

# Methodological Guidelines for Publishing Linked Data

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## Main References



Wood, David (Ed) Linking Government Data - 2011  
Methodological Guidelines for Publishing Government Linked Data  
Boris Villazón-Terrazas, Luis M. Vilches, Oscar Corcho, Asunción Gómez-Pérez



Best Practices for Publishing Linked Data

W3C Editor's Draft 31 August 2011

This version:

<http://www.w3.org/gld/bp/>

Latest editor's draft:

<http://www.w3.org/gld/bp/editor/>

Previous version:

<http://www.w3.org/gld/bp/20110831/>

Editor:

Bernadette Hyland, Michael Hausenblas

Boris Villazón-Terrazas, Sarven Capadisli

David Wood, Luis M. Vilches, Oscar Corcho

Best Practices for Publishing Linked Data  
W3C Editor's Draft – Government Linked Data Working Group  
Bernadette Hyland, Boris Villazón-Terrazas, Michael Hausenblas

<https://dvcs.w3.org/hg/gld/raw-file/default/bp/index.html>

Cookbook for Open Government Linked Data

Editor:

Bernadette Hyland, Michael Hausenblas, Boris Villazón-Terrazas, Sarven Capadisli

David Wood, Luis M. Vilches, Oscar Corcho

Cookbook for Open Government Linked Data

W3C Editor's Draft – Government Linked Data Working Group

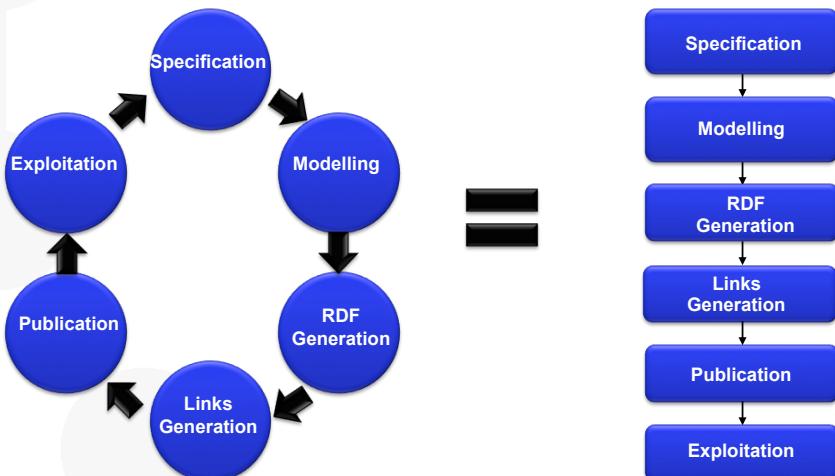
Bernadette Hyland, Boris Villazón-Terrazas, Sarven Capadisli

[http://www.w3.org/2011/gld/wiki/Linked\\_Data\\_Cookbook](http://www.w3.org/2011/gld/wiki/Linked_Data_Cookbook)



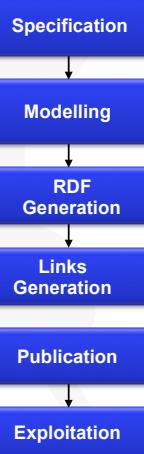
## Methodology

- The process of publishing Linked Data has an iterative incremental life cycle model



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## Methodology



### Specification

- Analysis of data sources
- URI design
- License definition

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## Specification

### Identification and analysis of the data sources

We have to distinguish

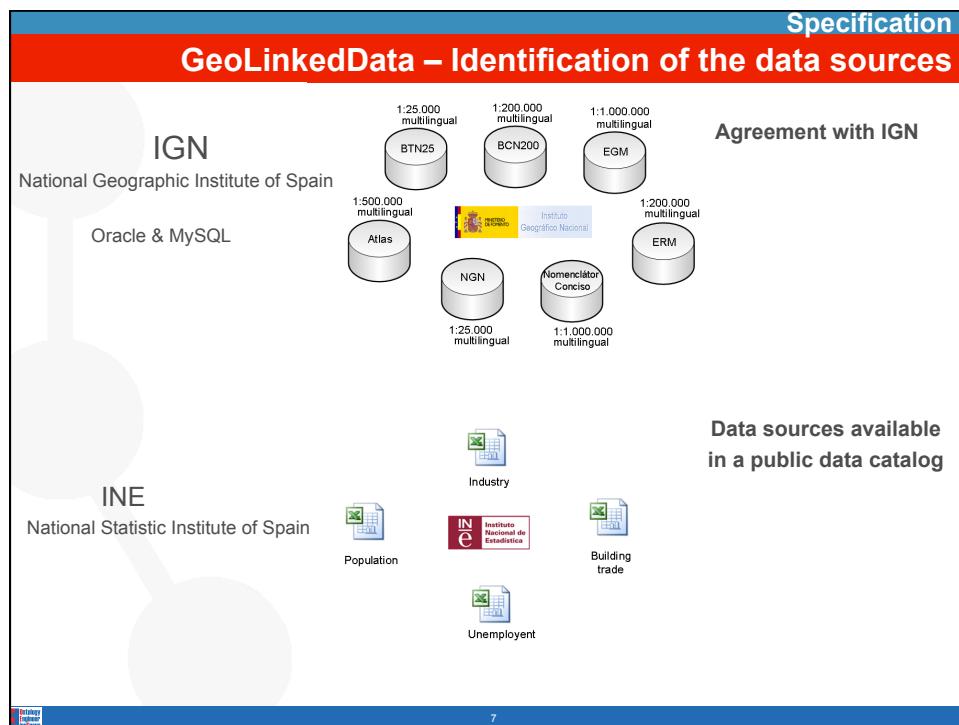
- Open and publish data that government agencies have not yet opened up and published
  - Task that may require contacting to specific government data owners to get access to their legacy data
- Reuse and leverage on data already opened up and published by government agencies
  - Task to look for these data in public government catalogs
    - Open Government Data
    - datacatalogs.org
    - Open Government Catalog
    - Open Data Euskadi, datos.gob.es

## Specification

### Identification and analysis of the data sources

After we have identified and selected the government data sources

- Search and compile all the available data and documentation about those resources
- Identify the schema of those resources including conceptual components and their relationships
- Identify the items in the domain, i.e., things whose properties and relations are described in the data sources



**Specification**  
**GeoLinkedData – Analysis of the data sources**

NOMBRE	ENTIDAD	CON/PROV	CODINE	XUTM	YUTM	HUSO	HOJA25	LongitudG	LatitudG	LongitudGMS	LatitudG
Abeyuela, Olivar de / Oli	Lugar/Paraje	0 02	02042	584300	246500	30	0967-3	-2,0351245814873	38,3620693572292	-02°02'06.44	38°21'43
Abeyuela, Rambla de	Corriente fluvial	0 04	04053	597560	152000	30	0974-4	-1,89618811907142	37,509177056304	-01°53'46.27	37°03'33
Abeyuela, Rambla de la	Corriente fluvial	1 46	46262	579190	123000	30	0638-2	-0,90285531710738	39,9374839997029	-00°54'10.27	39°56'14
Abeyuela, Rambla de la	Corriente fluvial	1 44	44002	578800	124000	30	0638-2	-0,901242388290964	39,9465700679236	-00°54'25.71	39°56'47
Abel, A	Población	0 27	27025	521500	336500	29	0003-3	-7,49293473672413	43,67078249186	-07°29'34.56	43°40'14
Abeladaira	Población	0 27	27039	522000	774030	29	0073-1	-7,50066276897865	43,1084031553505	-07°30'02.38	43°06'30
Abeladaira	Lugar/Paraje	0 27	27039	521550	774200	29	0073-1	-7,50615404547912	43,1100057447368	-07°30'22.15	43°06'36
Abelaedo	Lugar/Paraje	0 27	27005	548100	321300	29	0010-3	-7,167302692277051	43,5291689758955	-07°10'02.28	43°31'45
Abelaedo, Chao do	Llanura/Raso	0 27	27013	525500	330200	29	0009-1	-7,444800862332	43,613414717808	-07°26'41.28	43°36'48
Abelaedo, Monte do	Lugar/Paraje	0 27	27064	509000	341000	29	0002-4	-7,6470271512085	43,7132267731492	-07°38'49.29	43°42'47
Abelaedo, O	Población	0 27	27064	508500	340500	29	0002-4	-7,65333254552948	43,708799463333	-07°39'11.99	43°42'31
Abelaedo, Rego do	Corriente fluvial	0 27	27064	509000	340540	29	0002-4	-7,64712030731384	43,7090862344245	-07°38'49.63	43°42'32

Year

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Industrial	208580	22220	233607	271420	3064129	282620	301110				
Alicante	21980	22318	20875	20549	19838	19759	19638				
Almería	21980	21948	21948	21948	21948	21948	21948				
Albacete	19829	142507	140745	133016	123033	118652	111606				
Ávila	43551	45130	43970	43971	38795	36265	33947				
Badajoz	55585	73100	73100	73100	73100	73100	73100				
Barcelona	11455	11708	11434	10900	10611	10519	10211				
Castellón	13390	13390	13390	13390	13390	13390	13390				
Galicia	91026	93335	91254	88027	87024	86425	75561				
Girona	407395	477842	469102	444410	438294	417425	397050				
Jaén	26595	26595	26595	26595	26595	26595	26595				
Cáceres	26307	26454	26554	26539	24446	20595	23440				
León	33917	44937	44937	44937	44937	44937	44937				
Castilla-La Mancha	39811	40933	39950	37990	36861	36849	34017				
Castilla y León	47122	48555	42476	39749	37855	37214	34215				
Coruña	48979	50057	49302	47151	45495	43994	41964				
Guadalajara	14747	14620	14420	14242	14042	13842	13446				
Extremadura	14747	14620	14420	14242	14042	13842	13446				
Guipúzcoa	14747	14620	14420	14242	14042	13842	13446				
La Rioja	14747	14620	14420	14242	14042	13842	13446				
Province	13507	13735	12874	11825	10428	10120	9422				
Madrid	55000	55000	55000	55000	55000	55000	55000				
Malaga	26793	27463	27063	25407	24777	24270	22547				
Murcia	26793	27463	27063	25407	24777	24270	22547				
Palencia	26793	27463	27063	25407	24777	24270	22547				
Salamanca	36657	37368	36962	35933	34875	33157	32444				
León	35984	34012	33963	32399	31984	30665	30256				
Ourense	24601	26203	24601	23780	23122	22473	22396				
Portugal	117832	117832	117832	117832	117832	117832	117832				
Castilla-La Mancha	11832	116557	114647	108713	105282	96527	96527				
Murcia	95836	100075	97374	90636	85110	82487	75973				
Extremadura	103098	103098	103098	103098	103098	103098	103098				
Guadalajara	23394	29711	28520	22943	22452	21718	21560				

Industry Production Index

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Industrial	208580	22220	233607	271420	3064129	282620	301110				
Industry	407395	477842	469102	444410	438294	417425	397050				
Population	55000	55000	55000	55000	55000	55000	55000				
Building trade	26595	26595	26595	26595	26595	26595	26595				
Unemployment	39811	40933	39950	37990	36861	36849	34017				

Year

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Total Industrial	208580	22220	233607	271420	3064129	282620	301110				
Industry	407395	477842	469102	444410	438294	417425	397050				
Population	55000	55000	55000	55000	55000	55000	55000				
Building trade	26595	26595	26595	26595	26595	26595	26595				
Unemployment	39811	40933	39950	37990	36861	36849	34017				

**Specification**  
**URI Design**

- Use meaningful URIs, instead of opaque URIs, when possible
- Separate TBox (ontology model) from ABox (instances) URIs.
  - Base URI  
http://datos.gob.es/  
http://salud.datos.gob.es/
  - TBox URIs  
http://datos.gob.es/ontology/{class|property}
  - ABox URIs  
http://datos.gob.es/resource/  
http://datos.gob.es/resource/province/Madrid

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**Specification**  
**GeoLinkedData - URI design**

- Base URI  
http://linkeddata.es/  
http://geo.linkeddata.es/
- TBox URIs  
http://geo.linkeddata.es/ontology/{concept|property}  
http://geo.linkeddata.es/ontology/Provincia
- ABox URIs  
http://geo.linkeddata.es/resource/{r. type}/{r. name}  
http://geo.linkeddata.es/resource/Provincia/Madrid

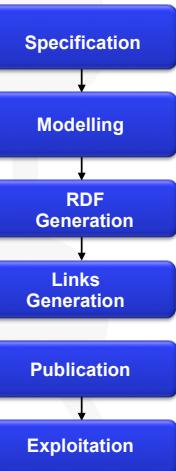
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## Specification Definition of the license

- Several possibilities
  - The UK Open Government License
  - Open Database License
  - Public Domain Dedication and License
  - Open Data Commons Attribution License
  - The Creative Commons Licenses
- It is also possible to reuse and apply an existing license of the government data sources.
- GeoLinkedData: We reuse the original license of the government data sources. IGN and INE data sources have their own license, similar to Attribution-Share Alike 2.5 Generic License



## Methodology



### Modelling

- Modelling of geospatial information
- Modelling of geometry
- Modelling of statistical information

## Modelling Ontology

- An ontology is an engineering artifact, which provides:
  - A set of terms
  - A set of explicit assumptions regarding the intended meaning of the terms.
    - Almost always including concepts and their classification
    - Almost always including properties between concepts
- Shared understanding of a domain of interest
- Ontologies expressed in OWL or RDF(S), both based on RDF



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## Modelling Reuse available vocabularies

Search for suitable vocabularies



are there suitable vocabularies?

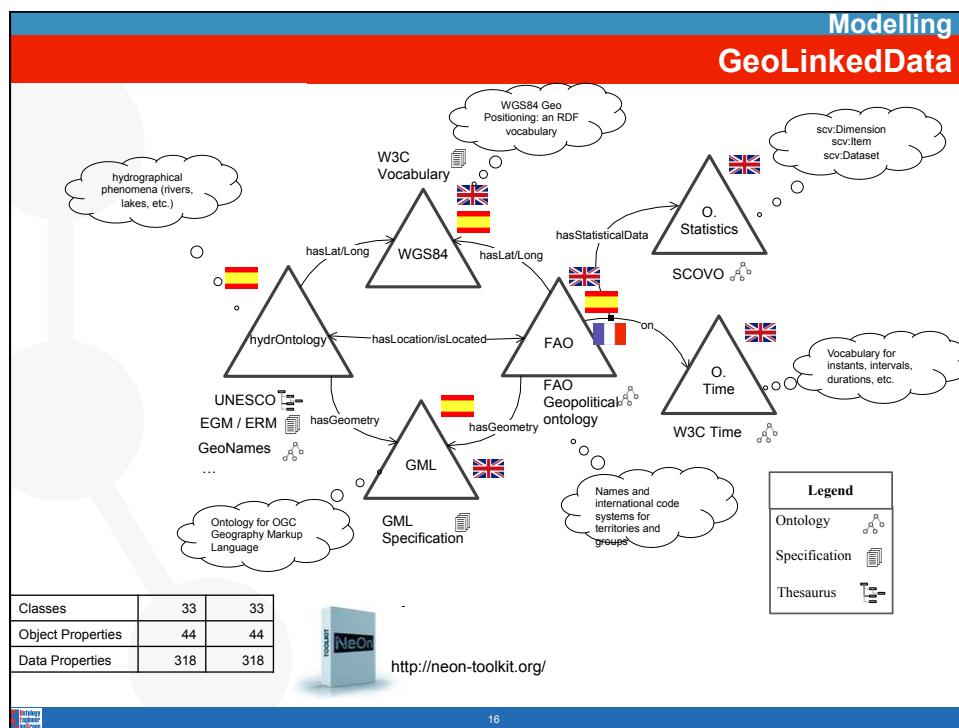
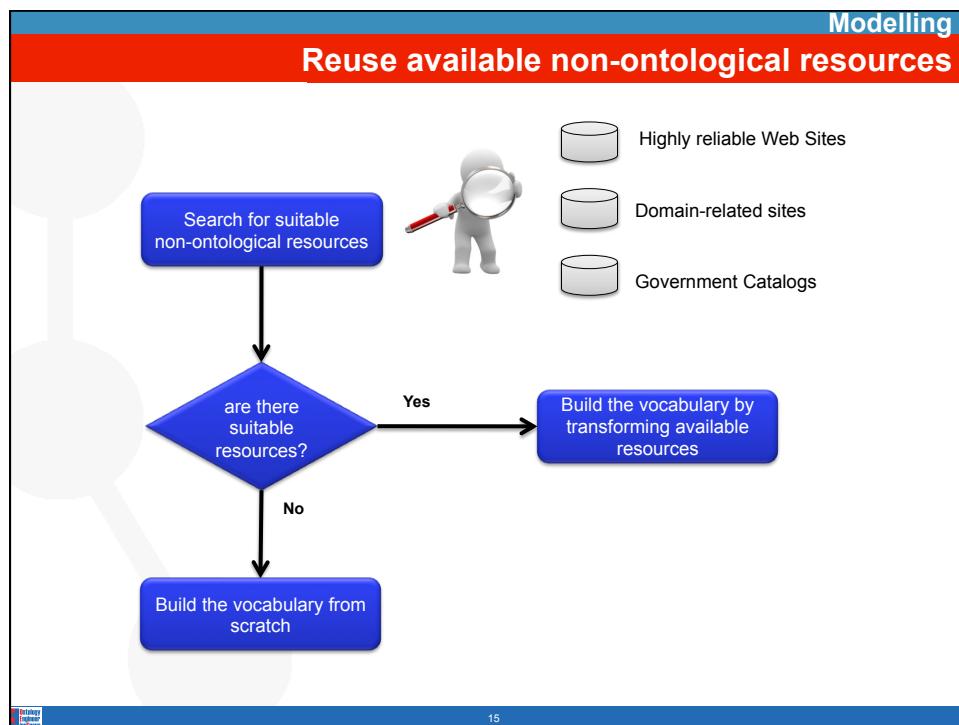
Yes

Build the vocabulary by reusing available vocabularies

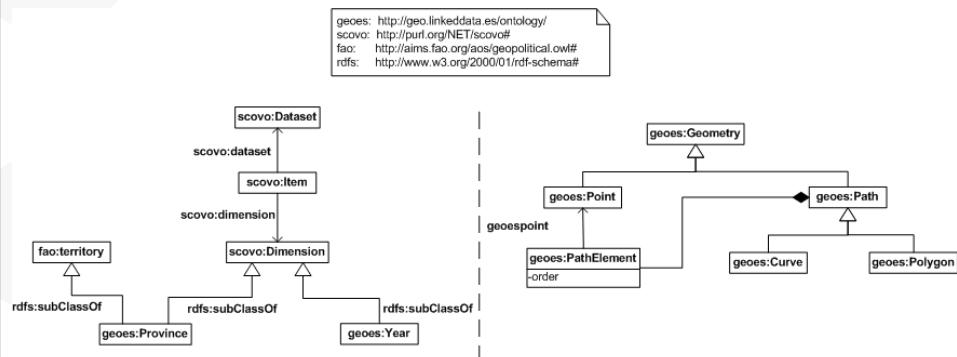
No

...

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## Modelling GeoLinkedData



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## Methodology

### Specification

### Modelling

### RDF Generation

### Links Generation

### Publication

### Exploitation

### RDF generation

- Geospatial RDF generation
- Statistical RDF generation

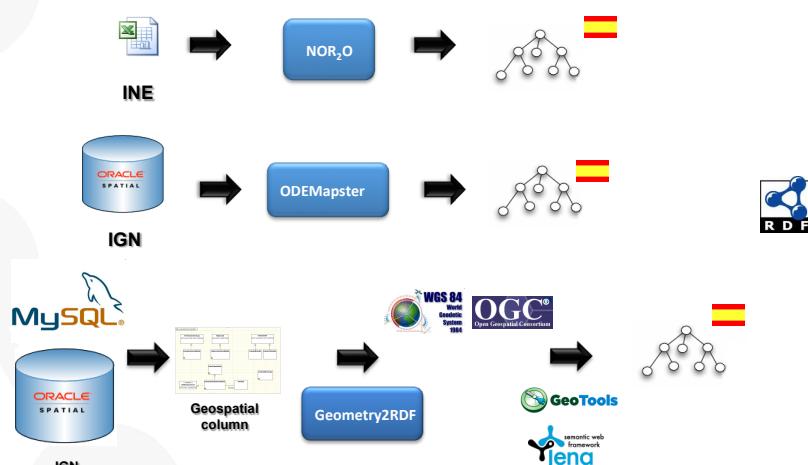
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## Generation Transformation

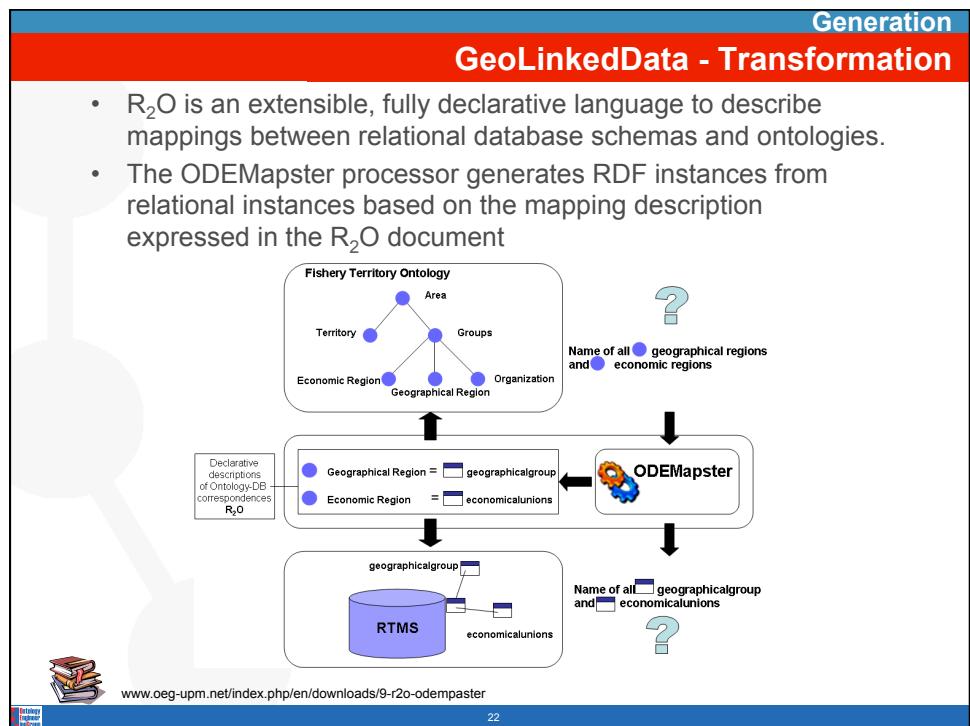
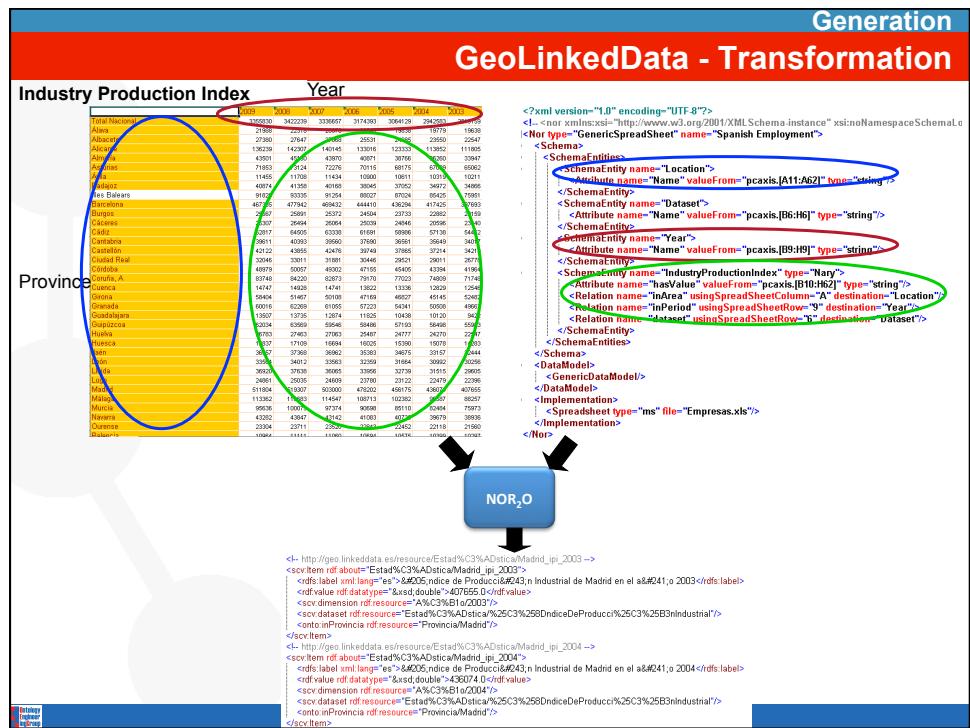
- Take the data sources selected in the specification activity and transform them to RDF according to the vocabulary created in the modelling activity
- Some tools
  - CSV and spreadsheets
    - Apache Any23, RDF Refine, XLWrap, RDF123, NOR<sub>2</sub>O
  - RDB
    - D2R Server, ODEMapster, Morph, W3C RDB2RDF WG – R2RML
  - XML
    - GRDDL, ReDeFer
- <http://www.w3.org/wiki/ConverterToRdf>

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## Generation GeoLinkedData - Transformation

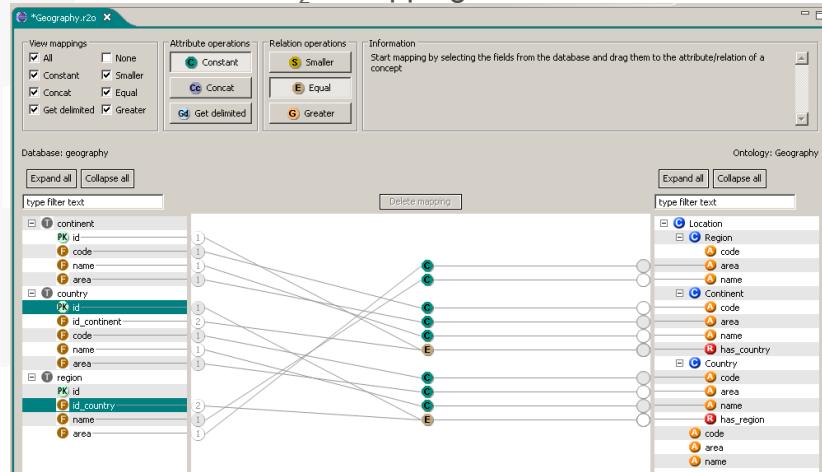


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Generation  
**GeoLinkedData - Transformation**

- #### • Creation of the R<sub>2</sub>O Mappings



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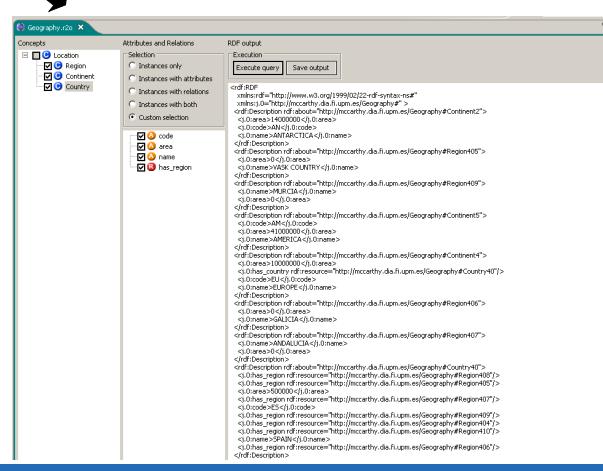
Generation  
**GeoLinkedData - Transformation**

```
<conceptmap-def name="http://mccarthy.dia.fi.upm.es/Geography#Region">
  <uri-as>
    <operation oper-id="concat">
      <arg-restriction on-param="string1">
        | <has-value>http://mccarthy.dia.fi.upm.es/Geography#Region</has-value>
      </arg-restriction>
      <arg-restriction on-param="string2">
        | <has-column>region.id</has-column>
      </arg-restriction>
    </operation>
  </uri-as>
  <described-by>
    <conceptmap-def>
```



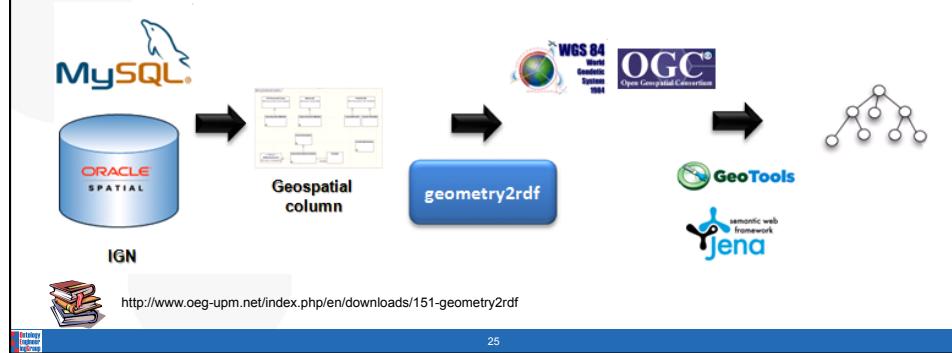
The screenshot shows the 'Geography Concept Map' interface. A black arrow points from the bottom left towards the 'Region' node in the tree view. The 'Region' node is highlighted with a blue selection bar and has a small orange checkmark icon next to it. The tree view lists nodes like 'Concepts', 'Attributes and Relations', and 'Regions'. Under 'Regions', there are three nodes: 'Region', 'Copper', and 'Copper' (with a small '2' indicating a duplicate). The 'Attributes and Relations' tab is visible at the top right.

## Excerpt of the R<sub>2</sub>O document



## Generation GeoLinkedData - Transformation

- Tool for generating RDF from geometrical information
- The geometry could be available in GML or WKT
- The RDF generated follows our Geometry Model



## Generation GeoLinkedData - Transformation

NOMBRE	GML(GEOMETRY)
Abengibre	(HUGECLOB)
Altoz	(HUGECLOB)
Abatana	(HUGECLOB)
Balsa de Ves	(HUGECLOB)
Ballesteros, El	(HUGECLOB)
Alborea	(HUGECLOB)
Alcadoco	(HUGECLOB)
Alcalá del Júcar	(HUGECLOB)

### Oracle STO UTIL package

```

SELECT TO_CHAR(SDO_UTIL.TO_GML311GEOMETRY(geometry))
      AS Gml311Geometry
  FROM "BCN200"."BCN200_0301L_RIO" c
 WHERE c.Etiqueta='Arroyo'
```

```

<?xml version="1.0" encoding="UTF-8"?>
<gml:Polygon srsName="SDO:8223" xmlns:gml="http://www.opengis.net/gml">
  <gml:outerBoundaryIs><gml:LinearRing><gml:coordinates decimal="," cs="" ts="">-1.48374108,39.23127677,-1.48404
  -1.4840765,39.22531695,-1.48544493,39.2231538,-1.4858725,39.22212319,-1.48608465,39.22141415,-1.4860584
  -1.48421126,39.21319056,-1.48390698,39.21064575,-1.48429166,39.2094524,-1.48529268,39.20490629,-1.492505
  -1.49590016,39.2038363,-1.49905691,39.20405732,-1.50256876,39.20446292,-1.50338941,39.20453654,-1.50483
  -1.51378498,39.2047147,-1.51398161,39.20472622,-1.5171434,39.20471246,-1.51894734,39.20373528,-1.5196271
  -1.52344981,39.20108038,-1.52699007,39.19901681,0,-1.5284903,39.19815278,-1.53151867,39.19619073,0,-1.5320861
  -1.5329951,39.19479473,-1.53398659,39.19603246,0,-1.53637021,39.19526414,-1.53807317,39.19544615,0,-1.536914
  -1.53953498,39.19602121,-1.54099994,39.19629185,-1.54110394,39.19630216,-1.54231647,39.19646151,0,-1.54461
  -1.54957924,39.19633592,-1.55131402,39.1964386,-1.55382202,39.19666799,-1.55798654,39.19690882,0,-1.559800
  -1.56633376,39.19750743,0,-1.5703604,39.19766603,0,-1.57231502,39.1977011,0,-1.57276711,39.19790204,0,-1.573636
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# Generation

# GeoLinkedData - Transformation

```

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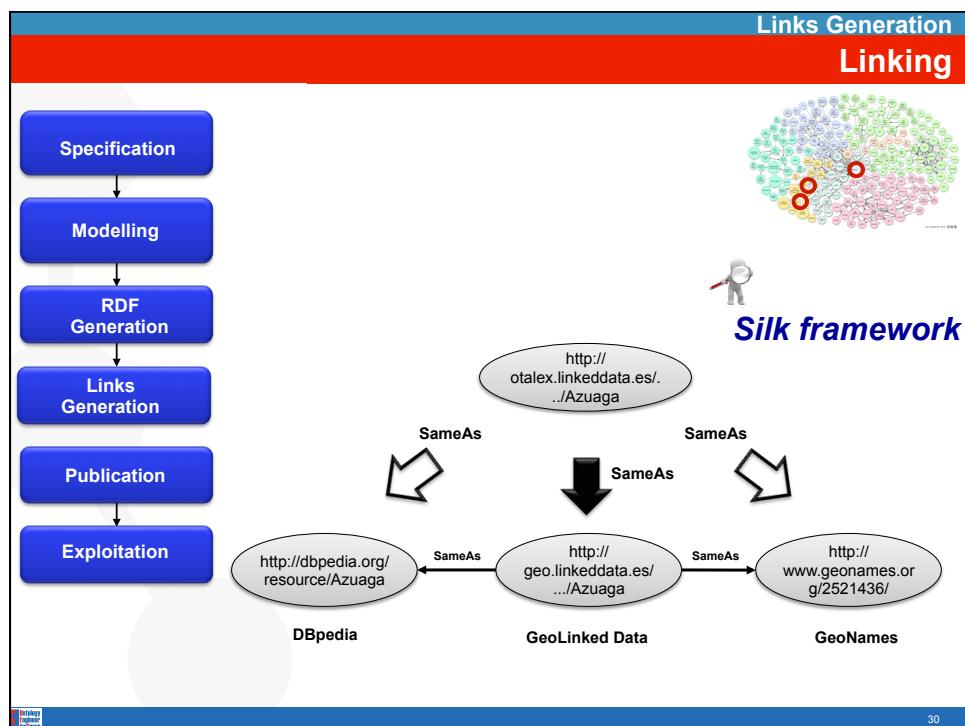
# Generation Data Cleansing

- To find possible errors, identified by Hogan et al.
    - http-level issues, such as accessibility and derefencability, e.g., HTTP URLs return 40x/50x errors
    - reasoning issues such as namespace without vocabulary, e.g., *rss:item* term invented
    - malformed/incompatible datatypes, e.g., “true” as xsd:int
  - To fix the identified errors

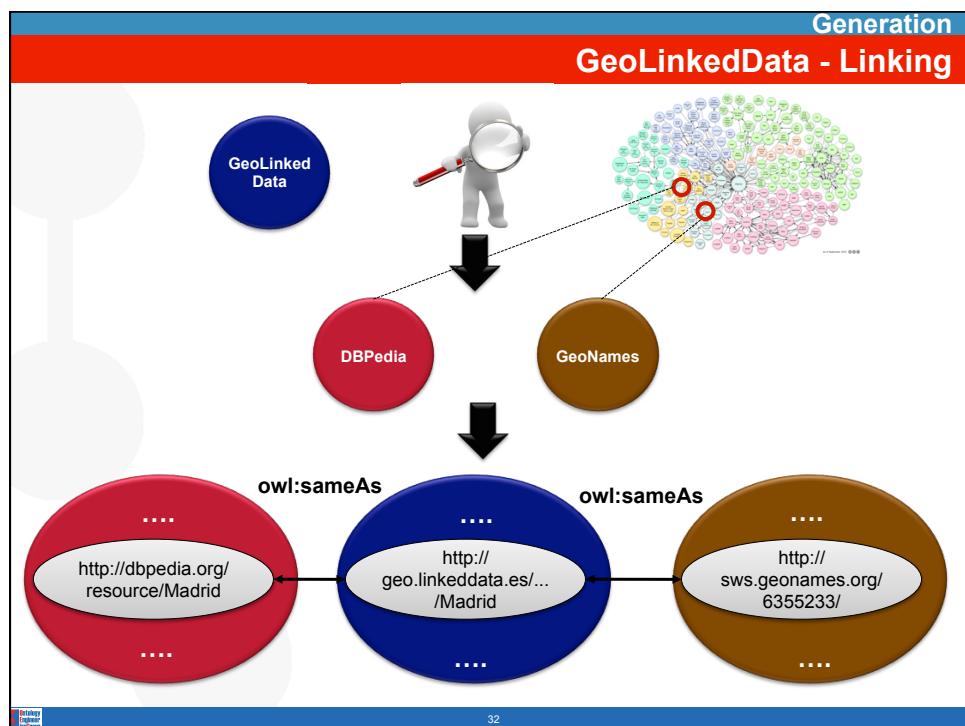
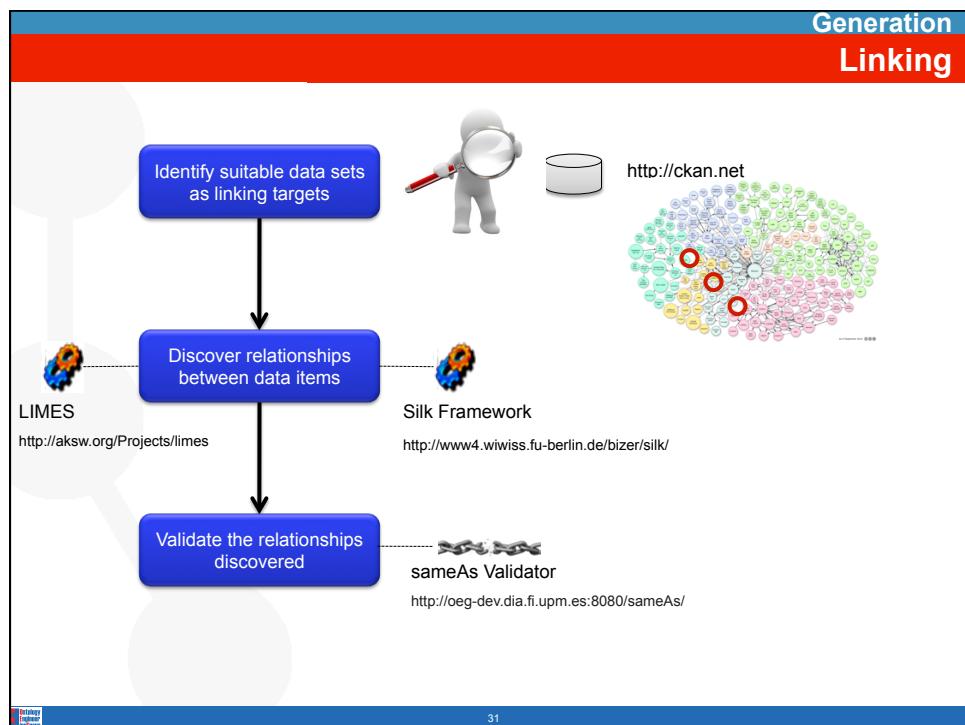
## Generation GeoLinkedData – Data Cleansing

- Errors
  - Some resources, with the same name, were mixed. For example, Granada municipality belongs to Granada province, and La Granada municipality belongs to Barcelona Province.
  - Autonomous communities that only have one province, e.g., Murcia Region, missed some municipalities, but their corresponding provinces, e.g., Murcia Province, have the correct number of municipalities.
  - Some hydrographical resources missed some parts of their geometrical information. We found errors in the original data sources thanks to transformation.

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Generation

# GeoLinkedData - Linking

Are both resources equivalent?			
Yes: <input checked="" type="radio"/>	No: <input type="radio"/>	N/A: <input type="radio"/>	<input type="button" value="Submit"/>

[http://dbpedia.org/resource/Province\\_of\\_M%C3%A1laga](http://dbpedia.org/resource/Province_of_M%C3%A1laga)
<http://geo.linkeddata.es/resource/ProvinciaM%C3%A1laga>

**About: Province of Málaga**

An Entity of Type [Provinces of Spain](#) from Named Graph: <http://dbpedia.org>, within Data Space: [dbpedia.org](#)

The Province of Málaga (Spanish Provincia de Málaga) is located on the southern coast of Spain, in the Autonomous Community of Andalusia. It is bordered by the Mediterranean Sea to the South, and by the provinces of Cádiz, Sevilla, Córdoba and Granada. Its area is 7,308 km<sup>2</sup>. Its population is 1,330,010 (2002), of whom two-fifths live in the capital Málaga, and its population density is 181.99/km<sup>2</sup>.

Property	Value
<a href="#">dbpedia-owl:abstract</a>	<ul style="list-style-type: none"> <li>Die Provinz Málaga (span. Provincia de Málaga) ist eine der si</li> <li>Die Provinz Málaga (span. Provincia de Málaga) is loca</li> <li>South, and by the provinces of Cádiz, Sevilla, Córdoba and Gr</li> <li>density is 181.99/km<sup>2</sup>. Its main industry and claim to fame is i</li> <li>Europe's second largest oil refinery. The beach, the most famous</li> <li>Concejal Ernesto Lechner, "Playa de la Caleta", is famous for the m</li> <li>Besides the capital, its main cities are Marbella, Vélez-Málag</li> <li>The population density surpasses both the Andalusia and Sp</li> <li>located in the interior. The prevailing climate is a warm Medite</li> <li>The Eastern coastal zone has a subtropical Mediterranean clir</li> <li>Central plateau has a semi-arid climate.</li> <li>La provincia de Málaga es una de las ocho provincias españ</li> <li>las provincias de Granada, al este y Cádiz, al oeste. Al norte</li> <li>101 municipios, 9 comarcas y 11 partidos judiciales. Su población</li> <li>España por población. Quedó constituida como provincia en li</li> <li>Sevilla. El código postal de los municipios de Málaga empieza</li> </ul>



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M  
A  
P  
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C

Málaga at <http://geo.linkeddata.es/resource/ProvinciaM%C3%A1laga>

**Property**      **Value**

geo:formaParteDe <<http://geo.linkeddata.es/resource/ComunidadAut%C3%B3noma/Andaluc%C3%ADa>>

geo:formaPadreDe <<http://geo.linkeddata.es/resource/Municipio%2361Isla>>

geo:lat <<http://geo.linkeddata.es/resource/Municipio%2361Isla#lat>>

geo:long <<http://geo.linkeddata.es/resource/Municipio%2361Isla#long>>

geo:lat <<http://geo.linkeddata.es/resource/MunicipioAlcauc%C3%ADn#lat>>

geo:long <<http://geo.linkeddata.es/resource/MunicipioAlcauc%C3%ADn#long>>

geo:lat <<http://geo.linkeddata.es/resource/MunicipioAlfaratej#lat>>

geo:long <<http://geo.linkeddata.es/resource/MunicipioAlfaratej#long>>

geo:lat <<http://geo.linkeddata.es/resource/MunicipioAlgarrobo#lat>>

geo:long <<http://geo.linkeddata.es/resource/MunicipioAlgarrobo#long>>

geo:lat <<http://geo.linkeddata.es/resource/MunicipioAlhaurin%20de%20la%20Gra>>

geo:long <<http://geo.linkeddata.es/resource/MunicipioAlhaurin%20de%20la%20Gra#long>>

geo:lat <<http://geo.linkeddata.es/resource/MunicipioAlm%C3%A1char#lat>>

geo:long <<http://geo.linkeddata.es/resource/MunicipioAlm%C3%A1char#long>>

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geo:long <<http://geo.linkeddata.es/resource/MunicipioAlmog%C3%ADa#long>>

geo:lat <<http://geo.linkeddata.es/resource/MunicipioAlzama#lat>>

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geo:lat <<http://geo.linkeddata.es/resource/MunicipioArchidona#lat>>

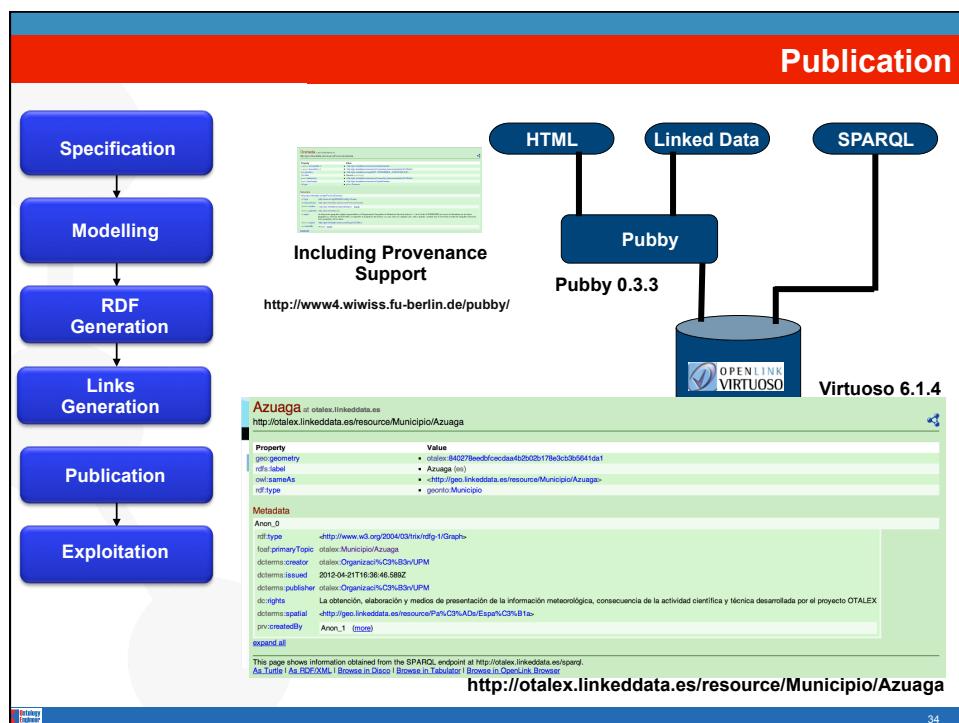
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geo:lat <<http://geo.linkeddata.es/resource/MunicipioBenah%C3%A1val#lat>>

geo:long <<http://geo.linkeddata.es/resource/MunicipioBenah%C3%A1val#long>>



**Publication**  
**Dataset Publication**

- Tools for storing RDF/SPARQL endpoint/Linked Data frontend
  - Virtuoso Universal Server, Jena, Sesame, 4Store, YARS, OWLIM, Talis Platform, Fuseki, Pubby

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**Publication**  
**Metadata Publication**

- VoID allows to express metadata about RDF datasets



Describing Linked Datasets with the VoID Vocabulary

W3C Interest Group Note 03 March 2011

This version:  
<http://www.w3.org/TR/2011/NOTE-void-20110303/>

Latest version:  
<http://www.w3.org/TR/void/>

Authors:  
Keith Alexander (Talis)  
Richard Cyganiak (DERI, National University of Ireland, Galway)  
Michael Heuer (DERI, National University of Ireland, Galway)  
Jun Zhao (University of Oxford)

- Open Provenance Model



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## Publication Dataset discovery

- Register the dataset into CKAN Registry
- Generate sitemap files for your dataset, by using sitemap4rdf
- Submit the sitemap location to Google and Sindice

**GeoLinkedData**

GeoLinkedData (es) is an open initiative whose aim is to enrich the Web of Data with Spanish geographic data. This initiative started off by publishing diverse information sources belonging to the National Geographic Institute of Spain. Such sources are made available as RDF (Resource Description Framework) knowledge bases according to the Linked Data principles. These data are interlinked with other knowledge bases belonging to the Linking Open Data Initiative.

**Resources**

Resource	Format	Actions
SPARQL endpoint	application/rdf+xml	
Download	application/rdf+ntriples	
RDF Schema	meta.rdf#schemas	
Link to an example data item within the dataset (RDF/XML)	example.rdf#xml	

**Additional Information**

Field	Value
links-dpedia	51
links-geonames-semantic-web	51
namespace	http://geo.linkeddata.es/resource/
triples	21664199

**Source** <http://geo.linkeddata.es/>  
**Author** Ontology Engineering Group, Facultad de Informática, Universidad Politécnica de Madrid  
**Maintainer** GeoLinkedData Team  
**Version** 2010-08  
**Tags**

- country-spain
- dataset-vocab
- formal-ds
- formal-rdf
- geodata
- geographic
- government
- iso
- no-inference-metadata
- no-provenance+metadata

[www.w3.org/wiki/TaskForces/CommunityProjects/LinkingOpenData/DataSets/CKANmetainformation](http://www.w3.org/wiki/TaskForces/CommunityProjects/LinkingOpenData/DataSets/CKANmetainformation)

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## Exploitation Visualisation

Specification

Modelling

RDF Generation

Links Generation

Publication

Exploitation

<http://oeg-dev.dia.fi.upm.es/projects/map4rdf/>



**map4rdf**

**map4rdf:**

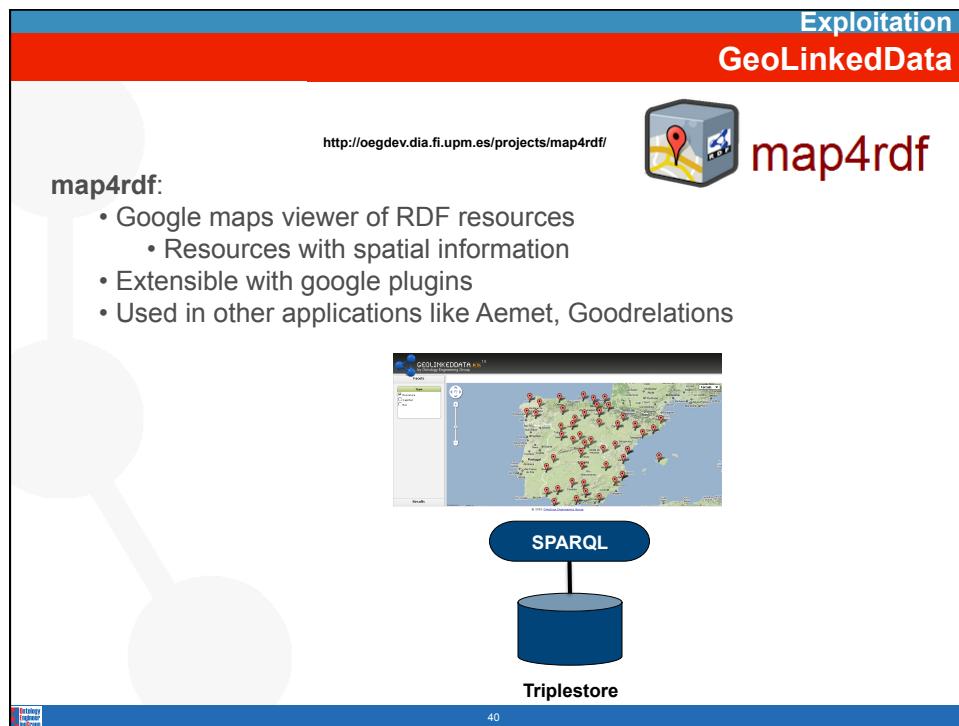
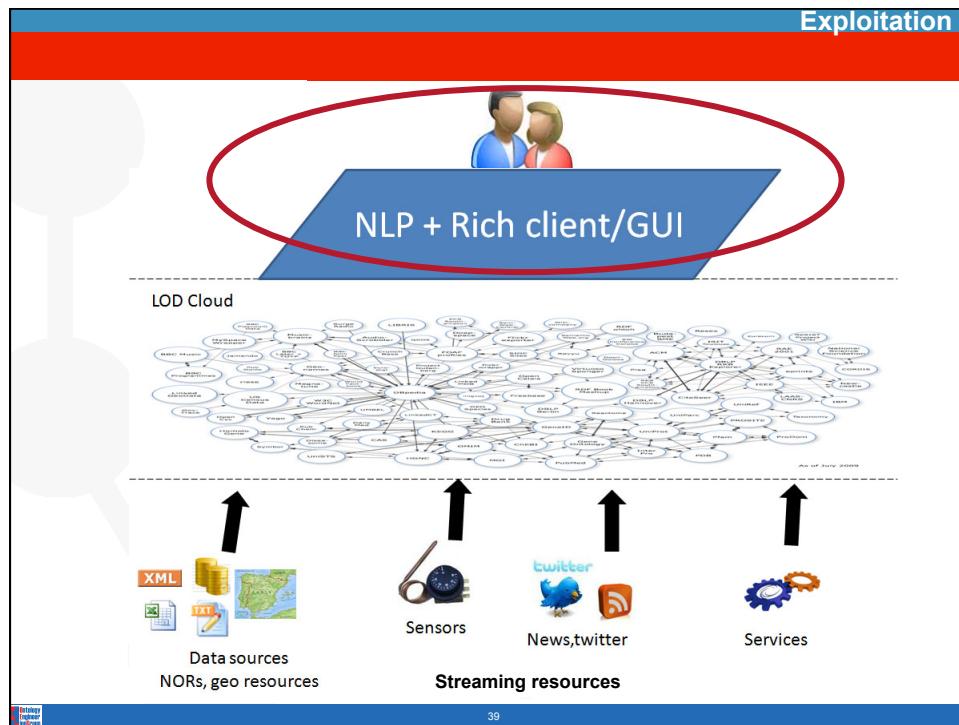
- Google maps viewer of RDF resources
  - Resources with spatial information
- Used in other applications like AEMET, Goodrelations, GeoLinked Data, El Viajero...

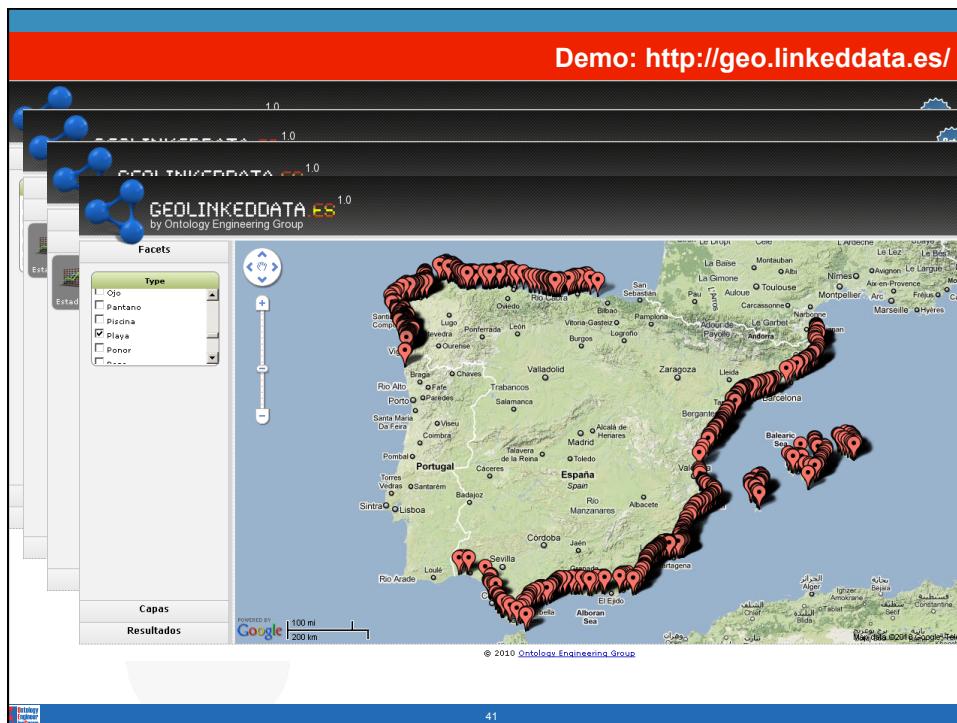


**SPARQL**



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## Methodological Guidelines for Publishing Linked Data

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 Phone: 34.91.3366605, Fax: 34.91.3524819

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