Evidence of droughts in agriculture, economic and environmental implications

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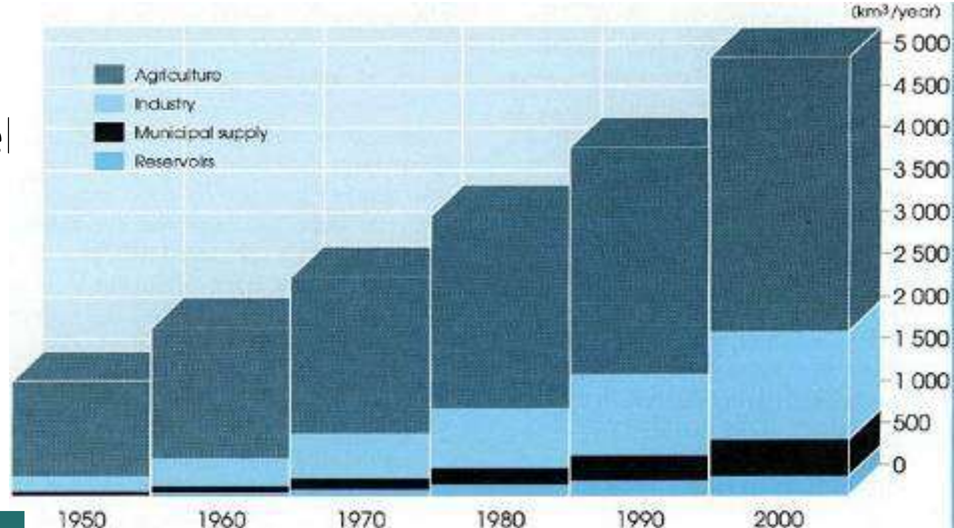
Drought

- A **drought** is an extended period of months or years when a region notes a deficiency in its water supply whether surface or underground water.

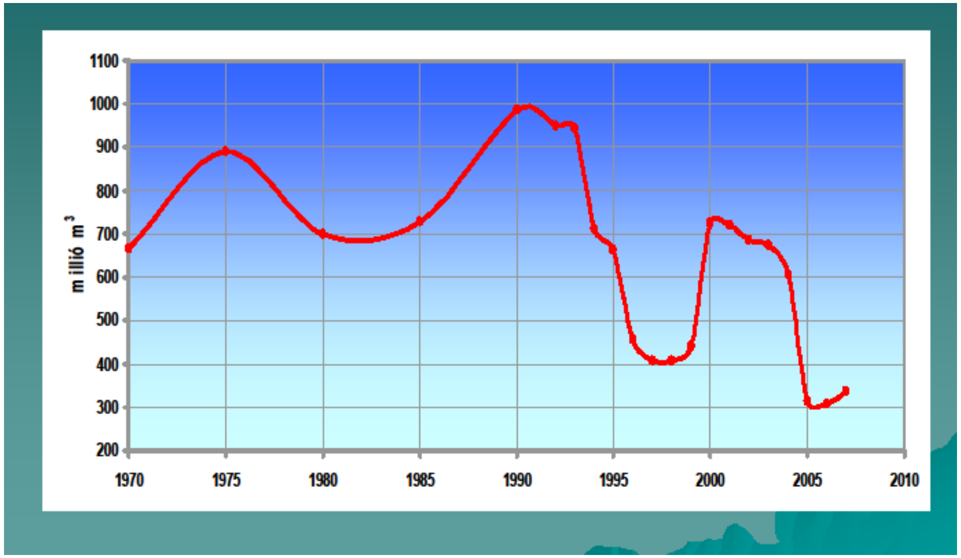
Impact on the ecosystem and ***agriculture*** of the affected region!!!!

Evidence of drought in agriculture

- Decrease in soil water content
- Decrease of ground water table level
- Yield decrease
- Quality decrease
- Food safety
- Increase in food price
- Increase in agricultural water use



Agricultural water use in Global term (1950-2000)



In Hungary…

The suggested priorities

Drought management plan

- Common risk treatment
- Comprehensive water management (cross border activities)
- Establish of water supply conditions, new water systems (Hungary)
- **Drought/flood induced migration** .
- **Biomass production** – to what extent it can increase water shortage and scarcity?
- Role **of alternative resources** in the mitigation of water scarcity (treated wastewater, sea water desalination, etc.
- **close cooperation between agricultural and environmental sector** with intention to find of what are true possibilities for adaptation related to available water resources balancing of consumption of water for agriculture
- **Drawing attention to** the need to providing **water supply** during drought periods at all potential risk areas.

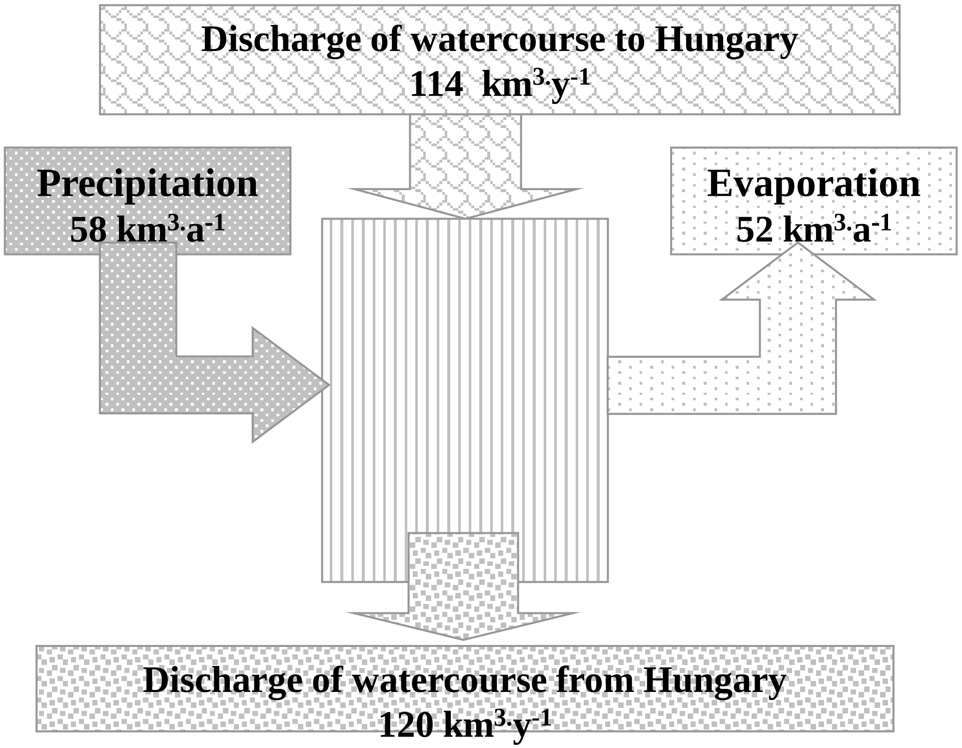
Enough or not, or too much is the water content in soil?

- It depends on:
  - Distribution of precipitation in space and time
  - The kind of cultivated plant (C_4, C_3, length of vegetation period..)
  - Static water demand: water demand of a plant in a vegetation period
  - Amount of avalible water content in soil in space and time
  - Critical soil water depletion

Enough or not, or too much is the water content?

- How much is the available water content of the soil?
- The key tool is the water balance
- According to the goals of the size and time scale of the measurements and the approriae or ignorable components have to be determined.
- Global water balance: P=ET
- Water balance of my corn field??

Water budget of Hungary



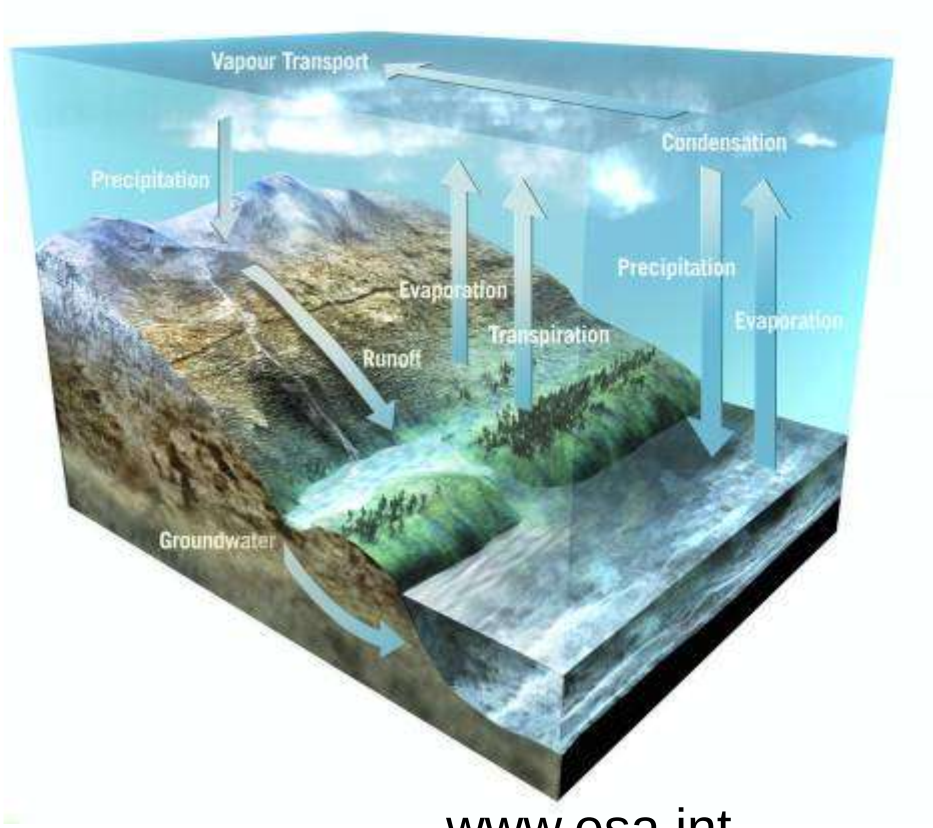
$$58\ km^3 + 114\ km^3 = 52\ km^3 + 120\ km^3$$

Simplified water balance of a site

Soil water content changes in time (ΔV_t)

$$\Delta V_t = V_p + V_i + V_{gw} + V_s - (V_{ep} + V_{tr} + V_d + V_r)$$

V_p: precipitation
V_i: irrigation
V_{gw}: water from ground water by capillarity
V_s: water coming from surface
V_{ep}: evaporation
V_{tr}: transpiration
V_d: drainage water
V_r: runoff
ΔV_t: soil water content changes of a site



www.esa.int

The error or the uncertainty of the parameters affect the results!

Measurement conditions - hypothesis

- Increasing the frequency of meteorological extremities
- Changing amount of precipitation both spatially and in time
- Increasing frequency of local, extremely intensive rainfall,
- The reliability of the extrapolation or forecasting based on past hydrological time series
- Drought in the beginning, is latent, hard to find the borders of it
- Such measurement methods become more important which measures continuously or regularly with more and more better spatial and time resolution
- Such strategic methods, in the case of certain conditions, is remote sensing

What kind of measurement should be made?

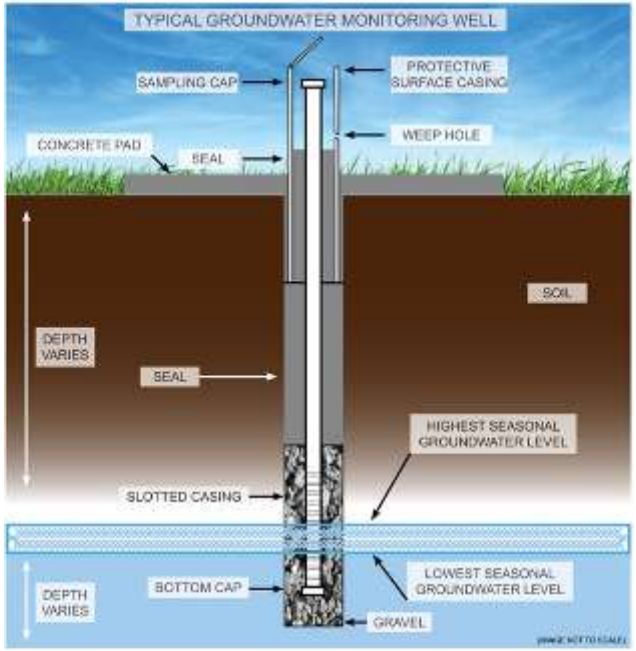
- There are several equipments with various for measuring methods are available for detecting drought related parameters.
- Some user doesn’t know or ignore the application reaquirement of these equipments.






What kind of measurement should be made?

- Problems with setting point measurements
- Which site is represented by the point measurement?
- How accurate the representation of the concern site?
- Where to put the sensor? – changing root zone, moving underground water table



What kind of measurement should be made?

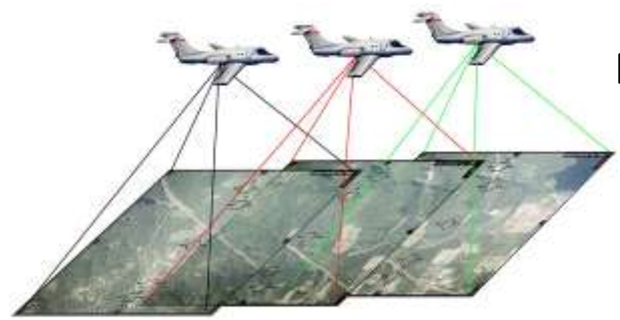
- Indirect water content measurement in soils?
  - Physical parameters of soils (pF, OM, grain size, soil structure)
- Maps – regional scale
  - Agrotopographic maps (1:100000)
  - Soil watermanagement map
  - Soil water utilization map

More detailed spatial data is needed -> remote sensing

Remote sensing

- Return time
- Spatial resolution
- Spectral resolution

Space remote sensing



Photogrammetry

Unmanned Aerial Vehicles (UAVs).

Hyperspectral SWIR sensor
Headwall Photonics

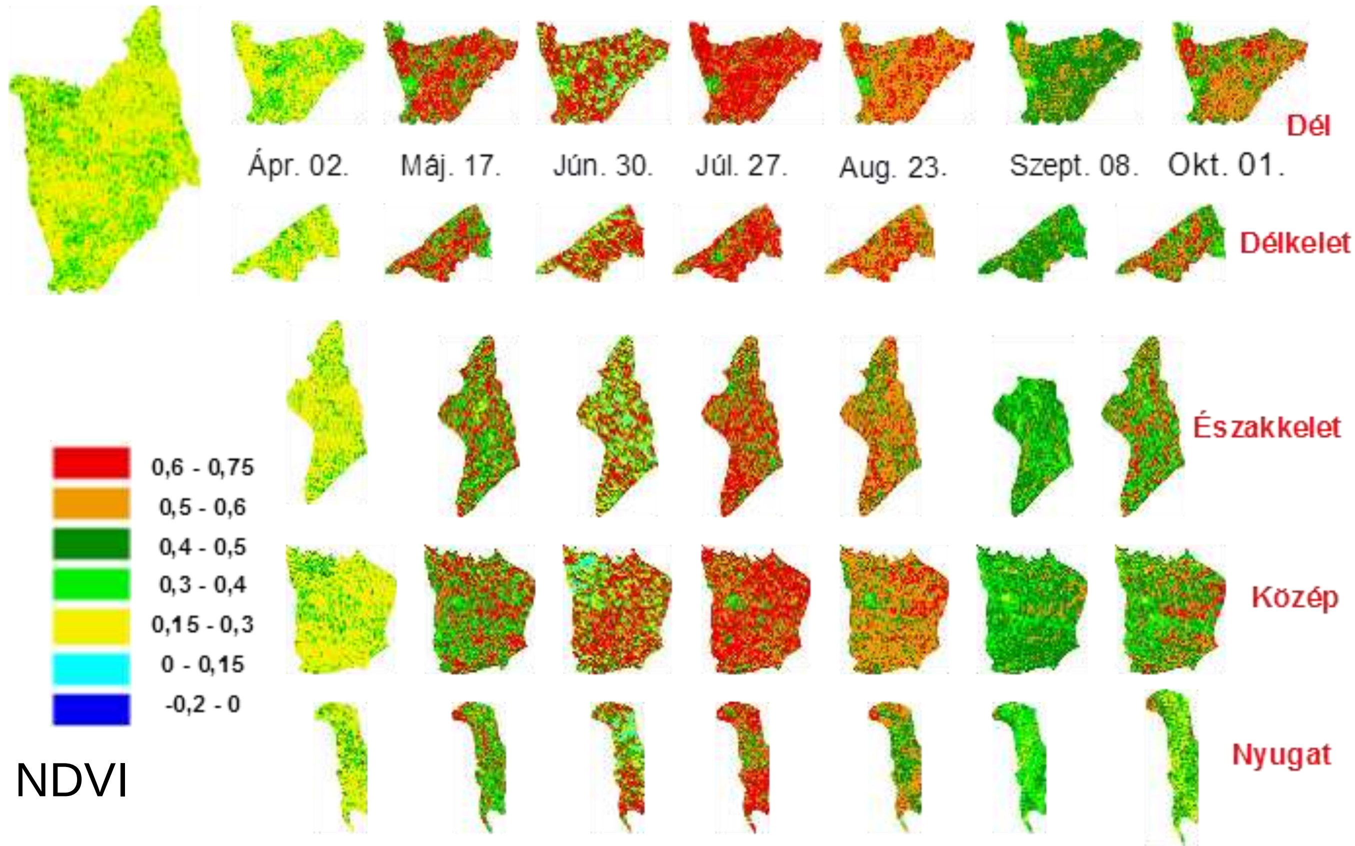
Field spectroscopy – thermo camera

Space remote sensing

MODIS
250/500/1km pixel
Daily return, 36 channel

TERRA

AQUA

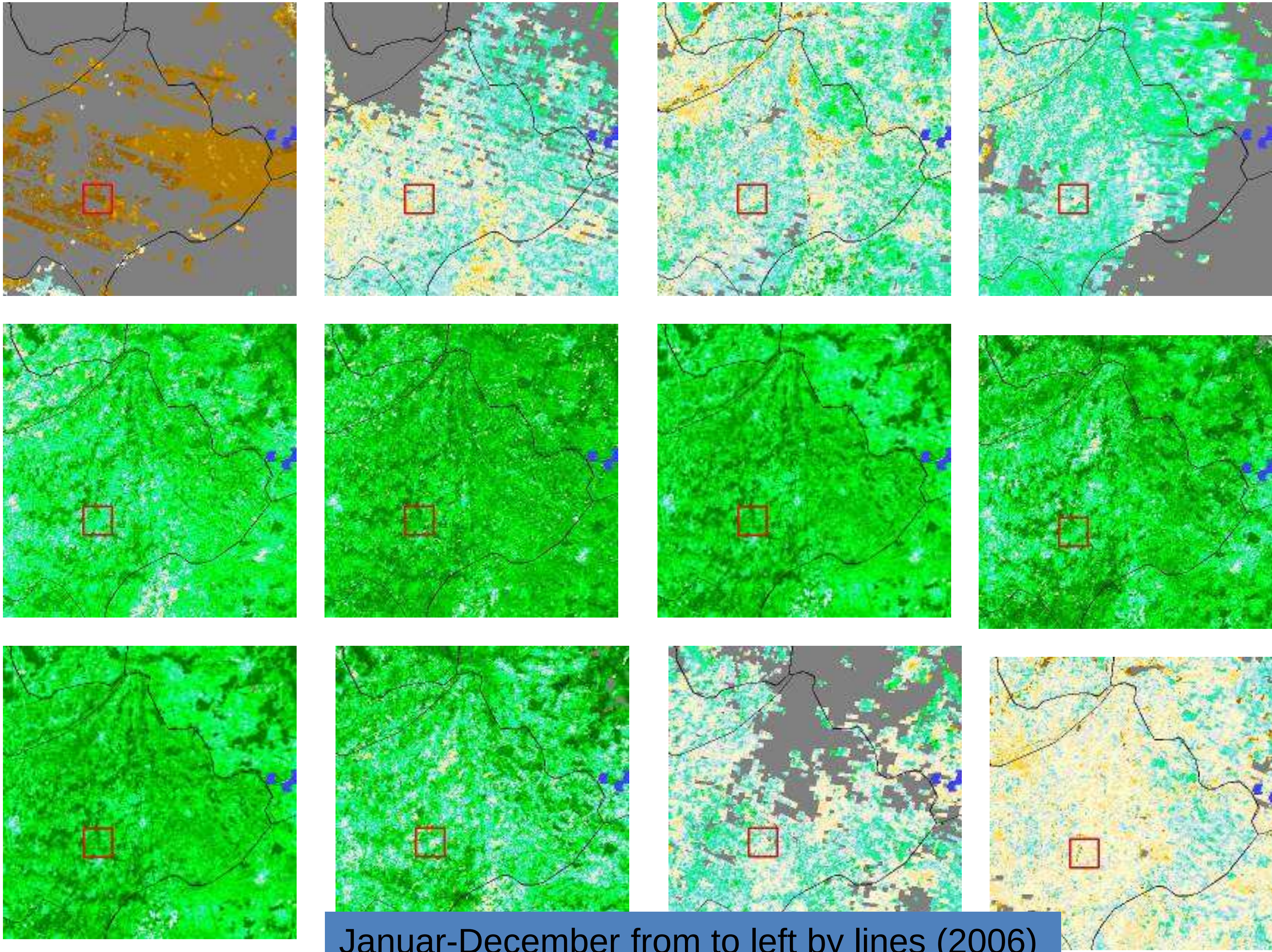


http://modis-land.gsfc.nasa.gov/

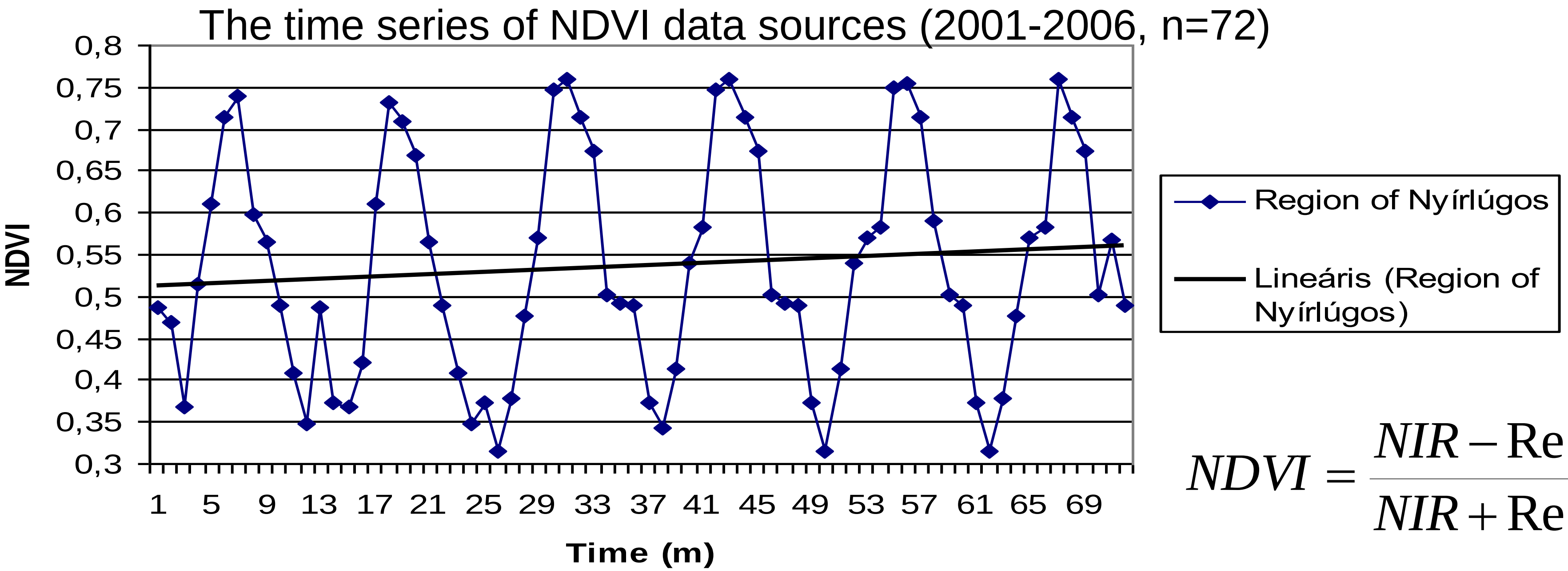
Primary Use	Band	Bandwidth[1]
Land/ Cloud/ Aerosols Boundaries	1	620 - 670
	2	841 - 876
Land/ Cloud/ Aerosols Properties	3	459 - 479
	4	545 - 565
	5	1230 - 1250
	6	1628 - 1652
	7	2105 - 2155
Ocean Color/ Phytoplankton/ Biogeochemistry	8	405 - 420
	9	438 - 448
	10	483 - 493
	11	526 - 536
	12	546 - 556
	13	662 - 672
	14	673 - 683
	15	743 - 753
	16	862 - 877
Atmospheric Water Vapor	17	890 - 920
	18	931 - 941
	19	915 - 965

Primary Use	Band	Bandwidth[1]
Surface/Cloud Temperature	20	3.660 - 3.840
	21	3.929 - 3.989
	22	3.929 - 3.989
	23	4.020 - 4.080
Atmospheric Temperature	24	4.433 - 4.498
	25	4.482 - 4.549
Cirrus Clouds Water Vapor	26	1.360 - 1.390
	27	6.535 - 6.895
	28	7.175 - 7.475
Cloud Properties	29	8.400 - 8.700
Ozone	30	9.580 - 9.880
Surface/Cloud Temperature	31	10.780 - 11.280
	32	11.770 - 12.270
Cloud Top Altitude	33	13.185 - 13.485
	34	13.485 - 13.785
	35	13.785 - 14.085
	36	14.085 - 14.385

MODIS test site - Nyírlugos



Januar-December from to left by lines (2006)



$$NDVI = \frac{NIR - Red}{NIR + Red}$$

Mean 0.536; standard deviation: 0.136; maximum: 0.759; minimum: 0.316.

Nyírlugos territorial matrix size: 10x10 km with 250 meter ground resolution
Time frequency data: 16 days (mean of period), 6 years long duration

- correctly evaluate potency of ecological biomass productivity.

- Trend present a long term effect of biomass increase and decrease depend on mid and long term climatic and agro-ecological stresses.

- crop yield forecasts and can serve as an early warning system for regions suffering from crop loss and food shortages

Space remote sensing

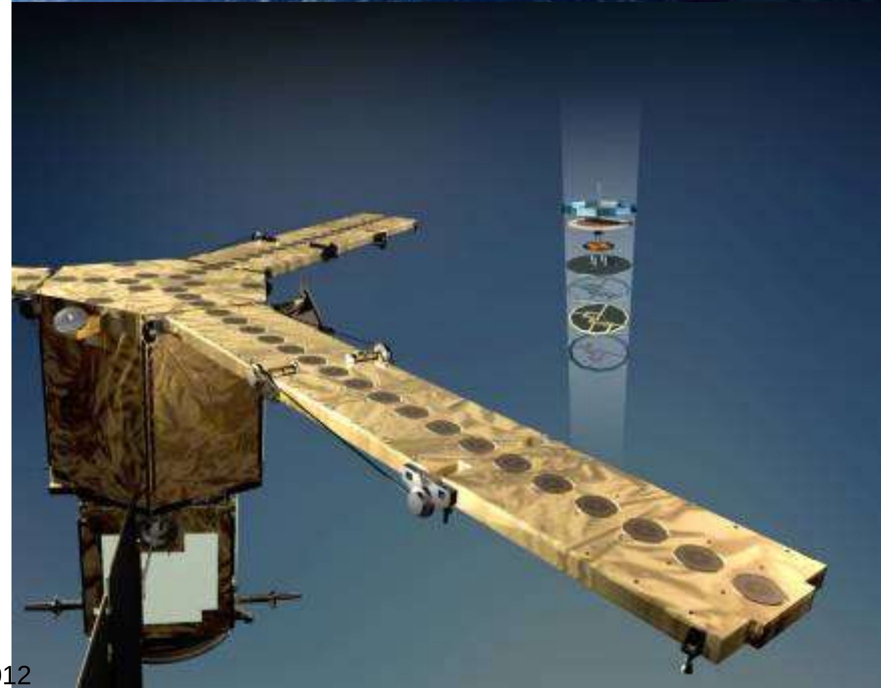
SMOS

Measure microwave radiation emitted from Earth’s surface within the ‘L-band’, around a frequency of 1.4 GHz.

This frequency provides the best sensitivity to variations of moisture in the soil and changes in the salinity of the ocean, coupled with minimal disturbance from weather, atmosphere and vegetation cover.

69 small antennas, distributed over the three arms and central hub of the instrument detects the microwave radiation.

Scanning width: 50 km with 2 days return



SMOS

- SMOS data will be available free of charge to scientific and non-commercial users. They will be made available through the ESA category-1 procedure, either through dedicated Announcements of Opportunities or, for users who have not participated in the past Announcements, a registration service online at ESA's Principal Investigator Portal

Airborne hyperspectral remote sensing

- The “hyper” in hyperspectral means “over” as in “too many” and refers to the large number of measured wavelength bands.
- Hyperspectral images are spectrally overdetermined, which means that they provide amply spectral information to identify and distinguish spectrally unique materials.

AISA DUAL system

AISA DUAL

FODIS

GPS/INS unit

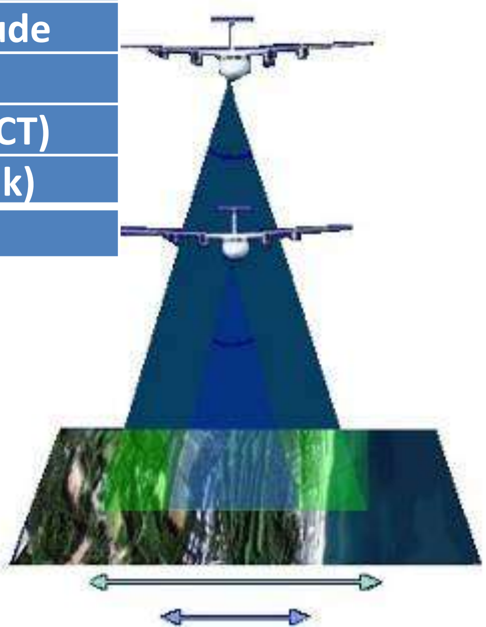
Gyro-stabilized
platform for AISA sensors

AISA Dual Sensor

	VNIR (EAGLE)				SWIR (HAWK)
Sensors characteristics					
Spectral range	400-970nm				970-2450nm
Spectral resolution	2.9nm				8.5nm
Spectral binning options	none	2x	4×	8×	none
Spectral sampling	1.25 nm	2.5 nm	5 nm	10 nm	6 nm
Fore optics					
#spatial pixels	320		1024		320
FOV	24		37,7		24
IFOV	0.075 degrees		0.075 degrees		0.075 degrees
Swath with	0.65×altitude		0.65×altitude		0.39×altitude
Electrical characteristics					
Radiometric resolution	12 bits (CCD)				14 bits (MCT)
SNR	350:1 (peak)				800:1 (peak)
Image rate	Up to 100images/s				

System specifications		Ground resolution							
		0.5 m		1 m		2 m		5 m	
Focal length (mm)	FOV (degrees °)	Altitude (m)	Swath (m)	Altitude (m)	Swath (m)	Altitude (m)	Swath (m)	Altitude (m)	Swath (m)
AISA Hawk									
30	18.2	500	160	1000	320	2000	640	5000*	1600

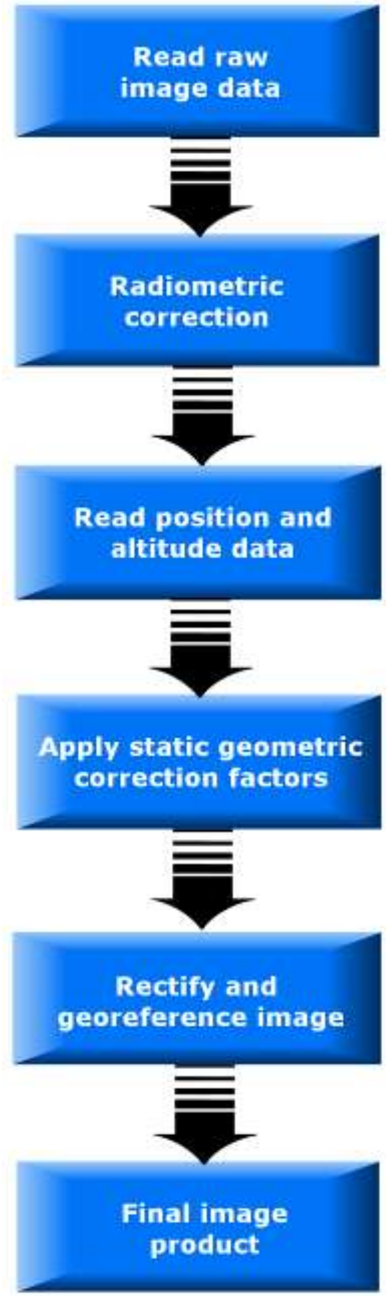
*) Pressurized aircraft required

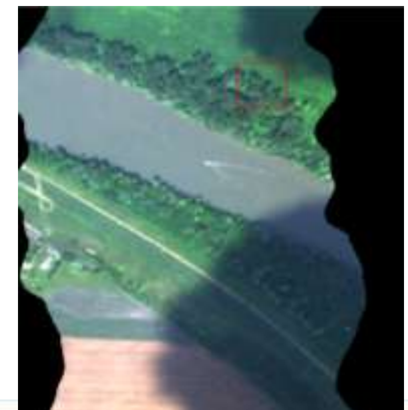


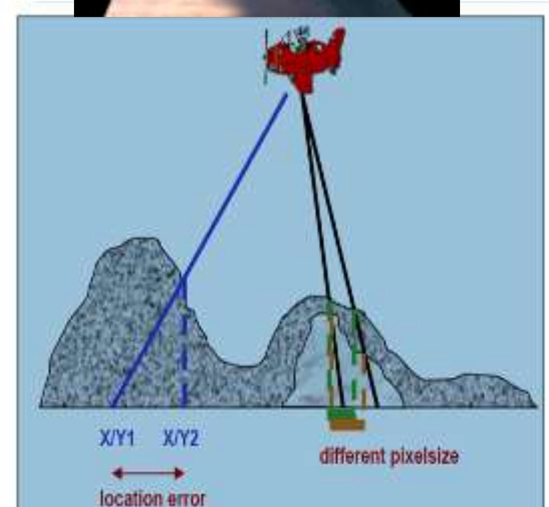
AISA Operating Software: GALIGEO – Work flow

AISA DUAL systems can be used in two operating modes:

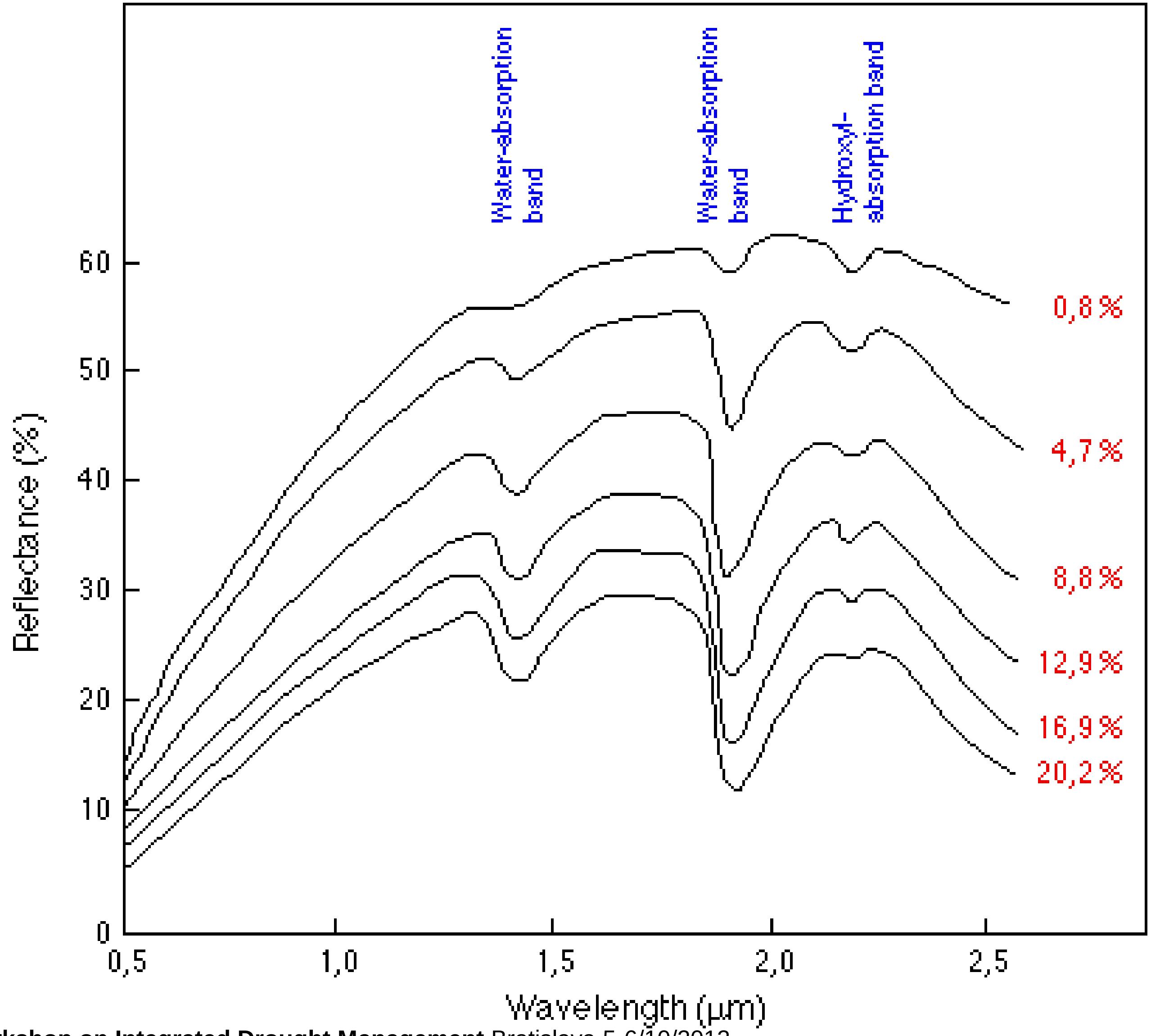
- full hyperspectral data acquisition
- multispectral data acquisition at programmable wavebands



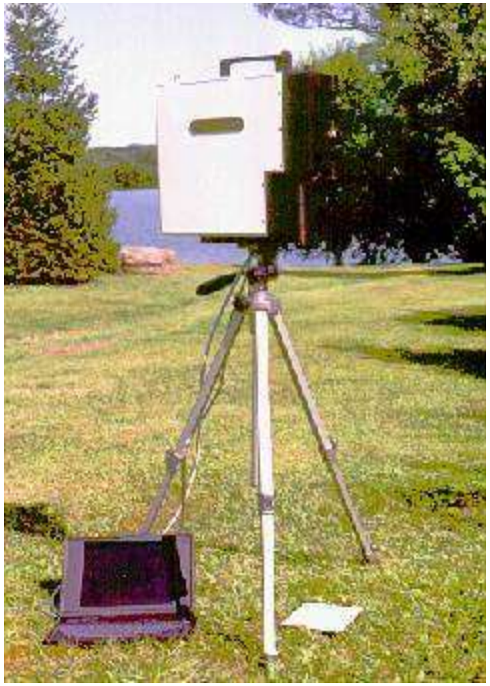




Reflexion properties of soil, concerning soil water content



APPLIED NEAR FIELD NARROW AND CONTINOUS SINGlE BAND FIELD SPECTROMETER



Applied Field spectrometer:
<u>GER 3700</u> 325 -2500 nm; 647 bandhe is a high performance single-beam field spectroradiometer measuring over the visible to short-wave infrared wavelength range

The Analytical Spectral Devices **<u>FieldSpec Pro</u>** (Full Range) is a single-beam field spectroradiometer measuring over the visible to short-wave infrared wavelength range. With a 0.35-2.5 µm spectral range and 10 nm spectral resolution,

Critical factor for hyperspectral remote sensing

- The accurate preparation is very important (have to try to avoid the improvisation, because no reserve time to modify anything)
- On the field also important: Sampling strategy (2-4% of the total scanned area), Special sensors,, RTK-GPS and relevant experts
- Never enough the number field spectral reference point (minimum 1 / site or much more)
- The highest risk factor - the weather
- The main enemies: clouds and low light intensity (and bureaucracy)

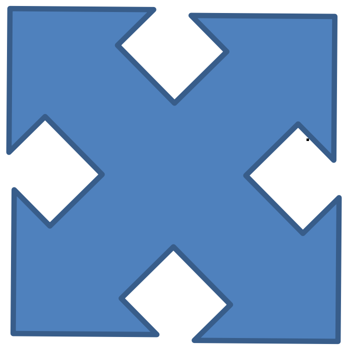
2012.09.22.

Precipitation

NOAA Meteorologic satelite
Pixel size 1.1X1.1km^2

Tornado hunter radar –Utah
Pixel size ~ 150-200 m

Scale!



Calibration
Table
Small watersheds, cities
Regional watersheds

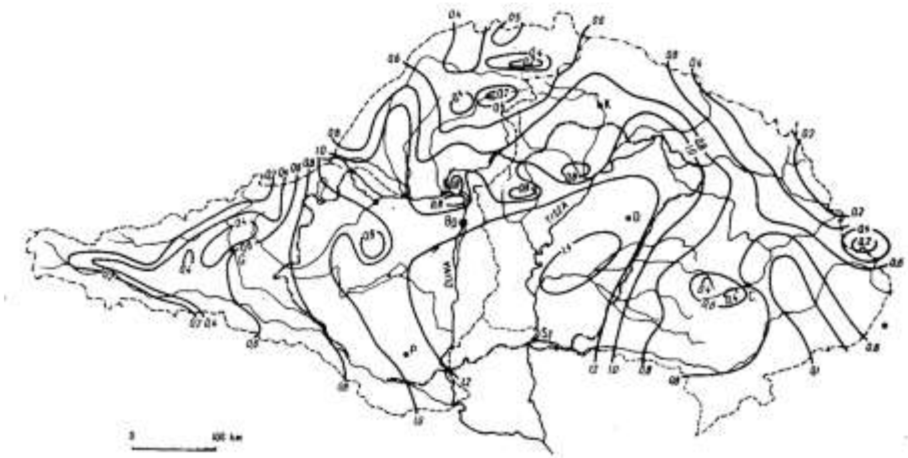
Radar (on Earth) pixel size 2X2 km^2

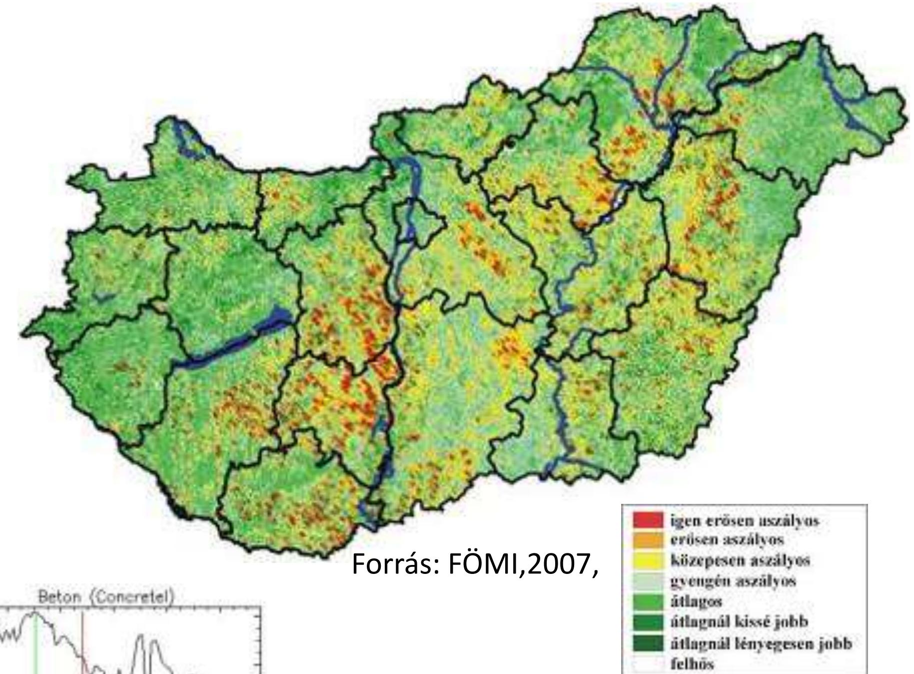
Dombai, F.(2009)Radar-ismerteto.OMSZ

Installed instrument forprecipitation intensity

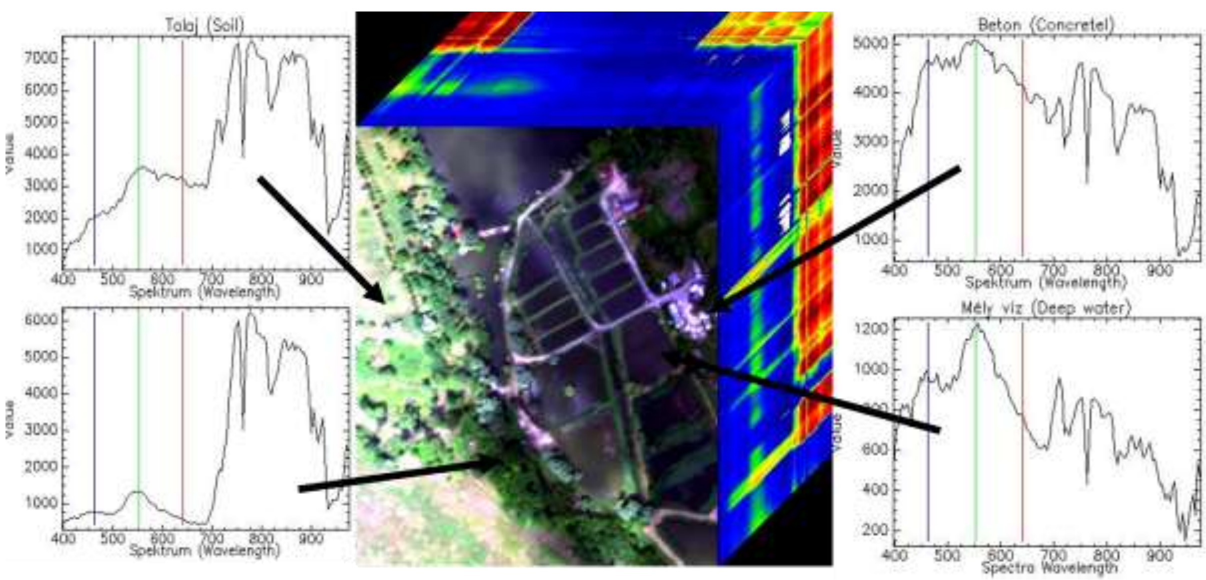
Evapotranspiration

Drought sensitivity 2007, Landsat TM- pixel 0,5 ha





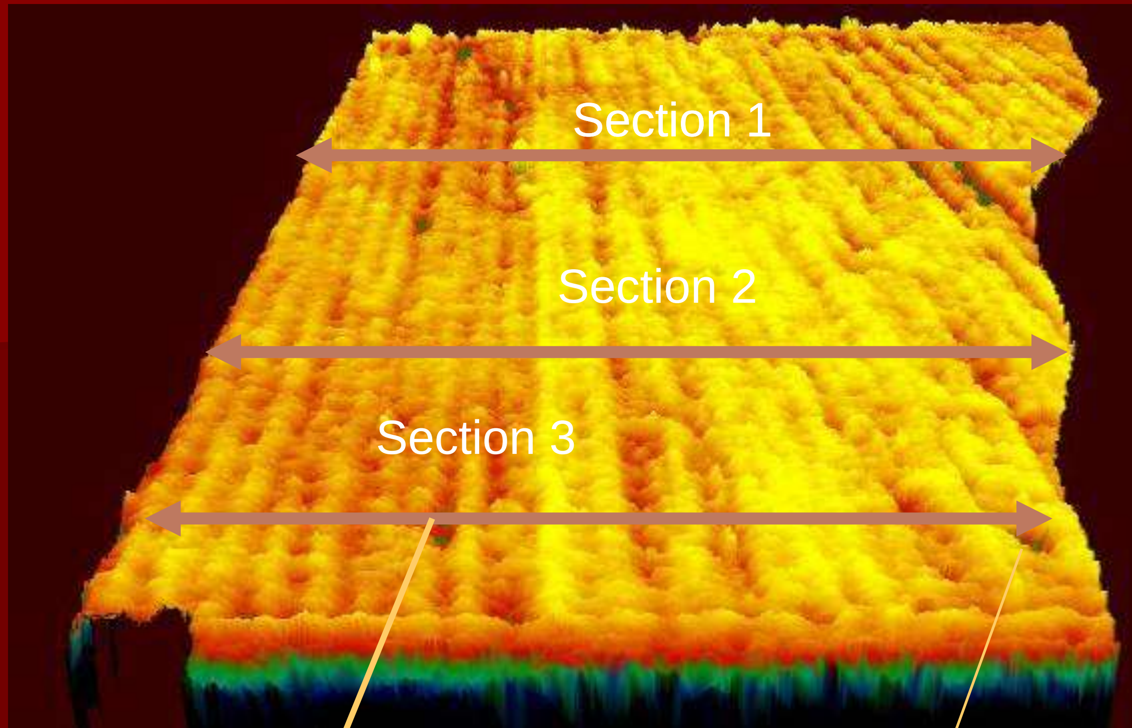
Forrás: FÖMI,2007,



Hyperspectral data cube with 298 channel 1m^2 pixel, Isaszeg

DE-VM GMI

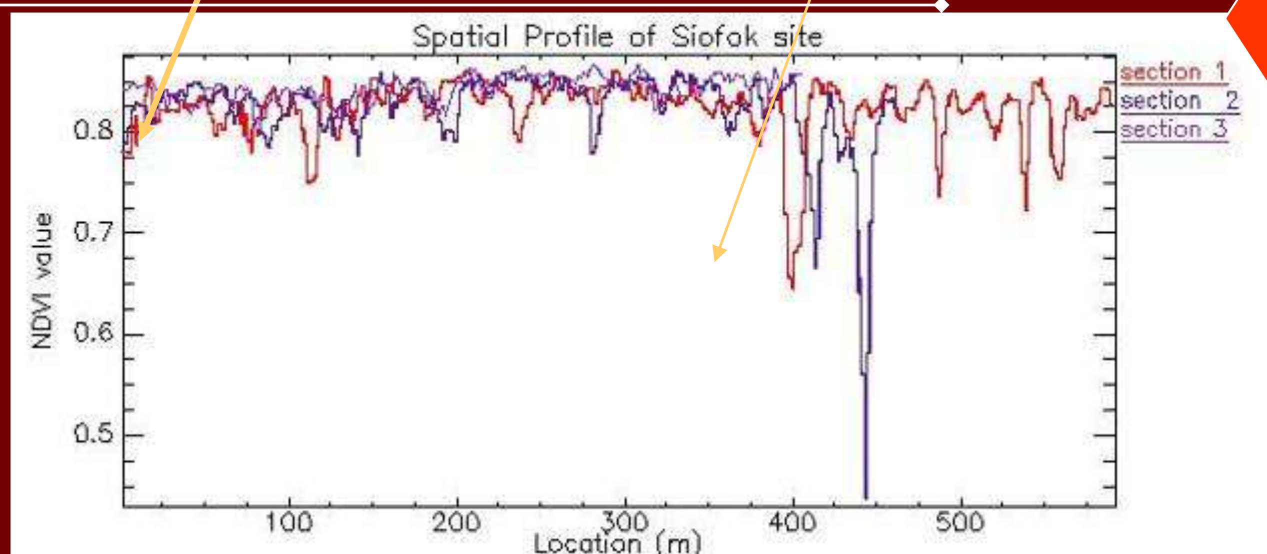
Airborne hyperspectral vegetation map



Siófok, 2008
Spatial resolution 0,5 m

NDVI
0.8

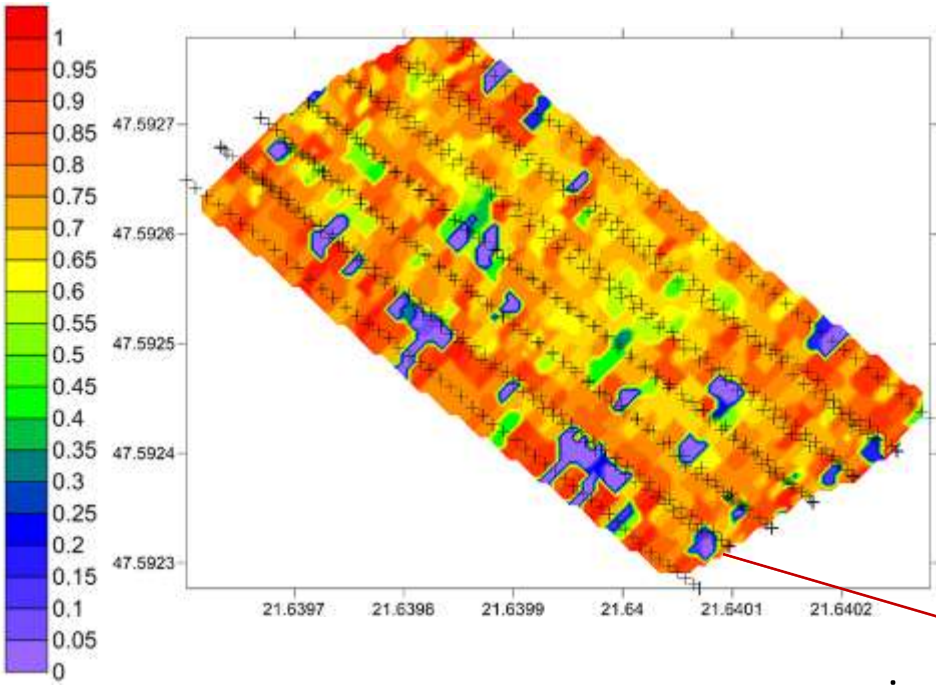
580 m

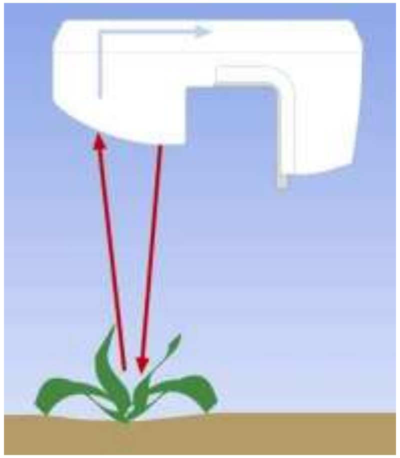


DE-VM GMI
hiperspektrális kamerája, 2008

Near-ground - remote sensing

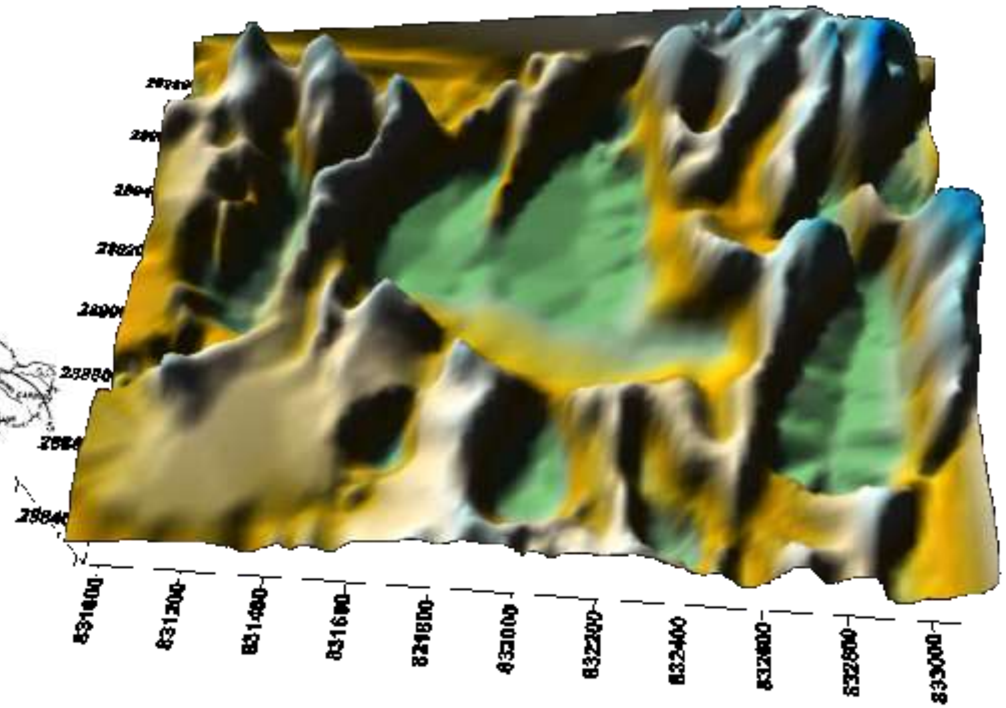
Debrecen –Pallag Research orchard
Biomass map (NDVI)



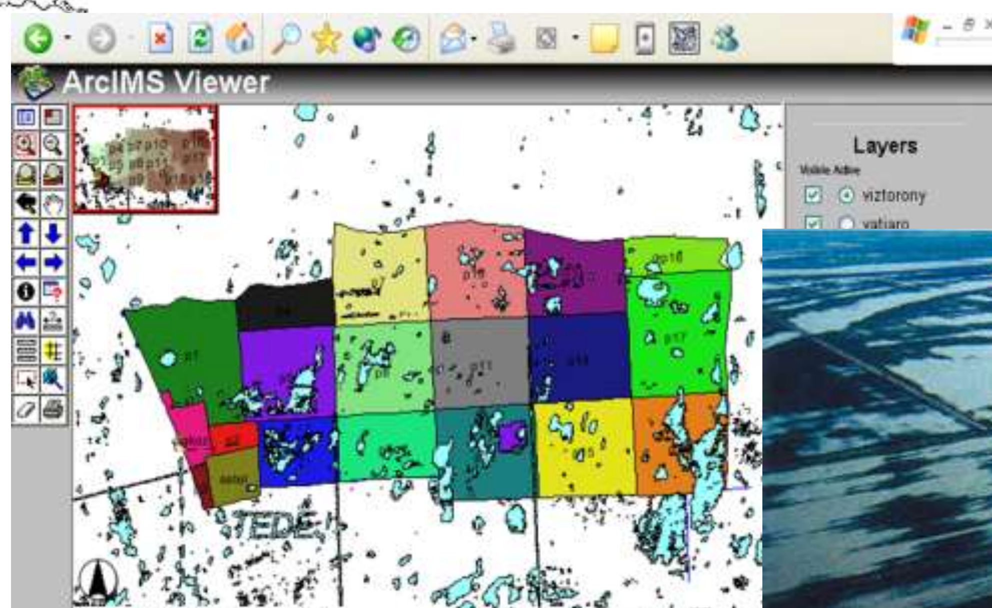


necrosis

Runoff – sink circumstances

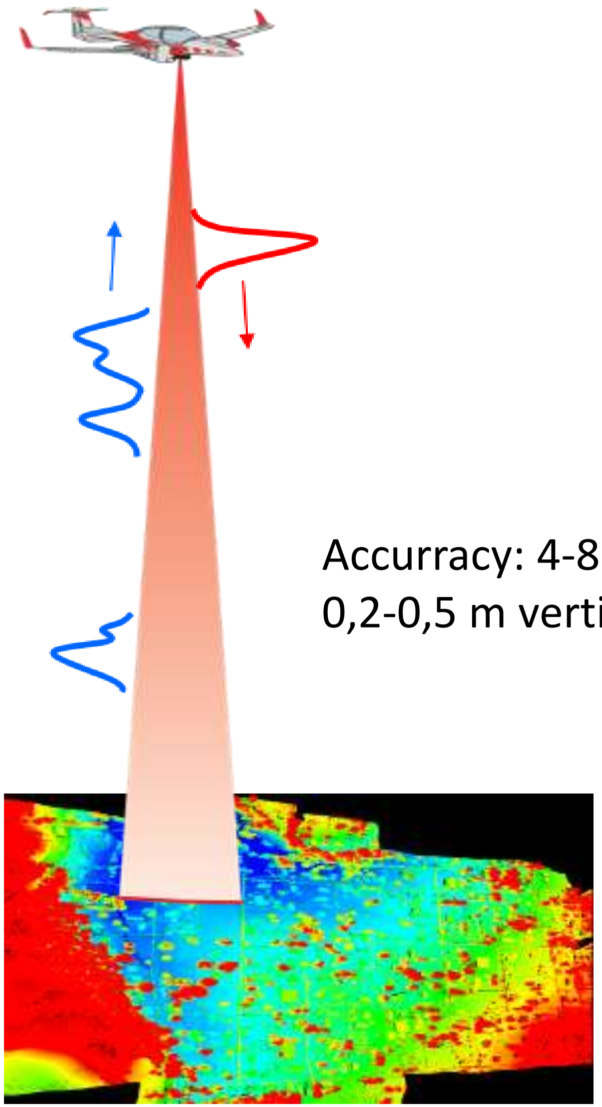


More precise relief!



LIDAR – Mobile - field laserscanner

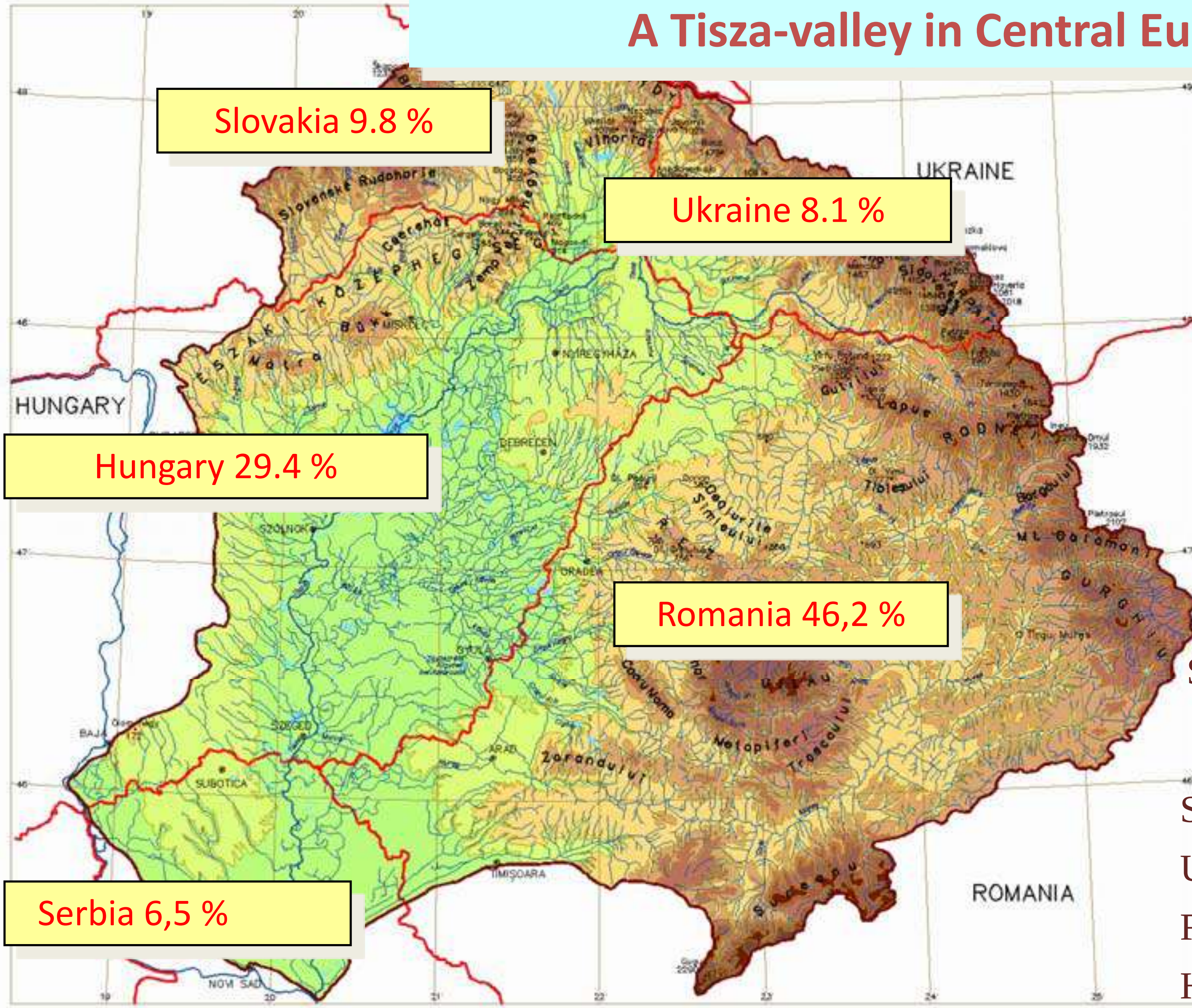
Pontosság: 20m-ig, 0,2 mm



Accurracy: 4-8 pt/m2
0,2-0,5 m vertically

Tisza river watershed – case study plan

A Tisza-valley in Central Europe



Rate of average annual runoff at Szeged cross section of Tisza :

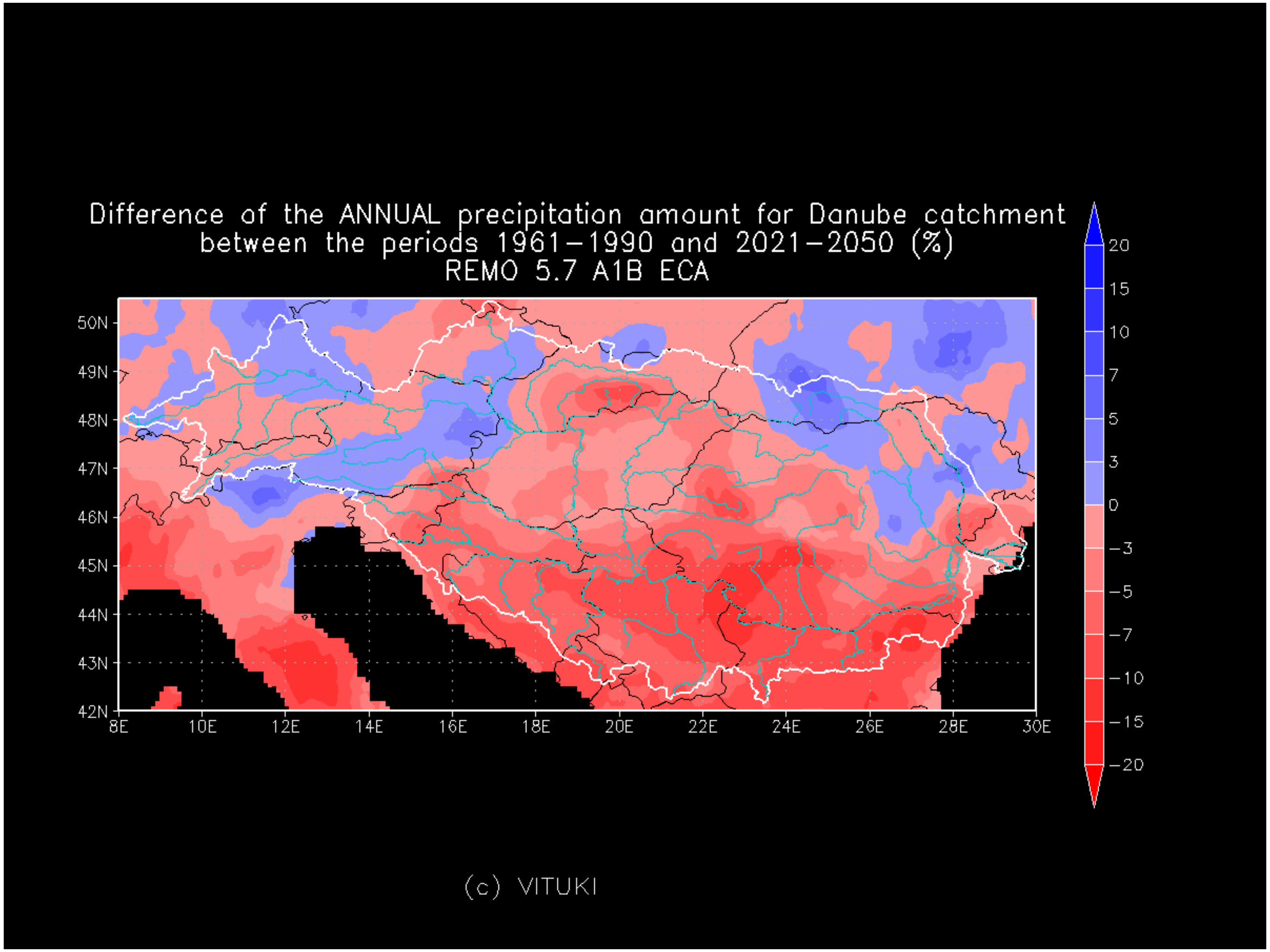
Slovakia 22,6 %

Ukraina 23,3 %

Romania 49,8 %

Hungary 4,3 %

Climate models: ECHAM 5 with REMO 5.7
Climate scenario: A1B



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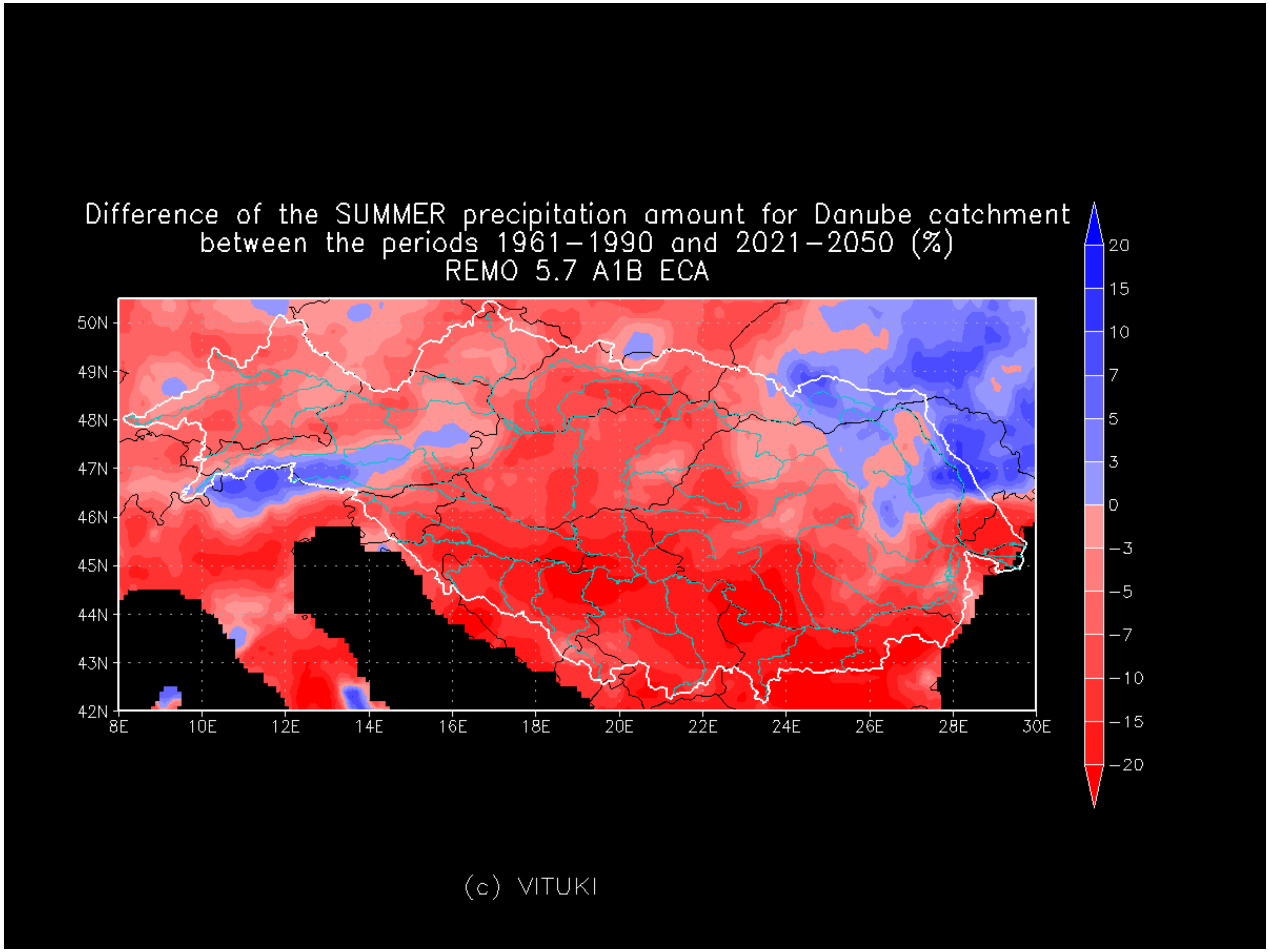


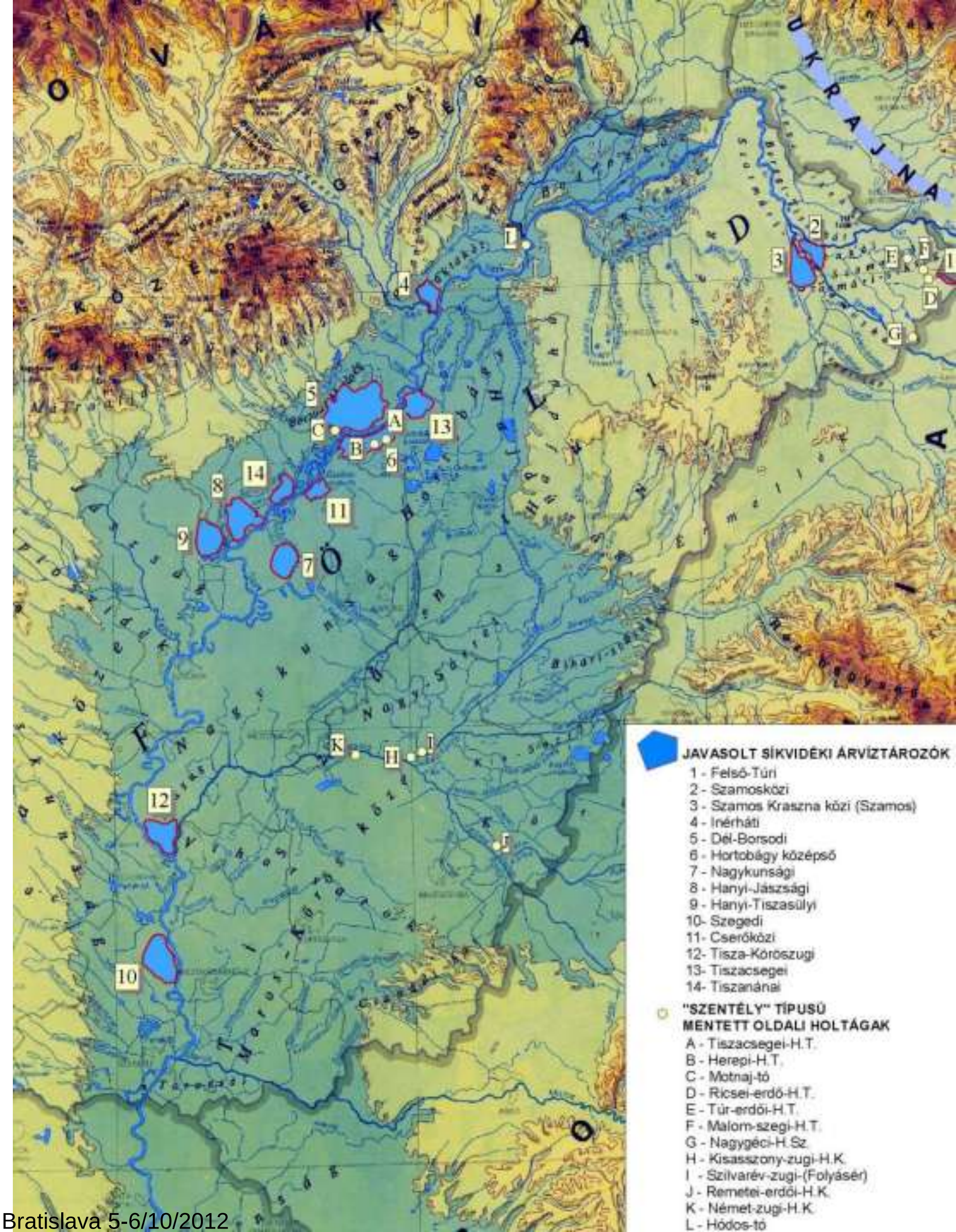
VITUKI BUDAPEST

70% of Hungarian watermanagement problems occur in Tisza valley (floods, surplus water, drought)

Surplus water and drought often occur in the same year or even in the same vegetation period!

ET>P salinization, high clay content

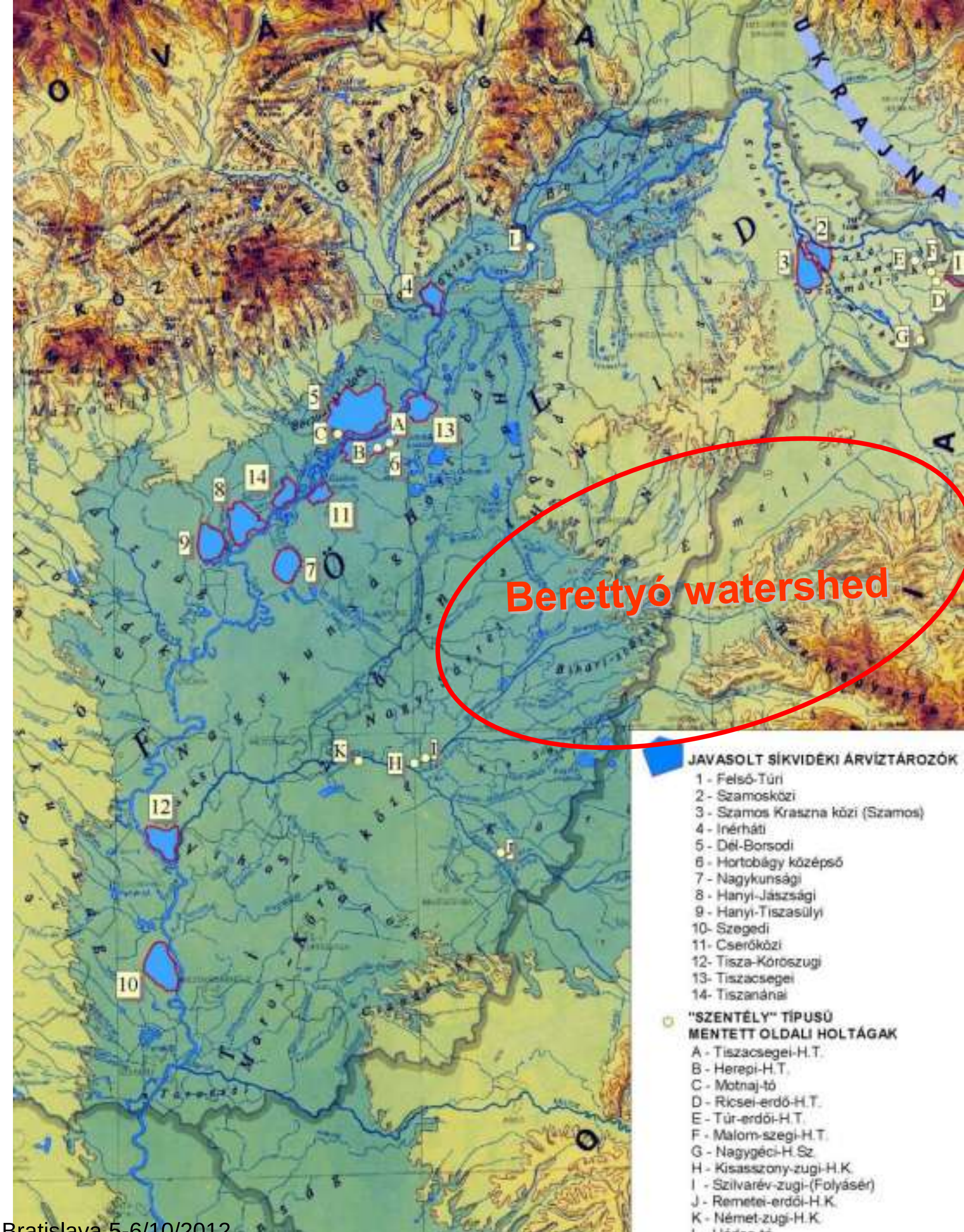
About 95% of the surface waters originate from upstream countries, thus Hungary is very much dependent on the actions that upstream countries are taken – True for Tisza basin



- Possible workpackages

- WP1: Drought monitoring data integration – drought mapping (50000 €)
- Goal is forecasting and damage detection, prediction
- Integration of landuse, vegetation, meteorological and soil data
  - landuse (CORINE database, topographic map etc.)
  - Biomass production (MODIS, AISA DUAL)
  - Remote sensing data (SMOS, MODIS)
  - Soil data (agrotopographic map, soil water management properties, map of watermanagement of soils)
  - Hydrology (soil water table)
  - DEM
- Outcomes:
- Drought monitoring strategy
- Sampling strategy of drought monitoring from soil and vegetation point of view
- 3 Dymensional monitoring

- WP2: Case study for Berettyó river (100000 €))
- (Hungary – Romania), tributary river of Tisza.
- Partner, University of Debrecen (Hungary), University of Oradea Romania
- Surveying agroecological circumstances of cultivated plant species integrating
  - digital elevation modellins,
  - soil maps
  - Meteorological data
  - Remote sensing data on the vegetation and soil moisture
  - MEPAR – Agricultural Parcel Identification System



- WP3: Best management adaptation to changed climate circumstances (50000€)
- Partners: University of Debrecen (Hungary), Slovakia, Ukraine, Romania, - Serbia? University of Debrecen have relationship with University of Novy Sad
  - Application of WP1 and WP2 results
  - Strategy based on watersheds
  - Soil cultivation (no till, strip till, mulch cover), irrigation strategy, determination of sowing methods and parameters based on available water demand in soil and water demand of cultivated plant species of its vegetation period
- Outcomes:
- data quality management,
- error propagation,
- guidelines for different crops in adaptation
- rain feed system

Summary

- Results of remote sensing are appropriate for watermanagement applications
- Lack of national drought – surplus water monitoring systems and its comprehensive hydrological and remote sensing concept
- Lack of field calibration
- Significant obstacle:
  - Not appropriate user knowledge
  - good infrastructure, but not sufficient collaboration
  - non - utilized infrastructure
  - not used (?) datasets
  - Continuous and hardly understandable administrative reorganization
  - Lack of money

Thank you for your kind attention!

„Irrigate from local water sources!”


Opening of Tiszaroff fload reservoir