UN-SPIDER

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Disaster Management and Space Technology:

“The 4C – Challenge:Communication – Coordination – Cooperation – Capacity Development”

Bonn, Germany, 12 – 14 October 2010

Earthquake Emergency Preparedness in Central-Hungary

- Preparing Rapid Response Measurements using Remote Sensing and GIS-Methods

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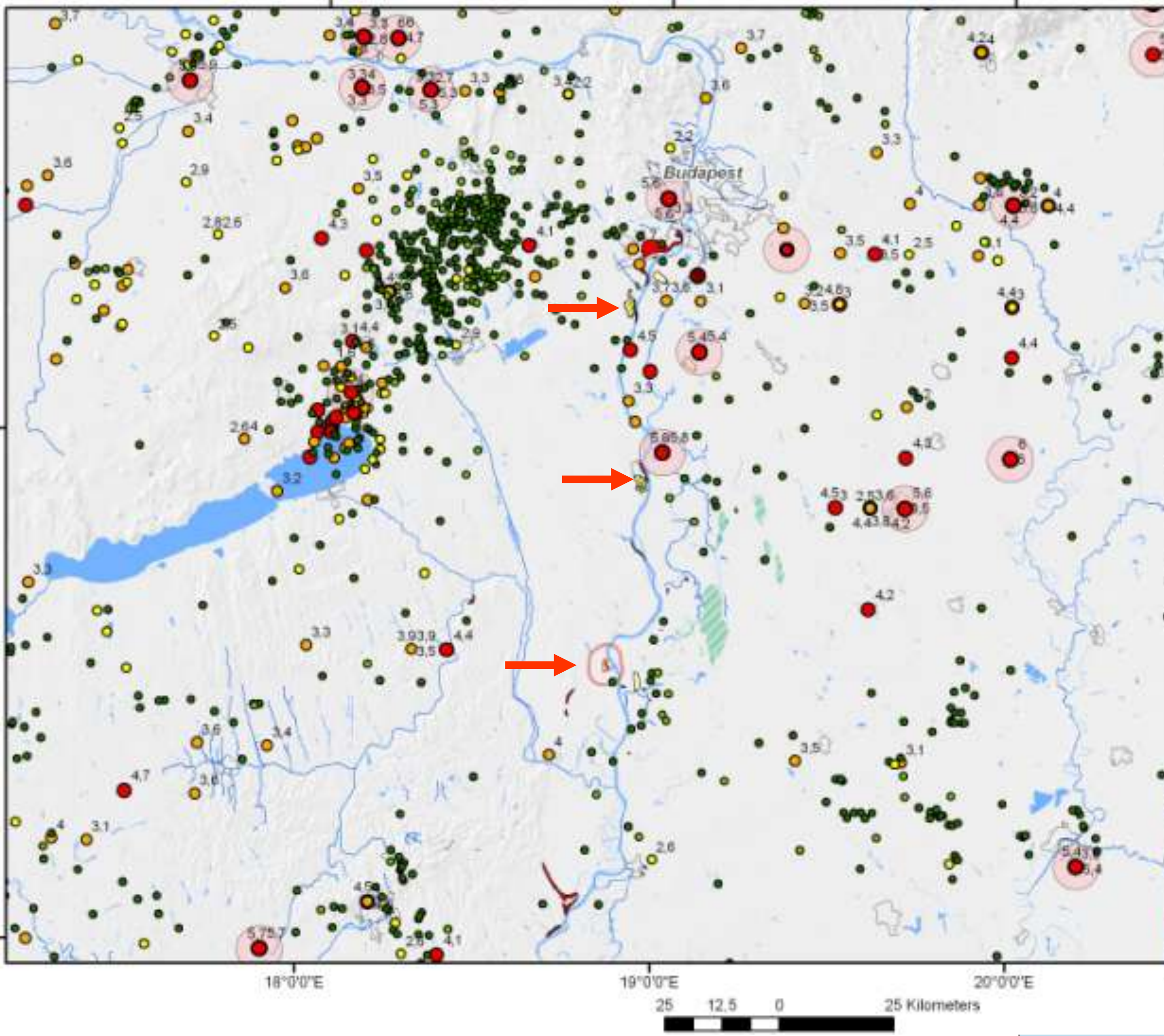
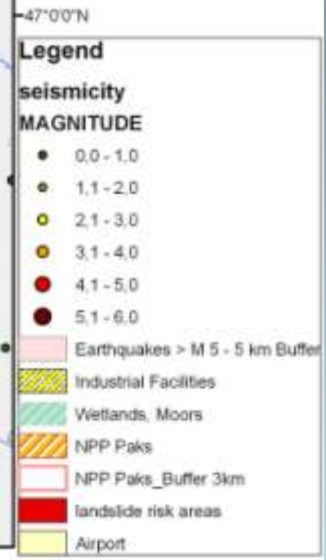
Content

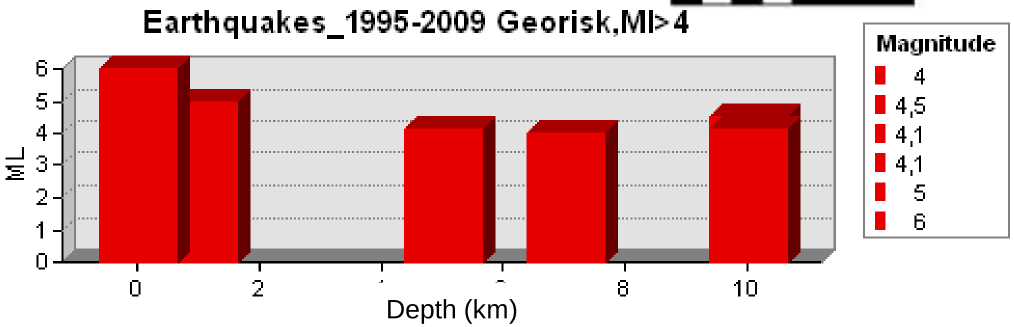
- Earthquakes in Hungary
- Digital Image Processing of LANDSAT- and RapidEye-Data
- Weighted Overlay of Factors Influencing Surface-near Earthquake Shock
- Emergency Preparedness
- Conclusion

Earthquakes in Hungary



Industrial facilities prone to earthquakes ?





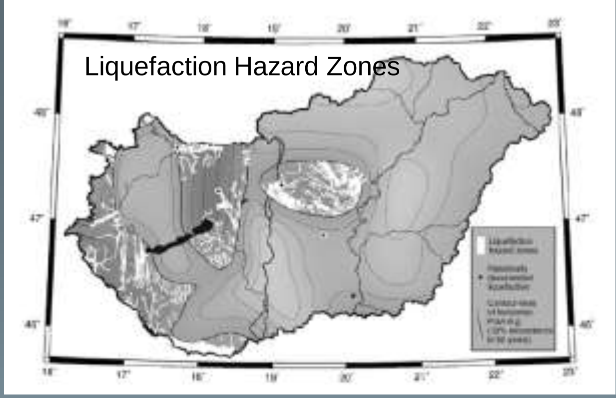
Despite Hungary - being characterized as a low-to-medium level seismicity region - , the risk of destructive earthquake is still a major concern.

Earthquake Hazardous Areas

in Central Hungary

including Secondary Effects :

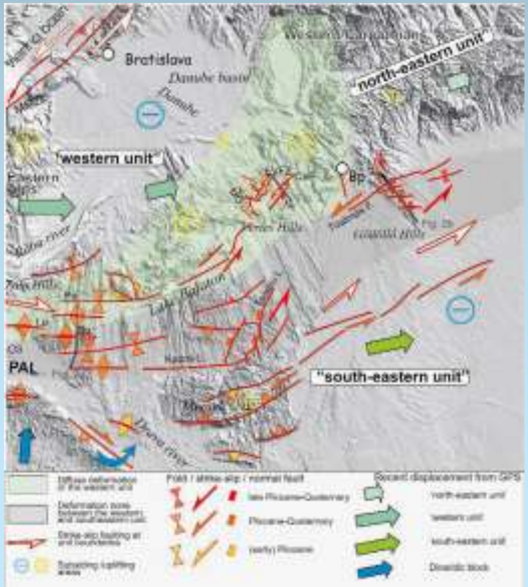
- Due to soil amplification because of local site conditions
- Due to liquefaction and compaction



Györi,2006

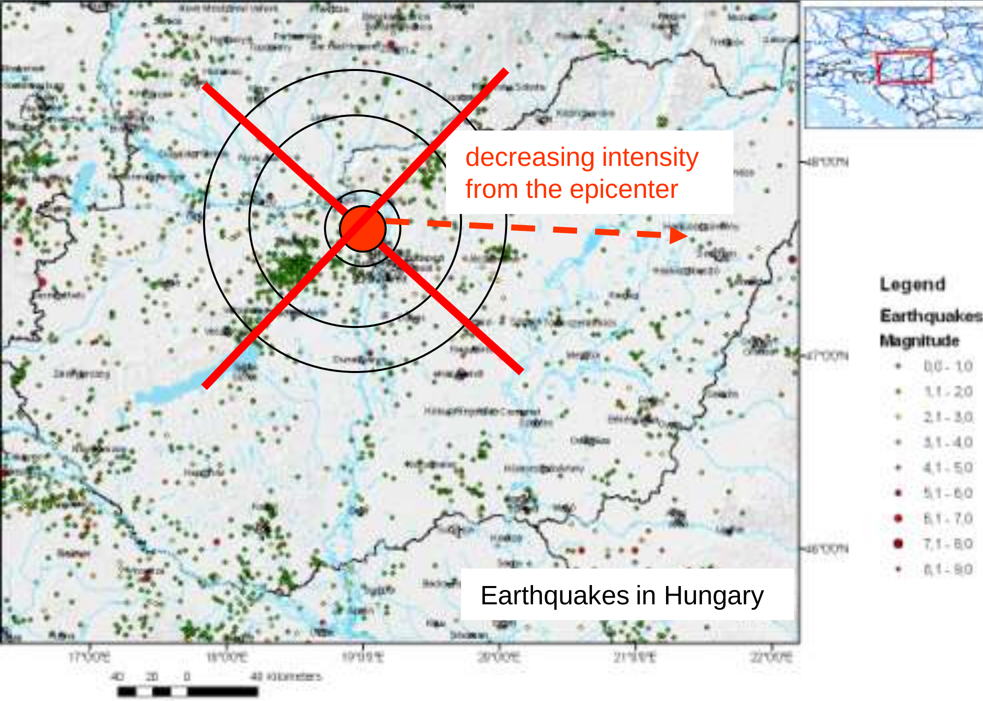
- Due to landslides

- Due to active fault zones and
- aseismic movements in the subsurface(horizontal and vertical)



Fodor et al.

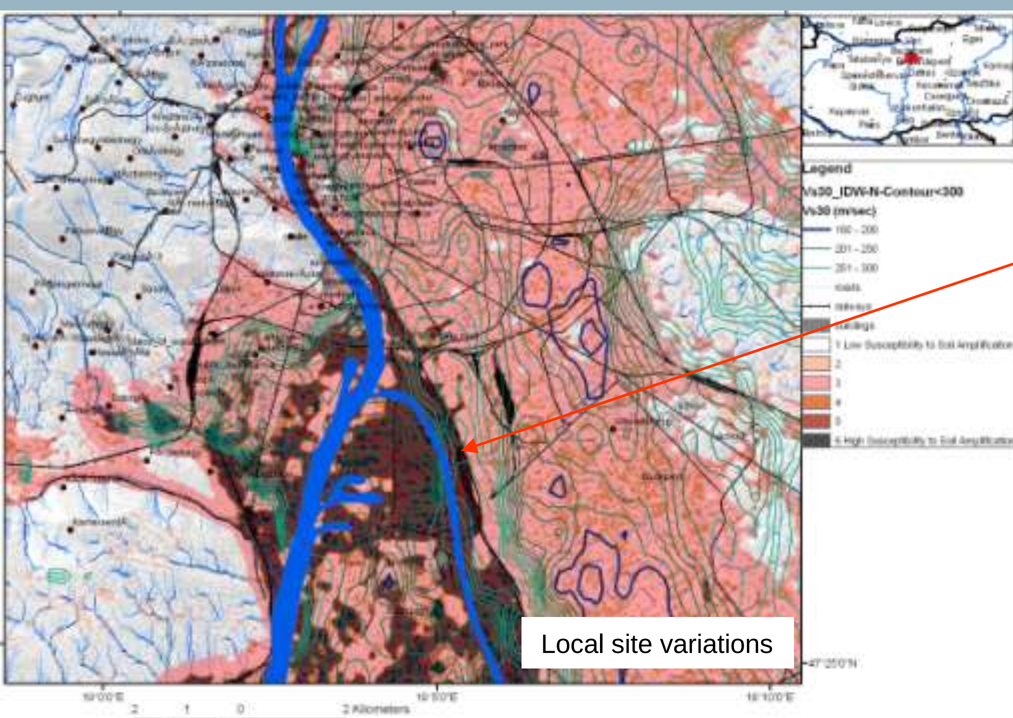
Introduction

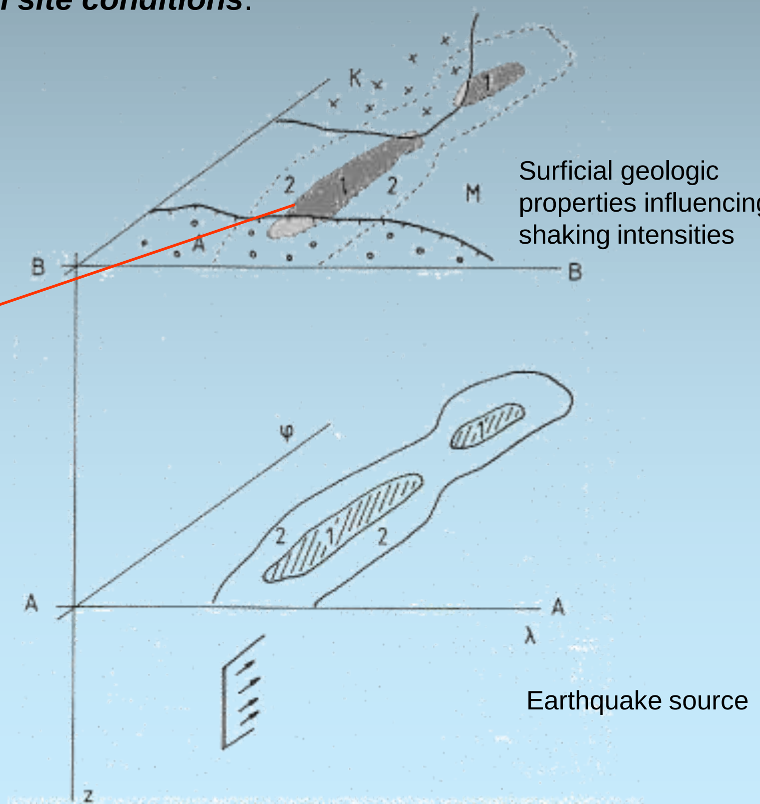


It has been observed that at many sites surface motions are influenced primarily by top 20-30 m of soil. Therefore the subsurface geology has a role to play in earthquake awareness.

In case of stronger earthquakes do not use only circles when searching for affected areas.

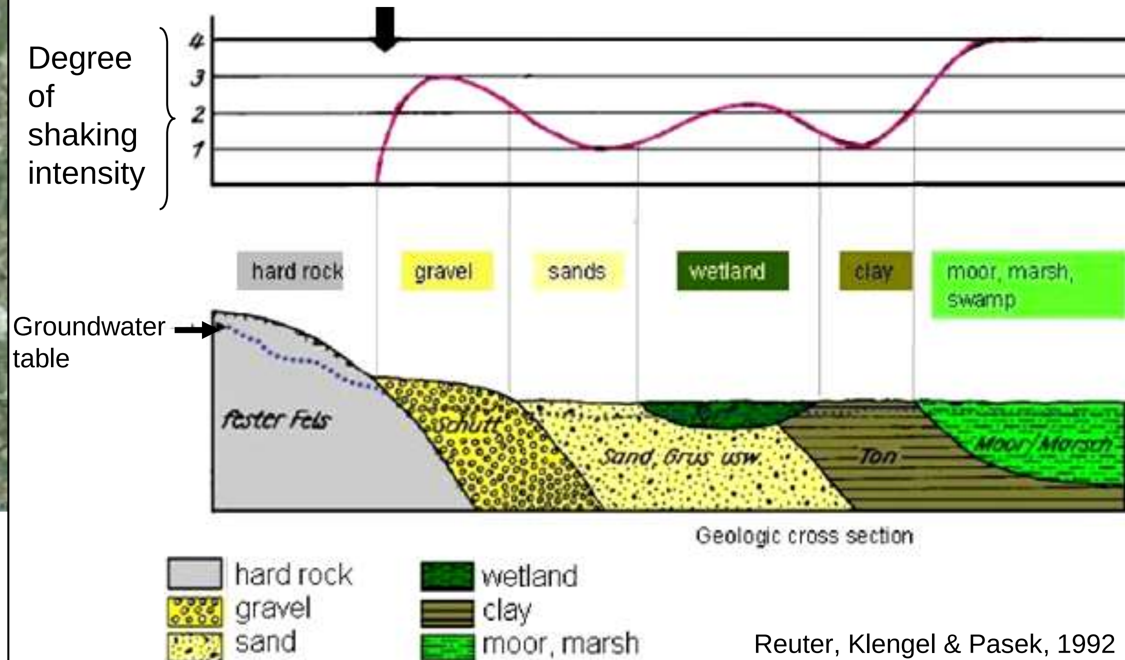
Get information of fault zones and earthquake parameters such as depth, fault plane solution, mechanisms, etc. and ***local site conditions***.





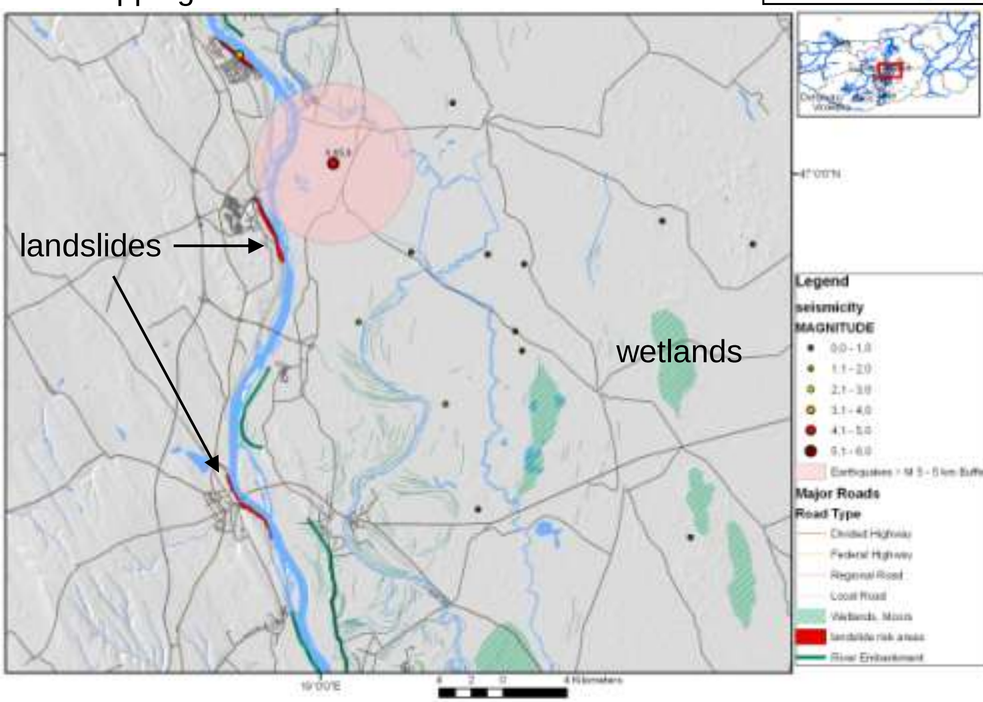
Google Earth -scene

Soil Amplification in Relation to Surficial Geologic Properties



Reuter, Klengel & Pasek, 1992

Mapping of wetlands and landslide areas



Local site conditions influencing shaking intensity such as wetlands, moor areas, varying grain sizes and thickness of sediments, groundwater tables, etc.

The detection and mapping of recent and ancient moor areas is important when dealing with soil amplification effects.

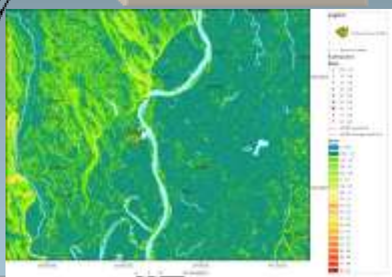
Remote Sensing and GIS Contribution to the Detection of Local Site Conditions and of Earthquake Related Secondary Effects

Causal Factors Influencing Ground Shaking Intensity and the Susceptibility to Secondary Effects (Mass Movements, Liquefaction, Compaction,etc.)

Climatic situation, seasonal effects

High groundwater tables

Slope degree



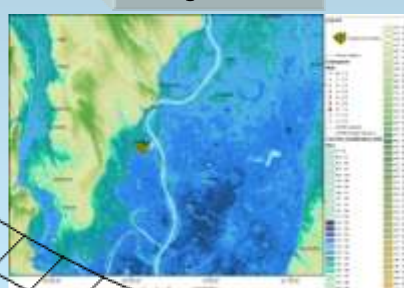
Lithology as unconsolidated, sedimentary covers

Local site conditions influencing earthquake ground motion and secondary effects

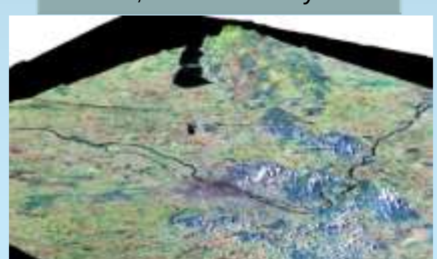
Curvature of the terrain

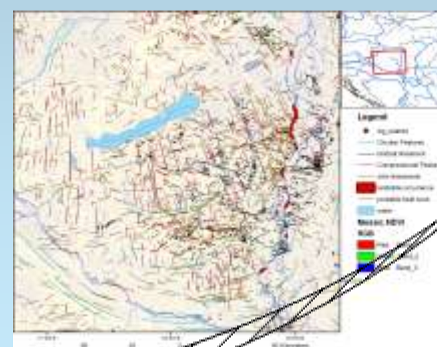
Surface-near fault and fracture zones

Height level



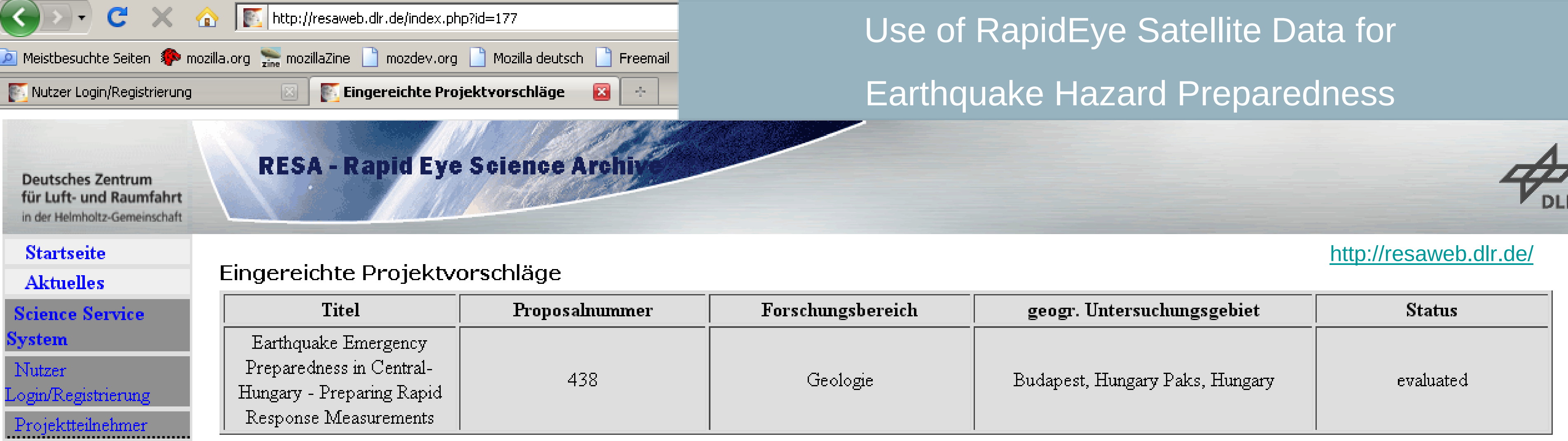
Topographic situation:
basins, broader valleys





Digital Image Processing of LANDSAT- and RapidEye-Data

Use of RapidEye Satellite Data for Earthquake Hazard Preparedness


http://resaweb.dlr.de/index.php?id=177

Meistbesuchte Seiten mozilla.org mozillaZine mozdev.org Mozilla deutsch Freemail

Nutzer Login/Registrierung | Eingereichte Projektvorschläge

Deutsches Zentrum für Luft- und Raumfahrt in der Helmholtz-Gemeinschaft

RESA - Rapid Eye Science Archive

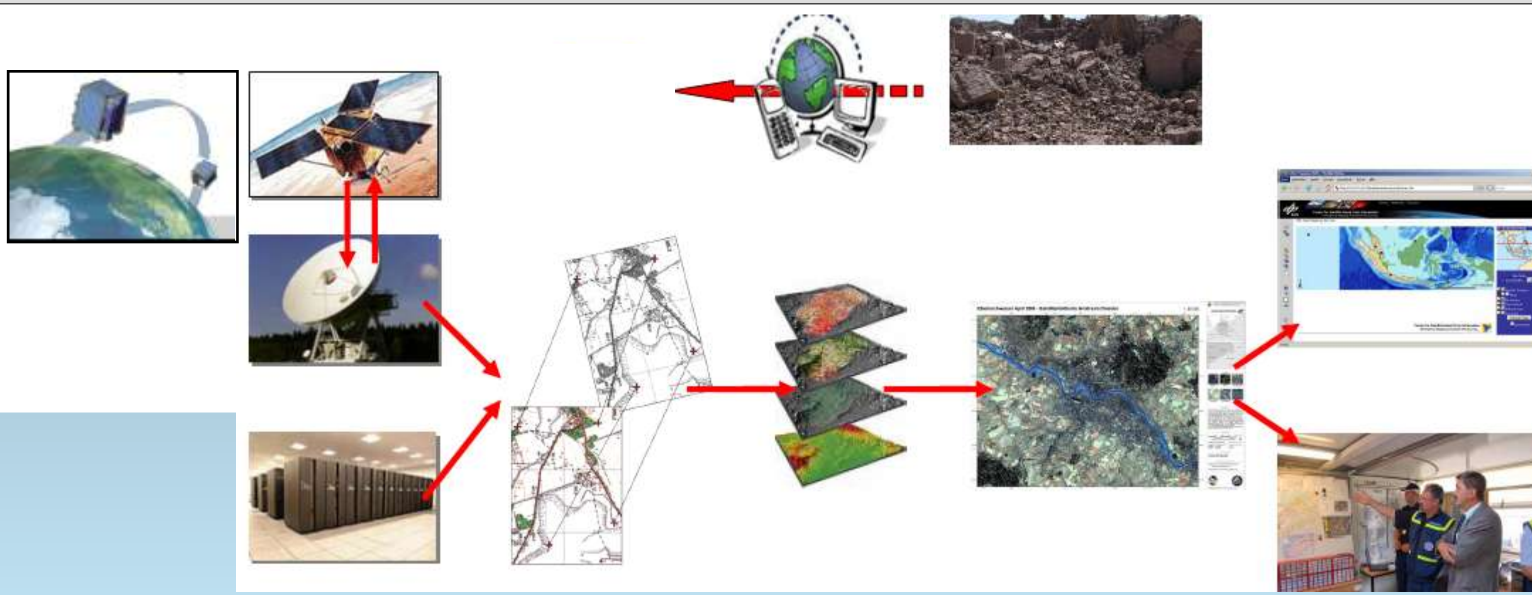
DLR

Startseite
Aktuelles
Science Service System
Nutzer Login/Registrierung
Projektteilnehmer
Eingabe Projektvorschlag
Eingabe Untersuchungsgebiete
Eingereichte Projektvorschläge
Akzeptierte Projekte
FAQ
Dokumentation
Links
Logout

http://resaweb.dlr.de/

Eingereichte Projektvorschläge

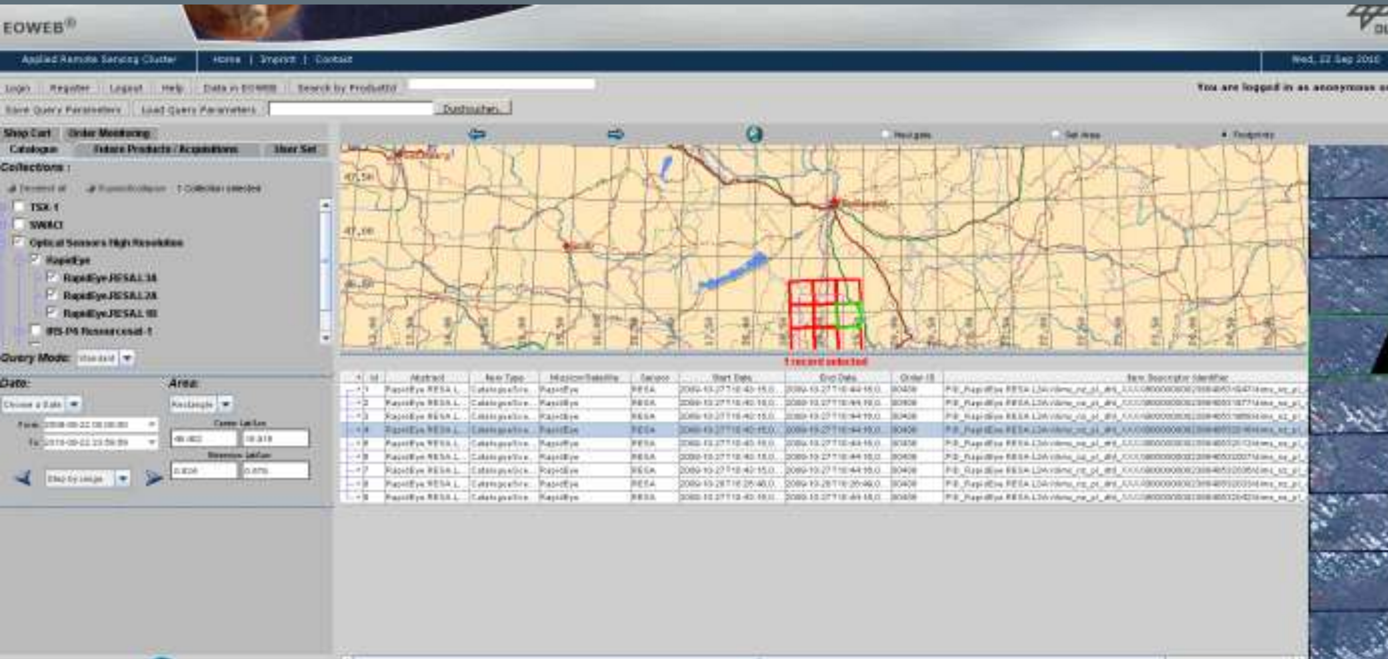
Titel	Proposalnummer	Forschungsbereich	geogr. Untersuchungsgebiet	Status
Earthquake Emergency Preparedness in Central-Hungary - Preparing Rapid Response Measurements	438	Geologie	Budapest, Hungary Paks, Hungary	evaluated



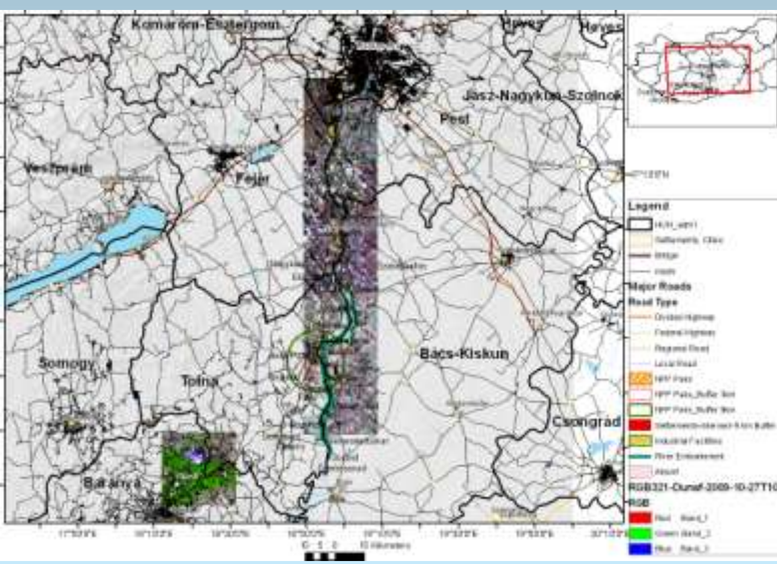
In **disaster preparedness phase**, GIS is a tool for the planning of evacuation routes, for the design of centers for emergency operations, and for merging of satellite data with other relevant data in the design of disaster warning systems.

High resolution satellite data serve to show potential changes that might occur between the acquisition dates before and after disasters. High-resolution satellite imagery offers possibilities for the earthquake damage assessment and, thus, multidisciplinary approach combining remote sensing techniques, spatial analysis and earthquake engineering knowledge.

Cloud Cover – an emergency monitoring problem in case of a stronger earthquake

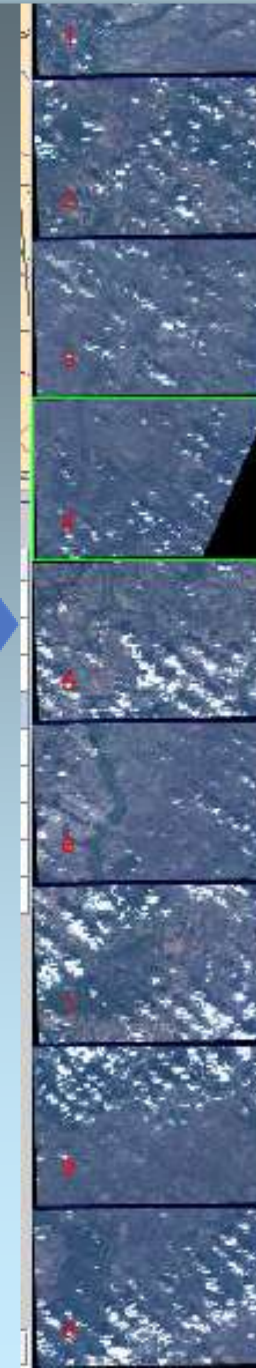


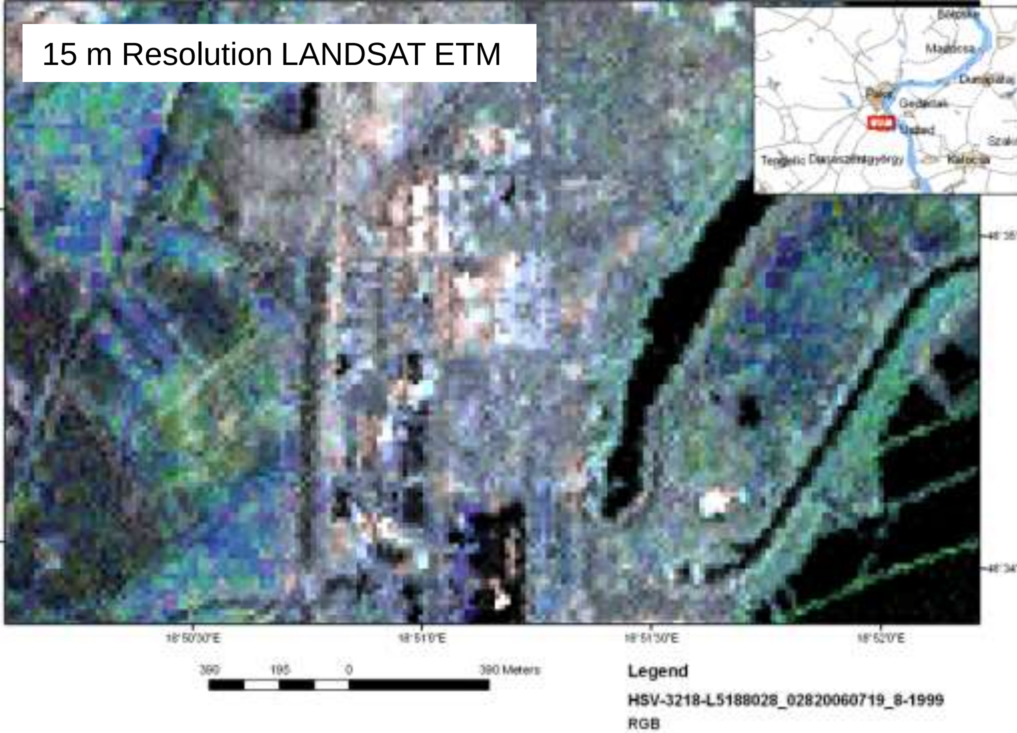
https://centaurus.caf.dlr.de:8443/eoweb-ng/template/default/welcome/entryPage.vm



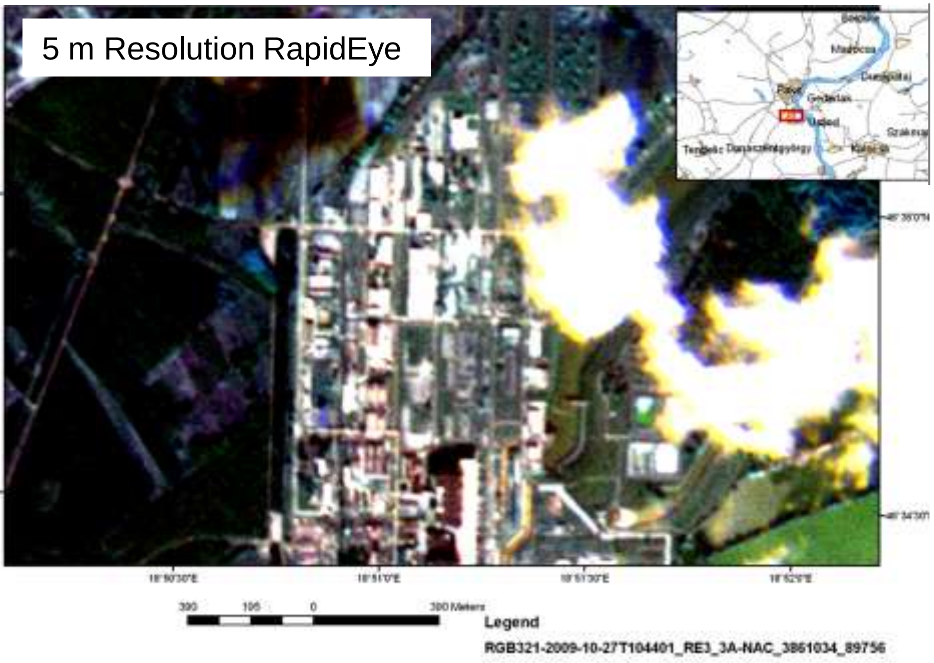
Available RapidEye imageries in September 2010

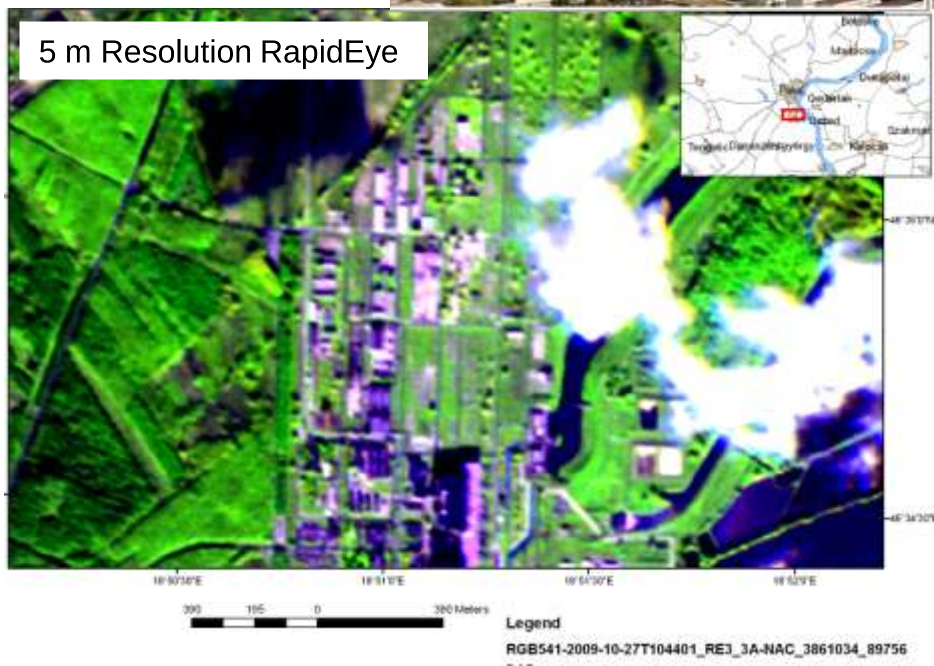
- waiting for cloud-free imageries

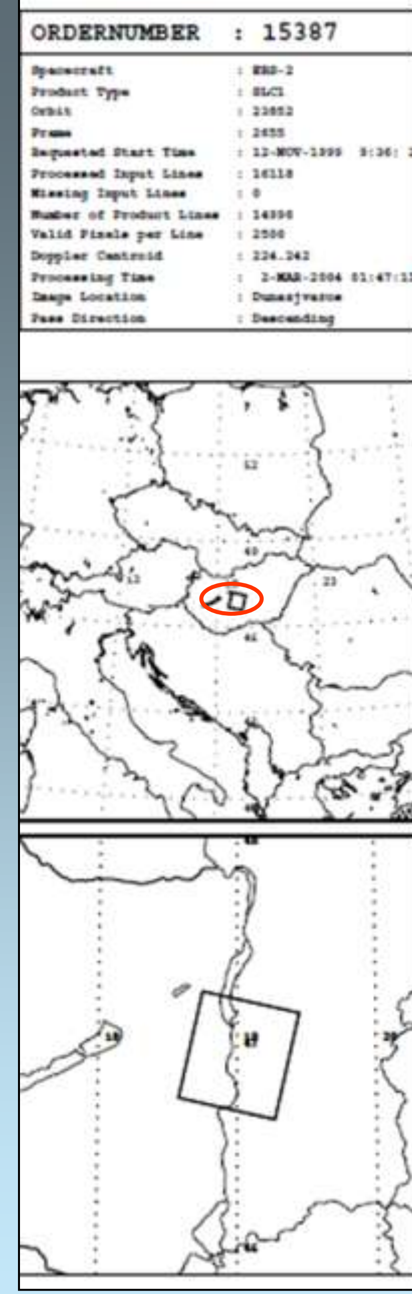




Google Earth







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Missing Input Lines	: 0
Number of Product Lines	: 14896
Valid Pixels per Line	: 2500
Doppler Centroid	: 224.242
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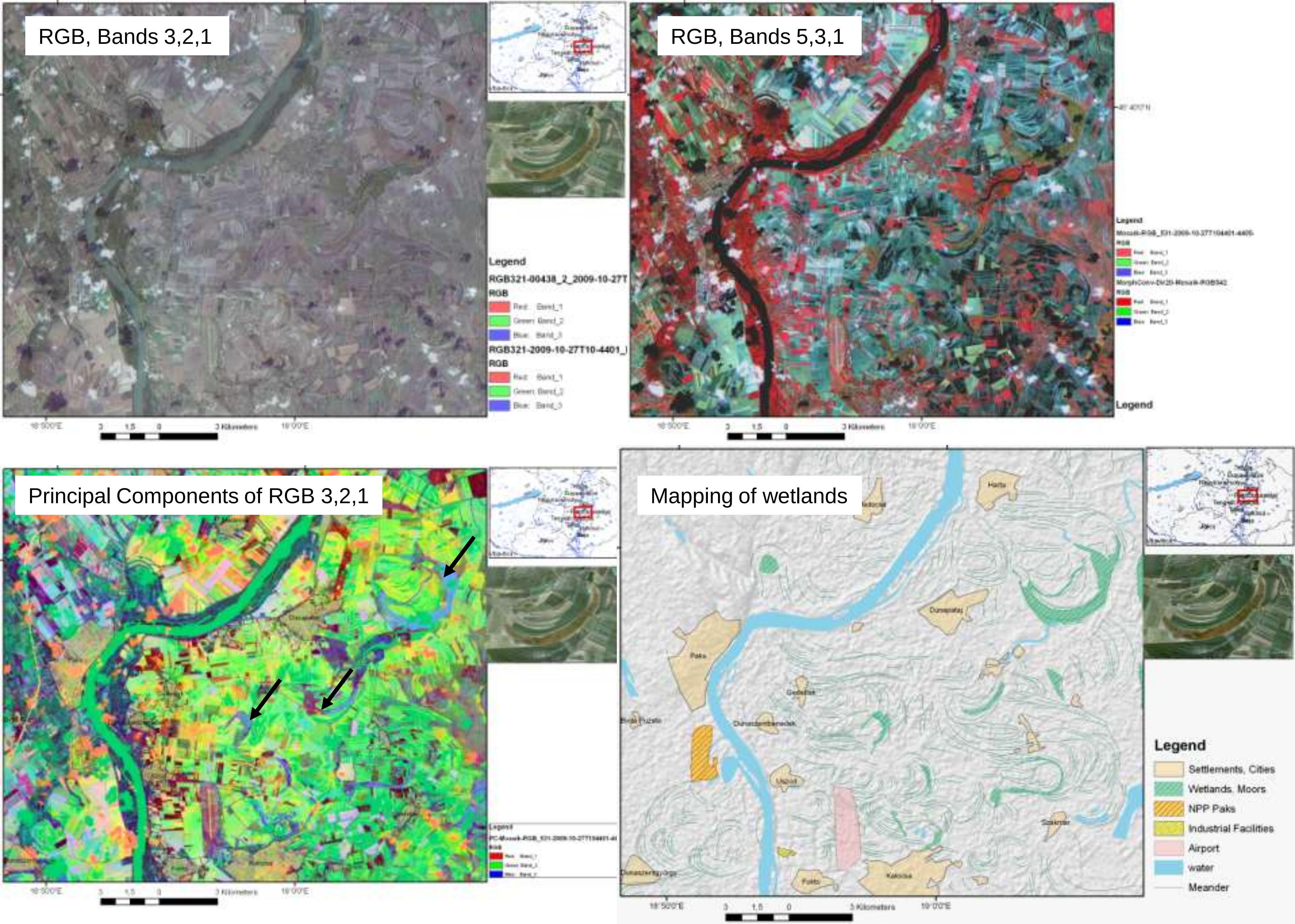
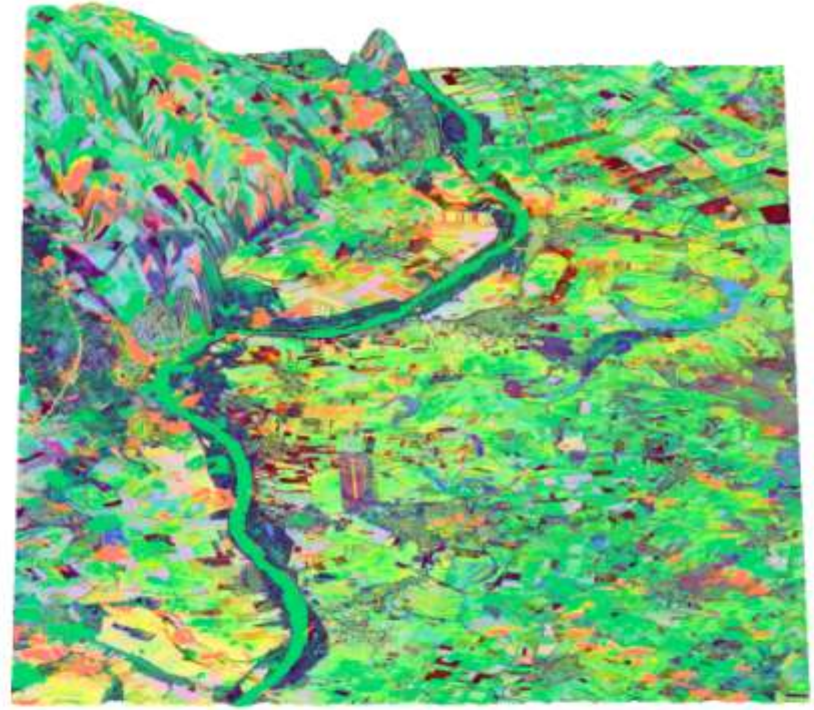
Image Location	: Dunaujvaros
Pass Direction	: Descending

ERS Radar Image

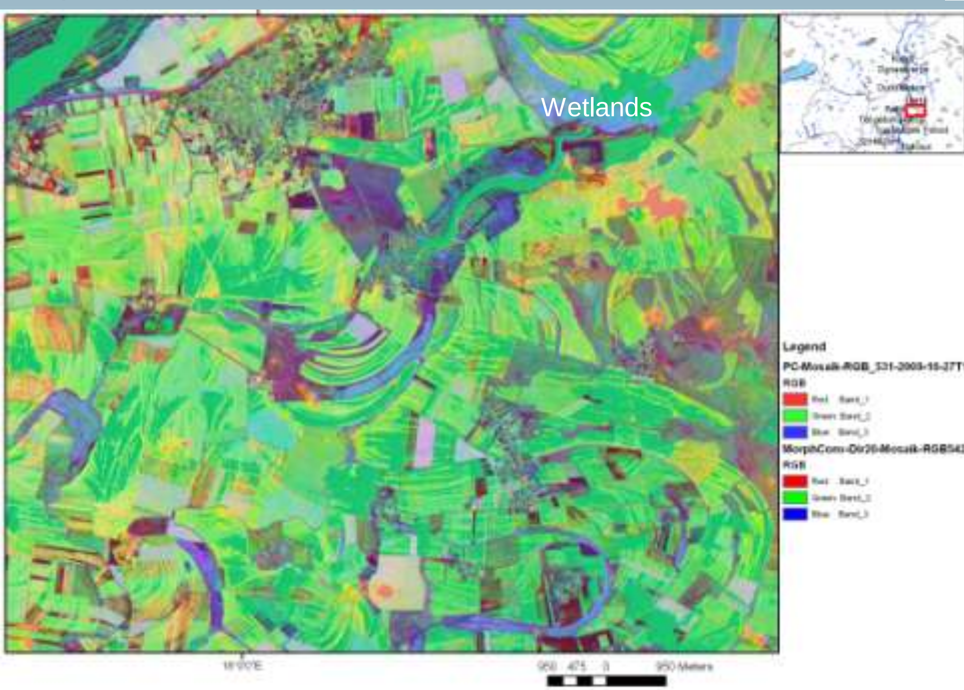


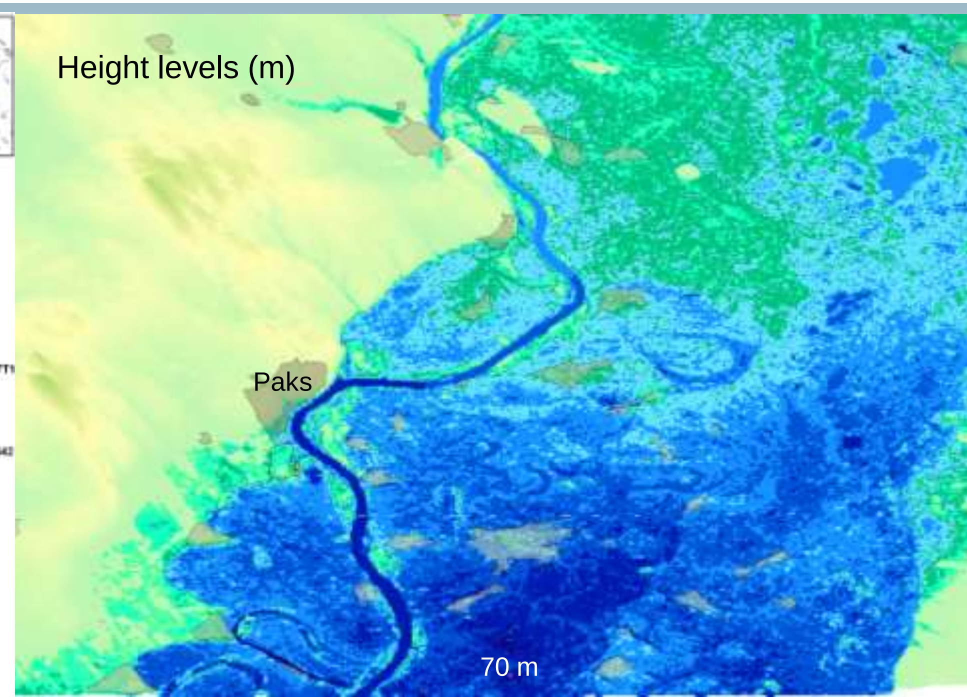
Digital image processing for the detection of wetlands

Wetland Occurrence



Principal Component image based on RGB 5,3,1-RapidEye-imagery merged with ASTER DEM data





Legend

Rez-1-m-Mosaic-RGB-321.tif

RGB

Red: Band_1

Green: Band_2

Blue: Band_3

MorphConv-Dir20-Mosaik-RGB542

RGB

Red: Band_1

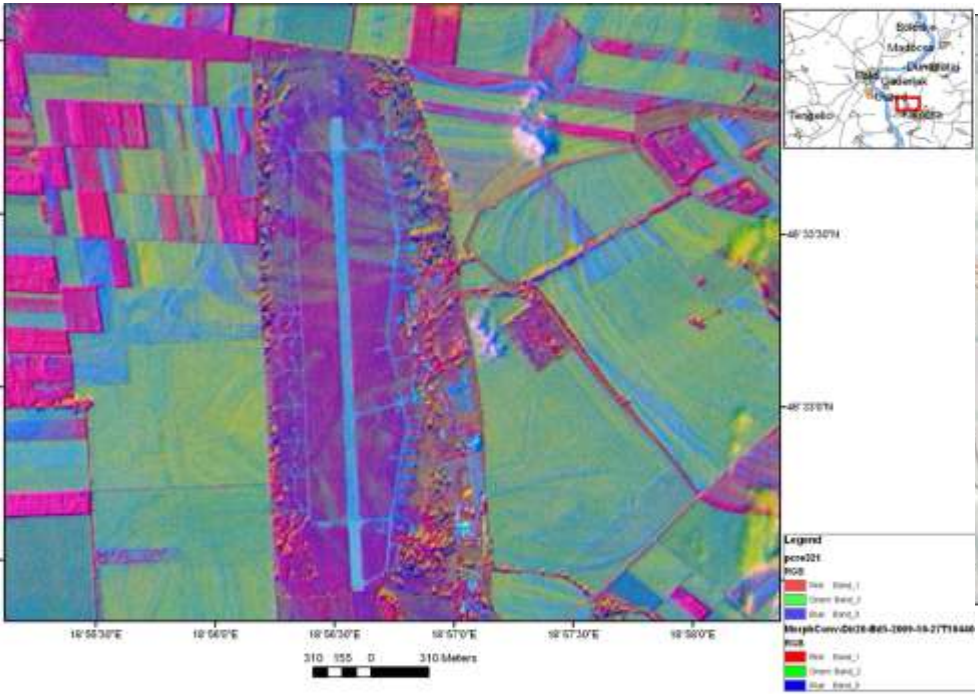
Green: Band_2

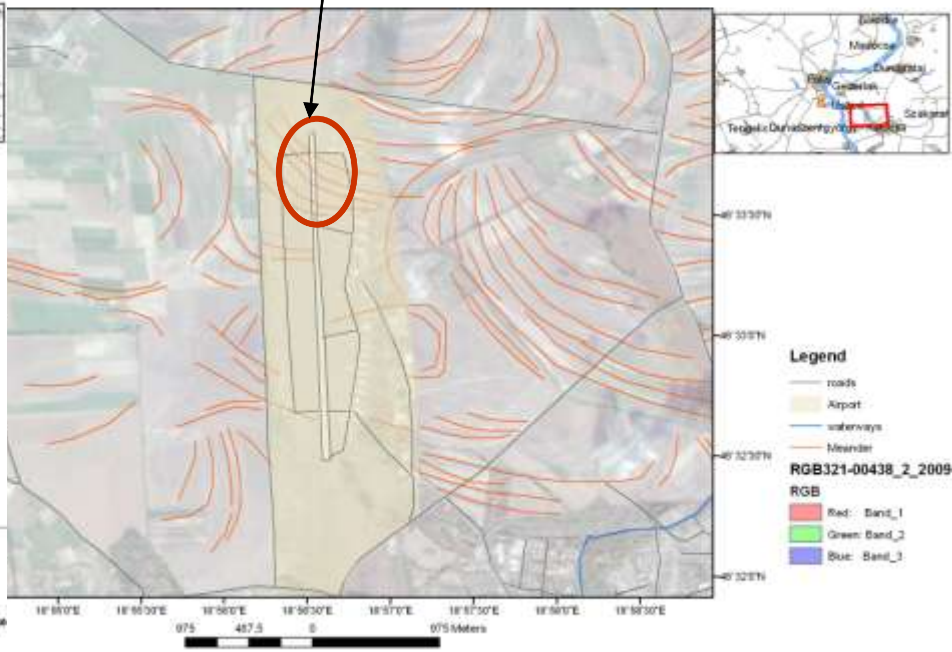
Blue: Band_3

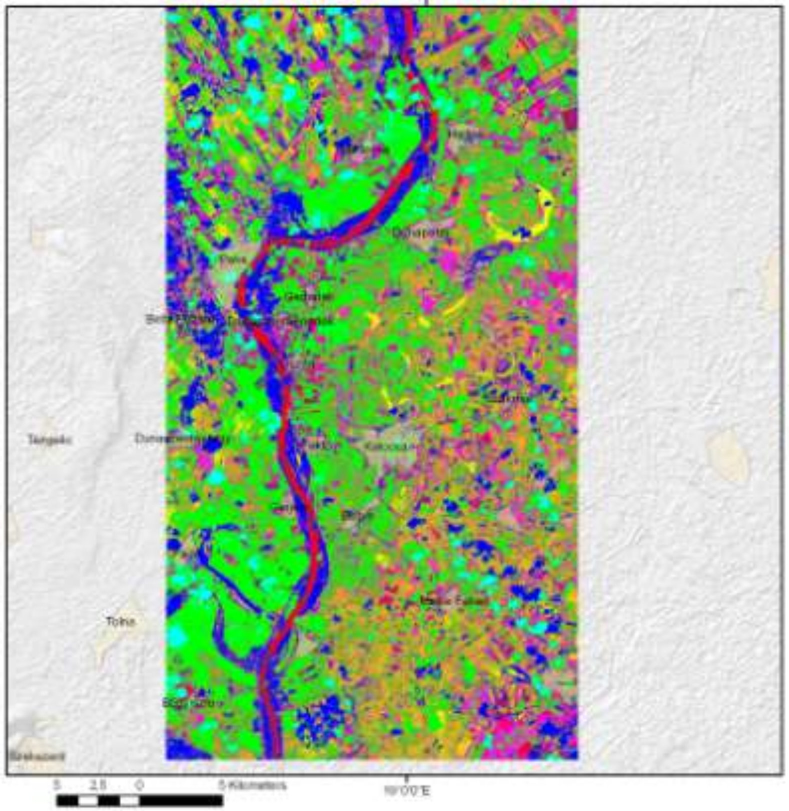
Resize of the spatial resolution from 5 m to 1 m pixelsize

Traces of ancient river meander on a RapidEye-scene

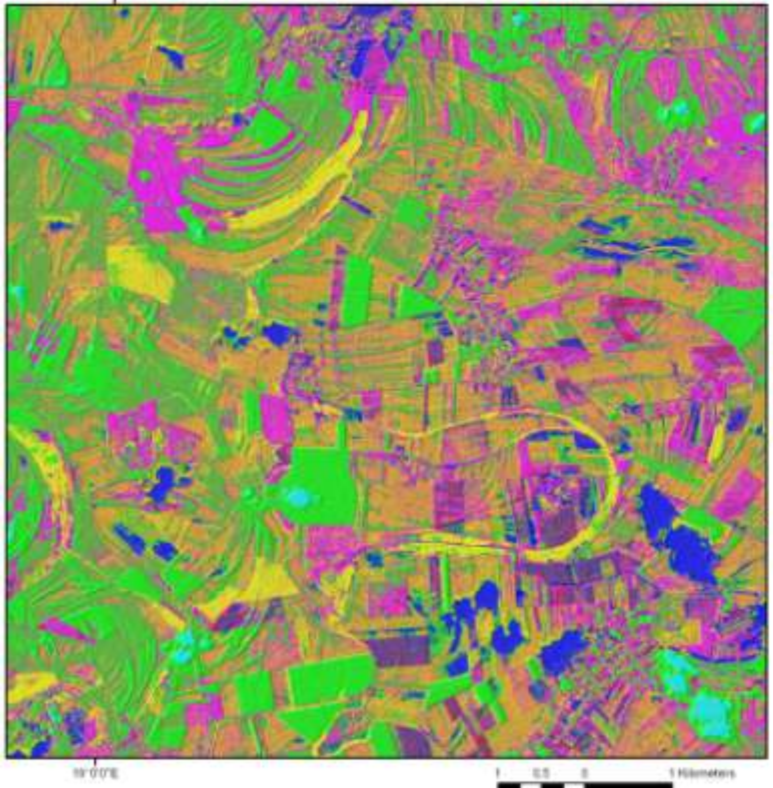
Different **compaction** in case of stronger earthquakes due to varying grain sizes of the meander sediments?







RGB, Bands 3,2,1



Supervised classification for landuse mapping

Change of Infrastructure

LANDSAT

Legend

RGB321-p188r27_5t19901011

LANDSAT

Legend

RGB321-p188r027_7t19990809

LANDSAT

Legend

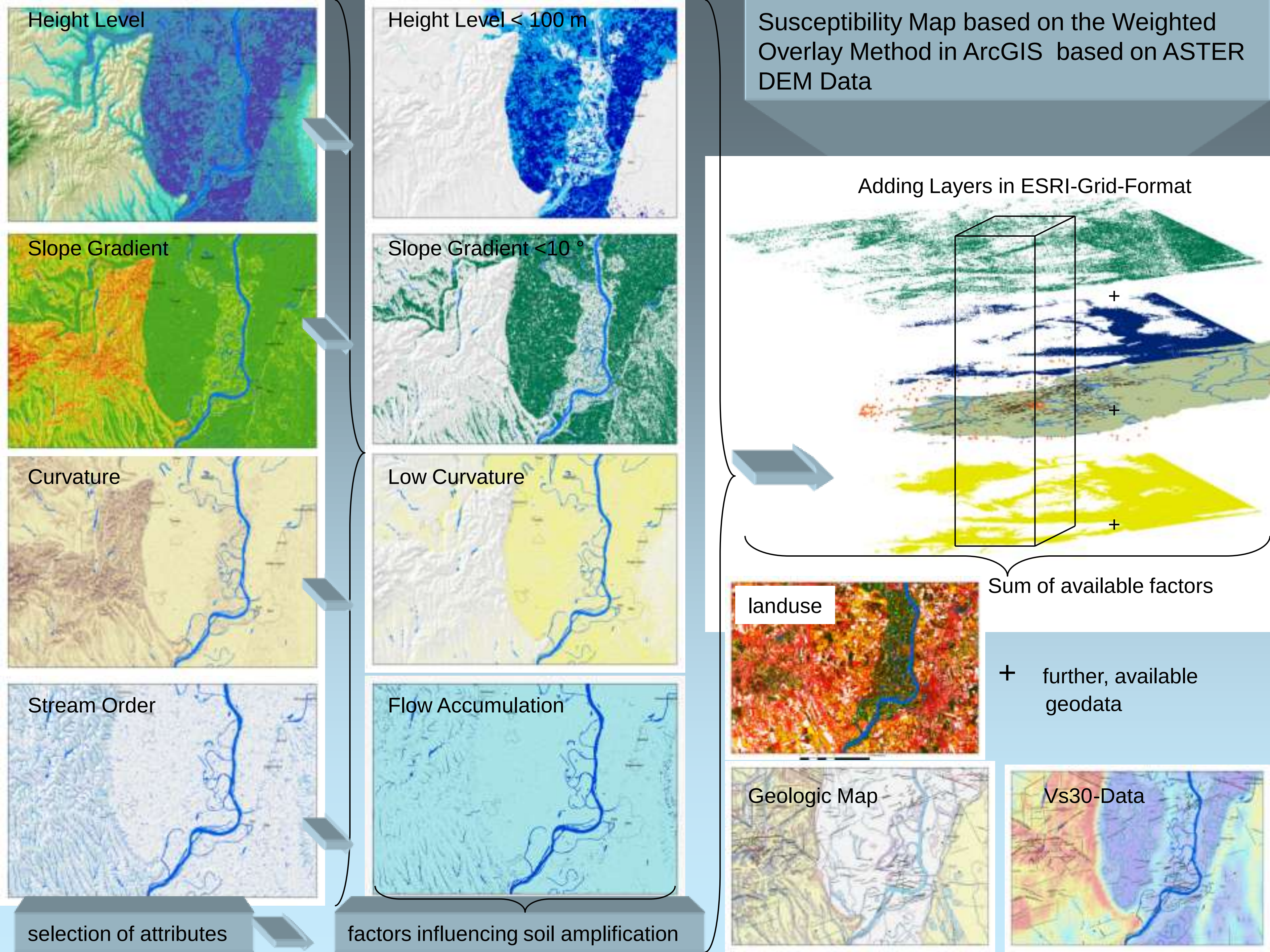
RGB-321-L5188027_02720100714

RapidEye

Legend

RGB321-Dunaf-2009-10-27T104358_RE3_3A-NAC_3861036_89756

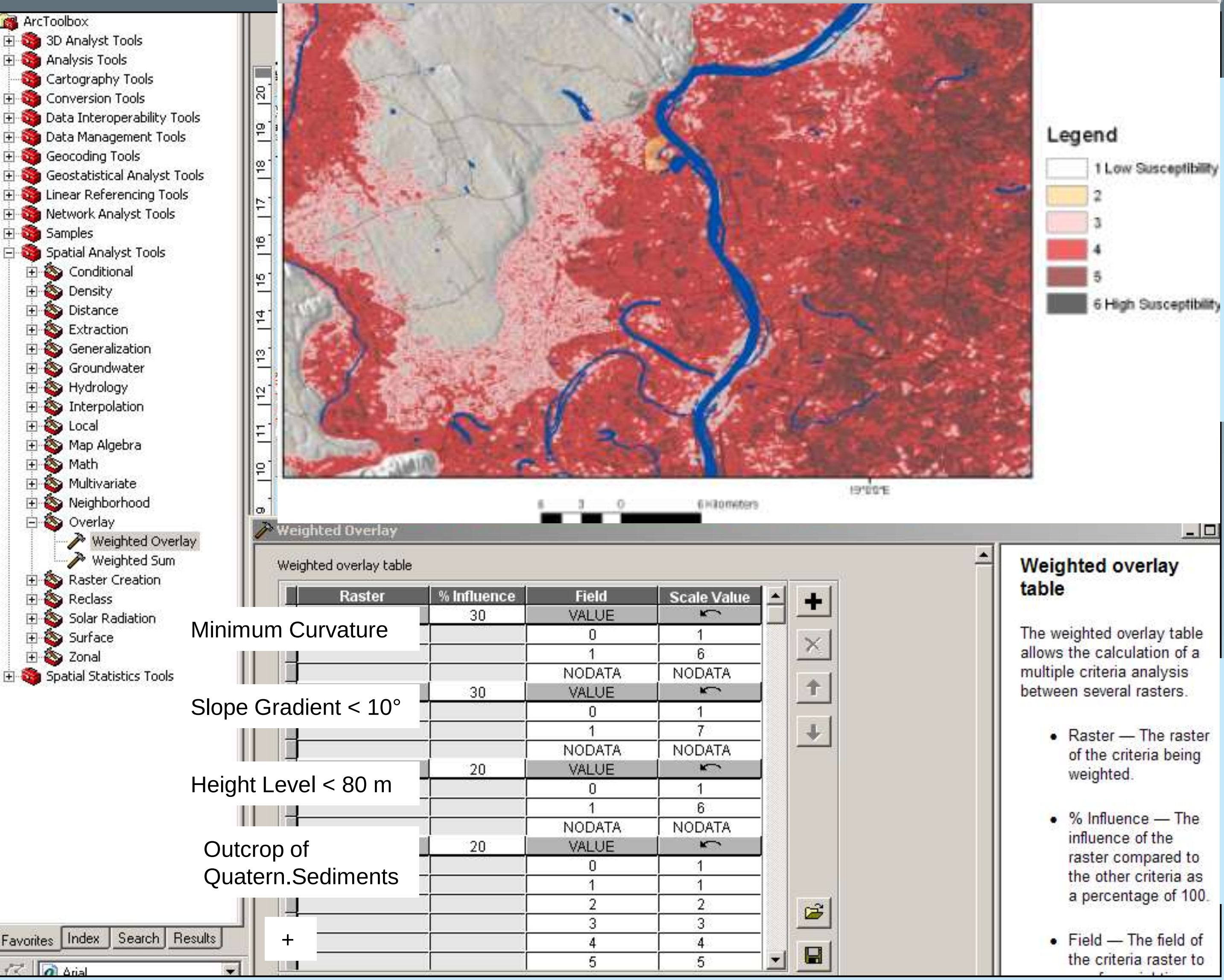
Weighted Overlay of Factors Influencing Surface-near Earthquake Shock



Susceptibility Map based on the Weighted Overlay Method in ArcGIS based on ASTER DEM Data
Height Level
Slope Gradient
Curvature
Stream Order
Height Level < 100 m
Slope Gradient <10 °
Low Curvature
Flow Accumulation
selection of attributes
factors influencing soil amplification
Adding Layers in ESRI-Grid-Format
+
+
+
Sum of available factors
landuse
+ further, available geodata
Geologic Map
Vs30-Data

The Weighted Overlay-Method in ArcGIS

for the elaboration of susceptibility maps



Factors influencing earthquake shock intensity at the surface such as outcropping unconsolidated sedimentary covers, surface morphology (curvature, slope gradient, morphologic setting), surface-near faults, etc, are displayed as layers in ArcGIS, converted into .grid-formats and weighted.

The percentage of influence of a factor is changing due to seasonal and climatic reasons. A stronger earthquake during a wet season will probably cause more secondary effects than during a dry season.

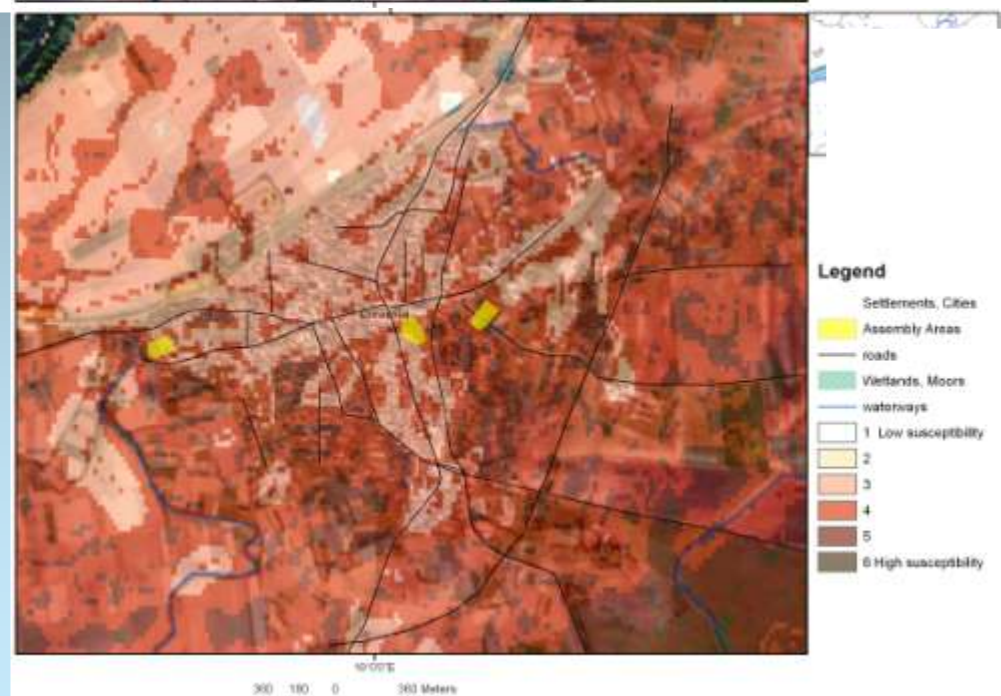
Further factors have to be included such as active faults, uplift / subsidence,……..

The susceptibility is calculated by adding every layer with a weighted % influence and by summarizing all layers. The result can be divided into susceptibility classes and presented as a susceptibility map.

Weighted overlay approach in ArcGIS based on ASTER DEM data summarzing the factors:

height < 80 m, slope degree < 5°, curvature=0, flow accumulation>1

This approach contributes to a better understanding of small, local differences in the damage intensity during stronger earthquakes due to local site conditions. However, the presented result is still incomplete. The level of the actual groundwater table, variations in the lithologic properties (grain sizes, etc.) and further geotechnical data have to be included for improving the result.



Susceptibility to soil amplification in case of stronger earthquakes

Emergency Preparedness

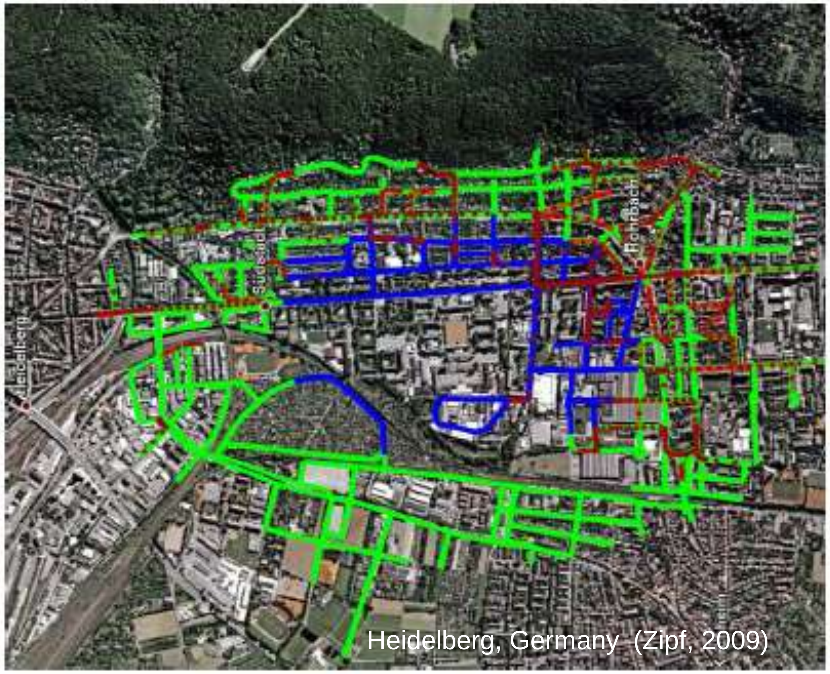
Planning of Evacuation Routes

Example Budapest

Blue: Dangerous Area

Red: Traffic Jam

Green: Free Routes



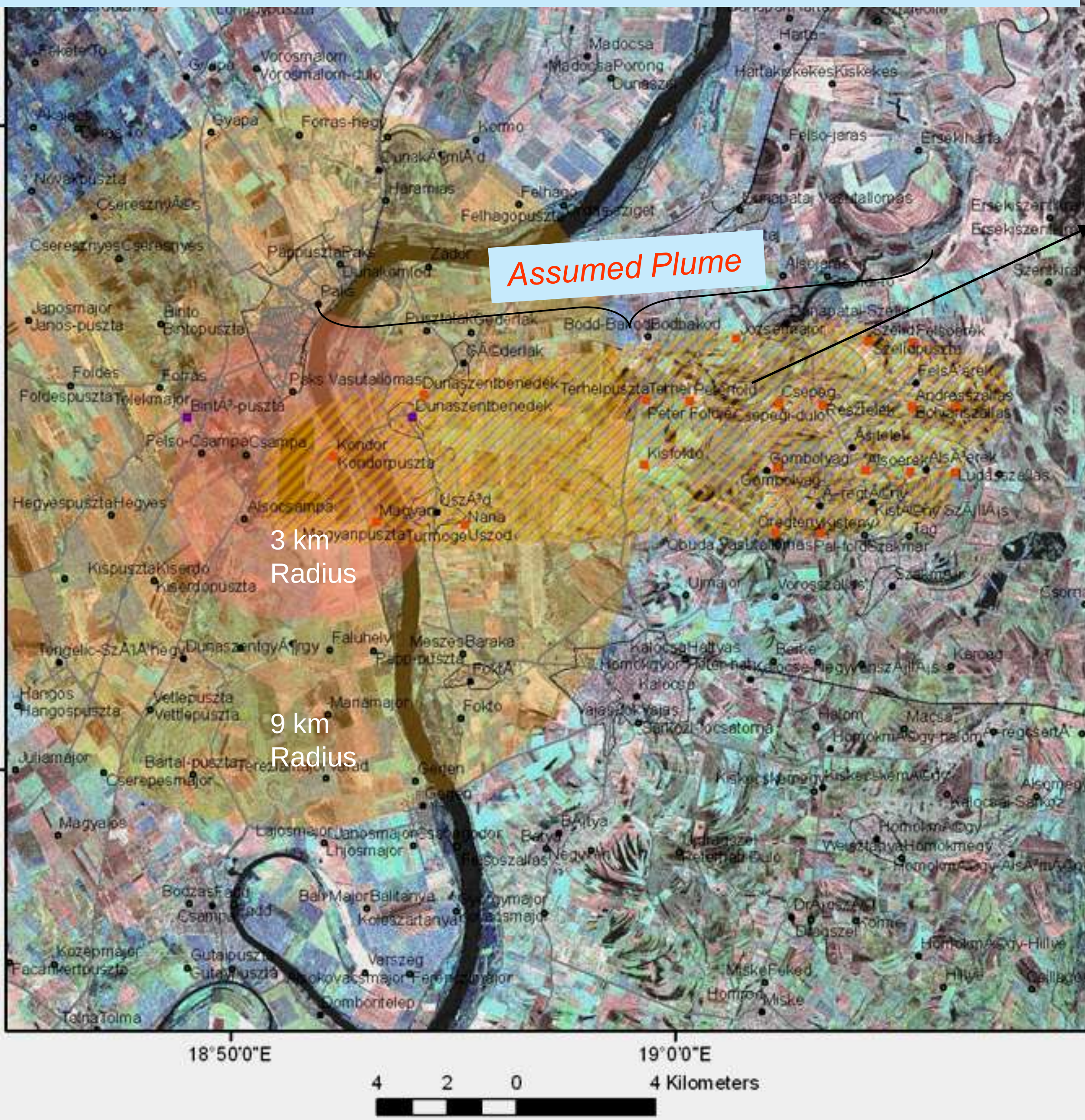
Heidelberg, Germany (Zipf, 2009)

Current, accurate information such as of hospitals and health centers, schools, governmental buildings, police and fire stations, industrial buildings, and gas stations, is important. for emergency planning and response measurements. Actual satellite data contribute to this task.

Google Street View of Budapest

Assuming an Accident in an Industrial Plant after a Stronger Earthquake….

Experience has shown that an earthquake's toll can be multiplied by follow-on disasters such as fires or accidents in industrial plants.



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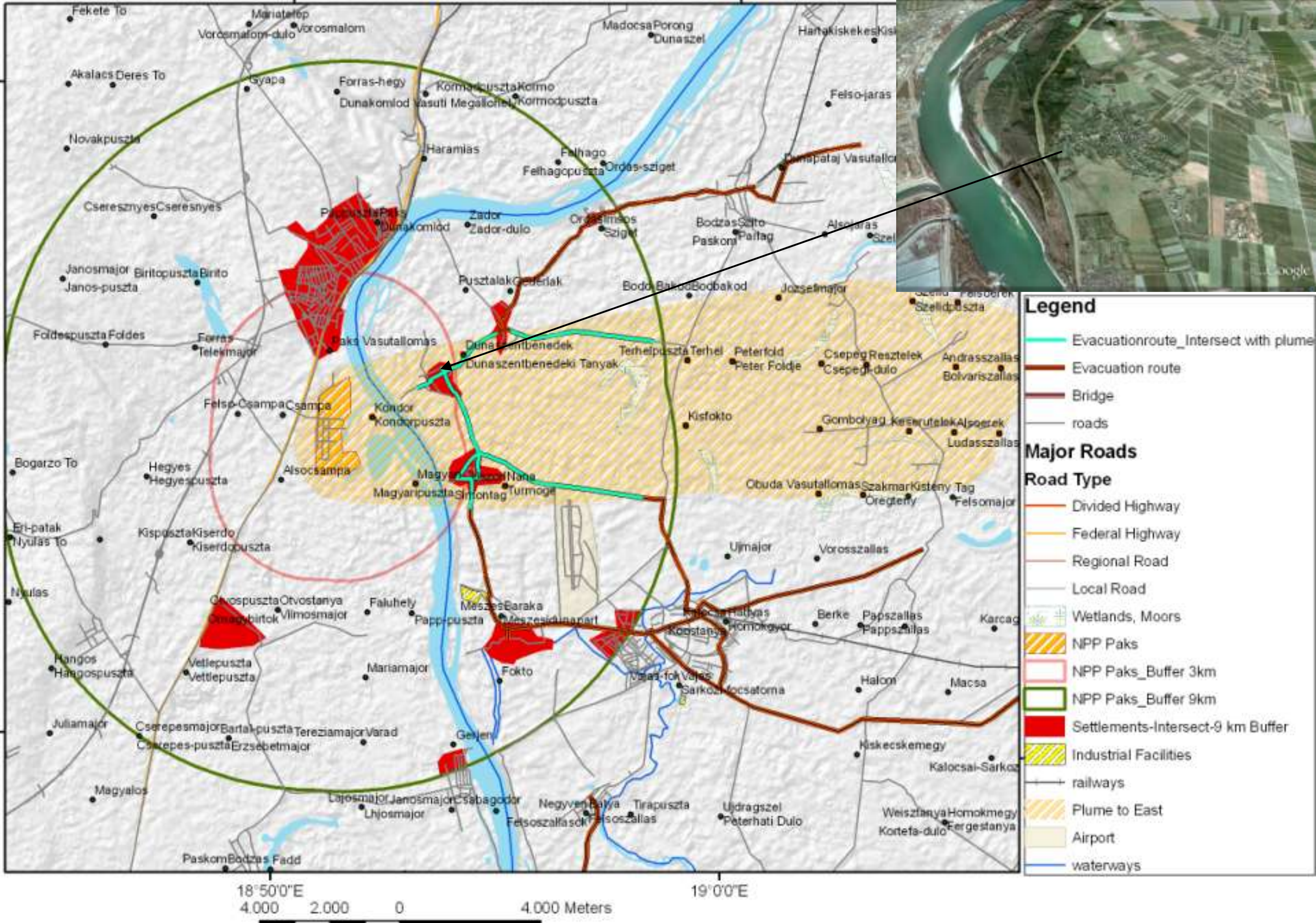
1	Point	13241	Magyari
2	Point	1749	Uszoditanyak
3	Point	1750	Uszod
4	Point	2385	Turmoge
5	Point	2587	Tosemoge
6	Point	6208	Simontag
7	Point	6333	Sejekmoge
8	Point	10624	Nana
9	Point	17060	Kenyertelek
10	Point	10081	Obuda Vasutallomas
11	Point	9630	Oregteny
12	Point	15242	Kondorpuszta
13	Point	15253	Kondor
14	Point	16349	Kisfokto
15	Point	21084	Gombolyag

Places situated within the assumed plume that have to be evacuated first according to their distance from the source

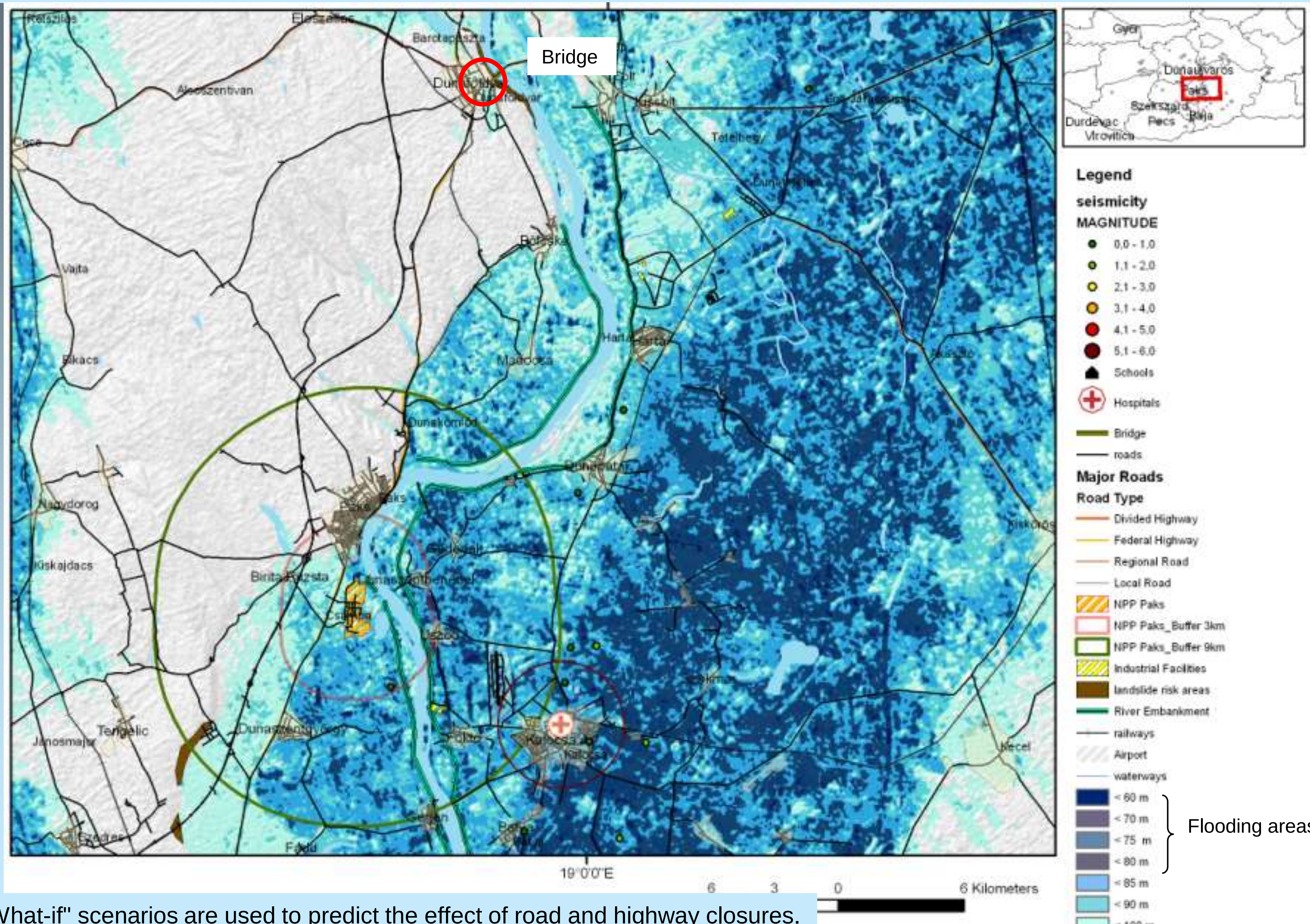
Places for evacuation in case of accident assuming a plume with eastwards directed distribution

In case of an accident climatic data (main wind direction) have to be included into the database. Assuming a wind transportation towards east the affected settlements can be determined immediately and the evacuation planned.

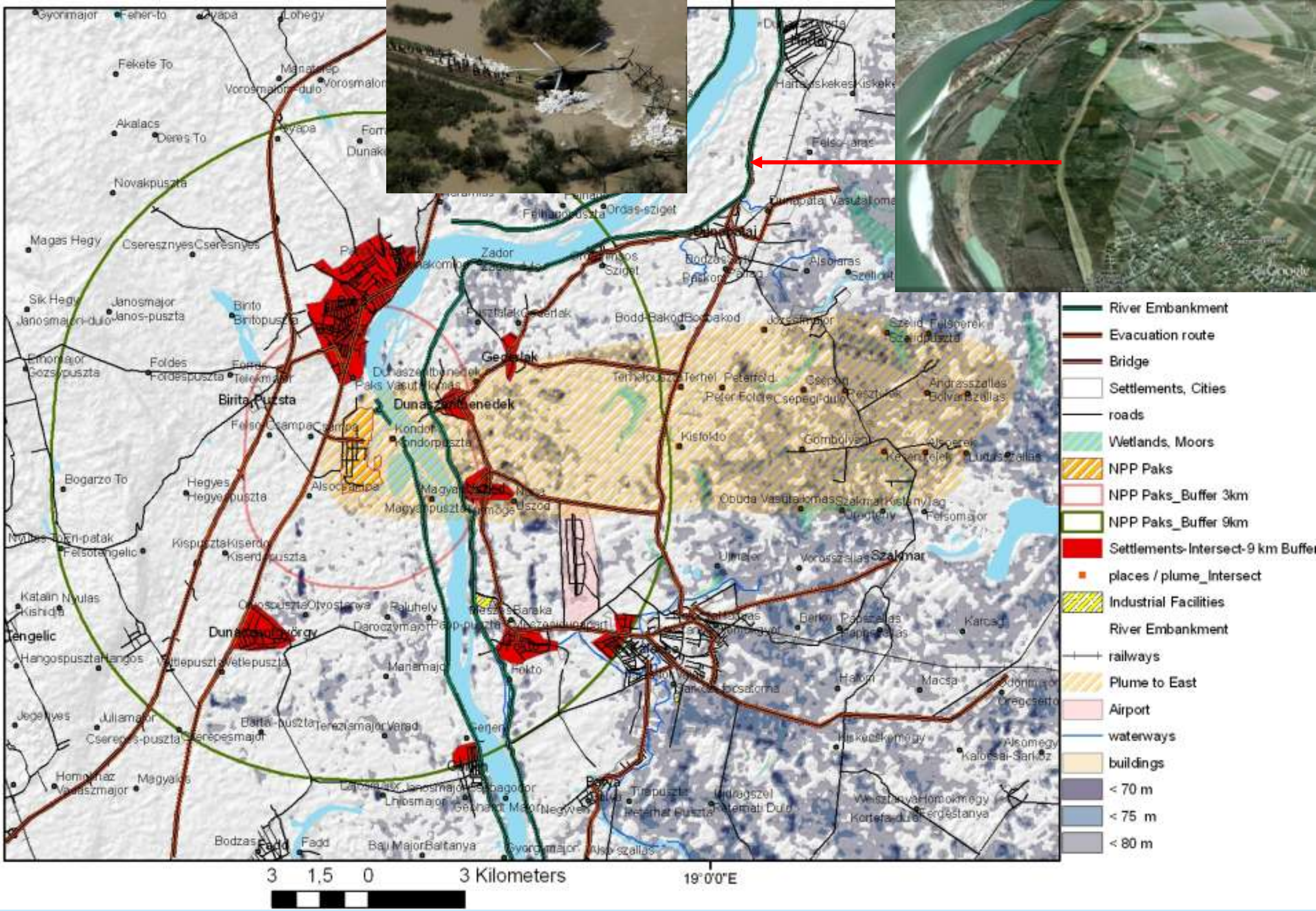


Elaboration of **evacuation routes** considering main wind directions influencing the distribution of pollution

But what happens when stronger earthquakes occur during a flooding season, or river embankments or bridges are destroyed? - A Worst Case-Scenario

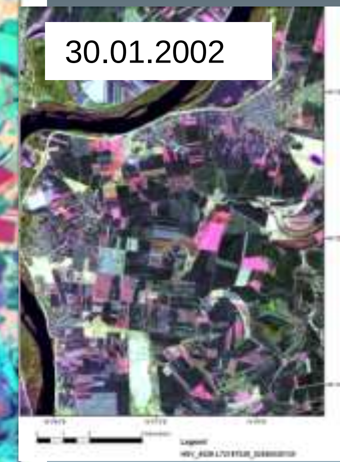


"What-if" scenarios are used to predict the effect of road and highway closures.

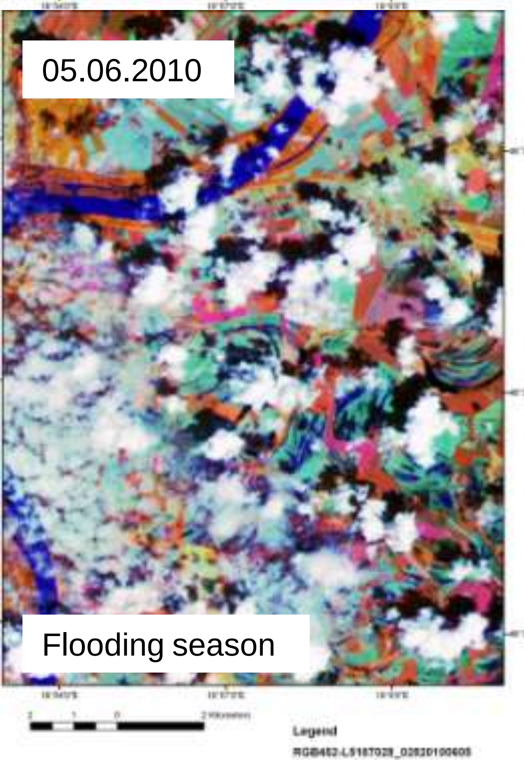


Conditions during wet and flooding seasons should be considered when planning evacuation routes because wetlands and potential flooding areas could affect and interfere evacuations.

LANDSAT TM- and ETM-Scenes from 1987-2010



Winter



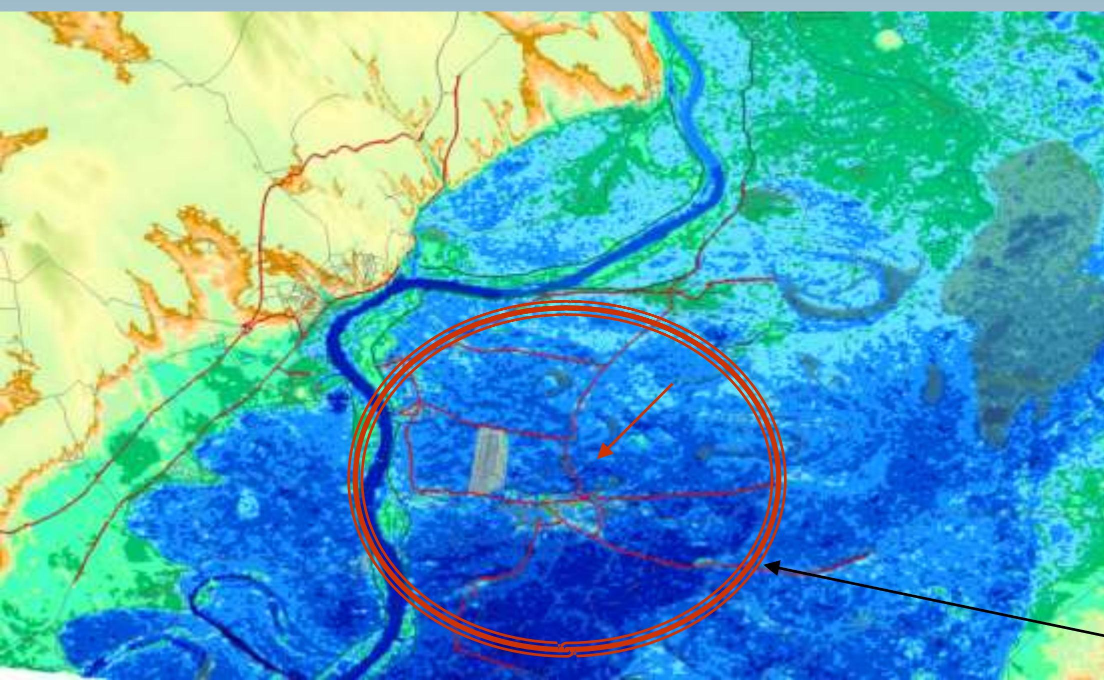
Detection of road segments prone to flooding

Flooded areas (dark-blue)

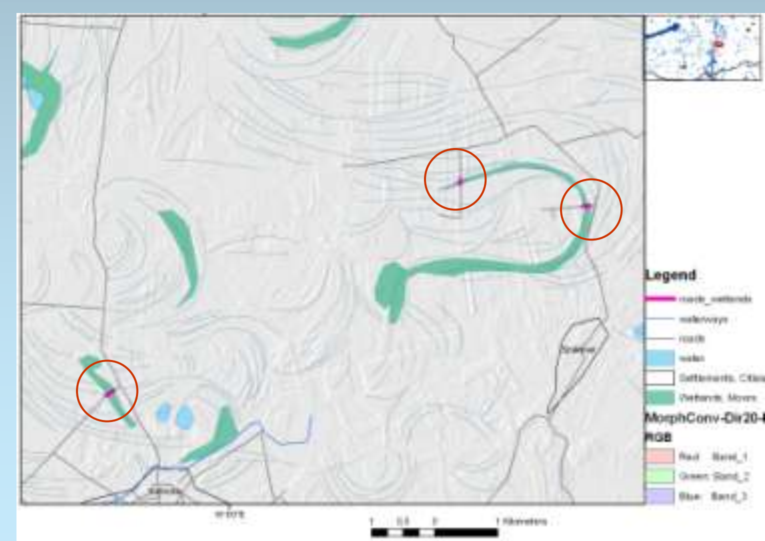
Roads Susceptible to Flooding

Perspective 3D-view of a RapidEye-satellite imagary from the Paks area

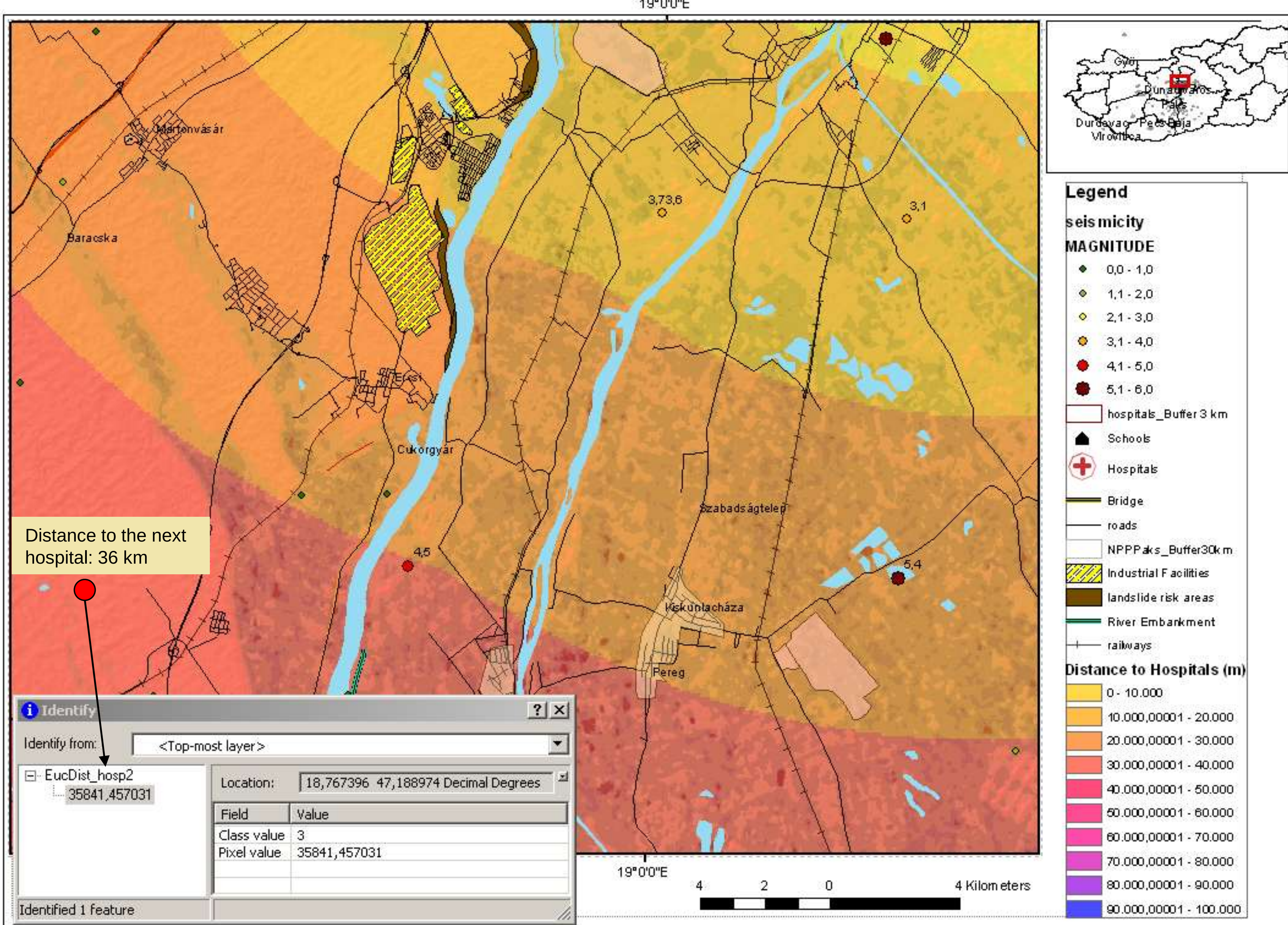
Red lines indicate potential evacuation routes, grenn areas correspond to wetlands.



Perspective 3D view of the height level map showing in dark-blue the lowest areas between 70 and 80 m height.

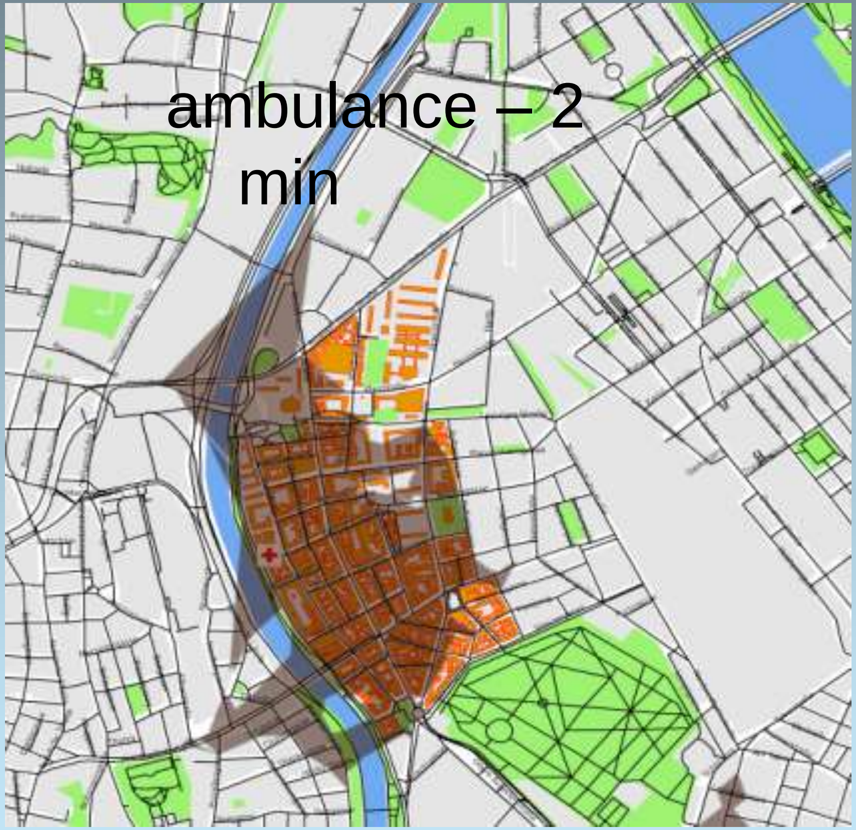


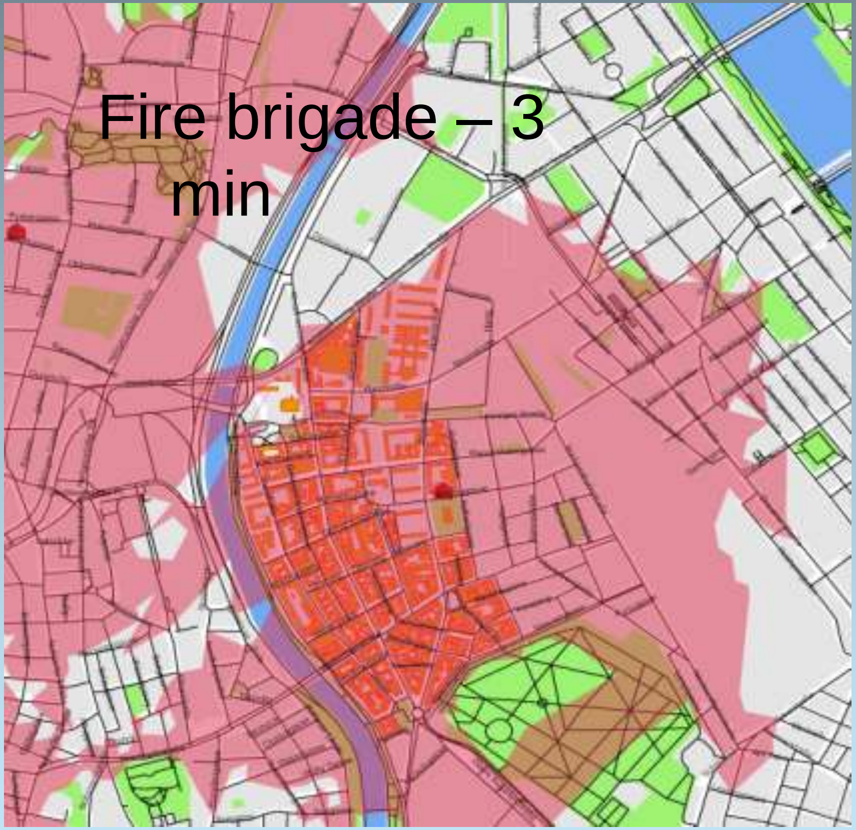
Roads susceptible to flooding



Calculation of the Distance to the next Hospital (Preliminary result)

Location study: accessibility for ambulance, fire brigade, police etc.





Pietsch, 2010

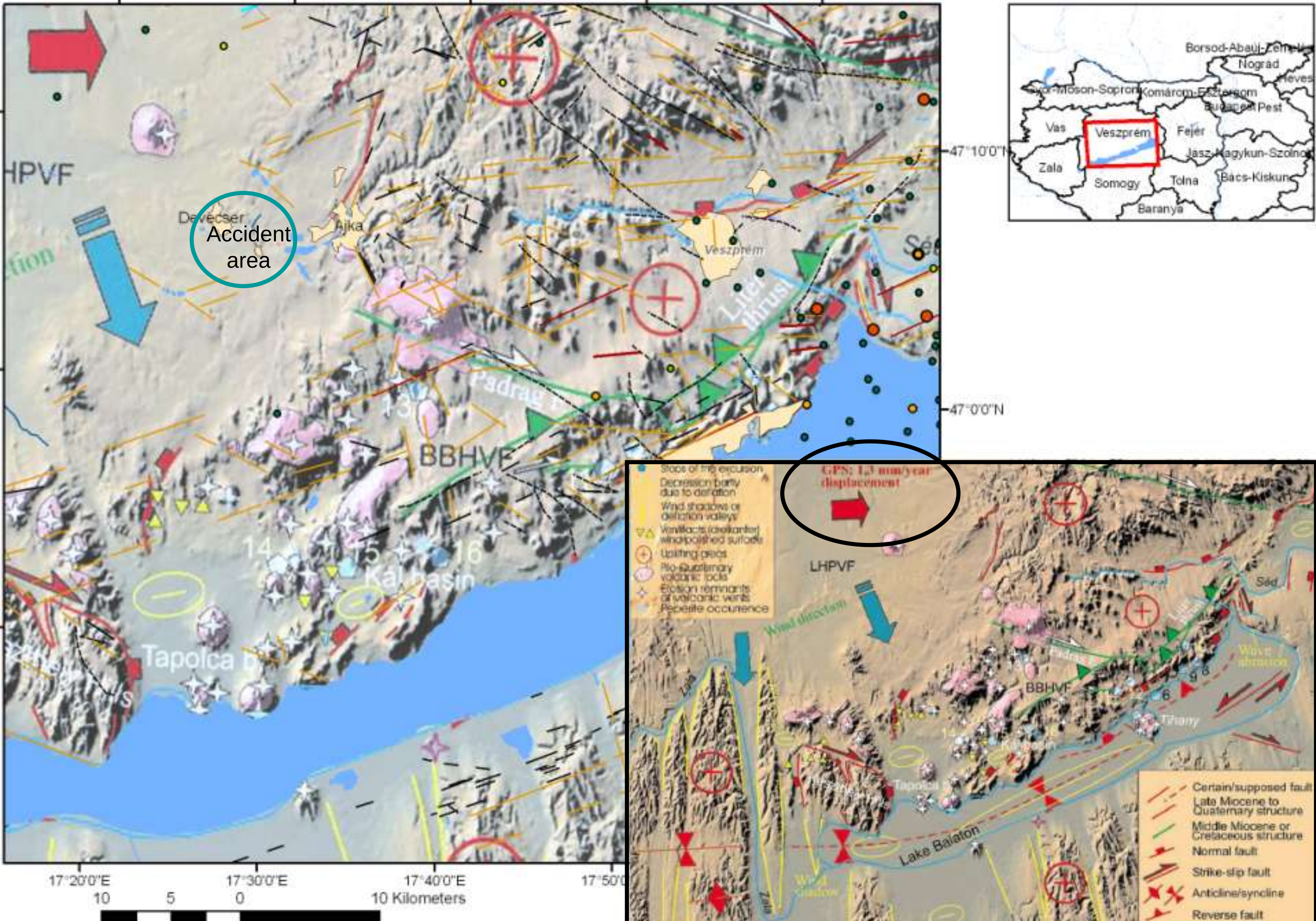
Service area analyses of hospitals and fire stations identifies routes that provide the quickest response.

http://en.wikipedia.org/wiki/File:Ajkai_v%C3%B6r%C3%B6siszap-katasztr%C3%B3fa_v%C3%A1zlat_2010-10-04.svg

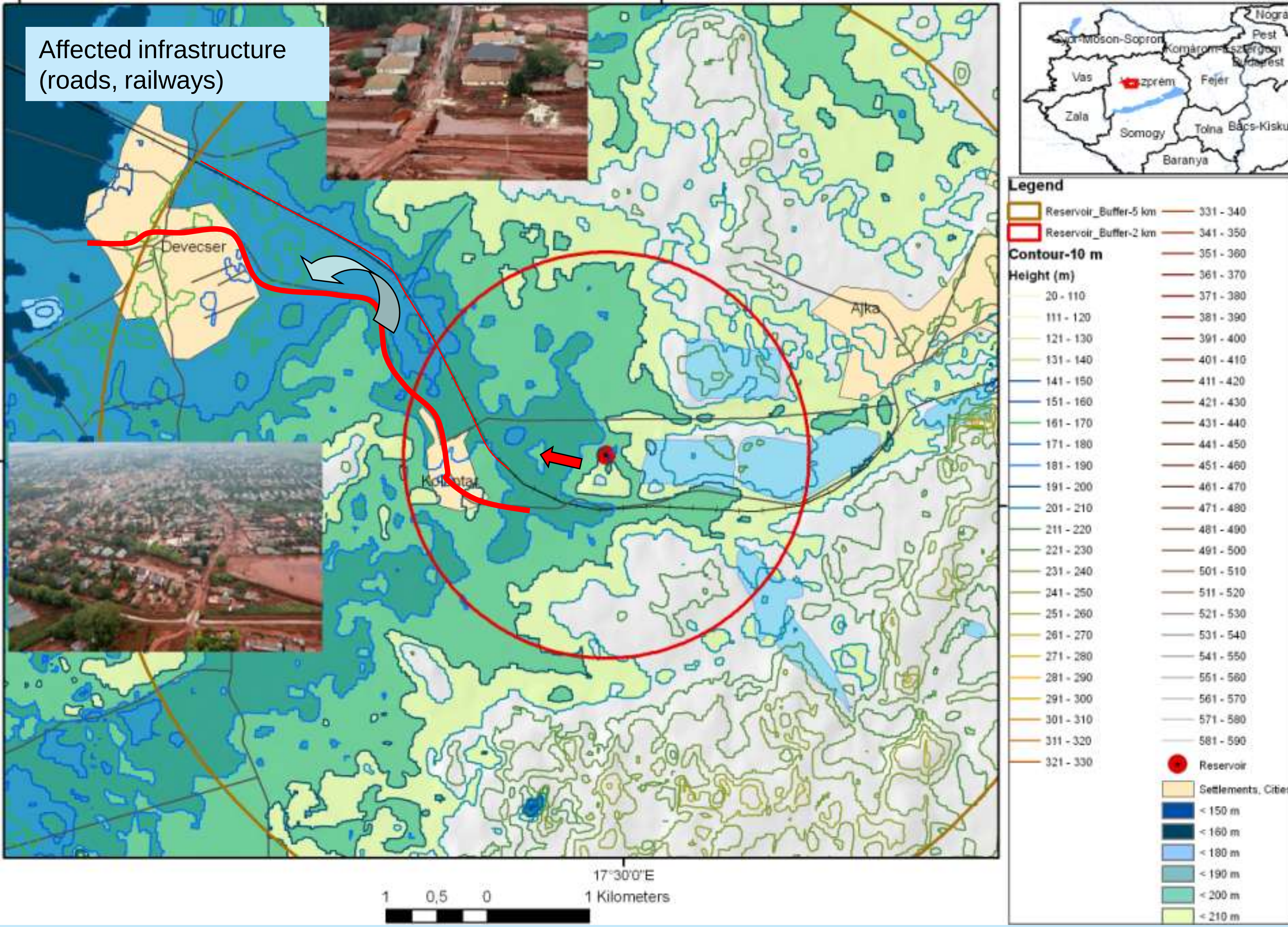
Pollution

The **Ajka alumina sludge spill** is an industrial accident in western Hungary. On 4 October 2010, at 12:25 CEST (10:25 UTC), the dam wall collapsed freeing about a million cubic metres (35 million cubic feet) of liquid waste "red mud“ from the Ajkai Timföldgyár alum earth plant in Ajka, Veszprém County. A >2m wave was released, flooding several nearby localities, especially the village of Kolontár and the town of Devecser.

http://projectworldawareness.com/2010/10/sludge-spill-in-hungary-flows-toward-danube-river-environmental-alert/

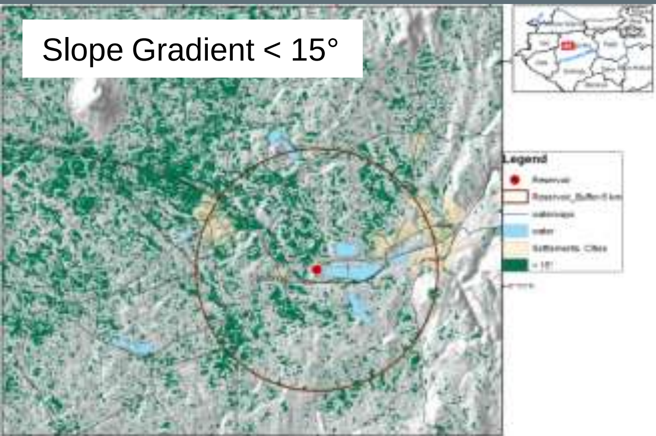


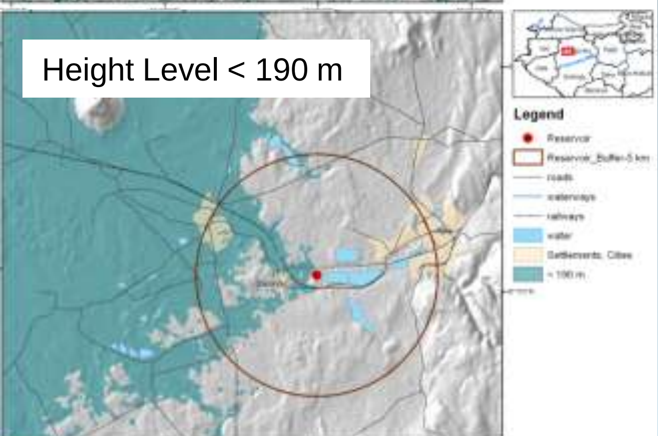
Horizontal and vertical movements influencing dam wall stability ?

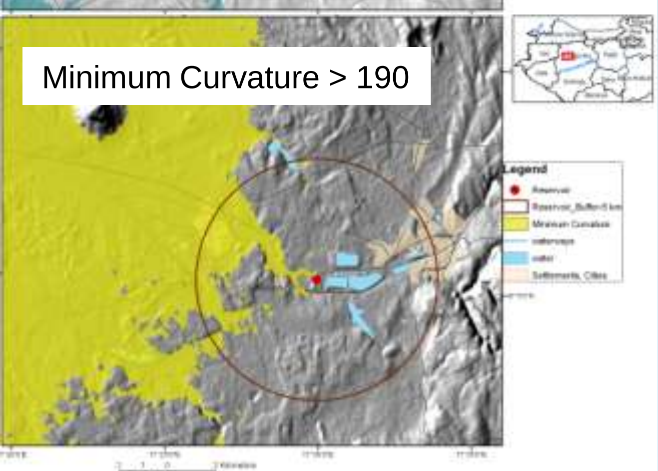


Height levels influencing flow direction of the alumina sludge spill

Summarizing the factors:







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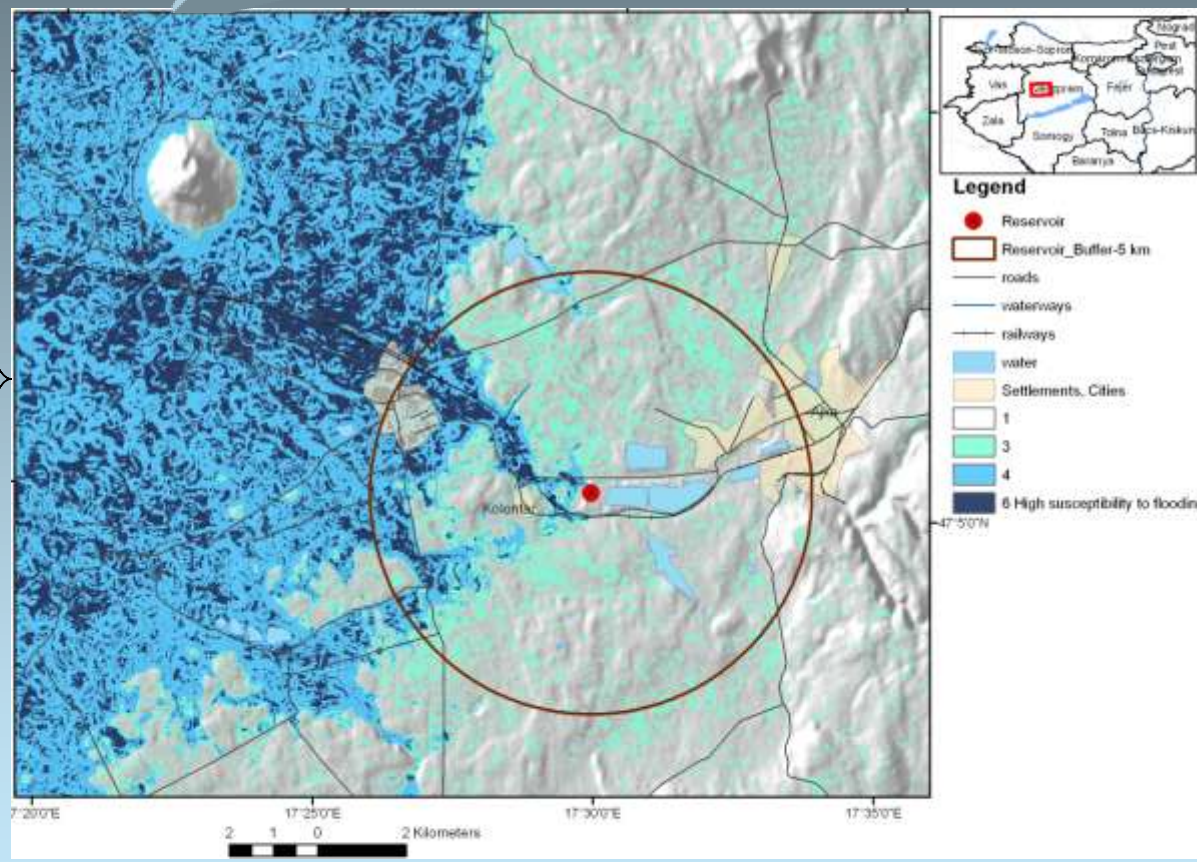
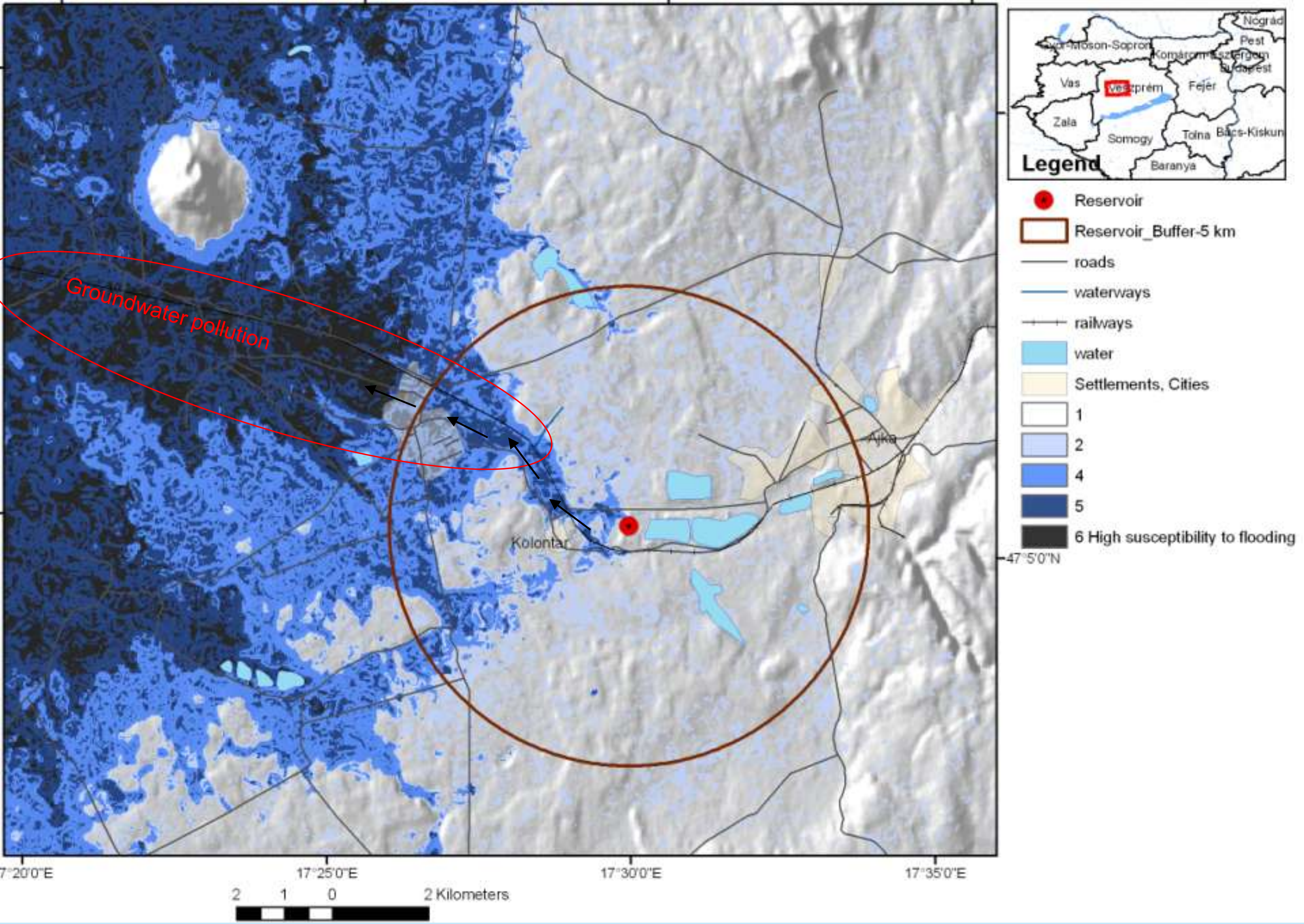
Susceptibility to Flooding using the Weighted Overlay Approach in ArcGIS





Susceptibility to Flooding using the Weighted Overlay Approach in ArcGIS

Conclusions

- There is a strong need to improve the systematic, standardized inventory of areas that are more susceptible to earthquake ground motions or to earthquake related secondary effects such as landslides, liquefaction, soil amplifications, or compaction.

- The evaluation of satellite imageries, digital topographic data and of open-source geodata can contribute to the acquisition of the specific tectonic, geomorphologic / topographic settings influencing local site conditions in Hungary and, thus, to a first data base stock.

- Remote sensing and GIS form an essential tool for getting actual information of an area as base for emergency planning.

Thank you for your attention