter better through a **webservices**
    - **File formats** (only tiff, jpeg2000) proposal to manage **internal tiled geoTIFF with jpeg compression**
    - Transform grid data into a **square Pan-European Grid**
    - Need of a software able to **edit tags automatically** big raster data
  - Webservices must ensure CRS, image tags and **accuracy of data**
    - **For visualization: WMTS** able to read/visualize directly internal geoTIFF tiles (without intermediate re-sampling/compression/tilling)
    - **For download:**
      - **GML: WFS**
      - **Images: WCS** able to read/serve directly internal geoTIFF tiles (without intermediate re-sampling/compression/tilling)
  - Adoption of **EVRS** reference system implies recalculate heights
  - **Conceptual redundancy** between INSPIRE GML, ISO-OGC Coverages and Metadata

Instituto Geográfico Nacional

Thanks for your attention

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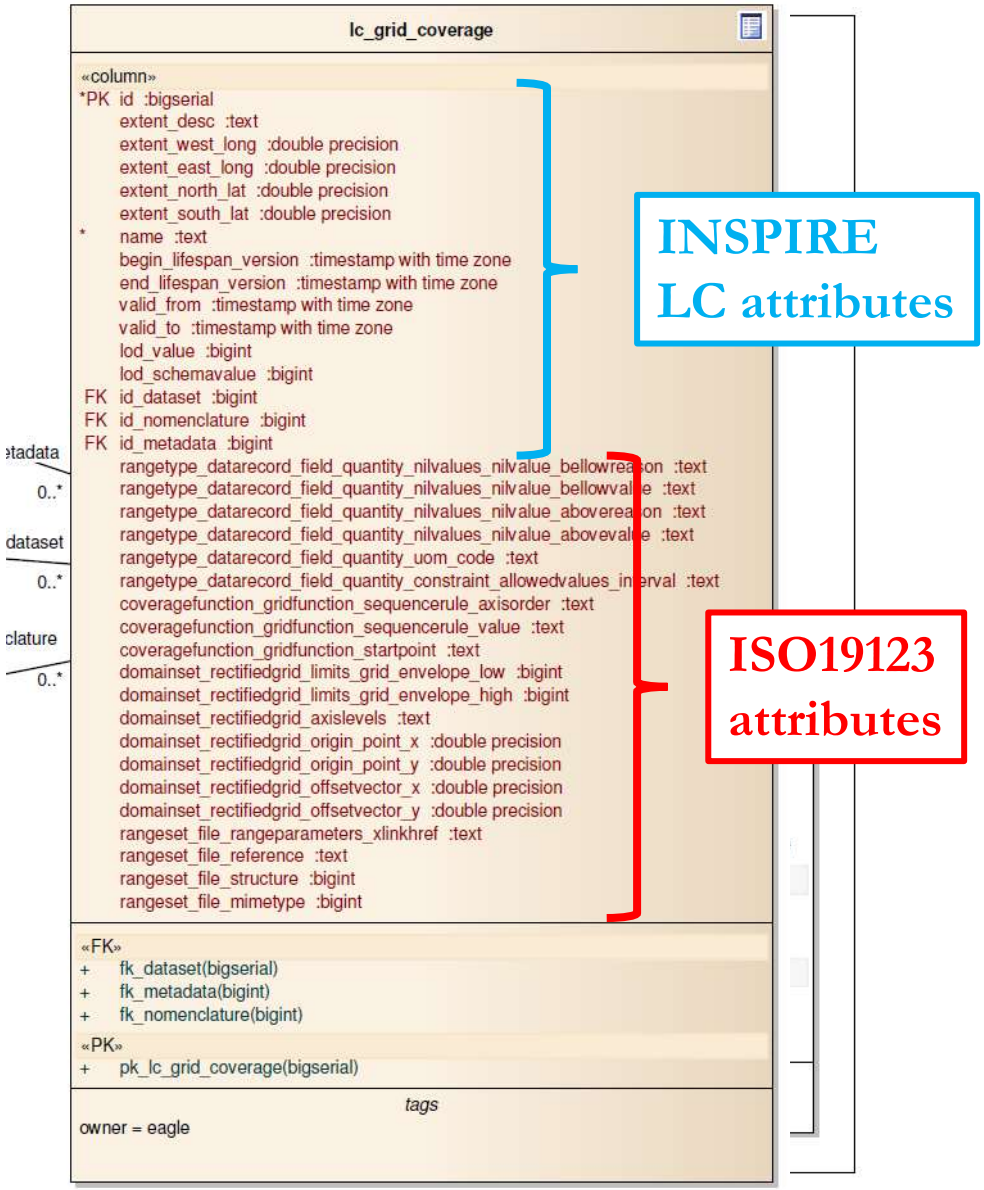
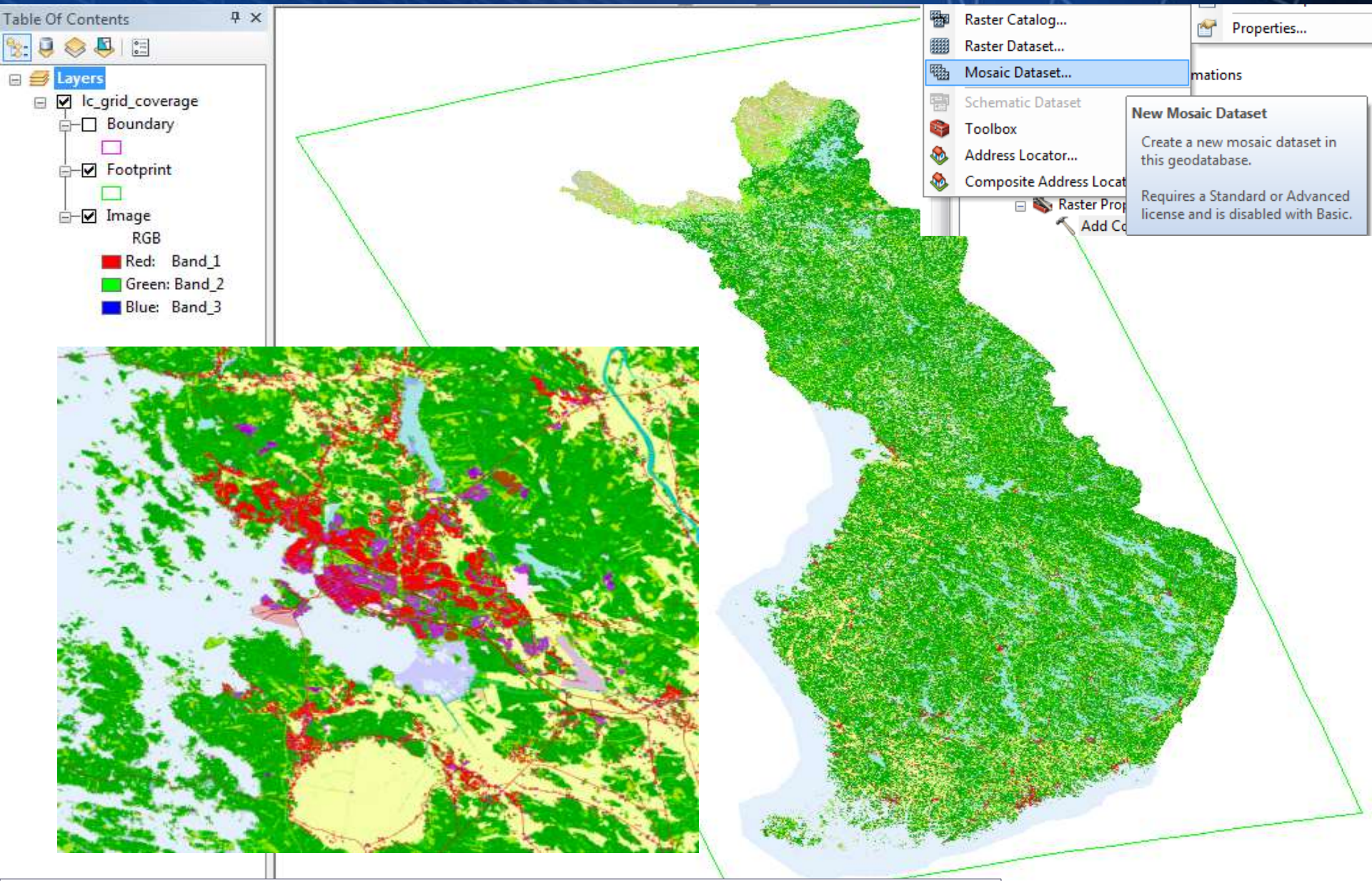
❖INSPIRE raster datasets with ESRI

- **EAGLE**: group of experts working for INSPIRE transformation of **LC/LU** (related with European Environment Agency)
- EAGLE results:
  - Vector GML for CORINE Land Cover and Urban Atlas
  - Vector/raster database for LC/LU data in **ERSI** and **PostGIS**
- INSPIRE LC and LU includes raster features



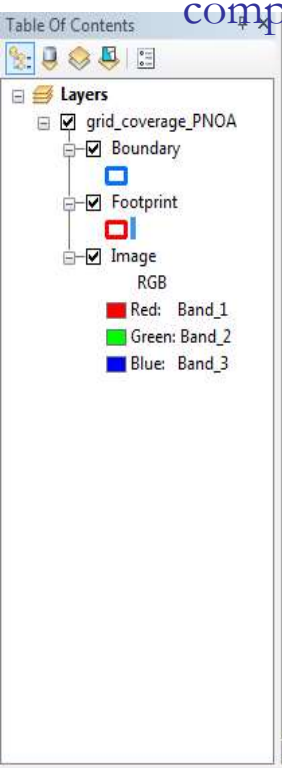
❖INSPIRE raster datasets with ESRI



Finnish national LC dataset (GSD 20m) © SYKE (partly © Metla, Mavi, LIVI, VRK, MML Maastotietokanta 05/2012)

❖INSPIRE raster datasets with ESRI

- A ESRI Mosaic dataset allows to deal with each **individualized mosaicked image (=OrthoimageCoverage)** and **globally raster dataset (=OrthoimageAggregation)**, and complete the attribute table with **ISO/INSPIRE attributes**



Table

grid_coverage_PNOA\Footprint

OBJECTID *	Raster	Name	MinPS *	MaxPS *	LowPS *	HighPS *	Category	Tag	GroupName	ProductName
1	<Raster>	PNOA_MA_OF_ETRS89_HU30_h50_0629	0	1484.375	148.4375	148.4375	Primary	Dataset		
2	<Raster>	PNOA_MA_OF_ETRS89_HU30_h50_0630					Primary	Dataset		

2 records in the table

General | Defaults | Key Metadata | XY Co
Raster Coordinate System | Fields | Indexes | Editor Tracking | Feature

Field Name	Data Type
coveragefunction_gridfunction_sequencerule_value	Text
coveragefunction_gridfunction_startpoint	Text
domainset_rectifiedgrid_limits_gridenvelope_low	Long Integer
domainset_rectifiedgrid_limits_gridenvelope_high	Long Integer
domainset_rectifiedgrid_axislevels	Text
domainset_rectifiedgrid_origin_point_x	Double
domainset_rectifiedgrid_origin_point_y	Double
domainset_rectifiedgrid_offsetvector_x	Double
domainset_rectifiedgrid_offsetvector_y	Double
rangeset_file_rangeparameters_xlinkhref	Text
rangeset_file_reference	Text
rangeset_file_structure	Text
rangeset_file_mimetype	Text