INSPIRE'D LINKED OPEN DATA TOWARDS WATER FRAMEWORK DIRECTIVE ACCOMPLISHMENT

ADDRESSING WATER MANAGEMENT SUSTAINABILITY AND INDUCING ECONOMIC GROWTH

Maria José Vale, *Rui Reis, Bruno M. Meneses, Marcelo Ribeiro, Raquel Saraiva*

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Summary

0. Water Framework Directive: main purpose
1. INSPIRE'D Linked Open Data
2. Addressing Water Management sustainability and inducing economic growth: Portuguese and EU Initiatives
3. Linked Open Data/ICT and the new paradigm of good Governance
4. INSPIRE'd Towards Good Governance- Water and land management efficiency - economic growth

WATER FRAMEWORK DIRECTIVE: MAIN PURPOSE

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0. Water Framework Directive: main purpose

- **Establishing a framework for water protection covering the EU territory.**
  - Economic growth
  - Preservation
  - Water Supply
    - Urban areas
    - Agriculture
    - ….
  - Drinking water
  - Cost/benefit

Water Stress - Land Use

1. INSPIRE'D LINKED OPEN DATA

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1. INSPIRE'D Linked Open Data

1.1 Definition: Open (government) Data and Open (government) Linked Data

Adapted from "The *5 Stars Model" of* Tim Berners-Lee

a. **Open Data**
- Information is available on the Web (any format) under an open license

b. **Linked Open Data:**
- Information is available as structured data (Non-proprietary formats)
- Use **URL** to name (identify) things
- Data is linked to other data to provide context
  - Publish and refer to other things using HTTP URI URI-based names so that IR can be looked up (interpreted,..)
  - Provide context useful information, using open standards such as RDF, SPARQL, etc.
- Enable linked Data Platforms

1. INSPIRE'D LINKED OPEN DATA

1.2 Benefits and Limitations

Benefits of *Linked Open Data (LOD):*

1. Discover new data of interest while consuming other information
2. Access to the data schema
3. Make the data discoverable
4. The value of your data is increased- big data
5. Cost/benefit

Limitations of *Linked Open Data (LOD):*

1. The value of your data is decreased- Entropy
2. Completeness in the context of good governance
3. Reduce the value of the data sets
4. Cost/benefit
5. Safety

Let's look to some examples/applications

2. ADDRESSING WATER MANAGEMENT SUSTAINABILITY AND INDUCING ECONOMIC GROWTH:

Portuguese and EU Initiatives

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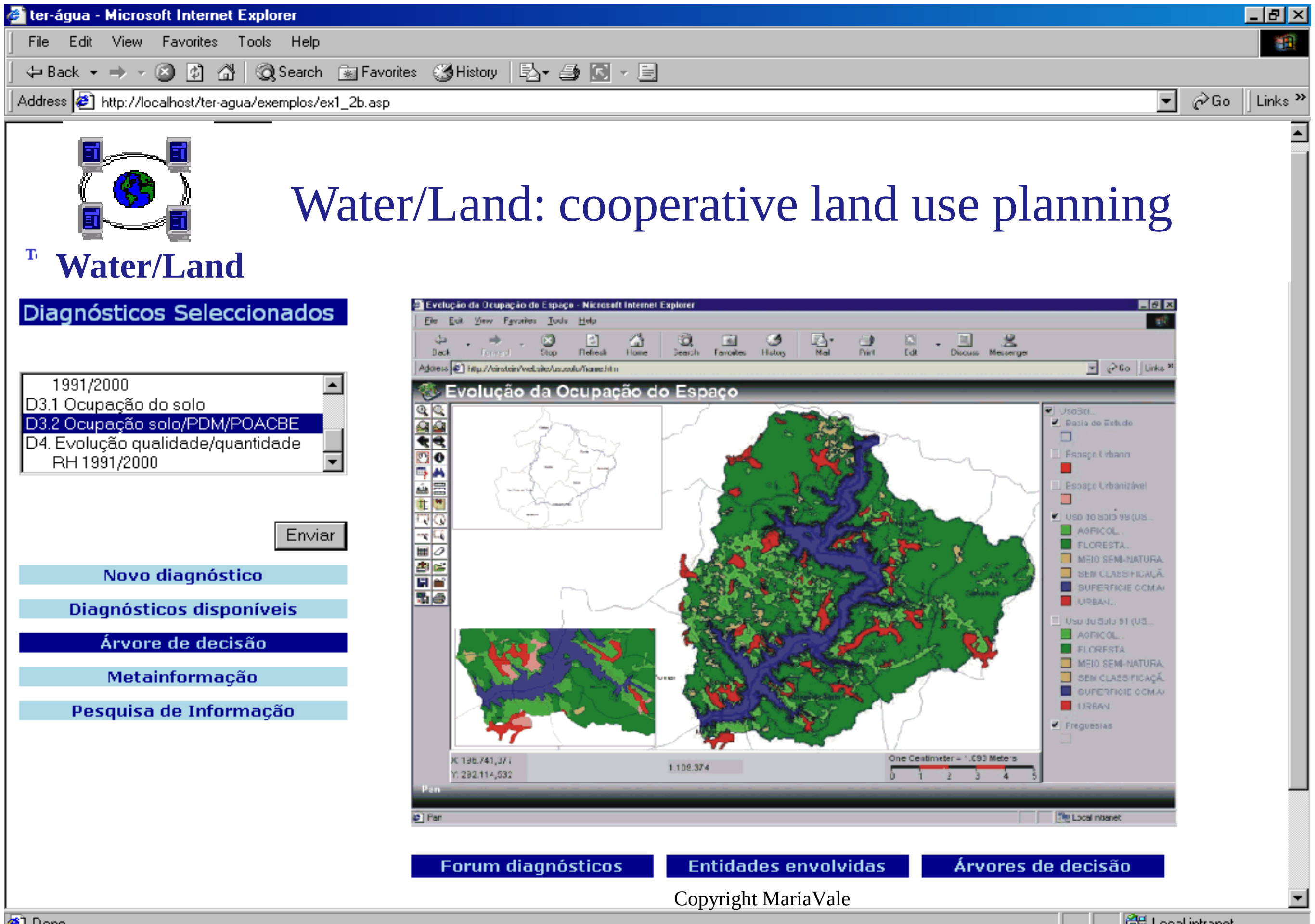
2. Water Management Sustainability and Economic Growth:

Portuguese and EU Initiatives

Open Linked Data – Water/Land collaborative SDI, in Vale,M. 2002



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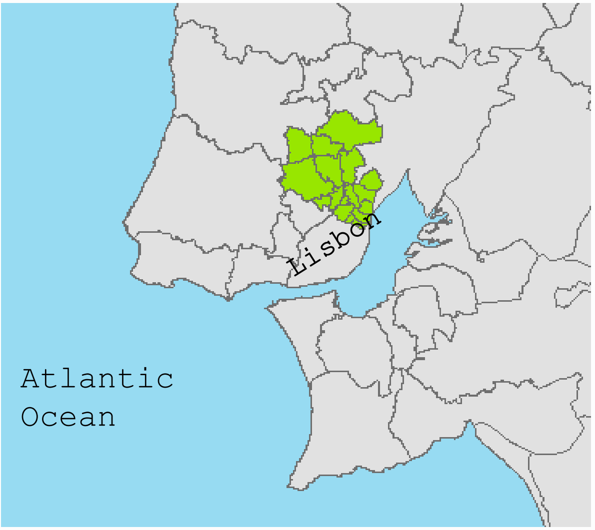
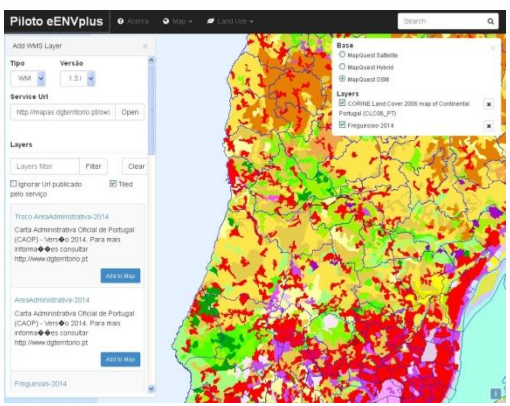
2. Water Management sustainability and economic growth:

Portuguese and EU Initiatives





eENVplus Project- main goals:

– Create an open and interoperable infrastructure to address environmental problems.

Portuguese pilot – main goals:

– Territorial management - monitor land cover changes over time - build indicators and monitor urban dynamics.

– Evaluate fitness for purpose - available datasets - urban growth sustainability evaluation

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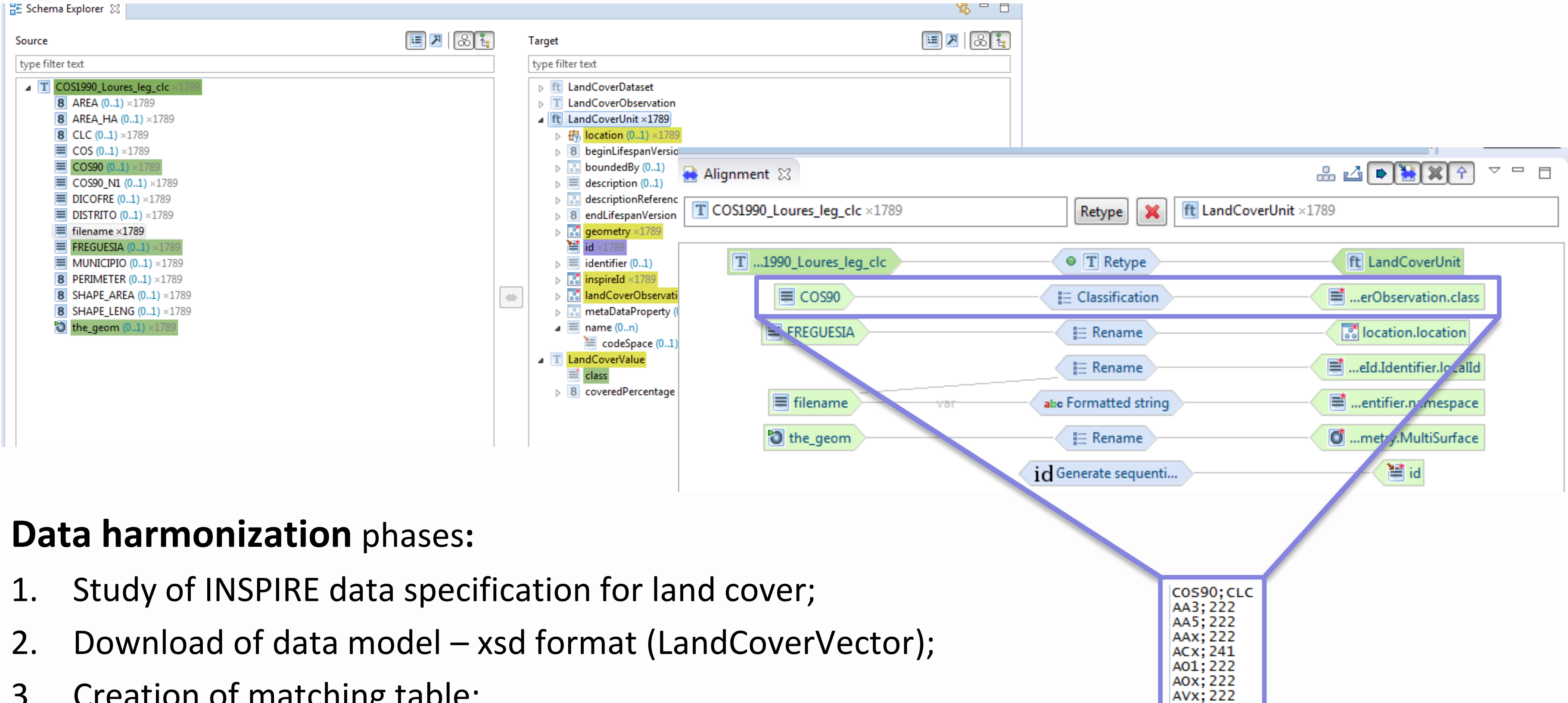
Data harmonization and data quality: Land Cover



Data harmonization phases:

1. Study of INSPIRE data specification for land cover;
2. Download of data model – xsd format (LandCoverVector);
3. Creation of matching table:
    1. Creation of codelists. COS 90 has a wide variety of combinations among the base classes of the nomenclature (eg. UU1, UU2, and so on). This step was important to establish the matching between COS and CLC nomenclatures.
4. Output: GML file created after the harmonization proccess.

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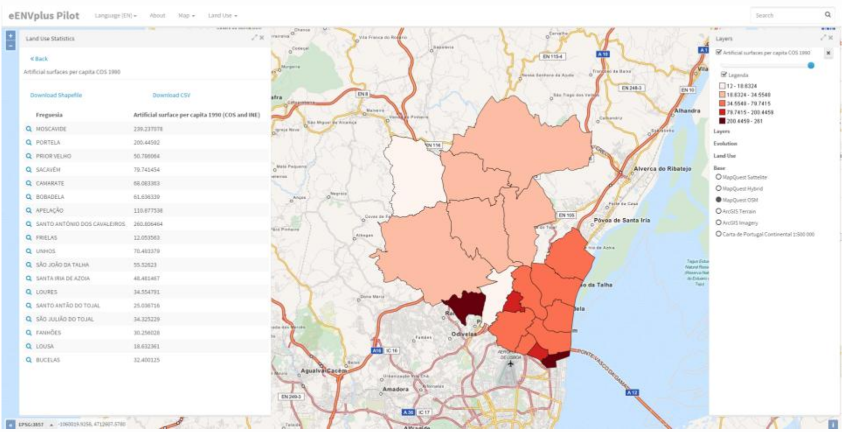
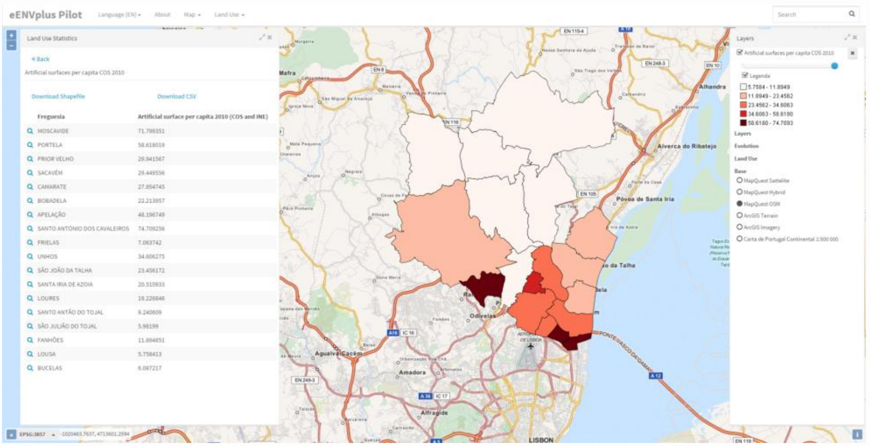
GeoPortal |Artificial surfaces per capita
(source: COS90; Demographic statistics)



GeoPortal |Artificial surfaces per capita
(source: COS10; Demographic statistics)



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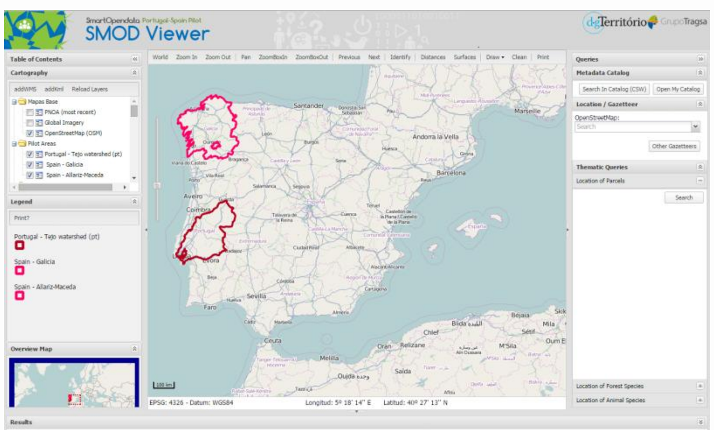
2. Water Management Sustainability and Economic Growth:

Portuguese and EU Initiatives



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SmartOpendata Project - main goals:

- Create a Linked Open Data for environmental management in European protected areas.
- Provide opportunities for SMEs inducing PP/PP/PP partnerships.

Portuguese pilot – main goals:

- Portugal-Spain Pilot will focus on building an SDI prototype to promote water and agroforestry management.
- Built as a collaborative tool for environment protection and economic development of rural areas - key factor is water management and drinking water protection.

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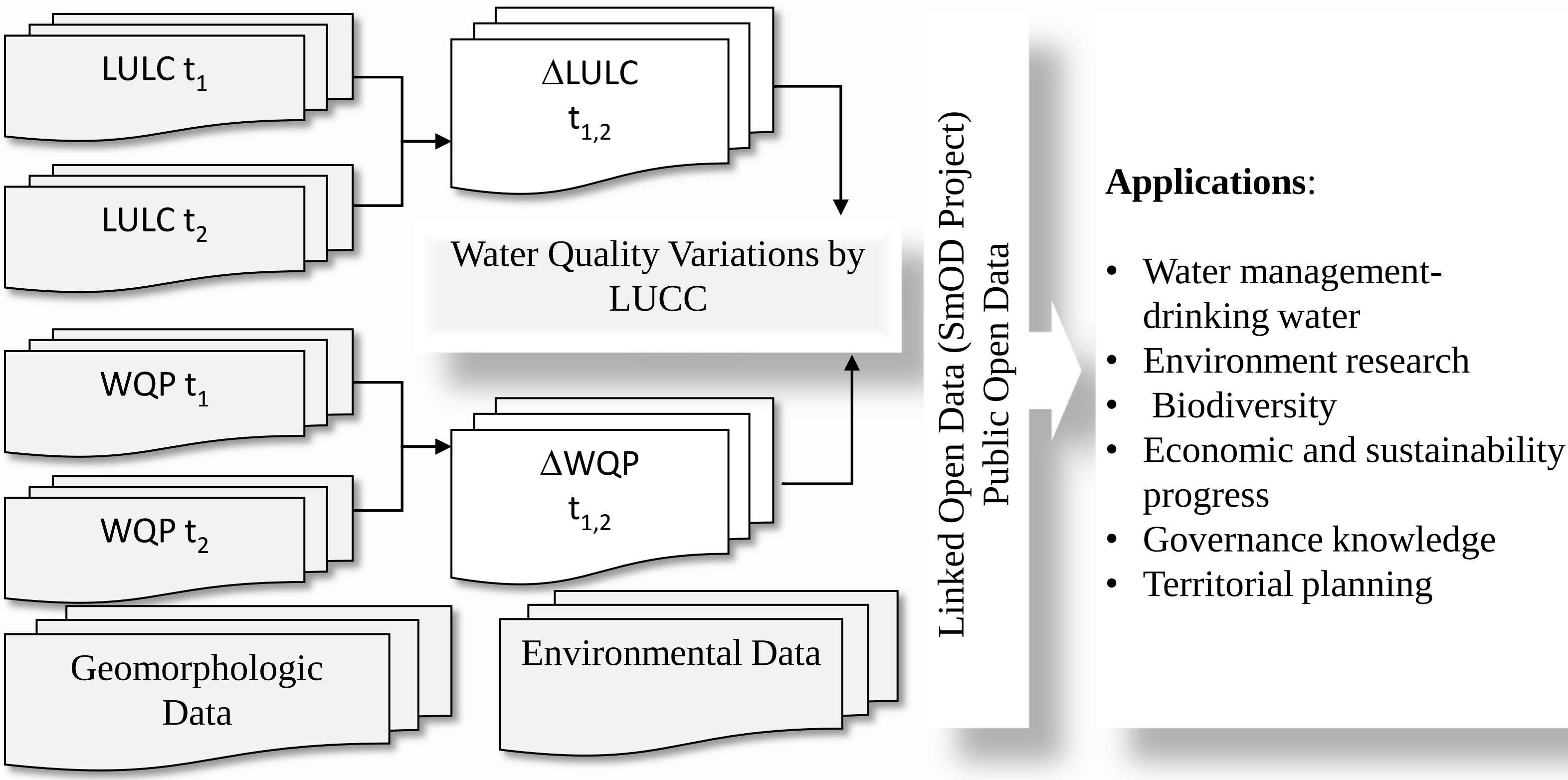
Model of Linked Open Data of the Portuguese Pilot (SmOD Project) and the possible applications



(WQP - *Water Quality Parameters;* LULC – *Land User and Land Cover;* t – *time)*

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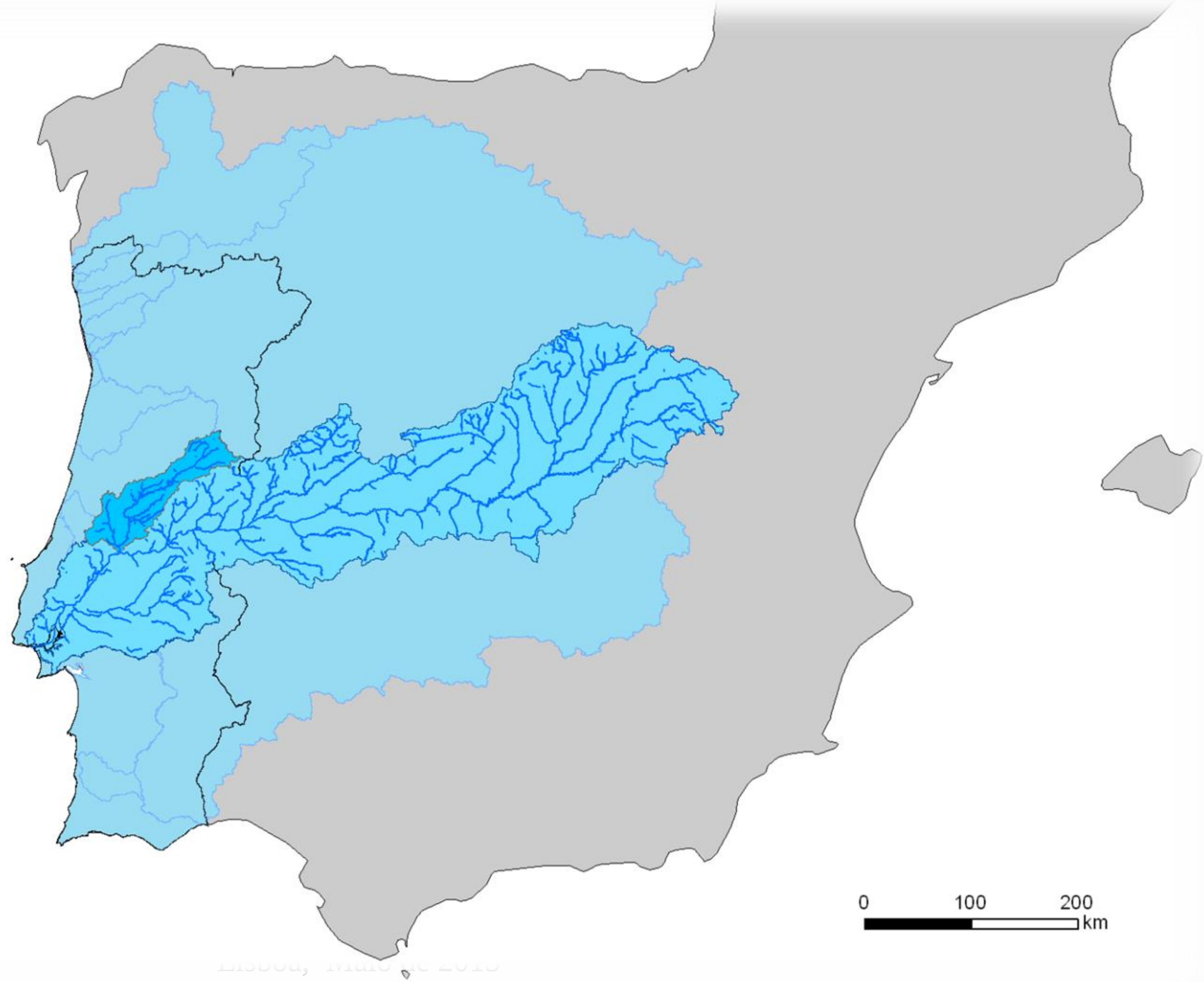
Portugal - Spain

Tagus Watershed

Zêzere watershed - 5063.7 km^2

Important Infrastructure - Castelo de Bode Dam



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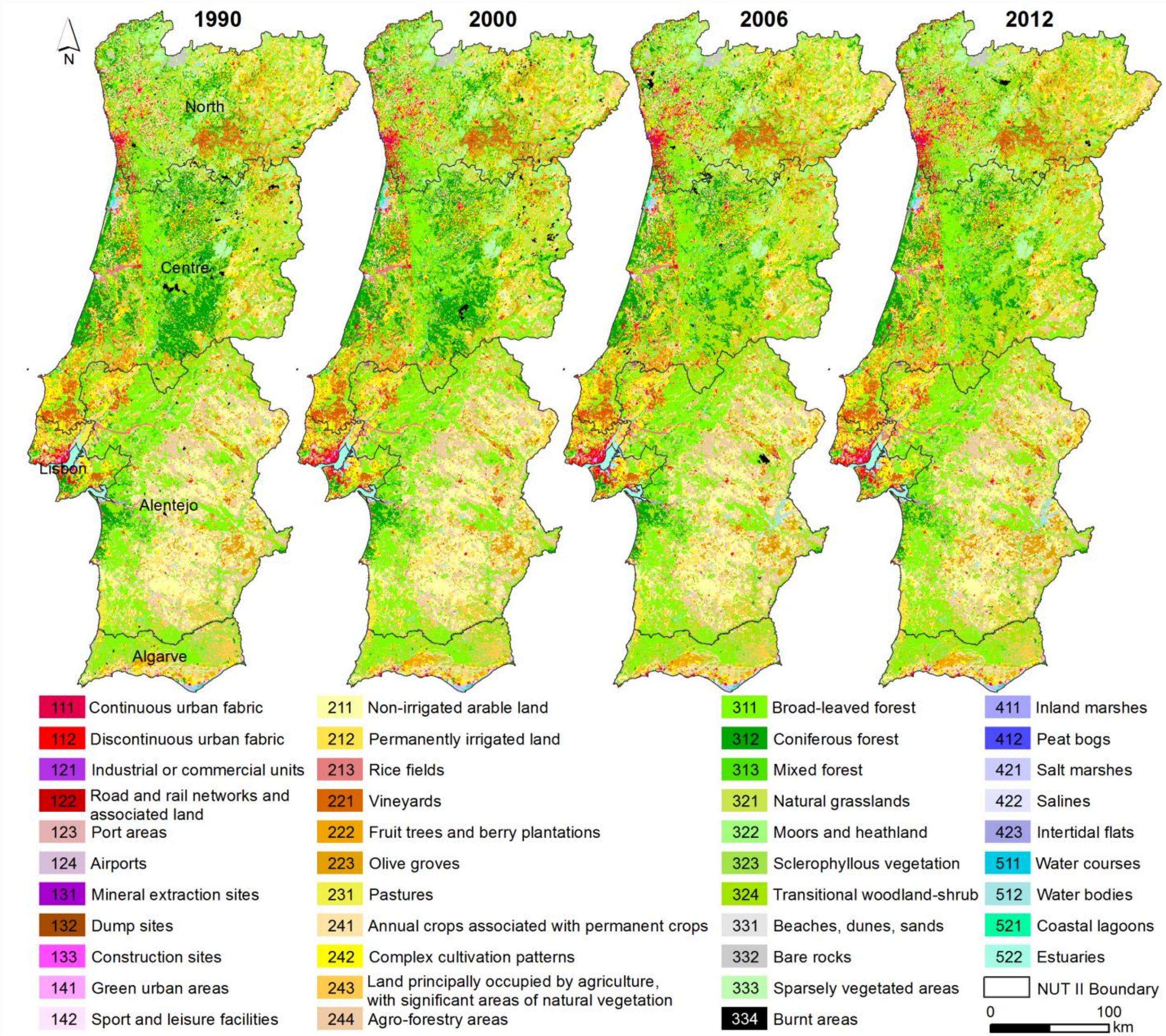

1990-2012 Land Cover Changes

CORINE Land Cover, EEA/DGT, 2014 V1.0

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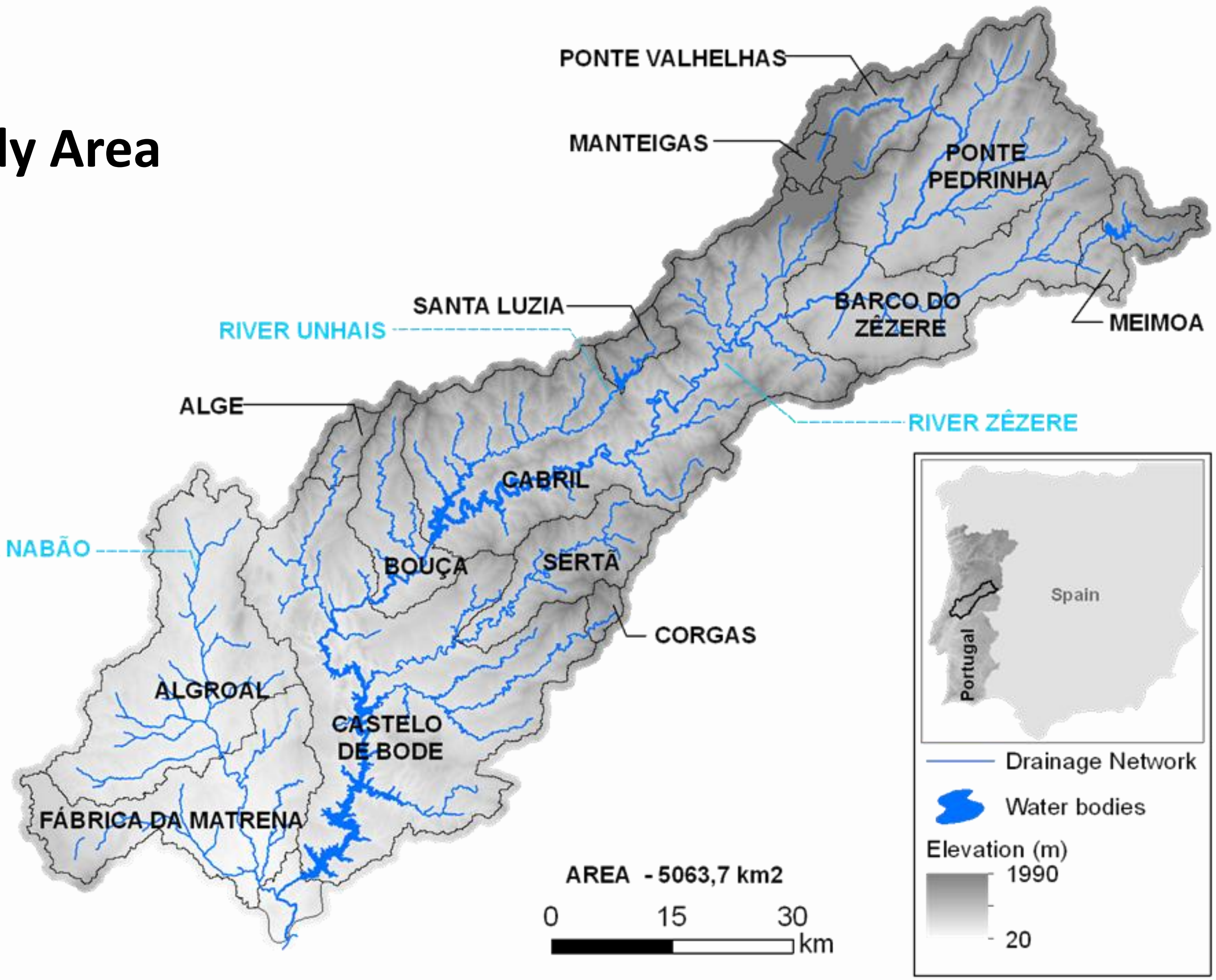
Portugal - Study Area

Zêzere Watershed
(5063,7 km²)



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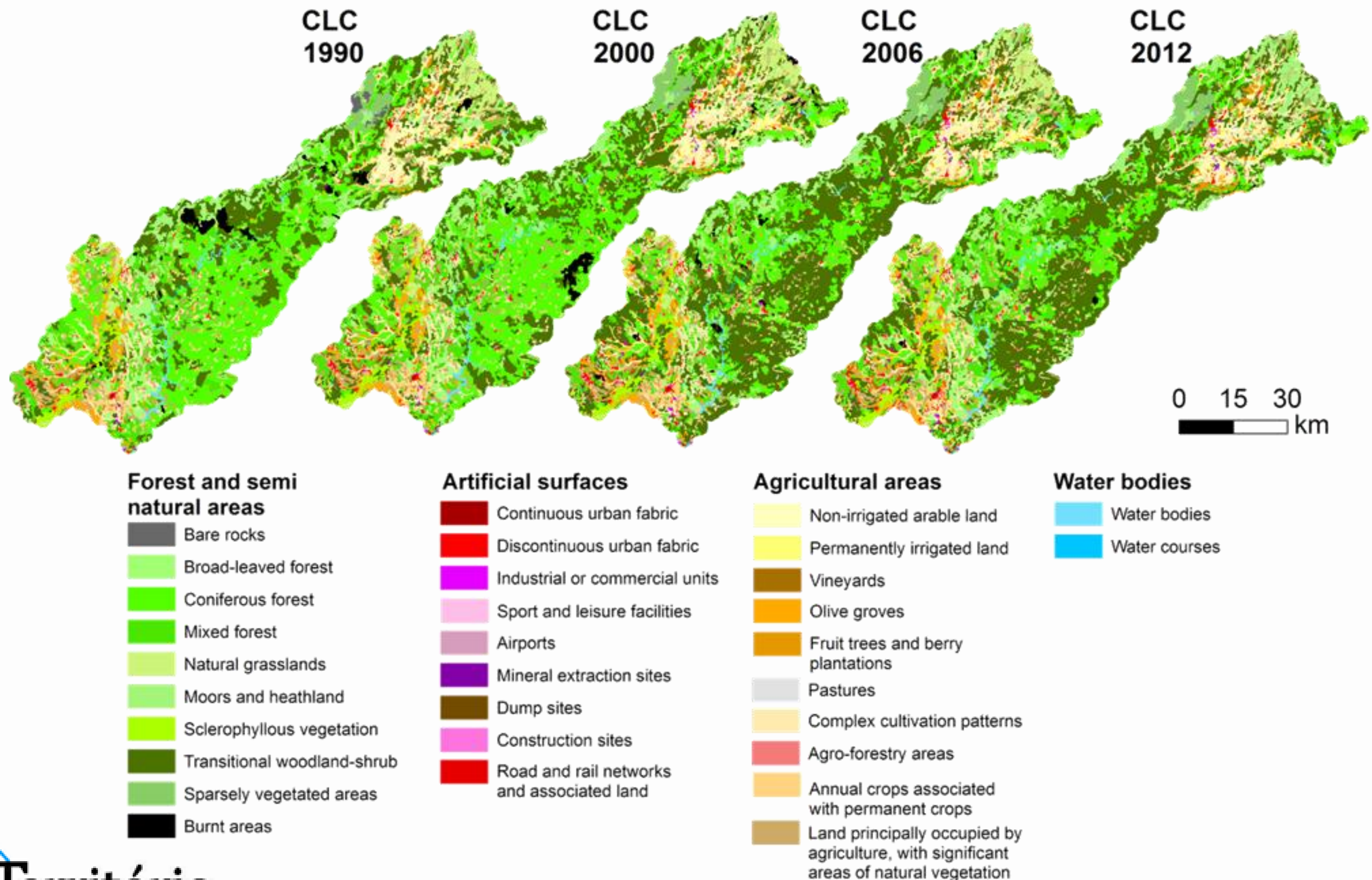
Zêzere Watershed - Land Cover Changes (CORINE Land Cover)



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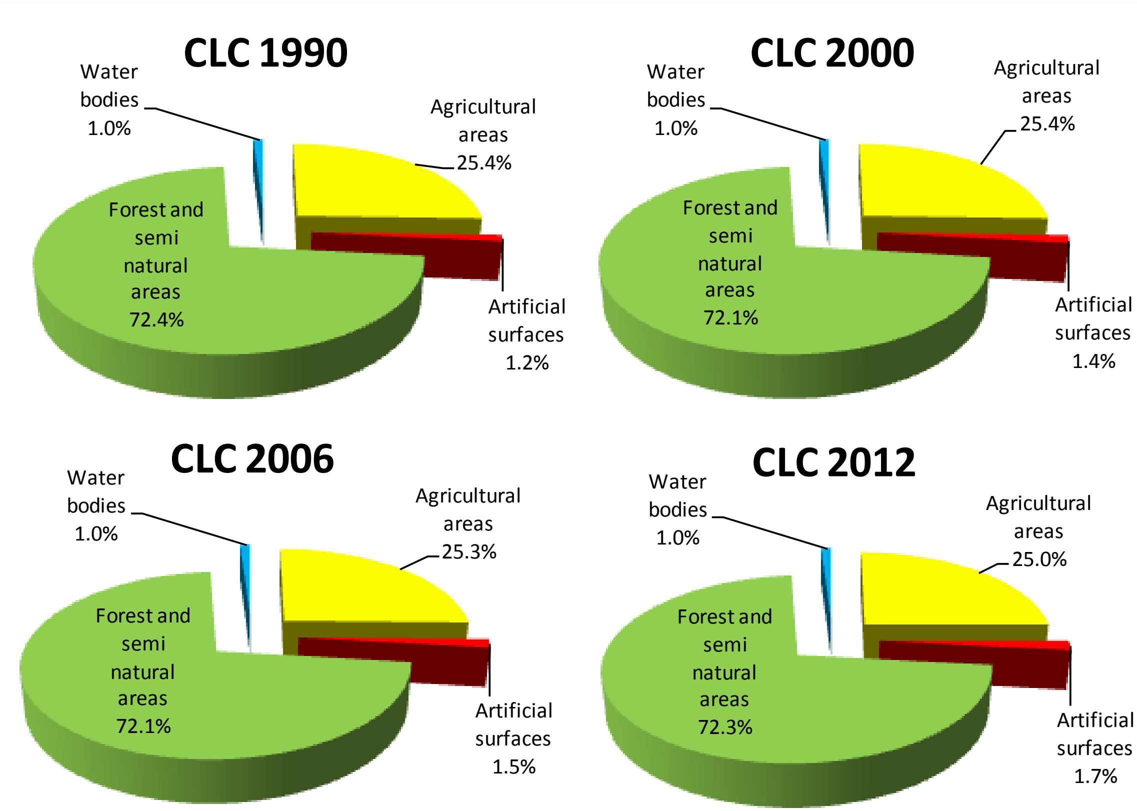
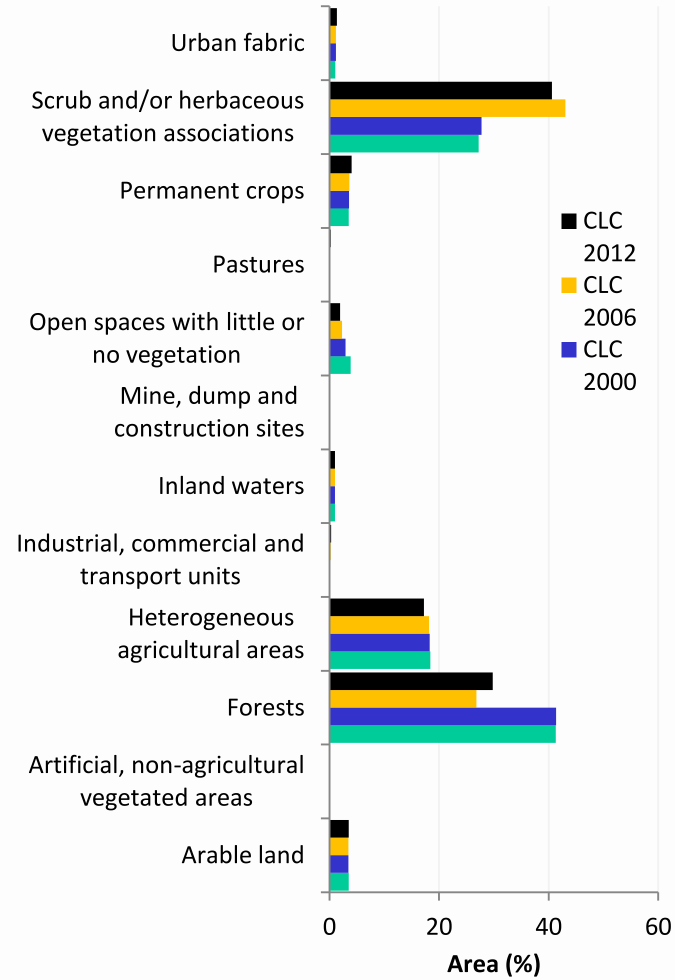
Land Cover Changes in Zêzere Watershed (CORINE Land Cover)

CLC - Level 1



CLC - Level 2



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Metadata:
CORINE Land Cover versus COS

Table 1 Evolution of Corine land cover projects

	CLC1990 Specifications	CLC2000 Specifications	CLC2006 Specifications
Satellite data	Landsat-4/5 TM single date (in a few cases Landsat MSS, as well)	Landsat-7 ETM single date	SPOT-4 and/or IRS LISS III two dates
Time consistency	1986–1998	2000 +/− 1 year	2006+/− 1 year
Geometric accuracy satellite images	≤ 50 m	≤ 25 m	≤ 25 m
CLC minimum mapping unit	25 ha	25 ha	25 ha
Geometric accuracy of CLC data	100 m	better than 100 m	better than 100 m
Thematic accuracy	≥ 85 % (not validated)	≥ 85 % (validated, see Büttner, G., Maucha, G., 2006)	≥ 85 %
Change mapping	N.A.	boundary displacement min. 100 m; change area for existing polygons ≥ 5 ha; isolated changes ≥ 25 ha	boundary displacement min. 100 m; **all** changes > 5 ha have to be mapped
Production time	10 years	4 years	1.5 years
Documentation	incomplete metadata	standard metadata	standard metadata
Access to the data	unclear dissemination policy	free access	free access
Number of European countries involved	26	32	38

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Metadata:
CORINE Land Cover versus COS

TABLE 1 – Technical specifications between COS2010 and CLC2012

Designation	**Carta de Ocupação do Solo 2010**	**Corine Land Cover 2012**
Acronym	COS2010	CLC2012
Positional accuracy (scale)	5,5m (1/25 000)	100 m (1/100 000)
Minimum mapping unit	1ha	25ha
Thematic accuracy	> 85% (average)	> 85% (average)
Reference Date	2010	2012
Data Model	Vector	Vector
Spatial Representation	Polygons	Polygons
Minimum mapping with	20m	100m
Reference Data (Spatial Resolution)	Aerial Photographs	Satellite Images
	50cm	20 m
Nomenclature	Hierarchical(5 Levels)	Hierarchical (3 Levels)
	225 Classes	44 Classes
Production Method	Visual interpretation	Visual interpretation

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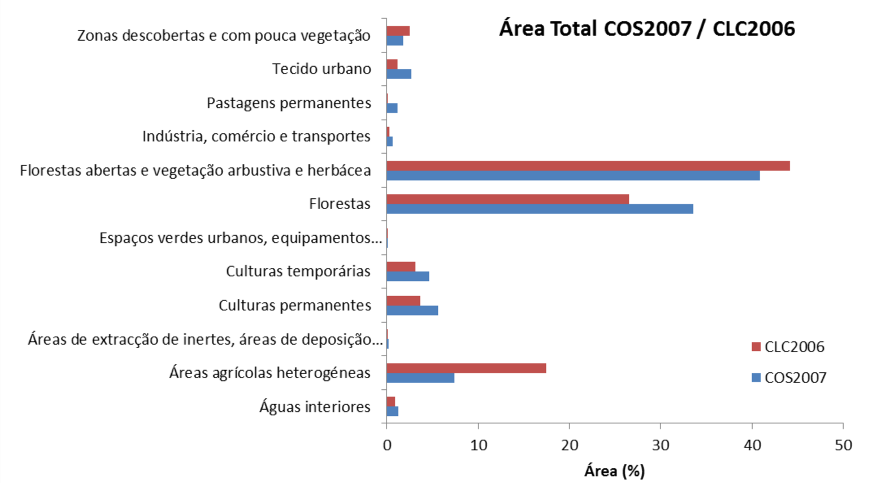
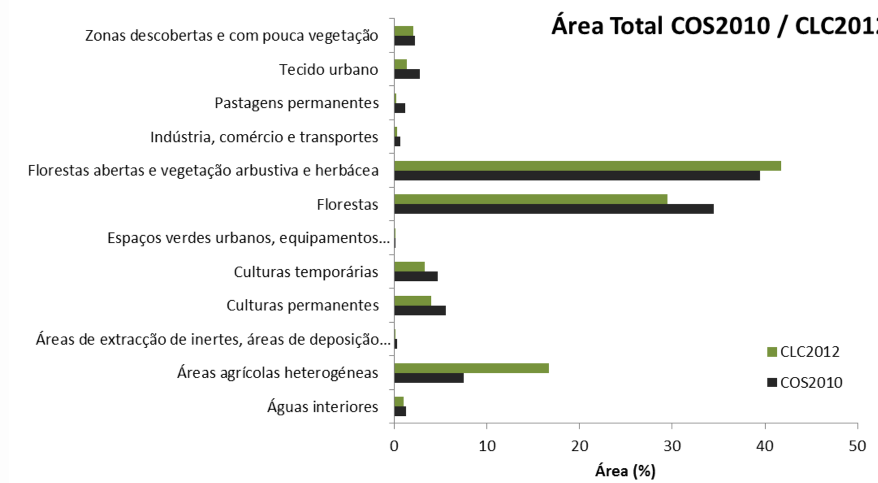
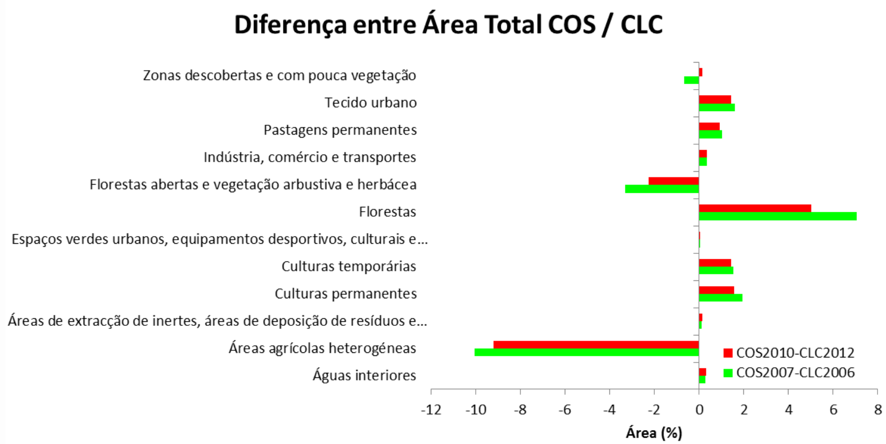
Land Cover Changes in Zêzere Watershed
CORINE Land Cover versus COS

CORINE Land Cover ⟷ **COS**







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Open Data of the Portuguese Pilot (SmOD Project) - Results

LULC of Drainage Area of Castelo de Bode Dam (Zêzere Watershed) in Different moments. Area (%) obtained by CLC Data

LULC	Year			
	1990	*2000*	*2006*	*2012*
Arable land	4.0	4.0	3.9	4.0
Artificial, non-agricultural vegetated areas	0.01	0.01	0.01	0.01
Forests	41.9	44.0	28.5	31.0
Heterogeneous agricultural areas	15.2	14.9	14.7	13.8
Industrial, commercial and transport units	0.0	0.1	0.2	0.2
Inland waters	1.3	1.3	1.3	1.3
Mine, dump and construction sites	0.1	0.1	0.0	0.1
Open spaces with little or no vegetation	4.7	3.8	2.8	2.4
Pastures	0.1	0.1	0.1	0.3
Permanent crops	1.7	1.7	1.7	2.3
Scrub and/or herbaceous vegetation associations	30.8	29.4	46.0	44.0
Urban fabric	0.4	0.7	0.7	0.7

Water Quality Parameters of Castelo de Bode Dam (annual average)

WQP	Year			
	1990	**2000**	**2006**	**2012**
BDO 5 days (mg/l)	1.43	2.44	3.08	3.00
Total Lead (mg/l)	0.027	0.002	0.004	0.003
Total Coliforms (MPN/100ml)	2839.4	320.7	243.5	75.6
Conductivity in laboratory at 20ºC (µS/cm)	59.0	76.6	85.3	70.8
Color (PtCo)	5	6	9	7
Phenols (mg/l)	0.001	0.008	0.012	0.001
Total Nitrogen (mg/l NO_3)	3.45	1.73	1.84	1.27
Total Nitrite (mg/l NO_2)	0.03	0.02	0.01	0.02
pH - Field	7.46	7.06	7.70	7.24

Correlation Coefficients for the WQP in Water of Castelo de Bode Dam Reservoir and Areas of LULC of Drainage Area

LULC	WQP								
	BDO 5 days (mg/l)	*Total Lead (mg/l)*	*Total Coliforms (MPN/100ml)*	*Conductivity in Laboratory at 20ºC (µS/cm)*	*Color (PtCo)*	*Phenols (mg/l)*	*Total Nitrogen (mg/l NO_3)*	*Total Nitrite (mg/l NO_2)*	*pH - Field*
Arable land	-0.62	0.62	0.60	-0.95	-0.85	-0.99	0.43	0.93	-0.35
Artificial, non-agricultural vegetated areas	0.93	-1.00	-1.00	0.84	0.73	0.54	-0.97	-0.88	-0.22
Forests	-0.77	0.42	0.52	-0.53	-0.80	-0.28	0.50	0.46	-0.59
Heterogeneous agricultural areas	-0.73	0.60	0.67	-0.21	-0.35	0.23	0.78	0.23	0.20
Industrial, commercial and transport units	1.00	-0.92	-0.95	0.82	0.85	0.49	-0.93	-0.83	0.05
Inland waters	0.98	-0.97	-0.99	0.87	0.83	0.56	-0.95	-0.88	-0.05
Mine, dump and construction sites	-0.93	0.80	0.83	-0.94	-0.98	-0.74	0.74	0.91	-0.35
Open spaces with little or no vegetation	-0.96	0.80	0.86	-0.64	-0.75	-0.25	0.89	0.63	-0.07
Pastures	0.60	-0.51	-0.57	0.06	0.18	-0.39	-0.71	-0.08	-0.32
Permanent crops	0.51	-0.37	-0.45	-0.07	0.10	-0.50	-0.60	0.05	-0.25
Scrub and/or herbaceous vegetation associations	0.80	-0.46	-0.56	0.54	0.81	0.27	-0.55	-0.48	0.55
Urban fabric	0.95	-0.99	-1.00	0.83	0.75	0.51	-0.98	-0.86	-0.19

3. Linked Open Data/ICT and the new paradigm of good Governance

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3. Linked Open Data/ICT and the New Paradigm of Good Governance – Water Framework Directive

- Data Harmonization (INSPIRE)
- Availability of metadata (SMOD Viewer)
- Modeling Artificial Surfaces Growth (Zêzere Watershed)
- Risk Assessment
- Models developed for the Zêzere Watershed can be extended to the Tagus river watershed, help building harmonized approaches, addressing Water Framework Directive concerns.
- Align different EU concerns: Input to INSPIRE and PSI Directives

3. Open Data/ICT and the new paradigm of good Governance

3.1 Advantages and Disadvantages based on the principles associated with Open Linked Data

1. **Access must be Non-discriminatory :** available to anyone, without implying registration. **?**
2. **Data formats must be Non-proprietary:** avoiding entities with exclusive control. **?**
3. **Data must be License - Free:** The data are not subject to any copyrights, patents, trademarks or secret regulation. A reasonable privacy and privilege and security restrictions may be permitted. **?**
4. **Data must be Accessible:** The data should be accessible to a broad user community. **?**
5. **Data must be Primary:** Data should be collected at source with the highest level of detail possible, without aggregations or modifications. **?**
6. **Data must be Timely:** Available in time - quickly - to preserve value. **?**
7. **Data must be Complete:** All public data must be made available. Public data is data that is not subject to privacy restrictions, security or access privileges. **?**
8. **Data must be machine-processable:** structured to enable automated processing. **?**

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4. INSPIRE’D LINKED OPEN DATA TOWARDS WATER FRAMEWORK DIRECTIVE ACCOMPLISHMENT:

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4. INSPIRE'd Linked Open Data Towards Water Framework Directive accomplishment

- Linked Open Data in the public sector: associated with transparency and good governance must integrate this participation with:
  - Responsibility - responsible participation –responsible governance
  - Quality - Assured to inform governing decision-making processes
  - Linked data -Fitness for purpose – Information -Knowledge
  - Security - People and goods- access to clean water
  - Ethics - Equity and justice
    - Territorial management and resources management -water and land in this case
    - Costs and benefits - efficiency
      - Data collection and data use
      - Partnerships PP-PP-PP. Economic-development-growth SMEs

Build the SDI – which better respond to territory and water management efficiency inducing economic growth

Portuguese Pilot(SmOD) - Propagation

GEOProcessing 2015 : The Seventh International Conference on Advanced Geographic Information Systems, Applications, and Services

Water Quality Impact Assessment of Land Use and Land Cover Changes

A dynamic IT model for territorial integrated management

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Abstract **– The land use and land cover (LULC) changes have influenced the water quality. Thus, addressing LULC can lead to the understanding of the actual problems and how to avoid future water stress problems. This paper presents a model that integrates land use and land cover changes (LUCC), and their impacts on water quality. The model is tested for the main drinking water reserve for Continental Portugal, the Castelo de Bode Dam located in the Zêzere watershed. This work integrates the specifications of SmartOpenData Project (SmOD), and is strictly related to the work developed in the eEnvPlus, and TerAGUA projects. It considers INSPIRE Directive specifications, and those related to linked open data integration. The results obtained so far address the most relevant LULC changes in Portugal, but can easily be applied to study the problem in other countries, allowing the creation of guidelines for spatial planning integrating the concerns of the Water Framework Directive.**

Keywords - LULC, LUCC; Water; Spatial Planning, SmartOpenData, INSPIRE.

I. Introduction

The land use and land cover (LULC) of the territory is constantly changing, mainly due the anthropogenic actions, but also due to natural causes. Many of these changes have a negative impact on water quality, a fact cited by some authors that show that there is a cause and effect relation between some land use/cover changes (LUCC) and the decrease in water quality [1]-[4]. The human related LUCC, namely deforestation, urbanization, urban sprawl or less adequate agricultural practices where large amounts of chemicals are applied (from industrial or domestic origin) is therefore a key factor to build well balanced land use planning initiates. Many land use practices result in an increase of contaminants that are easily transported to watercourses, contribute to the degradation of important water reserves namely those for public supply, and inducing relevant water stress [6]-[10].

Being so it is important to have an integrated watershed land use planning and management system, integrating the water legal framework with the land use planning legal framework with updated knowledge on LUCC changes and ongoing management of natural resources: water, energy production, environmental protection integrated with socioeconomic development strategies.

The interconnection between these areas is essential to understand the intensity of land use changes upstream of a drinking water reserve, in order to understand the impact of land use changes in water stress [11]. Therefore, it is essential to integrate LULC knowledge, e.g., intensive agriculture, industry location, urbanization and urban sprawl, with existing water treatment plants, the monitoring of human activities and their water management requirements. The gradual decrease in natural water quality, namely for drinking water reserves, leads to increasing pressures on water management efficiency in order to reduce migration or leaching of certain contaminants in surface and ground waters downstream. The increasing risk for public health is also relevant.

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Land use and land cover changes in Zêzere watershed (Portugal) — Water quality implications

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HIGHLIGHTS

- LUCCs for artificial soils constitute a reduction factor of water quality.
- The wastewater drainage into watercourses is an aggravating factor of water quality.
- Forestry areas in upstream of the dams have higher importance to water quality.
- Maintenance and preservation rules are important to the improvement of water quality.

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ABSTRACT

To understand the relations between land use allocation and water quality preservation within a watershed is essential to assure sustainable development. The land use and land cover (LUC) within Zêzere River watershed registered relevant changes in the last decades. These land use and land cover changes (LUCCs) have impacts in water quality, mainly in surface water degradation caused by surface runoff from artificial and agricultural areas, forest fires and burnt areas, and caused by sewage discharges from agroindustry and urban sprawl. In this context, the impact of LUCCs in the quality of surface water of the Zêzere watershed is evaluated, considering the changes for different types of LUC and establishing their possible correlations to the most relevant water quality changes. The results indicate that the loss of coniferous forest and the increase of transitional woodland-shrub are related to increased water's pH; while the growth in artificial surfaces and pastures leads mainly to the increase of soluble salts and fecal coliform concentration. These particular findings within the Zêzere watershed, show the relevance of addressing water quality impact driven from land use and should therefore be taken into account within the planning process in order to prevent water stress, namely within watersheds integrating drinking water catchments.

1. Introduction

The study of land use and land cover changes (LUCCs) has been developed in recent times in many countries (e.g. Portugal, Spain, France, and others), mainly to understand the impacts of these changes in the territory, in the economy and in the environment and also and mainly to understand the implications on achieving sustainability within development strategies.

These LUCC studies include those that analyze the implications on water resources (Zhang et al., 2014), in particular to understand the cause–effect of these LUCCs in the reduction of water quality and the implications on hydrological processes (Vale, 2002; Seeboonruang, 2012; Warburton et al., 2012; Erol and Randhir, 2013).

The land use and land cover (LUC) and water resources are linked (Vale and Painho, 1999; Gyawali et al., 2013). Water stress is influenced by LUC type in a certain area and from the intensity of use that each type of LUC requires, namely the surface water quality and quantity variation is highly correlated with inadequate anthropogenic practices or vegetation cover degradation processes (e.g. forest fires) (Wang, 2001; Casalí et al., 2010; Hong et al., 2011; Meneses, 2013; Smith et al., 2013).

On the other hand, water bodies reflect these LUCCs, especially when there is a reduction in water quality resources, in many cases caused by population growth, industrial expansion, land use conflicts and/or changes in land management policies (Ahearn et al., 2005; Mouri et al., 2011; Teixeira et al., 2014; Vale and Saraiva, 2012; Valle Junior et al., 2014b, 2015a).

Soil erosion is among the causes of reduction of water quality due to the amount of sediment that arrives to the watercourses and to water reserves (Nunes et al., 2011; OEH, 2012; Meneses, 2014). This is quite relevant in regions where land use intensity combined with land

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Thank You!

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