Coverages in INSPIRE

Making things Simpler
Coverage Features in INSPIRE

- **EnergyResources**: RenewableAndWastePotentialCoverage.
- **Natural Risk Zones**: ExposedElementCoverage, HazardCoverage, ObservedEventCoverage, RiskCoverage.
- **Elevation**: ElevationGridCoverage.
- **Land Cover**: LandCoverGridCoverage.
- **Land Use**: ExistingLandUseGrid.
- **Orthoimagery**: OrthoimageCoverage.
- **Soil**: SoilThemeCoverage, SoilThemeDescriptiveCoverage.
- **Geology (Hydrogeology)**: HydrogeologicalSurface.
What is a Coverage?

• Historically:
  • Satellite images
  • Orthoimagery

  *Could be subsumed as „Rastered Images from on high“*

• Increasingly for various types of gridded data
• Often utilizes image formats (i.e. TIF, JPG with geospatial additions), but also supports numeric values
What is a Coverage?

- Coverage is described by:
  - The grid for which values will be provided (the Domain)
  - Description of the values being provided
  - The values of each grid cell (the Range)
  - Additional Metadata
What is a Coverage Domain?

• The Domain (Grid) is defined by:
  • The Origin (bottom left corner)
  • The Offsets (length and width of the individual grid cells)
  • Limit (number of cells; length and width of the entire grid)
What is a Coverage Domain?

Origin:

Offsets:

Limits:
N: 10
E: 15
What is a Coverage Domain?

Coverage Domain

Origin: Coordinate Pair
Offsets: 1 Vector per Dimension
Limits: one Integer per Dimension

1 Coordinate Pair
2 Vectors
2 Integers

→ ~25M Polygons!

Example: 1km Eurostat grid

Very compact Domain
Handfull of Bytes vs. Many many MB

4471 Cells on X
558 Cells on Y
→ ~25M Polygons!
What is a Coverage Domain?

- Coverage Domain can have many dimensions. Examples:
  - Time: daily satellite image, yearly land cover result
  - Other stratification, examples from demography:
    - Age
    - Gender
    - Education
  - Under CIS 1.1, not even a requirement to have Lat/Long (could refer to Administrative Units)
What is a Coverage Range?
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Range Formats:

• GeoTIFF or JPEG: formally graphics format, compressed binary format
• NetCDF, GRIB: useful as much tooling available, especially in the scientific community
• XML, JSON, RDF: compact formats providing direct access to range values

Many different result formats
What is a Coverage Range Type?

Description of the values provided in the Range. Depending on the data to be provided, this could be:

- RGB values for image formats
- Codelist Categories, i.e. Land Cover Types
- Numeric Values, i.e. Population
What is Coverage Metadata

Coverage Metadata

• WCS gives the user full control over the metadata
• Currently an issue in INSPIRE as not properly defined

Coverage Function

• Sequence in which the Range values are provided (i.e. Axis order)
What can we do with a Coverage?

WMS: you all know that!

WCS:

• Access Coverage information separately from Values
  • **DescribeCoverage** provides Domain, Range Type, Metadata
  • **GetCoverage** provides values
• All sorts of interesting subsetting
OGC Web Coverage Service (WCS)

- **WCS Core**: access to spatio-temporal coverages & subsets
  - Encoding on the fly
  - subset = trim

- **WCS Extensions**: optional functionality facets
  - from extraction up to flexible analytics

**Access the data you need, and ONLY the data you need!**

Large, growing implementation basis: rasdaman, GDAL, QGIS, Leaflet, OPeNDAP, MapServer, GeoServer, GMU, NASA WorldWind, EOx-Server; Pyxis, ERDAS, ArcGIS, ...
What can we do with a Coverage?

Web Coverage Processing Service (WCPS):

• Allows for server-side processing → only download the data you need,
• Combine data from multiple coverages

Access not the data you need, but ONLY the results you require!
What can we do with a Coverage?

WCPS coverage processing language

• Simple scripting language for creating and processing coverages

• Arithmetic and logical operators: and, or, not, xor, +, -, *, /, =, <, >, <=, >=, !=, overlay

• Function Calls
What can we do with a Coverage?

**WCPS Function Types**

**Metadata:**
- getMetaData
- setMetaData

**Administrative:**
- encodedCoverage
- store

**Coverage Scope:**
- trim
- slice
- extend
- clip

**Geo:**
- crsTransform
- scale

**Calculations:**
- reduce
- trigonometric
- exponential
- numericScalar
- unaryArithmetic
- boolean

http://service.datacove.eu/WCPS
What can we do with a Coverage?

WCPS Function Calls (exemplary)

<table>
<thead>
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<th>Reduce</th>
<th>Exponential</th>
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<tbody>
<tr>
<td>• add</td>
<td>• exp</td>
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<tr>
<td>• avg</td>
<td>• ln, log</td>
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<td>• count</td>
<td>Trigonometric</td>
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<tr>
<td>• all</td>
<td>• sin, cos, tan</td>
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<tr>
<td>• some</td>
<td>• arccsin, arccos, arctan</td>
</tr>
<tr>
<td></td>
<td>• sinh, cosh</td>
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Issues in INSPIRE

• INSPIRE coverage extensions
  • Additional information to OGC coverages shall be provided as Coverage Metadata (not extending the coverage class).

• Identifier and scope issues
  • What exactly is a dataset?
  • Do subsets require identifiers?

• Coverage aggregation

• Orthoimage mosaic elements
Coverage Metadata Model
...But That’s Not What You Want to See

- Let users remain in comfort zone of well-known tools
  - Map navigation: OpenLayers, Leaflet, ...
  - Virtual globe: NASA WorldWind, Cesium, ...
  - Web GIS: MapServer, QGIS, ArcGIS, ...
  - Analysis: GDAL, R, python (OWSLIB, Jupyter notebooks), ...
- ...via W*S
  as standard client/server APIs

[screenshots: rasdaman-based portals]
rasdaman Datacubes on Virtual Globes
ECMWF: River Discharge
MEA: Land Surface Temperature, Cloudfree
MEA: Daily Hydro Estimator
NCI Australia: Landsat8

WCS service endpoint: http://rasdaman.nci.org.au/rasdaman/ows

Available coverages

Footprint of geo-referenced coverages

Coverage Extent: lat_min=-26.47359, lon_min=141.14454, lat_max=-25.51725, lon_max=142.07660

[rasdaman backend]
PlanetServer
Coverages - Advantages

• More Compact encoding
  • Domain: only description, not polygons
  • Range: compact encoding
• Various standardized result types
• Tools for processing & visualization
• Selective data access (subsetting)
• WCPS – server side processing
Thanks for your attention!

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A revised model for INSPIRE coverages
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