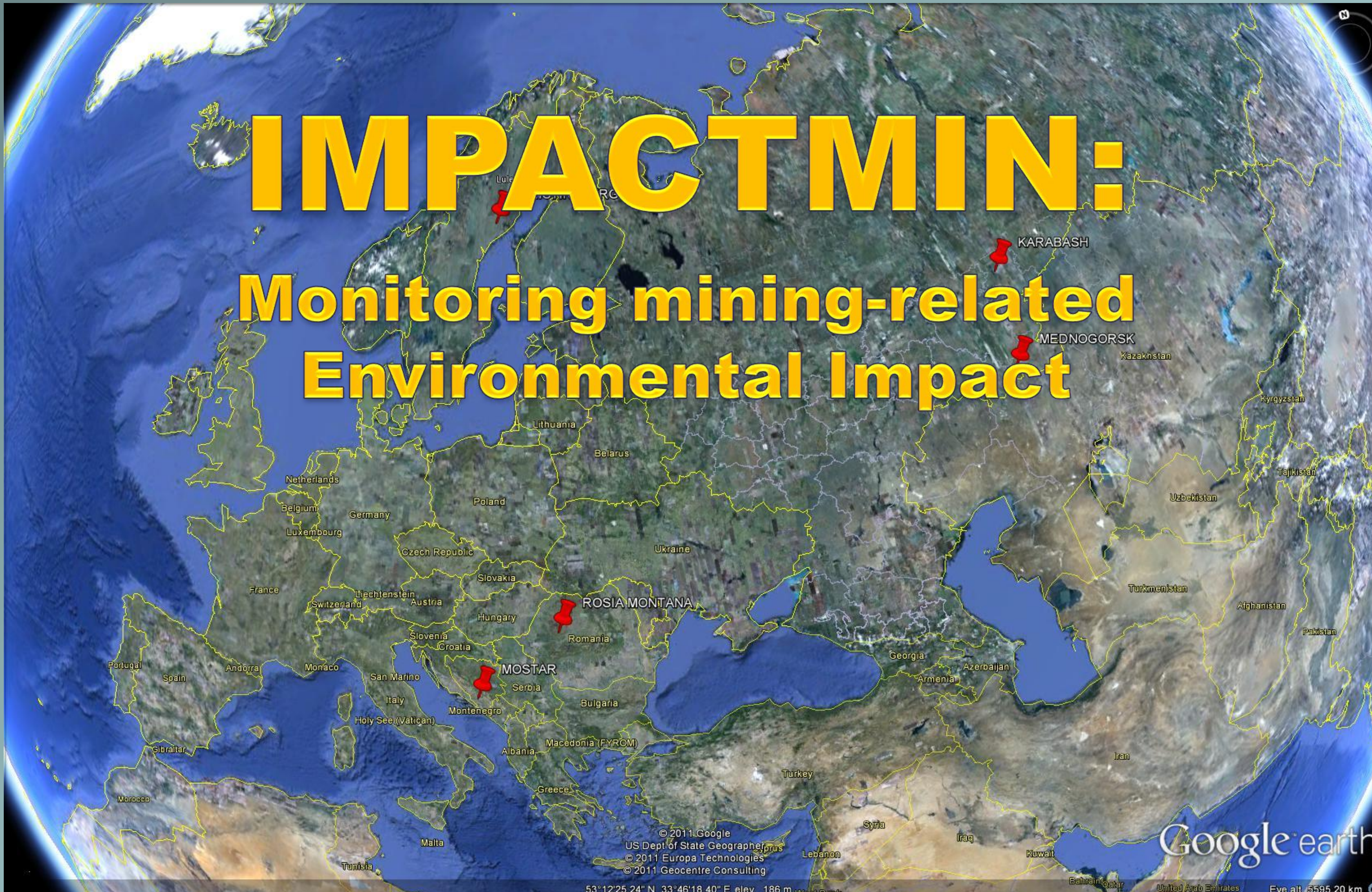
IMPACTMIN:

Monitoring mining-related Environmental Impact



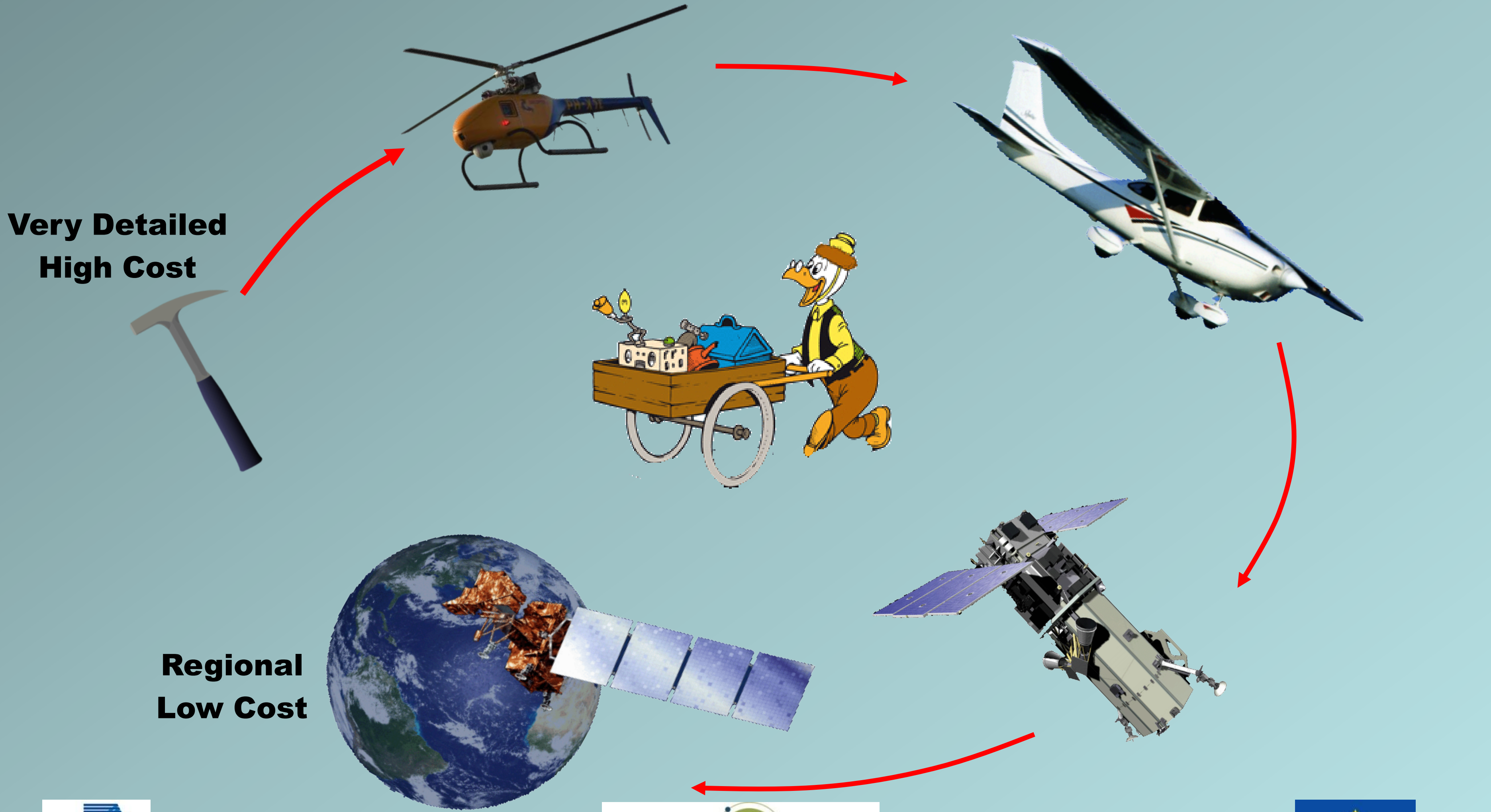
SEVENTH FRAMEWORK PROGRAMME

FOCUS ON REMOTE SENSING TOOLS

Combining conventional And innovative technology

Balance between DETAIL of information and COST of acquisition

How do we combine Multitemporal datasets and different resolutions



FIVE PROJECT AREAS

SEVENTH FRAMEWORK PROGRAMME

impact-min

Urals: KARABASH

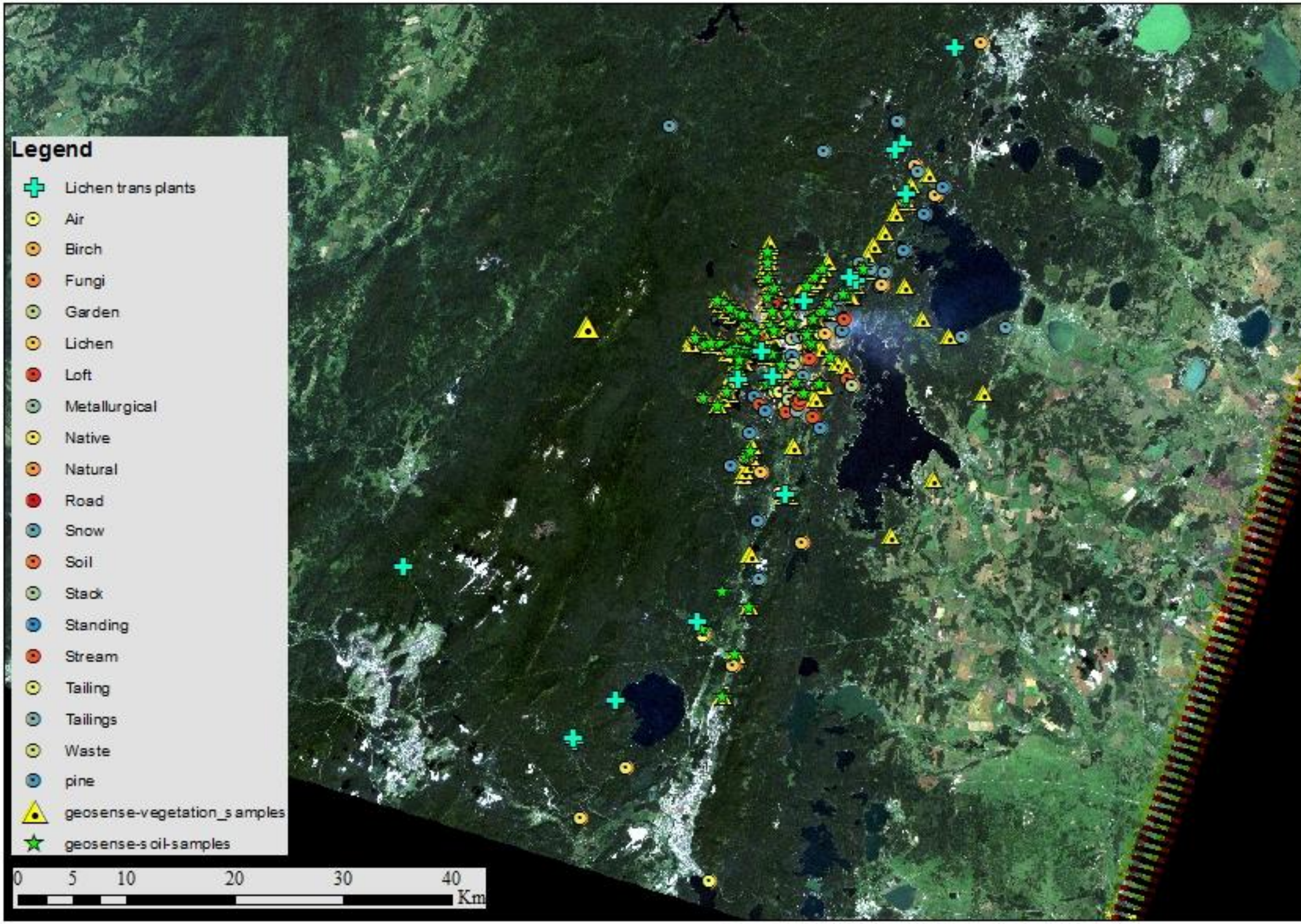
- 1822 Gold Mining
- 1833 Cu- smelting
- 1910 Blister Copper Smelting
- 1994 Ecological Disaster Zone
- 1998- 2007 Construction New smelter
- Production at Half Capacity
- Dirtiest Place in Russia

- Immense SO_2 - Emissions
- Fall-Out Metal-rich Particulates
- 27% Population Healthy
- Birth Defects
- Skin Diseases
- Heavy Metal Poisoning
- Lung Diseases
- Alcohol & Poverty

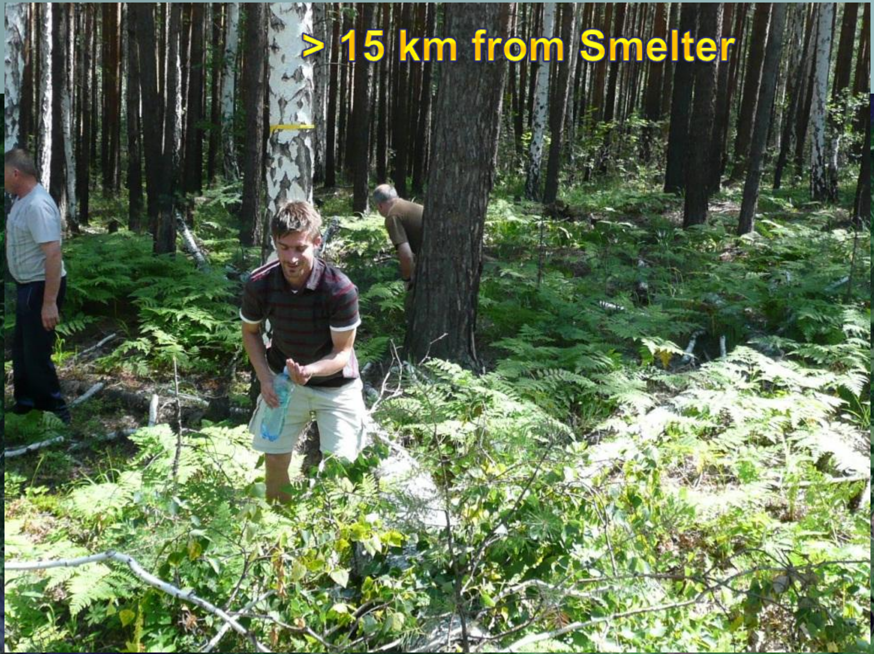
SEVENTH FRAMEWORK PROGRAMME

impact-min

GROUND DATA PROGRAMME, 2000-2012

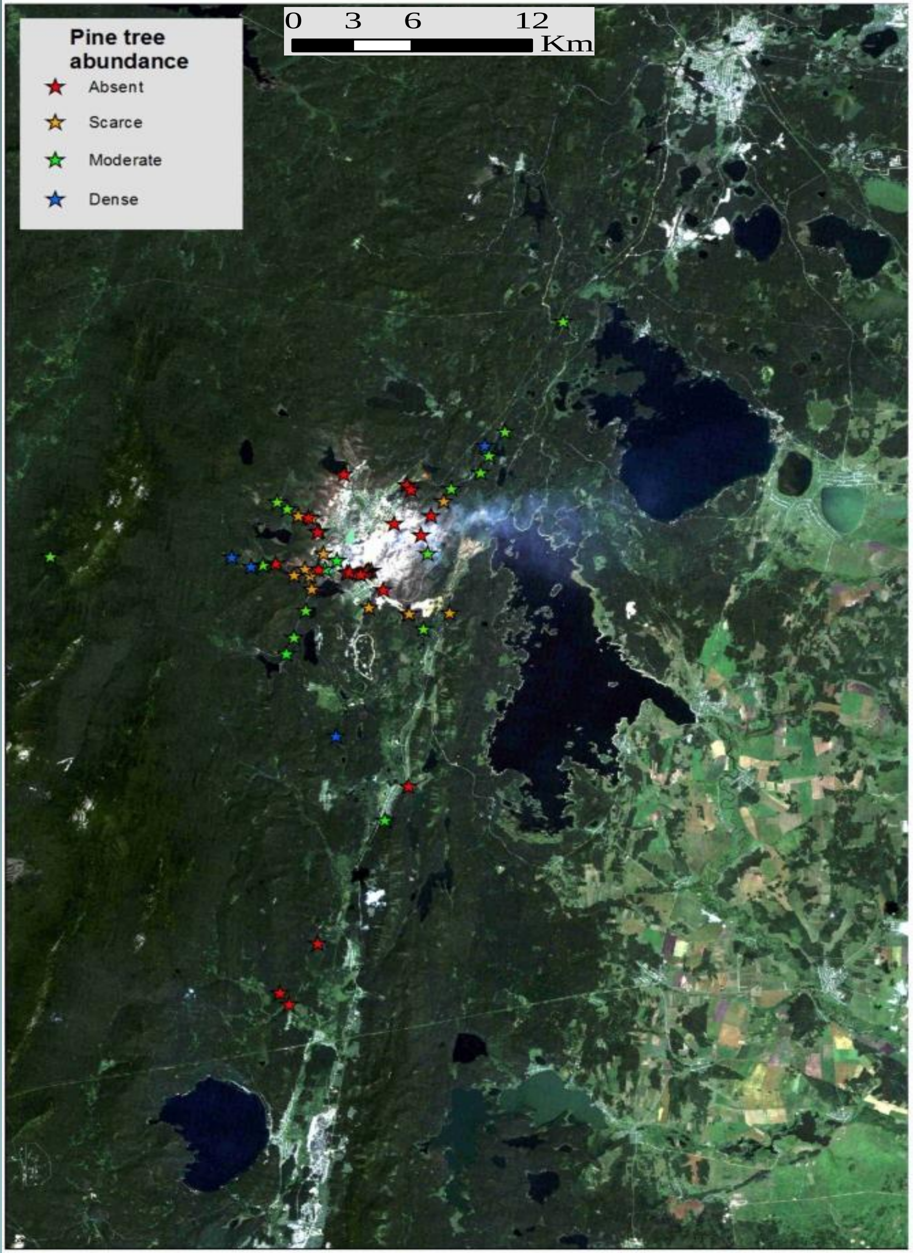


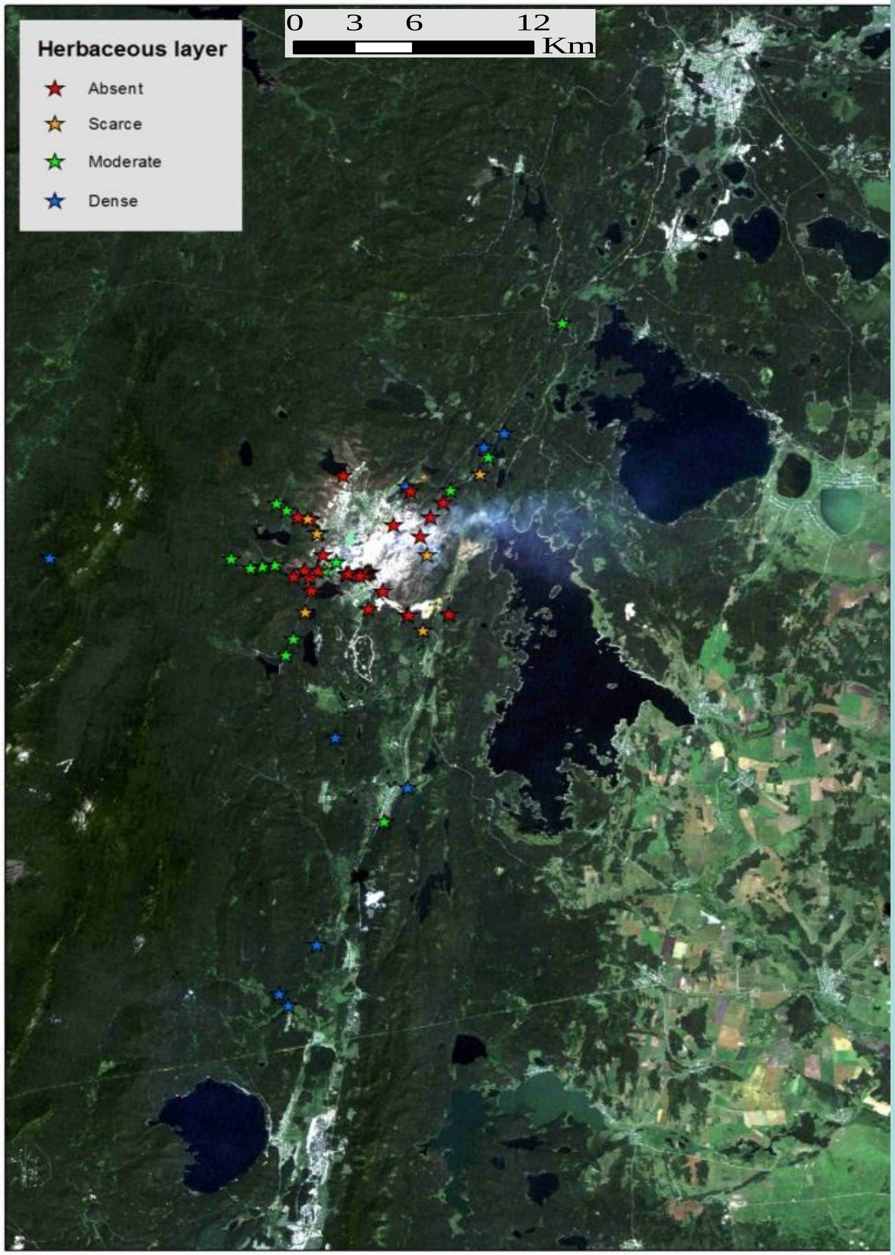
Vegetation changes



SEVENTH FRAMEWORK PROGRAMME

KARABASH vegetation zoning

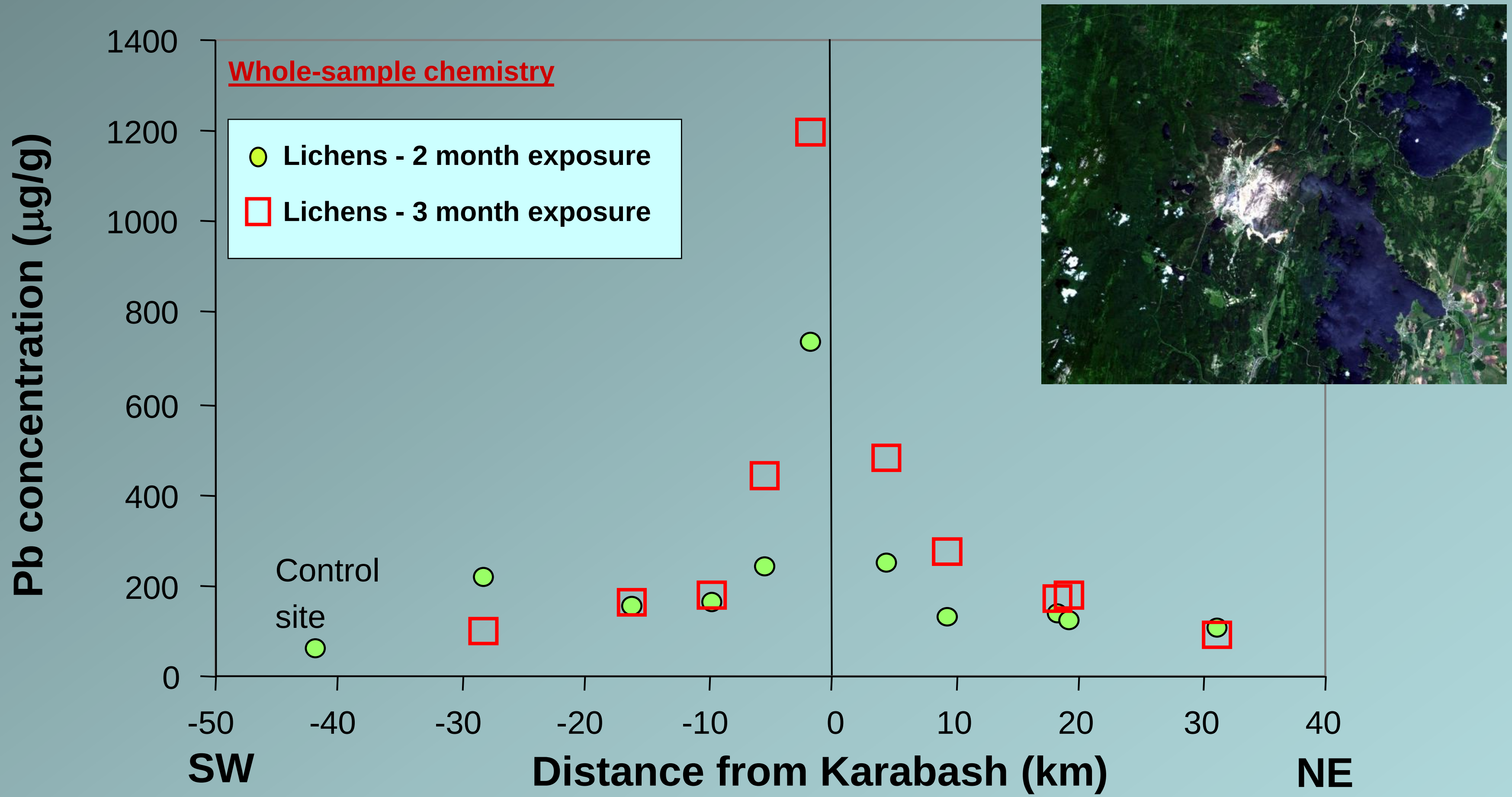




SEVENTH FRAMEWORK PROGRAMME

impactmin

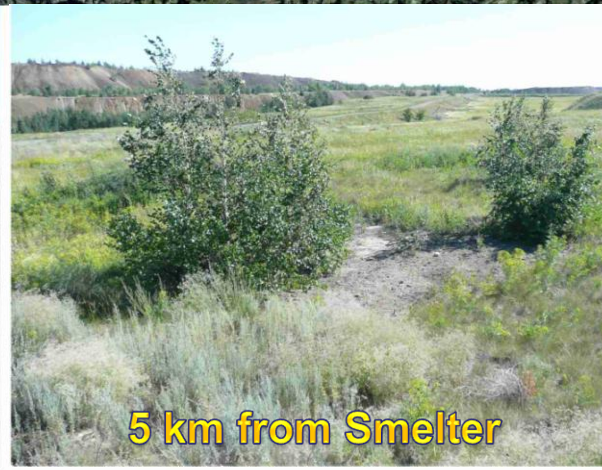
ZONING CONFIRMED BY LICHEN STUDY

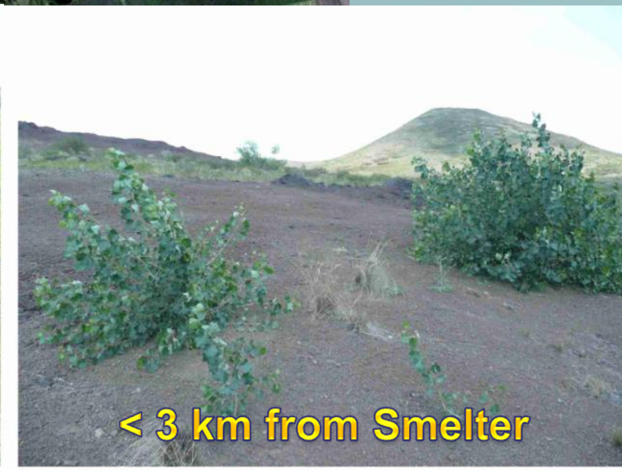


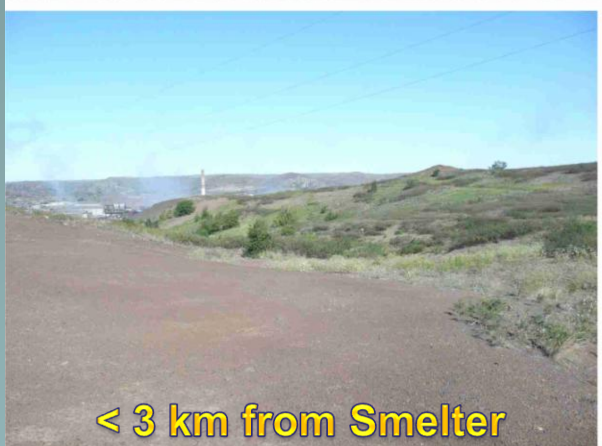
Ben Williamson[1,2], O. W. Purvis[2], I.N. Mikhailova[3], B. Spiro[2] and V. Udachin[4]

[1]Camborne School of Mines - University of Exeter, Cornwall
[2]Natural History Museum, London
[3]Institute of Plant and Animal Ecology, Ekaterinburg, Russia
[4]Russian Academy of Sciences, Miass, Russia

MEDNOGORSK vegetation



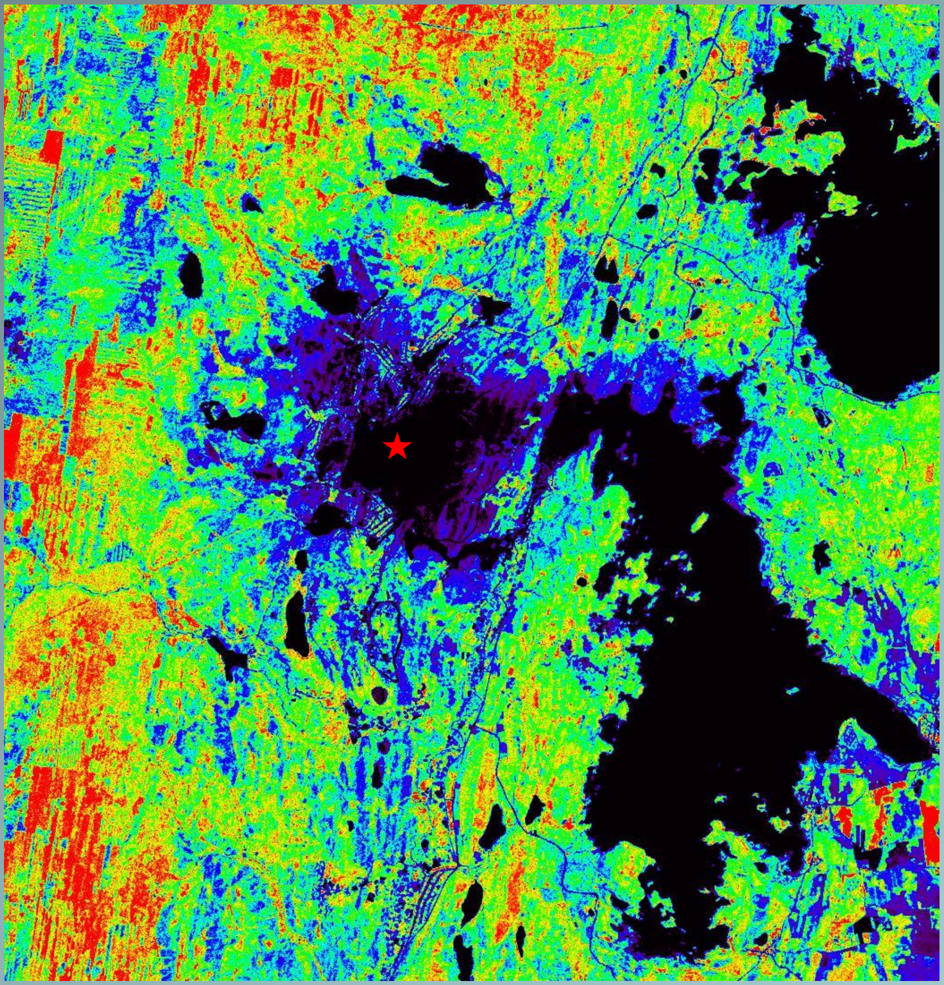




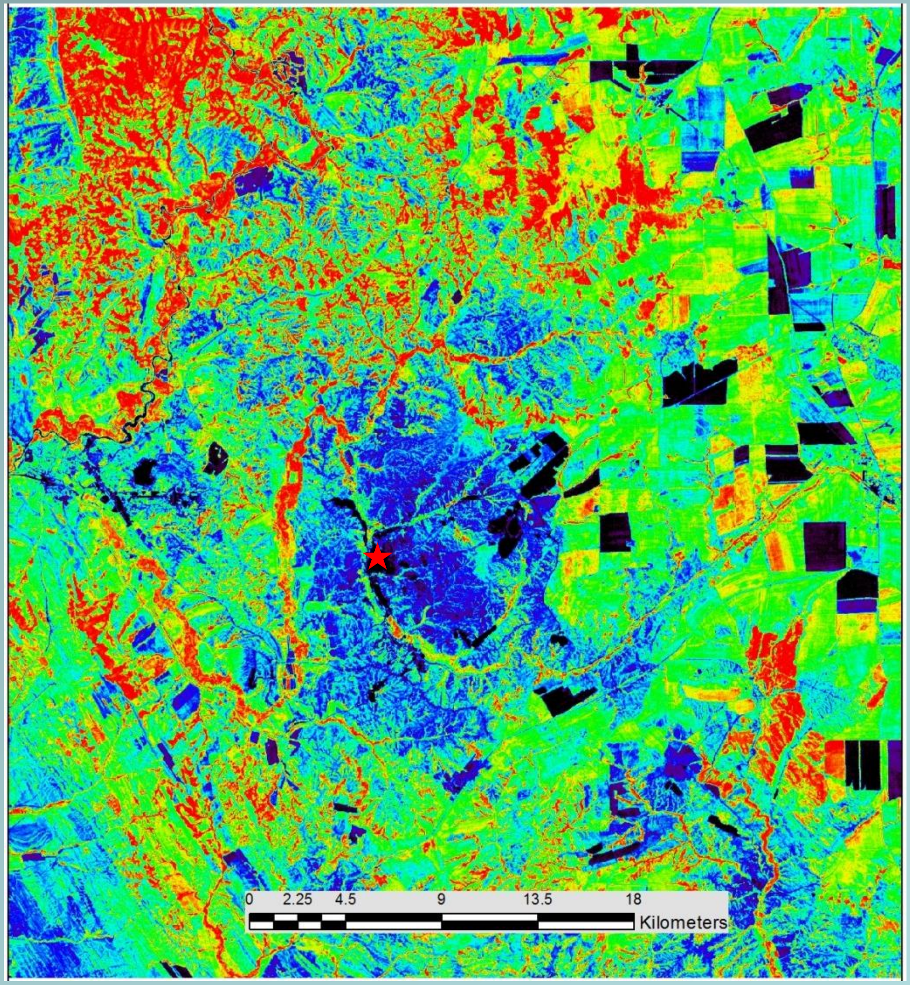
SEVENTH FRAMEWORK PROGRAMME

impact-min

LANDSAT NDVI



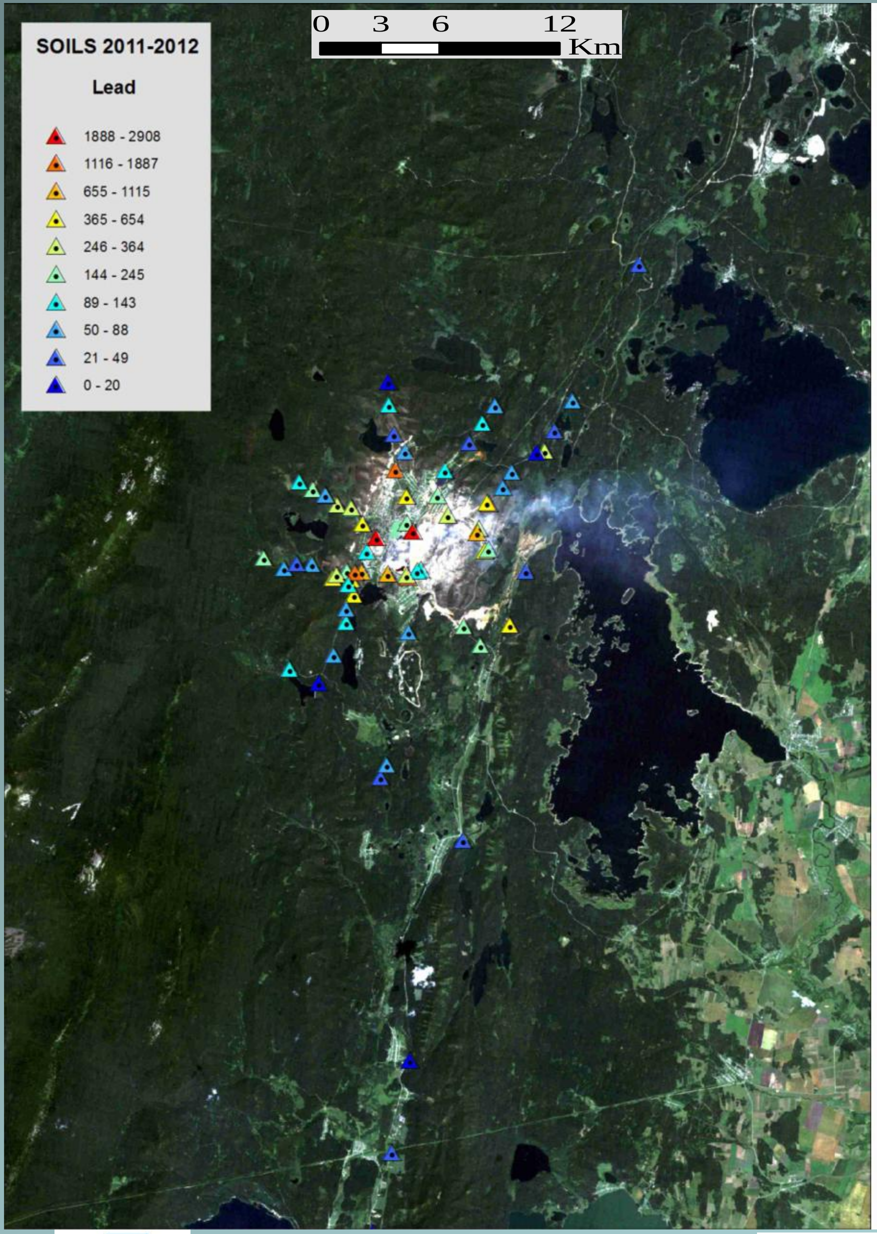
Karabash

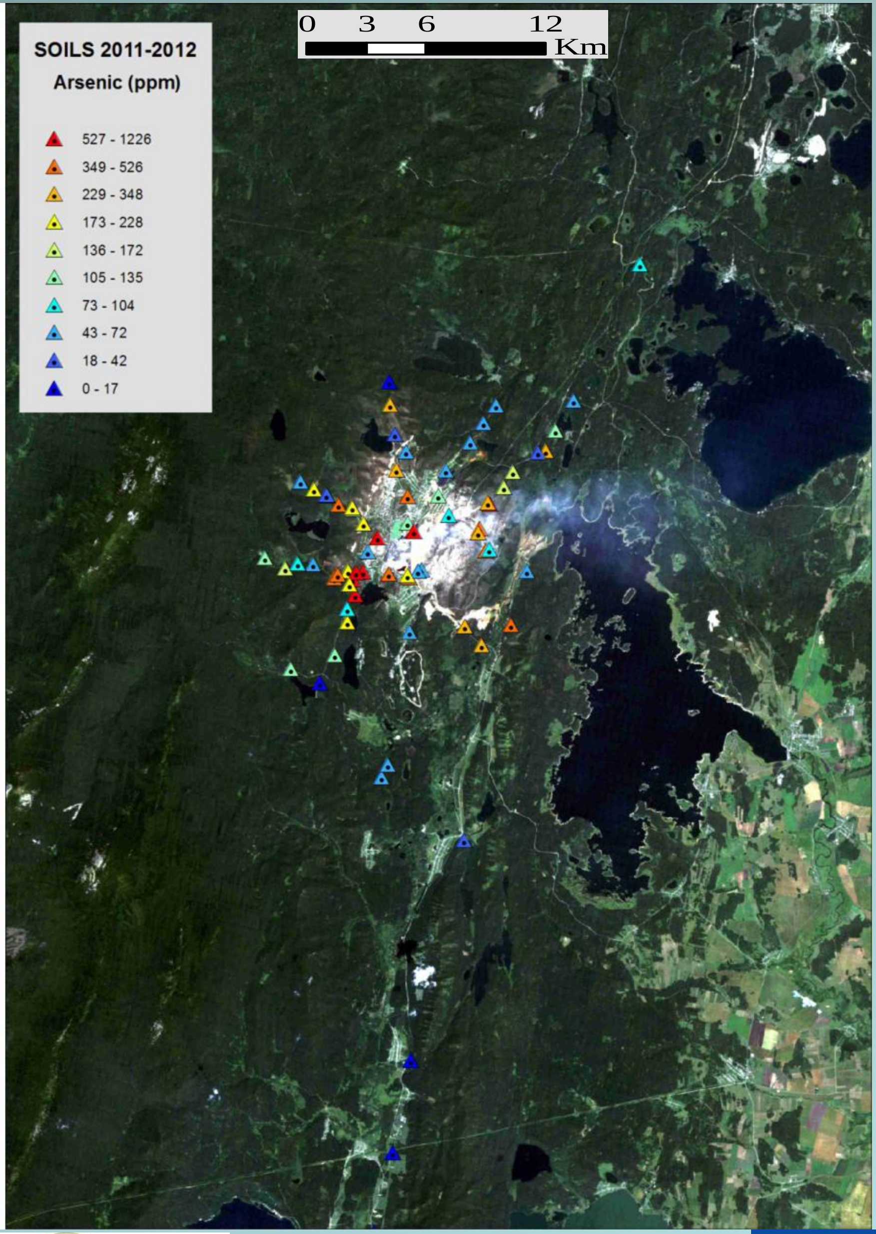


Mednogorsk

Soil Changes Karabash

Soil Chemistry Karabash: >100 times background

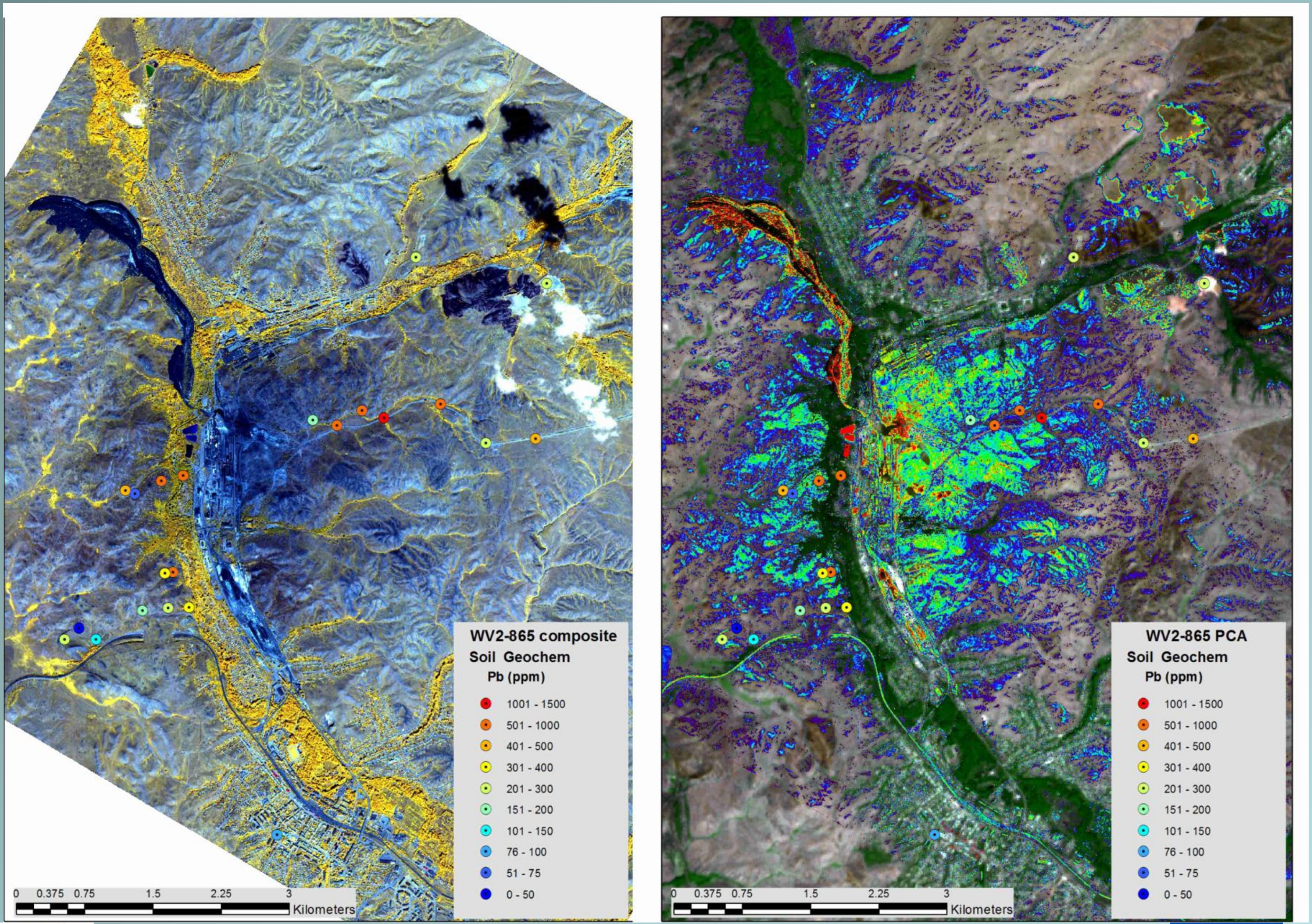




SEVENTH FRAMEWORK PROGRAMME

impact-min

Soil Chemistry Mednogorsk: >30 times background



SEVENTH FRAMEWORK PROGRAMME

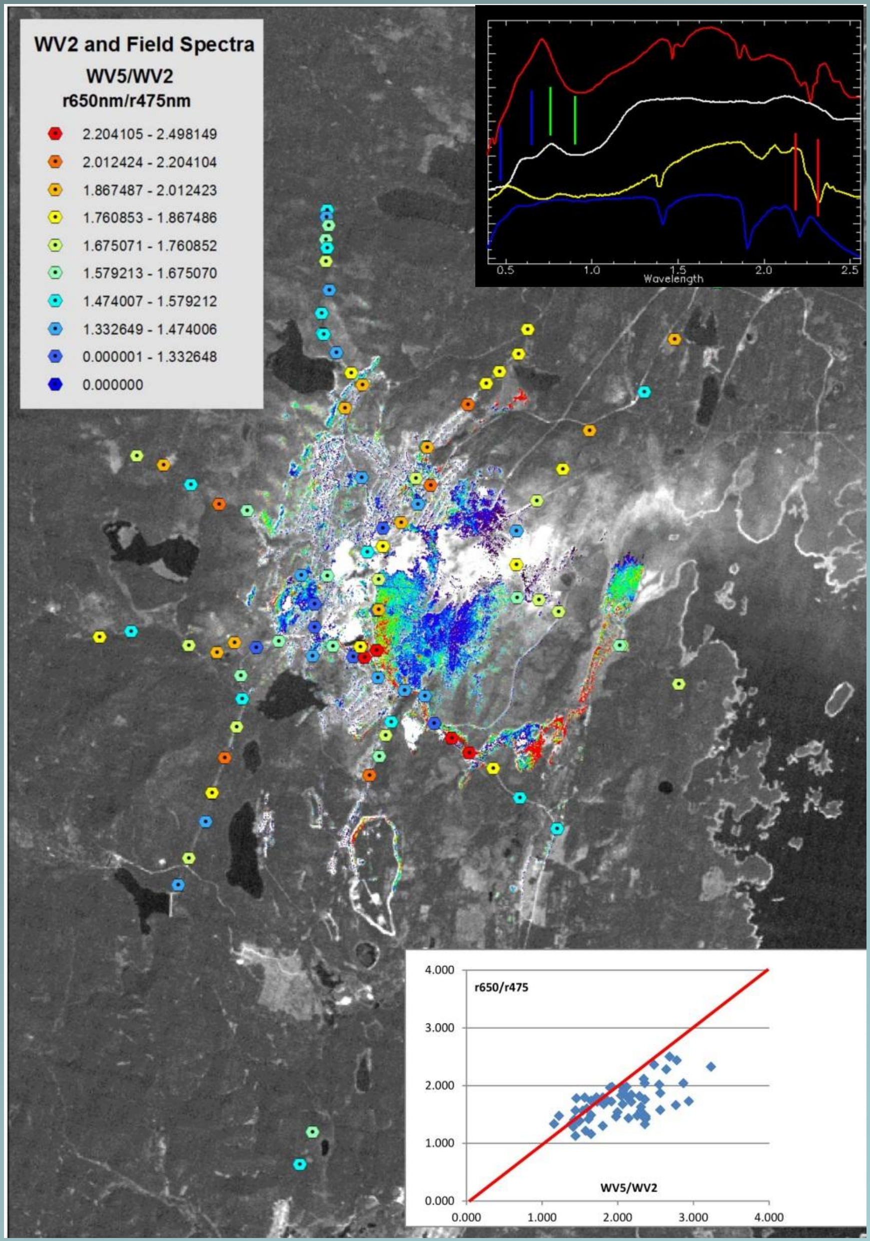
impaC+min

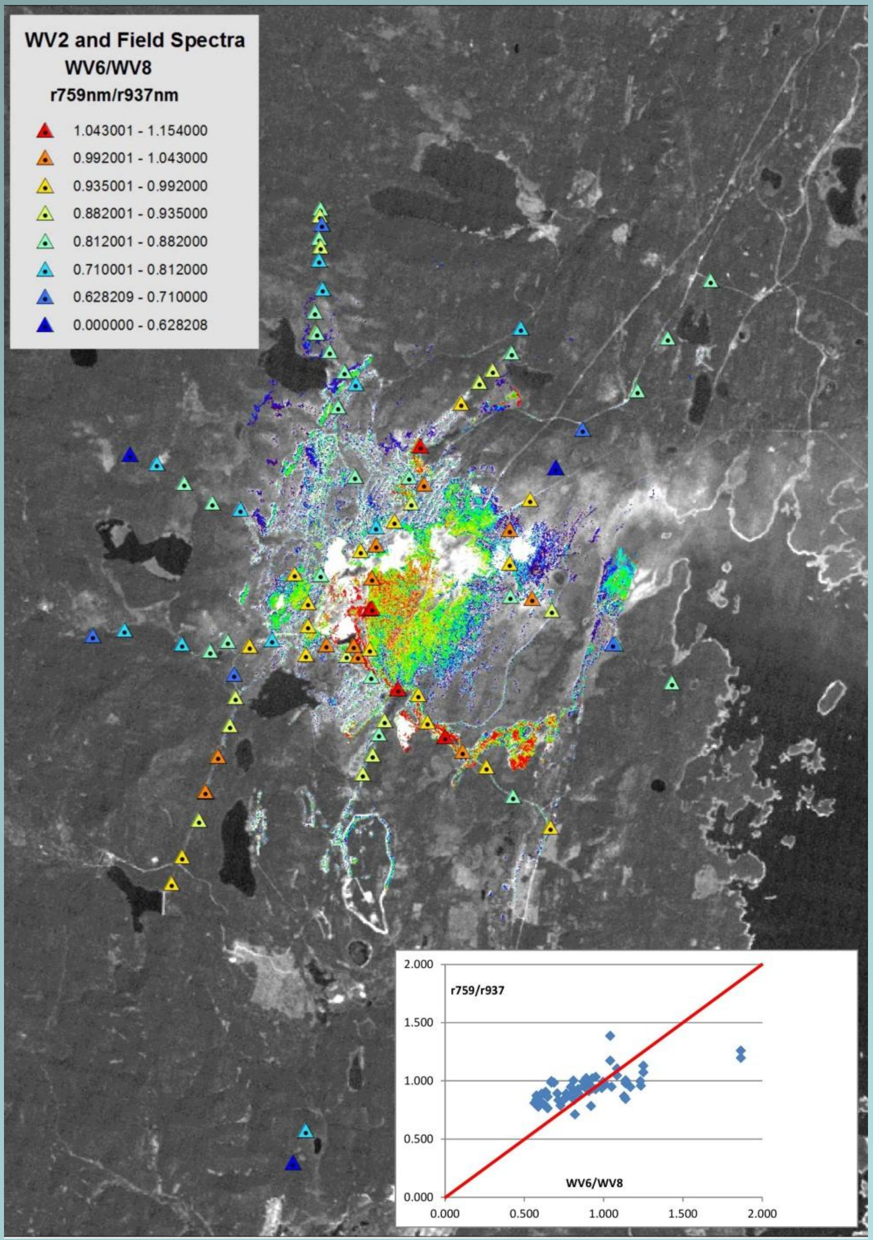
????

- Can we map this environmental impact using spectrosocopy
- Can we map this environmental impact using Satellite imagery
- Can we monitor changes using multi-temporal Satellite imagery

- SOILS
- VEGEGATION (Birch trees)

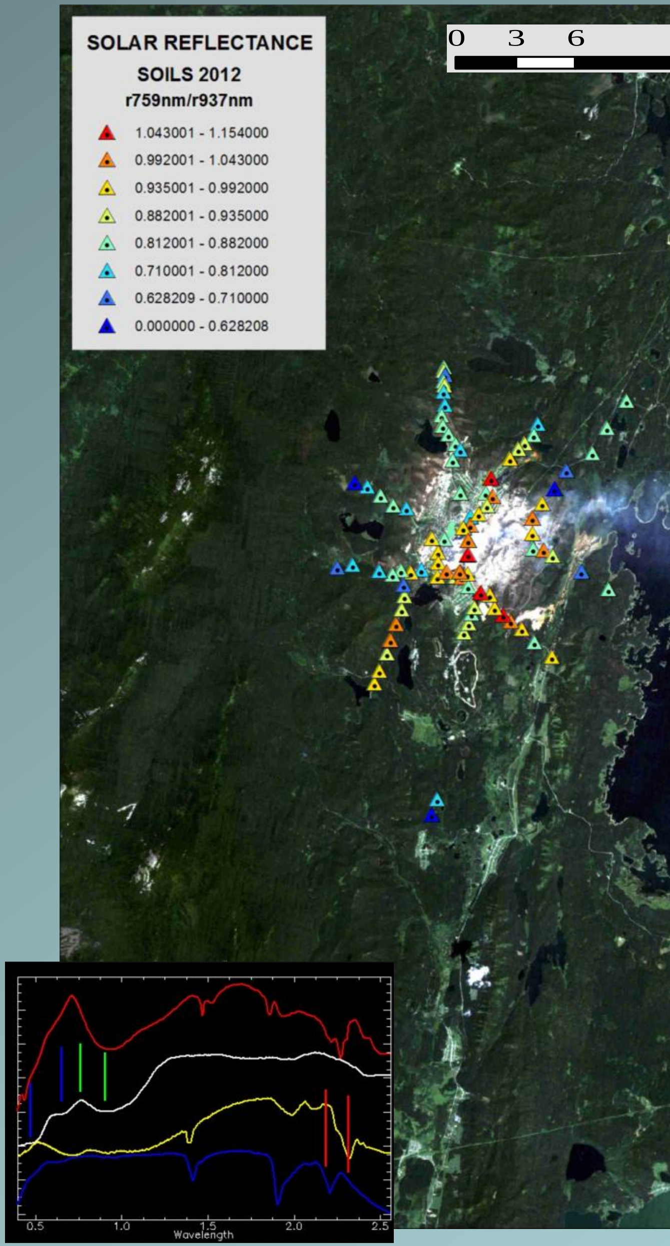
Karabash soils: solar reflectance measurements vs WV2-ratios

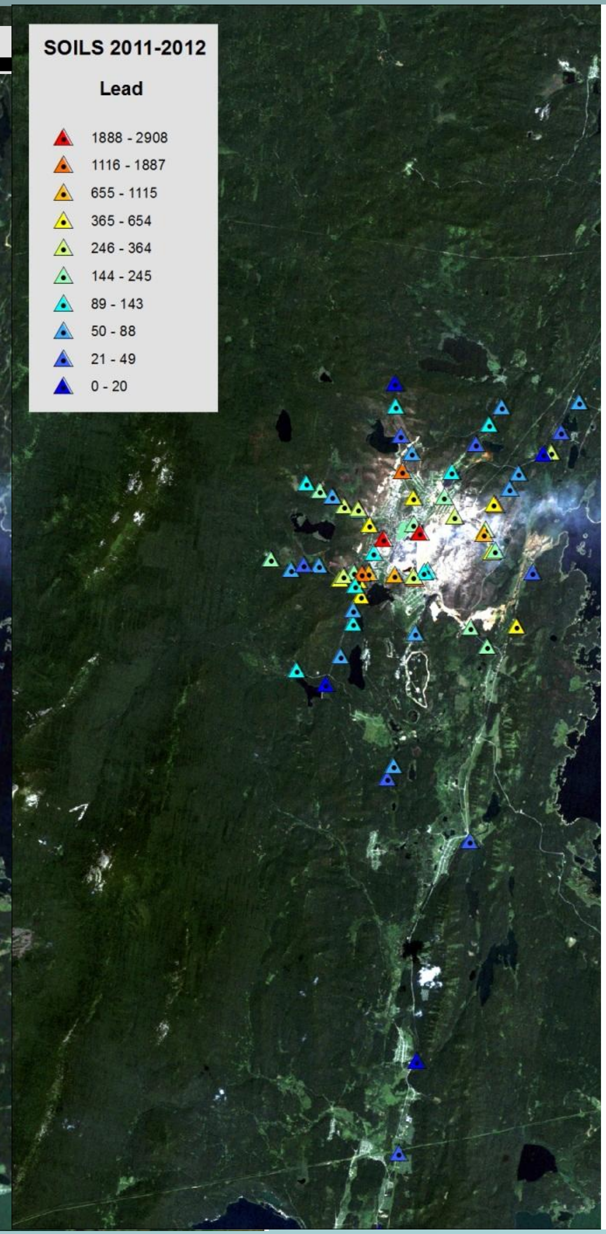


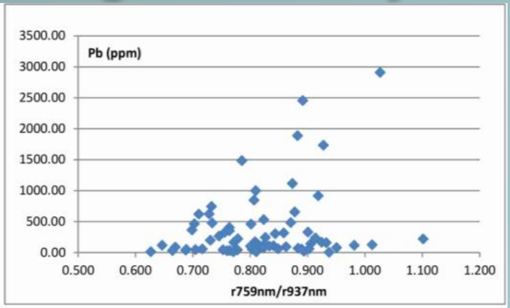


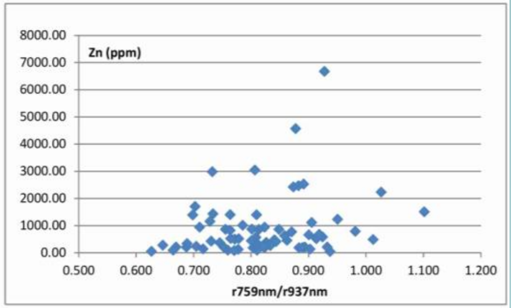
SEVENTH FRAMEWORK PROGRAMME

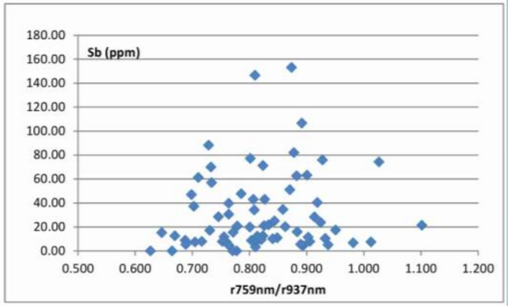
Karabash soils: solar reflectance measurements vs geochmistry

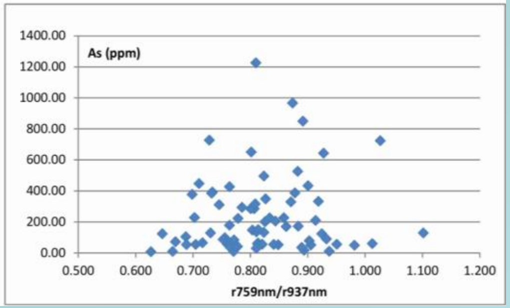






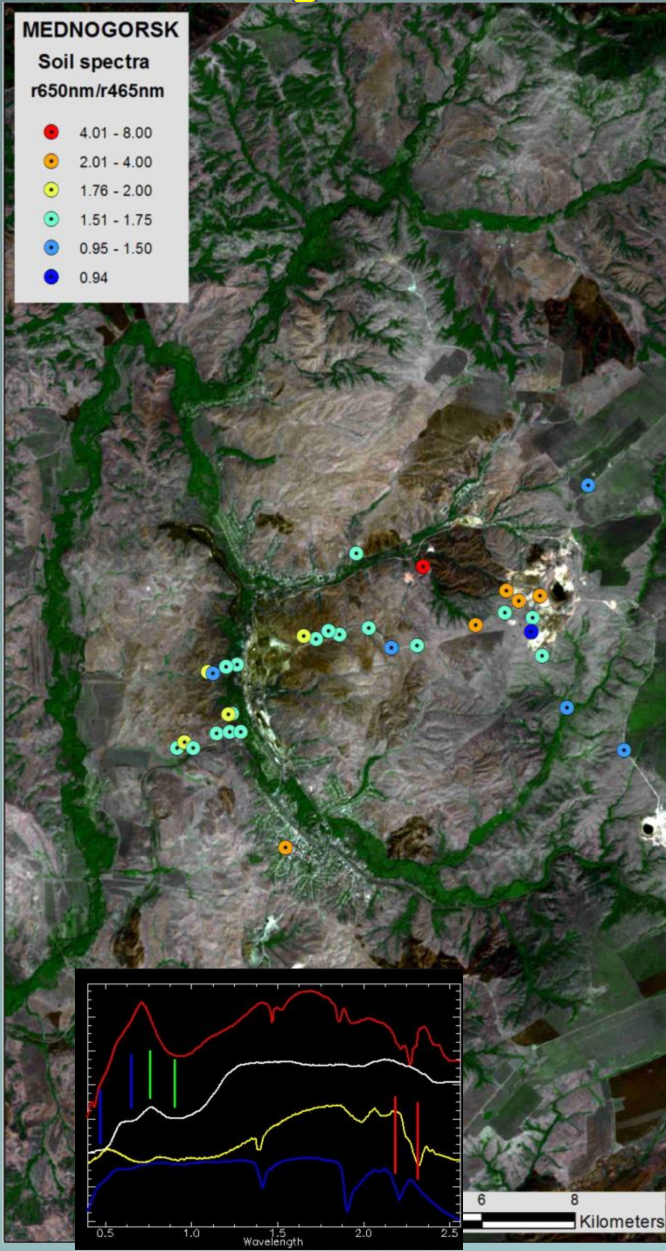


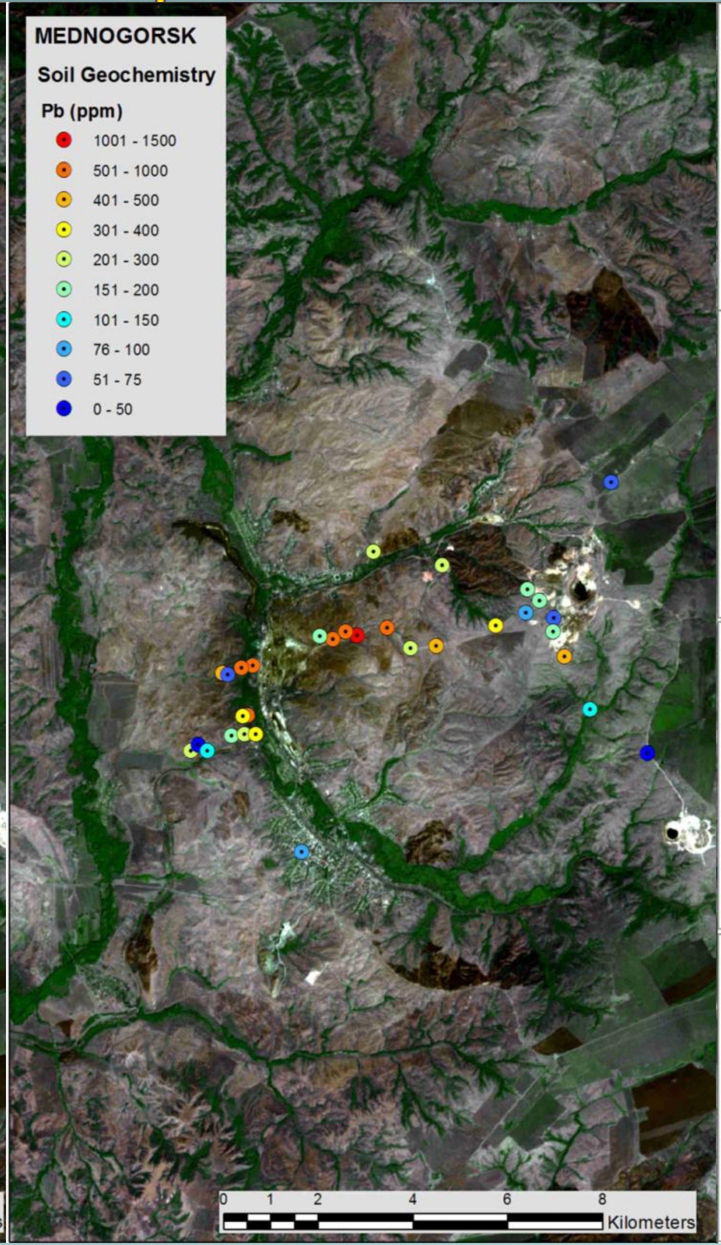


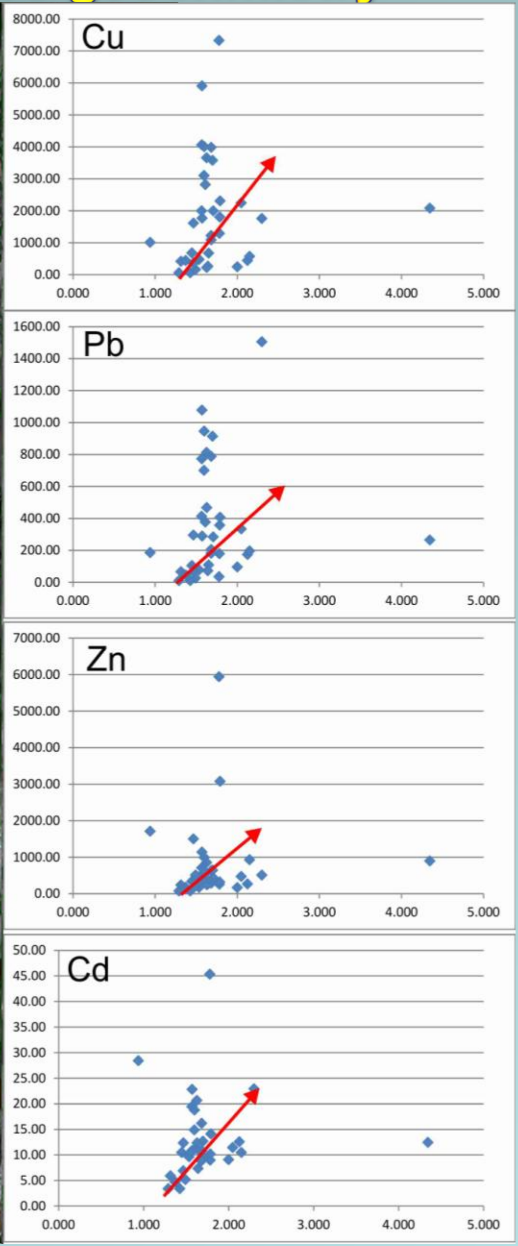


SEVENTH FRAMEWORK PROGRAMME

Mednogorsk soils: Contact probe measurements vs geochmistry



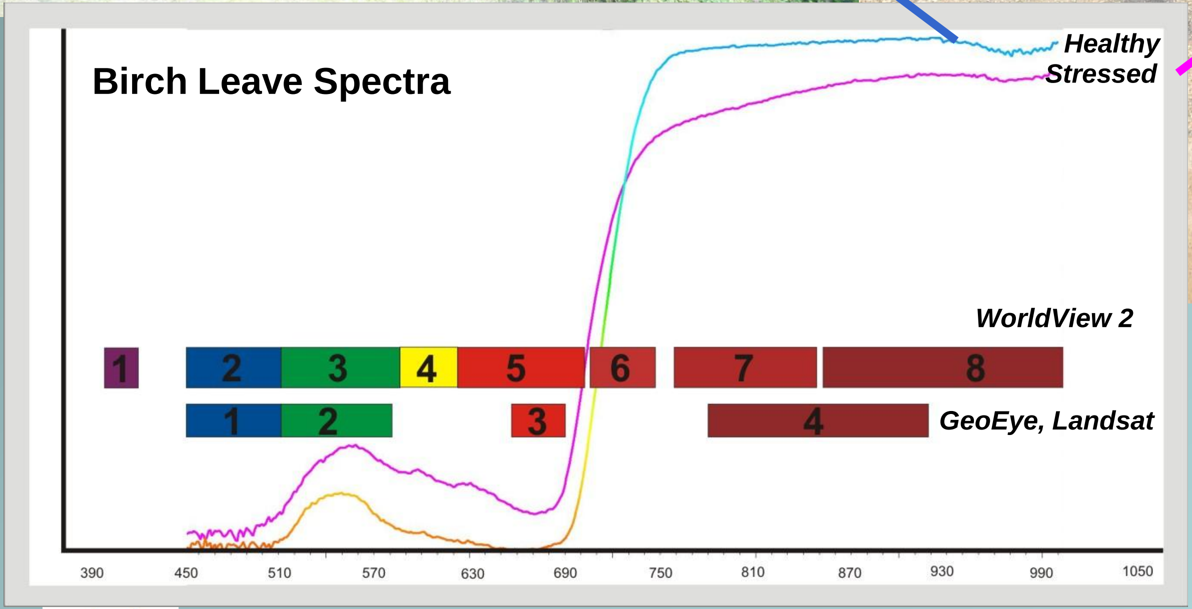




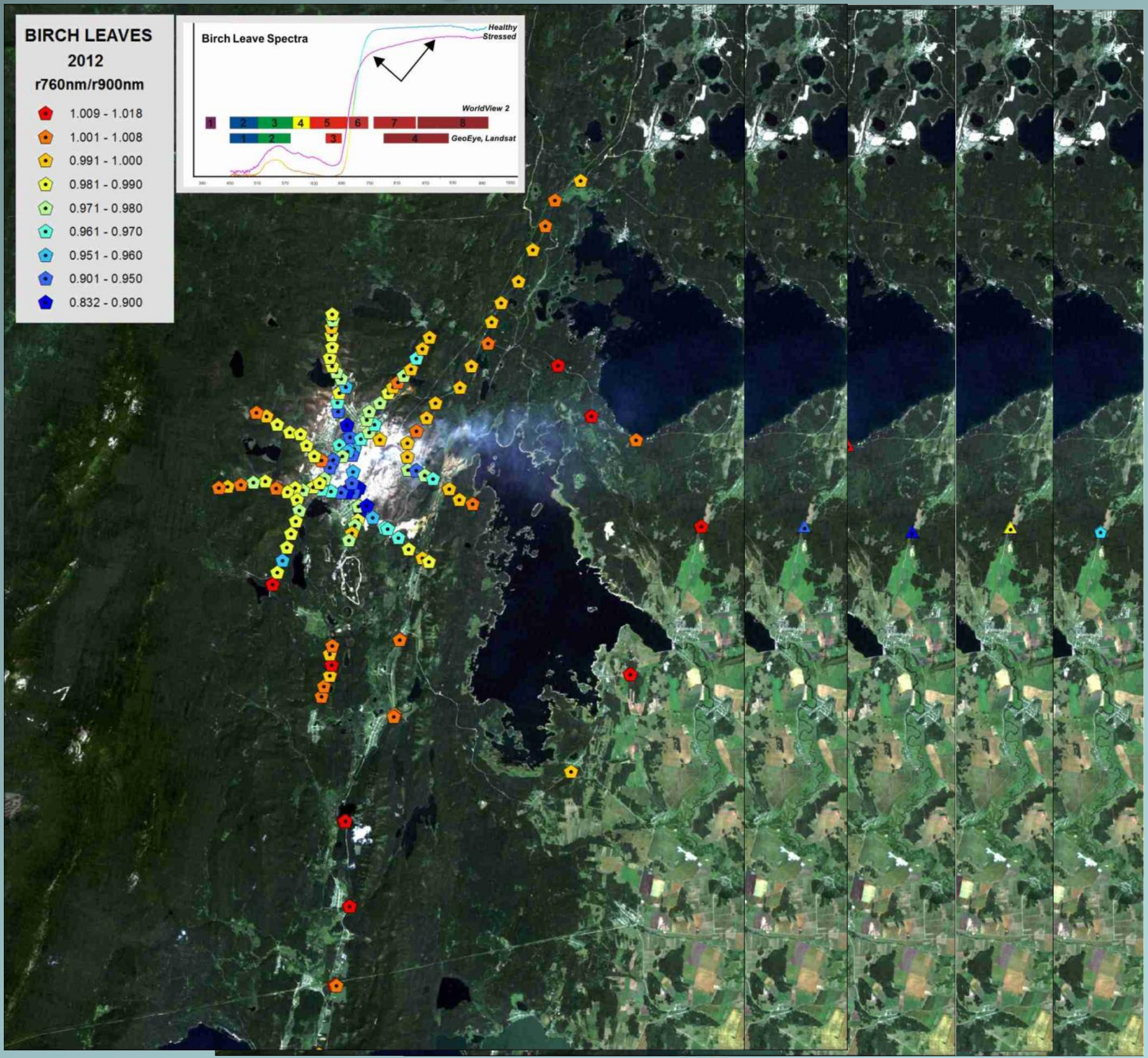
SEVENTH FRAMEWORK PROGRAMME

impactmin

KARABASH VEGETATION STRESS:



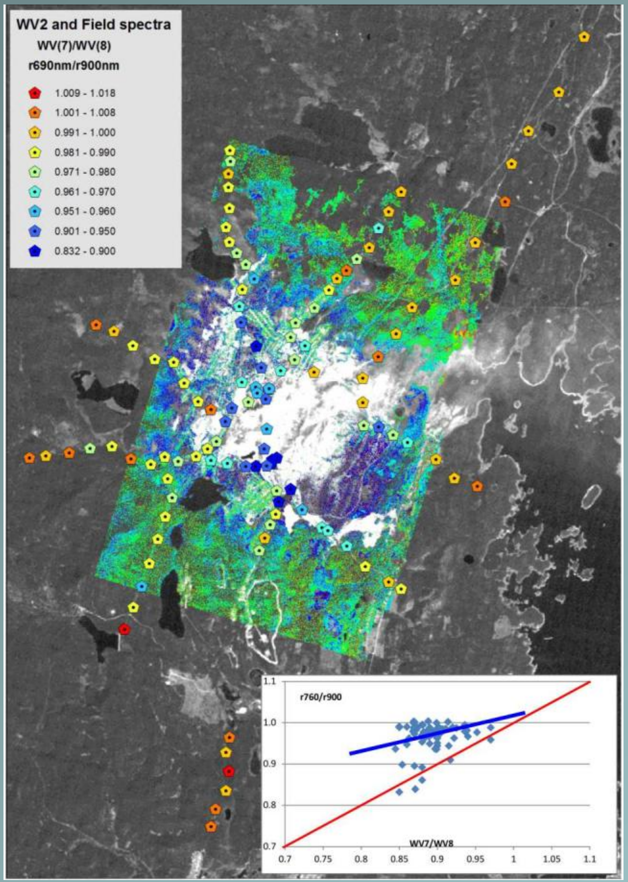
Karabash: Vegetation Indices for Birch trees

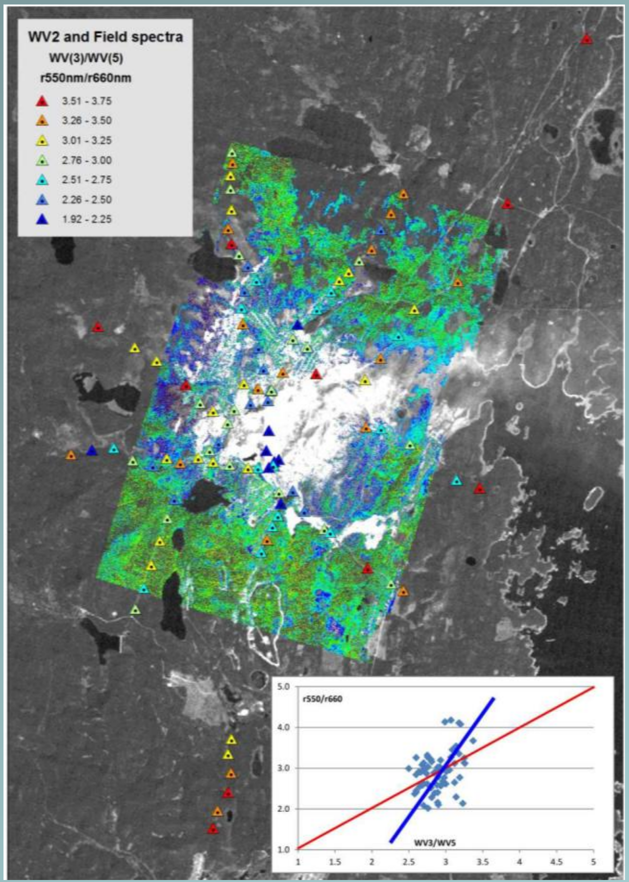


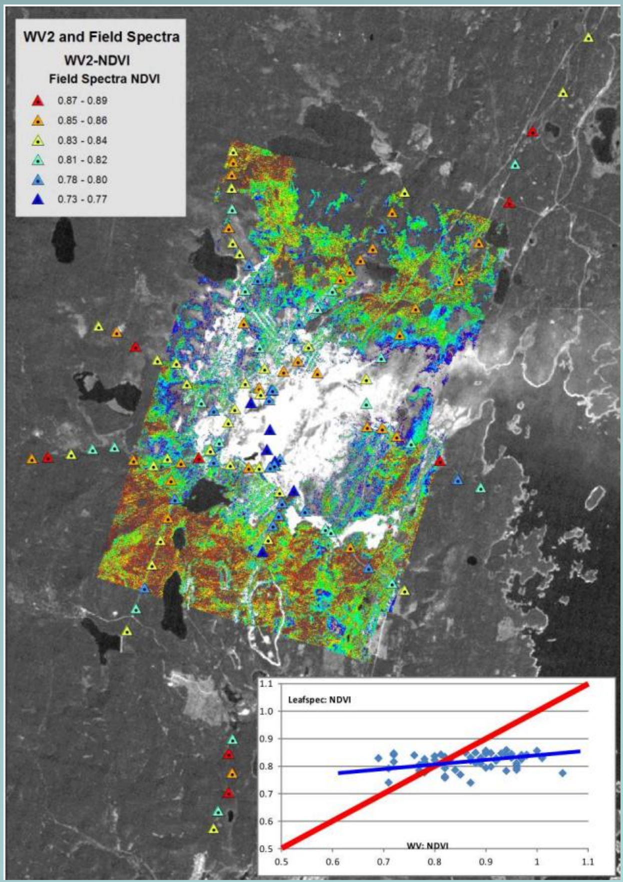
SEVENTH FRAMEWORK PROGRAMME

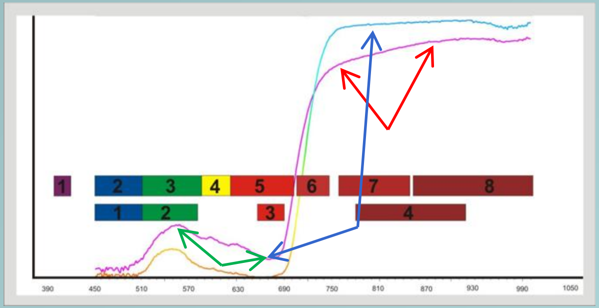
impactmin

Karabash: Vegetation Indices for Birch trees and WV2-ratios









SMELTER WAS MODERNIZED BETWEEN 2000 AND 2006

"Karabash now has a hi-tech and environmentally safe metallurgical plant which, apart from the Ausmelt furnace, also includes a modern waste treatment, sulphuric acid and effluent treatment plants. The Karabash plant is now one of the most modern plants of its type in Russia and the complex is among the most up-to-date and environmentally safe copper smelters globally. The Ausmelt-Karabash smelter has won two significant government awards: in 2005 the Ministry of Natural Resources of the Russian Federation awarded ZAO Karabashmed the honorary title of "Leader of Environment Protection Activity in Russia",

and in 2006 the plant General Director and the Chief Engineer were awarded

"the Ecological Shield of Russia" for the achievements in environment preservation. http://www.sulphuric-acid.com/sulphuric-acid-on-the-web/acid%20plants/ZAO%20Karabashmed%20-%20Karabash.htm

We should be able to notice the effects of this major improvement by means of remote sensing

MULTITEMPORAL IMAGERY

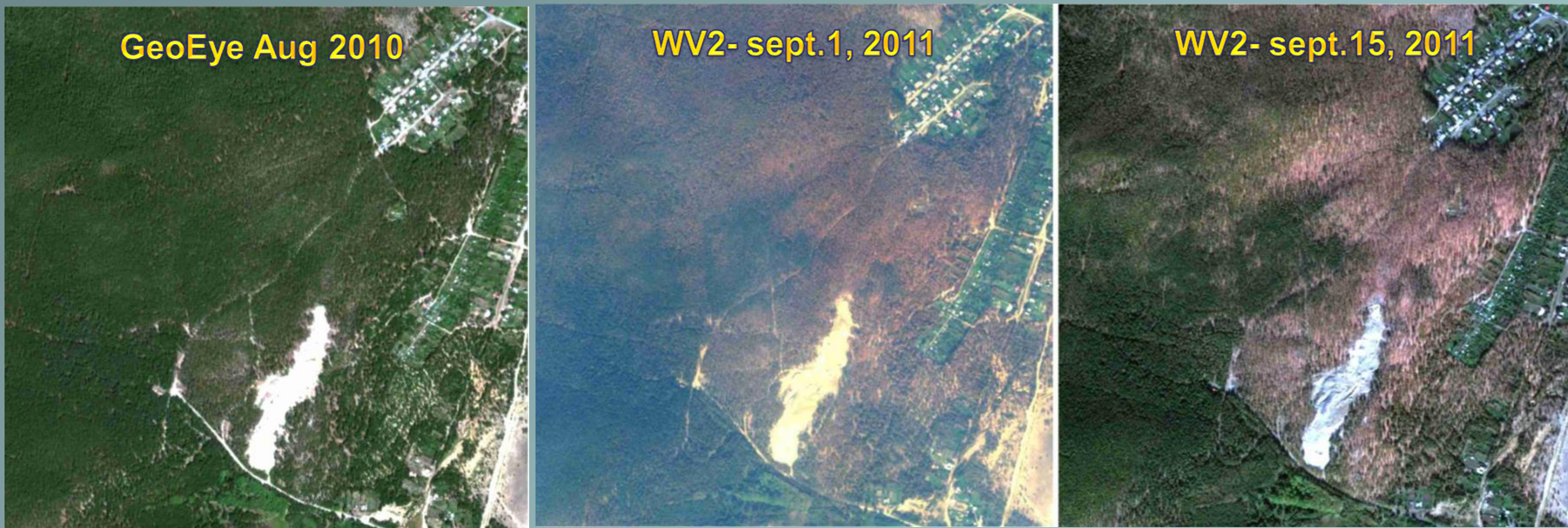
Short-term effects

Long-term effects

SEVENTH FRAMEWORK PROGRAMME

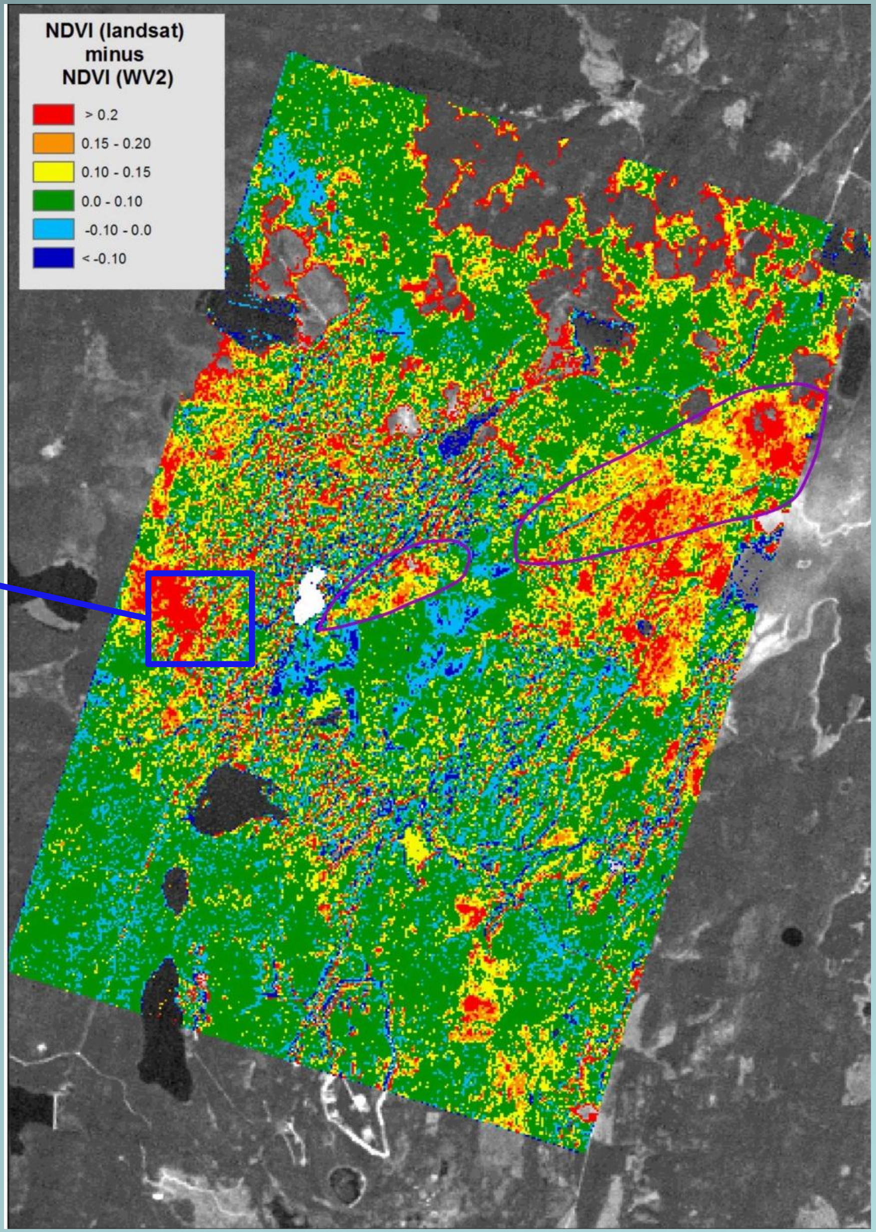
impact-min

Karabash: Short-term Vegetation Damage

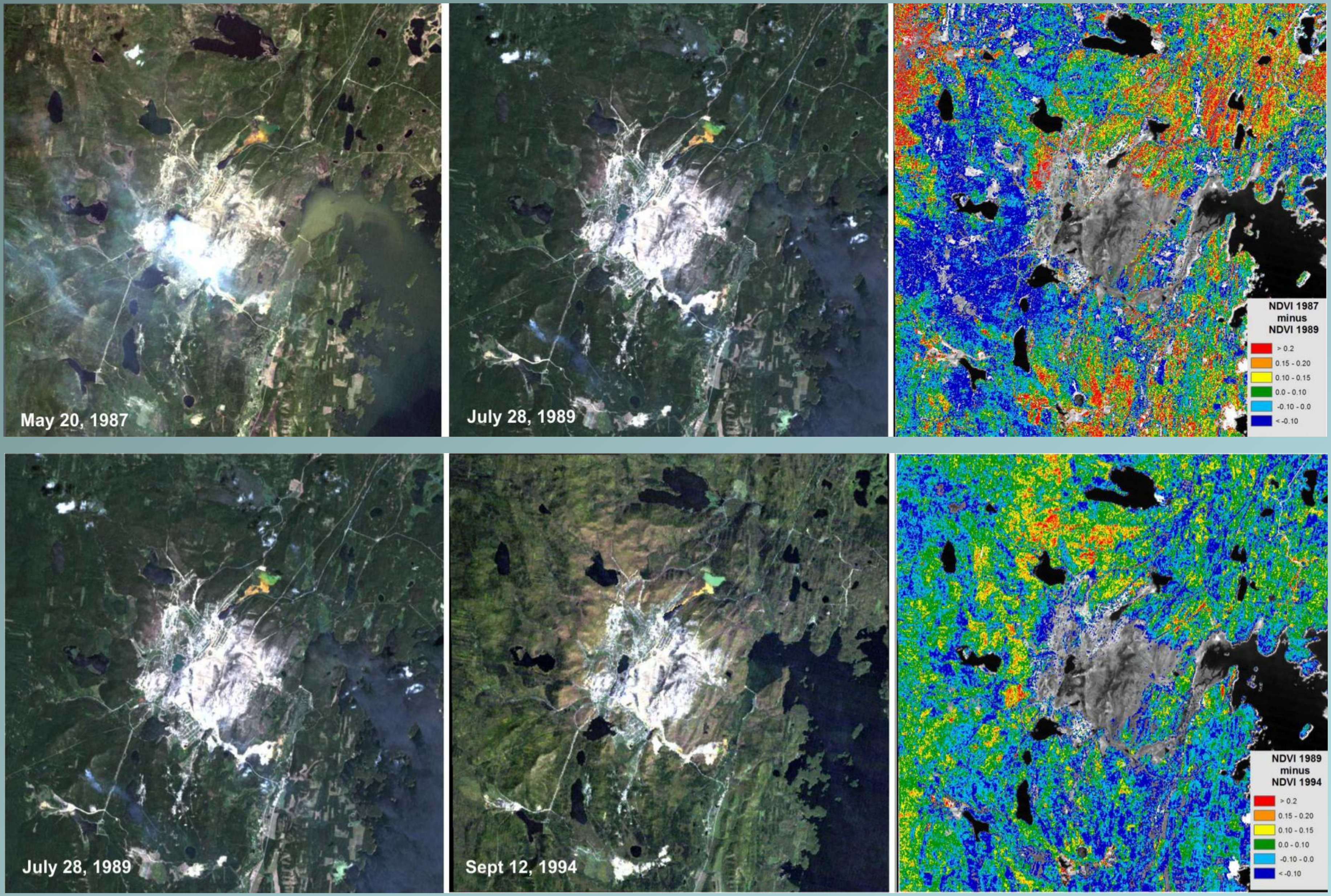


SEVENTH FRAMEWORK PROGRAMME

Karabash: NDVI (Landsat Aug 2011) NDVI (WV2 Sept 2011)

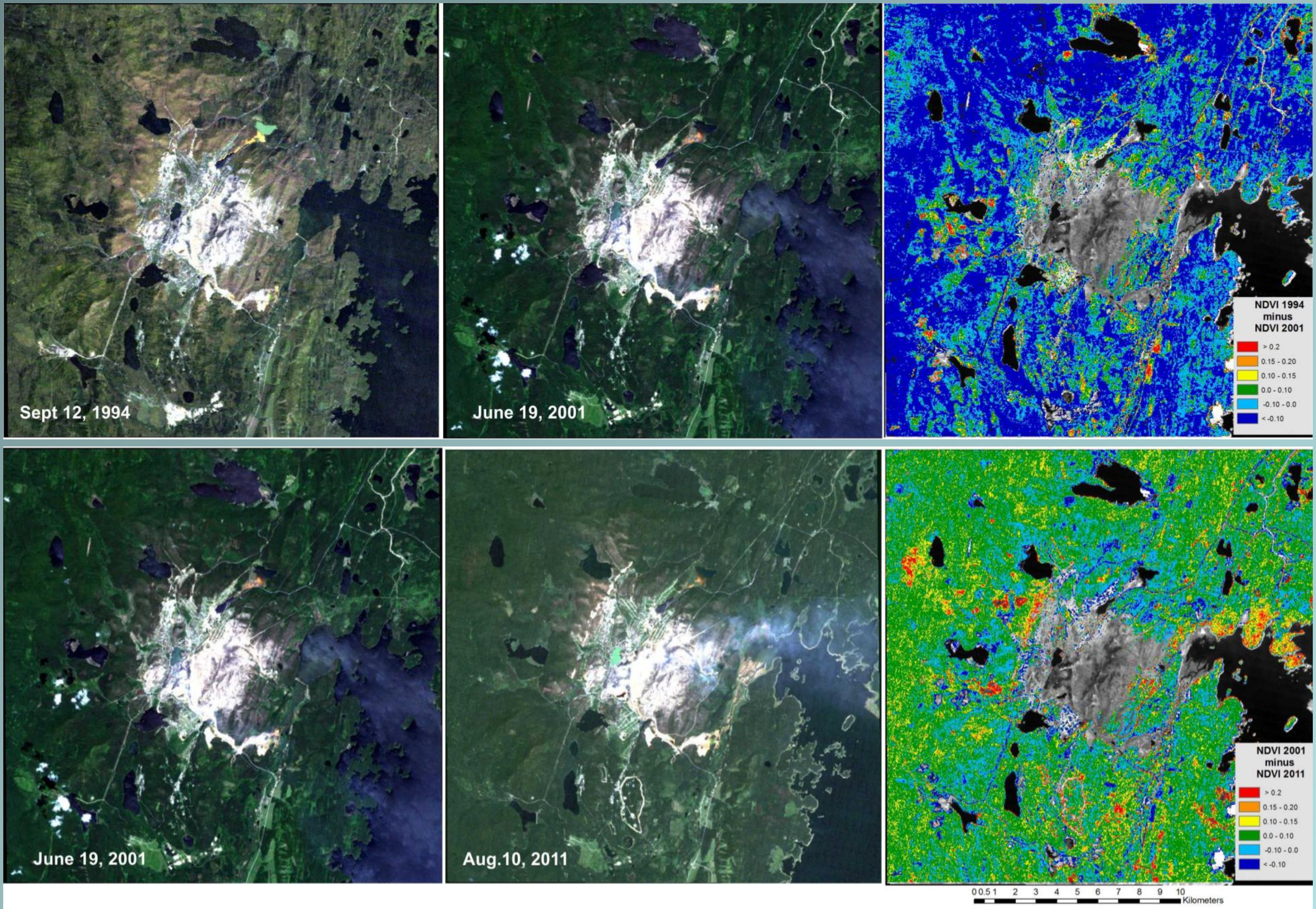


Karabash: Long-term Vegetation Damage



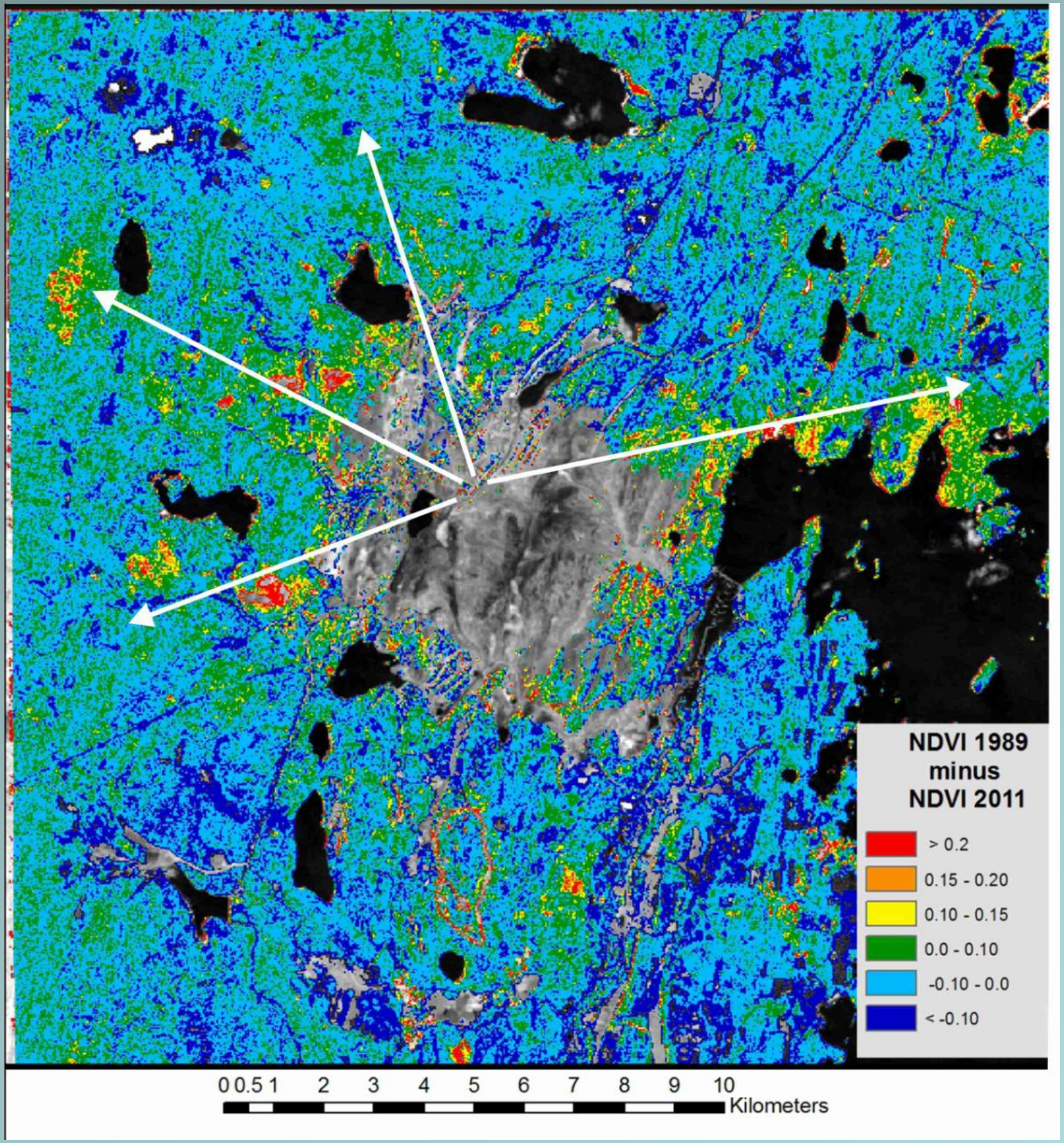
SEVENTH FRAMEWORK PROGRAMME

impact-min



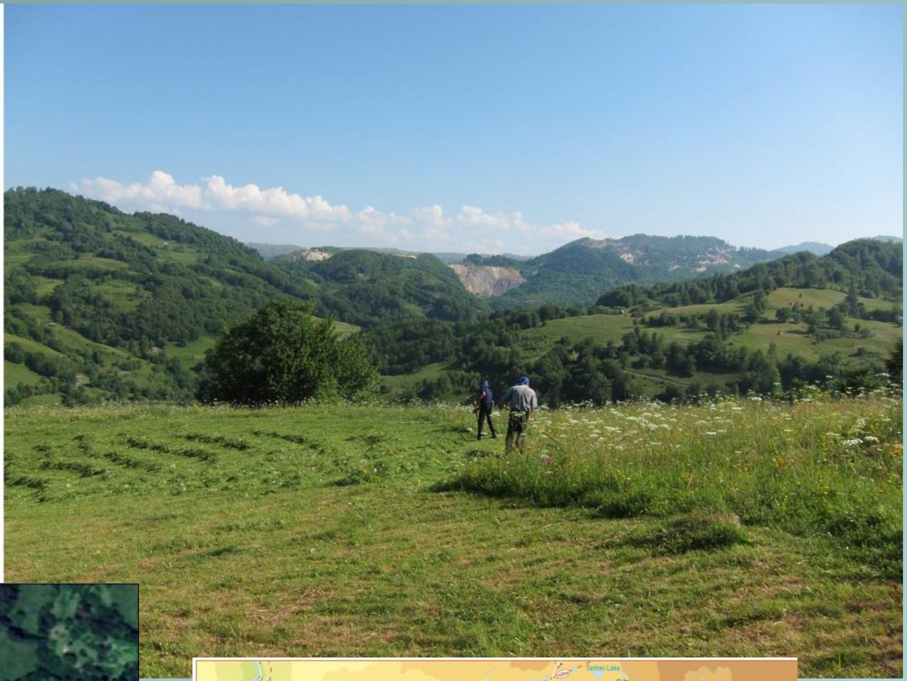
SEVENTH FRAMEWORK PROGRAMME

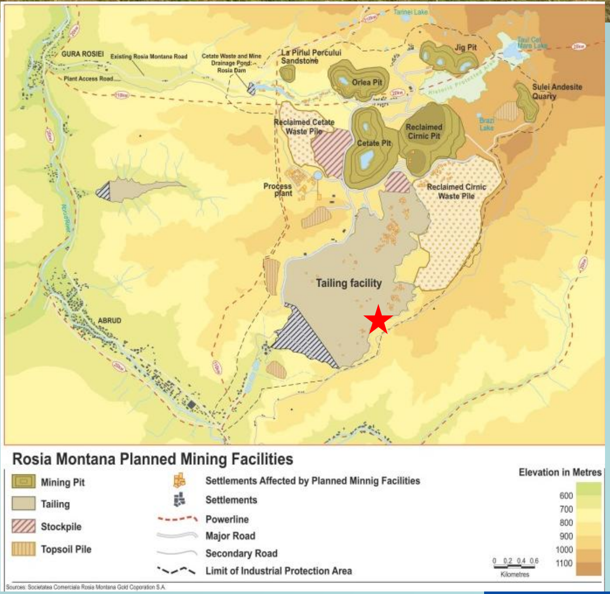
WHERE THE IMPROVENTS EFFECTIVE???



ROSIA MONTANA

SEVENTH FRAMEWORK PROGRAMME





SEVENTH FRAMEWORK PROGRAMME

impactmin

* Monitor Environmental Impact of future mining
* Current situation seems stable
* Characterization of the current situation
* Establishing a baseline for future monitoring using RS

DRAINAGE

ROCKS (weathering)

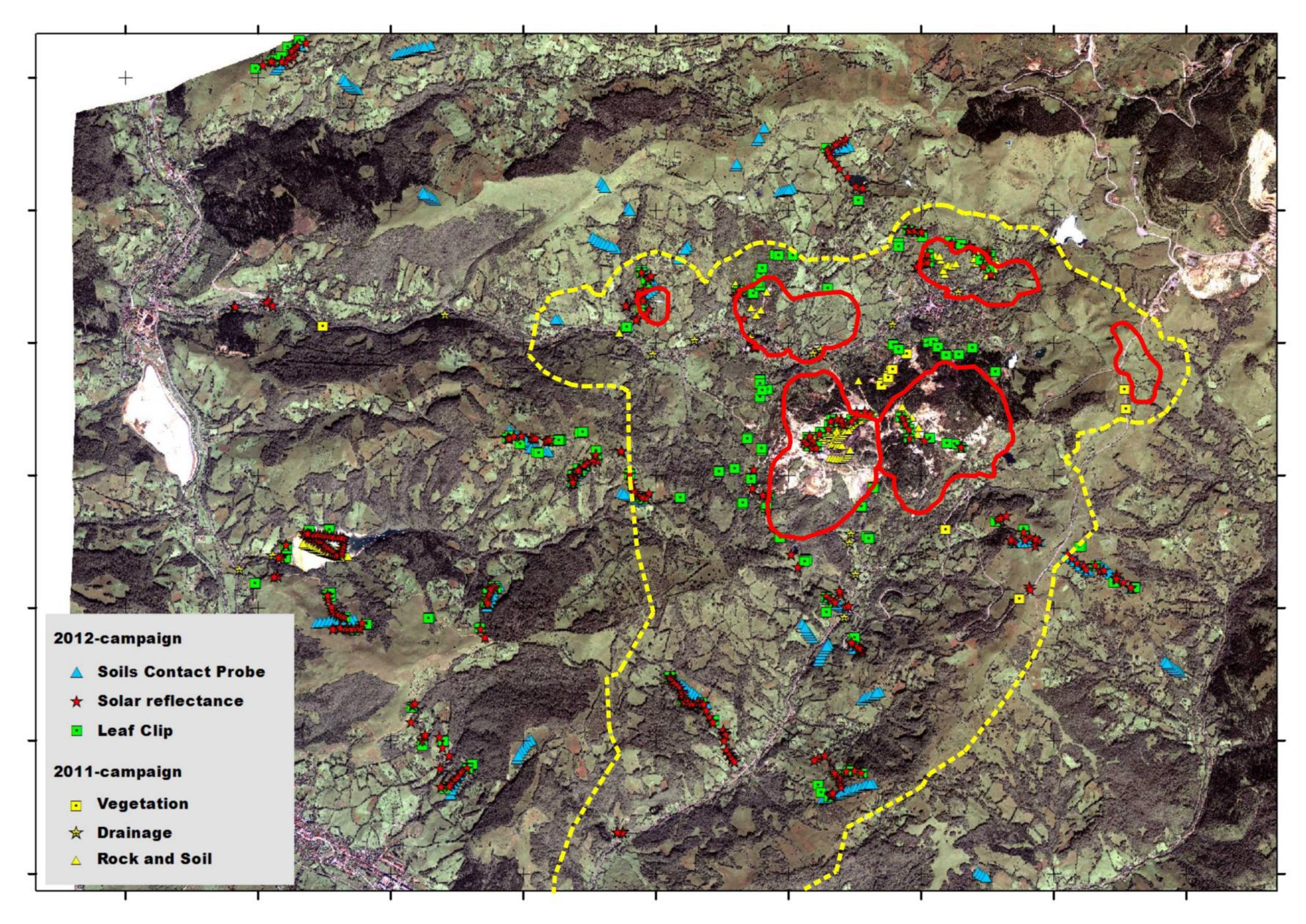
SOILS (degradation)

GRASSLANDS (degradation)

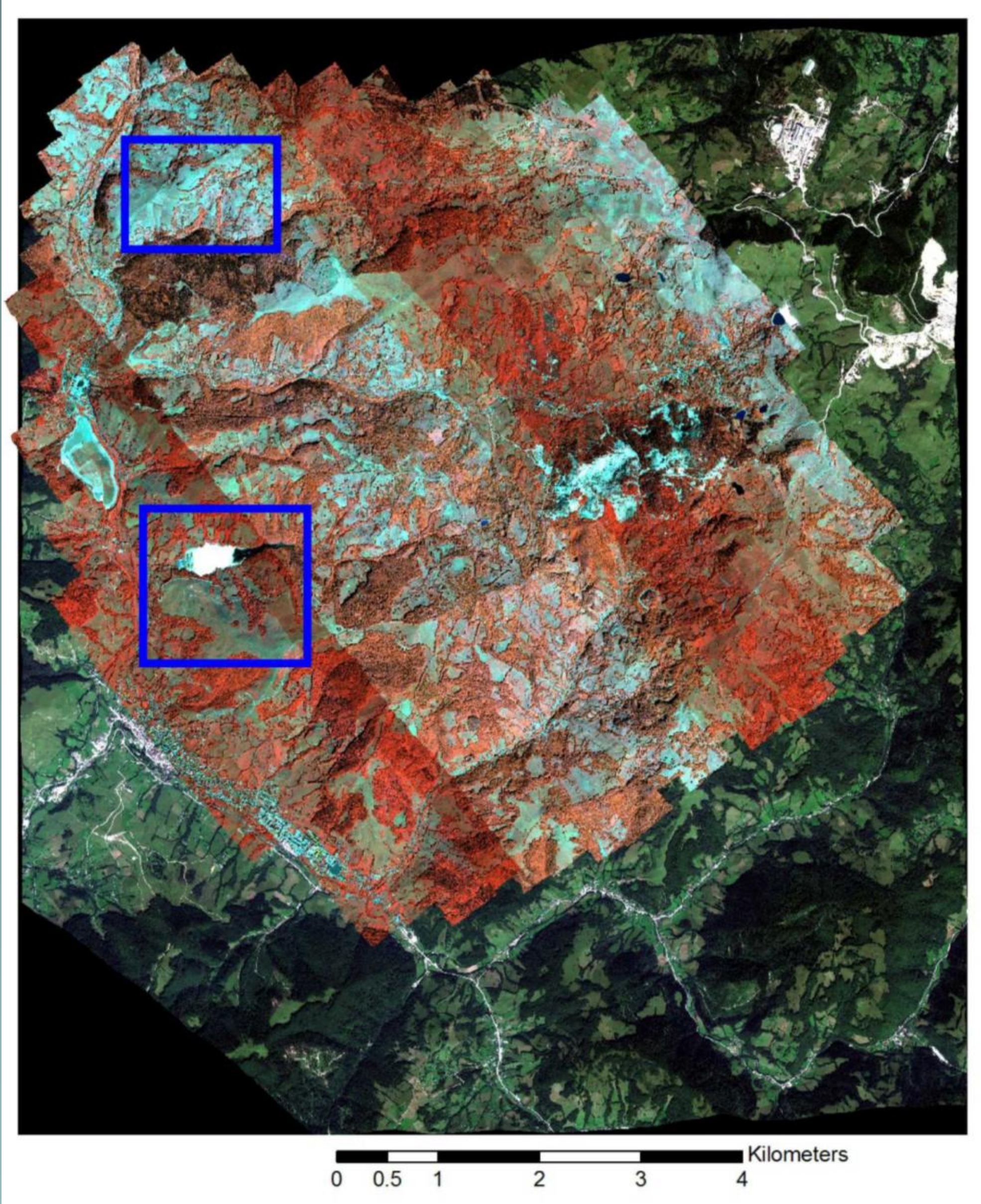
TREES (vegetation stress)

- Stream sediment geochem
- soil &rock geochem
- soil &rock spectra (contact probe and solar reflectance)
- Grasslands solar reflectance
- > 550 Birch-leaf spectra
- Smartplanes UAV-survey
- Hyperspectral VNIR (50cm resolution)
- 3 WV2-acquisitions (2010,2011,2012)
- 4 field campaigns

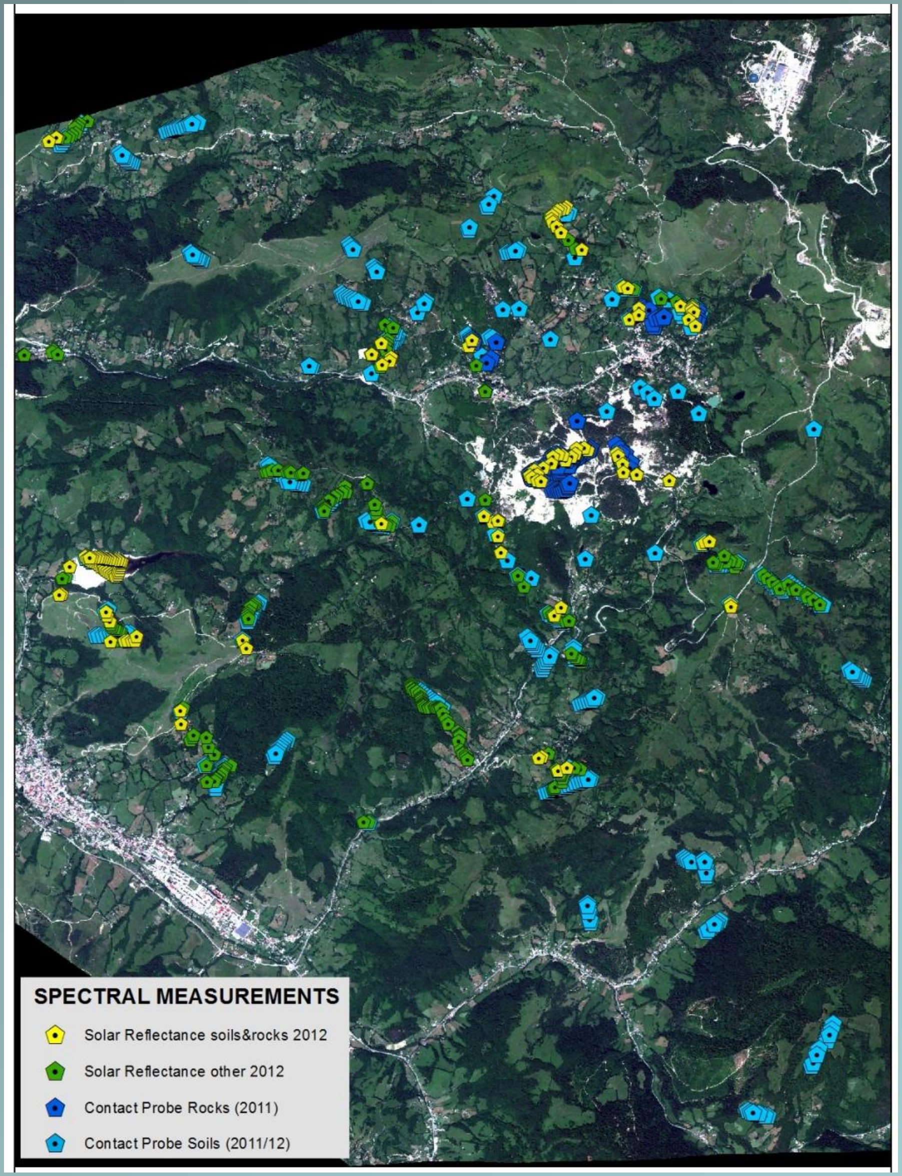
SAMPLING PROGRAMME

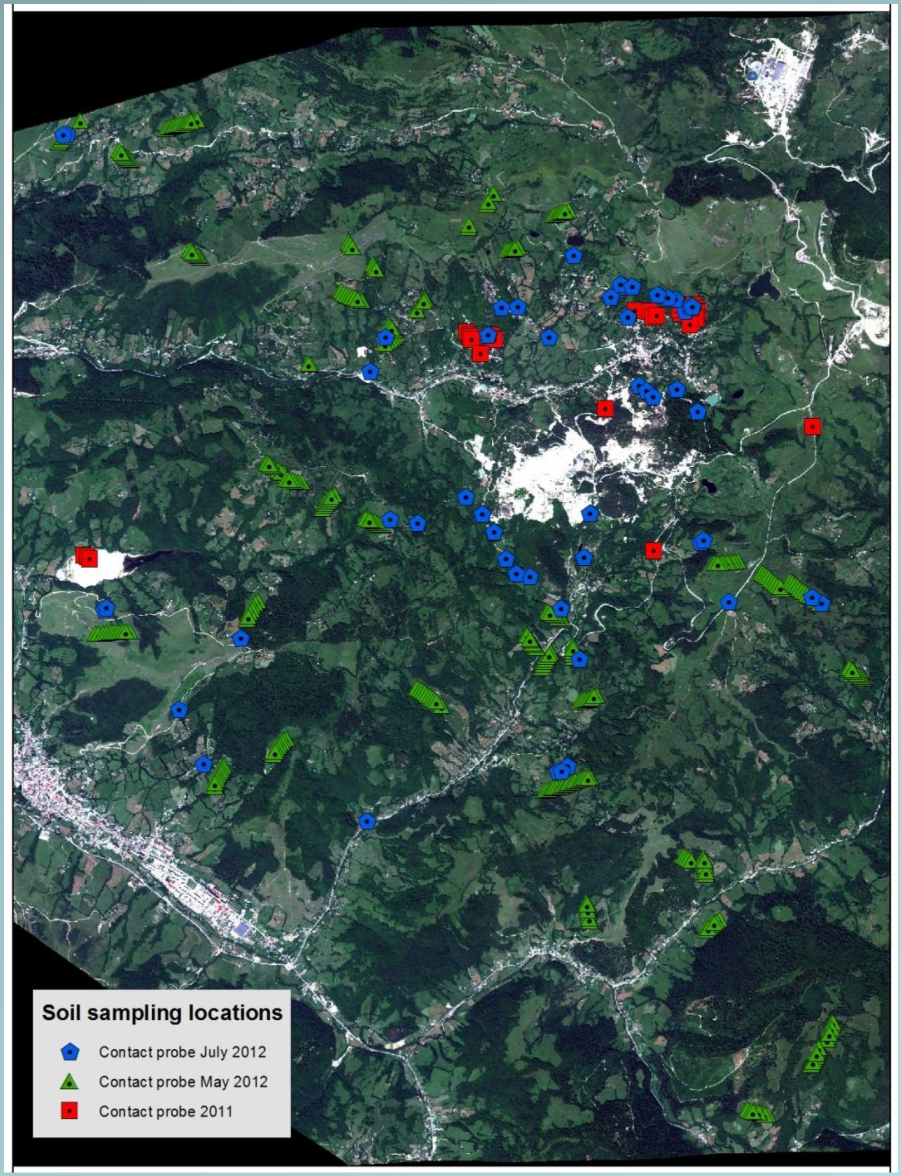


Airborne Surveys



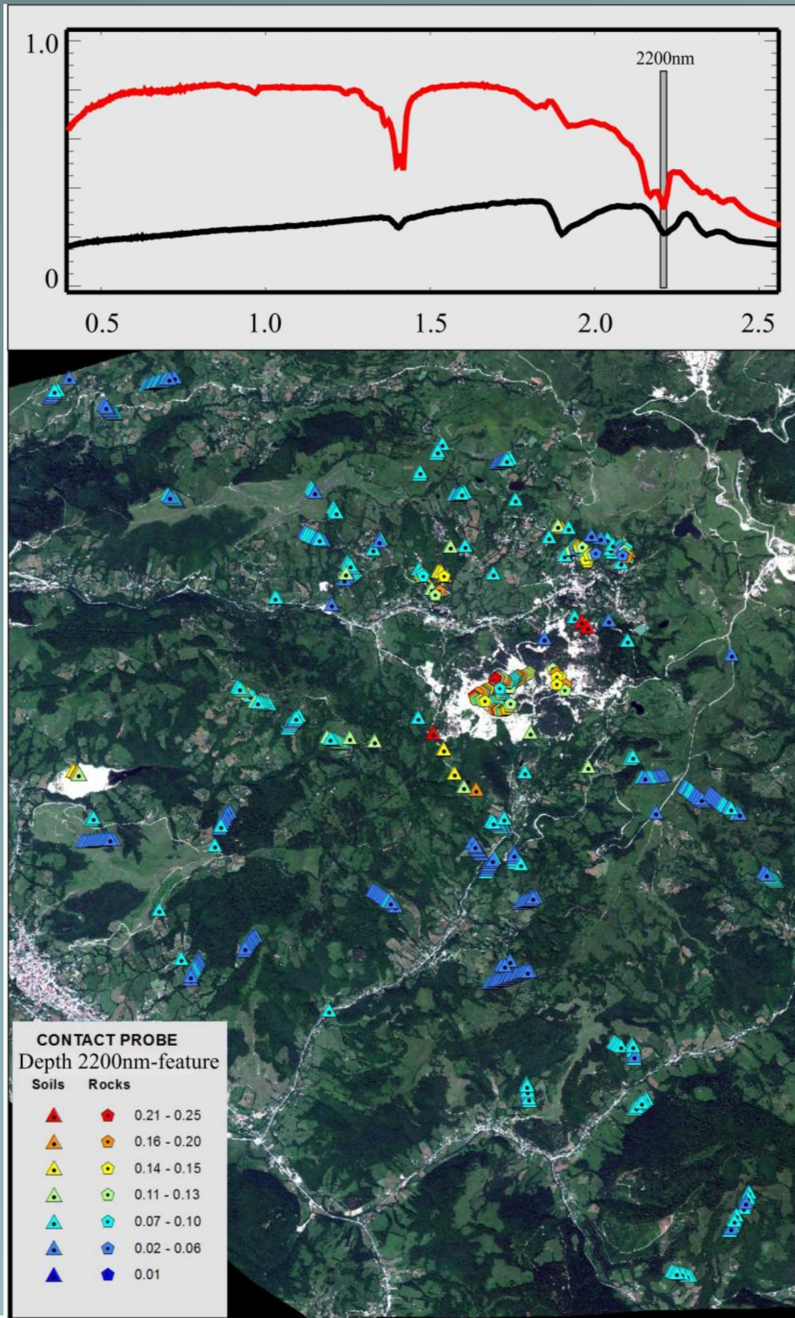
Spectral measurement locations

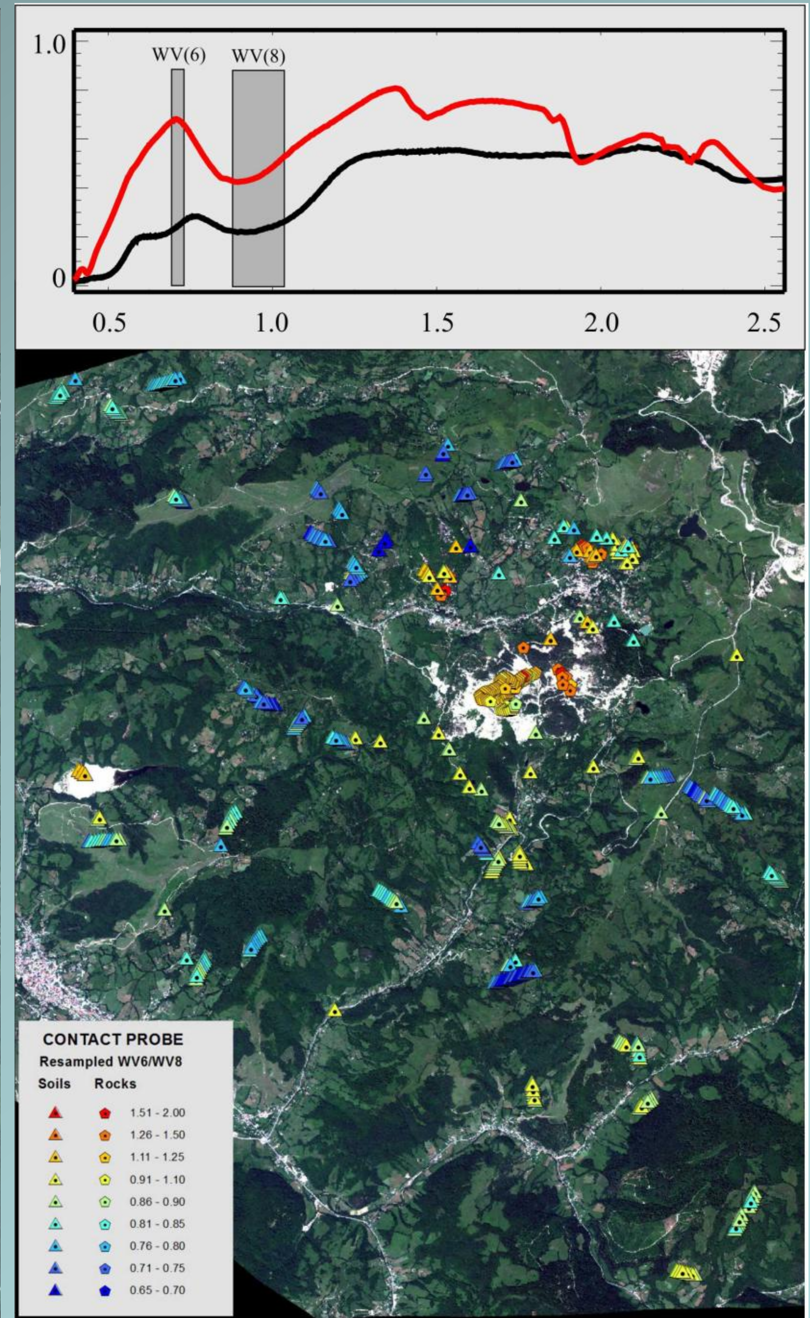




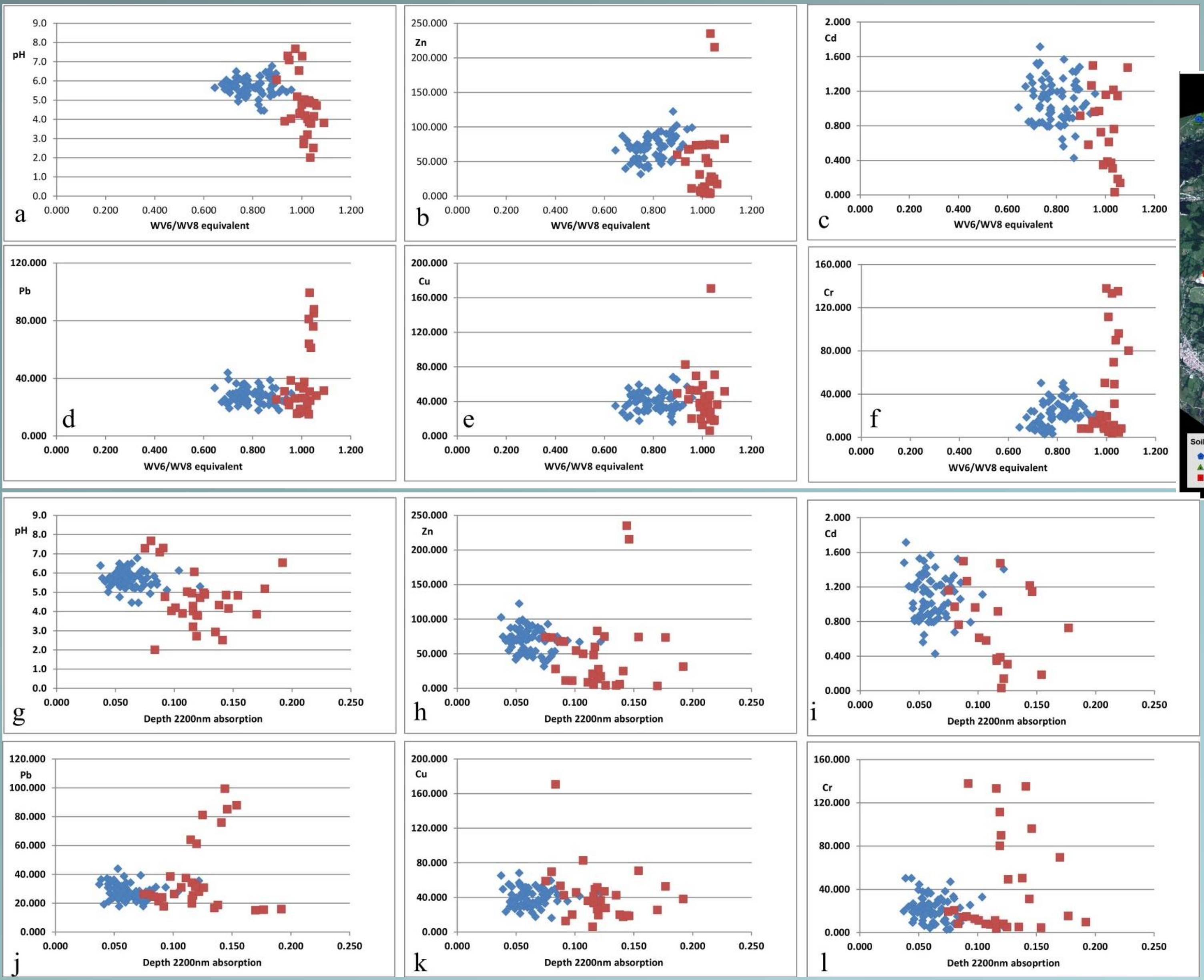
SEVENTH FRAMEWORK PROGRAMME

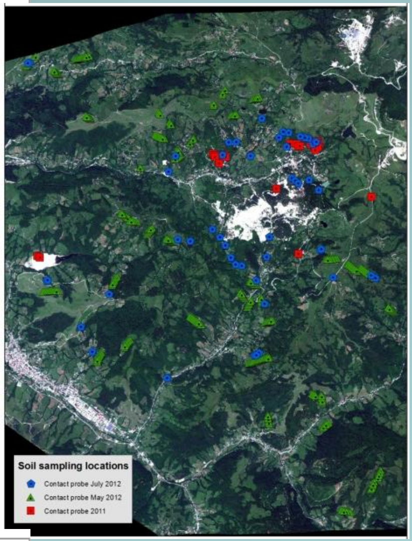
impactmin


1.0
0
2200nm
0.5
1.0
1.5
2.0
2.5
CONTACT PROBE
Depth 2200nm-feature
Soils
Rocks
0.21 - 0.25
0.16 - 0.20
0.14 - 0.15
0.11 - 0.13
0.07 - 0.10
0.02 - 0.06
0.01


1.0
0
WV(6)
WV(8)
0.5
1.0
1.5
2.0
2.5
CONTACT PROBE
Resampled WV6/WV8
Soils
Rocks
1.51 - 2.00
1.26 - 1.50
1.11 - 1.25
0.91 - 1.10
0.86 - 0.90
0.81 - 0.85
0.76 - 0.80
0.71 - 0.75
0.65 - 0.70

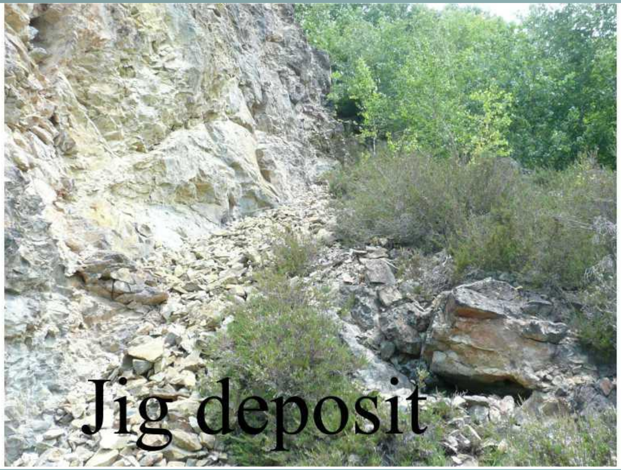
Correlation between soil spectra and chemistry

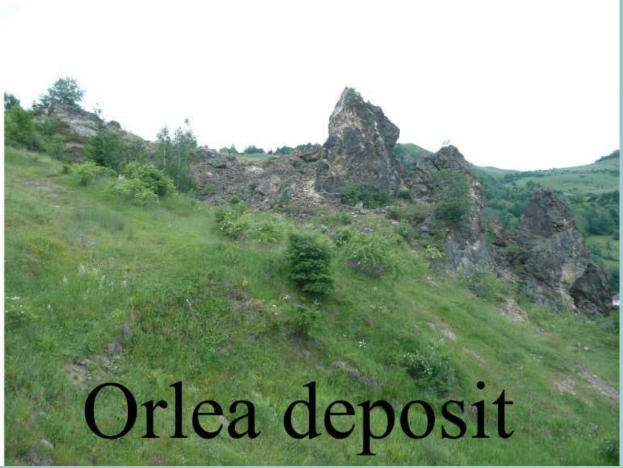




SEVENTH FRAMEWORK PROGRAMME

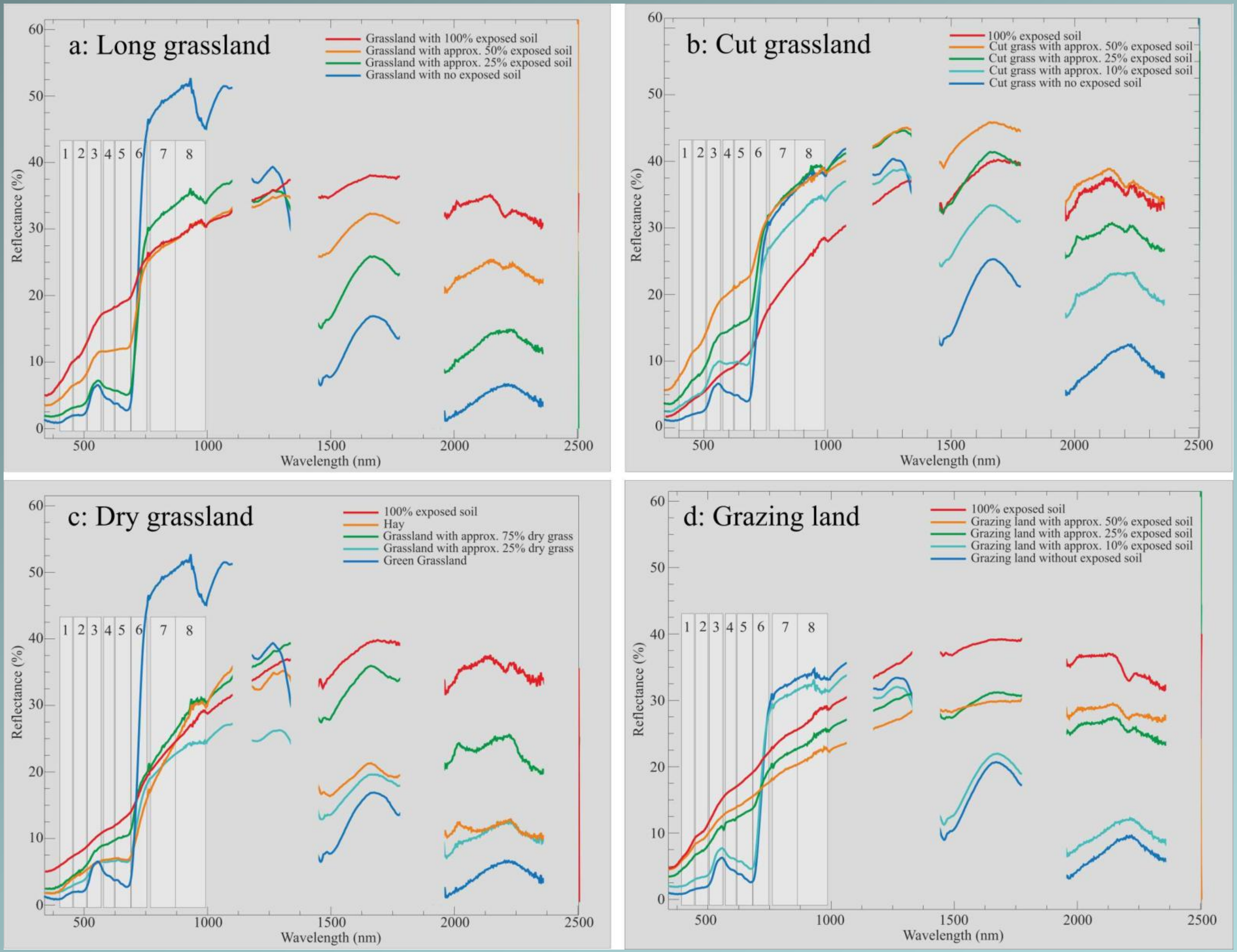
Outcropping rocks





Outcropping soils

Solar Reflectance of grasslands / soil mixtures



SEVENTH FRAMEWORK PROGRAMME

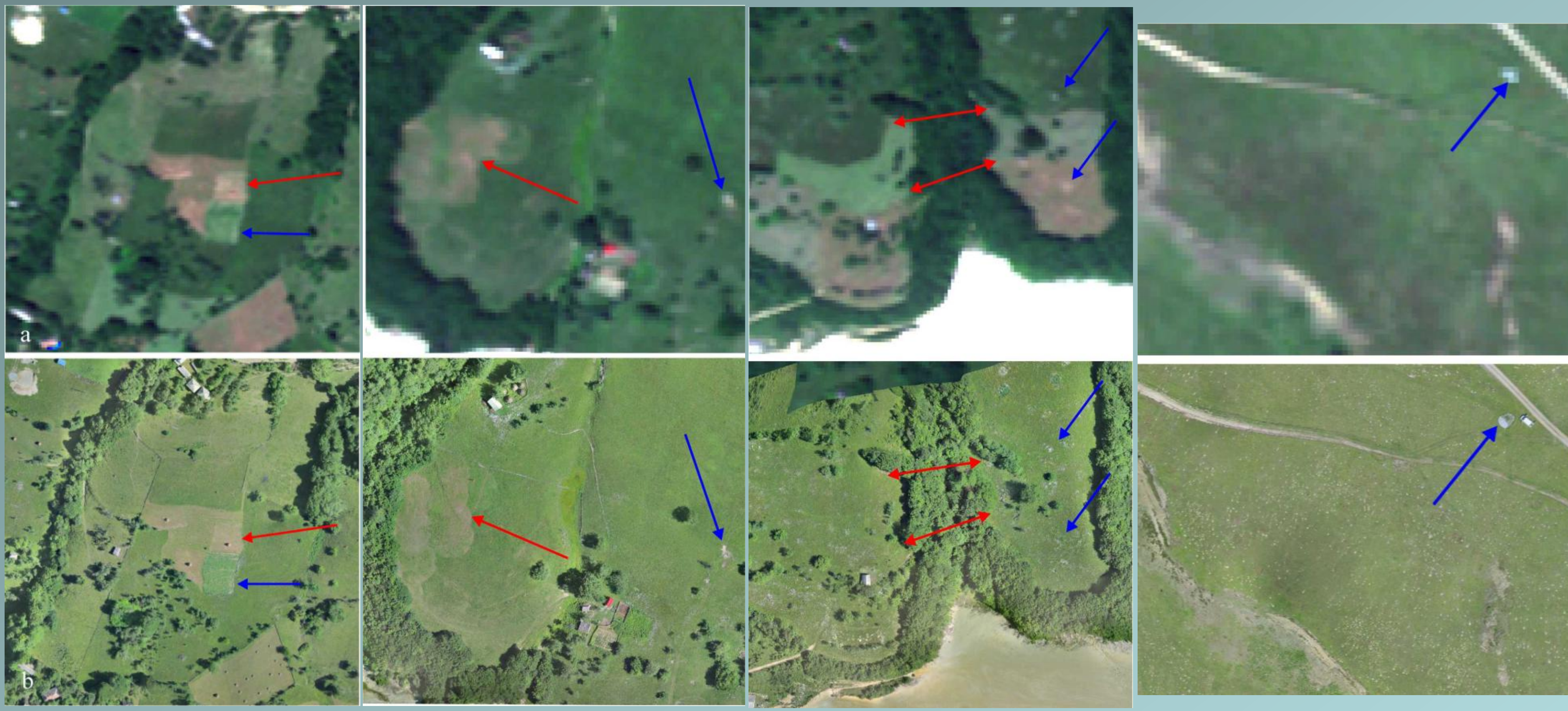
impactmin

Spatial Resolution of Imagery

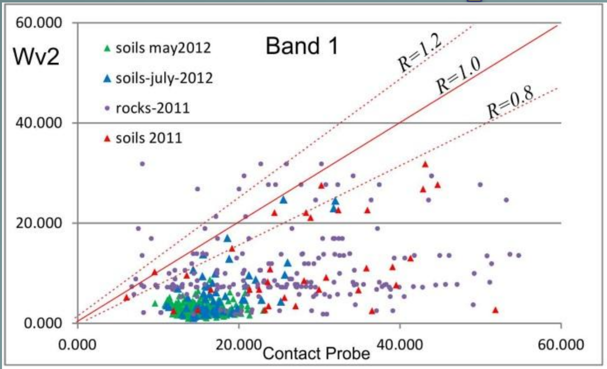
SEVENTH FRAMEWORK PROGRAMME

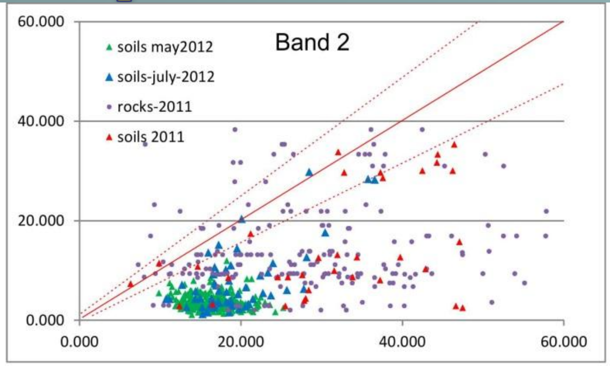
impactmin

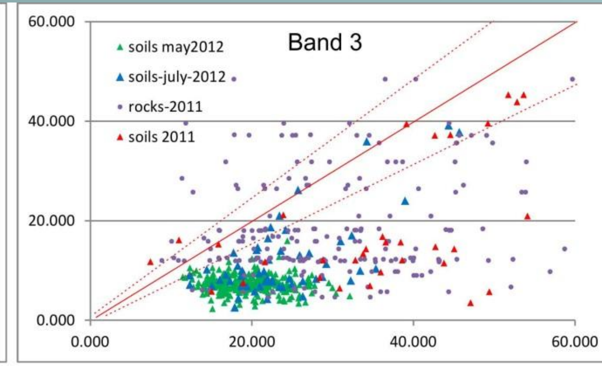
What can we identify in WV2-imagery

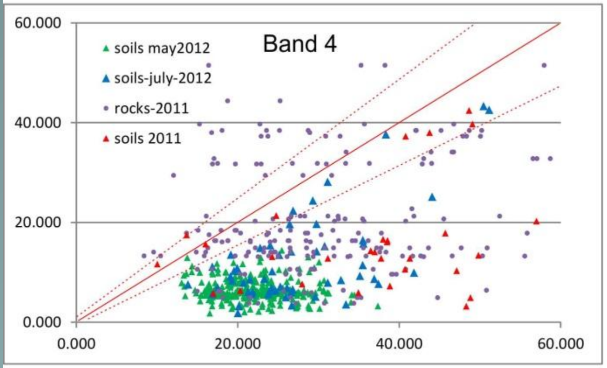


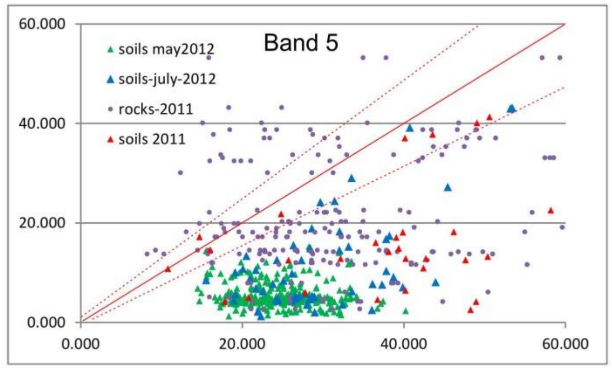
Contact probe spectra of soils versus WV2

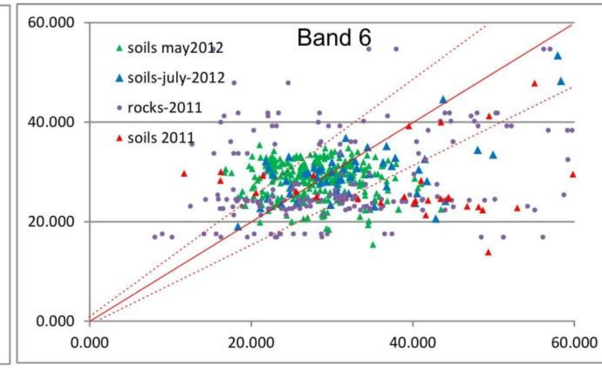


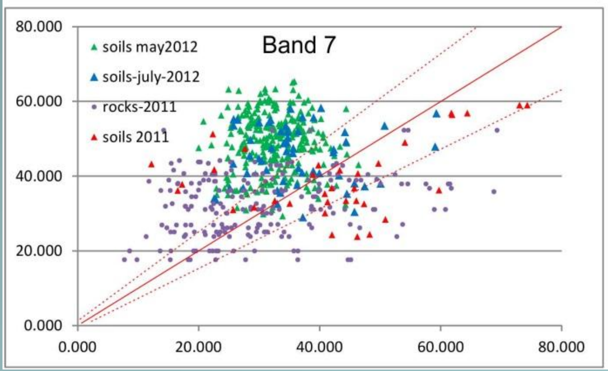


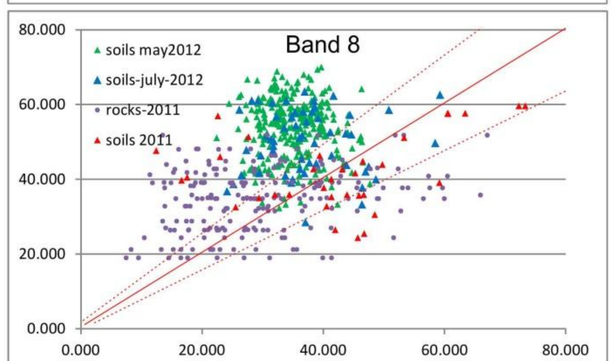


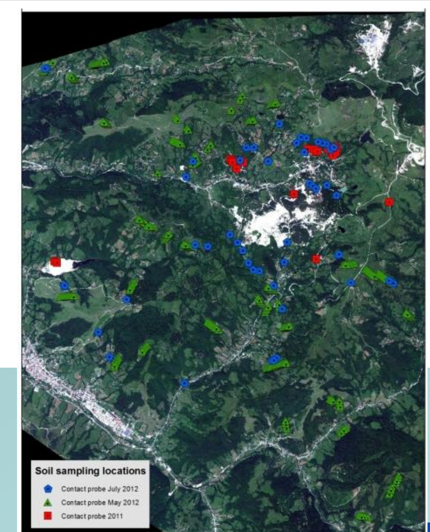










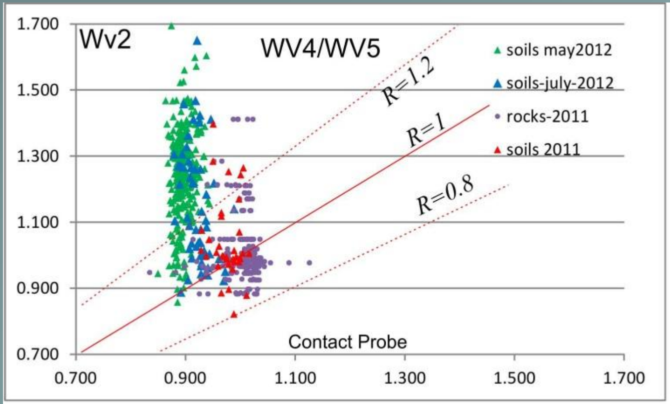


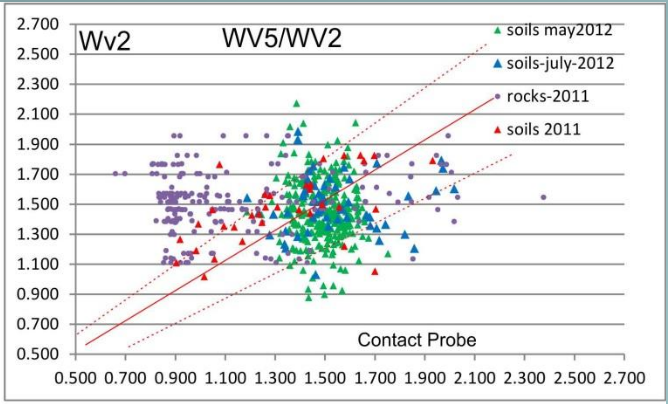
WV2-pixel is > 40.000 contact measurements

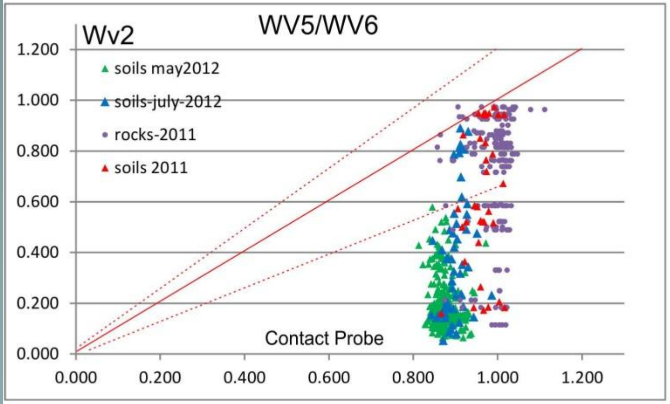
SEVENTH FRAMEWORK PROGRAMME

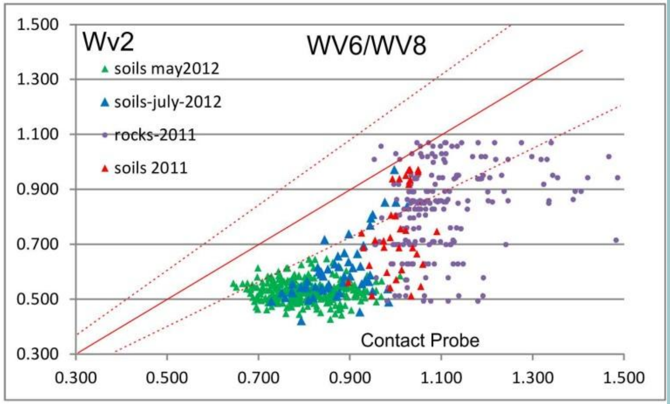
impactmin

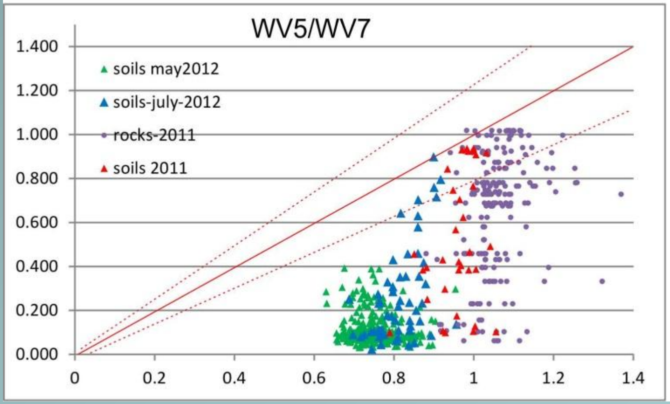
Band ratios of contact probe spectra vs WV2

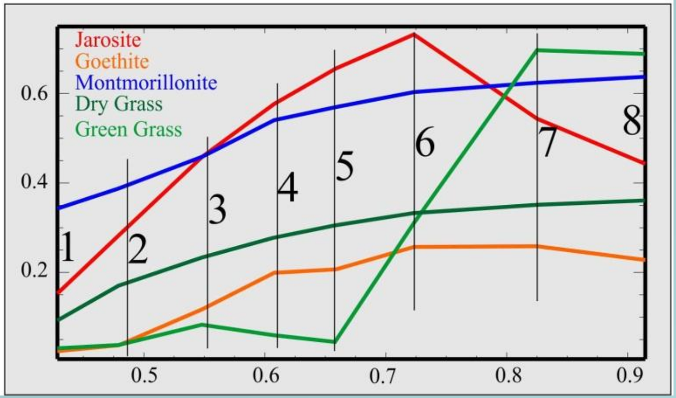


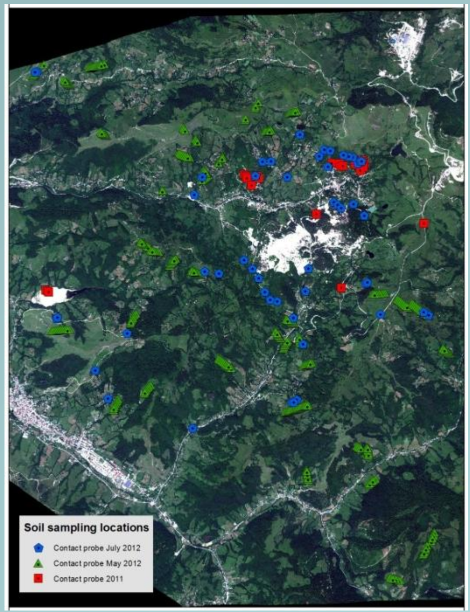




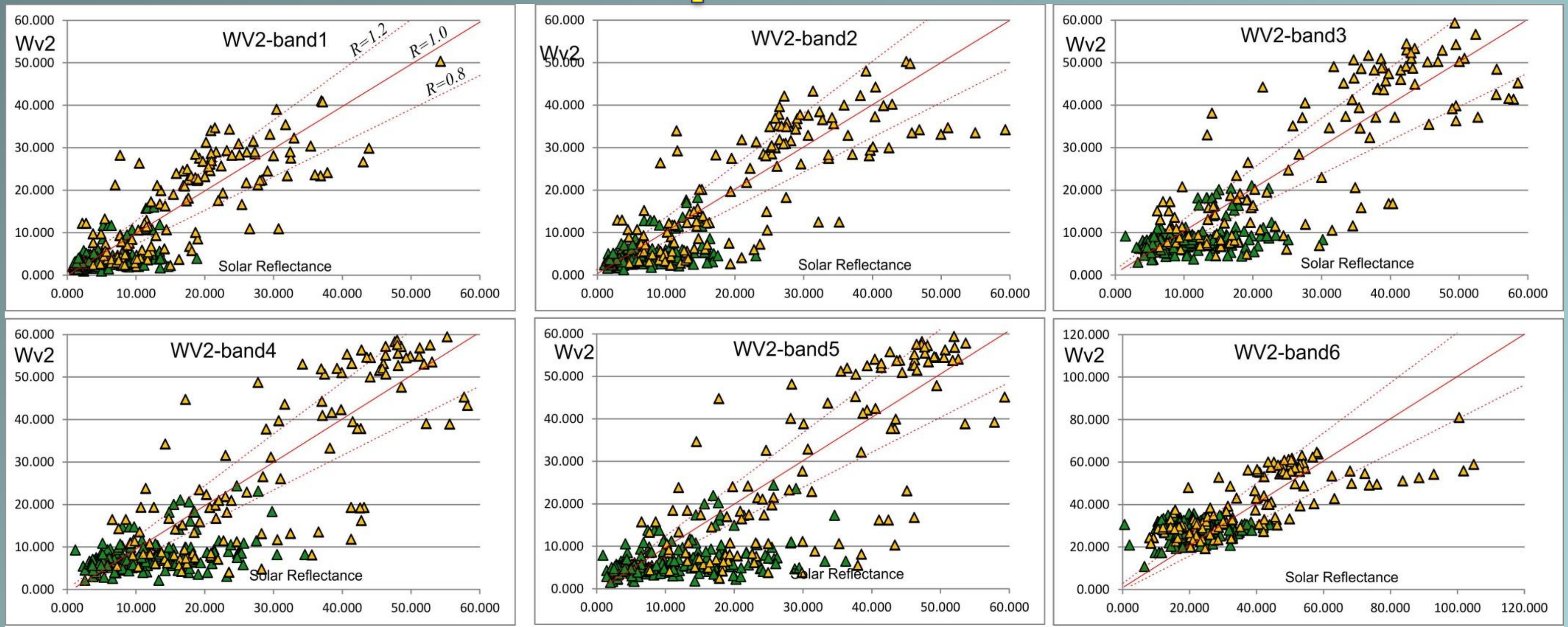


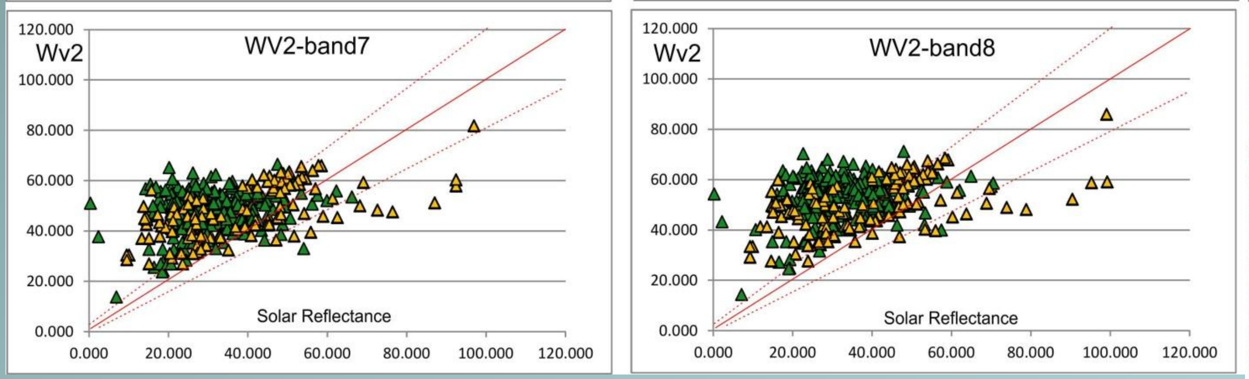


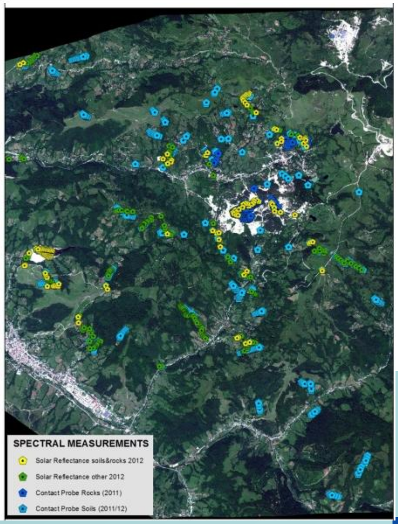




Solar Reflectance spectra of soils versus WV2





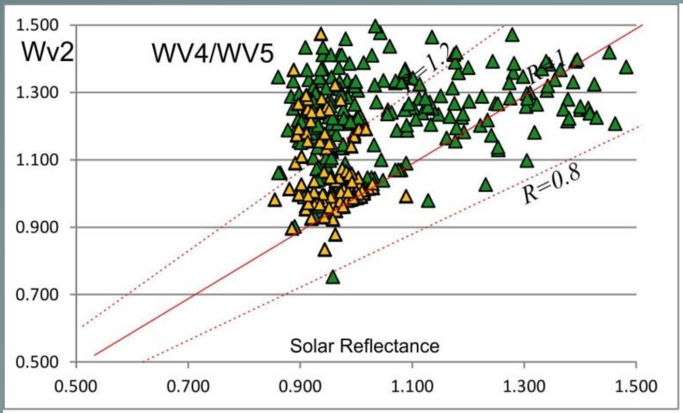


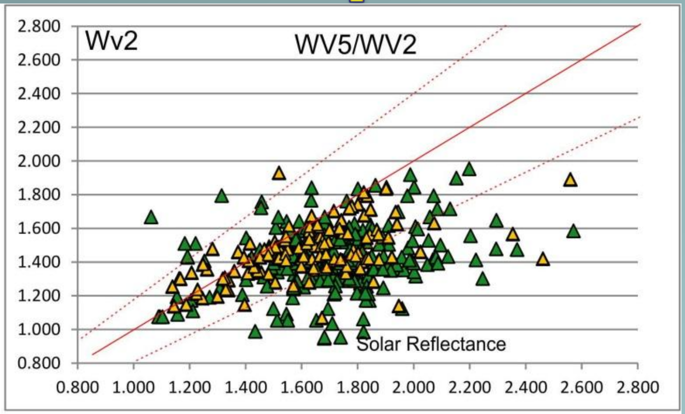
WV2-pixel is ~25 solar measurements

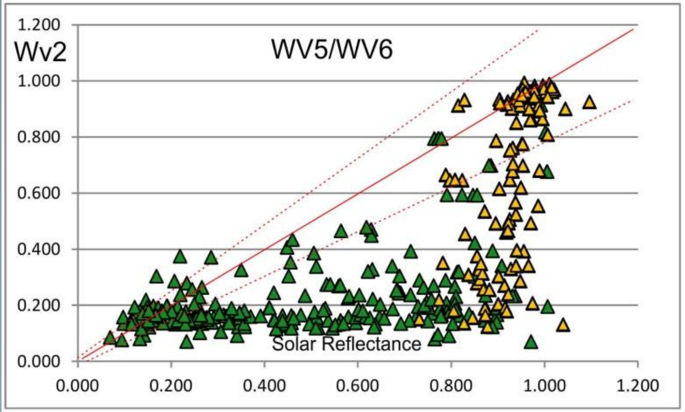
SEVENTH FRAMEWORK PROGRAMME

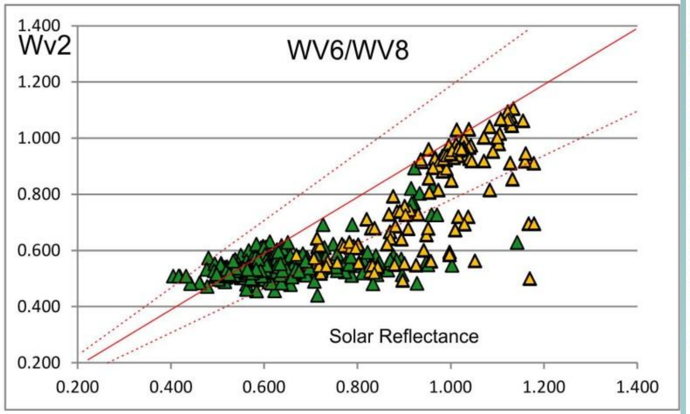
impaCt-min

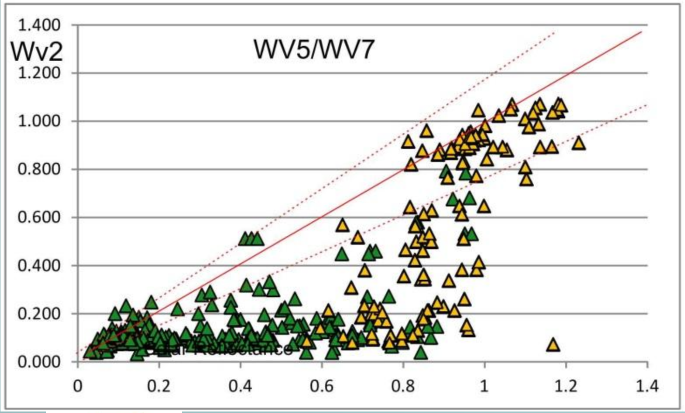
Band ratios of solar spectra vs WV2

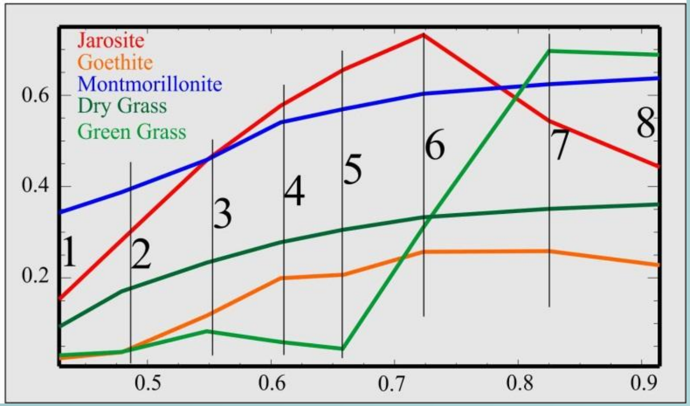


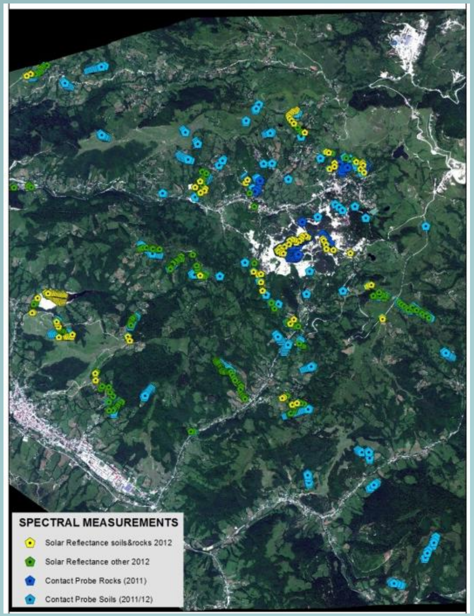








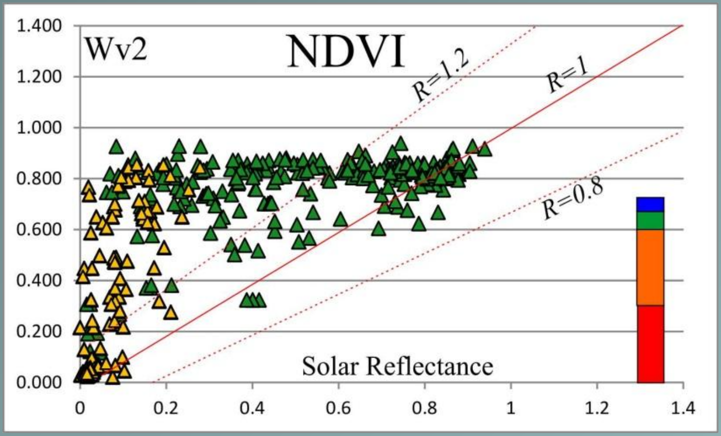


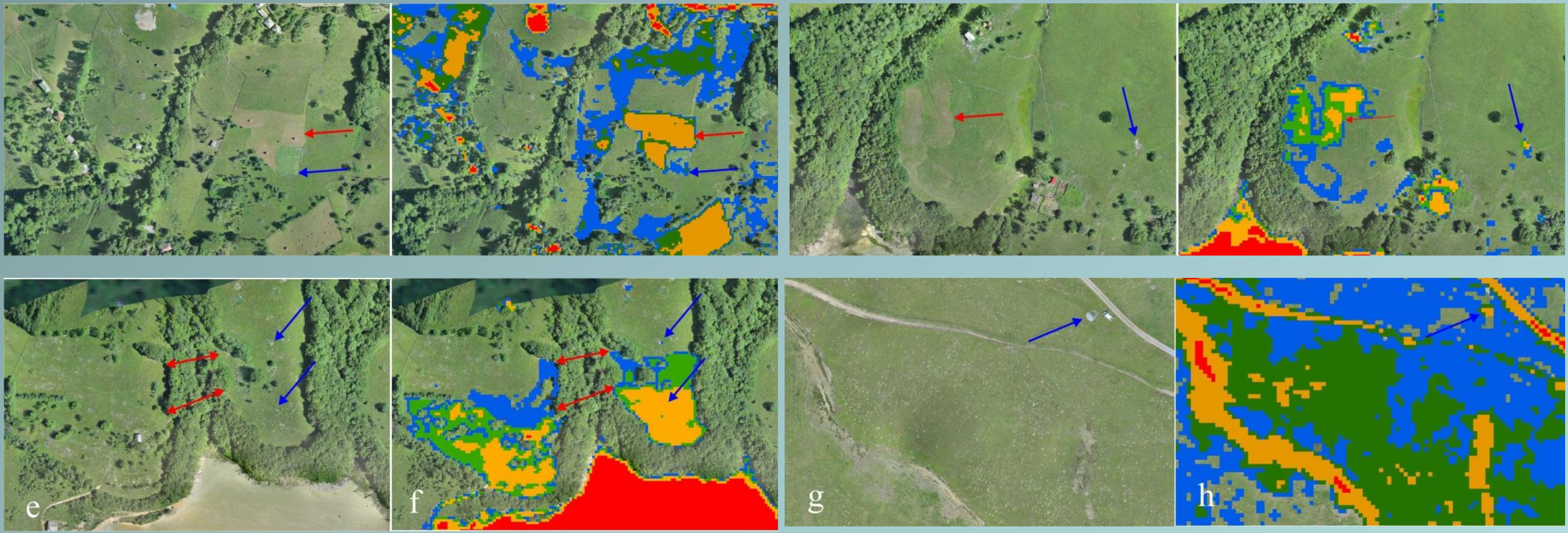


SEVENTH FRAMEWORK PROGRAMME

impact-min

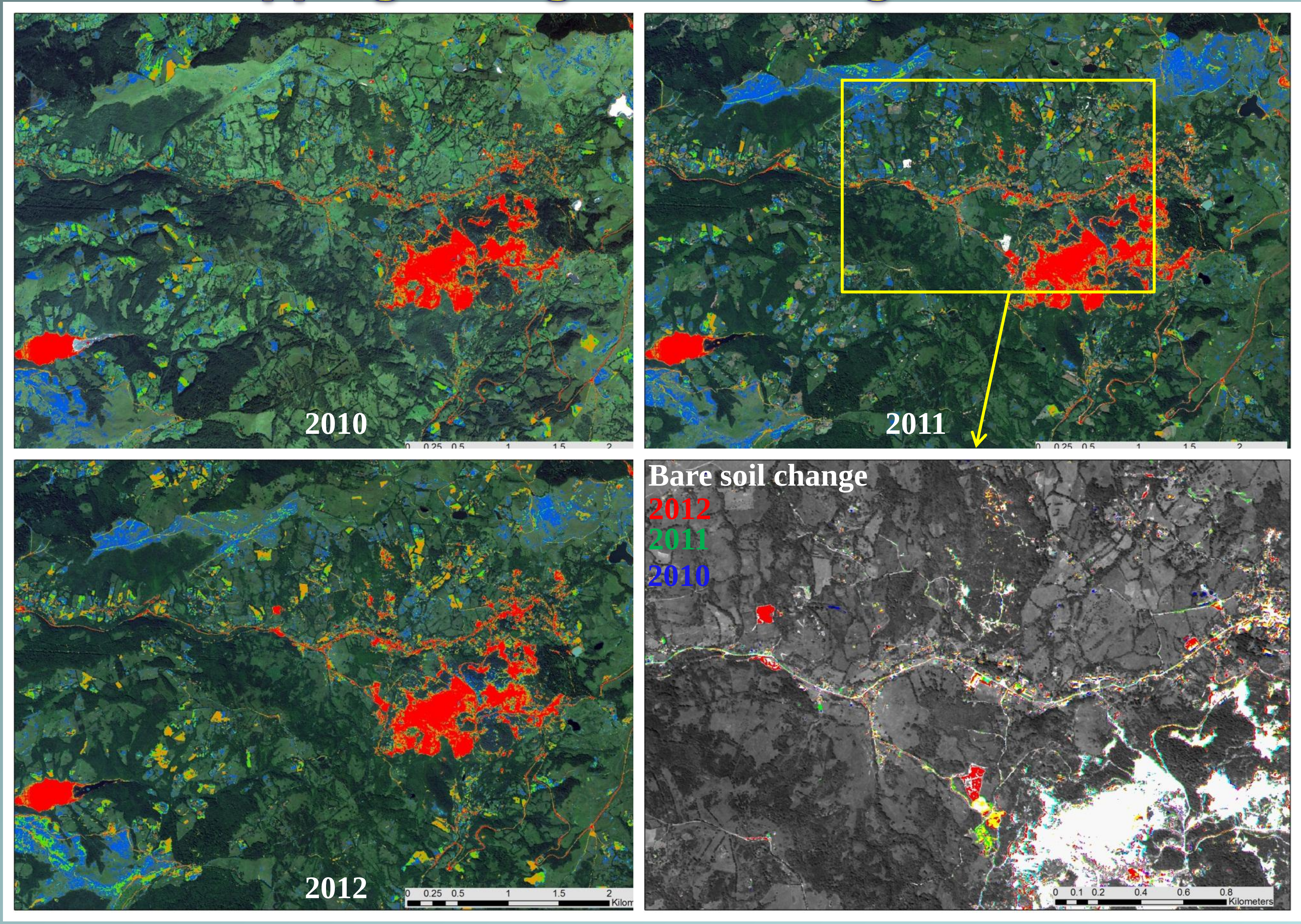
WV2-Classification of grassland /soil mixtures





SEVENTH FRAMEWORK PROGRAMME

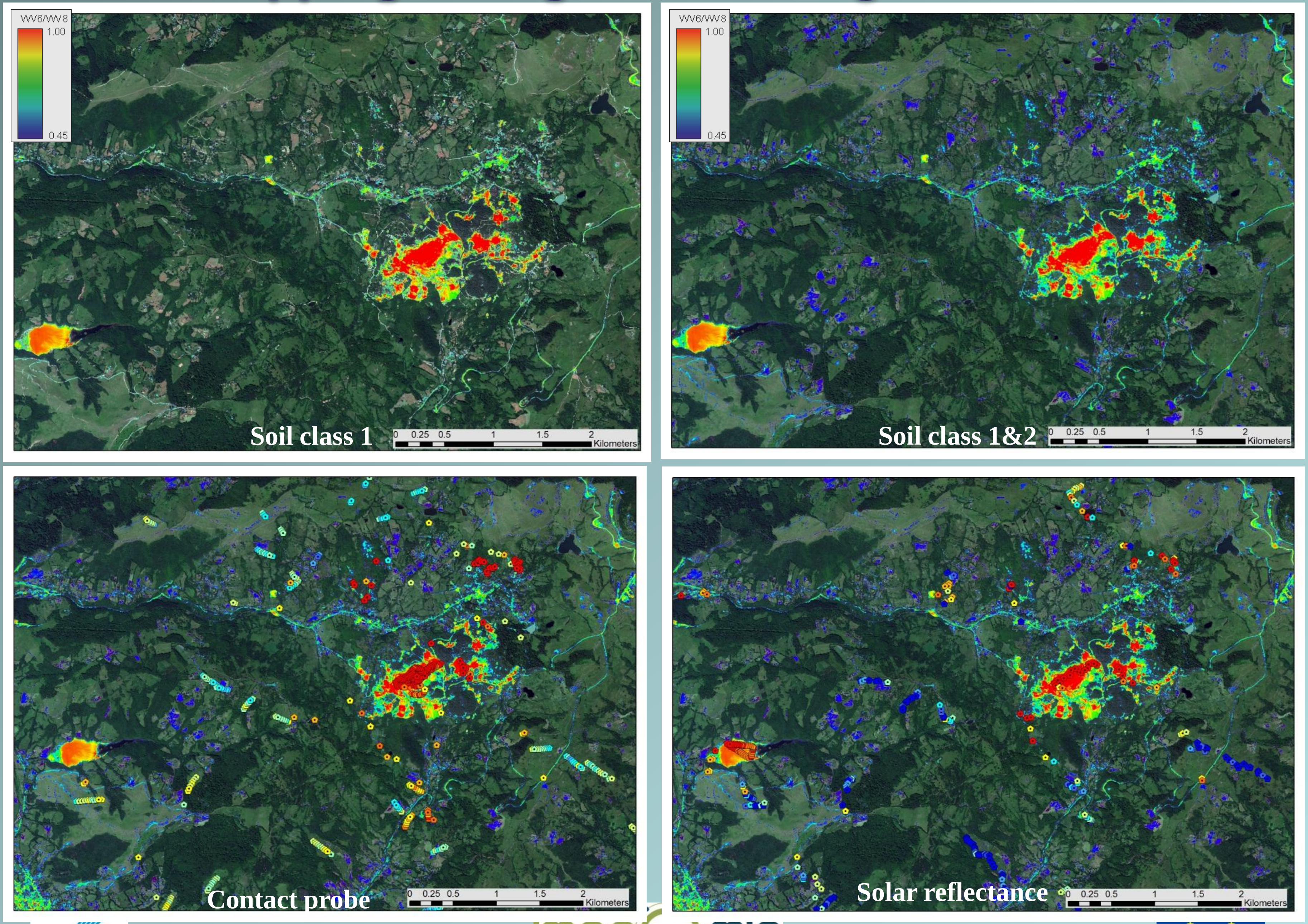
Mapping changes in soils /grasslands



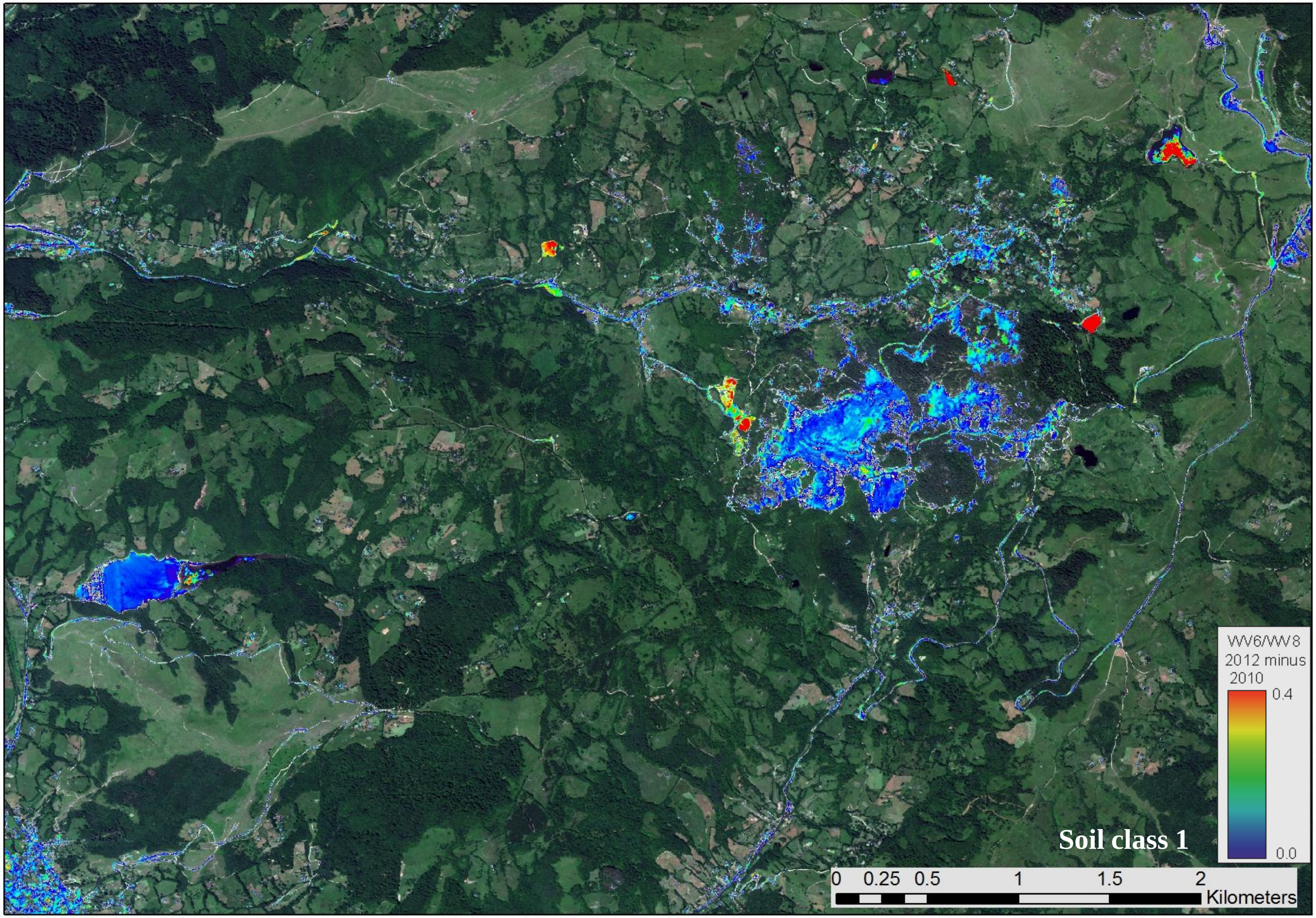
SEVENTH FRAMEWORK PROGRAMME

impactmin

Mapping changes in soils /grasslands



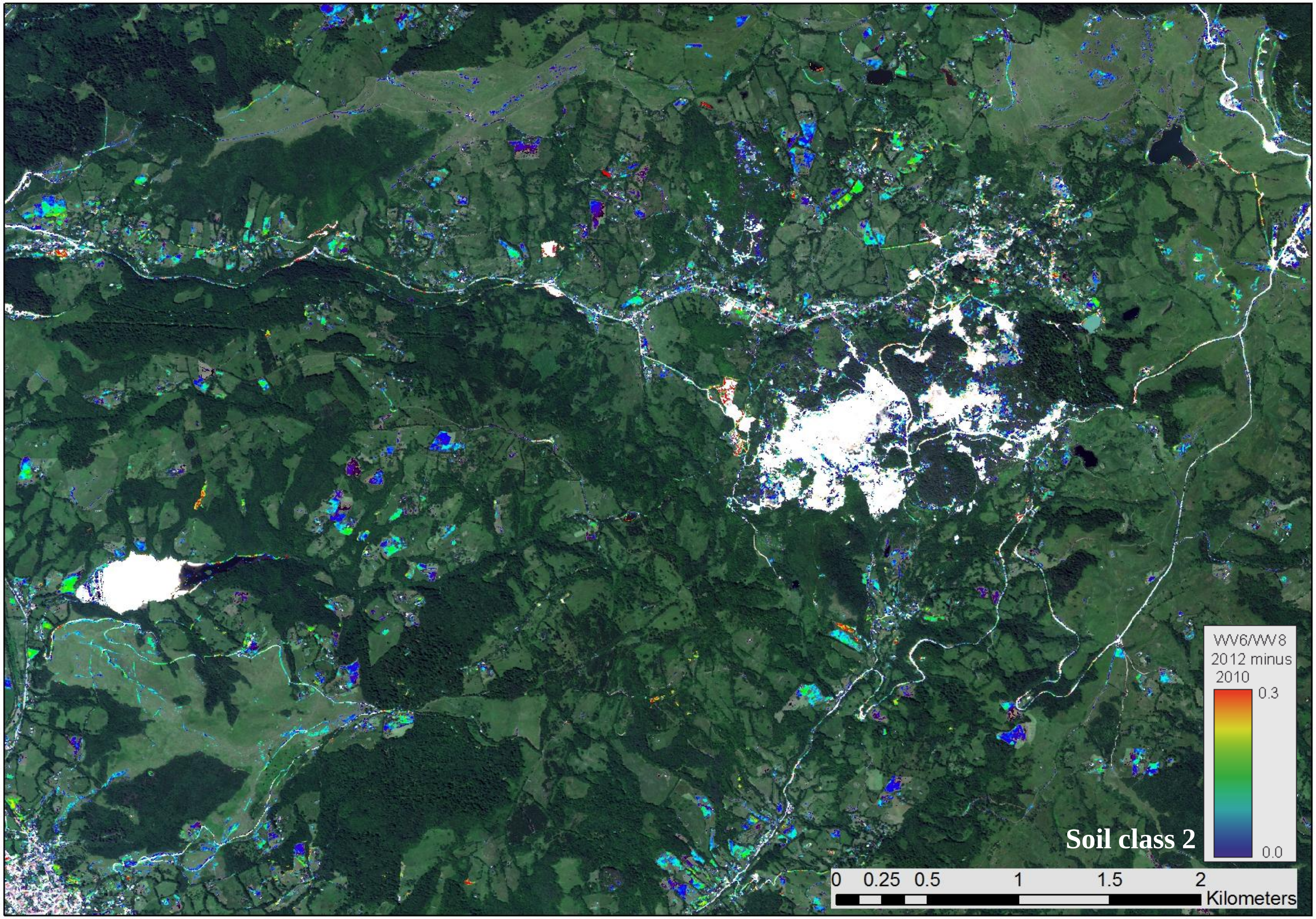
Mapping changes in soils /grasslands



SEVENTH FRAMEWORK PROGRAMME

impactmin

Mapping changes in soils /grasslands



impaC+min

The ImpactMin Crew:

- GEONARDO ENVIRONMENTAL TECHNOLOGIES, HUNGARY
- CAMBORN SCHOOL OF MINES, UNIVERSITY OF EXETER, UK
- DMT GMBh & CO. KG, GERMANY
- GEOSENSE, THE NETHERLANDS
- INST. OF MINERALOGY OF THE RUSSIAN ACADEMY OF SCIENCES, URALS BRANCH, RUSSIA
- LULEA UNIVERSITY, SWEDEN
- PHOTON SPLIT, CROATIA
- UKRAINIAN LAND & RESOUCE MANAGEMENT CENTER, KIEV, UKRAINE
- UNIVERSITY OF MOSTAR, BOSNIA-HERZEGOVINA
- UNIVERSITY OF BABES BOLYAI, CLUJ-NAPOCA, ROMANIA
- VLAAMSE INSTELLING VOOR TECHNOLOGISCH ONDERZOEK (VITO), BELGIUM