Regional pilot platform as EU contribution to a Global Soil Observing System

Enhancing the terrain component in SOTER database

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Overview

• Overview of tested methods for terrain analysis
  – Benchmark datasets
  – New methods
    • Physical entities (hill shed analysis)
    • Homogenous segments (object-based segmentation)

• Assessment
  – Cramer’s V statistic
  – Bayesian Networks

• Recommendations for e-SOTER
Methods found in literature

- **SOTER** – “Soter Cook Book” (Dobos et al. 2005)
- Hammond (Dikau et al., 1992)
- Iwahashi and Pike (2007)

**Grid based**
- Search windows of fixed sizes

**Limitations:**
- Sensitive to grid size
- Sensitive to window size
- Scale of the landscape may not be represented by the combination of the two factors

One of the ways to overcome the limitations of grid based methods is incorporation of **objects** into methodology of landform classification.
Physical entities

- Peak sheds
  - Generated by hill shed analysis (MacMillan, 2003)
  - Analysis of water flow in the inverted elevation
  - Represent scale of processes in the landscape
- Hill slope analysis
  - Associated with hill shed analysis
  - Provides polygons representing up to 6 major slope breaks
  - Polygons can be aggregated to target 1:250,000 mapping scale

Legend:
- Peak sheds
- Slope breaks
  - Upper slope
  - Lower slope

Peak sheds
Peak sheds + slope breaks
Generated from SRTM elevation values using eCognition Developer. ESP tool (Dragut et al., 2010) was used to segment elevation values into homogenous objects at 3 levels reflecting various scales of terrain features.
Concept of object based approach

Dissection of landscape into objects

- physical entities
- homogenous objects

Basic statistics for each object

- Elevation, slope

K-means analysis – higher level of landforms

K-means analysis – lower level of landforms

Post-processing

- Refinement to target mapping scale
- Hammond classification scheme
Cluster maps based on physical entities

Chemnitz pilot

UK window

Moroccan pilot
Cluster maps based on homogenous objects
Application of Hammond classification scheme

- Hammond classifiers:
  - Slope – occurrence of slope <8%
  - Local relief
  - Profile type – occurrence of lowlands

- Each cluster was characterised with the values of the three classifiers extracted within:
  - peak sheds
  - object-oriented segmentation

- Three-character code applied to ranges of Hammond classifiers (Dikau et al., 1991) → landform **subclass**

- **Landform class and type** assigned to each subclass
Assessment - Validation datasets

- NATMAP 1:250k (255)
- SGDBE 1:1mln (64)
- FAO Soil Map (22)
- NATMAP soilscapes 1:250k (27)
- RCP regions 1:? (76)
- National Character Areas 1:? (106)
Assessment – Cramer’s V

- Similarity measure between maps of different legends and different numbers of classes (Rees, 2008)

\[
\text{Cramer’s } V = \sqrt{\frac{G^2}{G^2 + N}}
\]

Where:

- \( O_{ij} \) = observed value
- \( E_{ij} \) = expected value in \( i \)th row and \( j \)th column

- Calculated for pairs of landform datasets and validation datasets
- Multidimensional scaling of \( V \) between a landform dataset and all validation datasets
- 3 Dimension graphs visualising similarity or dissimilarity
- List of distances in all dimensions

![Scatterplot 3D](image)

Final Configuration
Dimension 1 vs. Dimension 2 vs. Dimension 3
Assessment – Bayesian Networks

- Bayesian Belief Networks set to predict validation datasets with the use of various landform maps obtained in the project
- ‘Sensitivity to findings’ lists for each validation dataset – ordering according to the value of entropy reduction
- Indication of importance of each landform map
- Based on a sub-sample of regular points (~300k observations)
Discussion of validation results

- Both methods give different but not dissimilar results

- **Bayesian Networks** favour approaches based on homogenous objects

- **Cramer’s V statistic** finds more value in approaches based on physical entities.
### Hammond classification scheme

<table>
<thead>
<tr>
<th>TYPE, CLASS, SUBCLASS</th>
<th>Legend</th>
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</thead>
<tbody>
<tr>
<td>PLA, A1a, Flat_or_nearly_flat_plains</td>
<td>PHM, A3a, Plains_with_hills</td>
</tr>
<tr>
<td>PLA, A1b, Flat_or_nearly_flat_plains</td>
<td>PHM, A3b, Plains_with_hills</td>
</tr>
<tr>
<td>PLA, A1c, Flat_or_nearly_flat_plains</td>
<td>PHM, A4a, Plains_with_high_hills</td>
</tr>
<tr>
<td>PLA, A1d, Flat_or_nearly_flat_plains</td>
<td>PHM, A4b, Plains_with_high_hills</td>
</tr>
<tr>
<td>PLA, A2a, Smooth_plains_with_some_local_relief</td>
<td>PHM, A5a, Plains_with_low_mountains</td>
</tr>
<tr>
<td>PLA, A2b, Smooth_plains_with_some_local_relief</td>
<td>PHM, B3a, Plains_with_hills</td>
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<td>PLA, A5a, Smooth_plains_with_low_mountains</td>
<td>PHM, B5a, Plains_with_low_mountains</td>
</tr>
<tr>
<td>TAB, A3c, Tablelands_with_moderate_relief</td>
<td>OPM, C4a, Open_high_hills</td>
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<tr>
<td>TAB, A4c, Tablelands_with_considerable_relief</td>
<td>OPM, C4b, Open_high_hills</td>
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<tr>
<td>TAB, B4c, Tablelands_with_considerable_relief</td>
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![Map of Hammond classification scheme](image-url)
References: