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STATISTICS PORTUGAL
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BETTER POLICIES FOR BETTER LIVES
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Indicators for territorial policies: closing data gaps by using traditional and new sources and methods

SESSION: "Space transformation, land use and value"

MULTI-SOURCE APPROACH FOR ENHANCED LUCAS STATISTICS: A PILOT STUDY IN PORTUGAL[1]

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Summary

- Introduction and objectives
- LCLU: potentialities of COS 2010 when compared with LUCAS
- Methodology and technical solutions
  - Remote Sensing
  - Testing area
  - SAE
- Final considerations

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INTRODUCTION

Introduction

ESS: partnership between the Community statistical authority – Eurostat; NSIs; other national statistical authorities - responsible for the development, production and dissemination of European statistics

LUCAS

Harmonized

Quality-assured

LC/LU information

INSPIRE Directive

Objective 1

LCLU statistics according to a predefined classification (LUCAS)at NUTS 3 level

Objective 2

Evaluate the feasibility of future updates

Objective 3

National Integrated Approach to comply with ESS medium-term strategy

✓***A pilot study centered in land cover/land use (LCLU) statistics was developed in Portugal.***

✓**INE** and **DGT** are working together through a Memorandum of Understanding (MoU) articulated with other National Agencies, through the National Committee for LCLU Mapping (**CACTO**);

Research objectives

1. To present a methodology to operationalize Land Cover statistics;
2. To derive Land Cover, Land Use (LCLU) statistics based on Remote Sensing and ancillary data;
3. Use COS2010 (Portuguese Land Cover Map) as the base map;
4. To evaluate the process of deriving land cover maps, which may be applied in other Member States;
5. To explore the potentialities of Small Area Estimation (SAE) to enhance the LCLU desegregation;
6. To test multi-source integration of different nature: geospatial data and alphanumerical data

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LCLU: POTENTIALITIES OF COS2010 WHEN COMPARED WITH LUCAS

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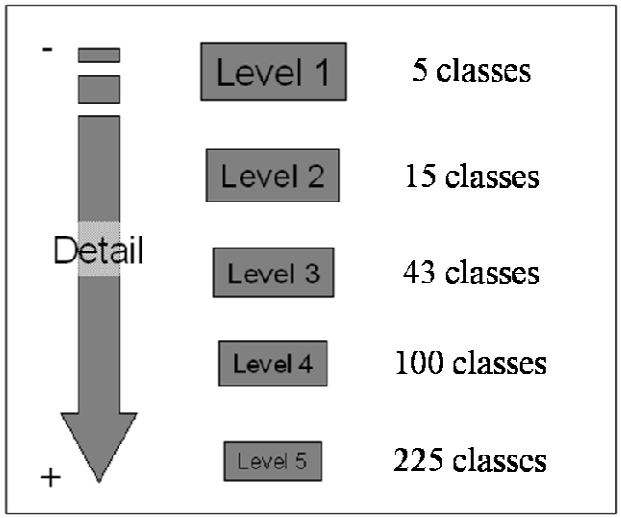
COS2010



Land Cover Map of Continental Portugal for 2010 (COS2010)

- COS2010 is based on an *a priori* and 5-level hierarchical system and has 225 classes at the most detailed level;
- Compatible with CORINE Land Cover (CLC) nomenclature at levels 1, 2 and 3

Data model	Vector
Data structure	Polygons
Acronym	COS2010
Reference year	2010
Scale	1/ 25 000
Minimum Mapping Unit (MMU) (ha)	1 ha
Minimum distance between lines (m)	20 m
Production method	Visual interpretation
Geometric accuracy	Better than 5,5 m
Thematic Accuracy	≥ 85%
Coordinate reference system	ETRS89/PT-TM06
Base data	2010 orthorectified digital aerial images (0,5m)

COS2010 Technical specifications

LUCAS GT 2015

Land Cover comparability between LUCAS GT 2015 classification and COS 2010

LUCAS GT 2015 LC Precision		Number of COS 2010 Classes per LUCAS Level
Level 1	**Level 2**	
A. ARTIFICIAL LAND	A10. Roofed built-up areas	13
	A20. Artificial non built-up areas	9
	A30. Other built-up areas	6
B. CROPLAND	B. CROPLAND	38
C. WOODLAND	CF10. Broadleaved forest	49
	CF20. Coniferous forest	21
	CF30. Mixed forest	25
	COLT. Other land with tree cover	34
D. SHRUBLAND	S. Shrubland	5
E. GRASSLAND	LCE. Permanent grassland	2
F. BARELAND, LICHENS, GLACIERS AND PERMANENT SNOW	F10. Rocks and Stones	4
	F20. Sand	2
G. WATER	G10. Inland water bodies	7
	G20. Inland running water	3
H. WETLANDS	H. WETLANDS	6
	Total classes COS	224

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METHODOLOGY AND TECHNICAL SOLUTIONS

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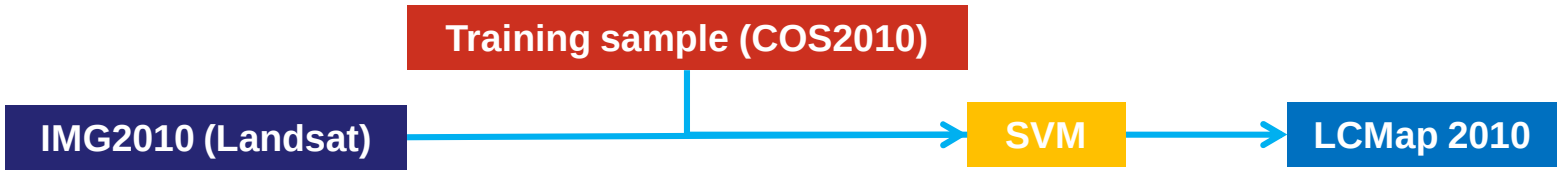
Remote Sensing (RS)

- Remote Sensing (RS) is the technique of information acquisition about an object or phenomenon when physical contact with the object is not possible.
- The Remote Sensing and GIS analytical procedures are characterized for its high universality, from the perspective of data and possible application;
- Useful for large scales and detailed classes, as land cover; withal, spectral differentiation is harder as the number of classes increase due to class variability;
- The use of multi-temporal images improves spectral discrimination accuracy.
- RS provides useful information and tools to identify long term trends and short-term variations, such as impact of rising sea levels or LCLU changes;
- It can also supply complementary information on LC location, limits and extent.

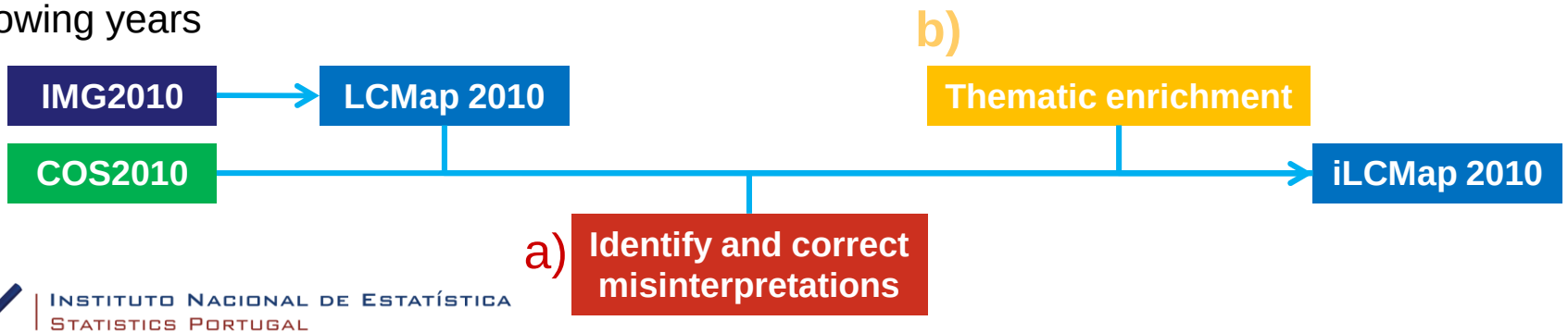
LC Map 2010

- The methodology for the production of the base map (LCMap 2010) aims to be an accurate and efficient process to derive land cover maps that could be applied in other MS.
- The mapping procedure to derive the LCMap 2010 consists in a supervised classification approach, such as the support vector machine (SVM).
- The training sampling consists of a set of pixels, known as training cases, used as representatives of each land cover class.
- The proposed approach to minimize the training sampling effort is based on the automatic selection of training pixels using previous land cover information in the format of a vector land cover map (COS2010).



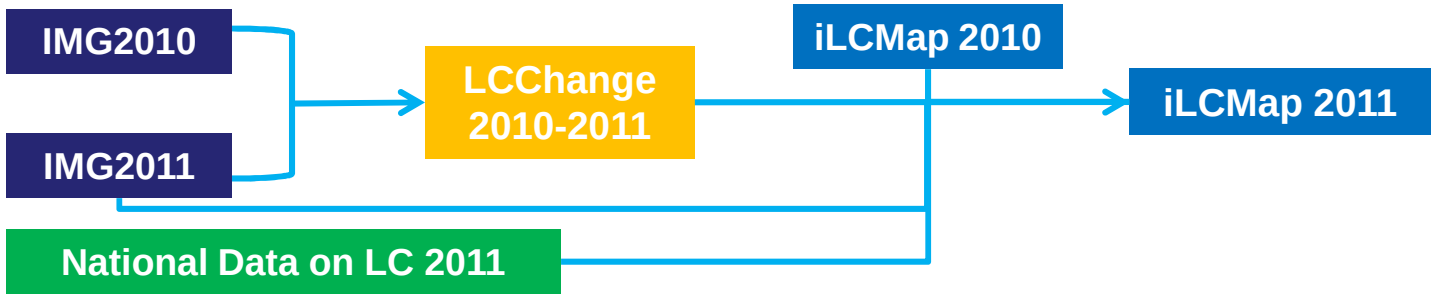
iLC Map 2010

- To produce iLCMap 2010 – integrate LCMap 2010 with COS 2010 at level 5 detail and 1ha MMU.
- This operation of spatial analysis will give two sets of data:
  - a) **Correction of thematic errors from the LCMap 2010**
  - b) **Provide thematic enrichment (detail) to the present classification.**
- Is assumed that COS2010 is likely to be correct – i.e if the LCMap 2010 gives an attribute of "Agriculture", but COS2010 identifies the same area as "Urban soil";
- LC class detailed information is added to the previous established classes and therefore improve the LCMap2010;
- The advantage of this procedure is to achieve a reliable base to test the data algorithm for the following years



iLC Map 2011 to 2015

- A Landscape Change Detection methodology was developed to update iLCMap 2010;
- Taking the reference year of 2011, previous produced iLCMap 2010 will be used and combined with LC change from images 2010 and 2011 - result will be the iLCMap 2011;
- Aiming t**o validate previous results and detect inter annual changes, a training sampling is used to confirm coherence between images and between unchanged areas in iLCMap 2010 and iLCMap 2011.**
- Reproduce this methodology forward: iLCMap2012, iLCMap2013, iLCMap2014, iLCMap2015.



Testing area

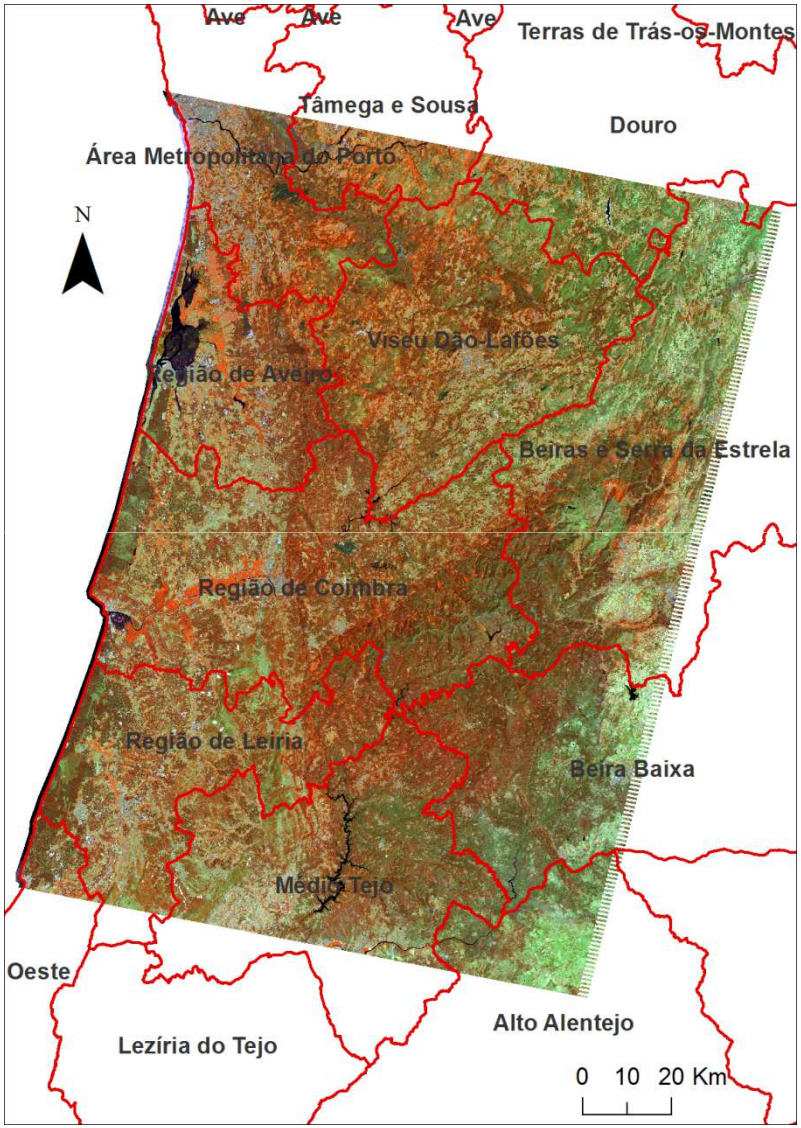
- The selection of the study area was made based on the prior knowledge of the LCLU class characteristics and Landscape diversity of the region;
- This study applied supervised classification-SVM algorithm to produce a LC map statistics and to detect LCLU changes;
- Uses multispectral satellite data from Landsat 5 and Landsat 7;
- The images are composed by 12 bands - resulted from a model of spatiotemporal image-fusion;
- The goal is to use RS data in a GIS framework to integrate LCLU changes, through the analysis of normalized time-series, in the LC map statistics process.

Testing area

- Full coverage: Region of Aveiro; Viseu & Dão Lafões and Region of Coimbra;

- Partially: Metropolitan Area of Porto, Médio Tejo, Region of Leiria, Alto Alentejo, Oeste, Tâmega & Sousa, Beira e Serra da Estrela and Douro.

- Landsat 5 image of 2010
  - → Spring 25th April;
  - → Summer 30th July



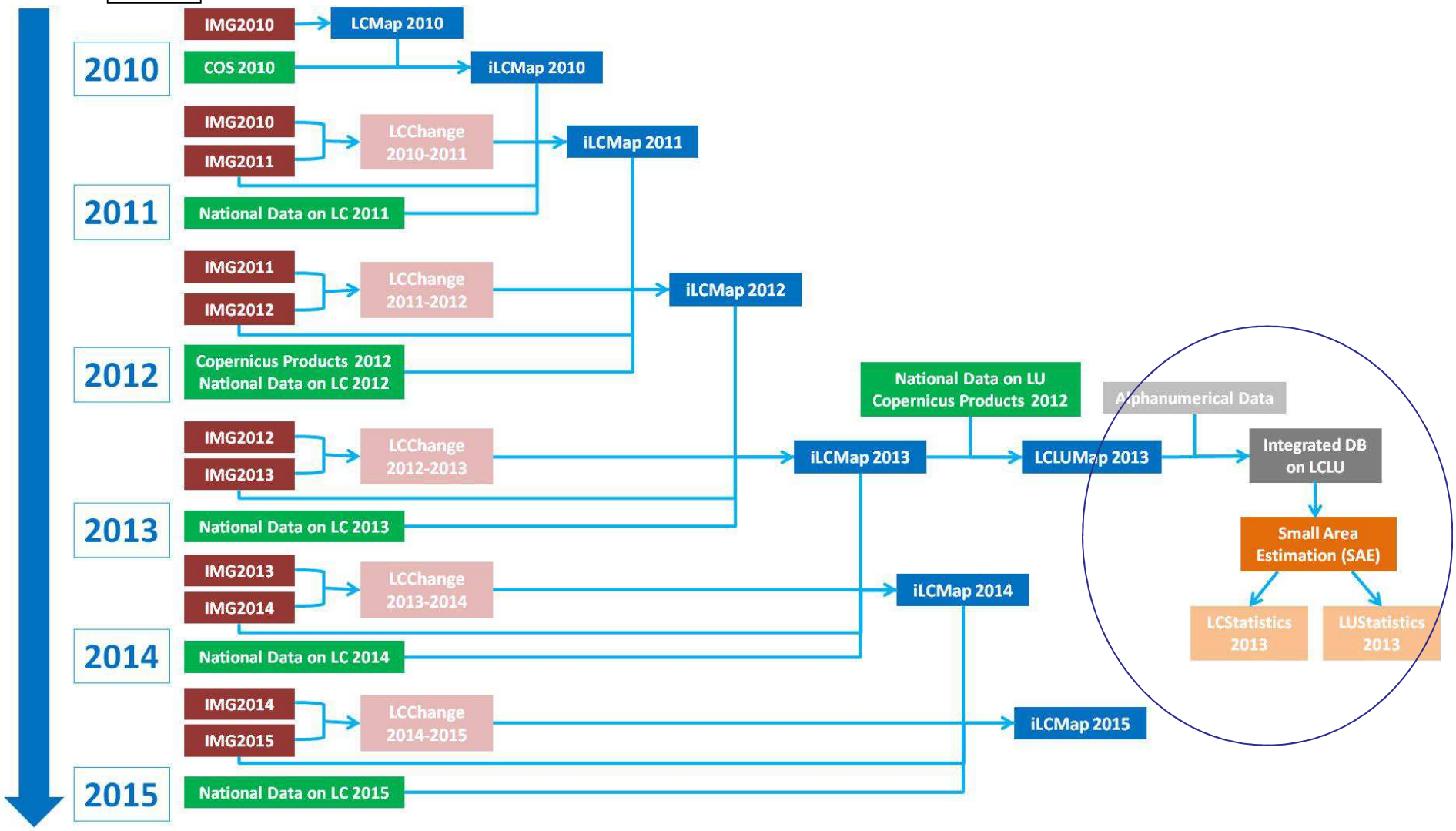
Small Area Estimation (SAE)

- The model-based approach of SAE is as an alternative to design-based approaches for the domains where the sample size is unable to deliver reliable results.
- Obtained by fitting a model to the data - a regression model, in which covariates are used as auxiliary information.
- This auxiliary information comprises the several sources already available for NUTS3;
- Results are acceptable even in small samples, since estimation is based on regressions between the variables underlying the model.
  - the indirect estimators borrow strength from other areas and/or time periods, in order to increase effective sample size.

Small Area Estimation (SAE)

- To produce estimates at NUTS 3 level, we are going to use covariates as auxiliary information, mainly from National Data Sources (NDS).
- To accommodate these processes, a feasibility study is being applied to evaluate data accuracy;
- Completing the disaggregation process, it will be possible to obtain a detailed Land Cover classes at NUT3 level;
- The application of this method allows collecting information at different levels of detail and combining upper and lower levels of the hierarchical system;
- Results will be articulated with geographic information to derive the LCMap2013.

Complete Workflow



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FINAL CONSIDERATIONS

Final considerations

- Results accuracy and quality must be considered and framed under the European quality patterns;
- The application of this innovative methodology, which combines RS and SAE, is a challenge in the sense that meta information description should find accordance with the Eurostat´s SDMX;
- The approach and techniques suggested, based on spatial analysis operations (GIS´s) must be validated under the European Model of Statistics Production;

- This multi-source integration methodology, focusing RS, satellite imagery and SAE can be applied elsewhere and supplant spatial desegregation:
  - ✓ comply with INSPIRE Directive;
  - ✓ harmonized with the procedures of data acquisition and dissemination of ESS;
  - ✓ can be continually updated.

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Thank you for the attention

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