Pilot-study on mapping and assessment of ecosystem services in Portugal, Alentejo region

Workshop on Ecosystem Assessment and Ecosystem Services in Portugal
Cascais, December 11\textsuperscript{th} 2015
Target 2

By 2020, ecosystems and their services are maintained and enhanced by establishing green infrastructure and restoring at least 15 % of degraded ecosystems.

Action 5

Improve knowledge of ecosystems and their services in the EU

Member States, with the assistance of the Commission, will map and assess the state of ecosystems and their services in their national territory by 2014, assess the economic value of such services, and promote the integration of these values into accounting and reporting systems at EU and national level by 2020.
ptMAES Pilot Study

Scope

Agro-ecosystems
Agro-forestry ecosystems
Forest ecosystems

NUTS II Alentejo

Mapping

• Ecosystems

• Ecosystem Condition
  • Soil organic matter
  • Ecological value of plant communities
  • Phytodiversity
  • Zoodiversity

• Ecosystems Services
  • Soil protection
  • Carbon sequestration
  • Fiber production
  • Crops production
  • Animal production
ptMAES Team

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Mapping Ecosystems

Mapping Condition

Mapping Ecosystem Services

ptMAES EUNIS
Why use the EUNIS habitat classification?

● **Comprehensive**, including artificial habitats and common vegetation as well as more valuable habitats.

● **Hierarchical**, allowing the use of the level which is more adequate to the detail of available information.

● Is being revised and crosswalks have been developed between level 3 EUNIS terrestrial habitat types and vegetation syntaxa, which are established for most of the Portuguese native vegetation.

● **Pan-European** classification.
Ecosystems Mapping

How to map ecosystems from COS’07 (N5)?

- 1 (COS N5) : 1 (EUNIS) relations between land use types and EUNIS habitat types
- 1 (COS N5) : N (EUNIS) relations solved using auxiliary information:

**Geological map**

- to separate pine forests of high natural value from other pine plantations;

**Distance to coast line**

- to separate coastal cliffs and dunes ecosystems from inner cliffs and sparsely vegetated areas;

**NDWI derived from satellite imagery**

- to separate dry grasslands from wet grasslands;

**Vegetation series map**

- to separate different types of native heathland, scrub and woodland.

1: N auxiliary information (25%)

1:1 direct relationship (75%)


![Map of ecosystems](image)
Ecosystems Mapping

- N1: (0%) Auxiliary information required
- N2: (21%) Directly attributed
- N3: (53%) (6%) Auxiliary information required, (46%) Directly attributed
- N4: (11%) (3%) Auxiliary information required, (12%) Directly attributed
- N5: (11%) (15%) Auxiliary information required, (1%) Directly attributed
- N6: (1%) (15%) Auxiliary information required, (1%) Directly attributed

Level “N”:
- (25%) Auxiliary information required
- (75%) Directly attributed
Ecosystems Mapping

EUNIS ptMAES N2

- **Grasslands** [35.0%]
  - Dry grasslands
  - Seasonally wet/wet grasslands
  - Dehesa
- **Woodlands** [37.1%]
  - Broadleaved deciduous woodland
  - Broadleaved evergreen woodland
  - Coniferous woodland
  - Mixed deciduous and coniferous
  - Lines of trees, small woodlands, recently felled woodland
- **Cultivated Lands** [21.7%]
  - Arable land and market gardens
Ecosystem Maps

Highlights

- First ecosystems map produced in Portugal, with high thematic (EUNIS levels 2 to 5) and spatial detail (1:25 000);
- Ecosystems mapping based on interpreting land-use units as territorial units of ecological succession;
- Replicable methodology, allowing timely updates;
- Higher (ecological) detail than COS
Ecosystems Condition

Soil Organic Matter

Ecological Value

Zoodiversity

Phytodiversity
Each EUNIS level N ecosystem was given a score (1 to 5) for each of the five parameters;

Scores were given based on the EUNIS classification and considering spatial information on land-use (COS 2007) and the Potential Natural Vegetation map (PNV);

- **Naturalness**  
  1 = maximum human alteration  
  5 = minimum human alteration

- **Replaceability**  
  1 = exotic vegetation and plantations  
  5 = climax communities

- **Threat**  
  1 = isolated communities/biotopes  
  5 = communities near urban centers

- **Rarity**  
  1 = rarity type 0 (Izco, 1998)  
  5 = rarity type 6 and 7 (Izco, 1998)

- **Condition**  
  1 = maximum perturbation  
  5 = low perturbation (dense forests)

Ecological Value = Average of scores
Ecosystems Condition: Phytodiversity

● Approach overview
  • Methodology based on the assumption that vegetation series map provides information on the natural communities occurring at each location.
  • It is thus possible to consult phytosociological table of these communities and to know its average or characteristic floristic composition;
  • For calculating phytodiversity in each plant community, estimates were made of mean values of:
    i) protected species
    ii) other endemic species
    iii) other rare plants
    iv) characteristic species
  • The final value of phytodiversity is a weighted average of these parameters using, respectively, values of 4, 3, 2 and 1
Ecosystems Condition: Soil Organic Matter

- Attribution of Kyoto Protocol (KP) classes to COS 07 and COS 1990 categories
- Spatial land-use transition analysis from 1990 to 2007
Ecosystems Condition: SOM

**SPATIAL LAND-USE TRANSITION ANALYSIS**

- **COS 1990** (with missing data)
- **COS 2007**
- **KP 2007**

- **<Mask>**
- **<Clip>**

- **CORINE LAND COVER 1990**

- **<Merge>**

- **COS 90 x COS 07**

- **COS 1990* (no missing data)**
- **KP 1990**

- **Transition Analysis (1990 → 2007)**

**Harmonization of legend (CLC – COS)**
Ecosystems Condition: Zoodiveristy

- Portugal Aves database contains different types of records
  - Only validated bird data from official SPEA Campaigns (2004-2011) was used
- Binary model for probability of occurrence considering biophysical variables (atmospheric temperature, precipitation, topography, land use)
- 50 bird species modeled (top-50 species considering observation frequency in NUTS II Alentejo); 40 species with satisfactory and eligible model results
Ecosystems Condition: Zoodiversity

Highlights

Little egret (Garça-branca pequena) – *Egretta garzetta*
- Very common on the Tagus estuary and riversides, Alverca saltmarshes, and Ponta da Erva. Present throughout the coast line of Alentejo, most common in the Sado estuary and in interior riversides and dams

Thekla lark (Cotovia-montesina) - *Galerida theklae*
- Present throughout most of Alentejo, though more common on the countryside. Mostly abundant in Nisa and Marvão (Alto Alentejo), and in Mourão, Castro Verde and Mértola
Ecosystems Condition: Global Overview

EUNIS ptMAES

- B: Coastal habitats
- E: Grasslands
- F: Scrub
- G: Woodland
- H: Sparsely vegetated habitats
- I: Agricultural
- J: Artificial habitats
- X: Habitat complexes

Ecological Value

- Valor
  - Higher
  - Lower

Phytodiversity

- Classe
  - Higher
  - Lower

Zoodiversity

- Nivel
  - Higher
  - Lower
Ecosystem Services: Soil Protection

Soil Protection (erosion avoidance)
Contribution of each ecosystem to decrease potential soil erosion

- Methodology based on the Universal Soil Loss Equation (USLE)

\[
\text{Avoided Erosion} = (R \times K \times LS \times \overset{\text{P}}{\overset{\text{CR}}{\text{P}}} \times CR) - (R \times K \times LS \times \overset{\text{P}}{\overset{\text{CA}}{\text{P}}} \times CA)
\]

- Potential Erosion
  - \( R \) = Erosivity factor
  - \( K \) = Erodibility factor
  - \( LS \) = Topographic factor
  - \( CR \) = Reference soil cover = 1 (no cover)

- Estimated Erosion
  - \( R \) = Erosivity factor
  - \( K \) = Erodibility factor
  - \( LS \) = Topographic factor
  - \( CA \) = Actual soil cover

⚠️ \( P \) = Conservation practice factor, considered constant (= 1)
Ecosystem Services: Soil Protection

Estimated erosion

Potential erosion (worst-case scenario)

Avoided erosion (soil protection service)
Ecosystem Services: Crop Production

- Attribution of crop statistics (INE) to land use classes (COS’07), considering only “pure” classes (e.g., 2.2.1.02.1 Vinhas com pomar was not considered)

<table>
<thead>
<tr>
<th>Principais Culturas Alentejo (NUTS II)</th>
<th>Correspondência com COS07NS5</th>
<th>Produção Alentejo (t)</th>
<th>Suorefície Alentejo (ha)</th>
<th>Produtividade (t/ha)</th>
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<tr>
<td></td>
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<td>Principais leguminosas secas</td>
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<td>x</td>
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<td>137121</td>
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<td>x</td>
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<td>Tabaco</td>
<td>x</td>
<td>1321</td>
<td>132</td>
<td>x</td>
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<td>Beterraba</td>
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<td>208867</td>
<td>2259</td>
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<td>Lúpulo</td>
<td>x</td>
<td>0</td>
<td>0</td>
<td>x</td>
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</table>
Average increment rates for forest species were used as a proxy for the quantification of the service;

Increment rates were spatialized using the Kyoto Protocol land use classes land use map for Alentejo (after compatibilization of legends - KP/COS 07)
Ecosystem Services: Carbon Sequestration

The service of CO$_2$ sequestration is highly dependent on land-use changes, as land-use changes cause variations in CO$_2$ stocks and fluxes to (and from) the atmosphere

- Two carbon pools considered: **Biomass** and **Soil**;

- Based on the methodology of the National Inventory Report (NIR, APA 2014) ▼

- **Carbon sequestration in biomass** is given by the balance “GAINS – LOSSES” for a given period of time, considering land-use changes, mortality, and other relevant events that may have occurred during this period (e.g. fire events);

- **Land-use changes** (transitions) were determined as explained in “Soil Organic matter”;

- **Carbon sequestration in soils** is given by the variation in soil carbon stock due to land-use changes

⚠️ Different land-use classification system (KP)
• Methodology involved determining the average livestock density in pasture areas (using INE information at the Municipality level);

• COS 07 classes considered:

<table>
<thead>
<tr>
<th>Classes COS’07</th>
<th>Superfície de prados e pastagens permanentes</th>
<th>Área COS’07 (na área de estudo) (ha)</th>
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<td>SAF de sobreiro com pastagens</td>
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<td>2.4.4.03.2</td>
<td>SAF de azinheira com pastagens</td>
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<td>2.4.4.03.3</td>
<td>SAF de outros carvalhos com pastagens</td>
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<td>2.4.4.03.4</td>
<td>SAF de outras espécies com pastagens</td>
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<td>2.4.4.03.5</td>
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<td>2.4.4.03.6</td>
<td>SAF de outras misturas com pastagens</td>
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<td>Total</td>
<td></td>
<td>923154</td>
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</table>
Linking Condition and Ecosystem Services
São Mamede Natural Park
São Mamede Natural Park
EUNIS ptMAES (N2)

Soil Protection

Carbon Sequestration

Fiber

Crops production

Animal production
São Mamede Natural Park
<table>
<thead>
<tr>
<th>Area</th>
<th>Ecosystem Condition</th>
<th>Ecosystem Services</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>Ecosystem Condition</td>
<td>Phytodiversity</td>
<td>SOM</td>
<td>Zoodiversity</td>
</tr>
<tr>
<td>EUNIS ptMAES Level N</td>
<td>%</td>
<td>4 or 5</td>
<td>4 or 5</td>
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<tr>
<td>E1 Dry grasslands</td>
<td>14</td>
<td>4 or 5</td>
<td>&gt; 85 tonC/ha</td>
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<tr>
<td>E7 Sparsely wooded grasslands</td>
<td>20</td>
<td>&gt; 20 ton/ha/yr</td>
<td>&gt; 2 tC/ha/yr</td>
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<tr>
<td>F4 Temperate shrub heathland</td>
<td>1</td>
<td>2</td>
<td>2</td>
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<tr>
<td>F5 Maquis and thermo-Mediterranean brushes</td>
<td>2</td>
<td>1</td>
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<tr>
<td>F6 Garrigue</td>
<td>1</td>
<td>2</td>
<td>2</td>
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<tr>
<td>FB Shrub plantations</td>
<td>1</td>
<td>1</td>
<td>1</td>
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<tr>
<td>G1 Broad. deciduous woodland</td>
<td>1</td>
<td>3</td>
<td>3</td>
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<tr>
<td>G2 Broad. evergreen woodland</td>
<td>23</td>
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<td>1</td>
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<tr>
<td>G3 Coniferous woodland</td>
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<td>2</td>
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<tr>
<td>G4 Mixed deciduous &amp; coniferous woodland</td>
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<td>G5 Lines of trees, small woodlands, recently felled woodlands</td>
<td>8</td>
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</table>
Conclusions - Alentejo

- Ecosystem types tend to be specialized in the services they provide, however:
  - dry and sparsely wooded grasslands (*montado*) combine soil protection and animal production;
  - coniferous woodland combines carbon sequestration and fiber production.

- There is a significant mismatch between condition and ecosystem services:
  - e.g., shrublands and broadleaved deciduous woodland tend to have high ecological condition but low provision of ecosystem services;
Conclusions - Outlook

- First mapping and assessment of ecosystem services in the EU based on the European Commission’s MAES guidelines: mapping ecosystems using the EUNIS classification and analyzing conditions and services based on it.
- The fine grained (1 ha) analysis here developed can provide the basis for spatialized natural capital management policies (e.g., identification degraded areas for recovery, green infrastructure, payments for ecosystem services in the CAP).
- Future work involves the extension to all of Portugal, the increased use of process based models and the consideration of a wider range of ecosystem services and indicators of ecological condition.
Pilot-study on mapping and assessment of ecosystem services in Portugal, Alentejo region

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