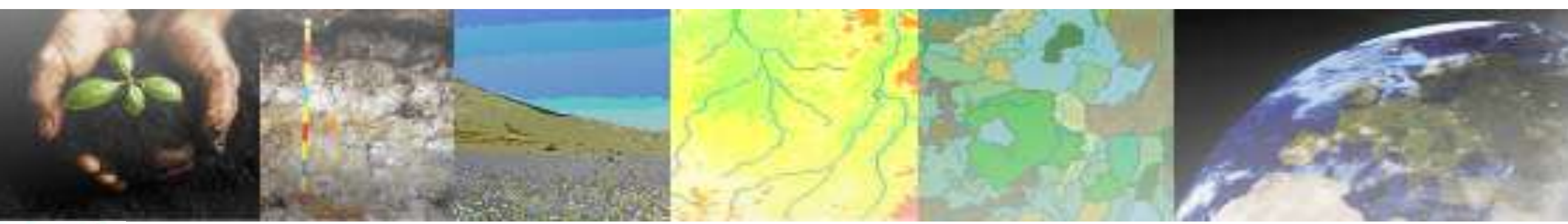
e-SOTER

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

Development of a terrain and parent material platform at scale 1:1 million

Endre Dobos

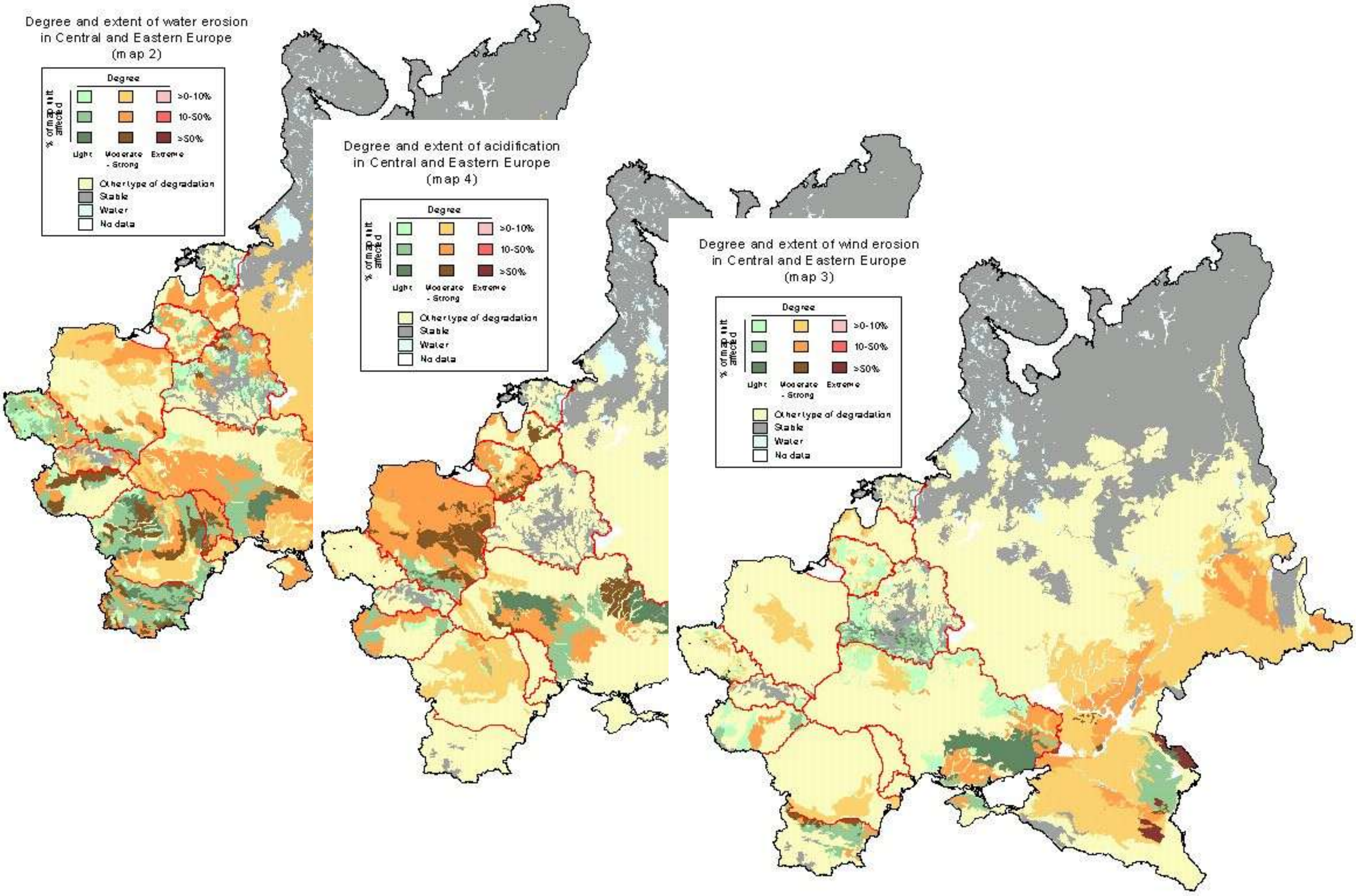
on behalf of the WP1 team



Contributing Institutions

- ISRIC - World Soil Information (coordinator)
- Dept of Phys. Geogr. and Environm. Sc. - University of Miskolc
- Federal Institute for Geosciences and Natural Resources (BGR)
- Institute of Environment and Sustainability - Joint Research Centre
- National Soil Resources Institute - Cranfield University
- Alterra B.V.
- Dept. of Soil Sc. and Agric. Chemistry - Szent Istvan University
- Scilands GmbH
- Institut National de la Recherche Agronomique- Orléans
- Centre for Geospatial Sciences - University of Nottingham
- Czech University of Life Sciences
- Institute of Soil Science – Chinese Academy of Sciences
- INRA Maroc
- CGI - Wageningen University

Assessing land degradation processes



Objectives of WP1

Development of a quantitative methodology to delineate SOTER terrain units (landform and soil parent material) using digital data sources like satellite imagery and digital terrain models in combination with legacy data

Rational, framework limitations

- Globalness
- Often no or very limited data
- Potential variation in the scale of the available data
  - More coarse data, with limited and randomly distributed higher resolution data
- SRTM, MODIS, AVHRR, SPOT Vegetation
- Existing thematic framework (SOTER methodology)
- No well defined PM classification (consolidated/unconsolidated)
- Existing maps (potential inputs for training) contains mixed interpretations

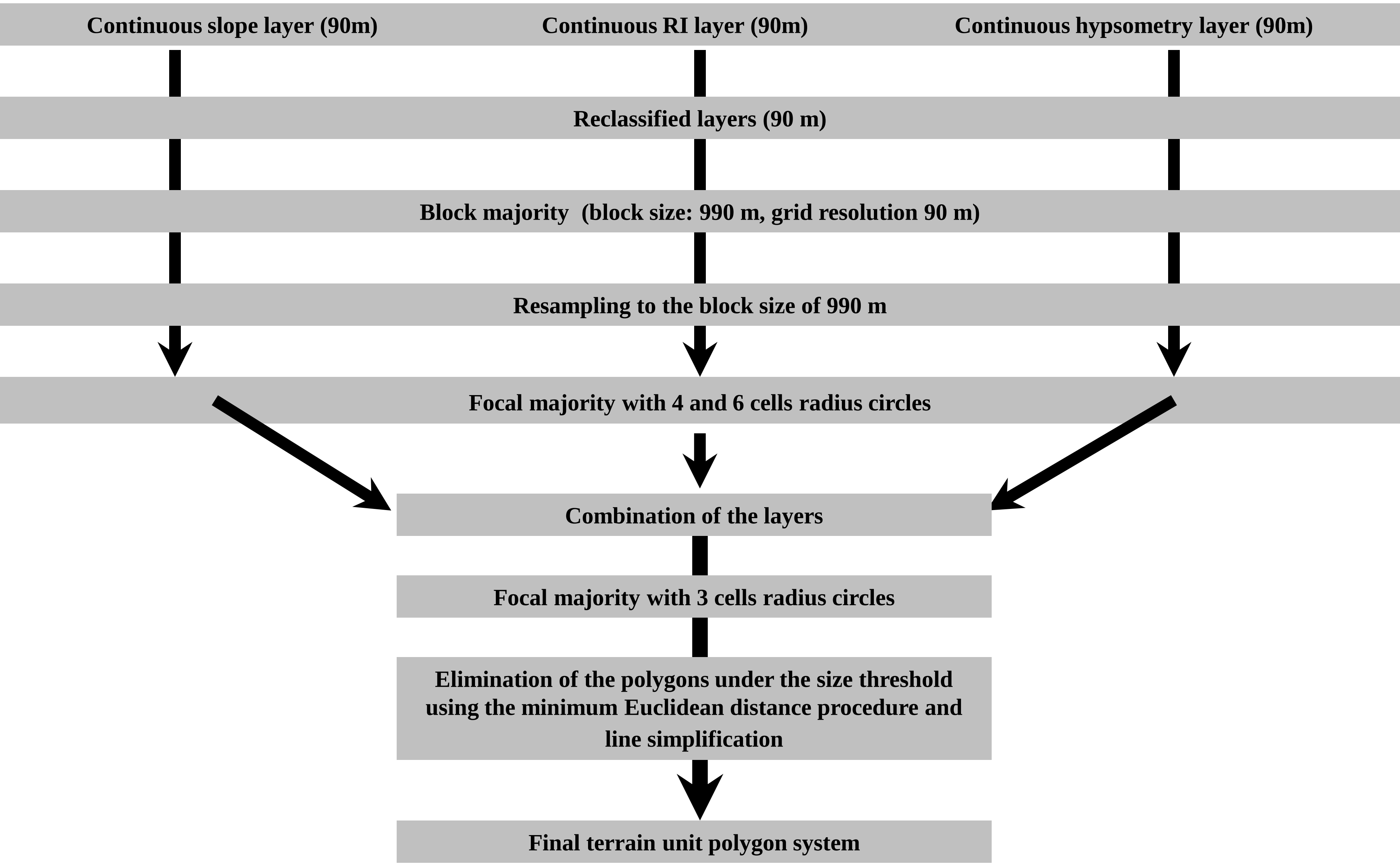
SOTER mapping approach

- Mapping Units are defined by
  - physiography and
  - lithology

Physisography is charaterized by four differentiating features:

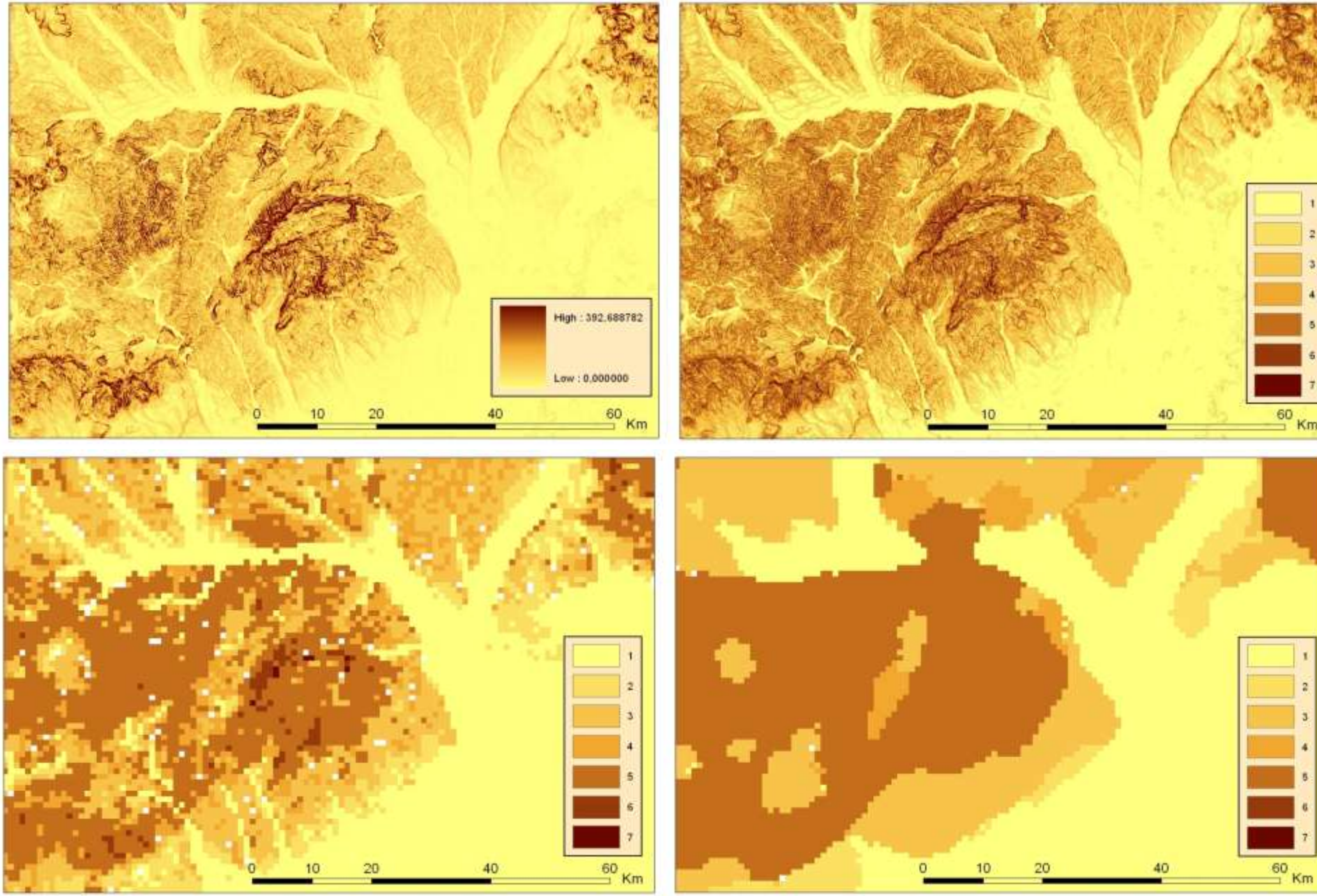
1. Slope
2. Relief intensity
3. Hypsometry (the combination of relief intensity and altitude)
4. Dissection

SRTM DEM – based procedure for terrain classification



Regional slope classification

	Original SOTER	Quantitative procedure
Depression	-	„0 %”
Flat	0-2 %	0.01-2 %
Gently undulating	2-5 %	2-5 %
Undulating	5-8 %	5-8 %
Rolling	8-15 %	8-15 %
Moderately steep	15-30 %	15-30 %
Steep	30-60 %	30-60 %

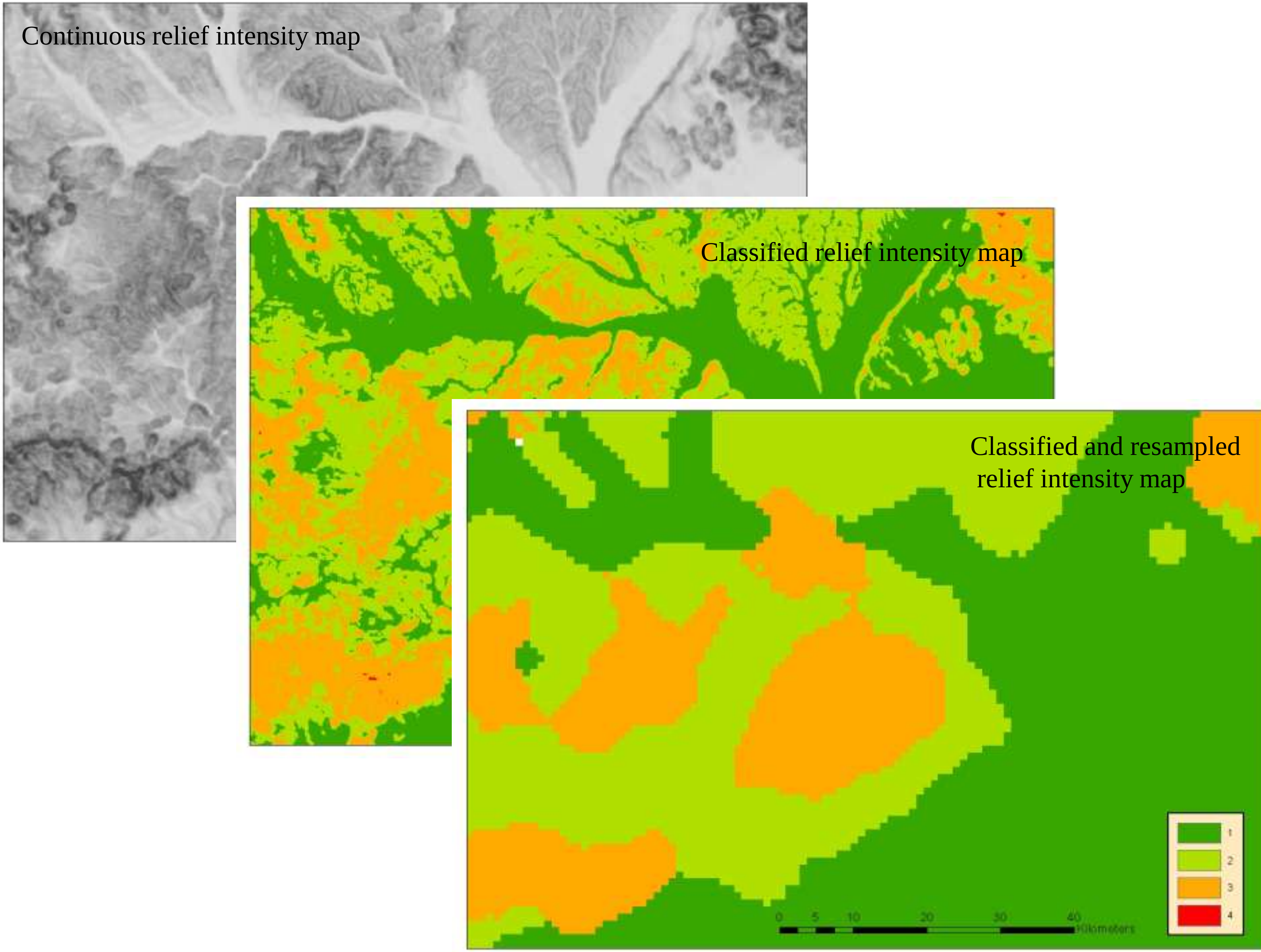

High : 392.688782
Low : 0.000000
0
10
20
40
60
Km
1
2
3
4
5
6
7
0
10
20
40
60
Km
1
2
3
4
5
6
7
0
10
20
40
60
Km
1
2
3
4
5
6
7
0
10
20
40
60
Km

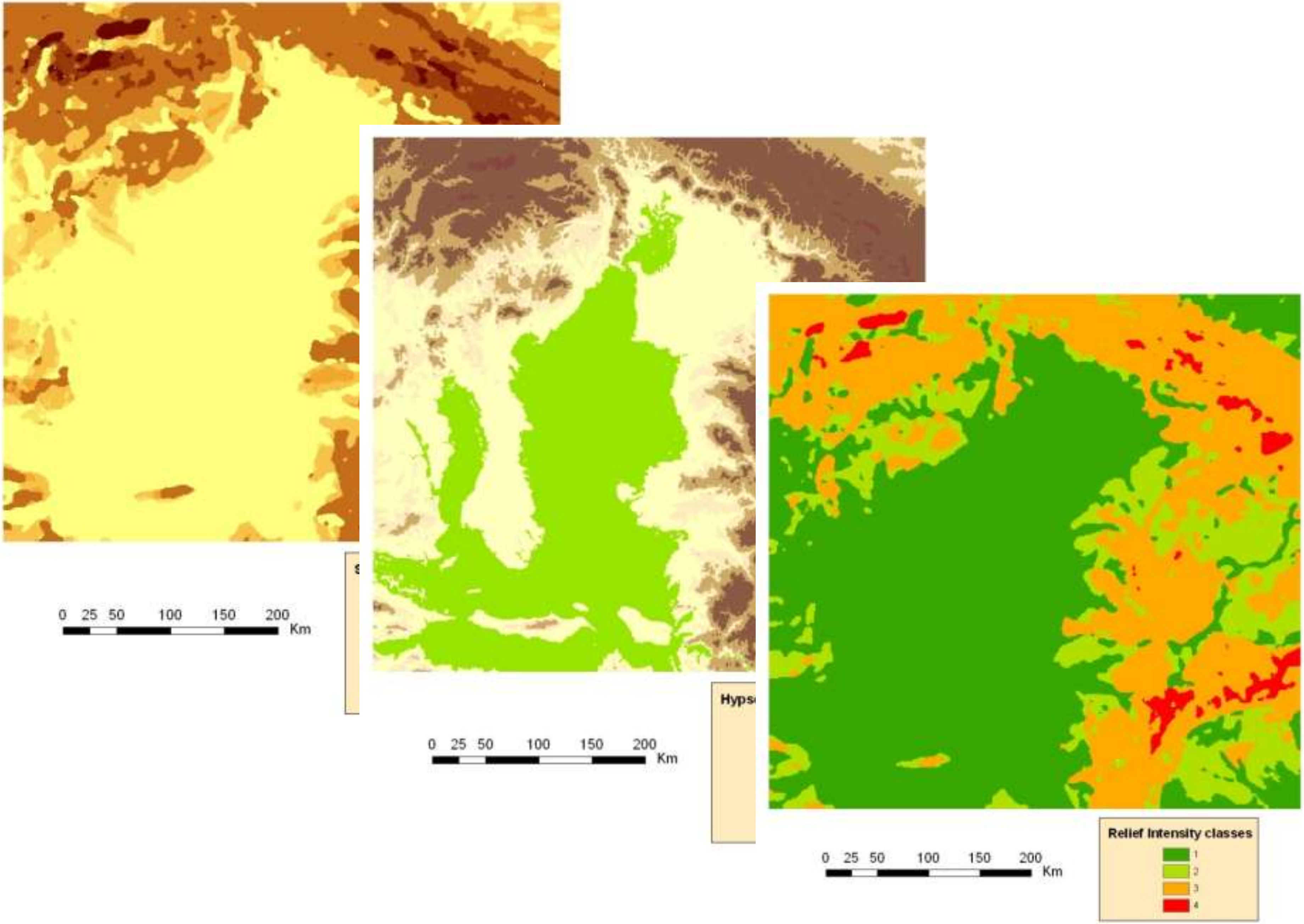
Relief Intensity

…median difference between the highest and lowest point within the terrain per specified distance. Units are m/km, m/slope unit, m/2 km

Changes of the approach: interpret relief intensity on an aerial basis.

0-50 m/area of a 1 km diameter circle
50-100 m/area of a 1 km diameter circle
100-300 m/area of a 1 km diameter circle
300- m/area of a 1 km diameter circle

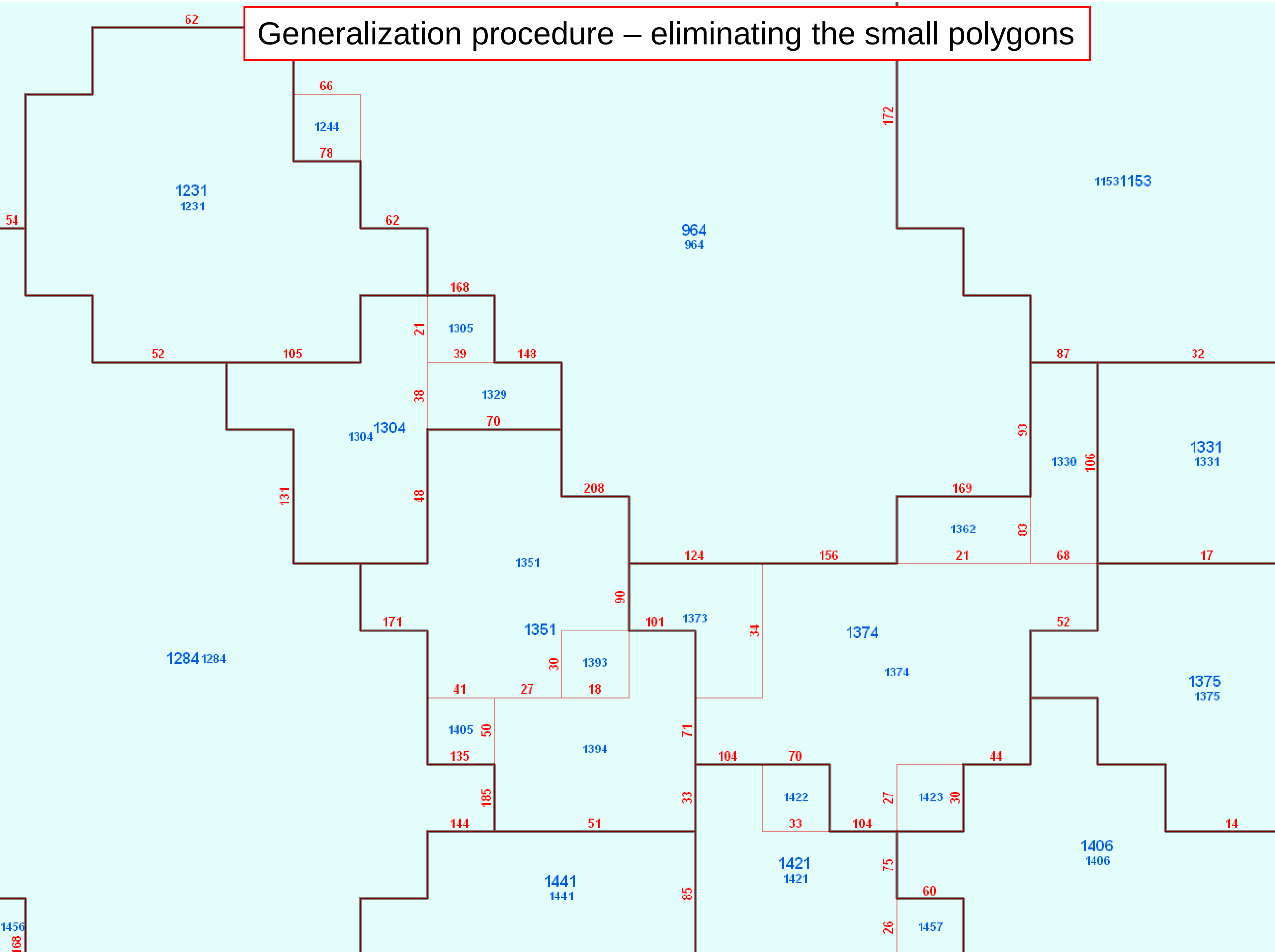

Continuous relief intensity map
Classified relief intensity map
Classified and resampled relief intensity map
0 5 10 20 30 40 Kilometers
1
2
3
4


0 25 50 100 150 200
Km
0 25 50 100 150 200
Km
0 25 50 100 150 200
Km
Relief Intensity classes
1
2
3
4

Aggregation procedure

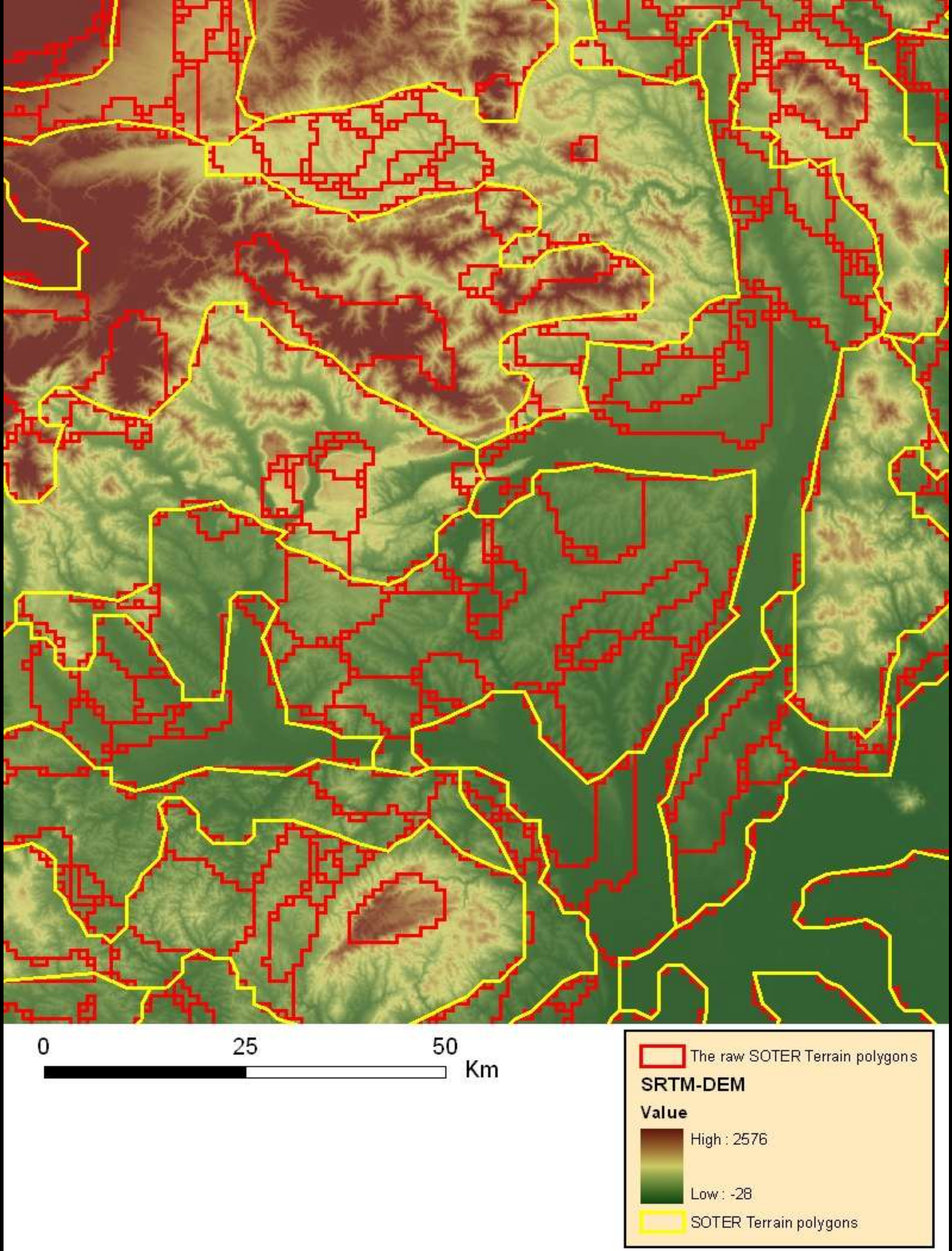
- Selecting the polygons under the minimum size limit
- Minimum Euclidean distance
  - Calculating the mean terrain variables for each polygons
  - Calculating the Euclidean distance for each polygon pairs
  - Dissolving the bordering arc between the polygons having the smallest Euclidean distance

Generalization procedure – eliminating the small polygons



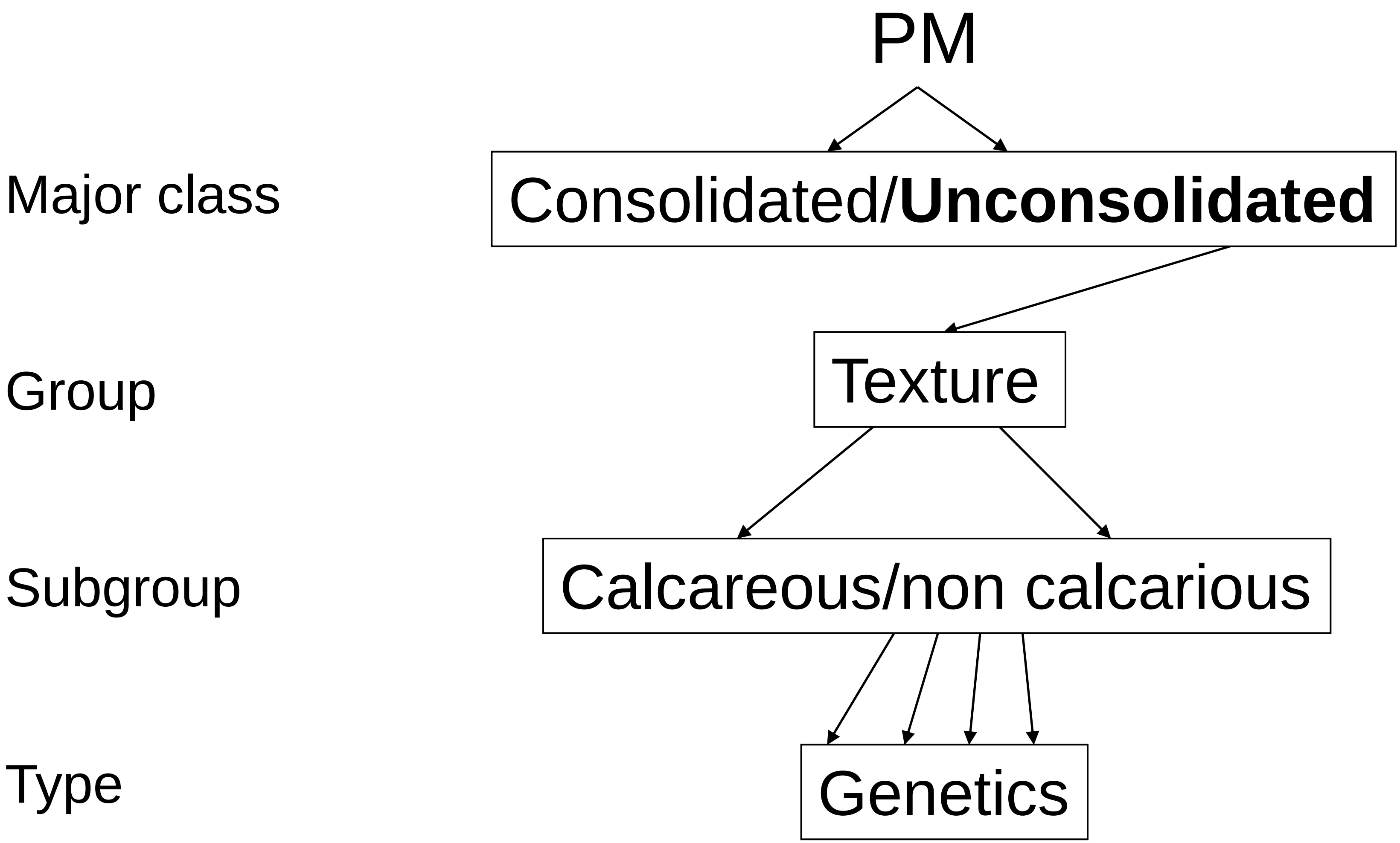
Line simplification procedure

- 0.2 mm separability distance between features on the printout.
  - Displacement of the vertices with maximum 200 and 1000 m in ground units respectively for the 1:1 and 1:5 million scales


0
25
50
Km
The raw SOTER Terrain polygons
SRTM-DEM
Value
High : 2576
Low : -28
SOTER Terrain polygons

Adding the parent material information

Hierarchical, four level system



Microsoft Excel - quatern_1mil_SOTER.xls

	AGE	QUATER_SED	SOTER PM major class	SOTER PM Group	SOTER PM Subgroup	SOTER PM Type	Note
874	Holocene	moors	U	UO			1 or 2 ?
875	Holocene	moors	U	UO			1 or 2 ?
876	Holocene	moors	U	UO			1 or 2 ?
877	Holocene	moors	U	UO			1 or 2 ?
878	Holocene	moors	U	UO			1 or 2 ?
879	Holocene	moors	U	UO			1 or 2 ?
880	Holocene	moors	U	UO			1 or 2 ?
881	Wurm	mountain glaciers basins and firn basins sediments					?
882	Wurm	mountain glaciers basins and firn basins sediments					?
883	Wurm	mountain glaciers basins and firn basins sediments					?
884	Wurm	mountain glaciers basins and firn basins sediments					?
885	Wurm	mountain glaciers basins and firn basins sediments					?
886	Wurm	mountain glaciers basins and firn basins sediments					?
887	Wurm	mountain glaciers basins and firn basins sediments					?
888	Wurm	mountain glaciers basins and firn basins sediments					?
889	Wurm	mountain glaciers basins and firn basins sediments					?
890	Riss	Saal (Riss) basal moraine sediments	U	UU		UUxT	? Subgroup? Can the age show if it is calcareous or not
891	Riss	Saal (Riss) basal moraine sediments	U	UU		UUxT	? Subgroup? Can the age show if it is calcareous or not
892	Riss	Saal (Riss) basal moraine sediments	U	UU		UUxT	? Subgroup? Can the age show if it is calcareous or not
893	Riss	Saal (Riss) basal moraine sediments	U	UU		UUxT	? Subgroup? Can the age show if it is calcareous or not
894	Riss	Saal (Riss) basal moraine sediments	U	UU		UUxT	? Subgroup? Can the age show if it is calcareous or not
895	Riss	Saal (Riss) basal moraine sediments	U	UU		UUxT	? Subgroup? Can the age show if it is calcareous or not
896	Riss	Saal (Riss) basal moraine sediments	U	UU		UUxT	? Subgroup? Can the age show if it is calcareous or not
897	Riss	Saal (Riss) basal moraine sediments	U	UU		UUxT	? Subgroup? Can the age show if it is calcareous or not
898	Wurm	slope sediments	U			C	?
899	Wurm	slope sediments	U			C	?
900	Wurm	slope sediments	U			C	?
901	Wurm	slope sediments	U			C	?
902	Wurm	slope sediments	U			C	?
903	Wurm	slope sediments	U			C	?
904	Wurm	slope sediments	U			C	?
905	Wurm	slope sediments	U			C	?
906	Wurm	slope sediments	U			C	?
907	Wurm	slope sediments	U			C	?
908	Wurm	slope sediments	U			C	?

quatern_1mil

Disaggregation of the Hierarchy

Transforming the four hierarchical level to four independent properties:

1. Consolidation status
2. Texture
3. Carbonate status
4. Genetics

Overlaying and combining the four layers

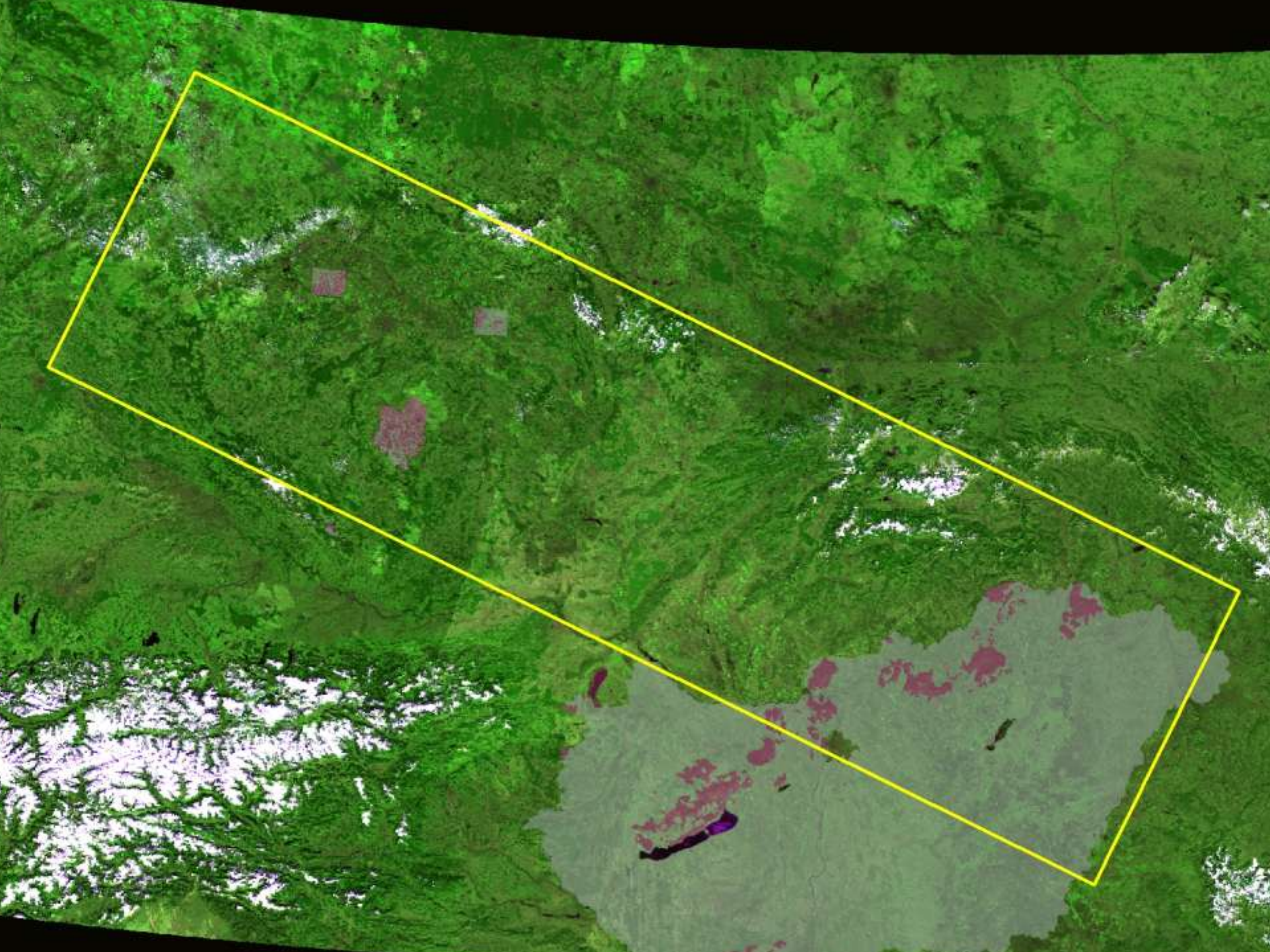
NO LOSS OF INFORMATION

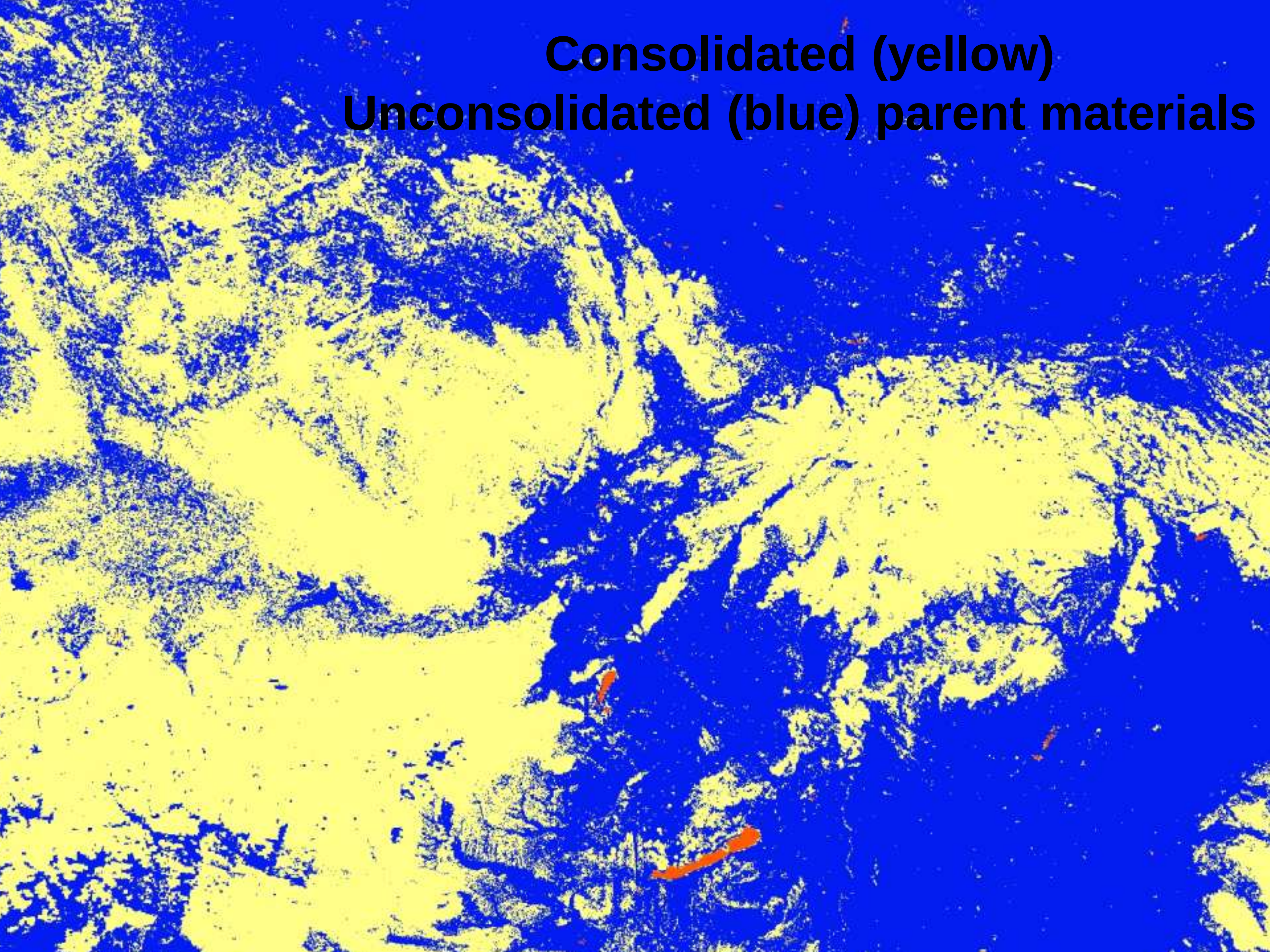
Development of the thematic PM layers

- RS image classification
  - MODIS-multitemporal 8 days composites
  - 11 bands, visible to the thermal spectra
  - 5 dates
  - PCA and DAFE to reduce the number of channels from 55 to 15
- Digital terrain modeling
  - SRTM, slope%, Reliewf intensity, Groundwater distance, PDD, Wetness index, UP/Low land index
- Combination of MODIS and SRTM layers to create a 20 band image

Training data

- Direct input (data with scale larger than 1:100K)
- Indirect input for data smaller than 100K
  - Requires further preprocessing and improvement



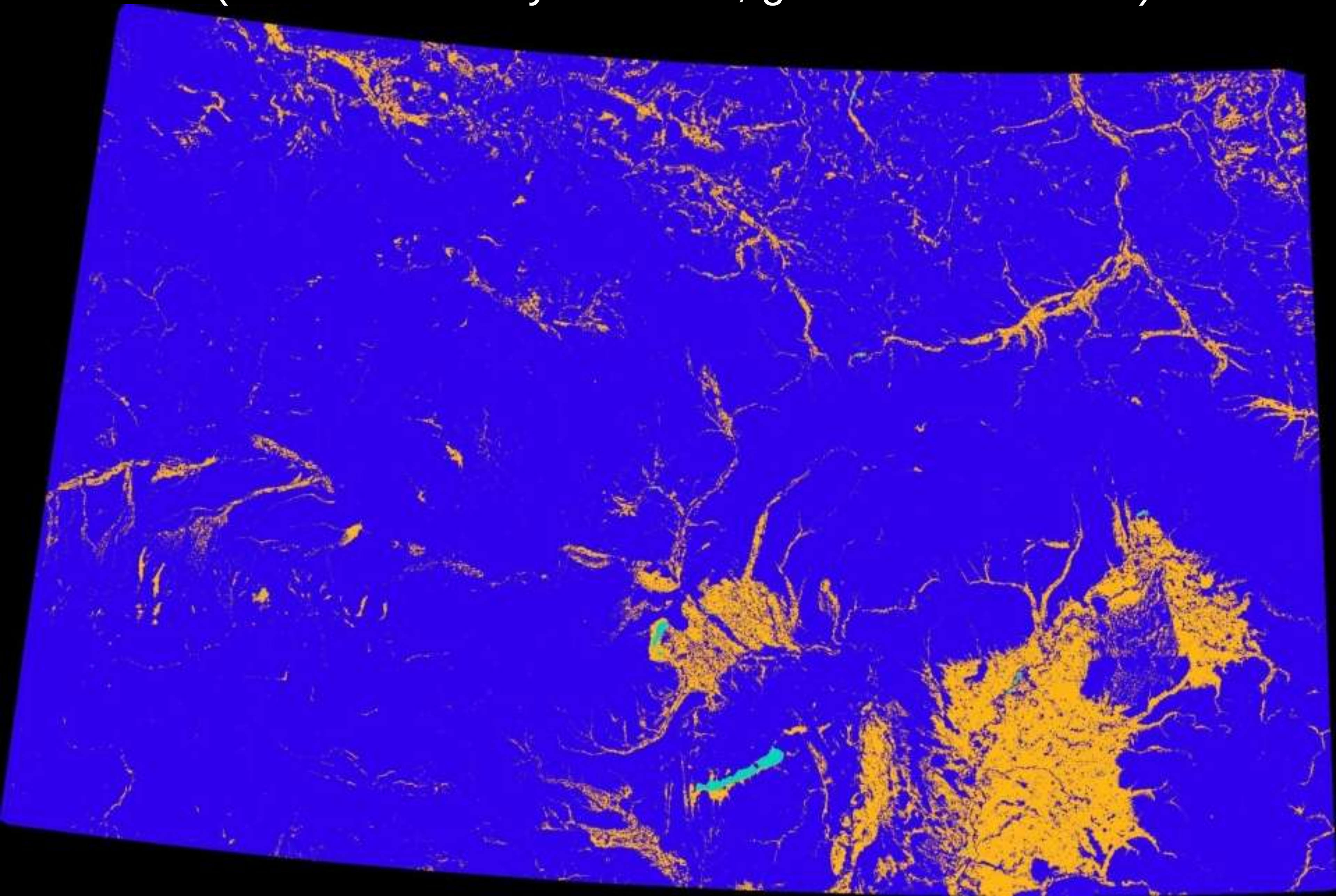

Consolidated (yellow)
Unconsolidated (blue) parent materials

This approach is used for the texture as well.

Classifying the genetic classes

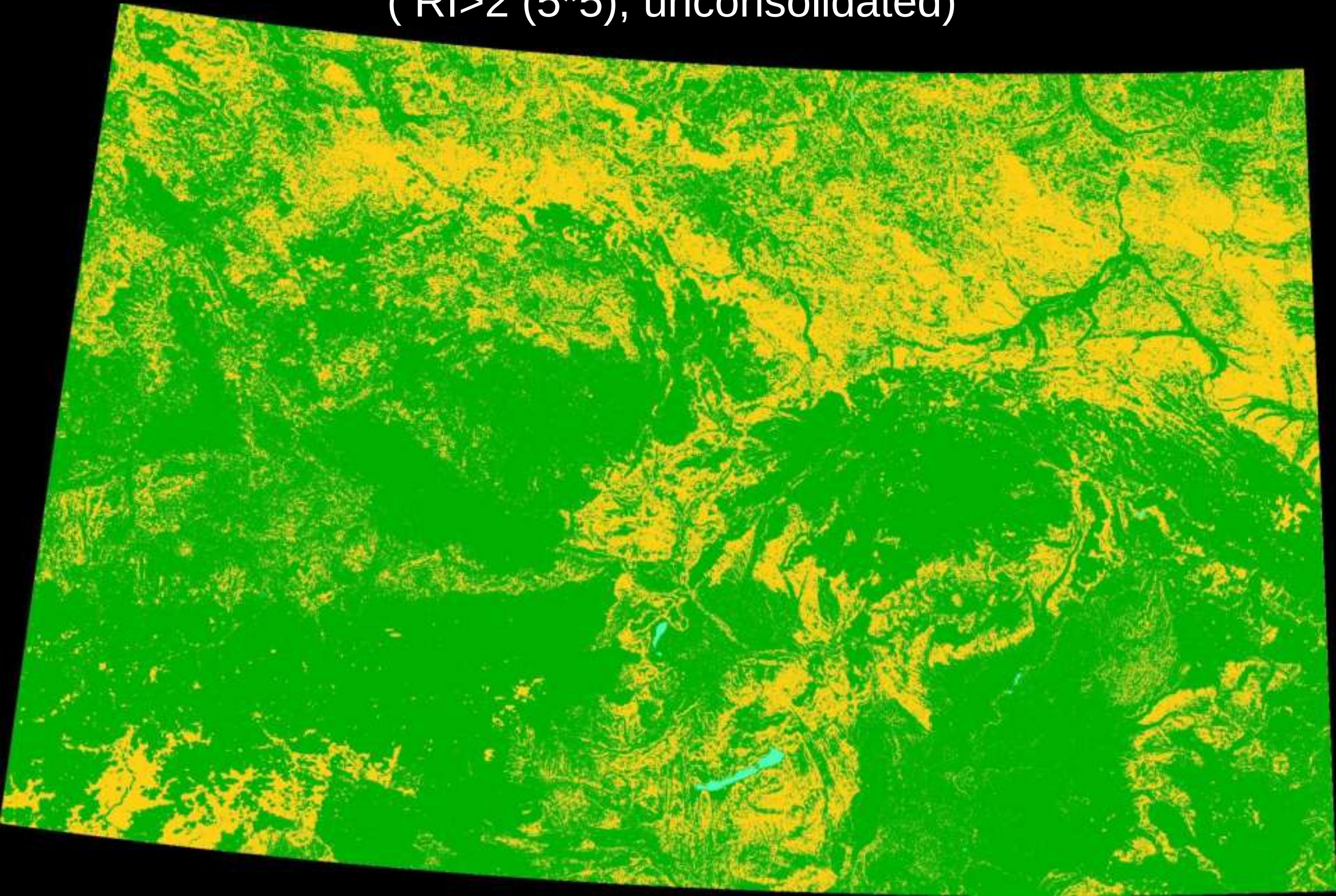
- Existing classes
  - Fluvial/alluvial
    - Plain, low slope and low relief intensity, close to the groundwater level
  - Marine and esturine
    - Follows the seashoreline and characterized with 0- 10 meter elevation along the seashore
  - Colluvial
    - Form a plain to concave surface, with significant slope
  - Glaciofluvial
    - Alluvial, with slightly higher relief
  - Glacial till
  - Lacustrine
    - Along the exisiting lakes within a given vertacal distance over the lake water level
  - Eolian
    - Unconsolidated, higher relief, higher above the groundwater level, not ifluenced by the fluvial activities.

Fluvial/Alluvial sediments (yellow)
(relief:0-2 for 5by5 window, groundwater lvl < 2)

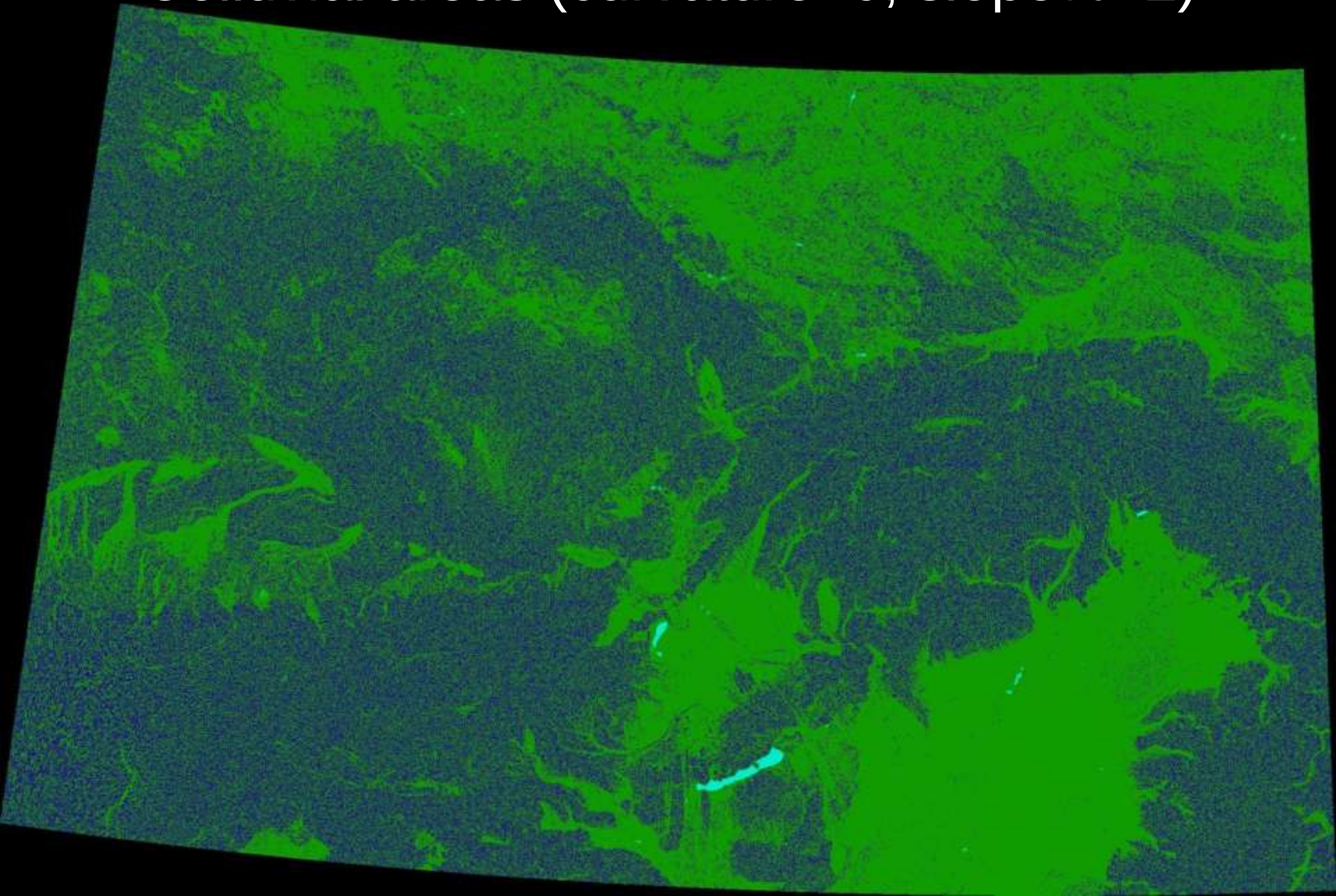


Aeolian sediments of the CE window

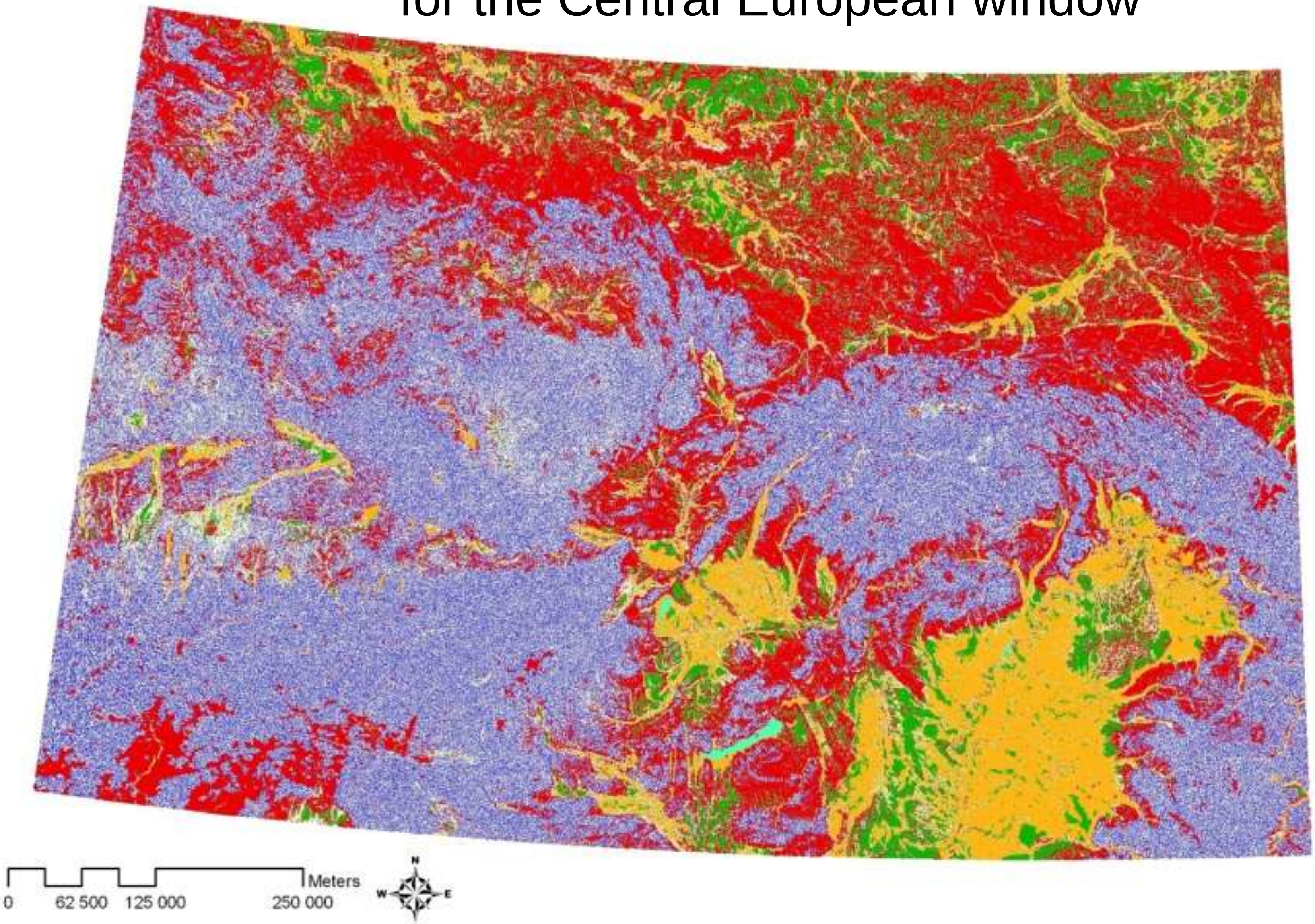
(RI>2 (5*5), unconsolidated)

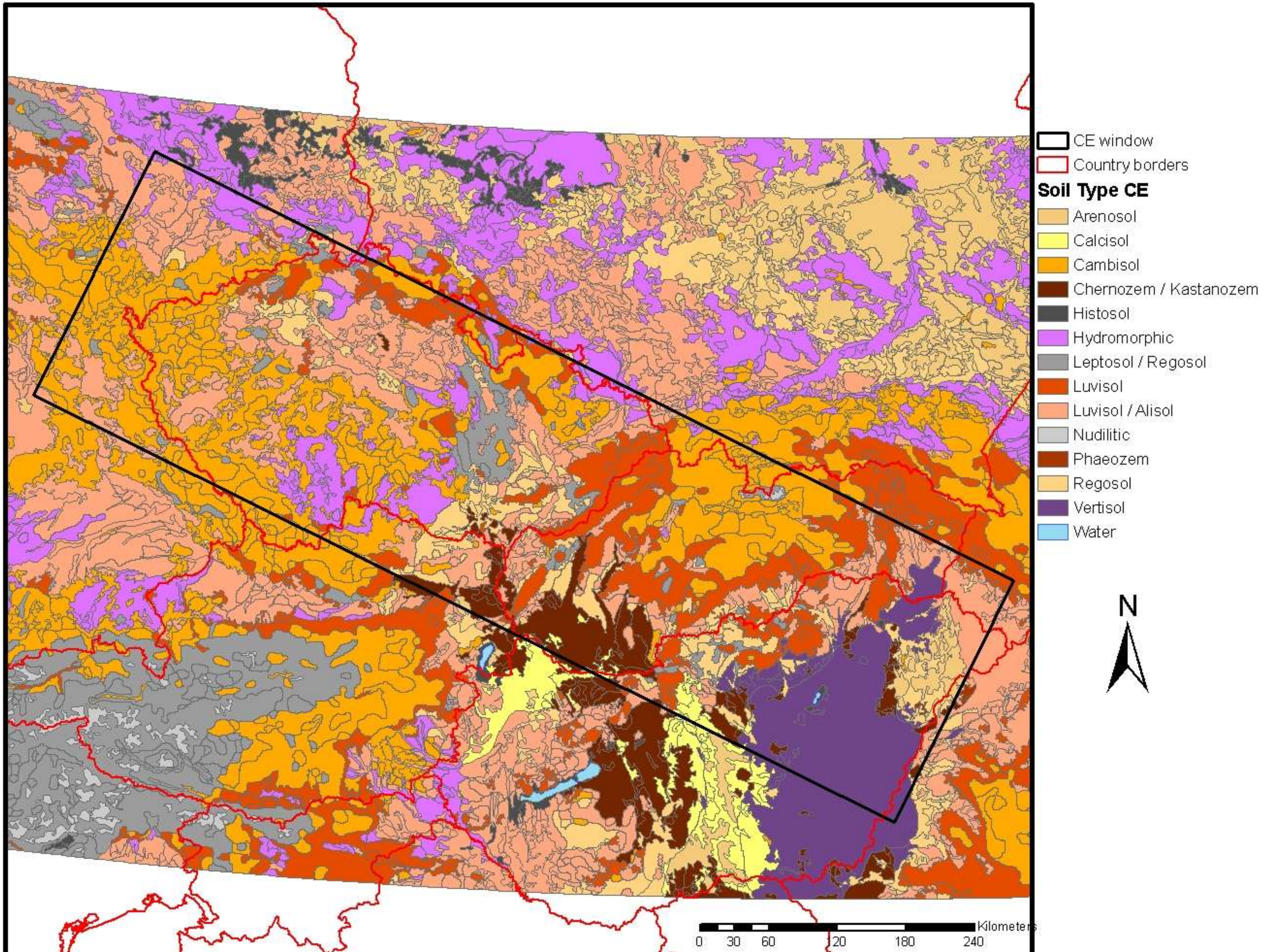


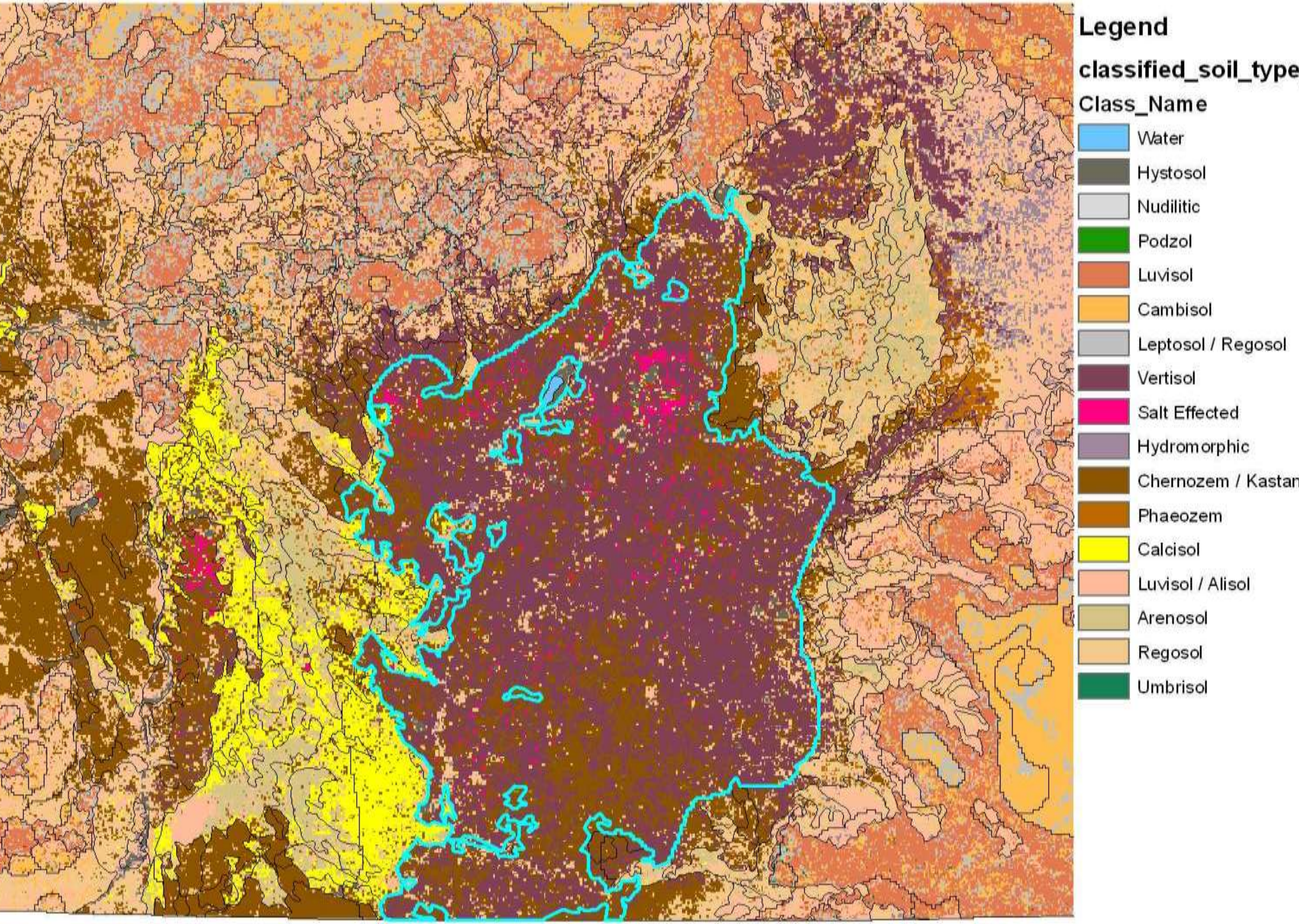
Colluvial areas (curvature<0, slope%>2)

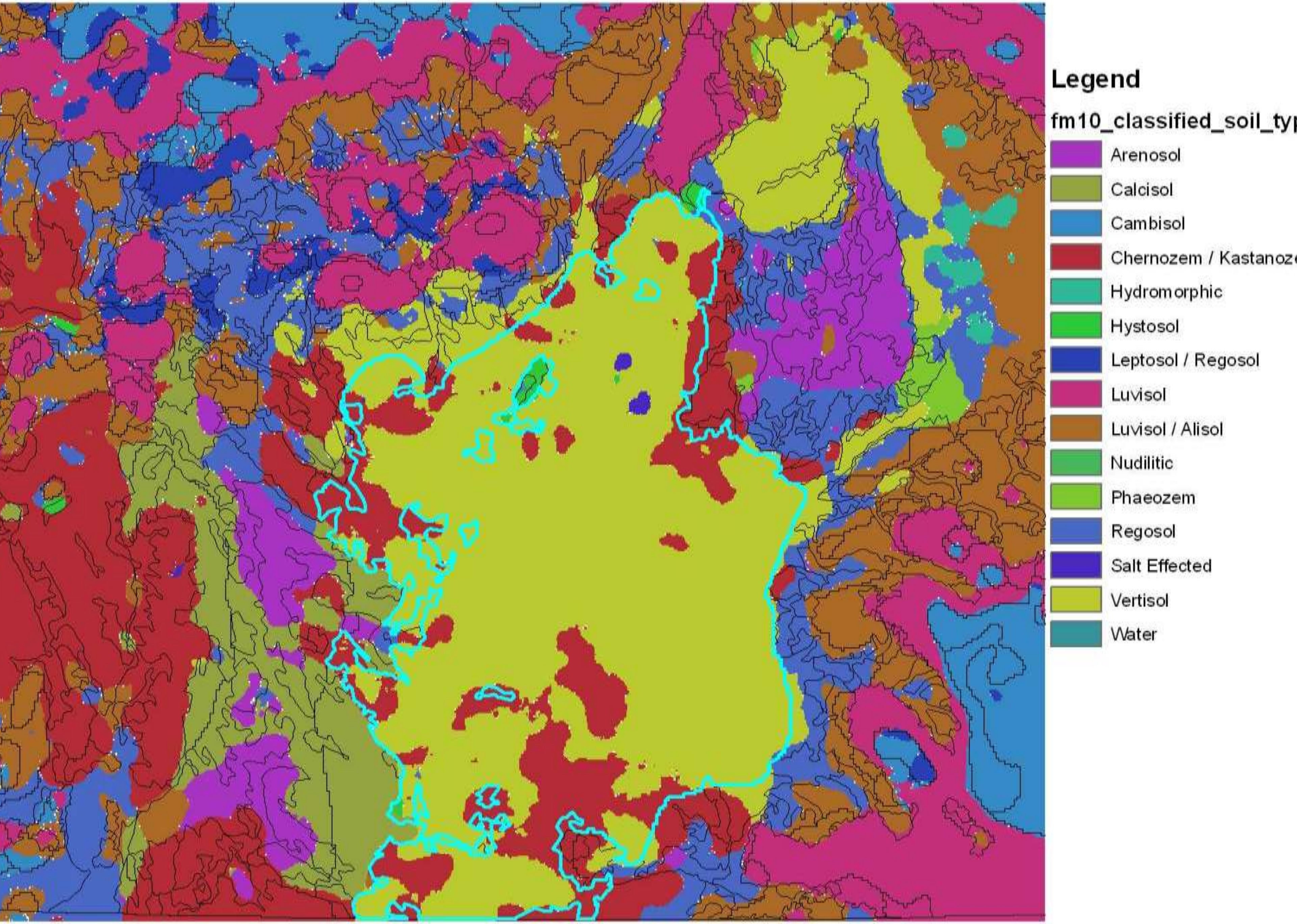


Combined parent material dataset for the Central European window

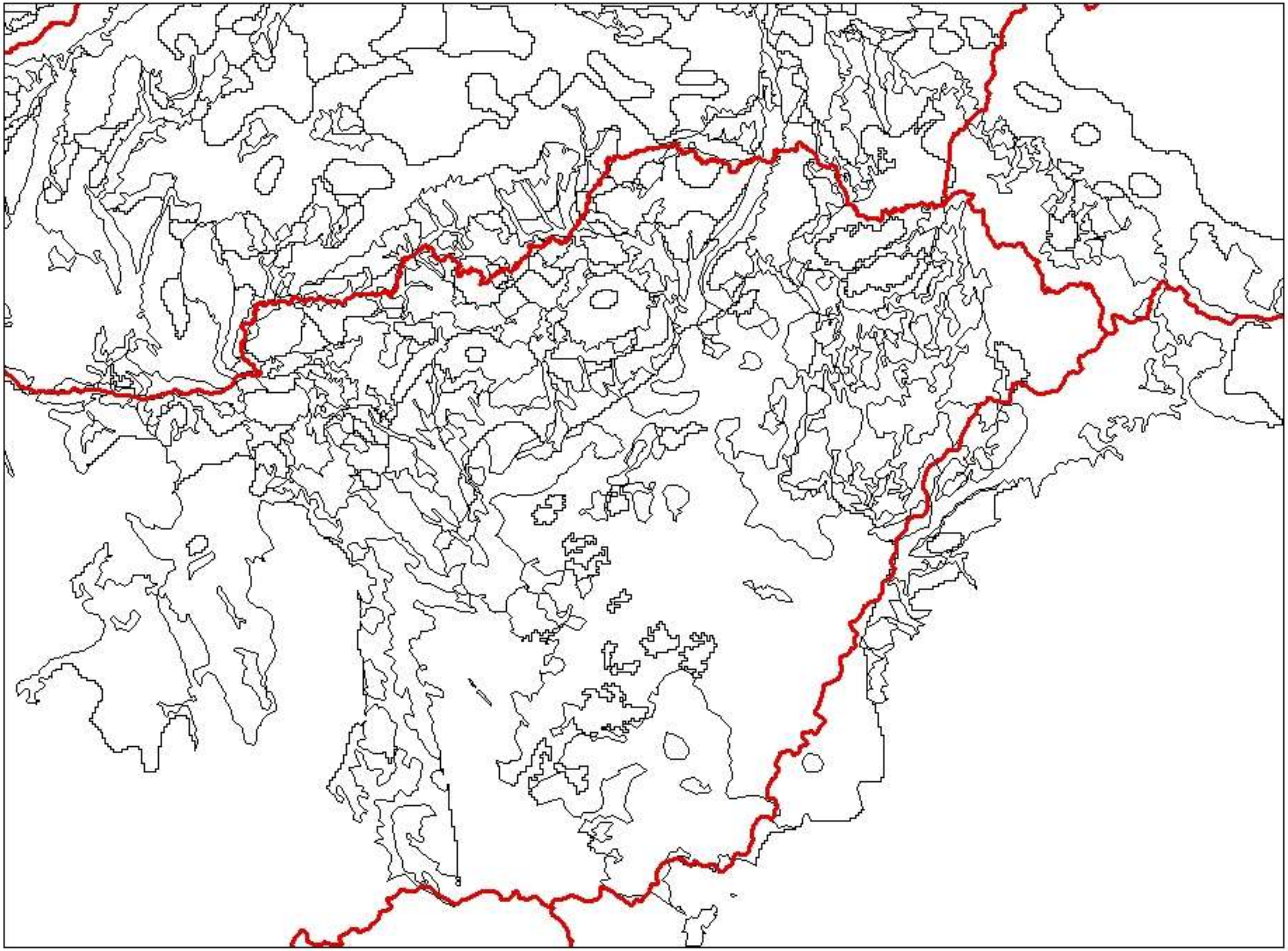


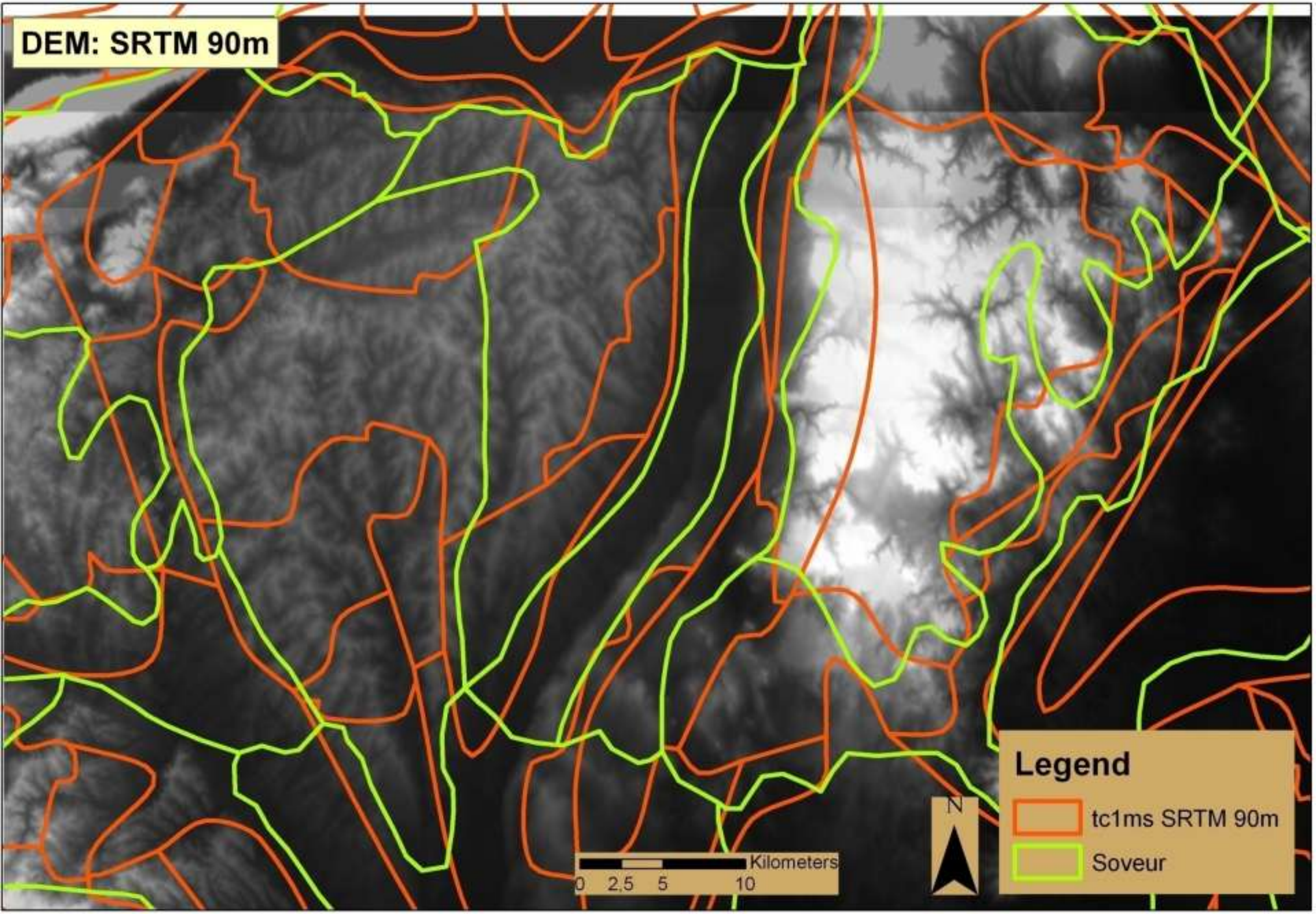

CE window
Country borders
Soil Type CE
Arenosol
Calcisol
Cambisol
Chernozem / Kastanozem
Histosol
Hydromorphic
Leptosol / Regosol
Luvisol
Luvisol / Alisol
Nudilitic
Phaeozem
Regosol
Vertisol
Water
N
Kilometers
0 30 60 120 180 240


Legend
classified_soil_type
Class_Name
Water
Hystosol
Nudilitic
Podzol
Luvisol
Cambisol
Leptosol / Regosol
Vertisol
Salt Effected
Hydromorphic
Chernozem / Kastan
Phaeozem
Calcisol
Luvisol / Alisol
Arenosol
Regosol
Umbrisol


Legend
fm10_classified_soil_typ
Arenosol
Calcisol
Cambisol
Chernozem / Kastanoze
Hydromorphic
Hystosol
Leptosol / Regosol
Luvisol
Luvisol / Alisol
Nudilitic
Phaeozem
Regosol
Salt Effected
Vertisol
Water

The final polygon system after burning in the soil polygons




DEM: SRTM 90m
Legend
tc1ms SRTM 90m
Soveur
Kilometers
0 2,5 5 10
N

Results:Relief Intensity <100m/km

Czech Republic LANDFORM	TOTAL COUNT	SUM	Rate (sum/total count*100)
LD	1166388	1154890	99,01
LP	3264142	3256190	99,76
LV	155176	154670	99,67

Hungary LANDFORM	TOTAL COUNT	SUM	Rate (sum/total count*100)
LF	875214	862084	98,50
LV	587187	579422	98,68
LP	9869464	9866850	99,97
LL	149332	146632	98,19

Romania LANDFORM	TOTAL COUNT	SUM	Rate (sum/total count*100)
LP	2045269	2033080	99,40
LD	552418	513288	92,92
LV	243249	229738	94,45

Results: Relief Intensity >600m/2km

Czech Republic LANDFORM	TOTAL COUNT	SUM	Rate (sum/total count*100)
TM	1342402	3453	0,26
SM	487830	0	0,00

Hungary LANDFORM	TOTAL COUNT	SUM	Rate (sum/total count*100)
SM	621468	0	0,00

Poland LANDFORM	TOTAL COUNT	SUM	Rate (sum/total count*100)
TM	1145658	15889	1,39
SM	718088	0	0,00

Romania LANDFORM	TOTAL COUNT	SUM	Rate (sum/total count*100)
SM	224614	407	0,18
TM	1428527	21029	1,47

Summary and conlcusions

1. Traditional SOTER approach can be replaced by digital soil mapping approach in a certain extent
   - Terrain and parent material classes and properties can be produced by digital terrain modeling and remote sensing tools
2. Some properties are difficult to produce in the same format, but can easily be replaced with other easy to derive ones refering to the similar phenomenon.
3. The procedures depend very much on the input data quality and density. However, it can produce reliable information with point density of $75km^2$/point.

Summary and conlcusions

5. Polygons still represent valuable information for any startification needs for modeling, analysis and data development. Easy way to visualize the major soil properties in a scale of 1:1M. However, the database structure and design limits its efficient use for modelers.
6. Several layers - with much higher detail of information - are produced through the developmental procedure, which are processed and degraded to support the polygon system development. These layers represent a great additional value of the database.
7. Classes are easier to spatialize and interpret when simple and general classes are used. More specific information can be derived afterwards by combining the dissagregated thematic classes.
8. The developped procedure can be used backwords to disaggregate the soil associations of the polygons of the traditionally made datasets.

Take home message

We should not try to reproduce the „traditional” datasets with the new tools,

but to convert and save all the information from the legacy datasets using the new tools in a novel dataset design!

The provisional SOTER database

- Polygons
  - Terrain and parent material based uniform units
  - Bases for interpreting the environments, variables, stratification tool
  - Easy way to visualize the major soil properties in a scale of 1:1M

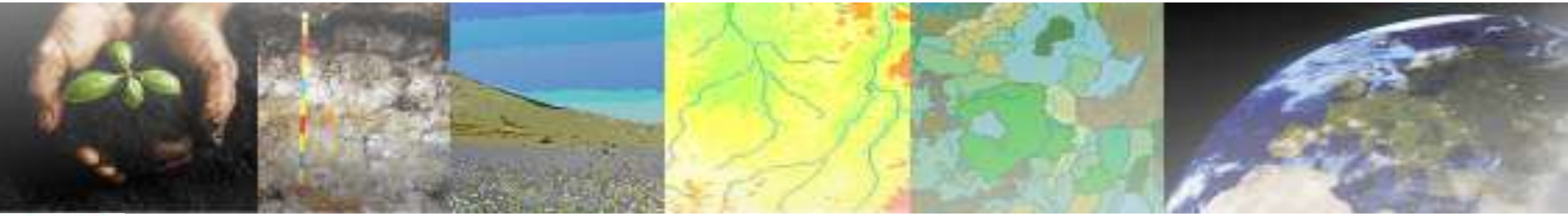
The provisional SOTER database

- Raster layers (90-500m resolution)
  - Terrain derivatives
  - Parent material properties/classes
  - Major diagnostic features relevant for the scale (likelihood)
  - RSG of the WRB

Köszönöm a figyelmet!

Thank You for your attention!

Grazie per l'attenzione!



Non-spatial attributes of the terrain component

Terrain Component

- SOTER Unit ID
- Terrain component number
- Proportion of SOTER Unit
- Terrain component data ID

Terrain component data

- Terrain component data ID.
- **Dominant slope**
- Lenght of slope
- Form of slope
- Local surface form
- **Average height**
- **Surface lithology**
- **Texture group of the non-consolidated parent material**
- **Depth to bedrock**
- Surface drainage
- **Depth to groundwater**
- Frequency of flooding
- Duration of flooding
- Start of flooding

Non-spatial attributes of the soil component level

Soil component

- <u>SOTER Unit ID.</u>
- <u>Terrain compponent number</u>
- <u>Soil component number</u>
- <u>Proportion of SOTER Unit</u>
- <u>Profile ID.</u>
- <u>Number of reference profiles</u>
- **<u>Position in terrain component</u>**
- <u>Surface rockiness</u>
- <u>Surface stoniness</u>
- Types of erosion/deposition
- Area affected
- Degree of erosion
- Sensitivity to capping
- Rootabel depth
- Relation with other soil components