

# **Satellite data use for severe meteorological events monitoring and related risks in Romania**

Romanian National Meteorological Administration  
Remote Sensing and GIS Laboratory

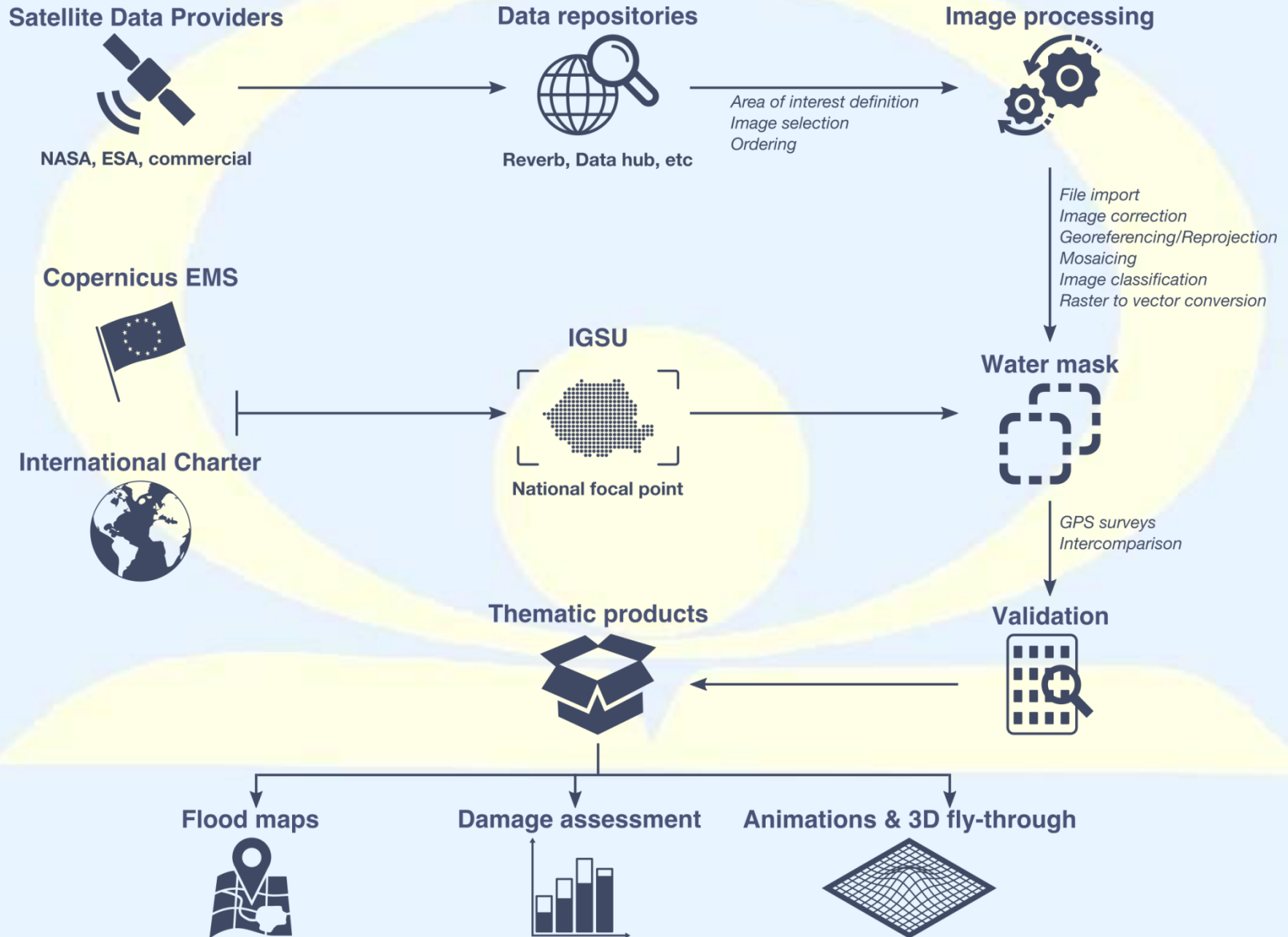
Anișoara Irimescu, Gheorghe Stăncălie,  
Vasile Crăciunescu, Argentina Nerțan, Denis Mihăilescu,  
Simona Catană, George Morcov

# REMOTE SENSING AND GIS ACTIVITY

- **OPERATIONAL and RESEARCH ACTIVITY**
  - Applications in monitoring of meteorological and hydrological hazardous phenomena
  - Applications in the environmental impacts studies
  - Satellite-based products validation using “in situ” measurements
  - Satellite data integration in crops growth models
- **RESEARCH DIRECTIONS**
  - Floods
  - Droughts
  - Soil moisture
  - Snow cover

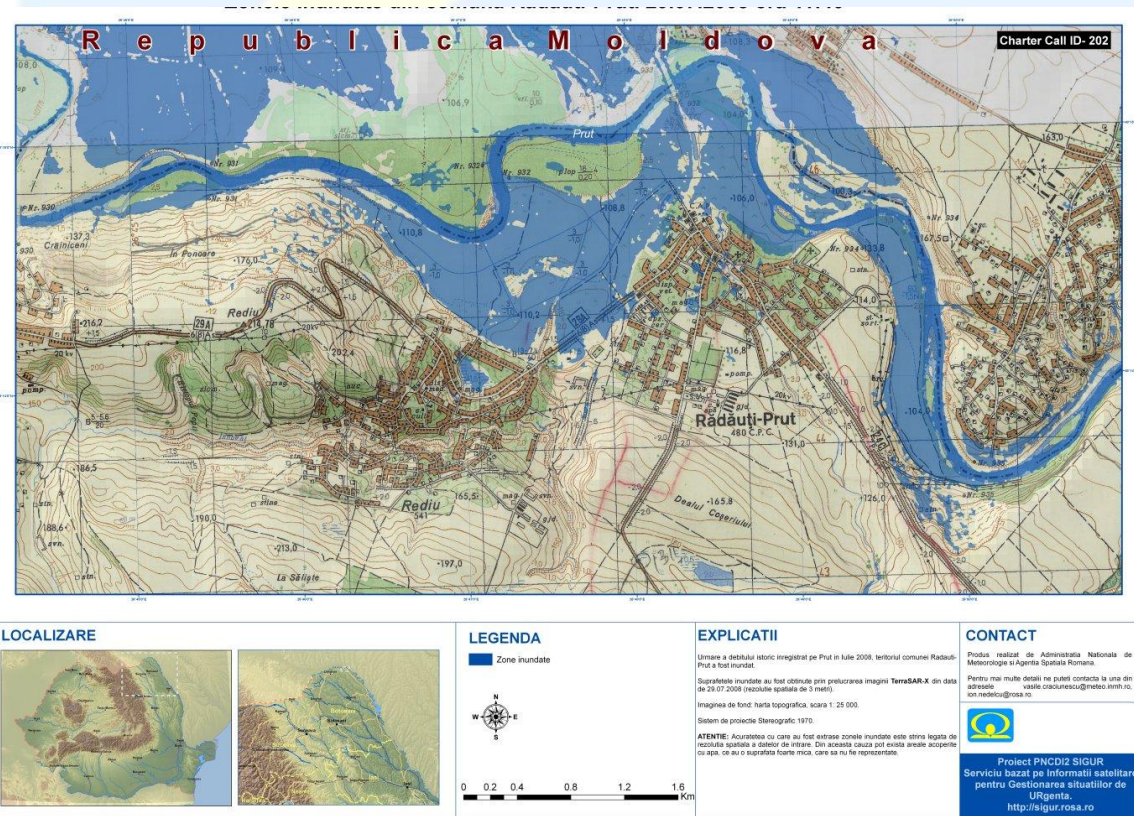
# FLOOD MONITORING USING SATELLITE DATA

# Flow chart

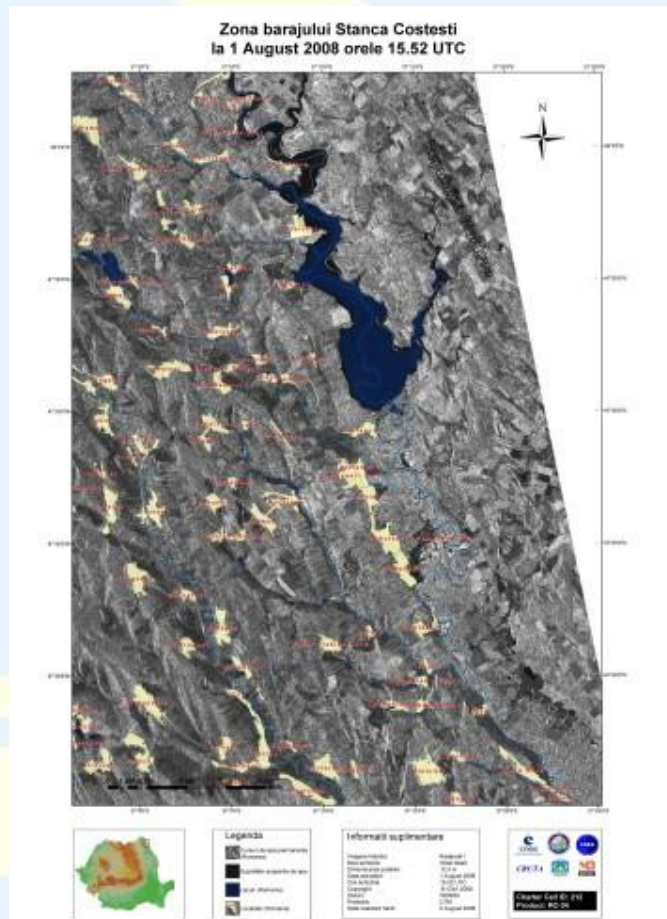


# NE of Romania along Prut River

## Map of the flooded areas – 27<sup>th</sup> of July - 3<sup>rd</sup> of August 2008



**Flooded areas in Rădăuți – Prut, based on TERRA-SAR – X, 29.07.2008**



**Flooded areas at Stâncă Costești Dam, based on RADARSAT, 1.08.2008**

# E of Romania along Siret River

## Map of the flooded areas – 27<sup>th</sup> of July - 3<sup>rd</sup> of August 2008

Romania. Flooded areas along Siret river: Sector Rachiteni - Săucești.  
28.07.2008 08:55 UTC



### LOCATION



### LEGEND



0 2 4 8 12 16 Km

**INTERPRETATION**  
Following the National Emergency response in July 2008 on Siret river Sector of Rachiteni and the river area flooded. The flooded areas were extracted from the SPOT 4 image, acquired on 27.07.2008 on 08:55 UTC. The temporal image (SPOT 4 mosaic - spatial resolution 10 meters) presents the situation in 2008.  
Projection: Stereographic 1970 (EPSG: 31700).

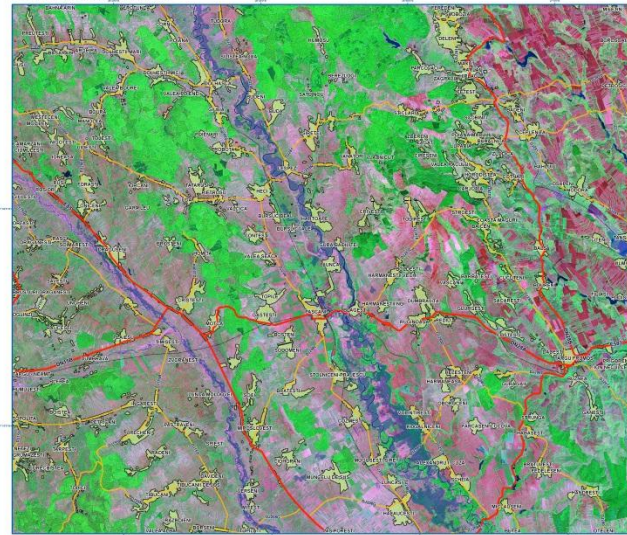
**CONTACT**  
The product was obtained by the National Meteorological Administration (Romania) from the MODIS satellite data for the Romanian Sector Rachiteni. For more details you can contact us by using one of the following e-mail addresses: [meteo@meteo.gov.ro](mailto:meteo@meteo.gov.ro) or [info@meteo.gov.ro](mailto:info@meteo.gov.ro).



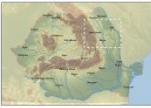
Charter Call ID- 212

Product no. RO-05

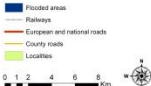
Romania. Flooded areas along Siret river: Sector Dolhasca - Hălăucești.  
28.07.2008 08:55 UTC



### LOCATION



### LEGEND



0 1 2 4 6 8 Km

**INTERPRETATION**  
Following the National Emergency response in July 2008 on Siret river Sector of Dolhasca and the river area flooded. The flooded areas were extracted from the MODIS 4 image, acquired on 28.07.2008 on 08:55 UTC. The temporal image (LANDSAT mosaic - spatial resolution 15 meters) presents the situation in 2008.  
Projection: Stereographic 1970 (EPSG: 31700).

**CONTACT**  
The product was obtained by the National Meteorological Administration (Romania) from the MODIS satellite data for the Romanian Sector Dolhasca. For more details you can contact us by using one of the following e-mail addresses: [meteo@meteo.gov.ro](mailto:meteo@meteo.gov.ro) or [info@meteo.gov.ro](mailto:info@meteo.gov.ro).

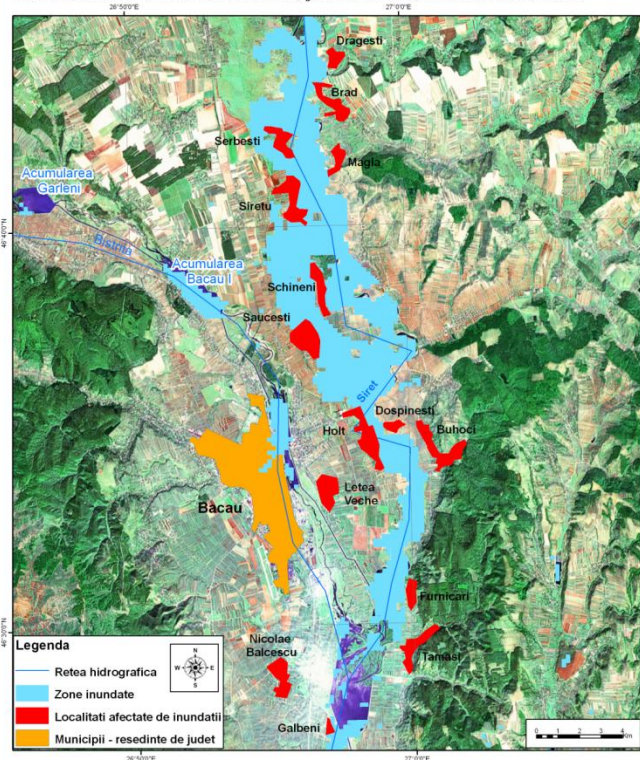


Charter Call ID- 212

Product no. RO-07

Flooded areas in Răchitești-Săucești, based on SPOT 4, 28.07.2008

Zonele inundate din Lunca Siretului, judetul Bacau, 29.07.2008 ora 11:20



### EXPLICATII

Suprafețele inundate au fost obținute prin preluarea imaginii MODIS TERRA din data de 29.07.2008 (rezoluție spațială 250m), la 11.20 TL.

Sistemul de proiectie Stereografic 1970.

Imaginea de fond, mozaic LANDSAT ETM+ (rezoluție spațială 15 m)

Acuratețea cu care au fost extrase zonele inundate este strâns legată de datele de intrare. Din aceasta cauză pot exista areale acoperite cu apă (cu suprafețe mici) care nu sunt reprezentate.

### CONTACT

Procesul realizat de Administrația Națională de Meteorologie, Laboratorul de Teledetectie și SIG

Pentru mai multe detalii ne puteți contacta la telefonul +40213183240 int.163



Flooded areas along Siret River, Bacău County, based on MODIS, 29.07.2008

# Romania – Lower Danube, Bechet sector

## Maps of the flooded areas – April-May 2006

Zonele inundate din Lunca Dunarii: Sector Bechet - Corabia. 16.05.2006 ora 11:00



### LOCALIZARE



### LEGENDA

- Rețea hidrografică (nivel de referință)
- Digi
- Zone inundate
- Drumuri europene sau naționale
- Drumuri județene
- Drumuri comunale, de exploatare, străzi
- Căi ferate
- Localități

00:51 2 3 4  
Km



### EXPLICATII

Urmare a debarșii istoric înregistrat pe Dunare în Aprilie 2006, digul ce protejează terenurile agricole din satul județului Gaj a cedat în data de 23.04.2006 pe teritoriul localității Sarata.

Suprafețele inundate au fost obținute prin prelucrarea imaginii MODIS/TERRA din data de 10.05.2006 (rezoluție spațială de 250 metri).

Imagiile de fond, produsă LANDSAT ETM+ (rezoluție spațială de 30 metri), prezintă situația terenului în anul 2000.

Sistem de proiectare Stereografic 1970.

**ATENȚIE:** Actualizarea cu care au fost extrase zonele inundate este stricte legată de rezoluția spațială a datelor de intrare. Din această cauză pot exista anumite acoperiri cu apă, ce au o suprafață mai mică de 250<sup>2</sup>, care nu au fost reprezentate.

### CONTACT

Proiect realizat de Administrația Națională de Meteorologie, Laboratorul de Telemetrie și GIS.

Pentru mai multe detalii vă rugăm contactați la adresă: inm@inmh.ro sau la telefon: +40 21 318 32 40 - lin. 103.

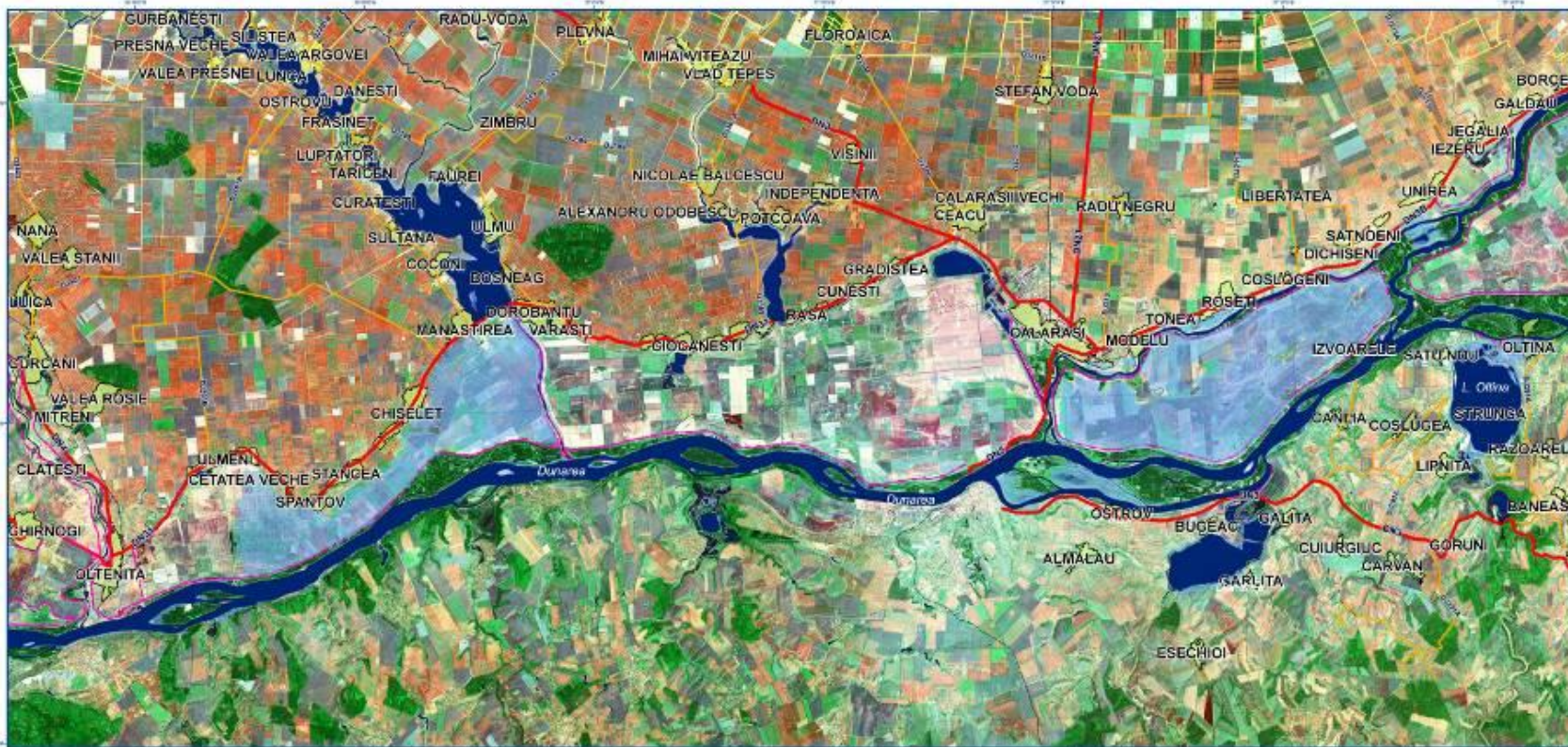


Proiect NATO SIF 978016  
Monitoring of extreme flood events in  
Romania and Hungary using EO data.  
<http://nato.inmh.ro>

# Romania – Lower Danube, Calarasi sector

## Maps of the flooded areas – April-May 2006

Zonele inundate din Lunca Dunarii: Sector Oltenita - Calarasi. 16.05.2006 ora 11:00

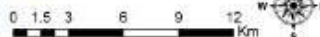


### LOCALIZARE



### LEGENDA

- Rețea hidrografică (nivel de referință)
- Digi
- Zone inundate
- Drumuri europene sau naționale
- Drumuri județene
- Drumuri comunale, de exploatare, străzi
- Căi ferate
- Localități



### EXPLICATII

Urmare a deborșării istorice înregistrată pe Dunare în Aprilie 2006, după ce proțega terenurile agricole din jurul județului Calarasi a cedat în data de 24.04.2006 pe cordonul din jurul Spantov. Apoi revărsată s-a și asupra porțiunii de miază de sud a Oltenitei.

Anterior, în data de 28.04.2006 s-a produs o înșurubire în digul de apărare brăzii Dunării de la sat Oltena. Datorită cvasitotalității înălțării a fost amenințată localitatea Oltena.

Suprafețele inundate au fost obținute prin prelucrarea imaginii MODIS/TERRA din data de 13.05.2006 (rezoluție spațială de 250 metri).

Imaginile de fond, mosaic LANDSAT ETM+ (rezoluție spațială de 15 metri), provința din data 20.01.2006.

Sistem de proiecție: Biografic 1970

**ATENȚIE!** Actualitatea cu care au fost extrase zonele inundate este strâns legată de rezoluția spațială a datelor de intrare. Din acest motiv pot exista anomalii, scoperte sau așa, ce au o suprafață mai mică de 200', care nu au fost reprezentate.

### CONTACT

Proiect realizat de Administrația Națională de Meteorologie, Laboratorul de Telemetrie și GIS

Pentru mai multe detalii vă rugăm să contactați la adresa: [inm@meteo.ro](mailto:inm@meteo.ro) sau la telefon: +40 21 318 32 40 - int. 105.

Romania



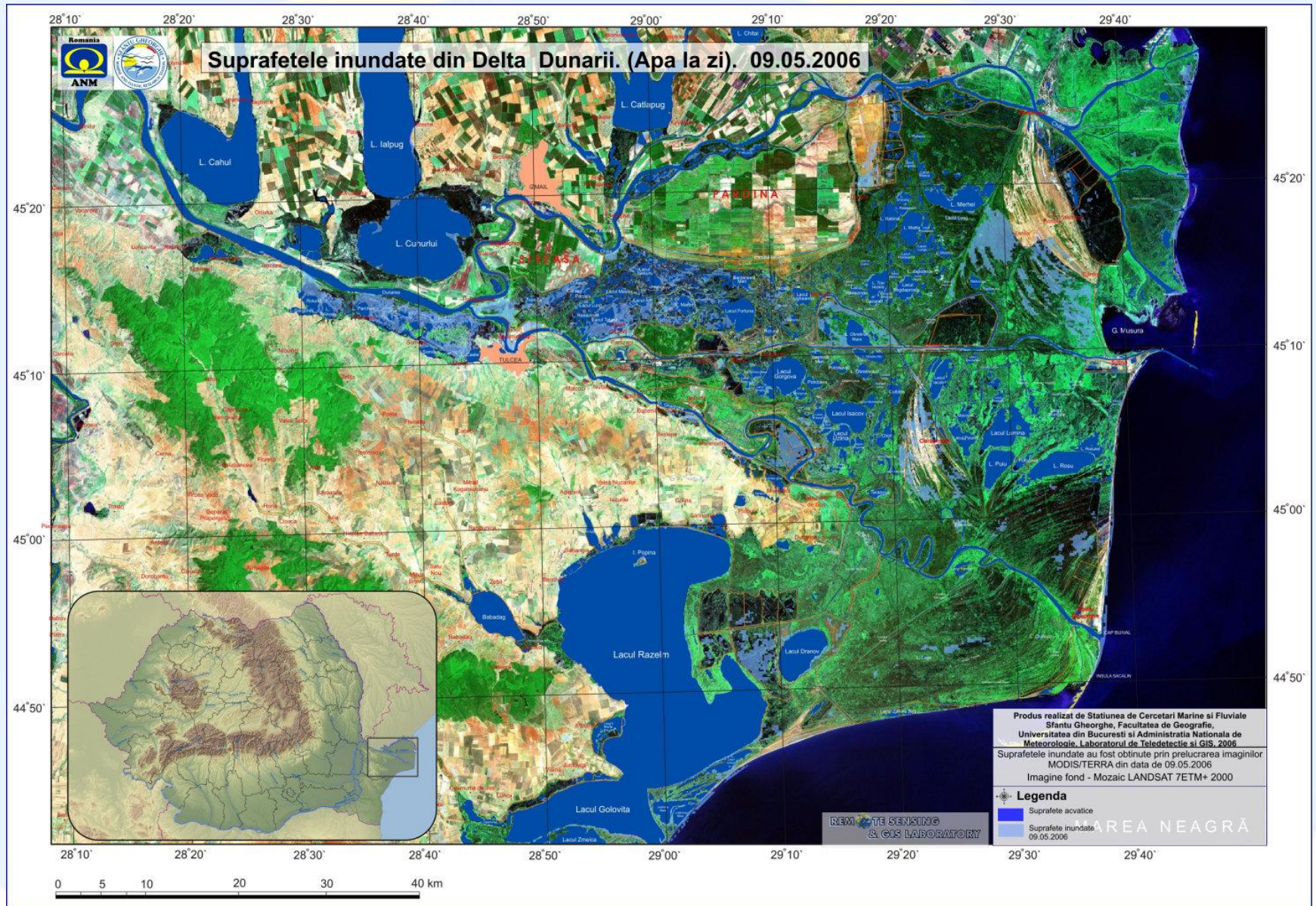
ROMANIA  
INSTITUTUL NAȚIONAL DE METEOROLOGIE  
<http://www.inmh.ro>

Proiect NATO SIP 978D16  
Monitoring of extreme flood events in  
Romania and Hungary using EO data.  
<http://nato.inmh.ro>



# Romania – Lower Danube, Danube Delta

## Maps of the flooded areas – April-May 2006



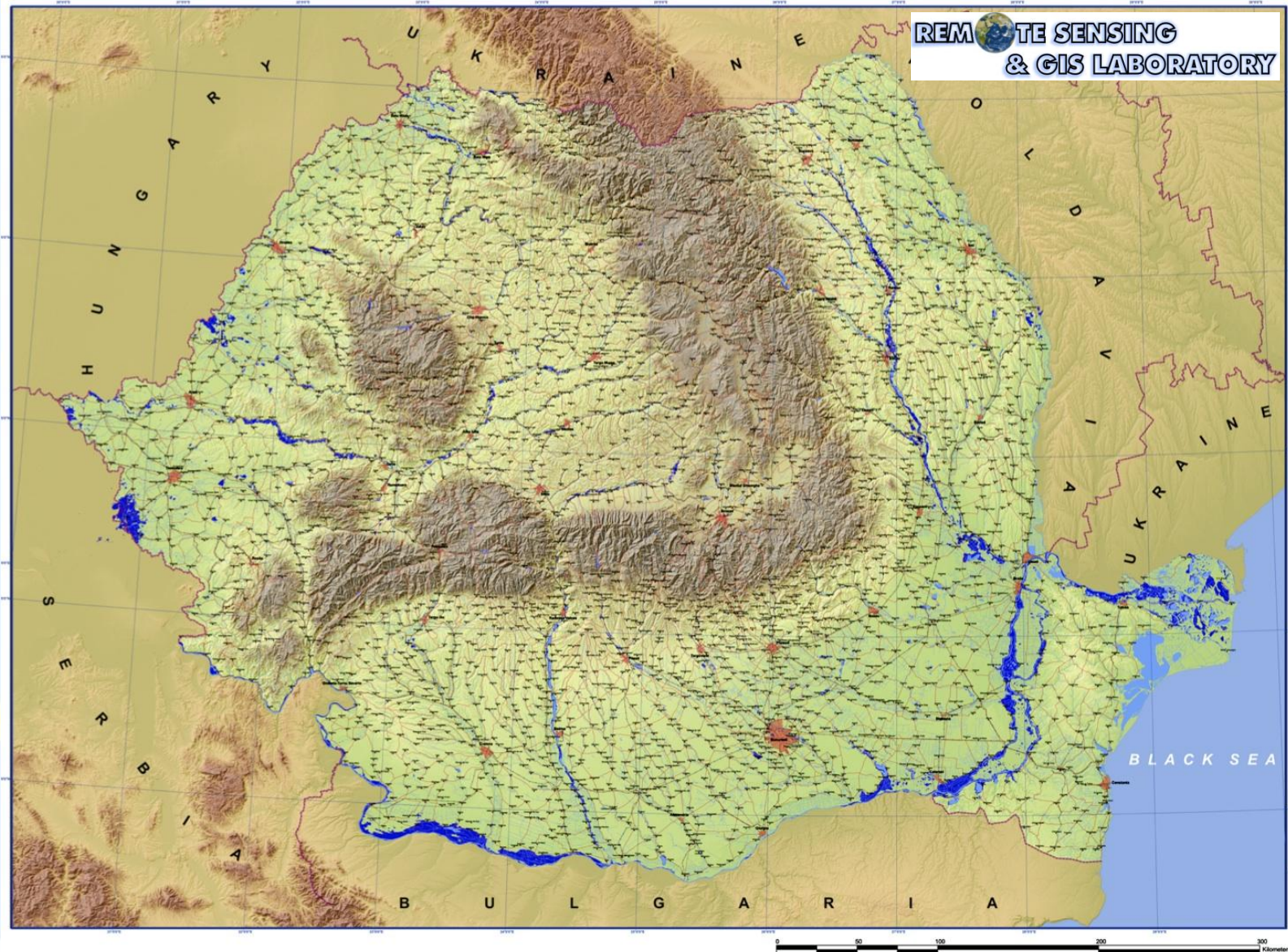
# Map animation: Romania – Lower Danube, Rast sector, April - May 2006

Zonele inundate din Lunca Dunarii: Sector Ghidici - Rast - Bistret - Macesu de Jos

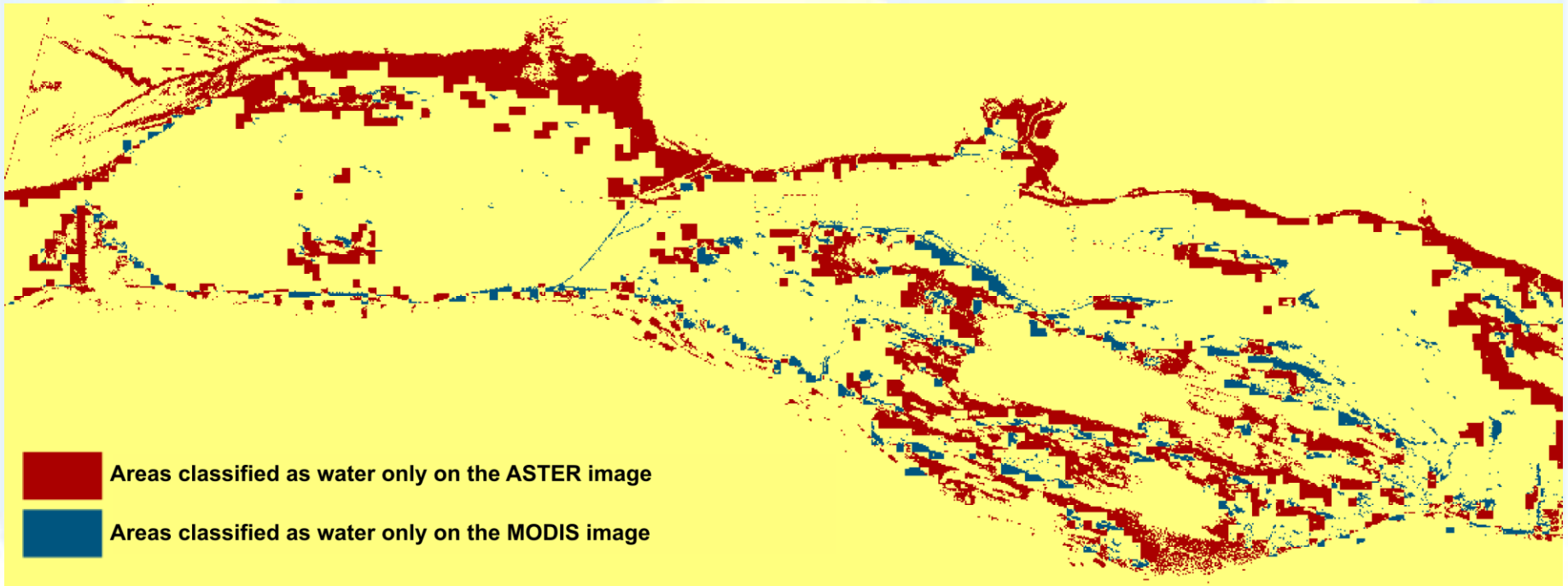
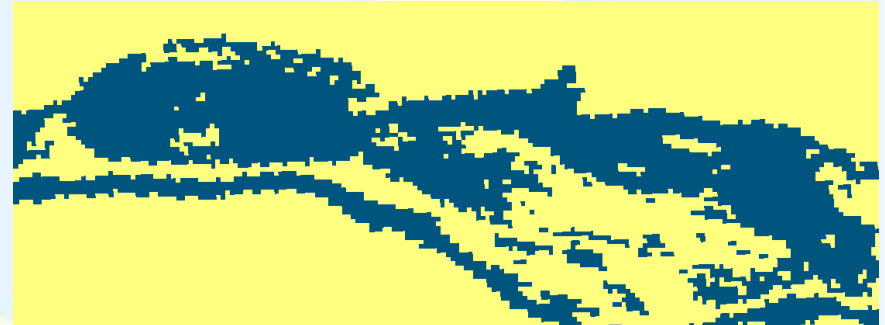
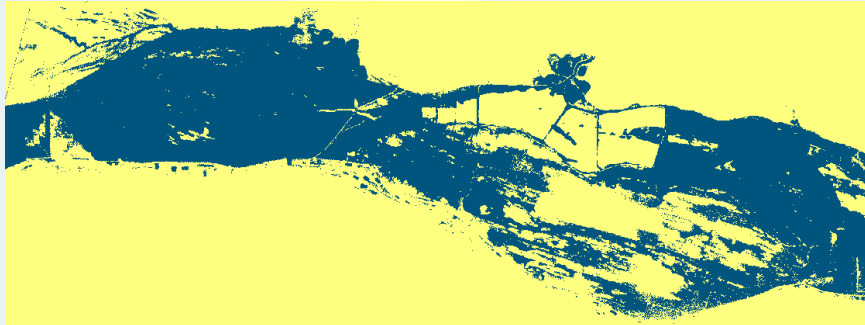
01.04.2006



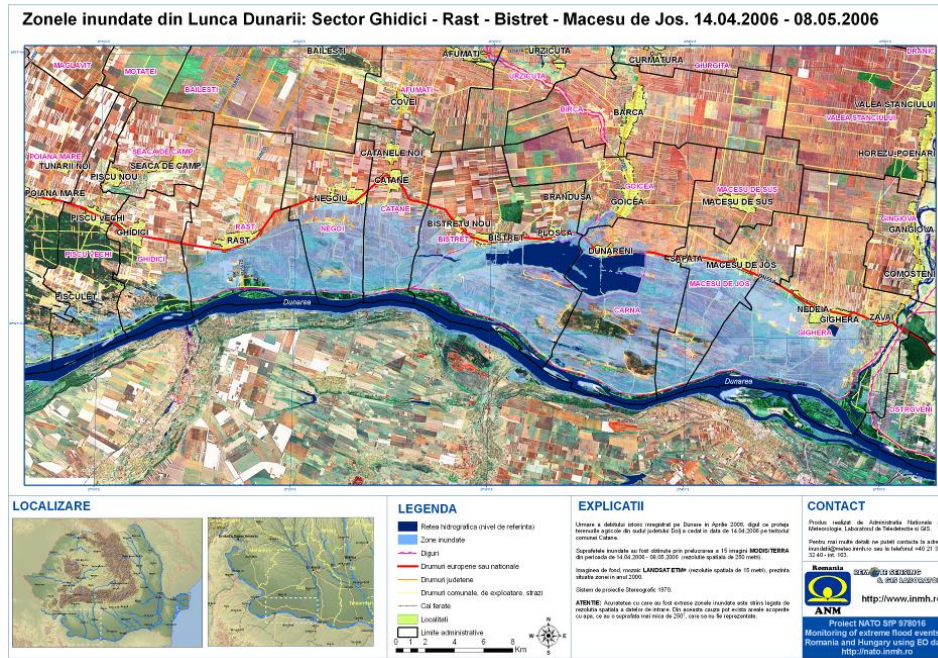
# Flood hazard map for Romania, based on MODIS data for 2000-2014



# Validation example

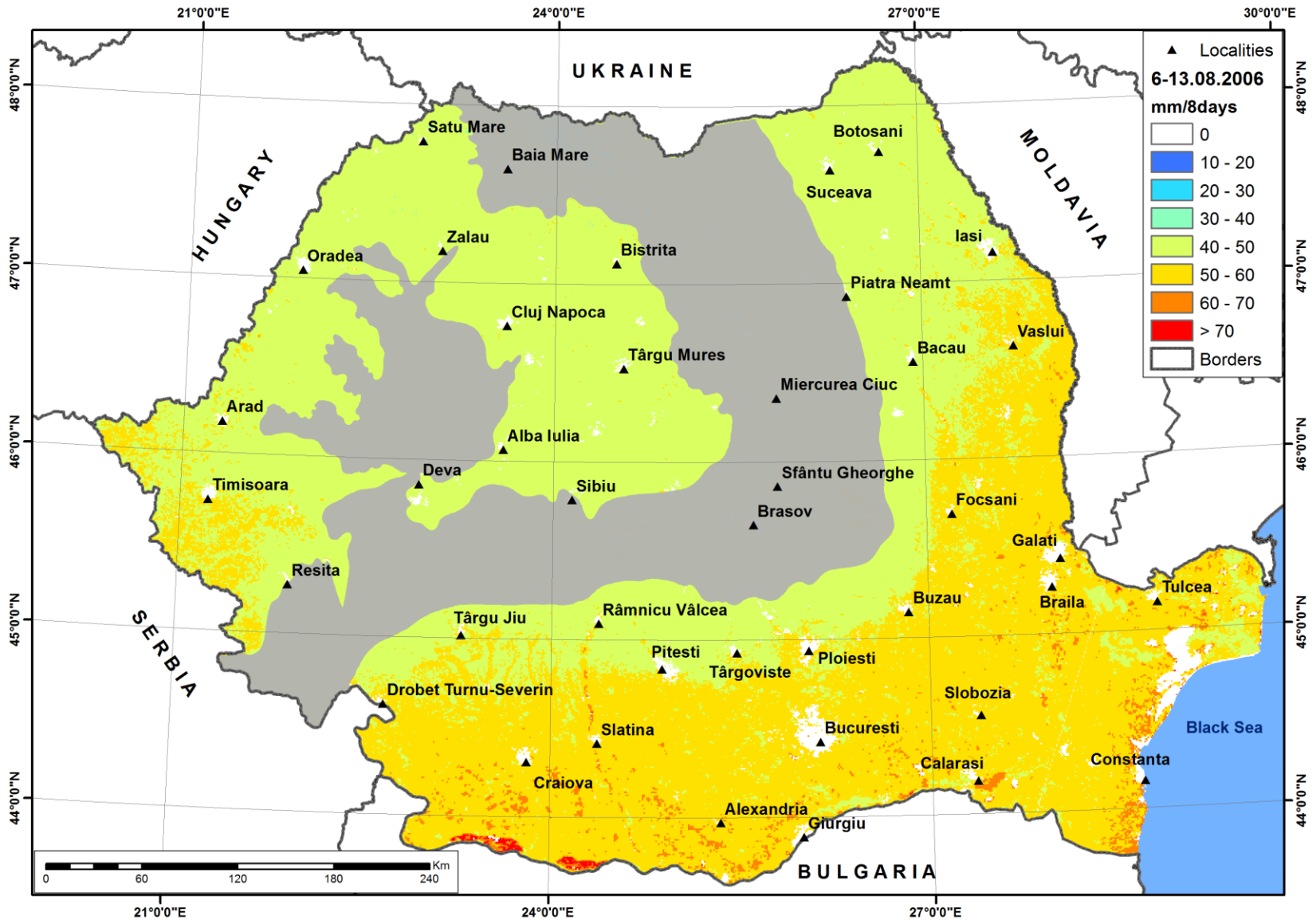


# Estimation of the affected areas Romania – Lower Danube, Rast sector



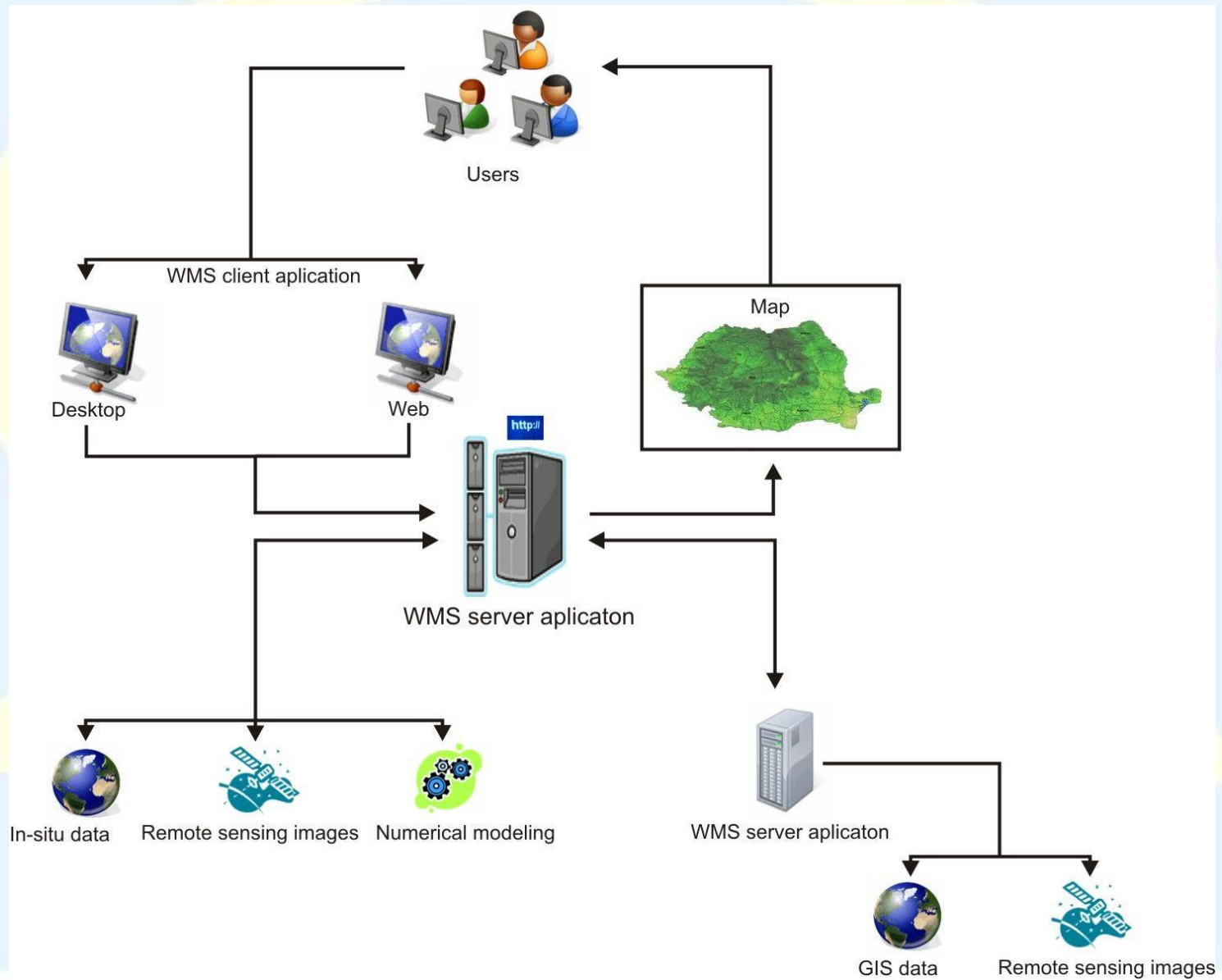
Name	Administrative area (Ha)	Affected area (Ha)	Affected percent of the admin. area (%)
RAST	8452	4500	53,2
BISTRET	12214	6632	54,3
GIGHERA	13154	6894	52,4
OSTROVENI	8245	590	7,2
<b>MACESU DE JOS</b>	<b>5639</b>	<b>3428</b>	<b>60,8</b>
<b>CARNA</b>	<b>8475</b>	<b>5603</b>	<b>66,1</b>
GOICEA	5841	324	5,6
CATANE	4702	2481	52,8
NEGOI	5019	3062	61
GHIDICI	4469	1585	35,5
PISCU VECHI	5782	1506	26,1

# Flood analysis using PET – Lower Danube, Rast sector



# **DROUGHT MONITORING USING SATELLITE DATA**

# Flow chart





# Satellite – Derived Information for Agricultural Drought Monitoring

## Drought prediction

- Assimilation of remotely sensed data into numerical prediction models (e.g. SWAT, crop models)

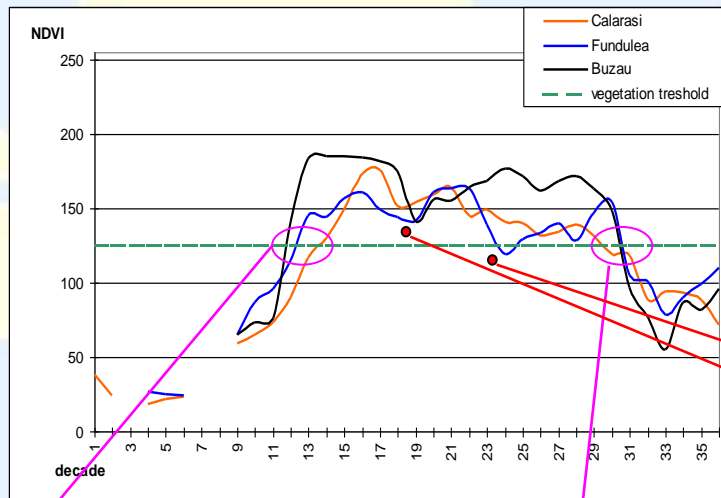
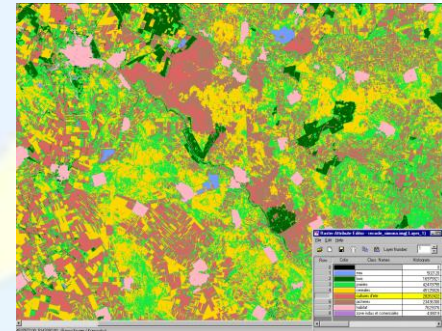
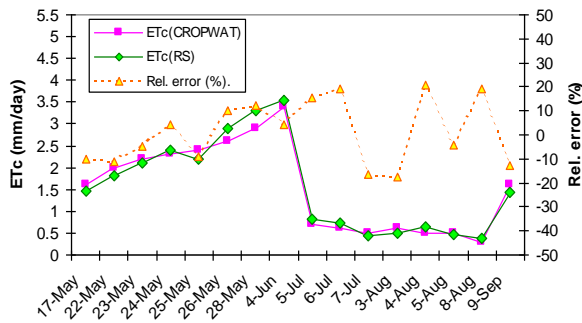
## Monitoring and early warning

- Earth Observations from satellites are highly complementary to those collected by in-situ systems.
- Satellites are often necessary for the provision of synoptic, wide-area coverage and provision of the frequent information required to put in-situ information into broader spatial monitoring of drought conditions.

## Assessment of impacts

- Land use type
- Intensity and areal extent
- Use of satellite data as input for crop model yield estimates.

CRAIOVA



• 01-10.07 plant stress period  
 • 11-21.08 at Fundulea, NDVI drops under Vegetation threshold

-vegetation season starts:  
 21-30.04 – Buzau, Fundulea; 1 –10.05 - Calarasi

-vegetation season ends 1-10.11

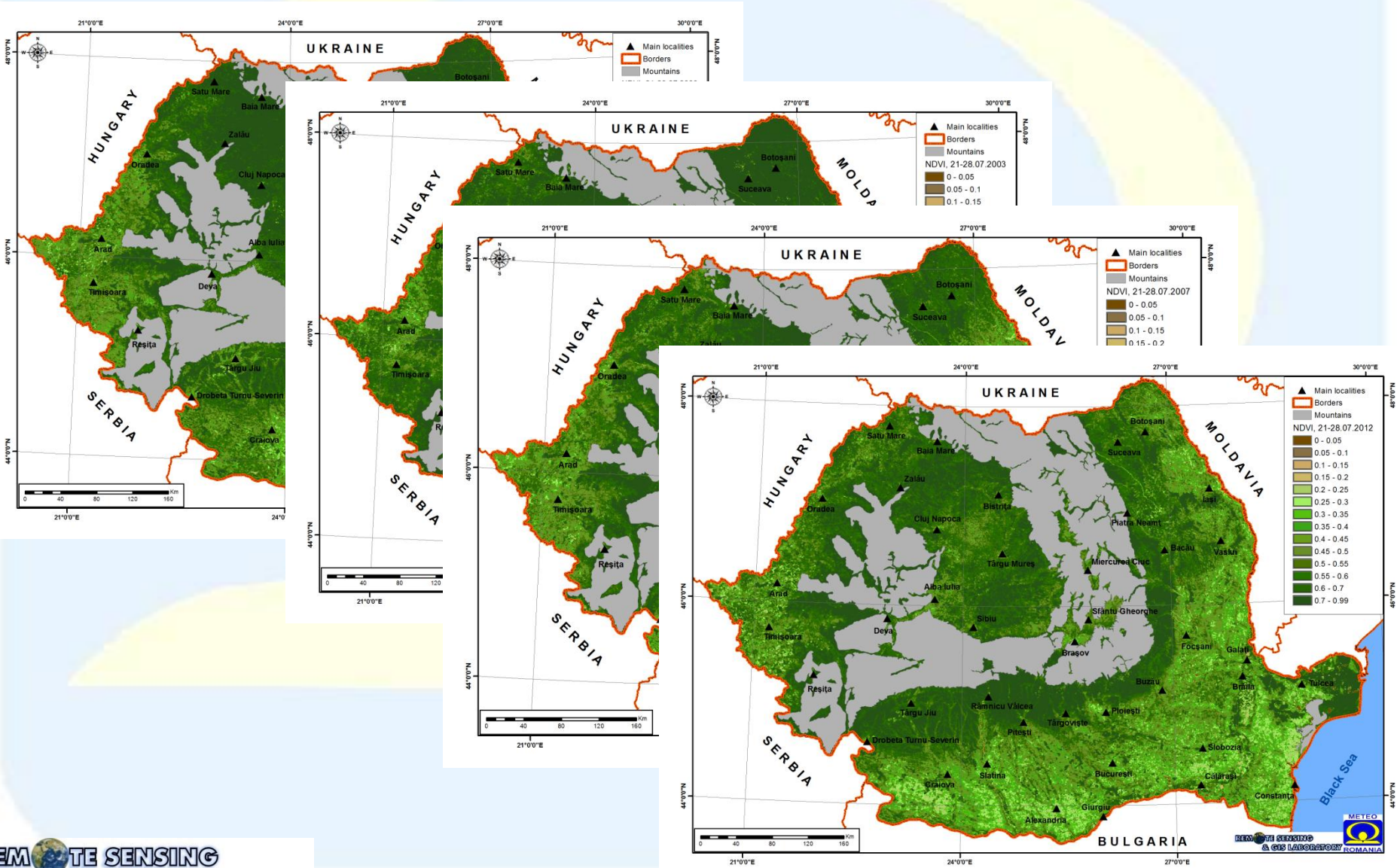


# In-situ measurements – soil moisture and LAI



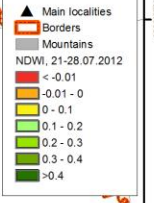
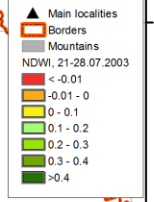
# Vegetation Indices

## Normalised Difference Vegetation Index- NDVI



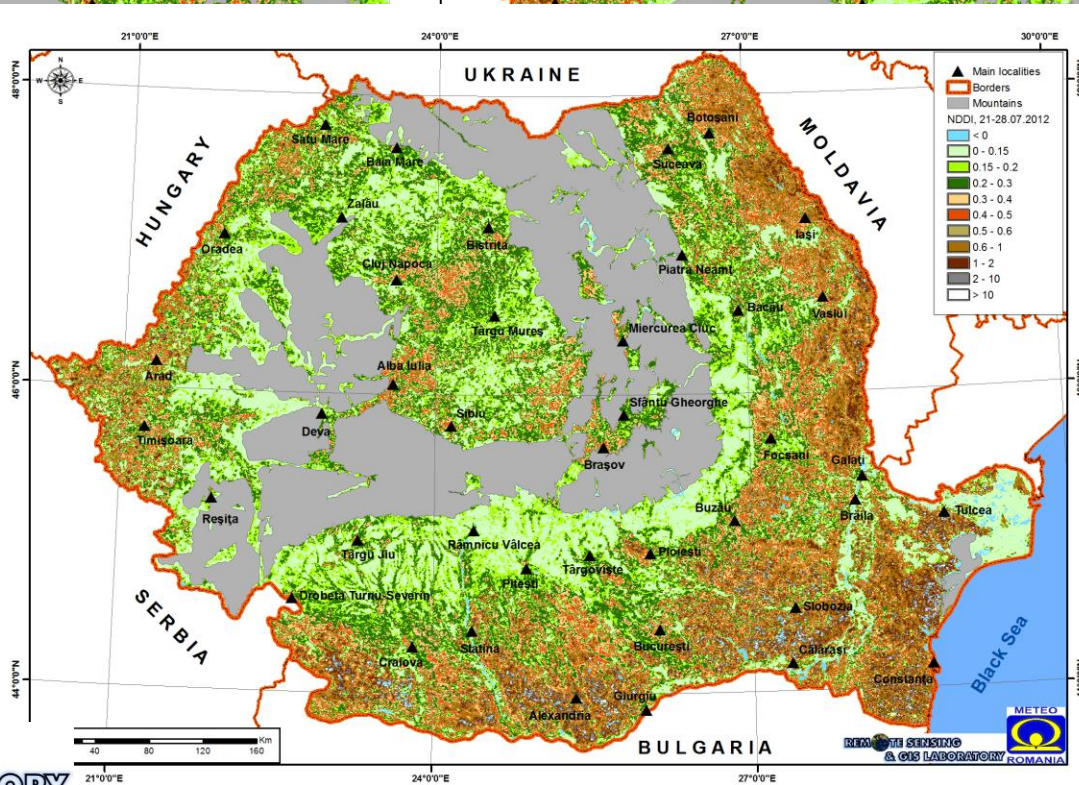
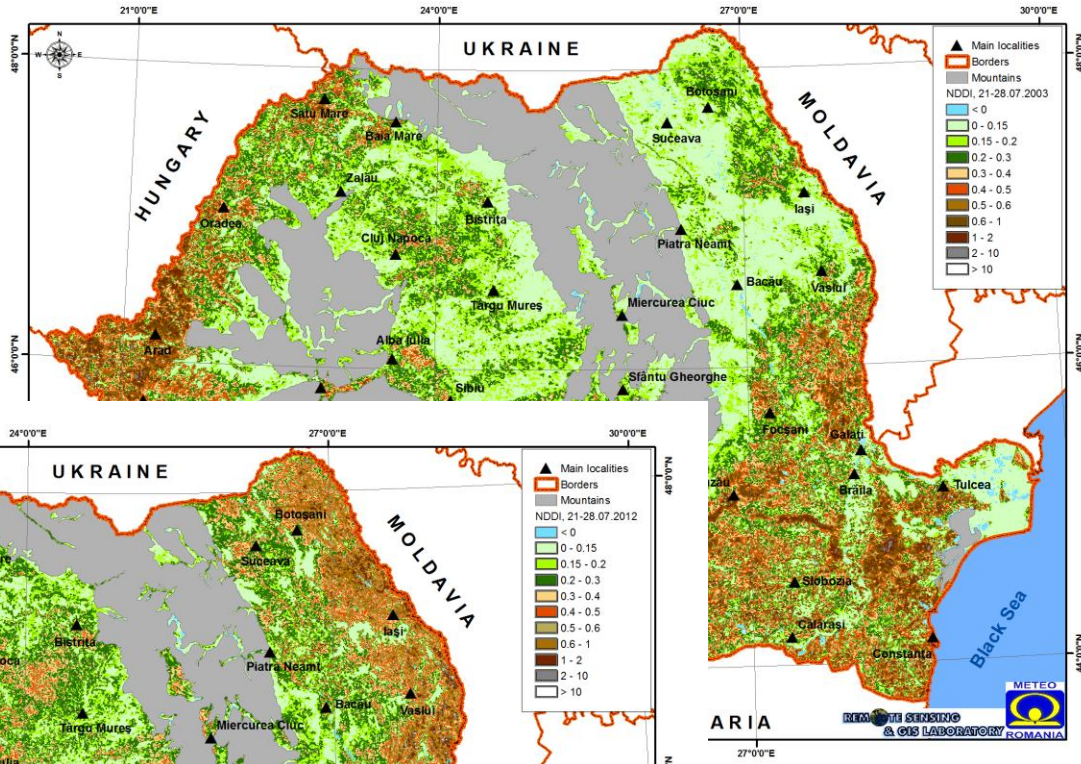
# Vegetation Indices

## Normalised Difference Water Index- NDWI



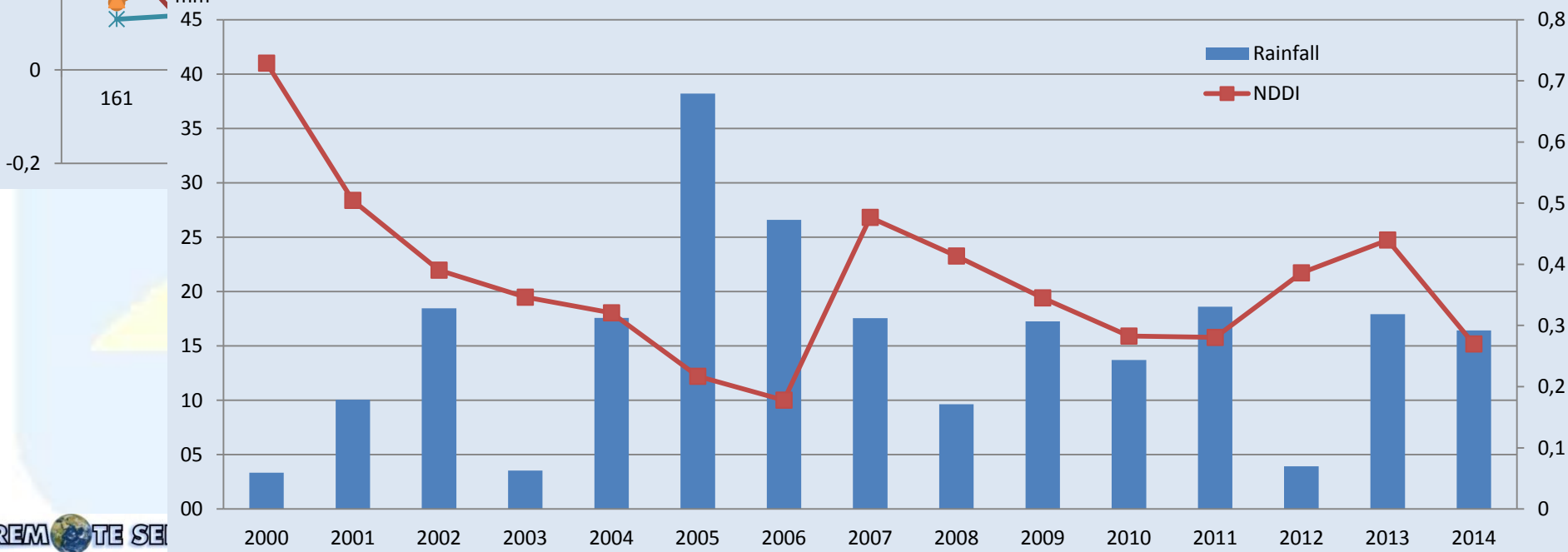
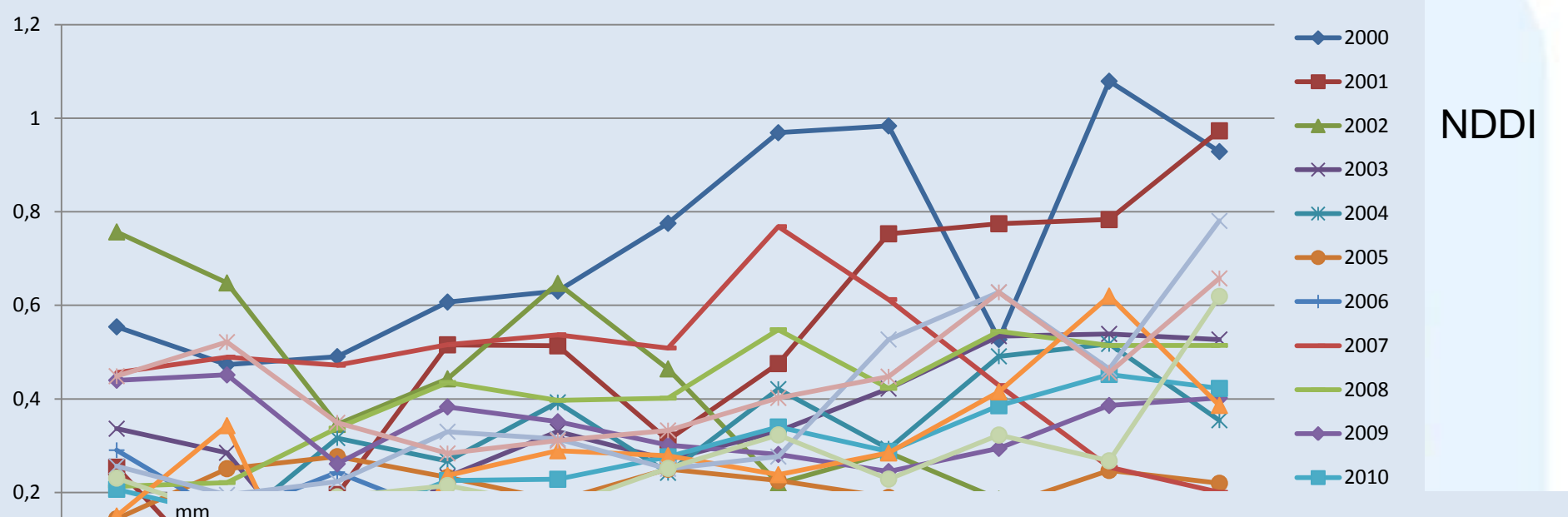
# Vegetation Indices

## Normalised Difference Drought Index- NDDI



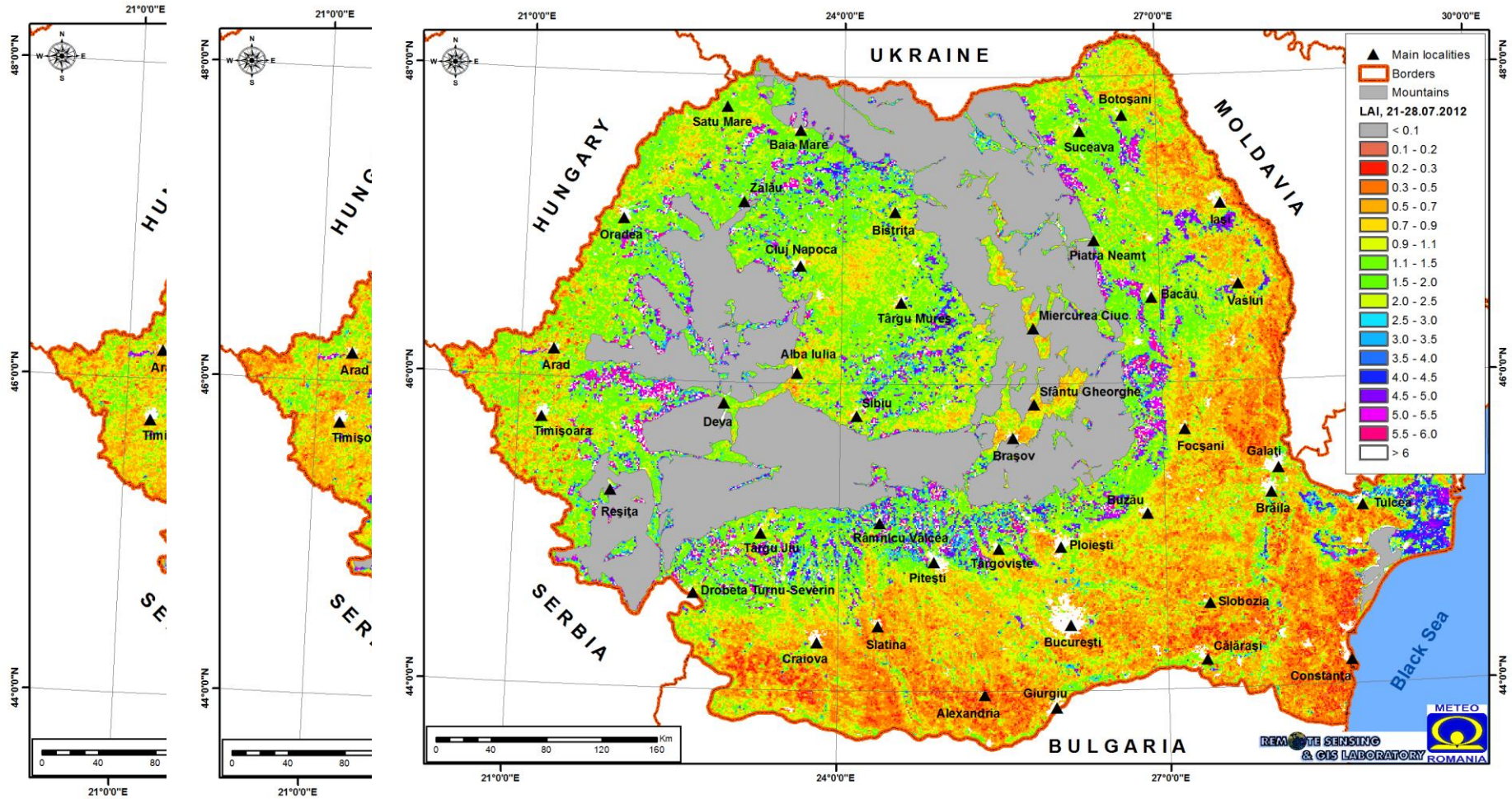
# Long term analysis - Caracal

NDDI



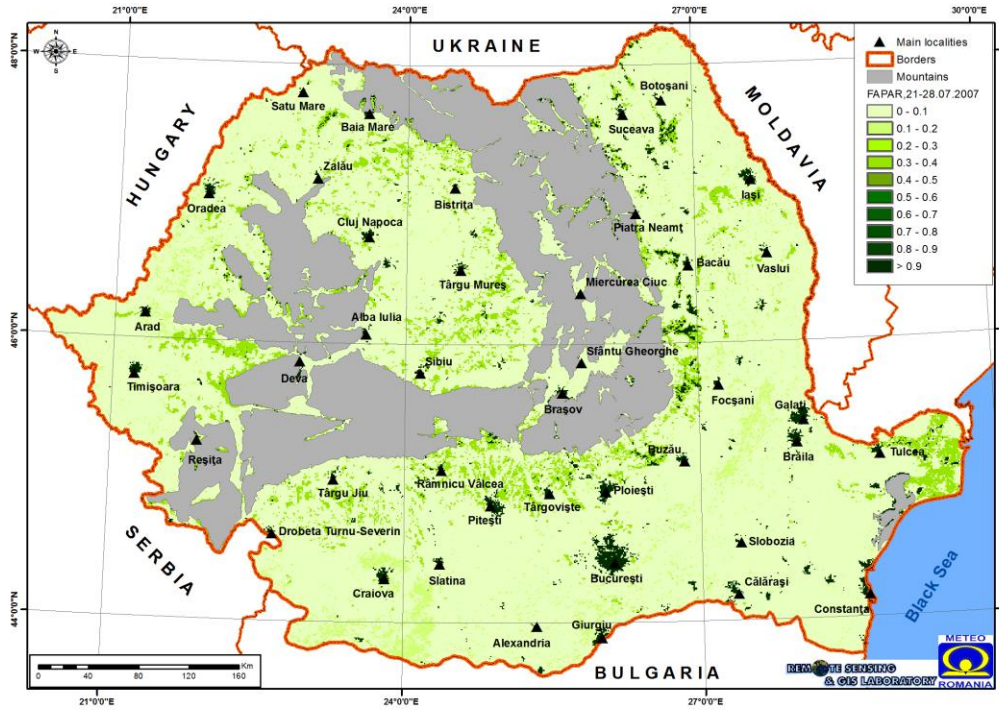
# Vegetation Indices

## Leaf Area Index - LAI



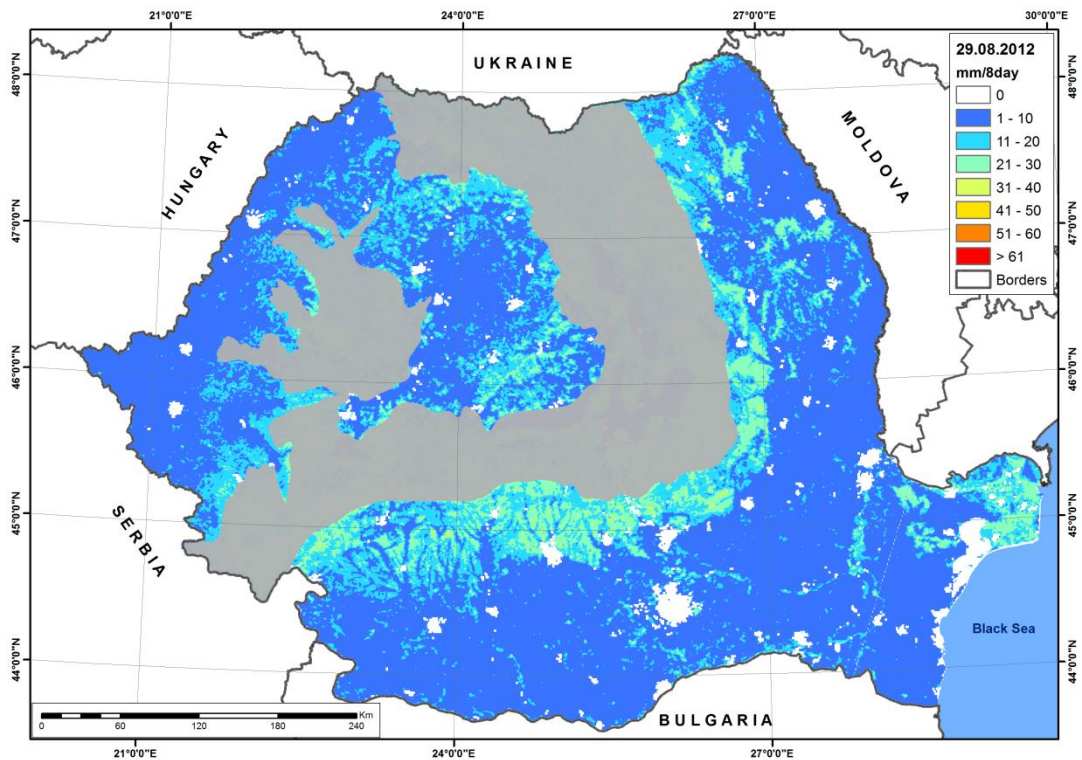
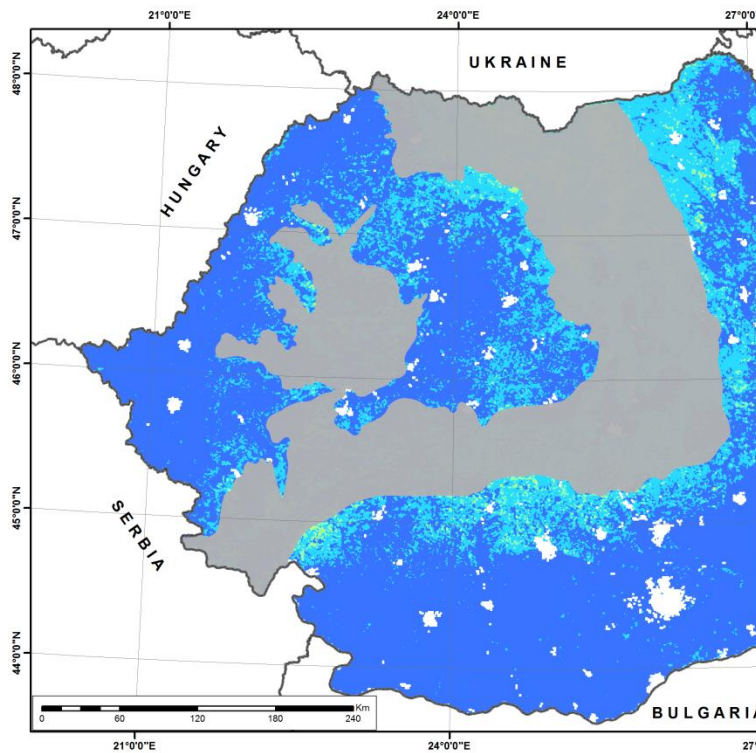
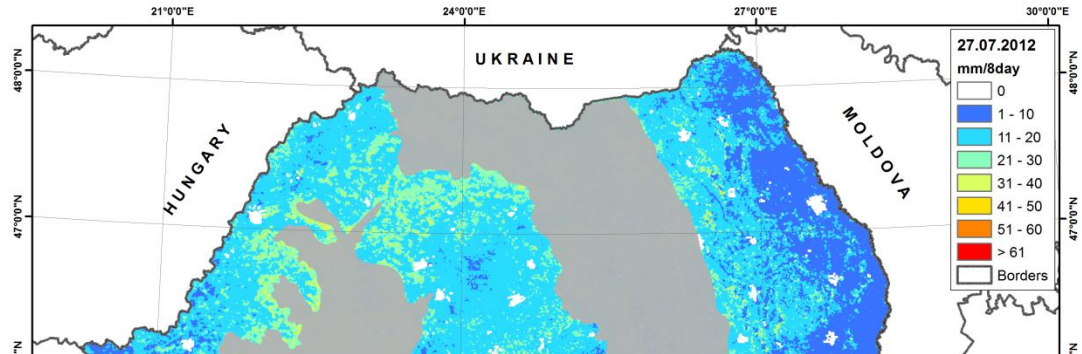
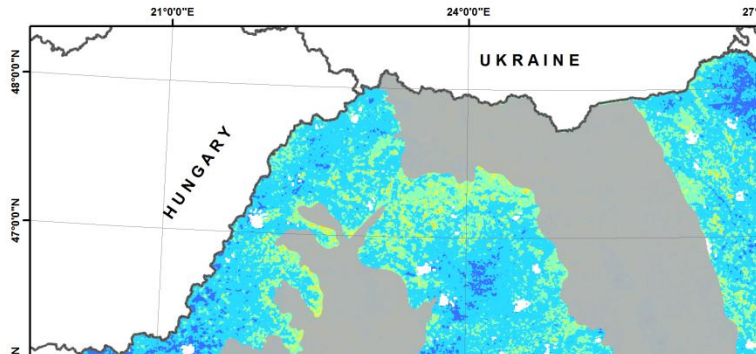
# Vegetation Indices

## The Fraction of Absorbed Photosynthetically Active Radiation - fAPAR

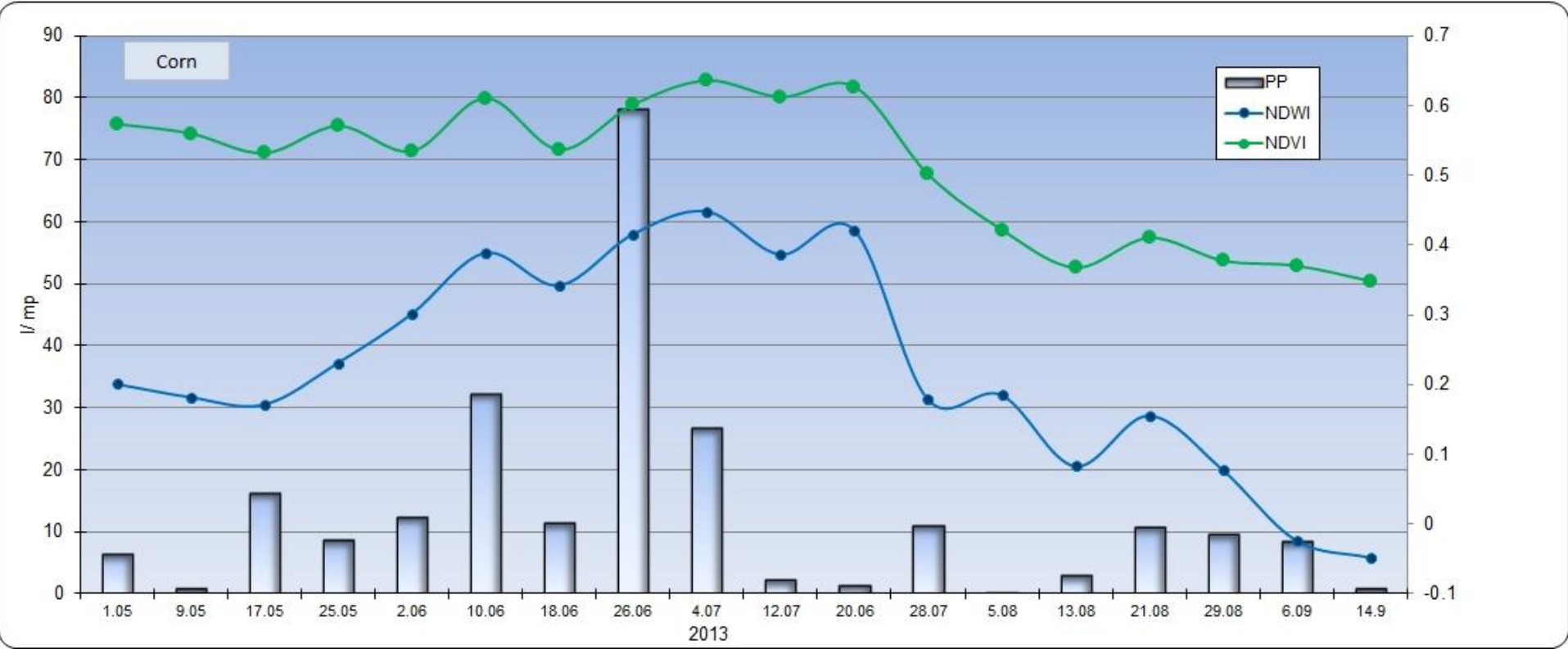
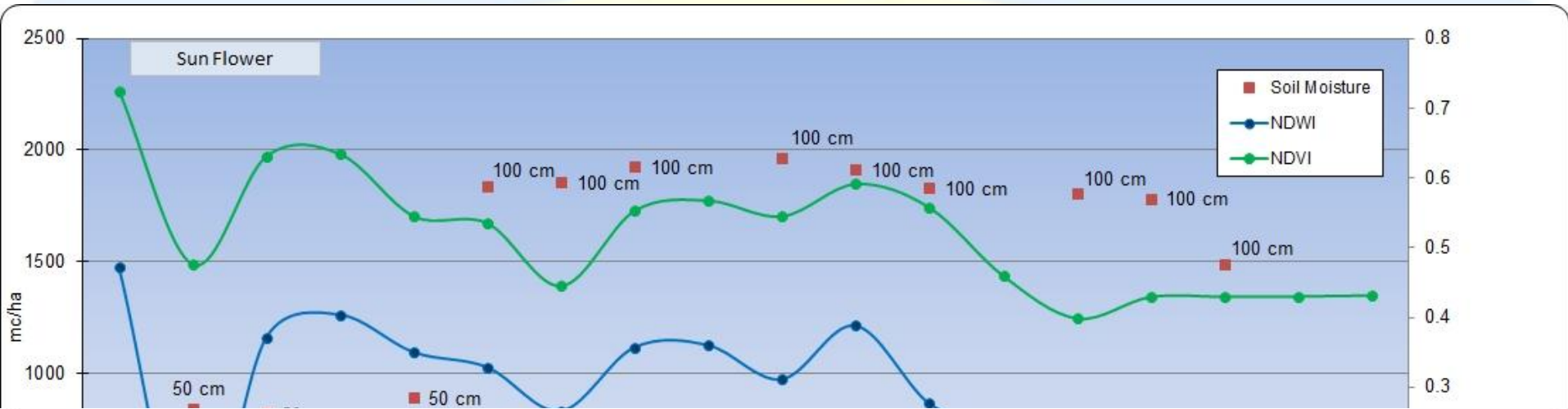




# Potential Evapotranspiration



# Drought analysis

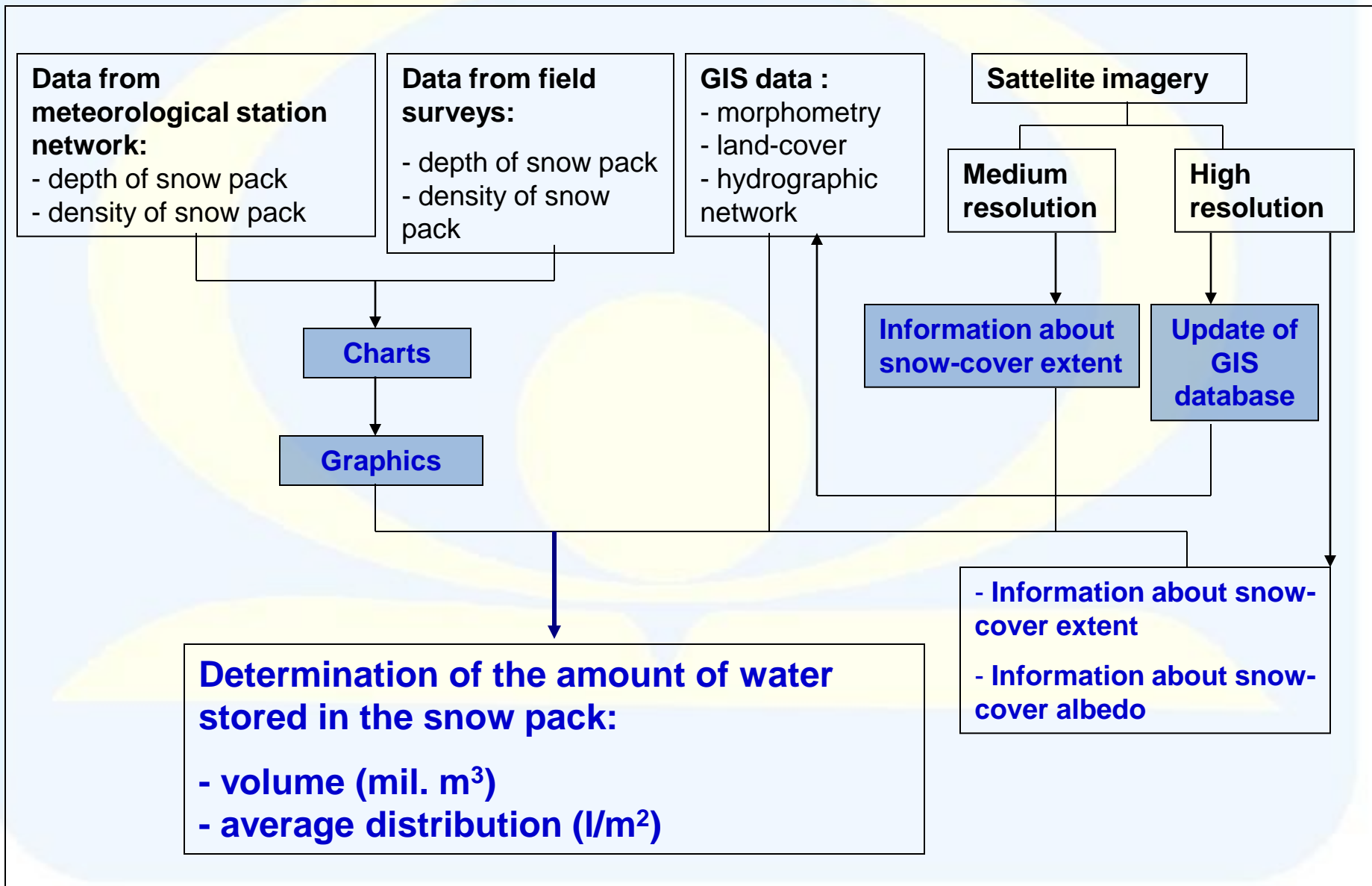


# SNOW MONITORING USING SATELLITE DATA

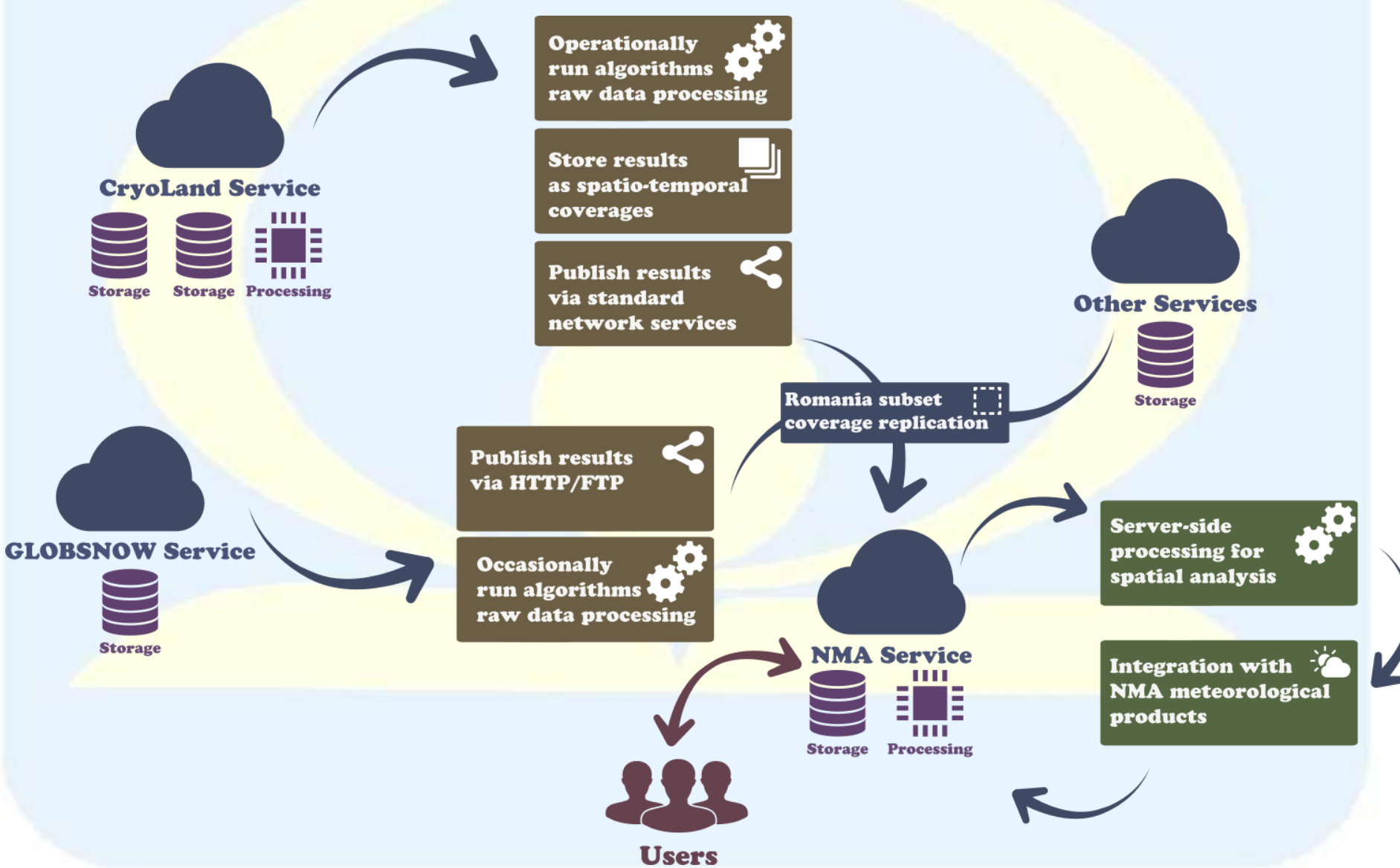
# Snow cover monitoring

- The evaluation of SWE for the main hydrographic basins
- Snow cover extent, albedo and fractional snow cover extent maps

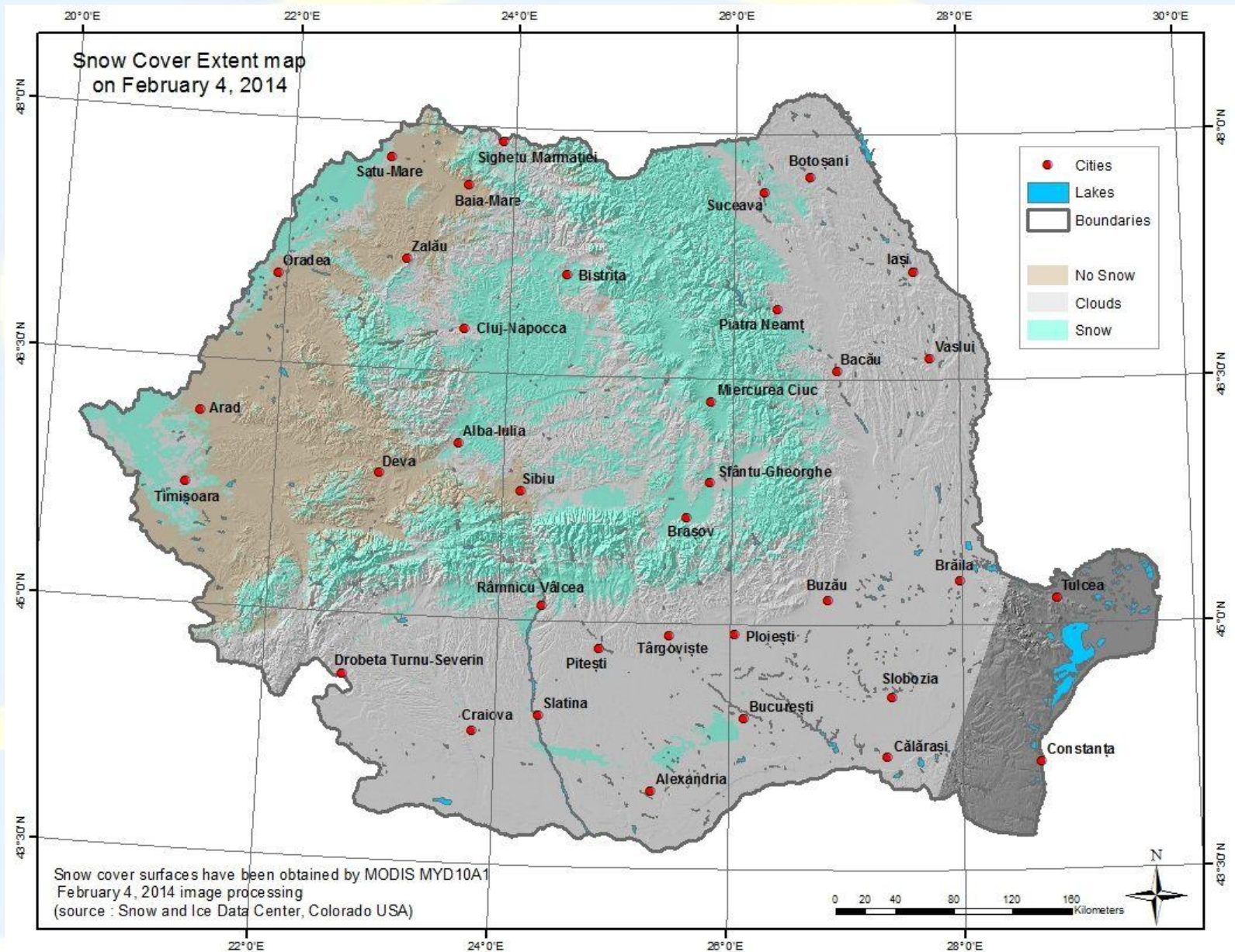
# Flow chart – internal procedure



# Flow chart – Cryoland integration

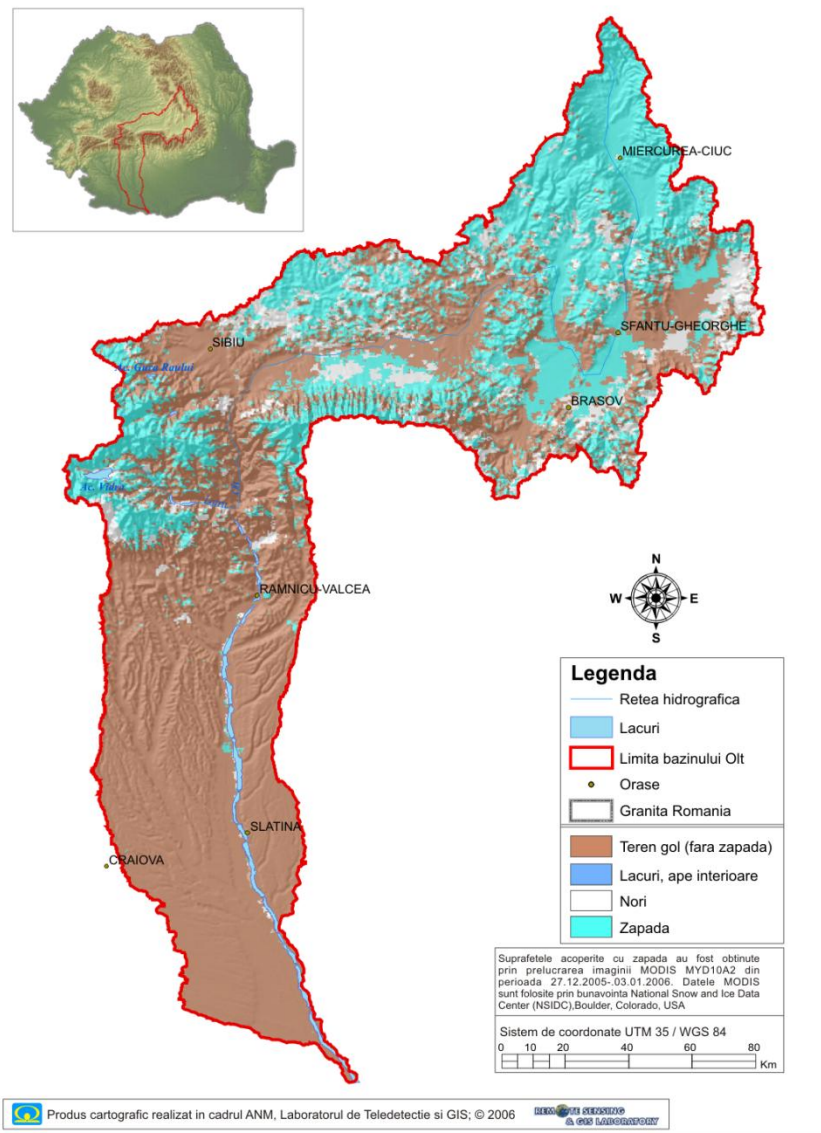


# Snow cover extent map

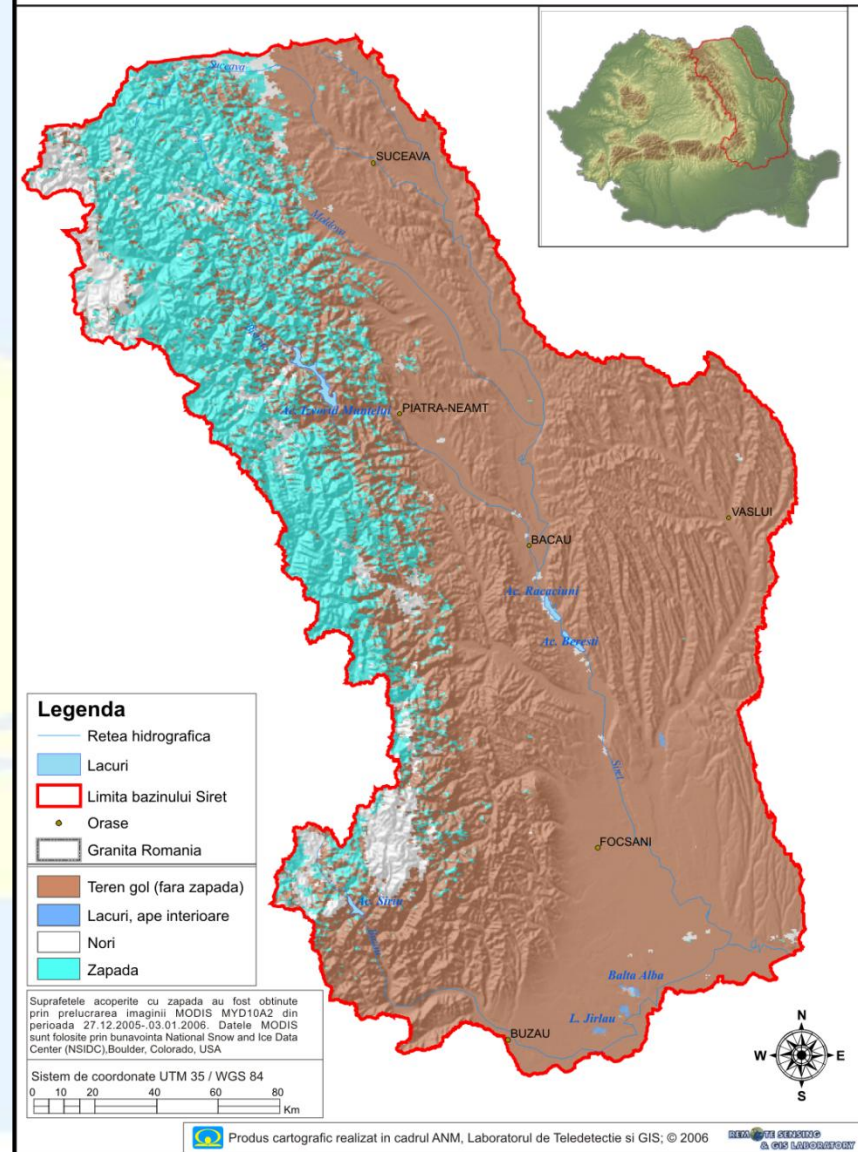


# Snow cover extent map – details for the major hydro. basins

Harta extinderii acoperirii cu zapada - bazinul raului Olt / 27.12.2005-03.01.2006



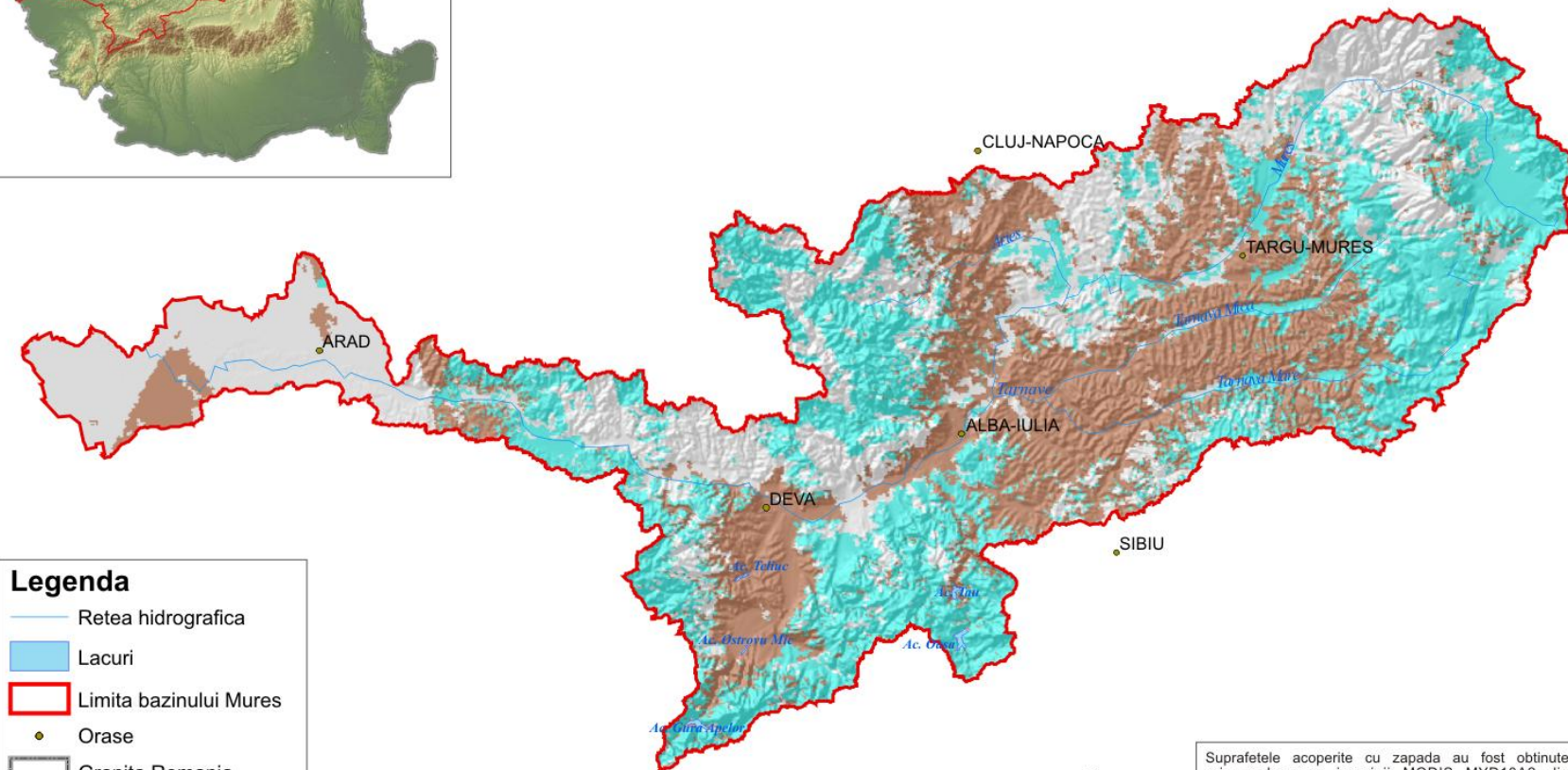
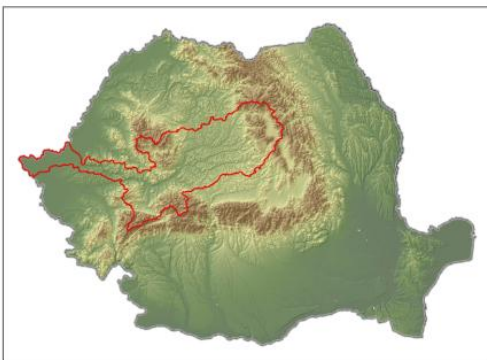
Harta extinderii acoperirii cu zapada - bazinul raului Siret / 27.12.2005-03.01.2006





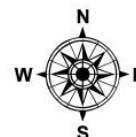
# Snow cover extent map – details for the major hydro. basins

Harta extinderii acoperirii cu zapada - bazinul raului Mures / 27.12.2005-03.01.2006



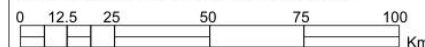
## Legenda

- Retea hidrografica
- Lacuri
- Limita bazinului Mures
- Orase
- Granita Romania
- Teren gol (fara zapada)
- Lacuri, ape interioare
- Nori
- Zapada



Suprafetele acoperite cu zapada au fost obtinute prin prelucrarea imaginii MODIS MYD10A2 din perioada 27.12.2005-03.01.2006. Datele MODIS sunt folosite prin bunavointa National Snow and Ice Data Center (NSIDC), Boulder, Colorado, USA

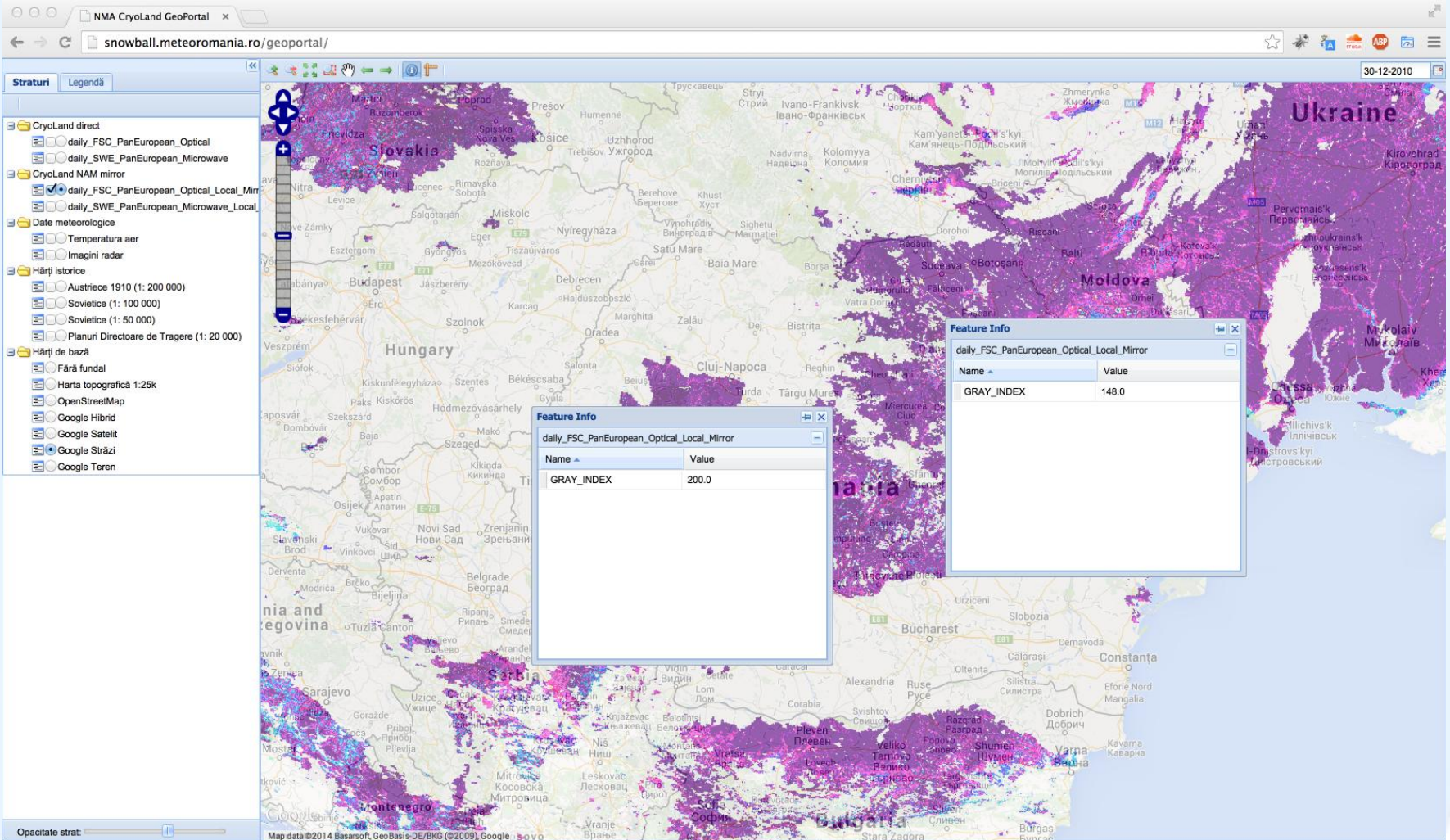
Sistem de coordonate UTM 35 / WGS 84



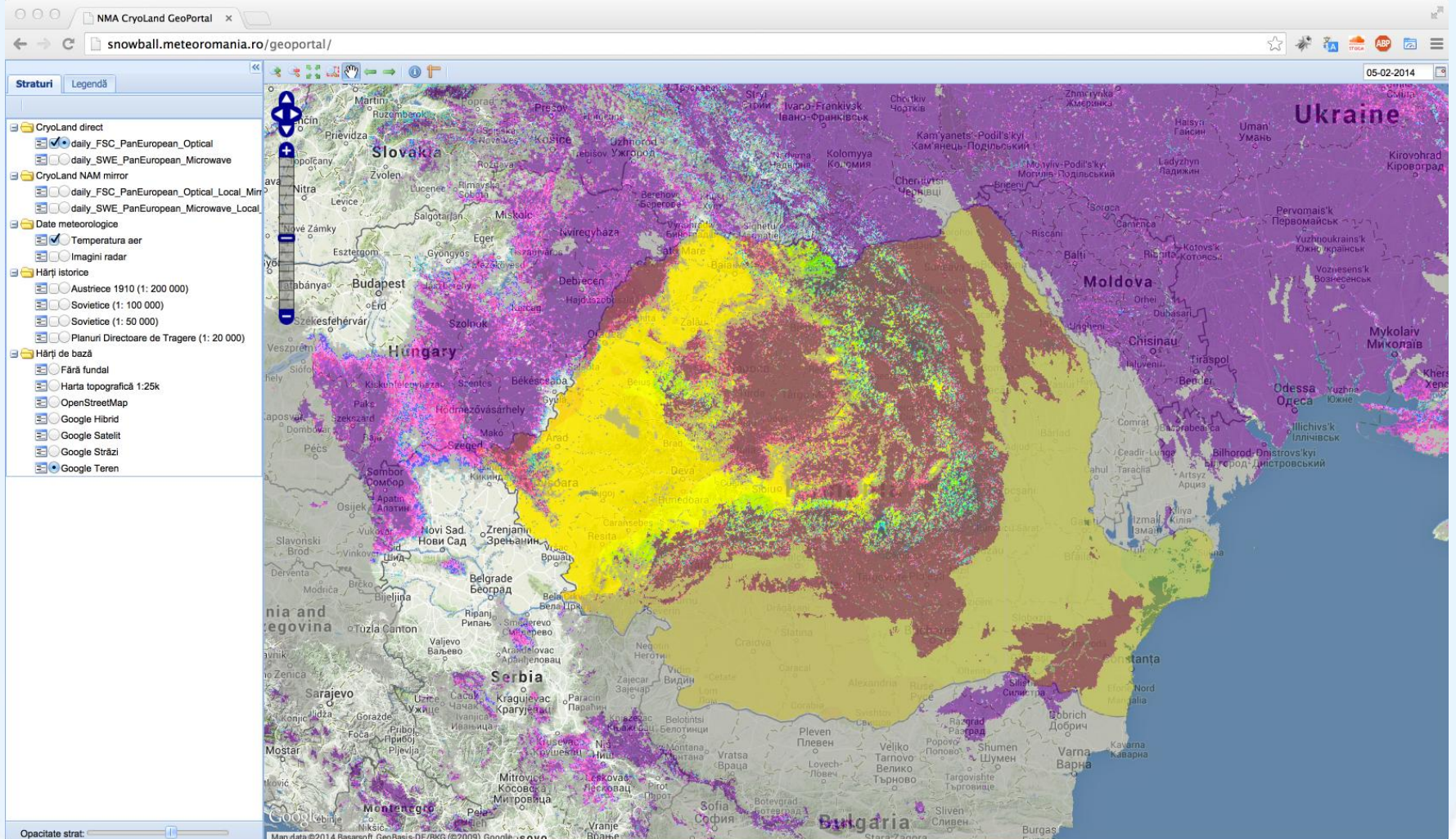
Produc cartografic realizat in cadrul ANM, Laboratorul de Teledetectie si GIS; © 2006

REMOTE SENSING & GIS LABORATORY

# Snow cover extent map – interactive map example

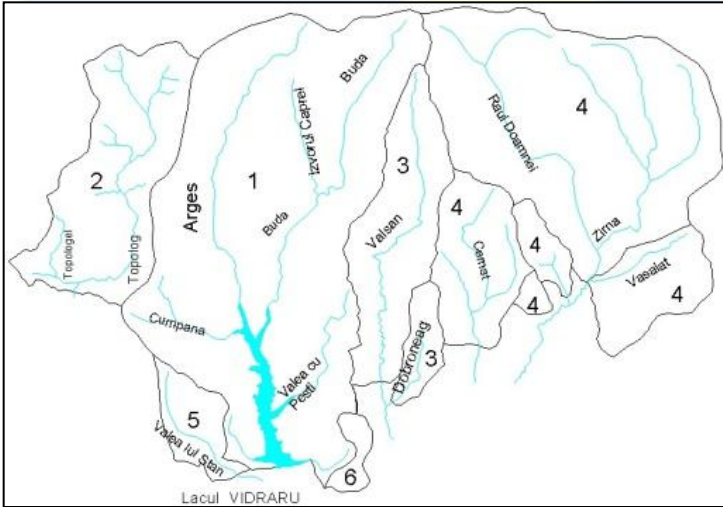


# Integration with other meteorological products

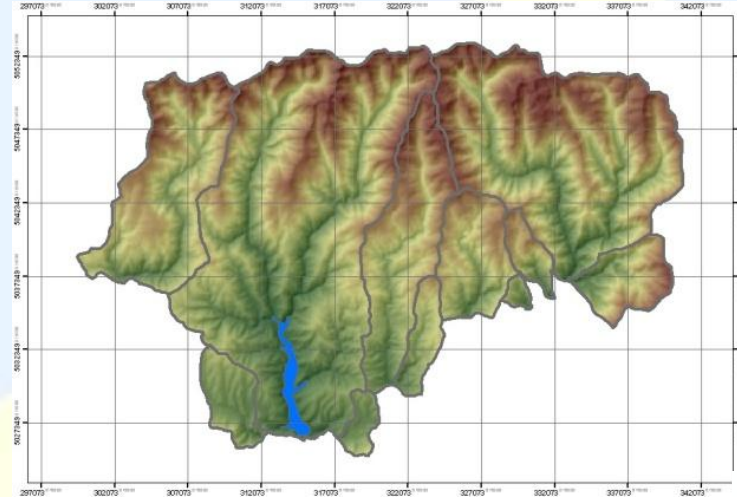


# Arges Catchment - the evaluation of SWE (I)

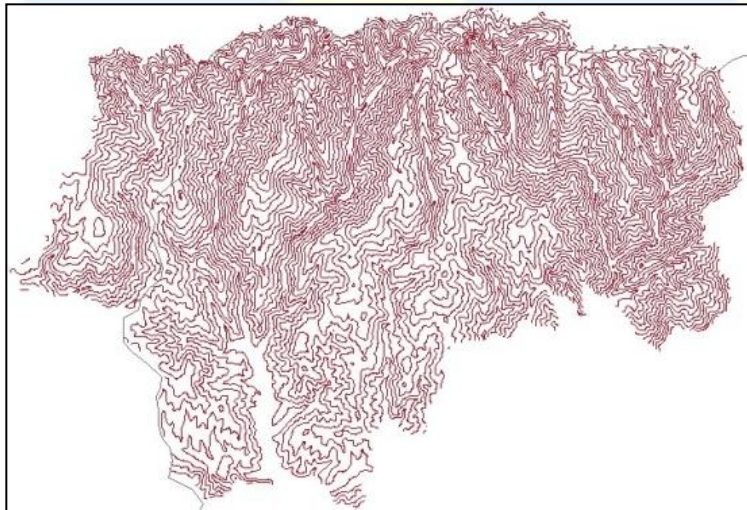
## 1. GIS data:



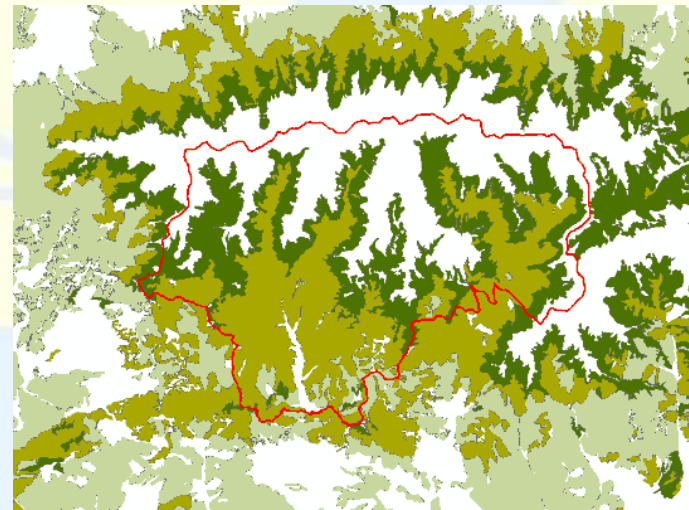
Hydrographical network



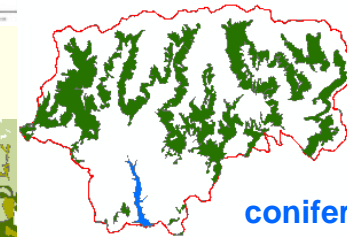
Digital elevation model



Contour levels



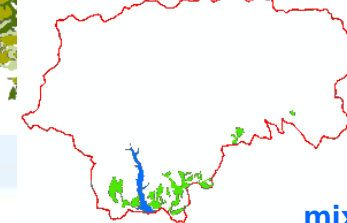
Land cover - forests



conifers



deciduous



mixt

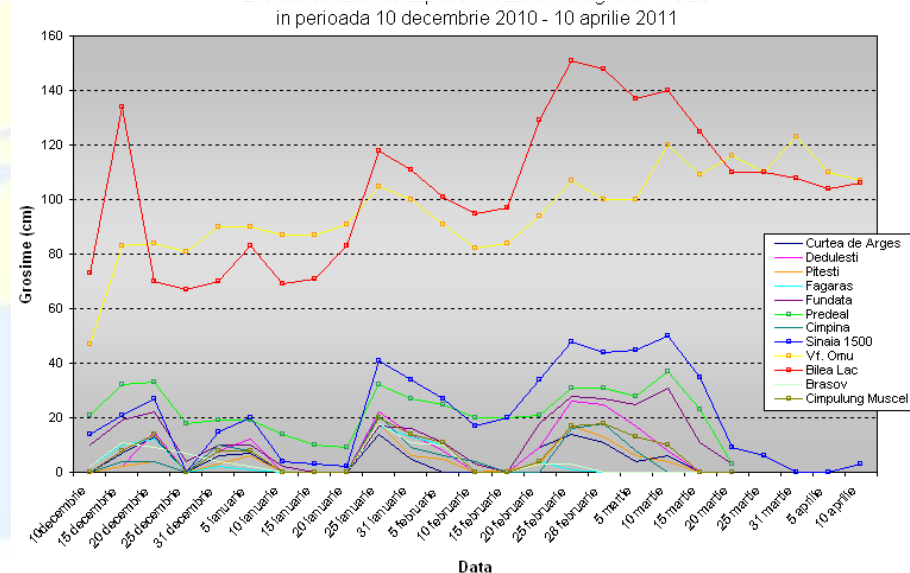
# Arges Catchment - the evaluation of SWE (II)

## 2. SWE on altitude:

	Basin name	Surface	Forest surface	Total Water volume	Water stratum
		(Km <sup>2</sup> )	(Km <sup>2</sup> )	(mil. m <sup>3</sup> )	(l/m <sup>2</sup> )
1	Arges basin (including Vidraru Lake)	274.43	190.97	45.335	165.197
2	Topolog basin	87.87	53.76	17.460	198.703
3	Valsan+Dobroneag basins	85.41	52.17	16.748	196.089
4	Raul Doamnei+Bradului+ Draghina+Cernat basins	256.43	163.23	54.131	211.095
5	Valea lui Stan basin	19.09	17.45	1.504	78.785
6	Limpedea basin	7.76	6.74	0.606	78.093
	<b>TOTAL</b>	<b>731</b>	<b>484.32</b>	<b>135.784</b>	

10 of February 2015

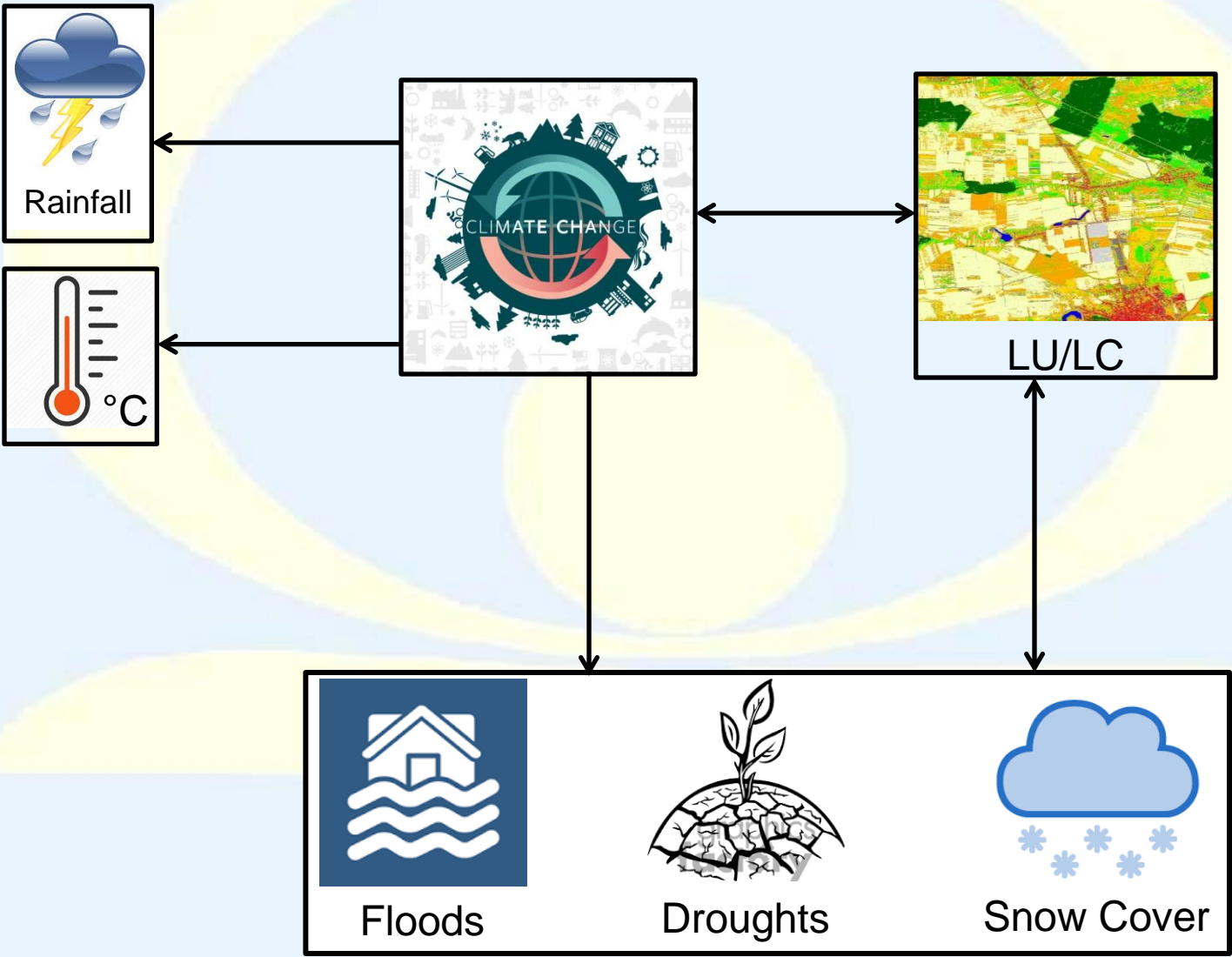
Snow cover in 2010 - 2011 winter



# Research Projects

- **SNOWBALL** “Remote sensing, model and in-situ data fusion for snowpack parameters and related hazards in a climate change perspective”, 2014-2017;
- **MEDGAME** “Serious Games based Virtual Centre for education and training in natural hazards emergency situations”, 2014-2016;
- **SiAIR** “Satellite & in-situ Information for Advanced Air Quality Forecast Services”, 2014-2015;
- **ASSIMO** “Assessment of Satellite Derived Soil Moisture Products over Romania”, 2013-2016;
- **GEODIM** “Platform for GeoInformation in Support of Disaster Management”, 2012-2016;
- **CLIMHYDEX** “Changes in climate extremes and associated impact in hydrological events in Romania”, 2012-2015;
- **DROMOSIS** “Drought monitoring based on space and in-situ data”, 2012-2014;
- **ORIENTGATE** “A structured network for integration of climate knowledge into policy and territorial planning”, 2012-2014;
- **CLEANWATER** “Integrated system for protect and analyse the status and trends of water threatened by nitrogen pollution”, 2010-2014;
- **CRYOLAND** “Service Snow and Land Ice - Stimulating the development of downstream GMES Services”, 2014-2015;
- **MIDMURES** “Mitigation Drought in Vulnerable Area of the Mures Basin”, 2010-2012;
- **MACC** “Monitoring atmospheric composition & climate”, 2009-2011;
- **HYDRATE** “Hydrometeorological data resources and technologies for effective flash flood forecasting”, 2006-2010;
- **EFFS** “European Flood Forecasting System”, 2003-2004;
- **NATO SfP 978016** “Monitoring of extreme flood events in Romania and Hungary using EO data”, 2002-2006.

# Land cover/Land use change



**Thank you for attention!**



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