Eötvös Lóránd Kollégium, Szeged, 13 November 2013, 16.00

Application of remote sensing in inland excess water research

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Szegedi Tudományegyetem

Természeti Földrajzi és Geoinformatikai tanszék

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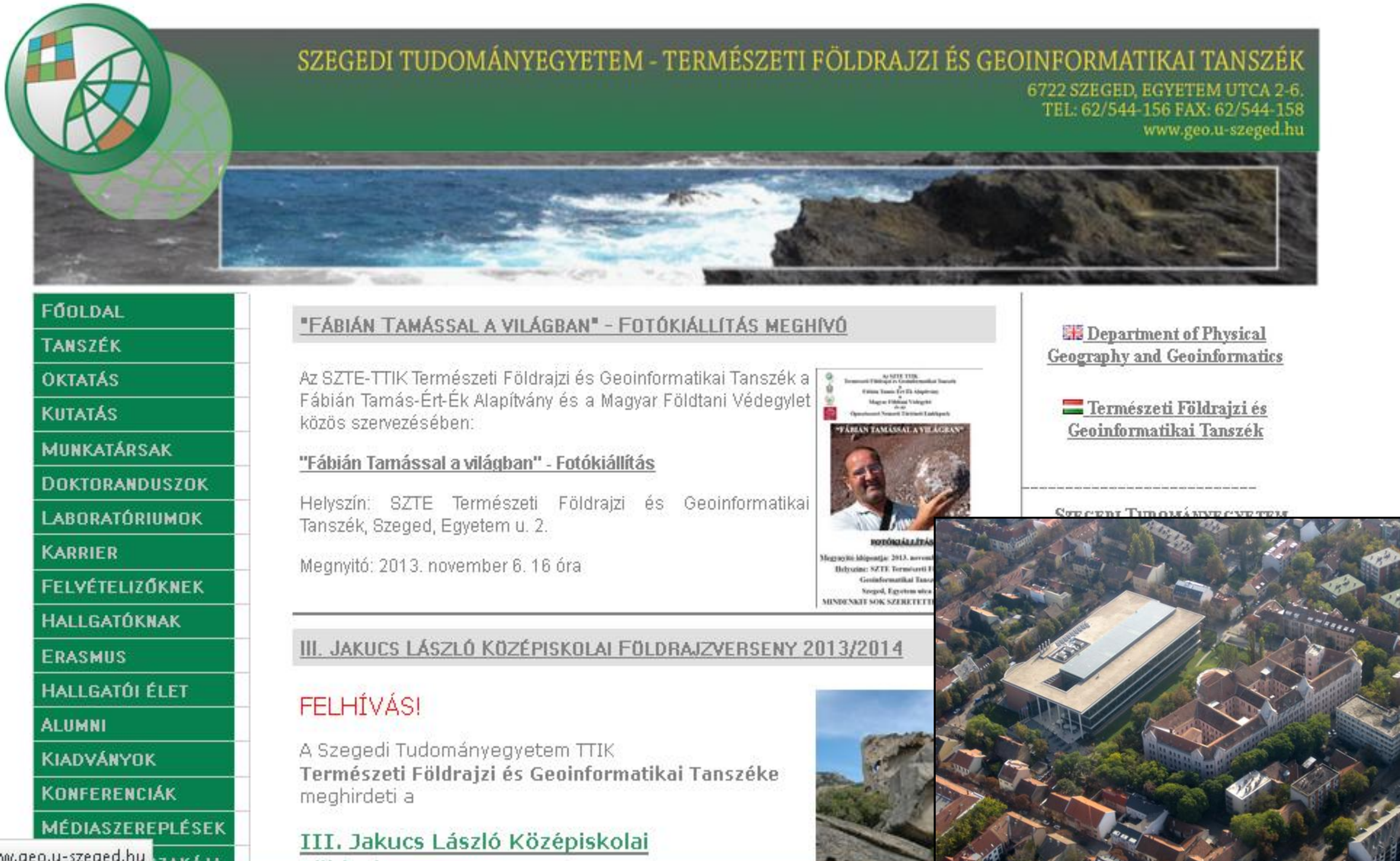


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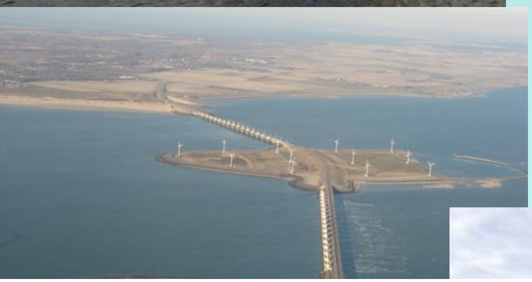
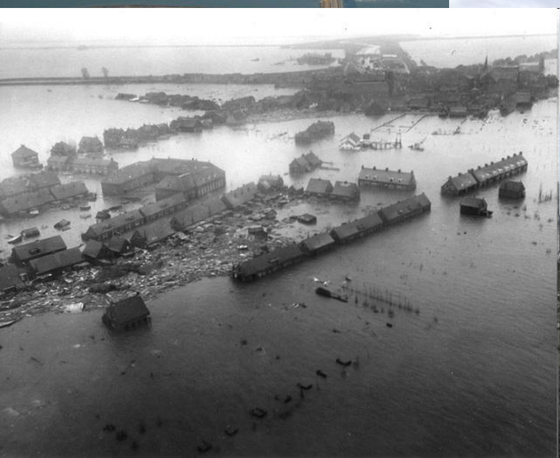
GERMANY





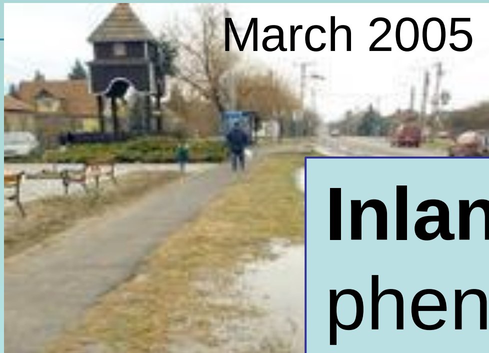


Contents

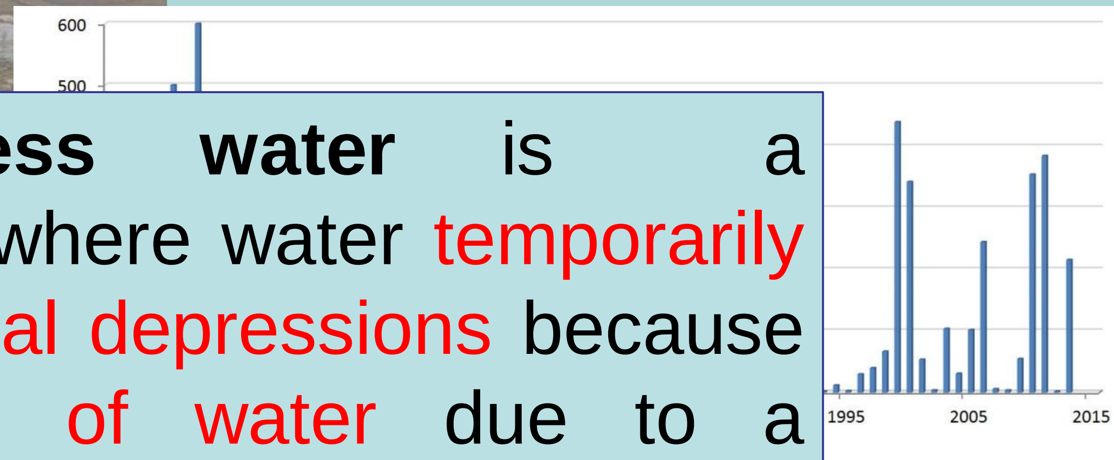
- Introduction
- Inland excess water – theoretical background
- Mapping of inland excess water
- Artificial neural networks method
- Results

Inland access water (belvíz) problem



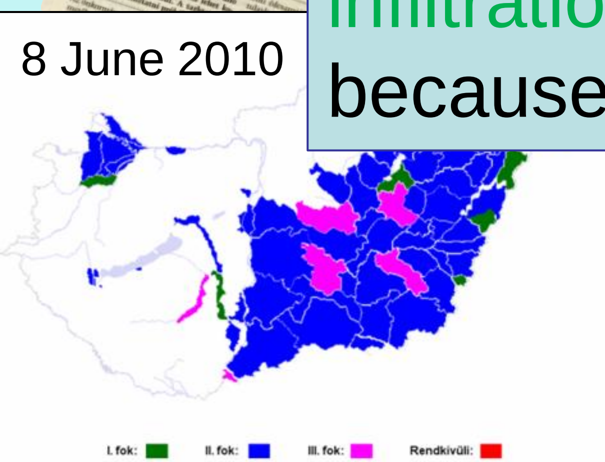
March 2005

March 2006

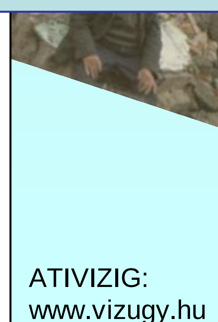


Inland excess water is a phenomenon where water temporarily remains in local depressions because of a surplus of water due to a combination of lack of runoff, insufficient evaporation and low infiltration capacity of the soil or because of upwelling of groundwater.

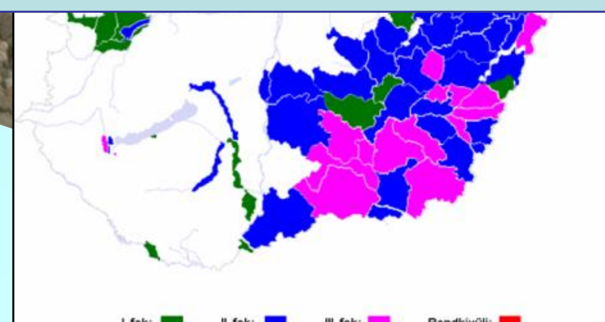
ebruary 2010



8 June 2010



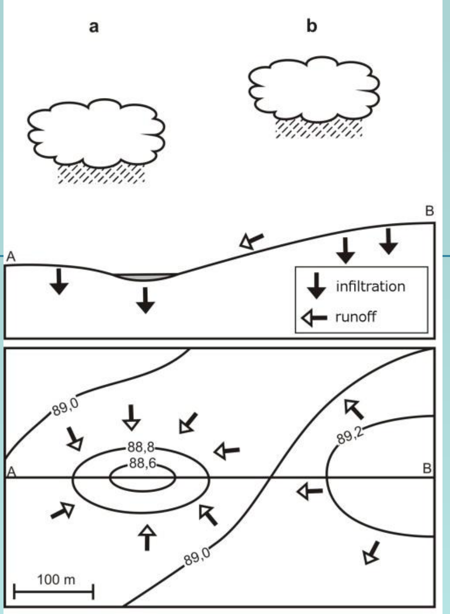
ATIVIZIG: www.vizugy.hu

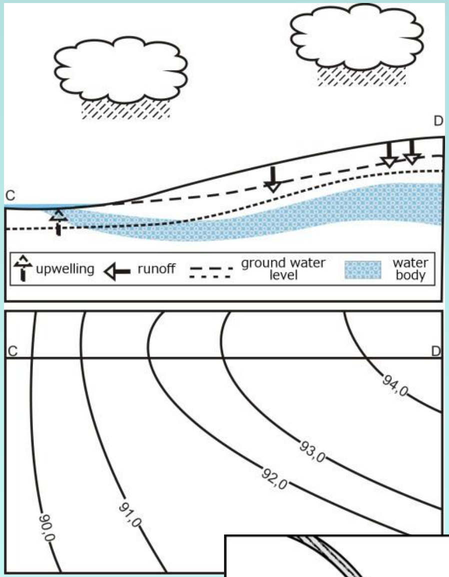


March 2011

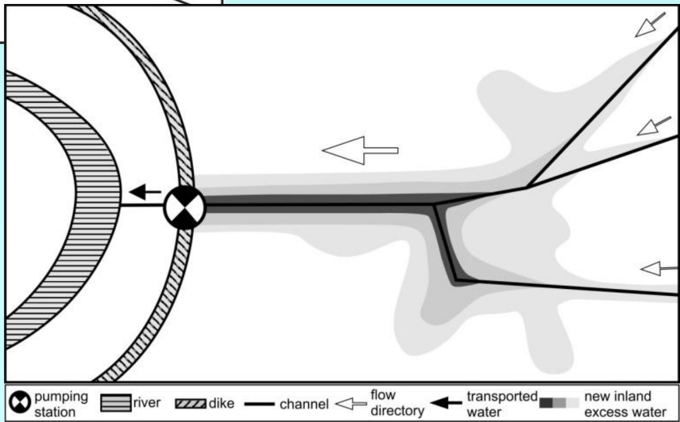
Types of inland excess water

- Horizontal – accumulative
  - On the surface
  - Source is precipitation
  - Closed depressions
- Vertical – upwelling
  - Edge of alluvial fans
  - Source is (high) ground water level
- Queuing up
  - In front of pumping stations
  - Along channels
  - Due to insufficient pumping capacity





Rakonczai et al. 2011



Factors involved in inland excess water

Inland excess water = f(M,R,S,Gr,L,Ge,A,…)

- Meteorology
- Relief
- Soil
- Groundwater
- Landuse
- Geology
- Antropogenic factors
- ….

Spatially varying

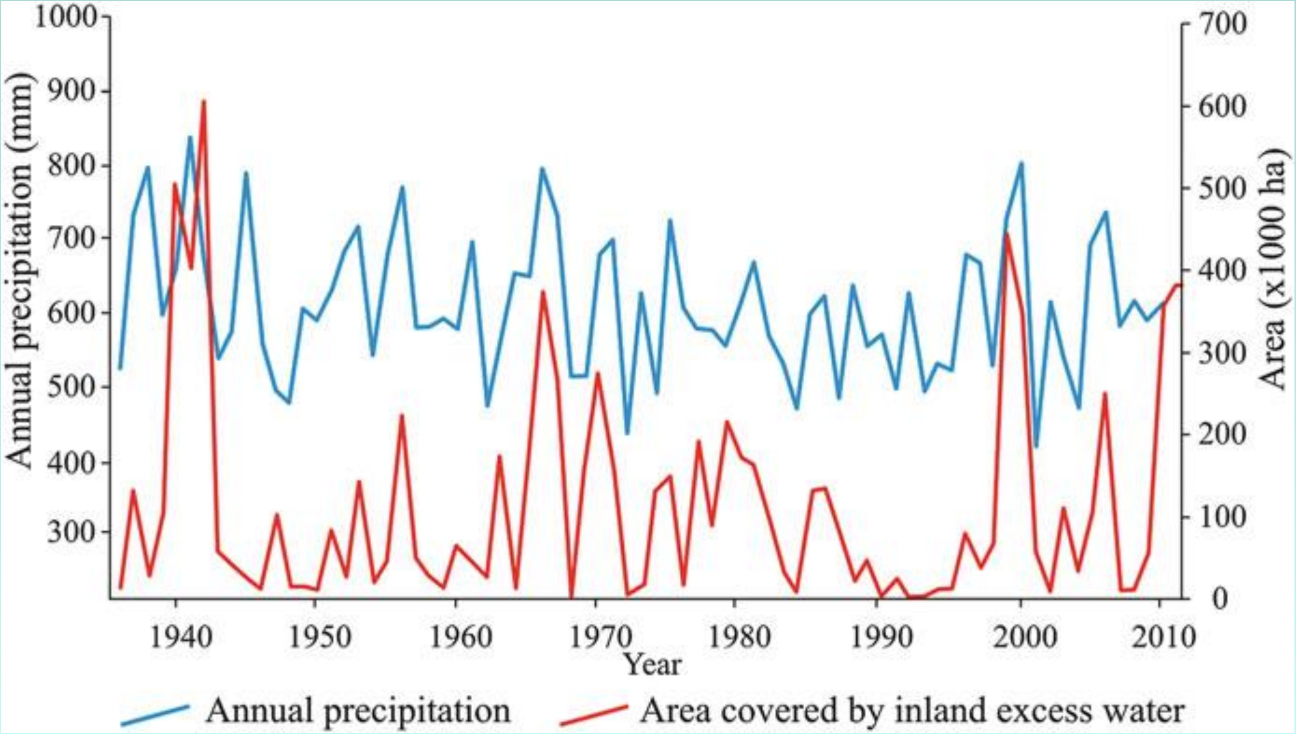
temporal variation

natural

Interrelated

Antropogenic

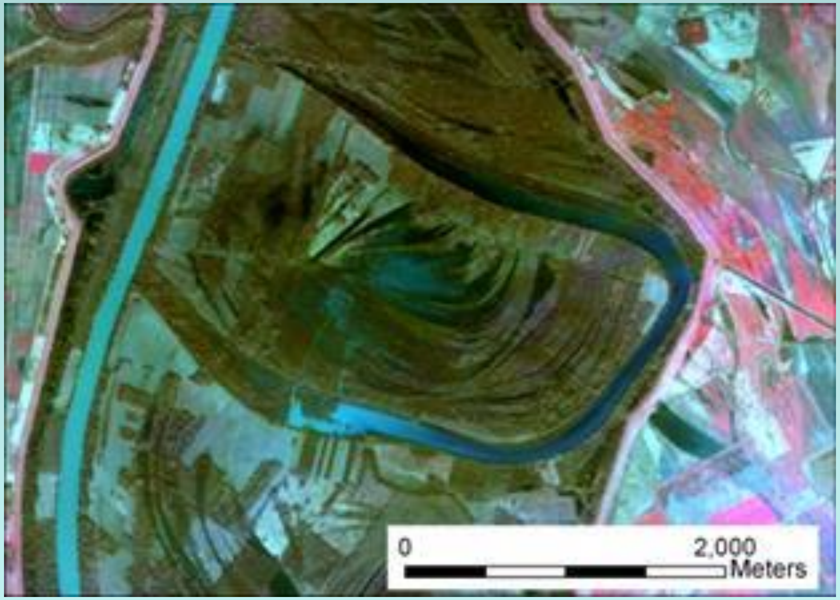
Meteorology



Source:
Pálfai 2011,
OMSz 2005, 2012

- Precipitation
- (Evapo-)transpiration
- Air temperature, wind speed

Relief and geomorphology

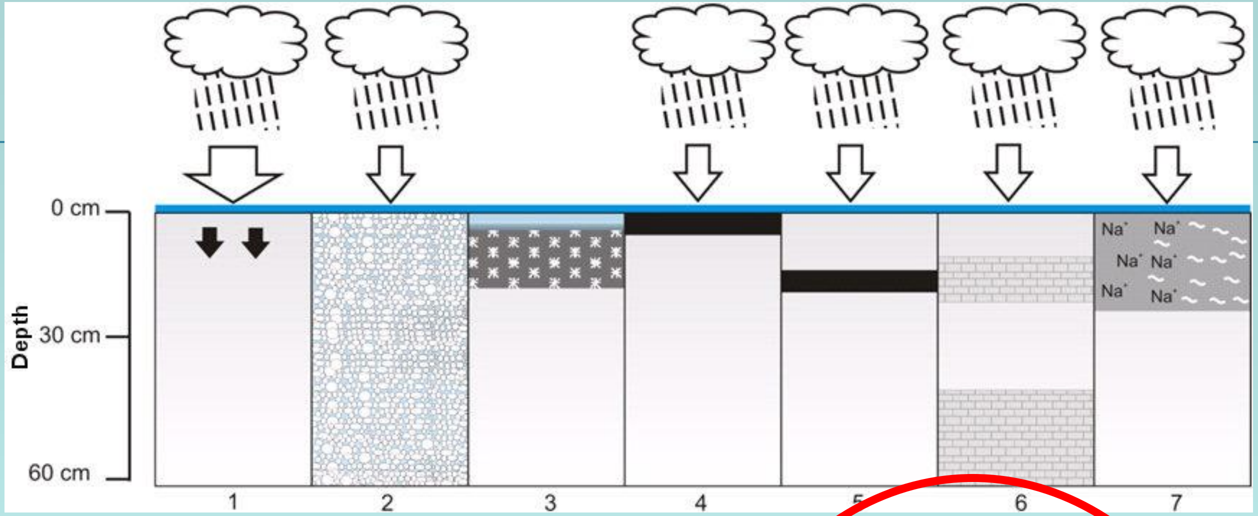


RapidEye FCC, 2011

- Very small relief difference
- Local depressions
- Former river arms

Rakonczai et al. 2011

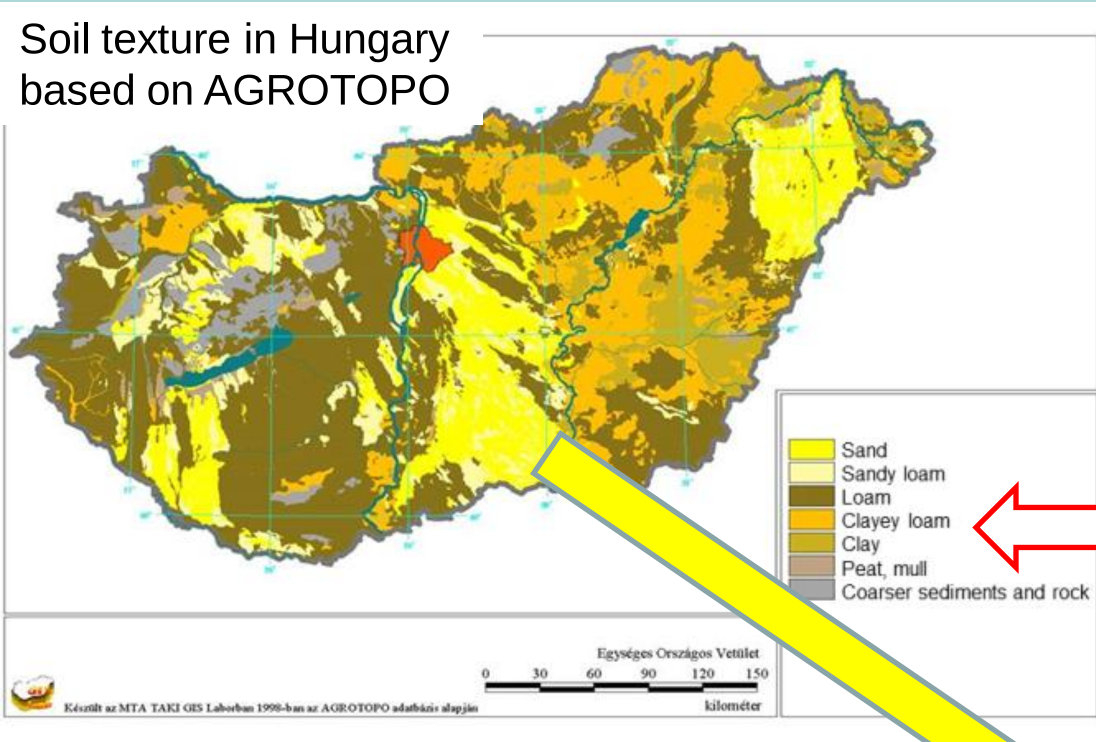
Soil



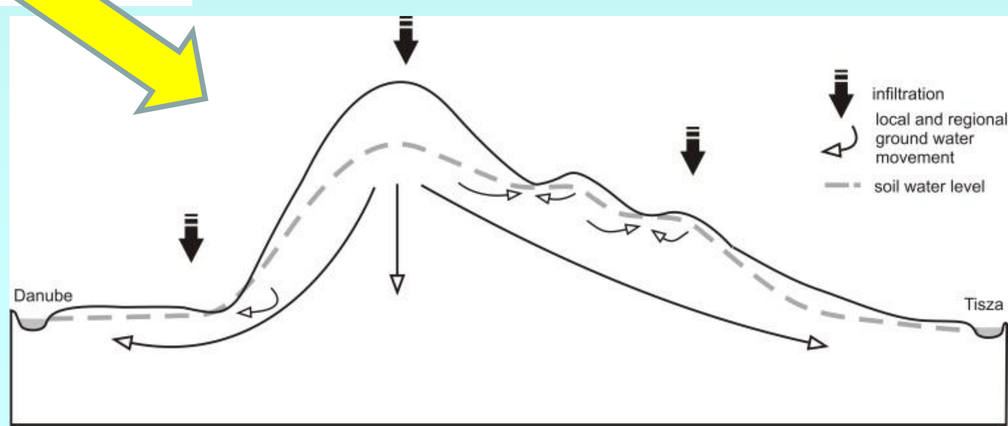
Influencing factor	Vulnerability to inland excess water category				
	Not Vulnerable	Moderate	Medium	Vulnerable	Highly
Infiltration capacity (m/day)	> 0,15	0,1–0,15	0,05–0,1	0,01–0,05	< 0,01
Maximum water capacity (mm)	400–500	350–400	300–350	250–300	150–250
Convexity	< 0	0–0,1	0,1–0,2	0,2–0,3	> 0,3
Size of the micro catchments (ha)	< 1	1–5	5–10	10–50	> 50
Land use	Forest	Garden, orchard	Plow land	Plow land (permanent)	Meadow

Lithology and groundwater

Soil texture in Hungary based on AGROTOPO

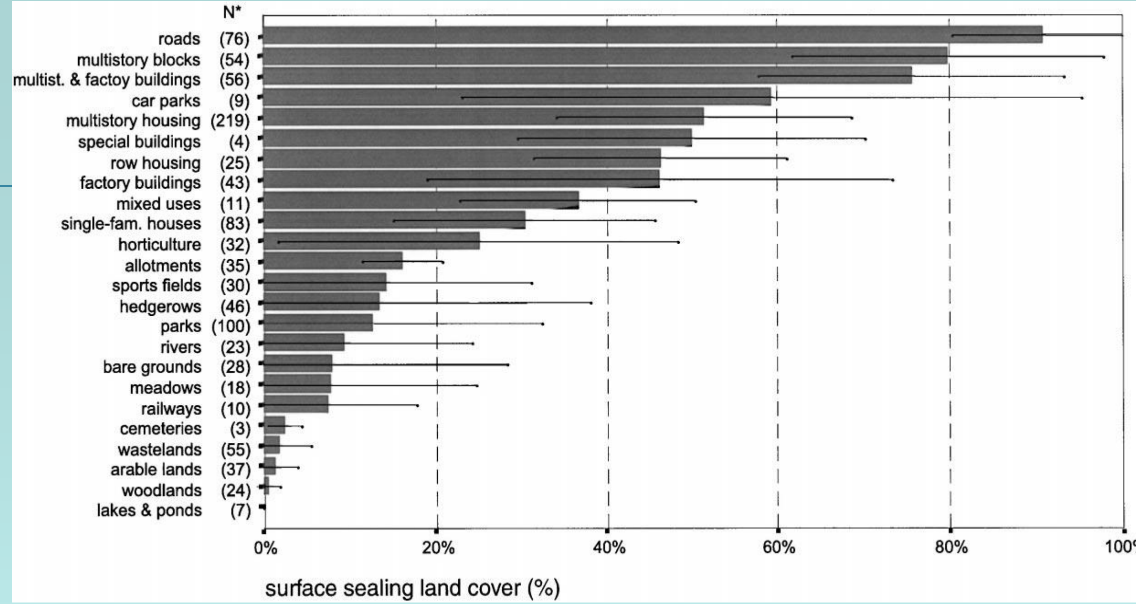


The hydrogeological situation on the Danube-Tisza Interfluve (Ladányi 2010



Landuse

- Build up type
- Infiltration
- Run off



Other antropogenic factors



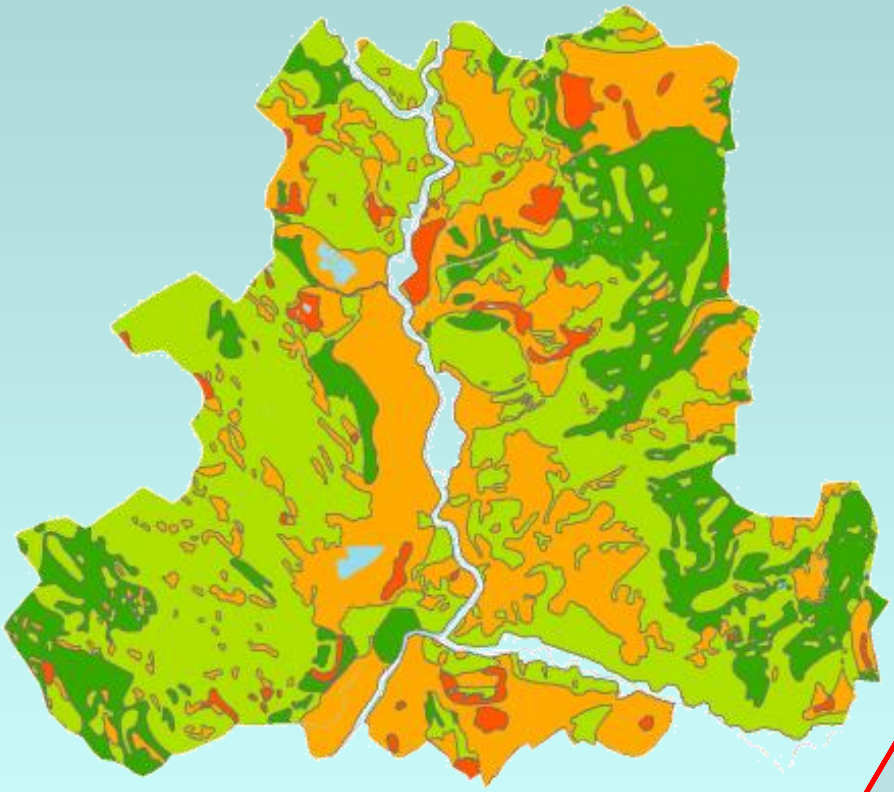

- Channels
- Pumping stations
- Levees
- Roads, rail roads

Possibilities for reduction and mitigation

The key questions:

- **to *locate* inland excess water**
- to understand the *formation* of the inundations
- to find the possibilities for *intervention*

Methods: 1. Vulnerability mapping

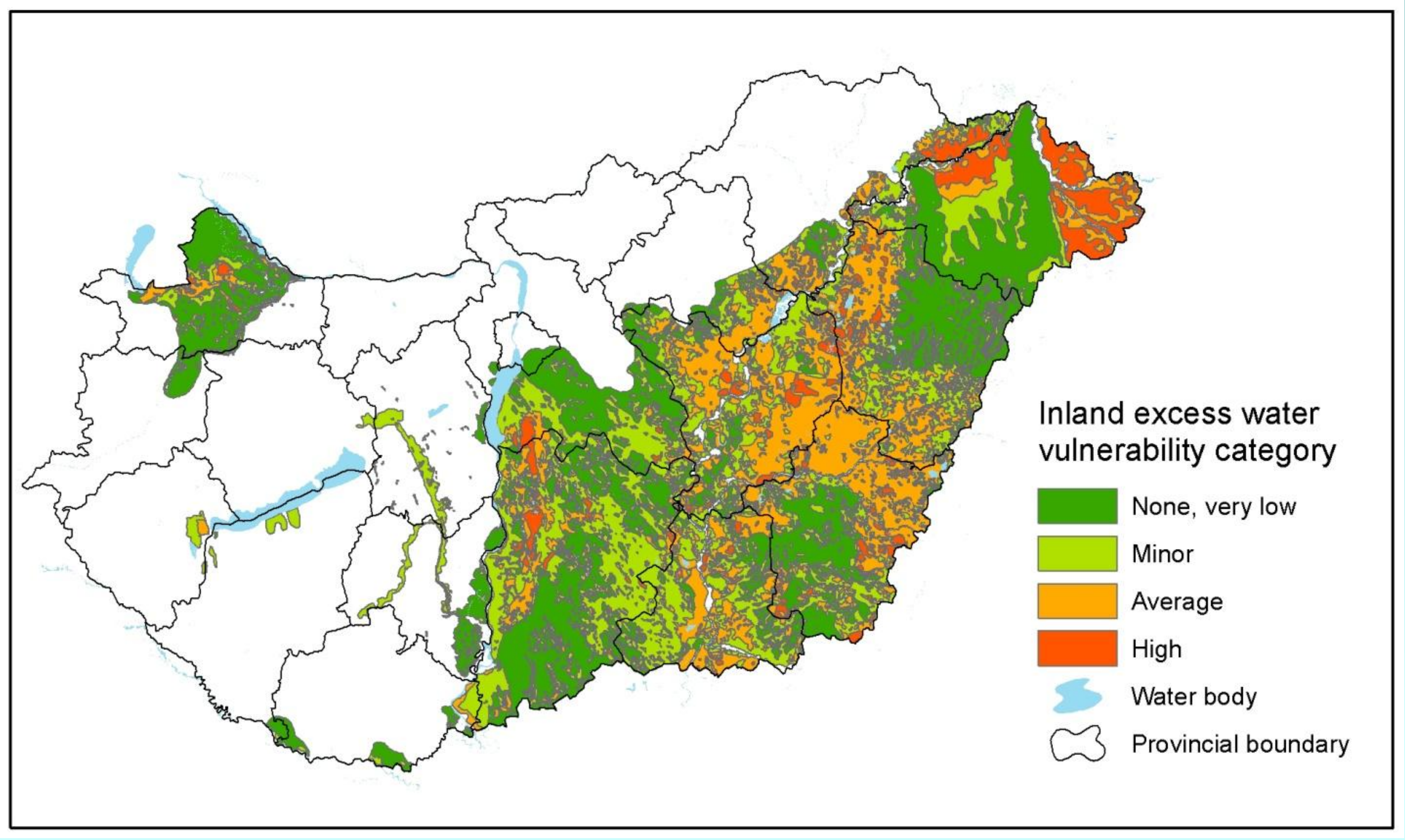


Linear statistical methods

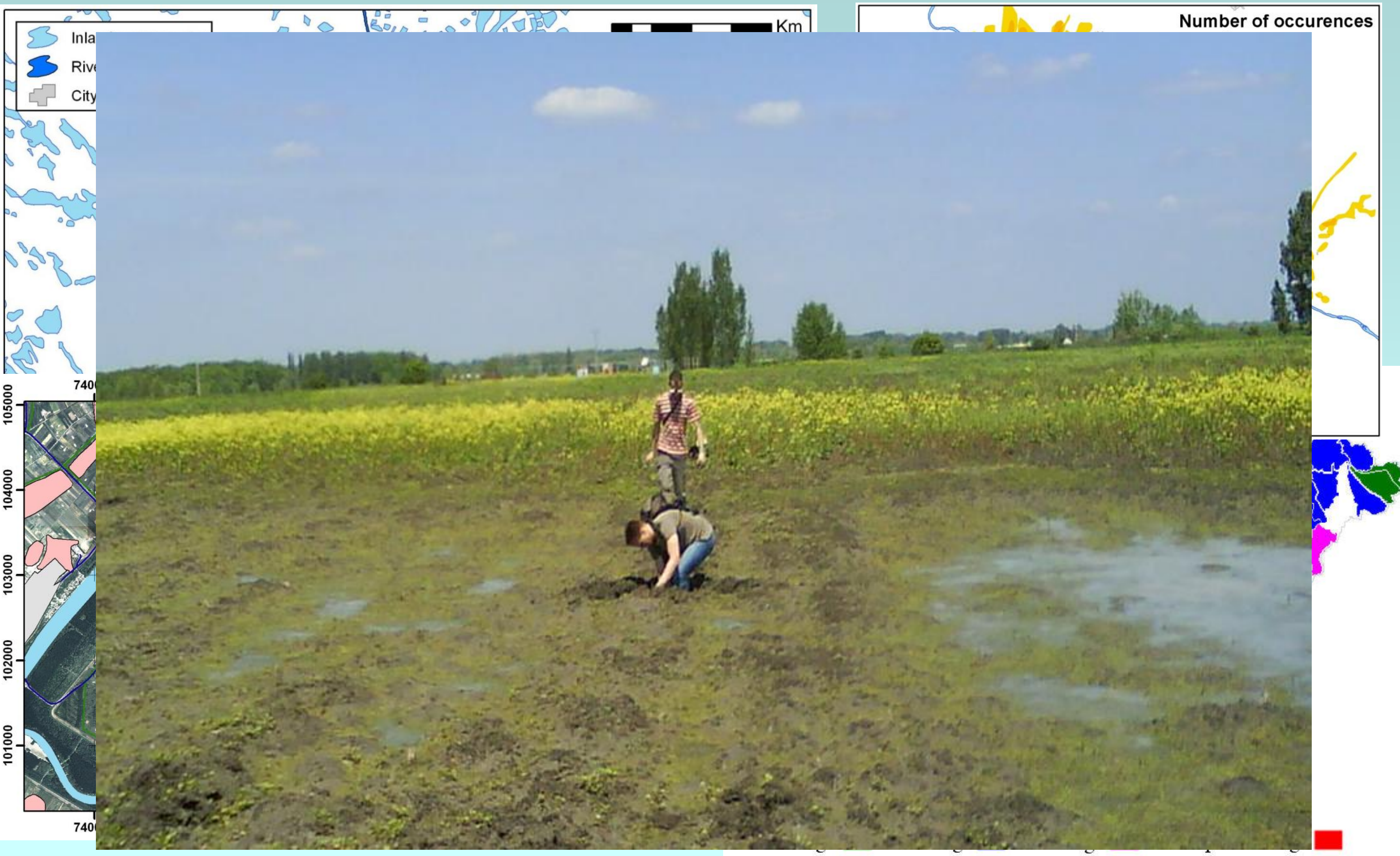
Weights need to be determined

Vulnerability index = $w_1 * T_1 + w_2 * T_2 + \ldots + w_n * T_n$	w_i = weight T_i = factor

Pálfai map 1:500 000

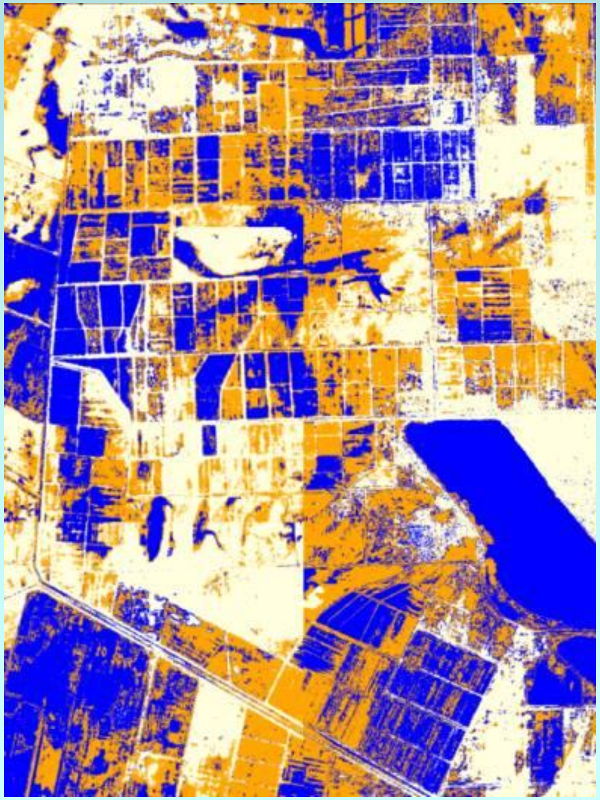


Methods: 2. *In situ* mapping -Field measurements



Methods: 2. RS based mapping

- Classification based on reflectance data of satellite images or digital aerial photographs



Rakonczai et al. 2001

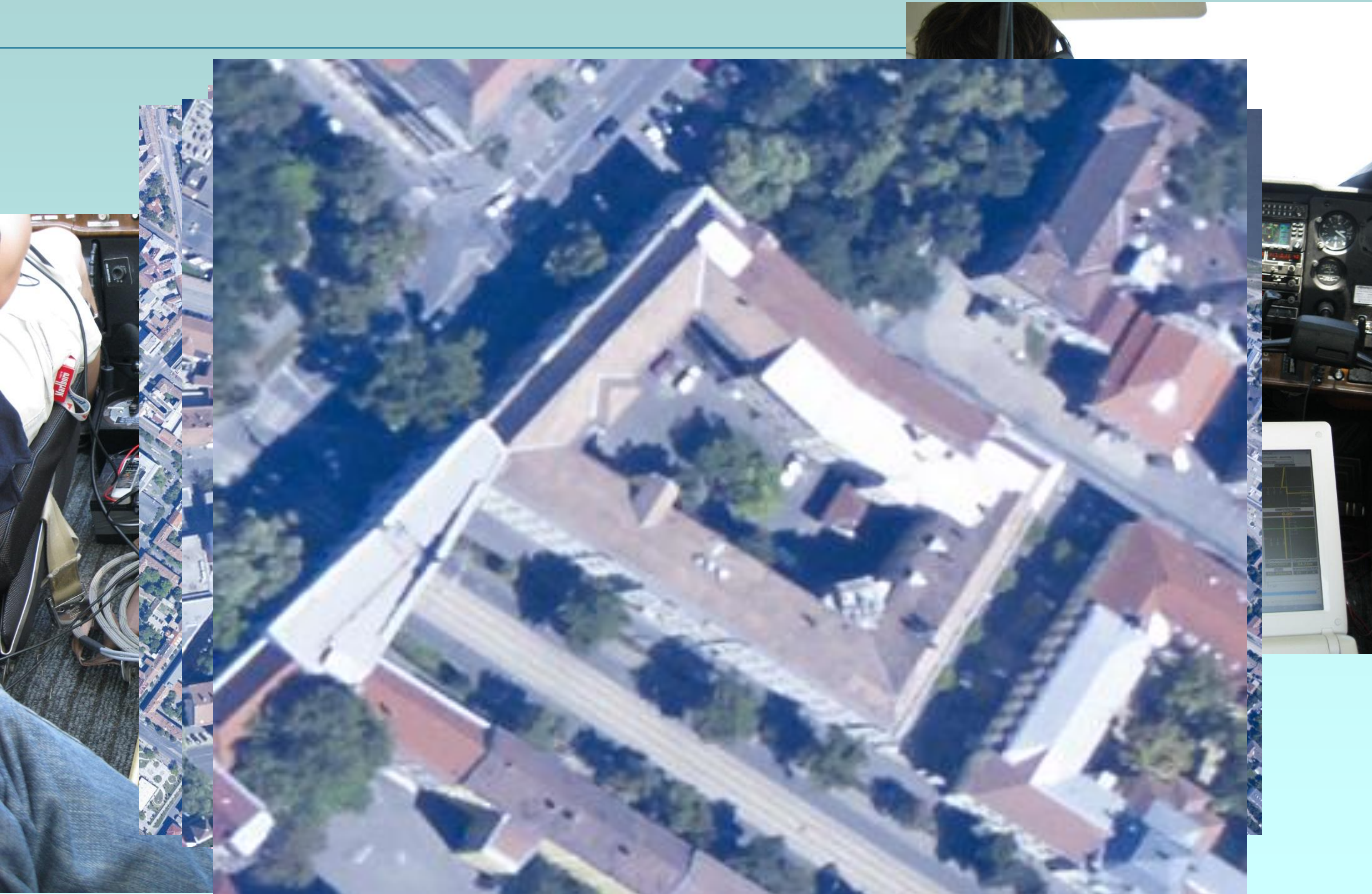
Generation of RS based inland excess water maps

www.rapideye.com

- Remote sensing data acquisition

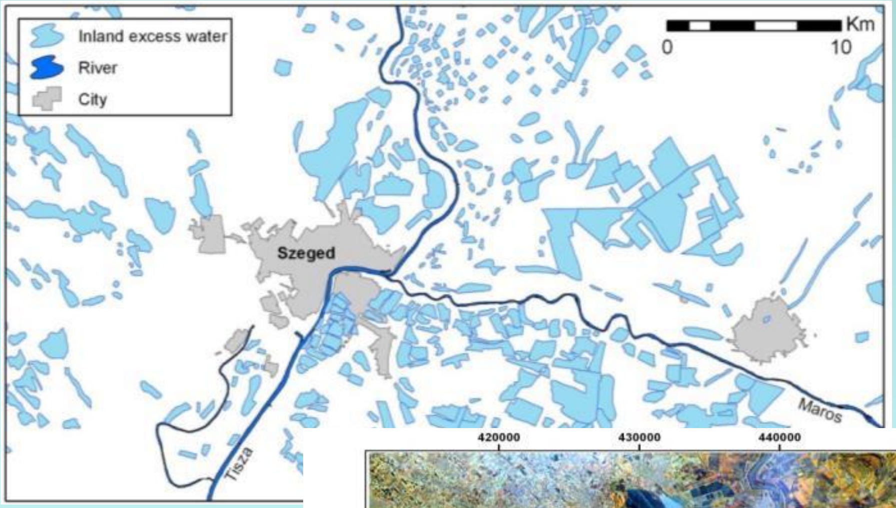
- Geoinformatics processing techniques
  - Index based
  - Classification based
  - Segmentation

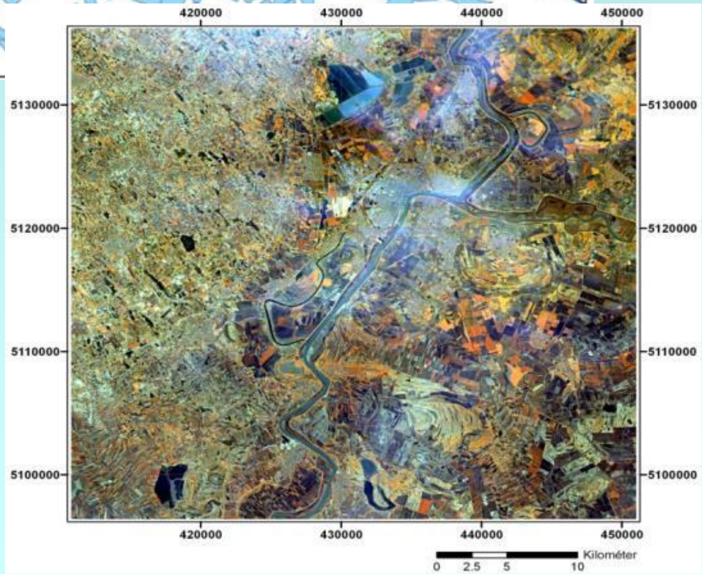
TFGT Data collection system



Inland excess water mapping

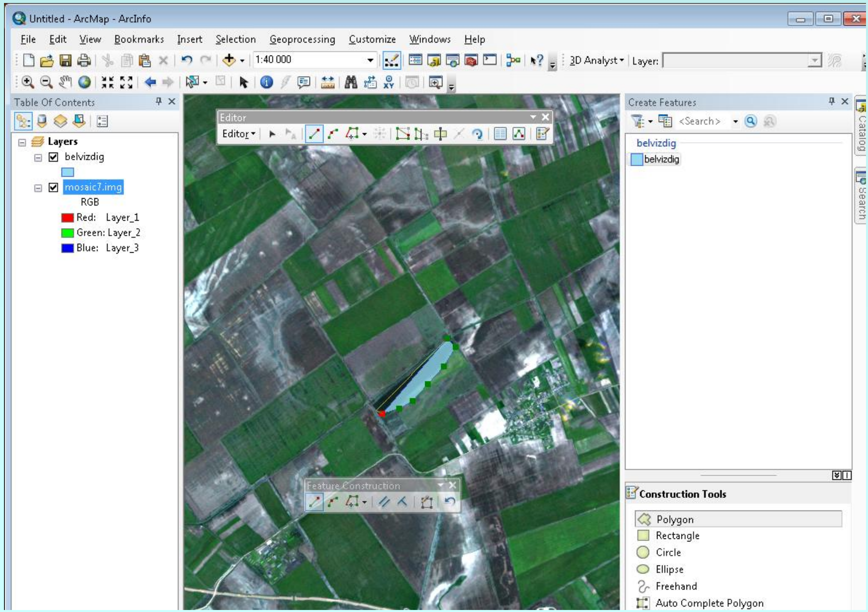
- Field observations
  - Financial constrains
  - Time consuming
  - Error prone
- Aerial photography
  - Financial constrains
  - Time consuming
- Satellite imagery
  - Spatial resolution
  - Temporal resolution
  - Coverage



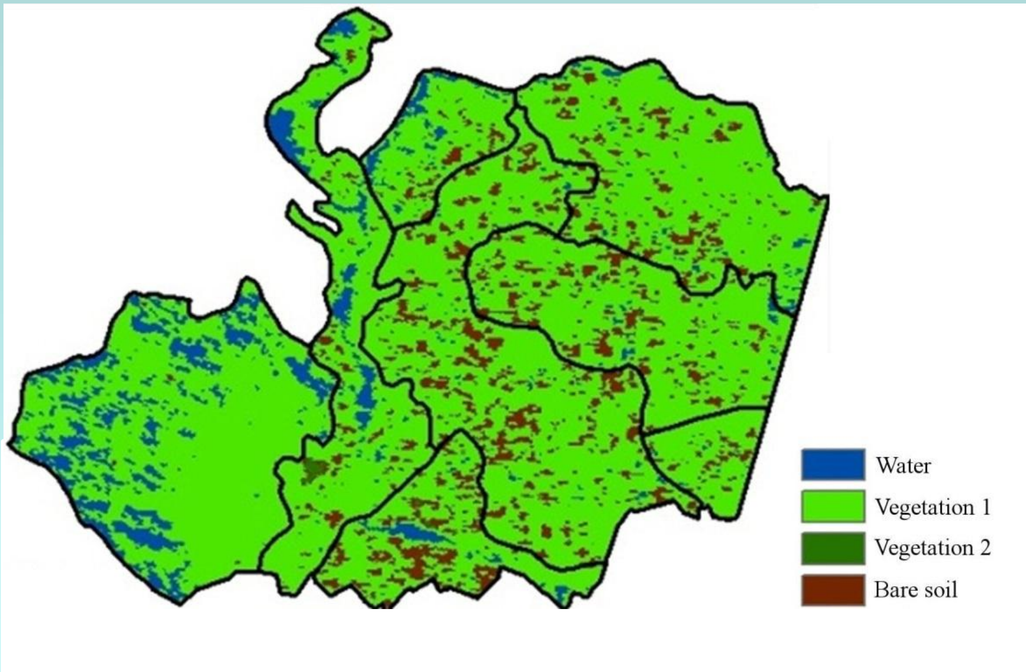


Processing of RS data

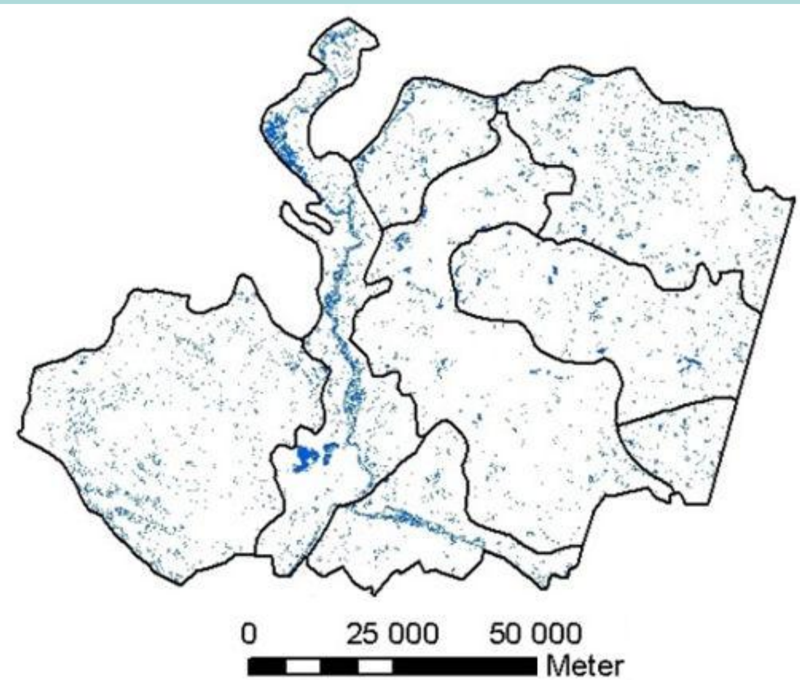
- Visual interpretation
- Indexing
- Classification
- Modelling



Index based water detection



Reclassified NDVI values derived from a MODIS satellite image (Baksa 2012).



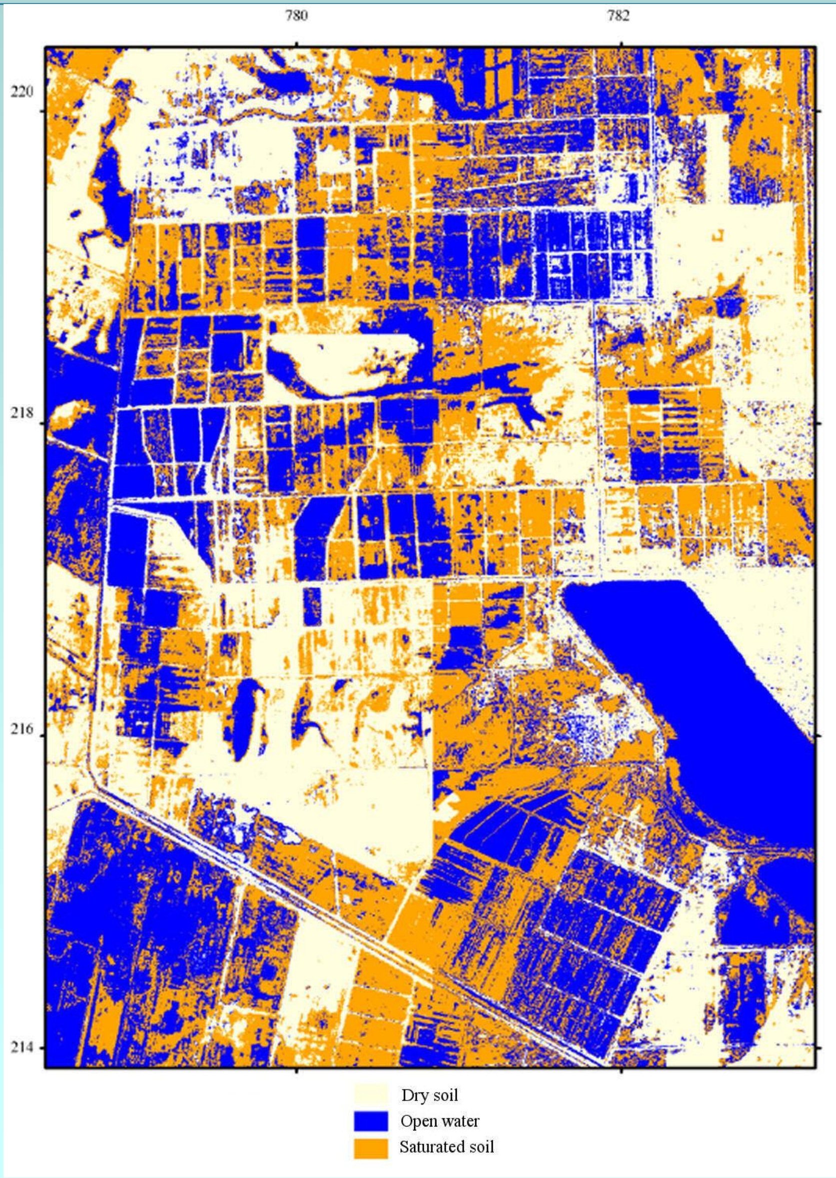
Wetness band of a Tasseled cap transformed LANDSAT image (Baksa 2012).

Traditional classifications

- Multispectral satellite data

- ISODATA
- Box classifier
- Minimum distance
- Maximum likelihood

Landsat
3 classes



Artificial neural networks (ANN)

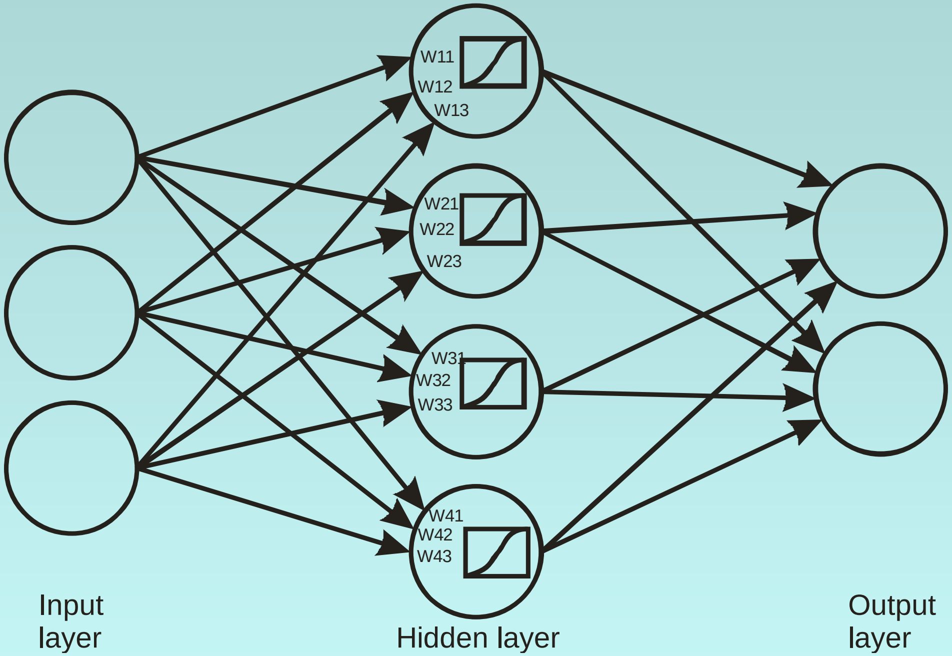
→ Training

→ Weights

→ Activation

→ Simulation

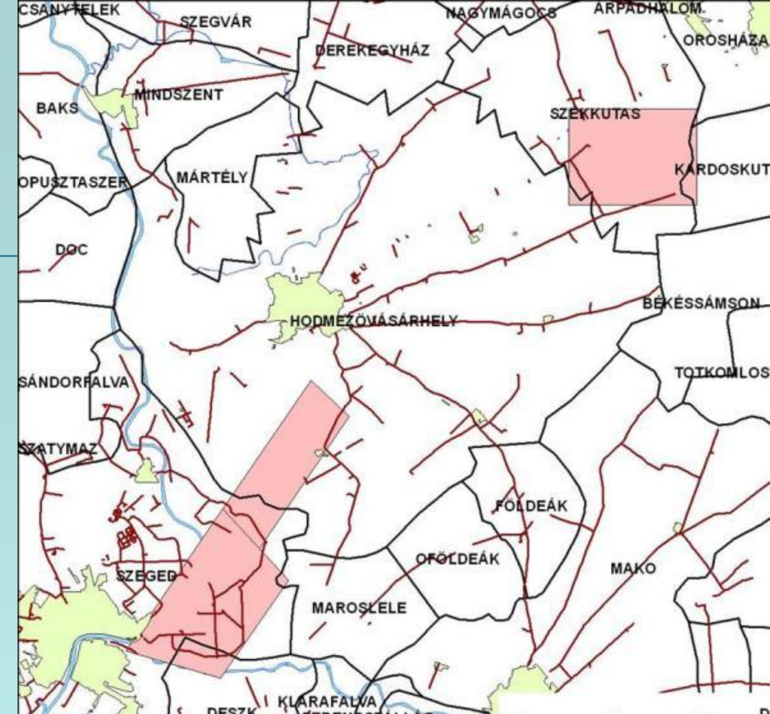
- *Advantages*
  - Robust
  - Non linear system
  - Huge data amounts
- *Disadvantages*
  - Difficult to understand what exactly happens
  - Calculation intensive



Determination of the weights is an integral part of the training

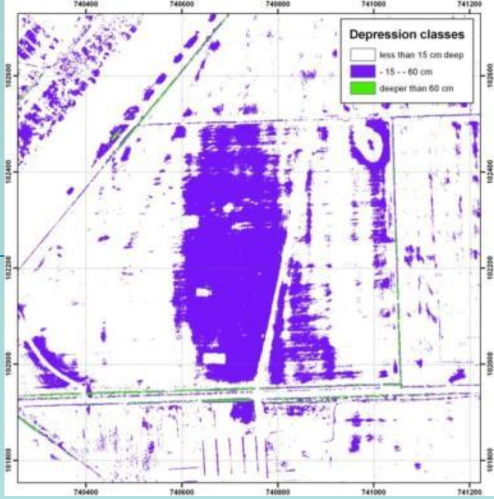
Study area

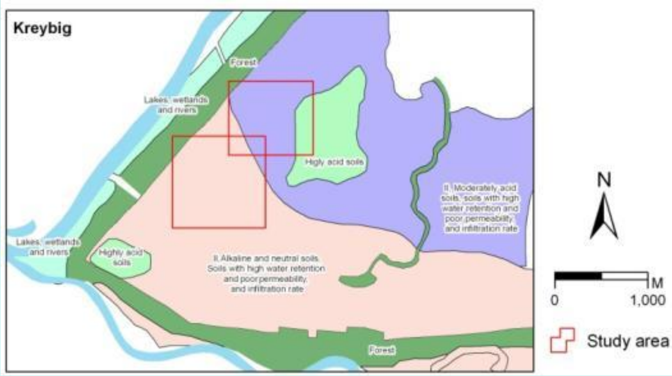
- Inland excess water occurrences
- Earlier scientific research TFGT
- Close to the local airport

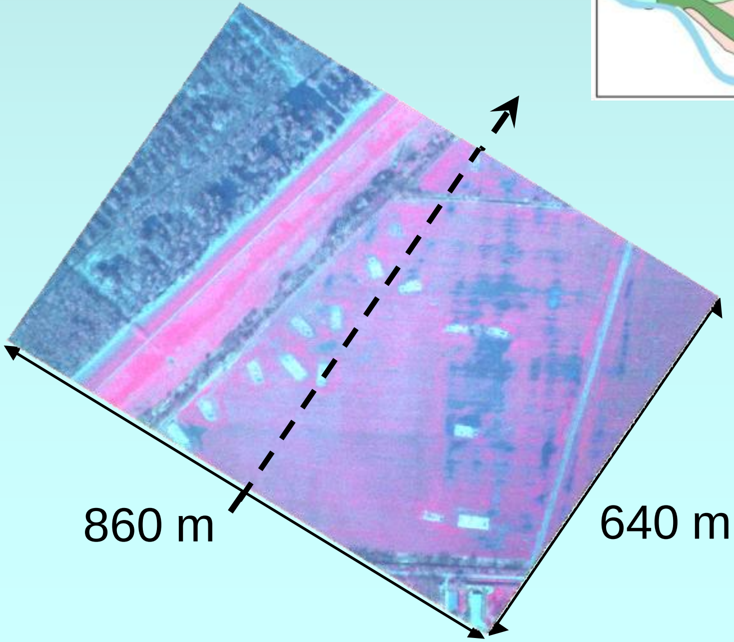


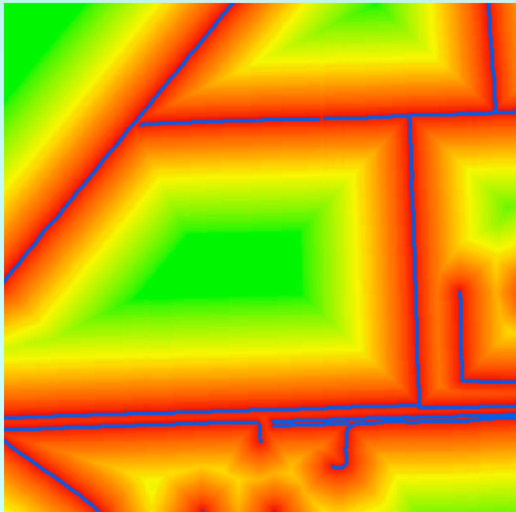
Data

- Local depressions derived from LIDAR DEM
- Color InfraRed digital aerial photographs
- Anthropogenic objects
- Soil map
- Fieldwork

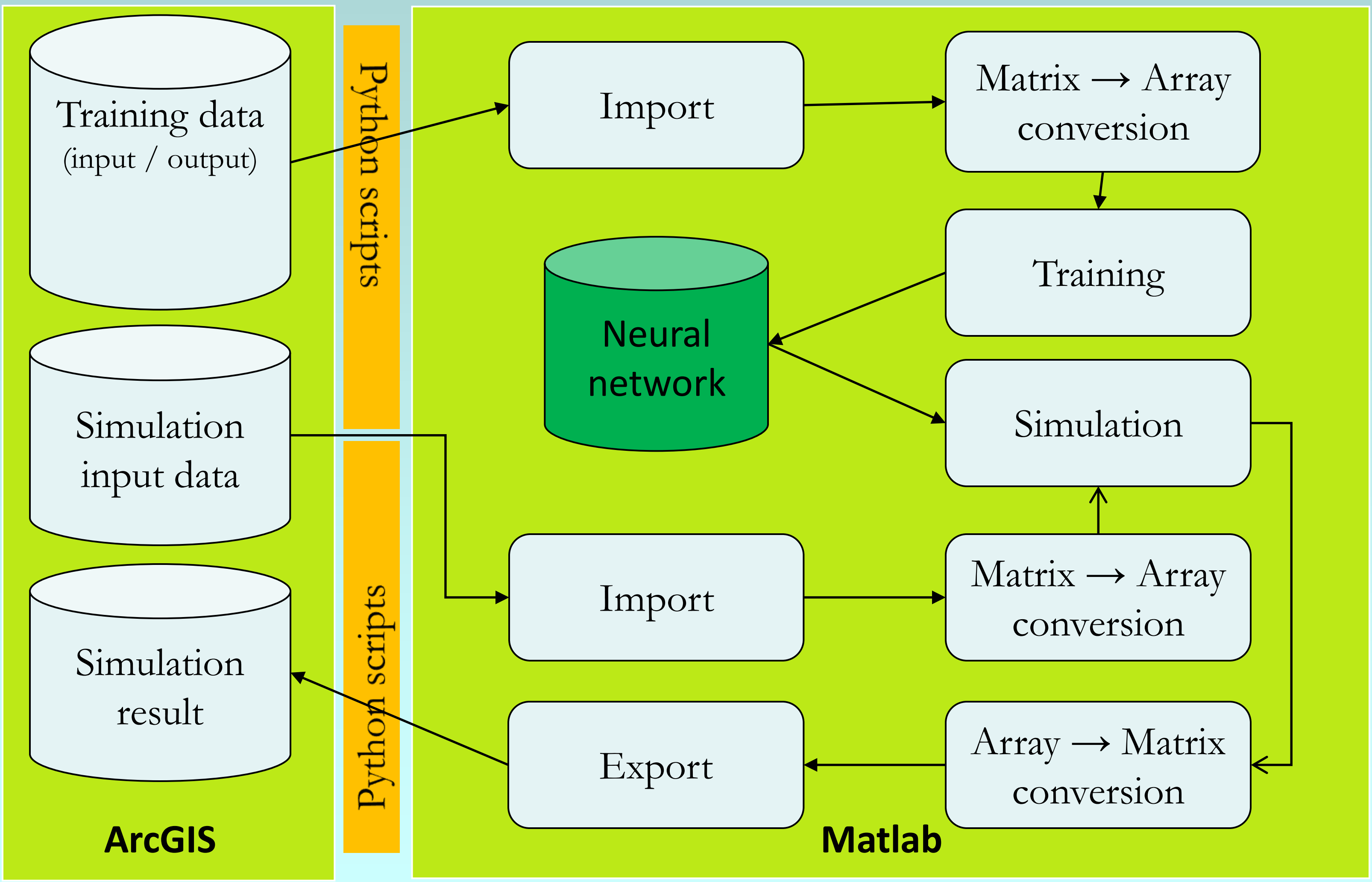




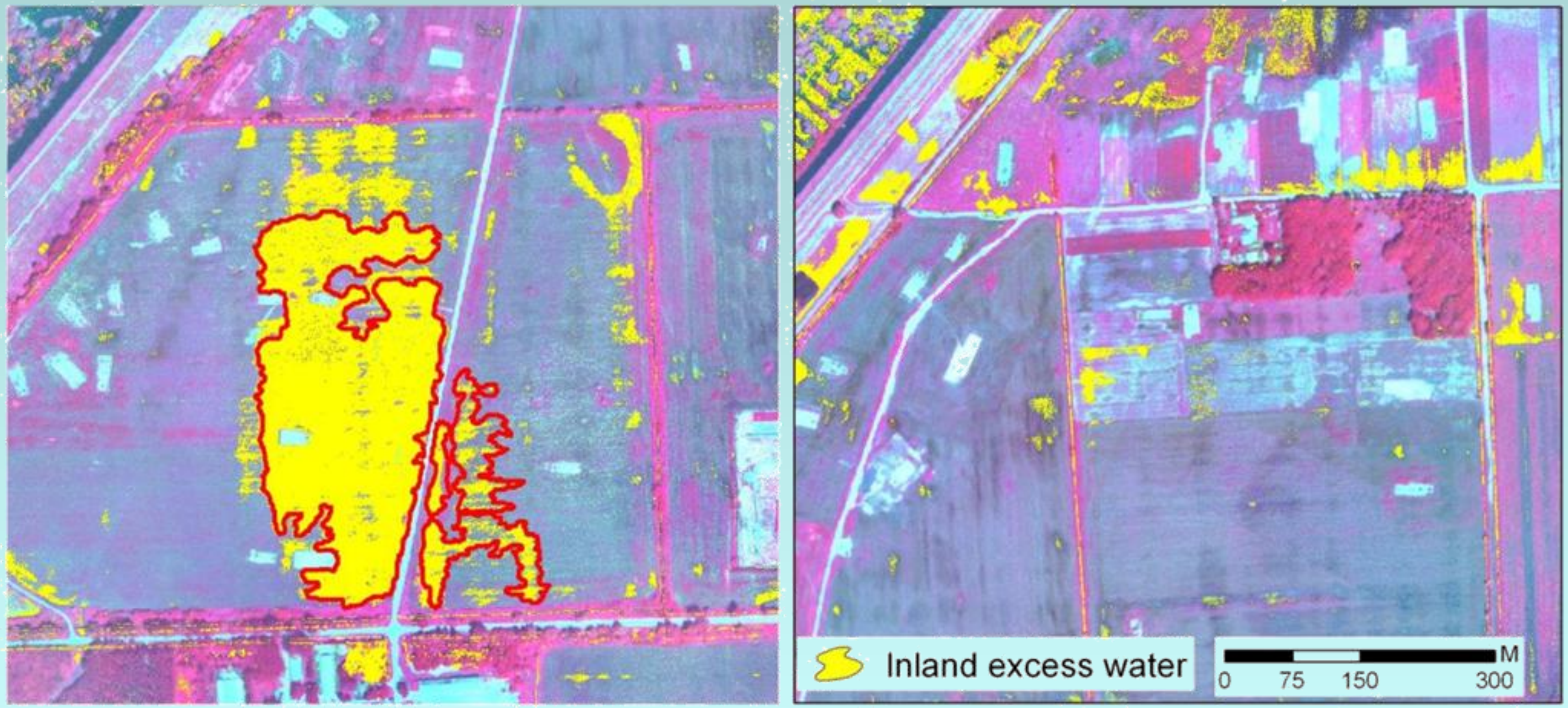




ANN – GIS Framework



Results



First experiment:

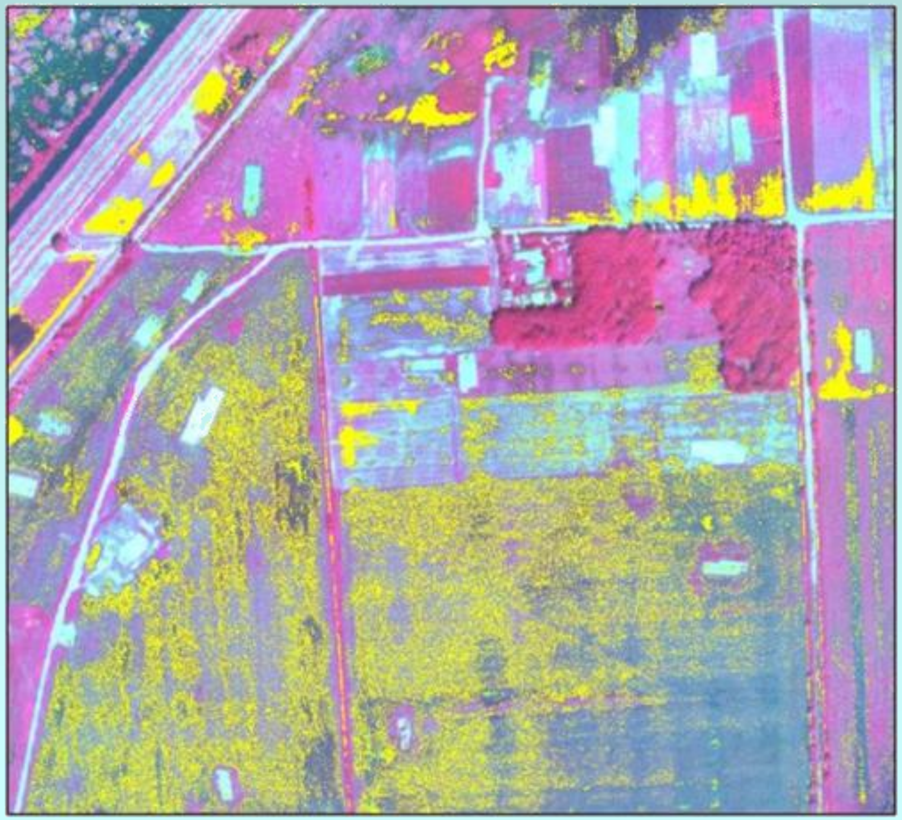
4 input layers. Training area (left) with the GPS fieldwork result and the simulation area (right)

Training result: R = 0.74

Simulation results – 2 different dates

24 March 2010

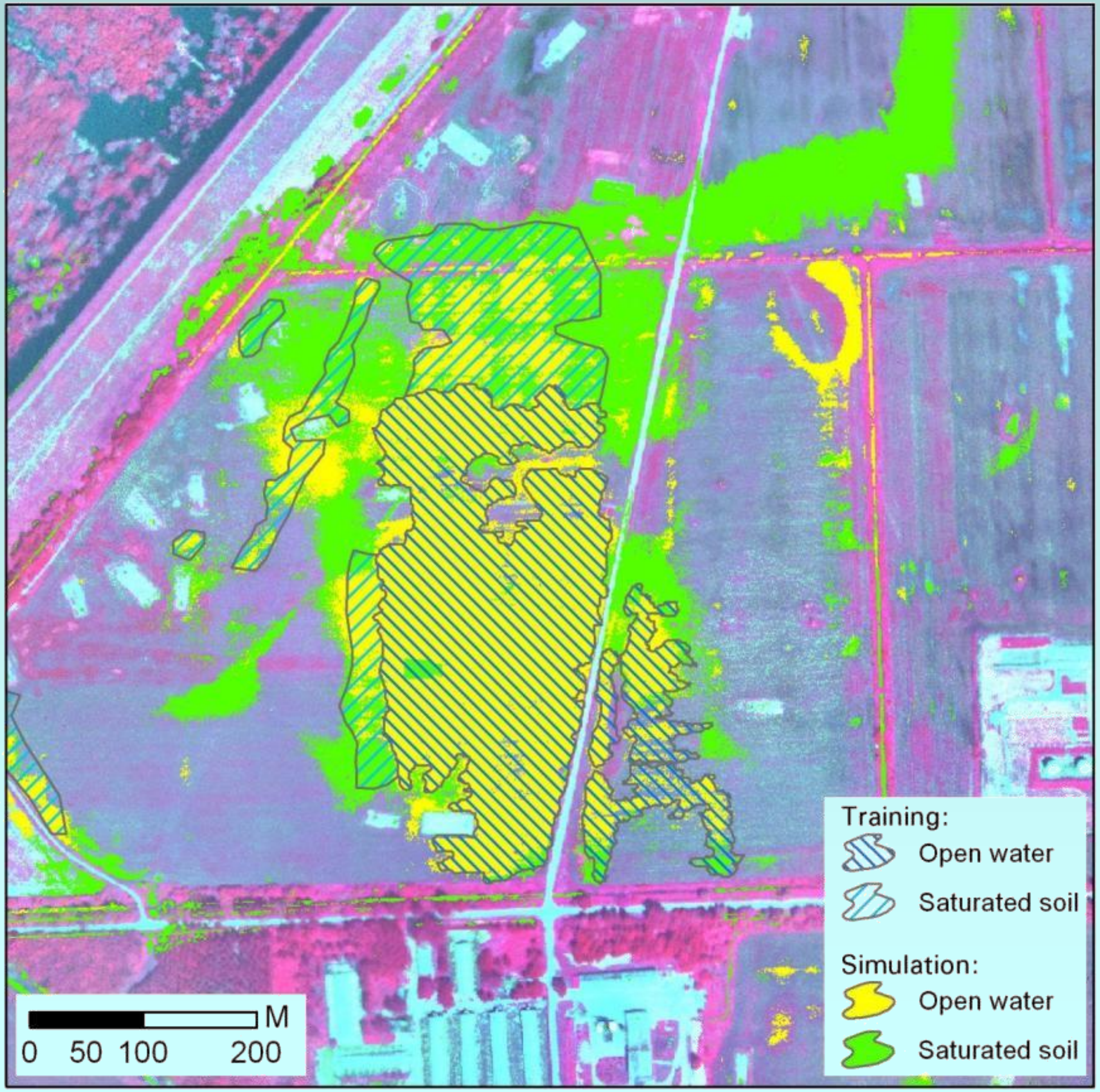
9 June 2010



Results

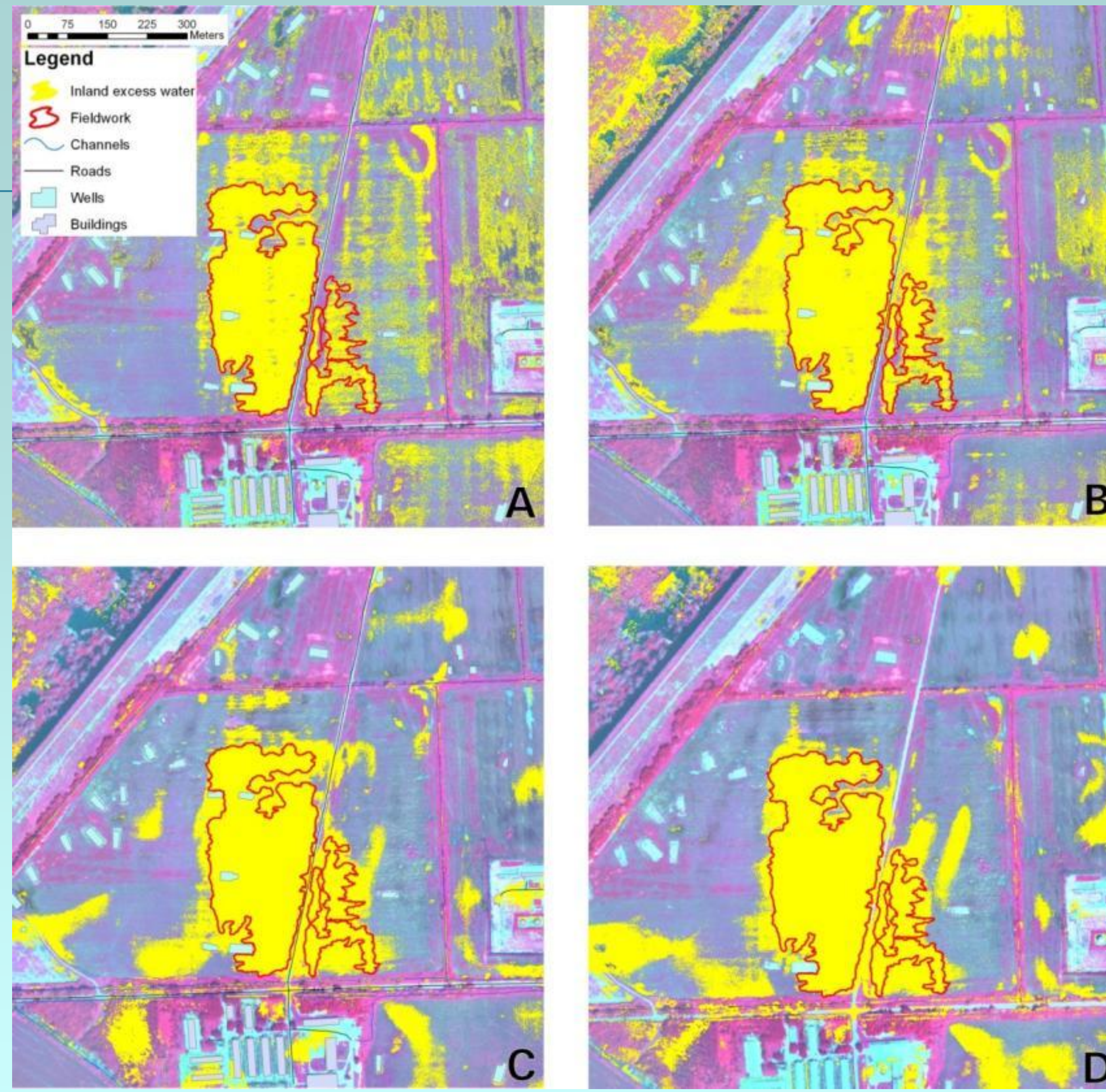
3 classes

- Open water
- Saturated soil
- Dry land



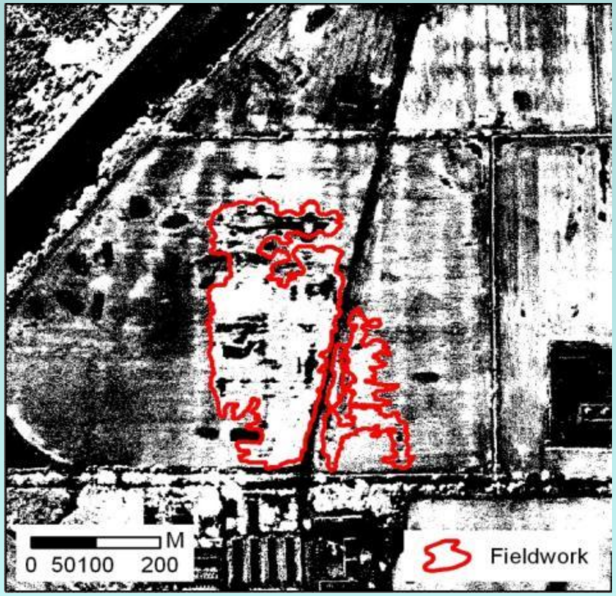
Influence of the input layers

A. 4 input layers
B. 5 input layers
C. 8 input layers
D. 9 input layers

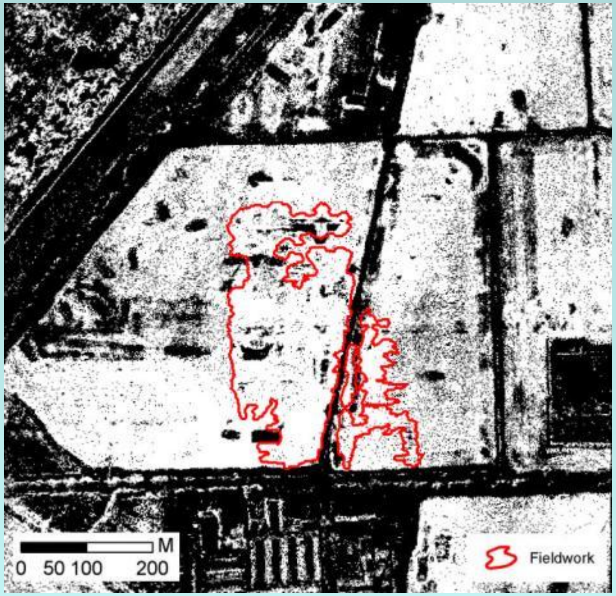


	4 inputs	5 inputs	8 inputs	9 inputs
Cohen's Kappa (κ)	0,76	0,81	0,86	0,83
Overall accuracy (%)	88	91	93	91

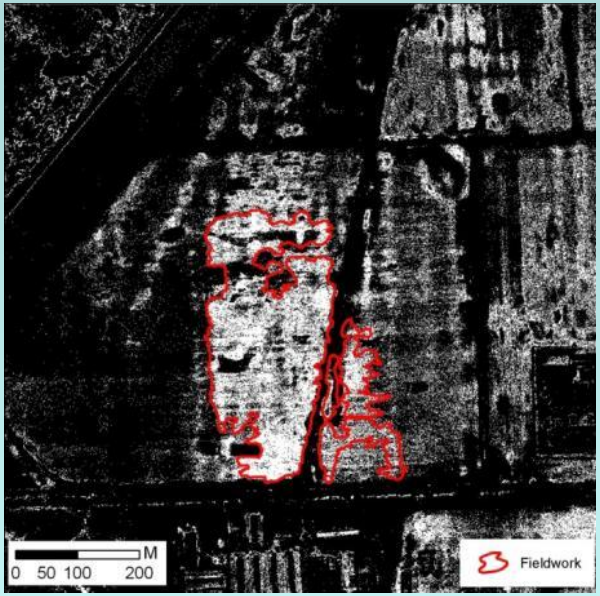
Comparison with traditional classifications



Minimum distance



Maximum likelihood

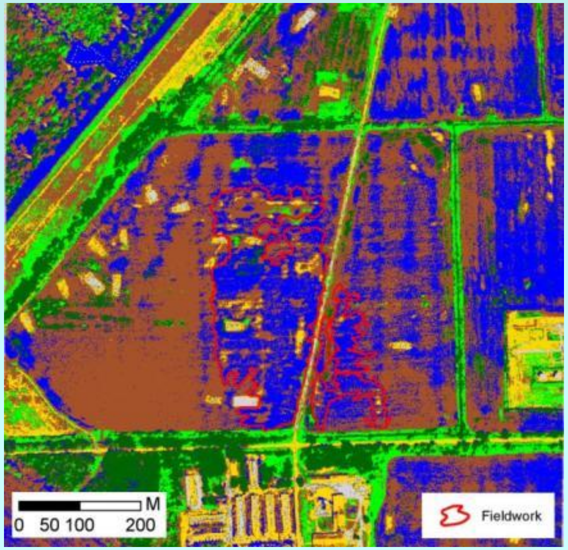


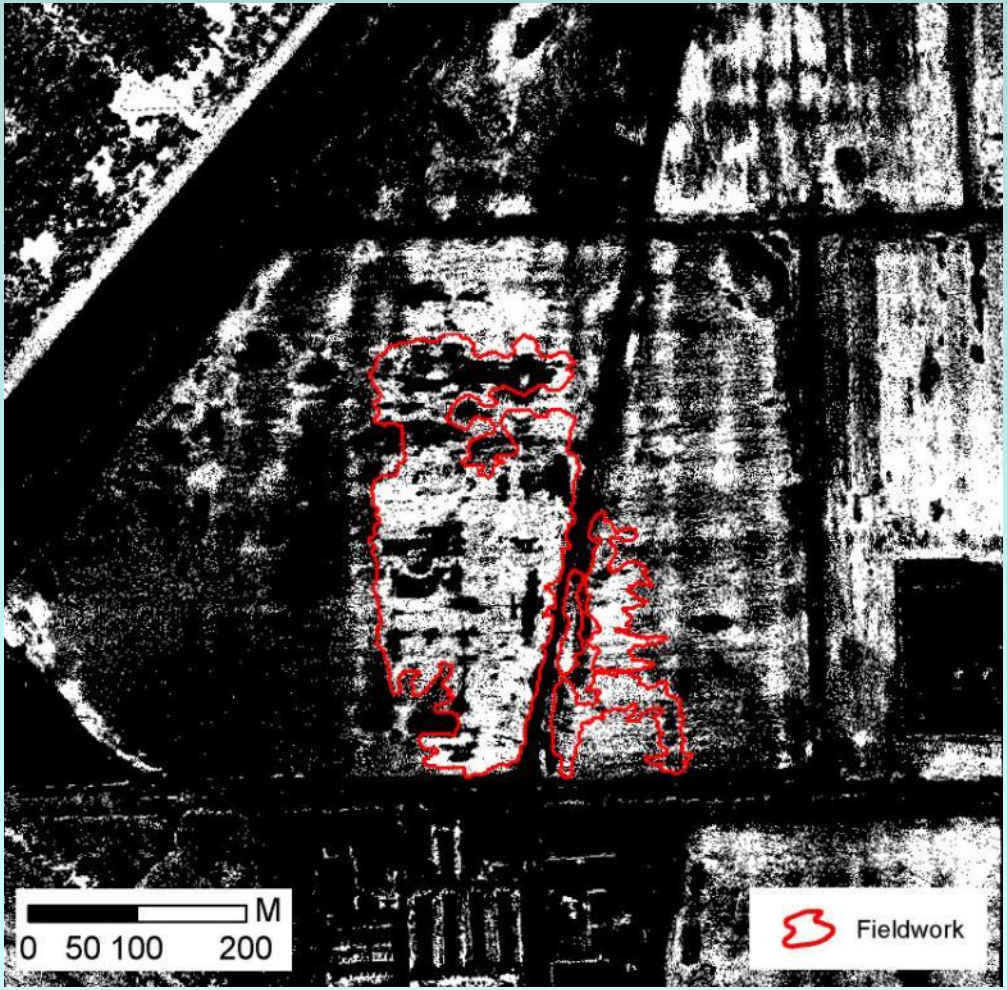
Artificial neural network

- 2 classes
- 3 input layers (CIR bands)

Maximum likelihood

- 7 osztály
- 6 non-water classes merged into one class



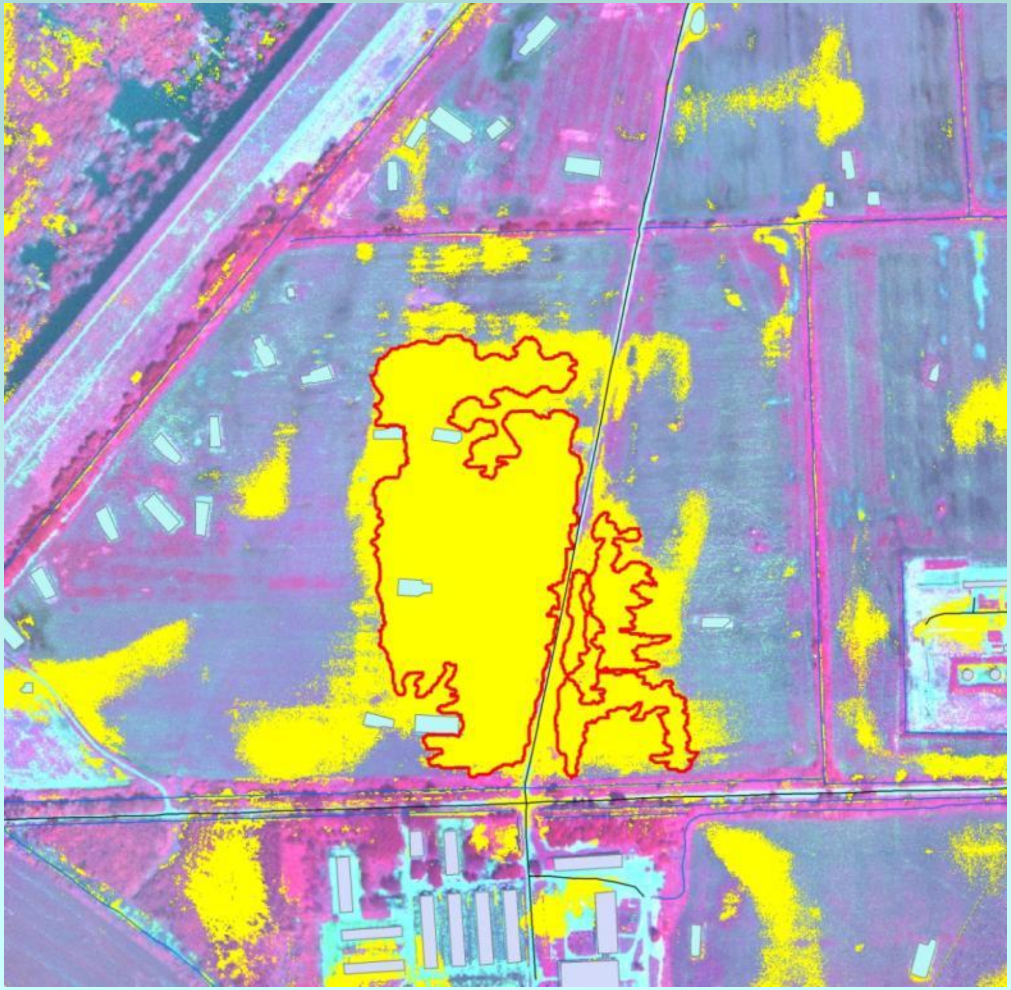


Results

	Correctly classified water	Correctly classified non-water	Total water found	Total non-water	Overall accuracy
MD based on 2 classes	119	83	186	114	67 %
ML based on 2 classes	135	72	213	87	69 %
ML with merged non-water classes	90	120	120	180	70 %
ANN two classes (3 layers)	93	128	115	185	74 %
ANN two classes (8 layers)	149	130	169	131	93 %

Artificial neural network

- ANN 2 classes
- 20 hidden neurons
- 8 layers:
  - 3 CIR
  - Local depressions
  - Channels
  - Buildings
  - Roads
  - Wells



Thank you for your attention

Boudewijn van Leeuwen

http://www.geo.u-szeged.hu/meriexwa

This research is supported by European projects:
Inland excess water INFO (GOP – 1.1.1 – 08 / 1 – 2008) – 025
and MERIEXWA (HUSRB/1002/121/088)