Forest indicators to support regional policy and management in the Carpathian Mountains

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The Carpathian Mountains are one of the most important forest ecosystems in Europe due to their **high concentration of virgin forests**;

The “**protocol for sustainable forest management**”, signed by the Carpathian Convention Parties is formalising the need to preserve the richness and ensure sustainable use of the Carpathian forests.

In this framework, EEA signed a partnership agreement with the Carpathian Convention Secretariat in July 2014 and included a work plan that is being implemented by one of its European Topic Centres (actually ETC/ULS) represented by the University of Malaga (UMA).
In 2014:
The UMA produced a report assessing the multi-sourced Carpathian-wide input datasets available that could be used for this purpose;

In 2015:
The Secretariat with the support of EEA and UMA produced a questionnaire and developed an assessment shared with the MSs to identify the local and national datasets available within the Carpathian countries;

In 2016:
The activities focused on the development of specific Carpathian wide forest resource indicators to support sustainable management:

- Forest naturalness,
- Spatial data on virgin forests,
- Forest connectivity and fragmentation,
- Temporal change in forest cover in the region 2000-2012 (based on the temporal data flow of Corine Land Cover)
Carpathian Environment Outlook

50 km buffer (black) around KEO limits of the Carpathian Mountains (EEA, 2007) and the NUTS regions included (ETC/ULS, 2016)
Limitations

- Coarseness of global datasets;
- Lack of regional harmonised datasets (i.e. different resolutions; different time coverage);
- Gaps in the available European datasets;
- Very limited accessibility to national and regional data;
- Heterogeneity of local data;

CLC 2012 layer in KEO Carpathian Area showing the gap of data in the case of Ukraine
## Towards harmonised indicators

<table>
<thead>
<tr>
<th>Regional</th>
<th>Year</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>MANTRA project (Romania)</td>
<td>2005</td>
<td>N/A</td>
</tr>
<tr>
<td>Primeval Forest Hungary</td>
<td>2009</td>
<td>N/A</td>
</tr>
<tr>
<td>Forest statistics (country level)</td>
<td>2014</td>
<td>N/A</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Provider</th>
<th>European</th>
<th>Year</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Copernicus</td>
<td>High Resolution Level Forest</td>
<td>2011/2013</td>
<td>25m</td>
</tr>
<tr>
<td>EEA</td>
<td>Corine Land Cover</td>
<td>2006/2012</td>
<td>100m</td>
</tr>
<tr>
<td>EEA</td>
<td>Protected Areas</td>
<td>2012</td>
<td>N/A</td>
</tr>
<tr>
<td>EEA</td>
<td>High Natural Forest</td>
<td>2006</td>
<td>100m</td>
</tr>
<tr>
<td>EFI</td>
<td>Dominant species</td>
<td>2011</td>
<td>1km</td>
</tr>
<tr>
<td>ESA</td>
<td>Global corine</td>
<td>2009</td>
<td>500m</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Provider</th>
<th>Global</th>
<th>Year</th>
<th>Resolution</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNEP</td>
<td>Protected areas</td>
<td>2015</td>
<td>N/A</td>
</tr>
<tr>
<td>JAXA</td>
<td>Palsar</td>
<td>2014</td>
<td>25m</td>
</tr>
<tr>
<td>Un.Maryland</td>
<td>Global forest</td>
<td>2014</td>
<td>25m</td>
</tr>
<tr>
<td>USGS</td>
<td>Landsat</td>
<td>2014/2015</td>
<td>30m</td>
</tr>
<tr>
<td>ESA</td>
<td>Sentinel 2</td>
<td>2015</td>
<td>10/20m</td>
</tr>
</tbody>
</table>
The indicator on the morphological structure of forests detects the geometry, patterns, fragmentation, and connectivity of forest ecosystems (Estreguil et al., 2012).
Patterns, fragmentation, & Connectivity

The indicator on the morphological structure of forests detects the geometry and the connectivity of forest ecosystems (Estreguil et al., 2012).

The core forests are estimated to cover a high share (79%) of the total forest of Carpathian Mountains.
Patterns, fragmentation, & Connectivity

Examples of forest perforation

East side of Oituz – Ojdulaarea area (RO)

Example of perforation forest (Stulpicani, RO)
Connectivity per MS

The diagram shows the connectivity per MS, with each country represented by a vertical bar chart. The bars are divided into four sections, each representing a different type of connectivity: Islet, Edge, Linear, and Interior. The percentage of each type within the country's total connectivity is indicated by the color and length of each section.
Connectivity in N2k
## Naturalness of Carpathian forests

$$N_i = \frac{DA}{TF}$$

<table>
<thead>
<tr>
<th>New European Forest Types (Barbati et al. 2011)</th>
<th>Main characteristics</th>
<th>Assemblage of tree species (Brus et al. 2011)</th>
</tr>
</thead>
</table>
| 1. Hemiboreal and nemoral coniferous and mixed broadleaved-coniferous forest | Latitudinal mixed forests located in between the boreal and nemoral (or temperate) forest zones with similar characteristics to EFT 1, but a slightly higher tree species diversity, including also temperate deciduous trees like Tilia cordata, Fraxinus excelsior, Ulmus glabra and Quercus robur. Includes also: pure and mixed forests in the nemoral forest zone dominated by coniferous species native within the borders of individual FOREST EUROPE member states like Pinus sylvestris, pines of the Pinus nigra group, Pinus pinaster, Picea abies, Abies alba | • Fraxinus spp  
• Quercus robur/petraea  
• Pinus sylvestris  
• Pinusspp  
• PiceaSpp  
• AbiesSpp |
| 2. Alpine forest | High-altitude forest belts of central and southern European mountain ranges, covered by Picea abies, Abies alba, Pinus sylvestris, Pinus nigra, Larix decidua, Pinus cembra and Pinus mugo. Includes also the mountain forest dominated by birch of the boreal region | • PiceaSpp  
• Abies Spp  
• Pinusspp  
• LarixSpp |
| 3. Acidophilous oak and oak-birch forest | Scattered occurrence associated with less fertile soils of the nemoral forest zone; the tree species composition is poor and dominated by acidophilous oaks (Q. robur, Q. petraea) and birch (Betula pendula) | • Quercus robur/petraea  
• Betula spp |
| 4. Mesophytic deciduous forest | Related to medium rich soils of the nemoral forest zone; forest composition is mixed and made up of a relatively large number of broadleaved deciduous trees: Carpinus betulus, Quercus petraea, Quercus robur, Fraxinus, Acer and Tilia cordata | • Quercus robur/petraea  
• Fraxinus spp  
• CarpinusSpp |
| 5. Beech forest | Widely distributed lowland to submountainous beech forest. Beech, Fagus sylvatica and F. orientalis (Balkan) dominate, locally important is Betula pendula | • Fagus Spp  
• BetulaSpp |
| 6. Mountainous beech forest | Mixed broadleaved deciduous and coniferous vegetation belt in the main European mountain ranges. Species composition differs from EFT 6, including Picea abies, Abies alba, Betula pendula and mesophytic deciduous tree species. Includes also mountain fir dominated stands | • Fagus Spp  
• PiceaSpp  
• AbiesSpp |
The Naturalness Index ($N_t$) identifies the relation between the percentage of natural forest species presence and the percentage of forest coverage.

- Naturalness is distributed throughout the Carpathian Mountains;
- In virgin forests (local analysis) a very high percentage of Hotspot clusters were registered (Paduri virgine & Krptiserdk).
2000-2006: Forest loss mainly due to felling and transition
Forest changing trends (2006-2012)

2006-2012: forest management & felling major causes of loss
Outlook

- Validation of indicators → Accessibility to local data
- Generation of forest habitat indicators (EUNIS classification);
- Assessment of pressures and impacts on Carpathian forests
- Assessment of ecosystem services within Carpathian forests to support restoration priorities, conservation efforts,…
Thank you for your attention

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