

SMOS

from science to public policies

Mário Caetano

Deputy-Director General

18 may 2022



The logo consists of the letters "SMOS" in a white, sans-serif font, centered within a solid blue rectangular background.

SMOS

Sistema de Monitorização de Ocupação do Solo

SMOS is a system based on space technologies and artificial intelligence
for land cover monitoring

developed by DGT

Land cover

Land cover is the observed biophysical cover on Earth's surface.



Artificial



Agriculture



Forest



Shrubland



Water



Wetland

Residential



Industry



Transport network



Land use

Description of the use of the Earth's surface.

Land Cover Land Use

LCLU

Why is LCLU important?

Land planning

Agriculture management

Forest management

Water resources
management

Fire risk

Flood risk

Erosion risk

Climate change

Desertification assessment

LCLU is the thematic
cartography most used
in Portugal and all over
the world

The best way to characterise the LCLU is through maps

The traditional way to do land cover land use maps

Visual
and manual interpretation of
aerial or satellite images



The traditional way to do land cover land use maps

Visual
and manual interpretation of
aerial or satellite images

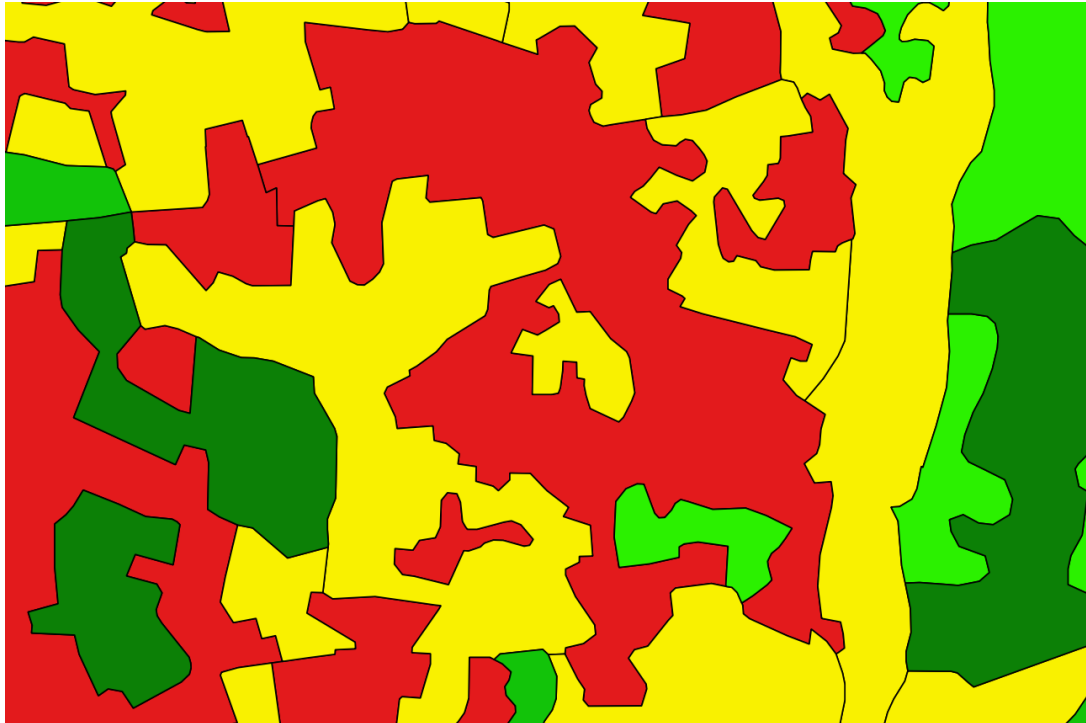


The producer
perspective

An analyst draw
polygon lines around
landscape units that
share the same land
cover land use

The traditional way to do land cover land use maps

Visual
and manual interpretation of
aerial or satellite images



The complexity
of the
landscape is
lost

The user
perspective

- Artificial land
- Agriculture
- Cork and Holm oak
- Eucalytus
- Other broadleaves
- Maritime pine
- Stone pine
- Other conifers
- Shrubland
- Spontaneous grassland
- Bare soil
- Wetlands
- Water

COS – National Land Cover Land Use Map



5 editions

1995

2007

2010

2015

2018



Land cover Land use maps are the geographical thematic information most used

But.... traditional maps

The production is very expensive and very time consuming

Long updating cycles

These maps do not meet all user requirements



Substantial generalisation (e.g. we do not map single trees or single buildings)



Traditional maps do not capture land cover dynamics (e.g. we do not map forest clear cuts)

We need:

- Less map generalisation
- Continuous monitoring for capturing land cover dynamics
- New products



How?

Through New data and new tools

data



Sentinel satellites

Paradigm shift in Earth Observation

High frequency of image acquisition

High spatial resolution

Free access data policy



High frequency of image acquisition

High spatial resolution

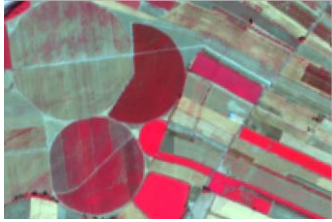
Free access data policy



Sentinel 2 satellite
Images every 5 days
Pixels – 10 m

Multi-temporal image data

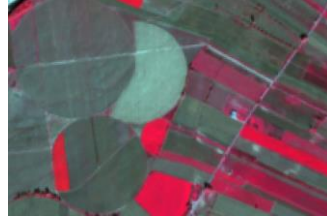
January



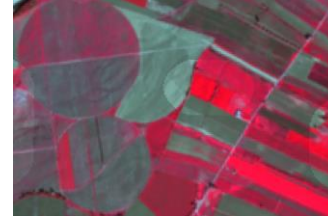
February



March



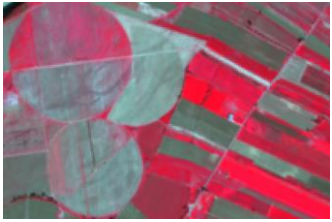
April



1.2 billion data values

big data problem

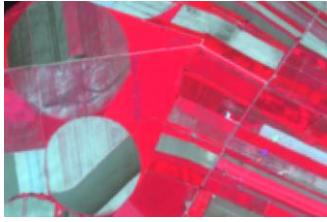
May



June



July



August

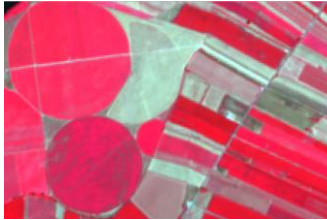


Traditional algorithms do not fully explore big data

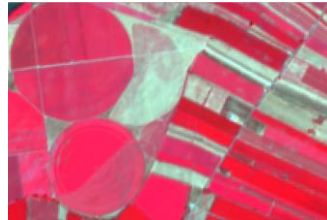
September



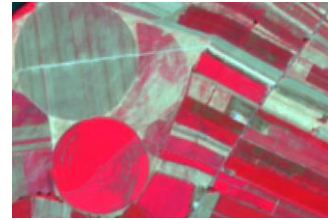
October



November



December



Artificial Intelligence

data



Free and open data
policy

Tools and
the now-
how



R&D



Public
Administration
Competence
Centre for
satellite image
processing for
the territory

Purpose

Societal needs

e.g. The definition, implementation and monitoring of
Public policies require reliable and updated data



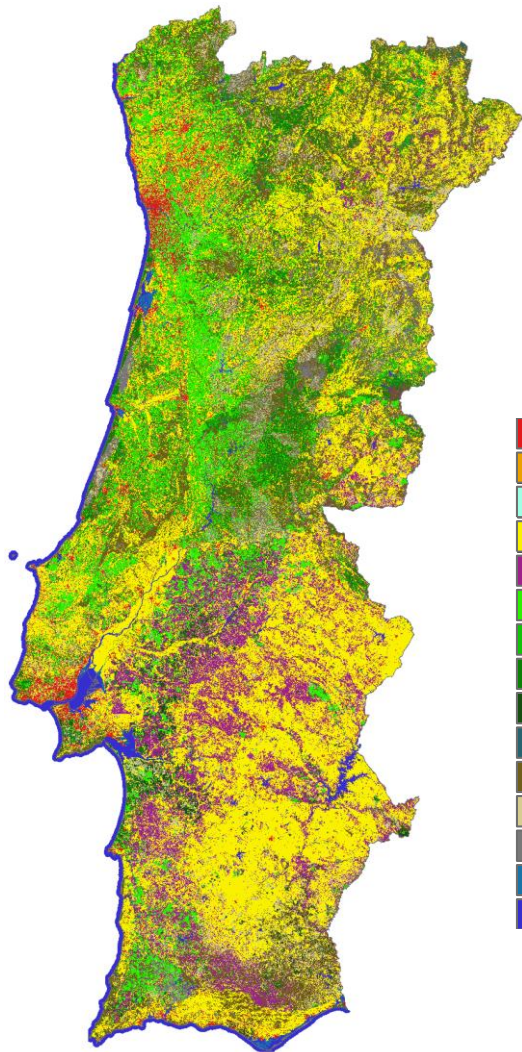
National Mapping Agency

Official land cover maps

Competence Center on
satellite image processing

Long history of co-creation
within Public Administration

The perfect combination of factors
for developing SMOS

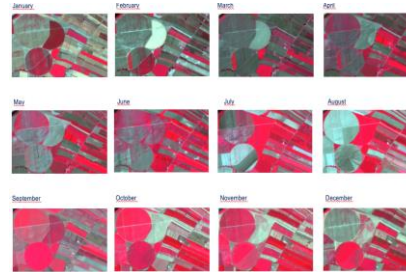


COSsim 2018

pixel – 10 m

Nomenclature – 13 classes

- Artificial land
- Outumn/Winter annual crops
- Spring/Summer annual crops
- Other agricultural areas
- Cork and Holm oak
- Eucalyptus
- Other broadleaves
- Maritime pine
- Stone pine
- Other conifers
- Shrubland
- Spontaneous grassland
- Bare soil
- Wetlands
- Water



AI



2018
2020
2021



Overall accuracy – 83%

SMOS

Land Cover Monitoring System for Portugal

		Data	Methods	Thematic detail	Spatial detail	Periodicity
COS	Land Cover Land Use map	Aerial photography	Manual	83 classes	1 ha	3 years
COSsim	Simplified Land cover map	Satellite	Automatic	13 classes	100 m2	1 year
MIAEV	Vegetation status map	satellite	Automatic	Quantitative	100 m2	1 month

Traditional map

COS

Visual interpretation
of aerial photos

vs

New map

COSsim

Automatic
classification of
satellite images

**COSsim captures the landscape heterogeneity better than
COS**

Urban areas

COS vs. COSsim



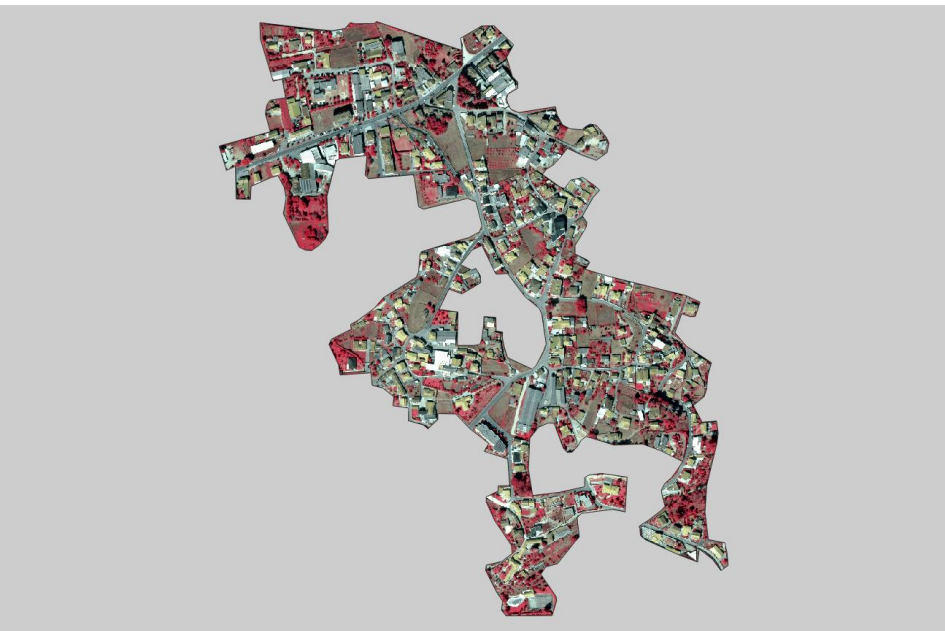
COS2018 polygons over ortos 2018



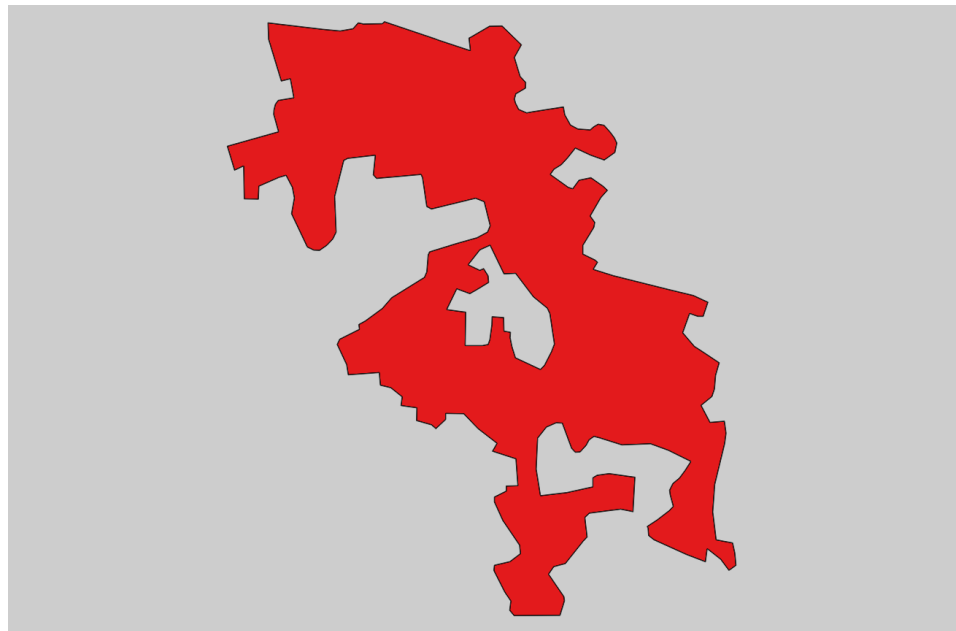
COS2018

- Território artificializado
- Agricultura
- Florestas de eucalipto
- Florestas de outras folhosas
- Florestas de pinheiro bravo

COS vs. COSsim



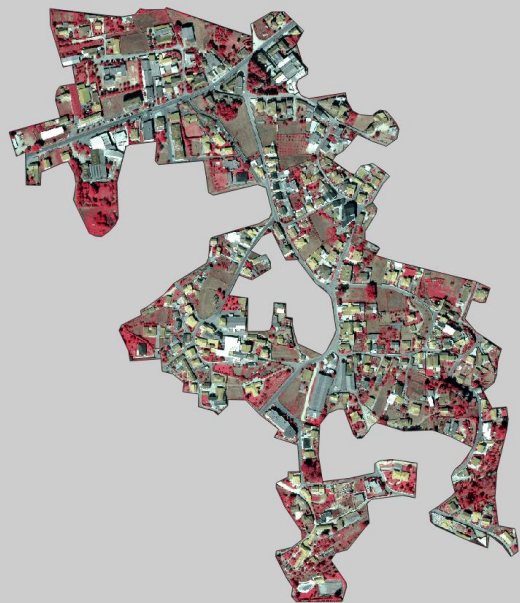
COS2018 polygons over ortos 2018



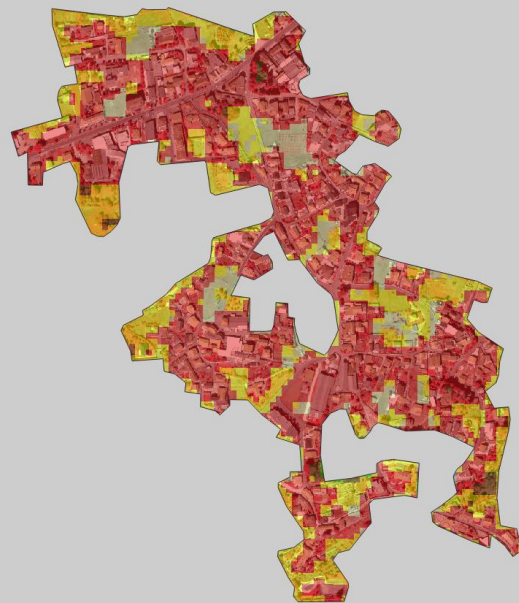
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COS vs. COSsim



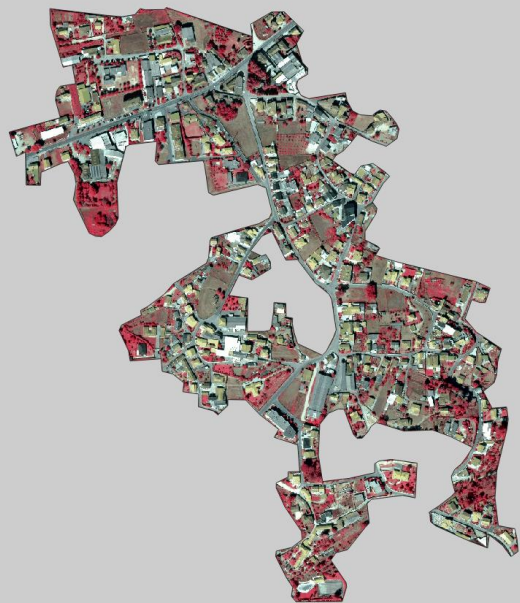
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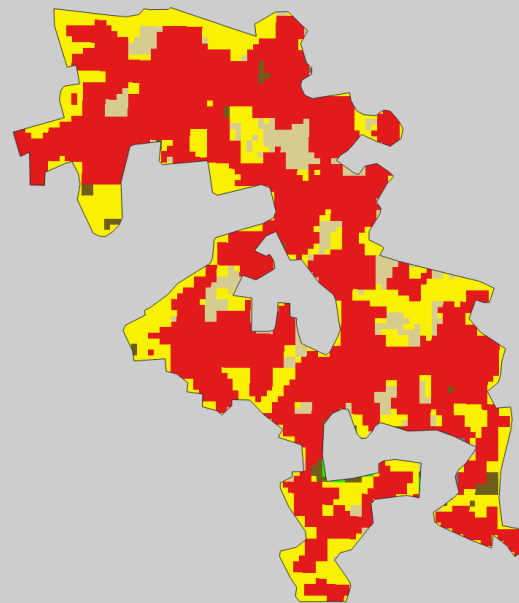
COSsim2018

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COS vs. COSsim



COS2018 polygons over ortos 2018

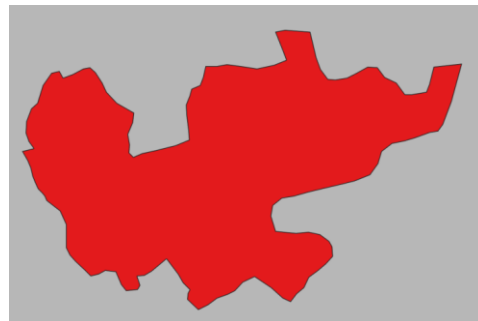
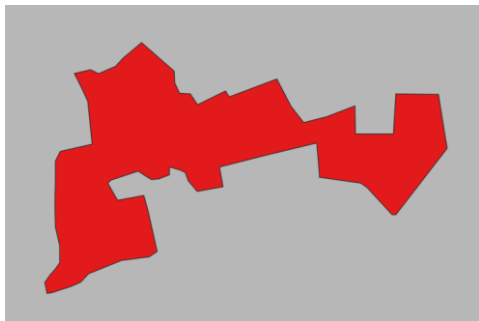


COSsim2018

- Território artificializado
- Agricultura
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COS



COSsim



- Artificial land
- Agriculture
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- Eucalytus
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- Shrubland
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- Flood risk
- Fire risk
- Urban planning

Traditional map

COS

Visual interpretation
of aerial photos

vs

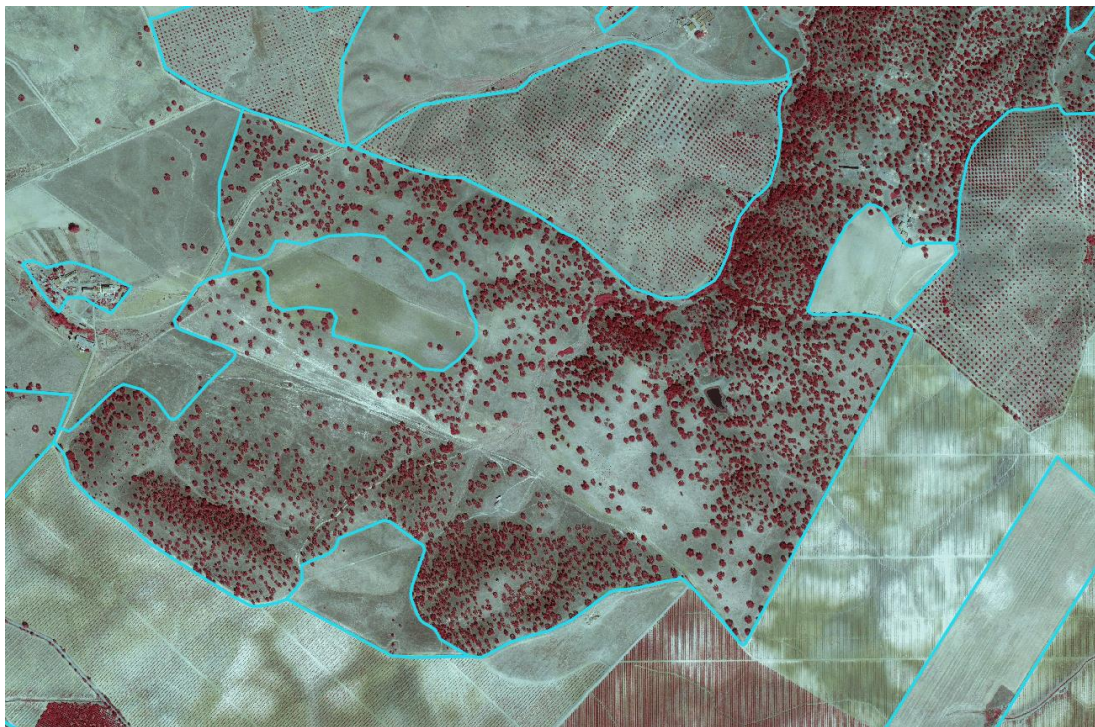
New map

COSsim

Automatic
classification of
satellite images

**COSsim captures the landscape heterogeneity better than
COS**

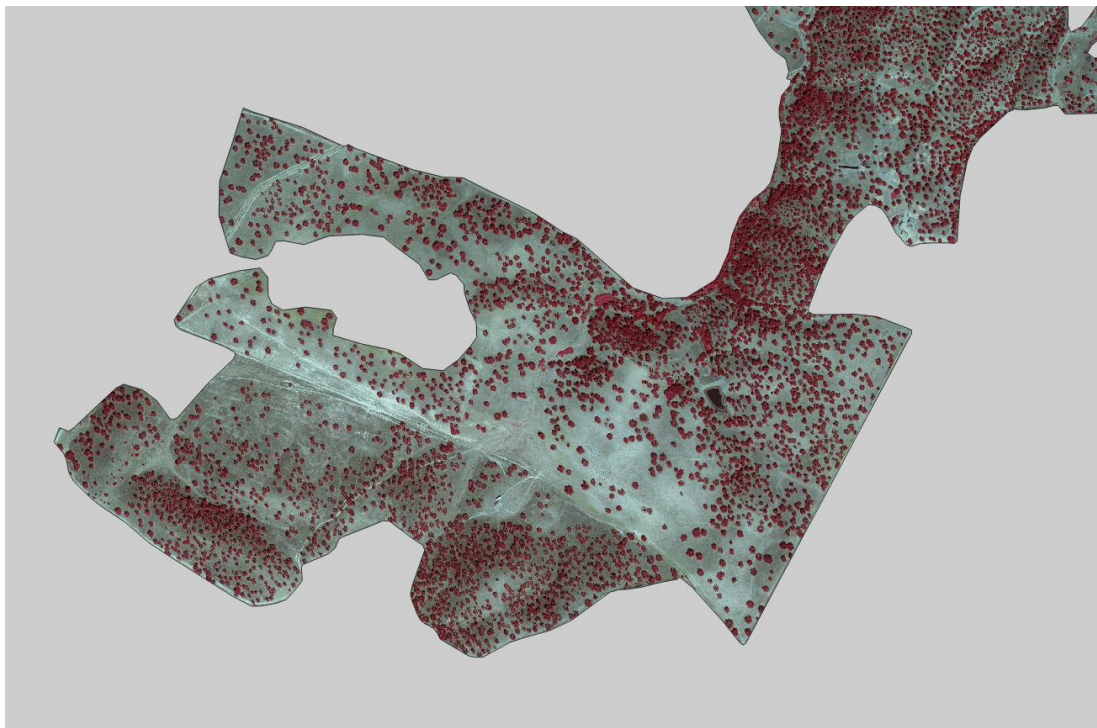
Agroforestry areas

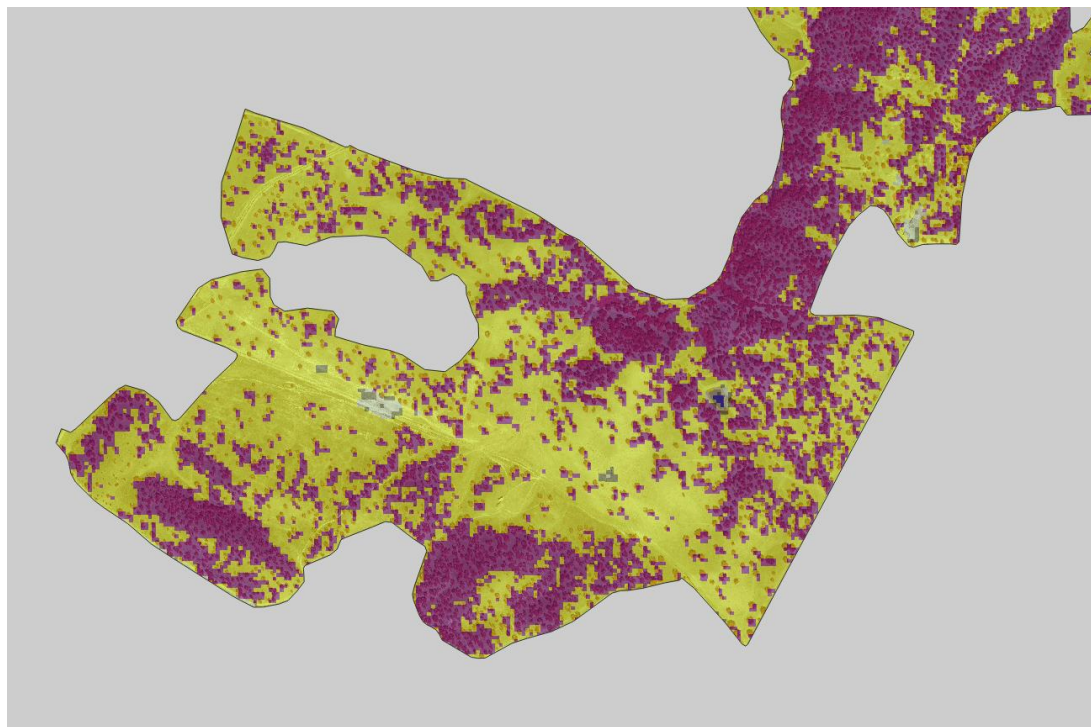


COS



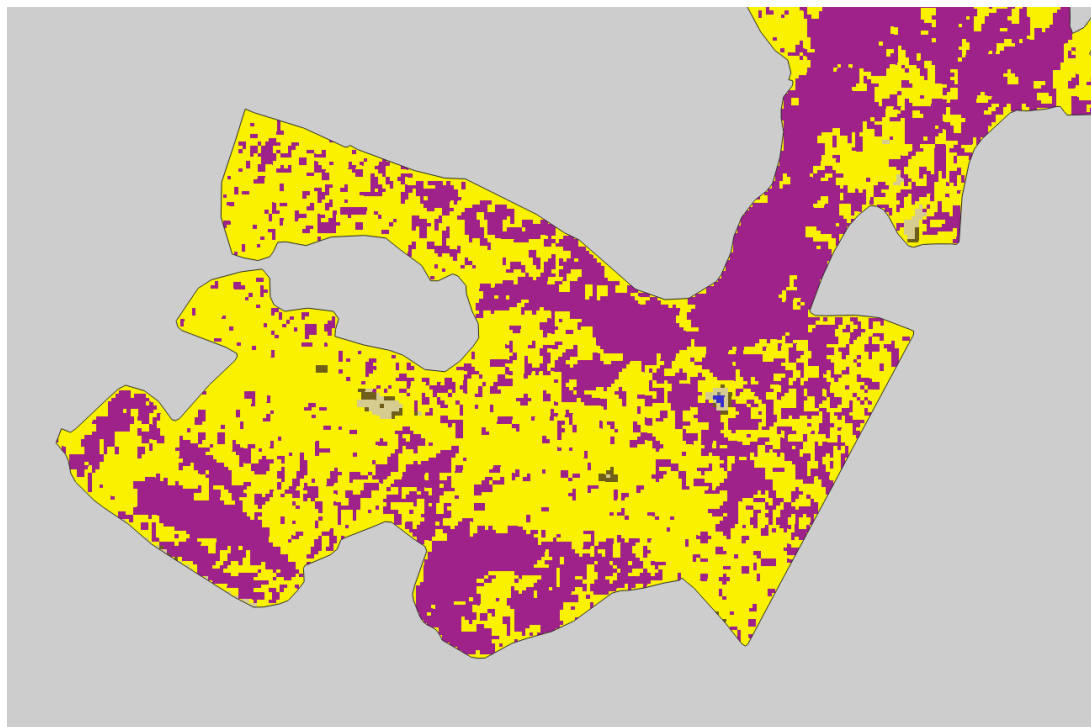






COSsim

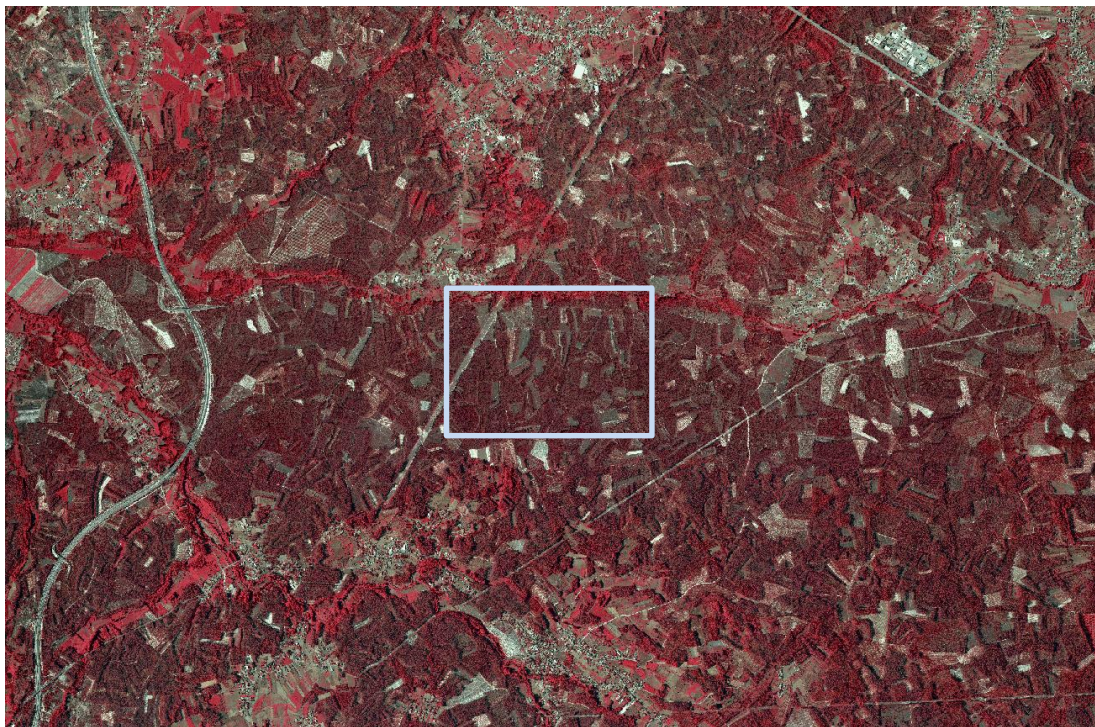
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COSsim

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SMOS for forest



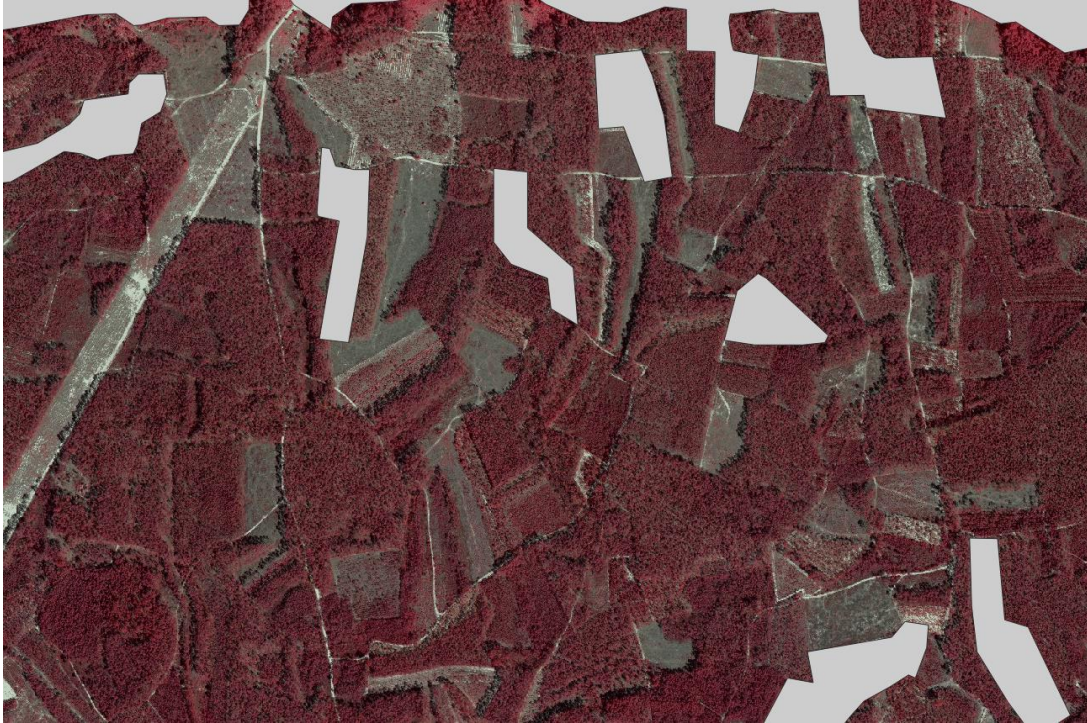




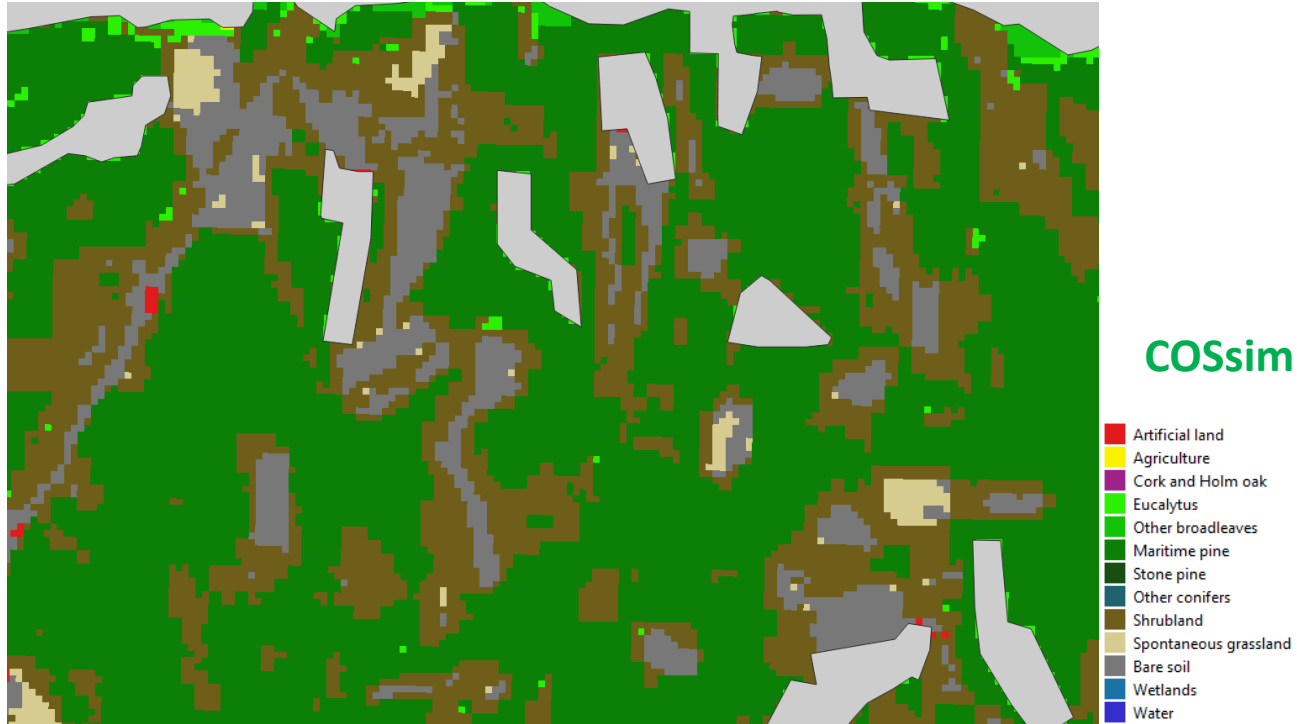
COS

 Pine stand forest

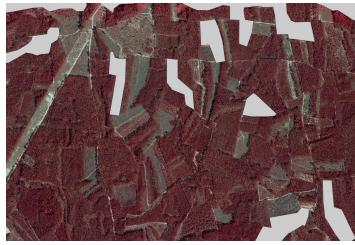
The same land use (e.g. pine forest) can have different land cover, e.g. trees and herbaceous (after clear cuts)



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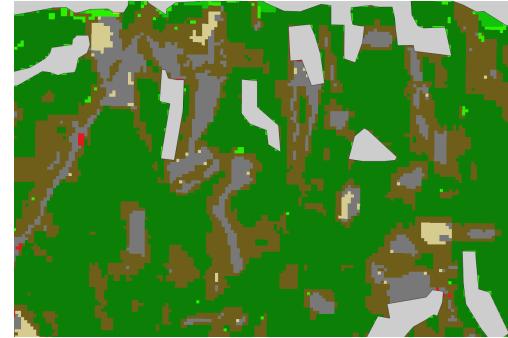
The same land use (e.g. pine forest) can have different land cover, e.g. trees and herbaceous (after clear cuts)



COS

Land use

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COSsim

Land cover



Free and open
data policy

AI

1 image every 5 days

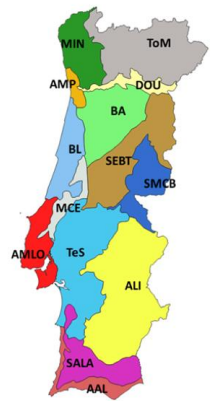
Forest monitoring

Legislation compliance verification

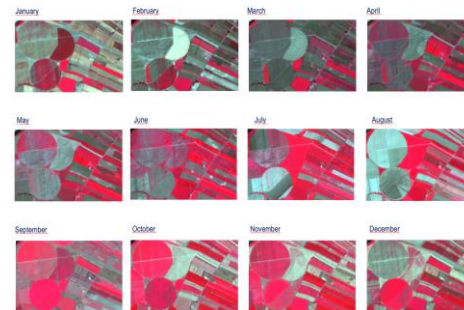
Timber yield estimation

Carbon stock monitoring

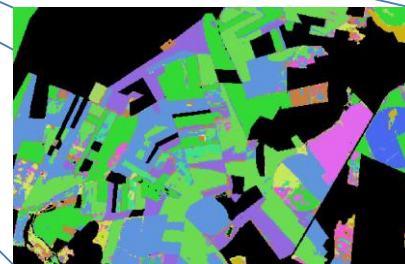
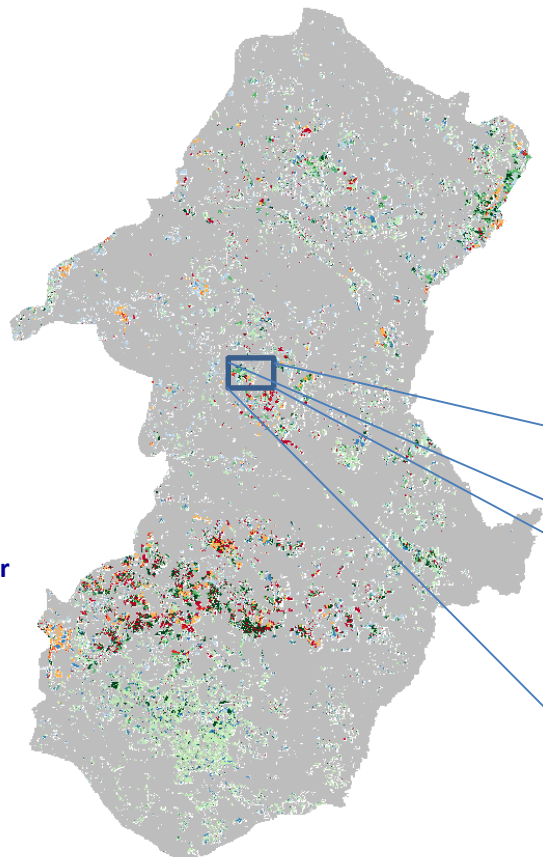
**SMOS
for
agriculture**



Crop maps



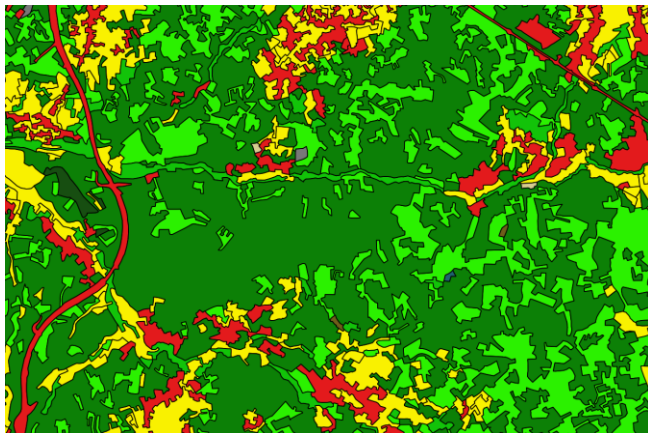
UP: Alentejo Interior



31 crops

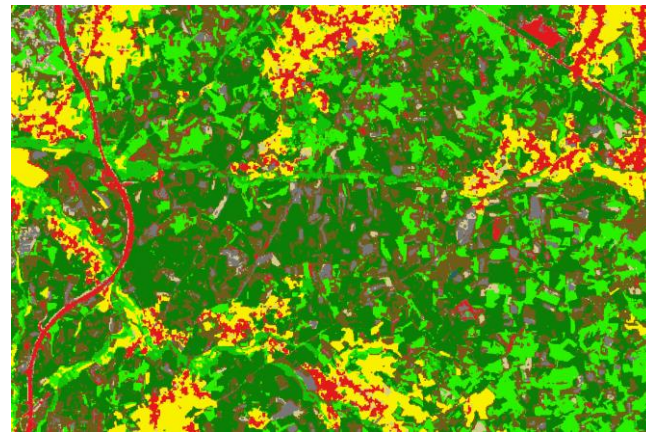
- Aveia
- Azevem
- Trigo
- Tríticale
- Centeio
- Cevada
- Tremocilha
- Tremçoço
- Consiação de fixadoras de azoto
- Ervilha
- Fava
- Trevo
- Milho
- Outras Hortícolas
- Batata
- Sorgo
- Abóbora e Aboborinhas
- Feijão
- Arroz
- Tom ate
- Girassol
- Batata doce
- Cenoura
- Couve
- Grão de bico
- Melão
- Beterraba
- Cebola
- Courgete
- Nabo
- Outras Leguminosas secas

SMOS
for
fire risk assessment and
management



COS

Land use map



COSsim

Land cover

Fire risk mapping

Fire spread modelling

Fire fighting

- Artificial land
- Agriculture
- Cork and Holm oak
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- Spontaneous grassland
- Bare soil
- Wetlands
- Water



SISTEMA NACIONAL
DE INFORMAÇÃO GEOGRÁFICA

→ ↺ 🏠 mapas.dgterritorio.pt/viewer/areasedificadas.html

☆ 🔍 Carta de Interface de Áreas Edificadas



[eMails] Dictionaries Scholar TV Utils Satellites Spotify Casa Jobs Liana Cursos Turismo Meteo R Altmetric it! Sentinel Almoços NTME Covid-19 Zoom Sci-Hub edoc TIB Design-based method... cos Ponto

Direção Geral do Território

CAOP 2018:

- ☒ Municipios
- ☐ Municipios 2018
- ☐ Freguesias

Interfaces de áreas edificadas

- ☐ Interface Estrutural 2018
- ☒ Interface Conjuntural 2020

☒ Direta

☐ Indireta 1

☐ Indireta 2

☐ Nula

Áreas edificadas

- ☒ Áreas edificadas 2018

Informações



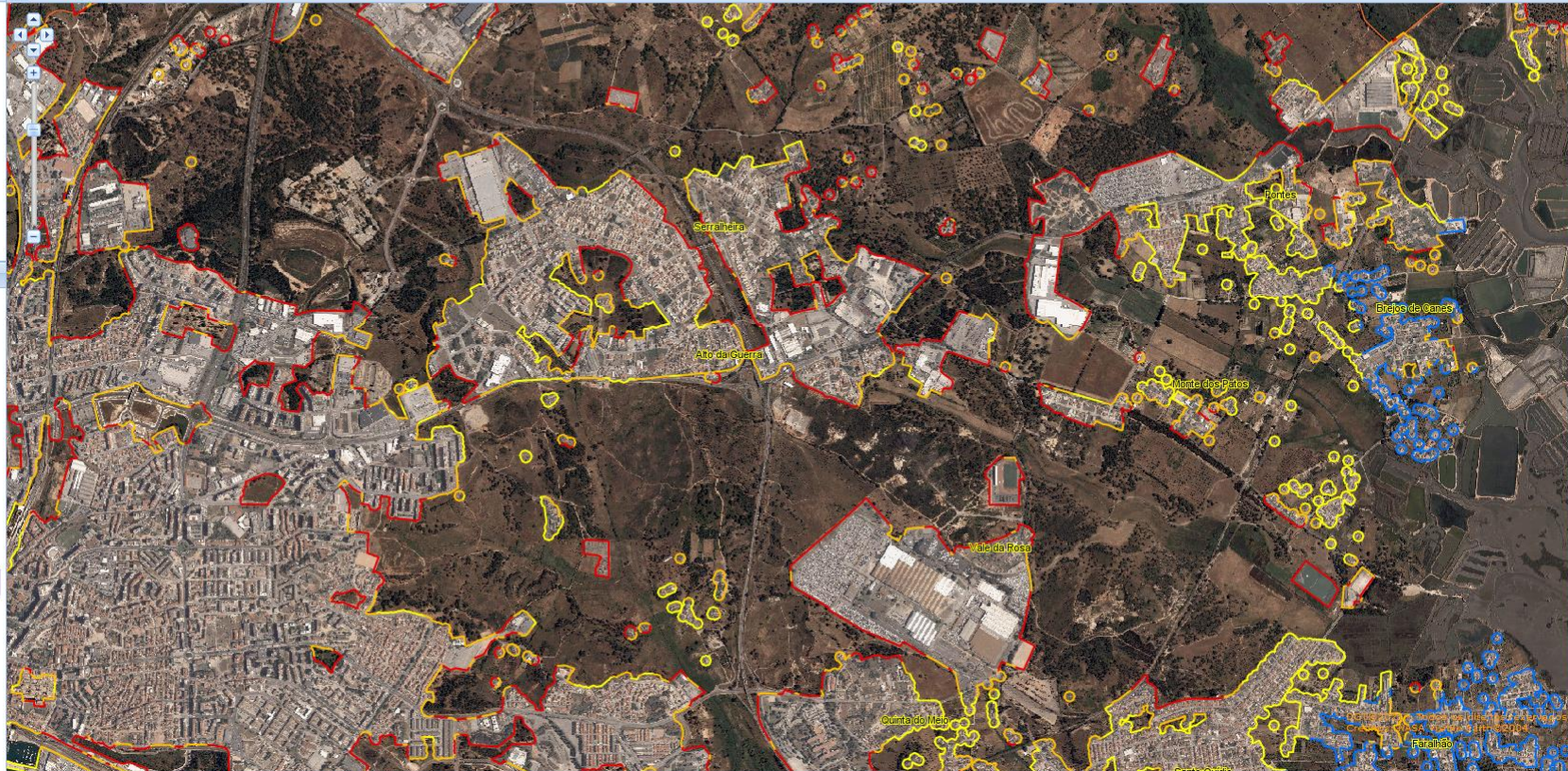
Sobre esta [Cartografia](#).

Todos os produtos estão disponíveis no [SNIG](#).

Notas: A informação relativa à interface e áreas edificadas só é visível a grandes escalas (zoom ≥ 8).

Para consultar os atributos dos temas apresentados, deve activá-los na barra lateral esquerda, seleccionar a ferramenta "I" e clicar no mapa sobre o tema pretendido.

Programa de financiamento: POSEUR-02-1810-FC-000504.

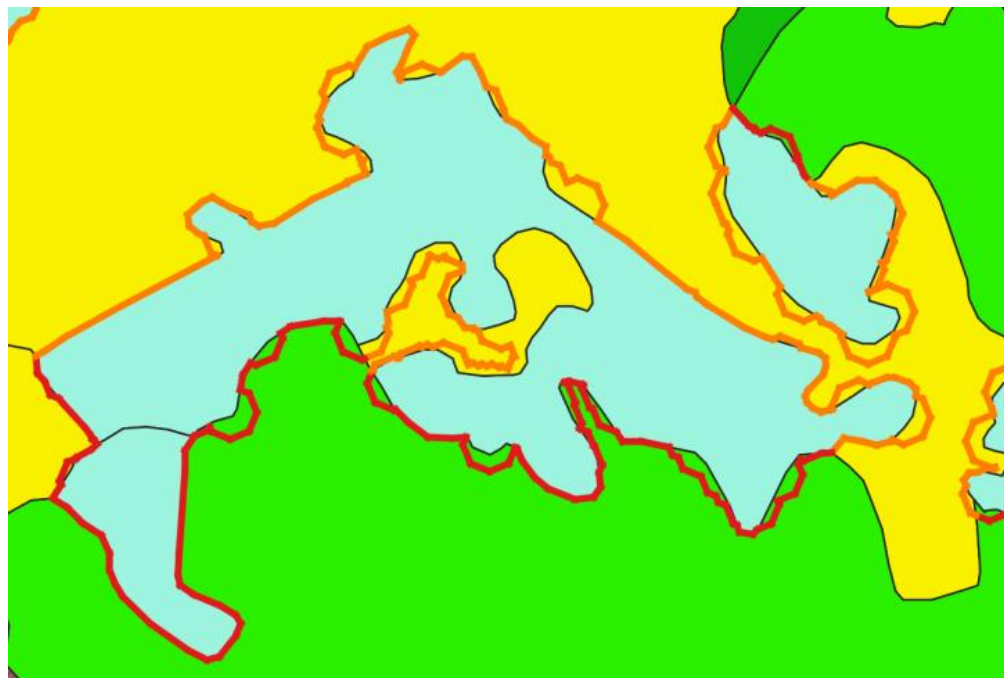


National Rural-Urban interface Map

Direct interface

Indirect interface

COS



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COS



National Rural-Urban interface Map

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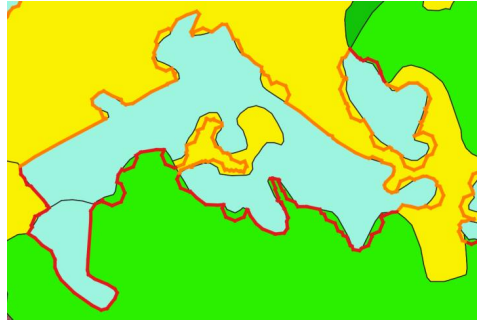
National Rural-Urban interface Map



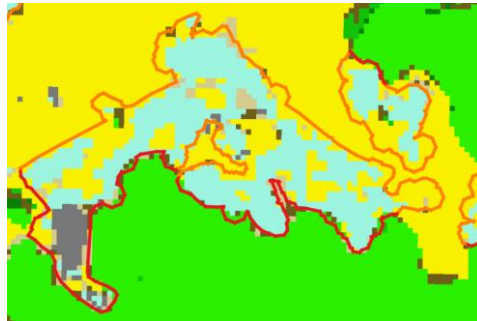
Direct interface

Indirect interface

COS



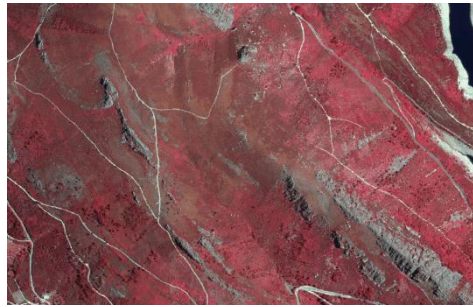
COSsim



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Capturing the recovery of burned areas

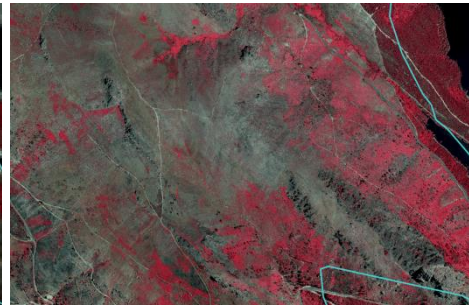
Shrubland



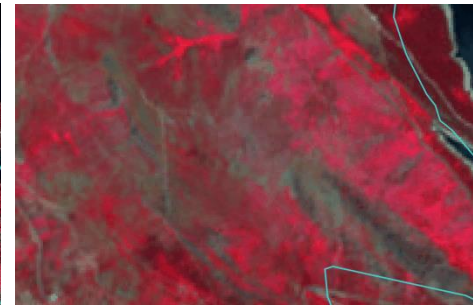
Orto 2015



S2 – October 2017

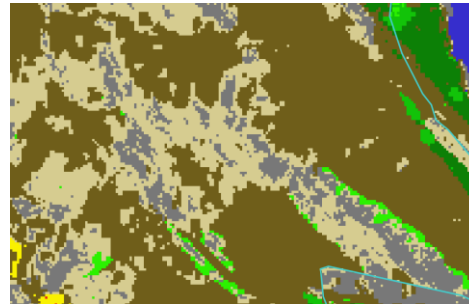


Orto 2018

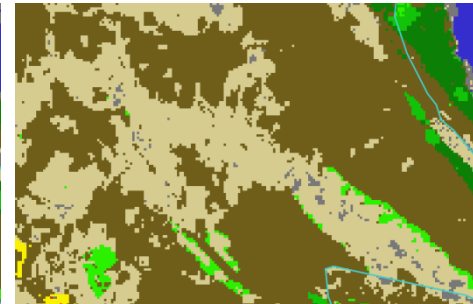


S2 – August 2020

- Artificial land
- Outumn/Winter annual crops
- Spring/Summer annual crops
- Other agricultural areas
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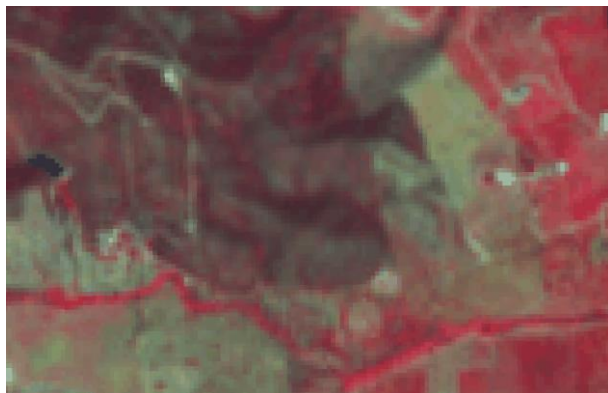


COSsim2018

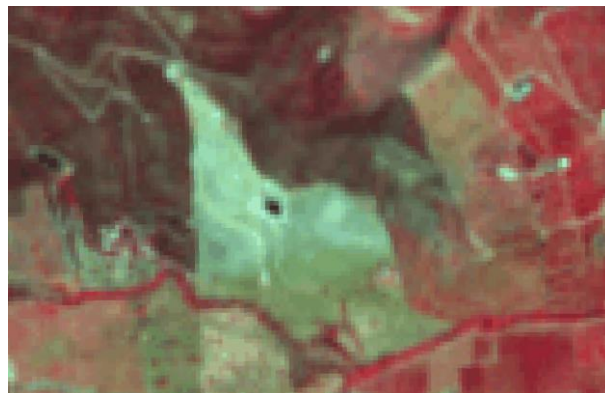


COSsim2020

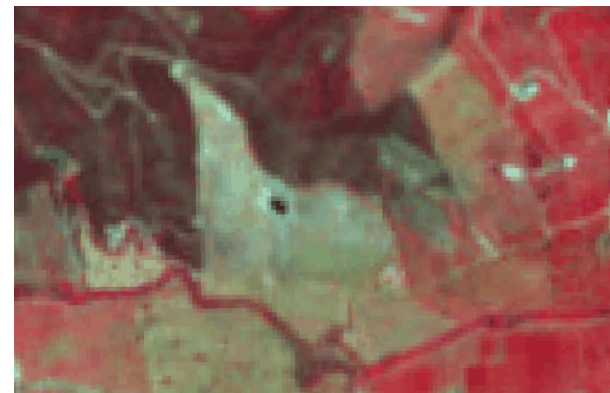
Vegetation clear cuts in 2019



2018

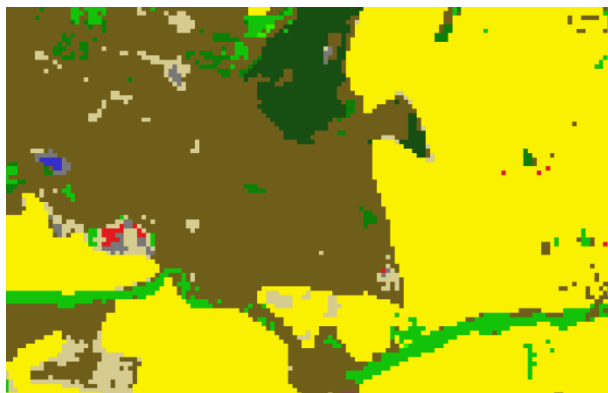


2019



2020

COSSim2018

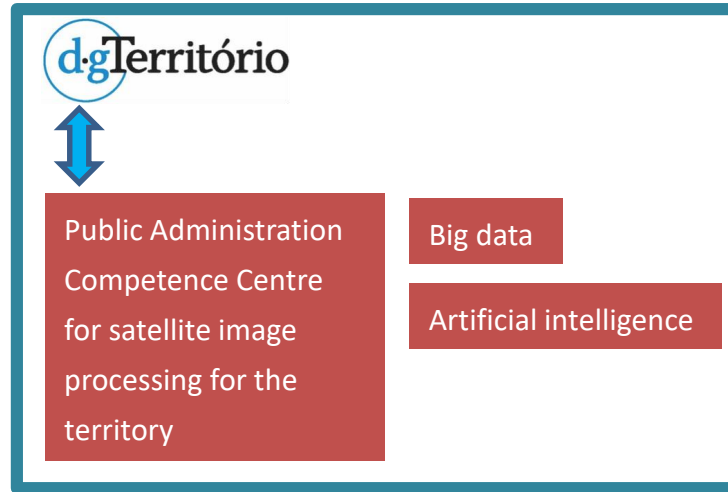


COSSim2020



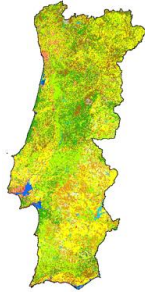
SMOS

Phase II – Cocreation with academia and user group (**guSMOS**) for development of new products and methodologies



Phase I –

- concept development
- prototyping
- concept demonstration





Co-creation through Design thinking

NOVA **innovation
& analytics** lab
powered by NOVA IMS



18 interviews
+ 50 participants in co-creation sessions
+ 30 entities

+ 390 ideas

SMOS

Phase II – Cocreation with academia and user group (guSMOS) for development of new products and methodologies



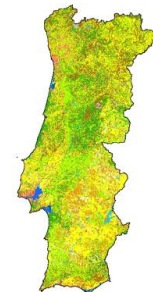
Public Administration
Competence Centre
for satellite image
processing for the
territory

Big data

Artificial intelligence

Phase I –

- concept development
- prototyping
- concept demonstration



Phase III – SMOS goes into operation (dec 2022)



Instituto de Geografia
e Ordenamento do Território
UNIVERSIDADE DE LISBOA



INSTITUTO
SUPERIOR D
AGRONOMIA
Universidade de Lisboa



Ciências
ULisboa

guSMOS



guSMOS

CTC

SMOS

a collaborative system

guSMOS - User consultation group (public administration, NGO) - entities

CTC - Technical and Scientific Board – persons

3 National committees (Cartography Committee, Territory Commission, Spatial Data Infrastructures Committee)

Development of
concept

Map definition

Methodology
development

Governance

evolution



SMOS

Sistema de Monitorização de
Ocupação do Solo

mario.caetano@dgterritorio.pt

