BULGARIAN ACADEMY OF SCIENCES

SPACE RESEARCH AND TECHNOLOGY INSTITUTE

Aerospace test sites on the territory of Bulgaria - state & prospects

Presenter: Chief Asst. Lachezar Filchev, Ph.D.
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Department of REMOTE SENSING AND GIS, SRTI–BAS

The *Remote sensing and GIS* Department of SRTI-BAS has been established in 1976.

The *Remote sensing and GIS* department consists of 15 scientists, who have graduated in the fields of geography, geology, geophysics, engineering, mathematics, and archaeology.

The *mission* of the Department is development, improvement, and transfer of methods for remote sensing of the Earth with integrated use of remote sensing of the Earth technologies, geoinformation systems and ground-based methods. Training of Master students, PhD students, and experts in the field.

The Department has been participating in over 40 national and international programmes and projects, under the PHARE, 6FP, and SEE-ERA.NET INTAS.

INTERCOSMOS International Programme (1975-1990)

- 1974 – on a meeting in GDR the INTERCOSMOS *Remote Sensing of the Earth* group was established;
- 1975 – first meeting of the RS group in Baku. Long-term programmes in RS and first 5 aerospace test sites in Bulgaria (Velikov, Mishev, and Roumenina 1995);
- 1981 – within *INTERCOSMOS-Bulgaria 1300* and *Meteor-Priroda-6* (Meteor-Nature) the earth resources were studied with the *Tangra* aparatus complex (4-band radiometer and 32 channel spectrophotometer) (Stoyanov1988).

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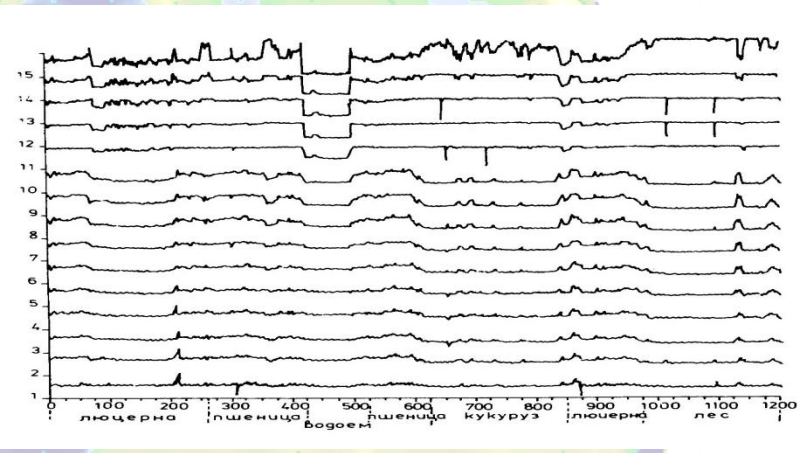
1979 - during the flight of the first Bulgarian astronaut *Georgi Ivanov* onboard of *Souyz-Salut 6* space station a total of 19 space experiments were planned among which:

- **Experiment *Balkan*** (spectrometry of different LU/LC types (including different crop types) from space using Spektar-15K and ISOH-020 from airplane /developed at SRTI-BAS/ and multispectral photography using MKF-6M (Serafimov 1979);
- **Experiment *Biosphere-B*** space photography of geology features and geography phenomenon, ecology, soils etc. Using Hasselblad-500E photocamera (Serafimov 1979);
- **Experiment *Nature*** – onboard Soyuz-Salut 6 radiometer *Icarus, synthetic aperture side-looking radar (SAR), IR radiometer, spectrometric system and onboard digital processing unit;*
- ***Project Geosystem*** – spectrometer (MKS-M2, IR radiometer ITS-7D and photometer EFO-I as well as multispectral photocamera MKF-6M with stabilized platform (Stoyanov 1988).

1987 - *the Shipka* space programme - consisting of 33 scientific experiments during the second Bulgarian astronaut mission to the MIR space station.

- **Spektar 256 C** – 256 channel specroradiometer – non imaging, Spektar- 15 and Spektar – 15 M, along with the 32 channel SMP-32. The KATE-140 and Hasselblat photocameras onboard the MIR space station. On board of the airplane laboratories the Spektar-15 MC and RM-1S (PM-1C), with the IR radiometer worked synchronously with the MIR's instruments in a sub-satellite experiment setting.
- The data was recorded and processed with the MIK-16 microcomputer system developed by the Institute for Technical Cybernetics and Robotics at the BAS (Stoyanov, 1988)

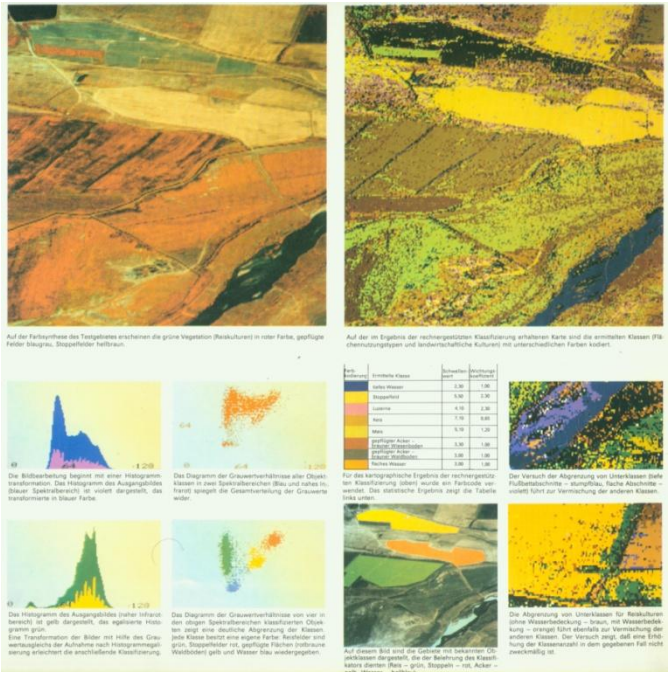
For conducting the sub-satellite experiments in 1977 and 1978 were used developed at Space Research and Technology Institute (SRTI-BAS) instrumentation for ground measurements: spectral reflectance of natural formations (ISOH 010 and ISOH 020), temperature profiles in the surface layer and topsoil; gradient topsoil and probe for rapid measurement of moisture in the topsoil



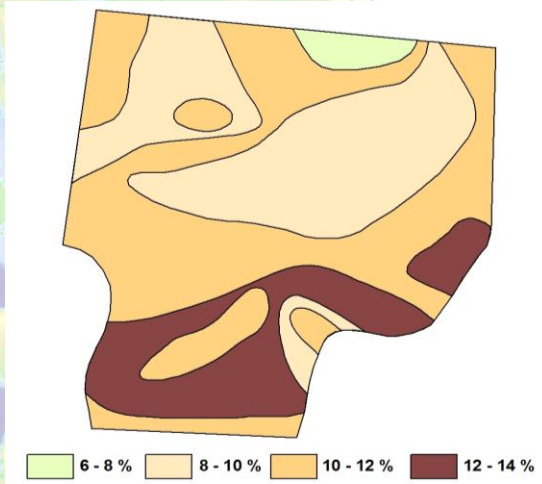
Trace data from Spektar-15MC

Development of a Universal Mobile Ground Station for Synchronous and Complex Space and Geonomic Investigations - *Intercosmos* International Program, Work Group on Remote Sensing of the Earth.

Experiment "Agricultural lands" for assessment of the information value of multispectral aerial images acquired by the camera MKF-6 MC and "Fragment" C-500 .



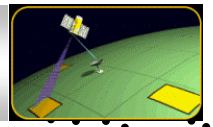
LU/LC classes
Deep water (*Maritza* river)
Corn field (harvested)
Alfa alfa
Rice pad
Corn field
Arable land (Chromic luvisols)
Arable land (Alluvial soils)
Shallow water



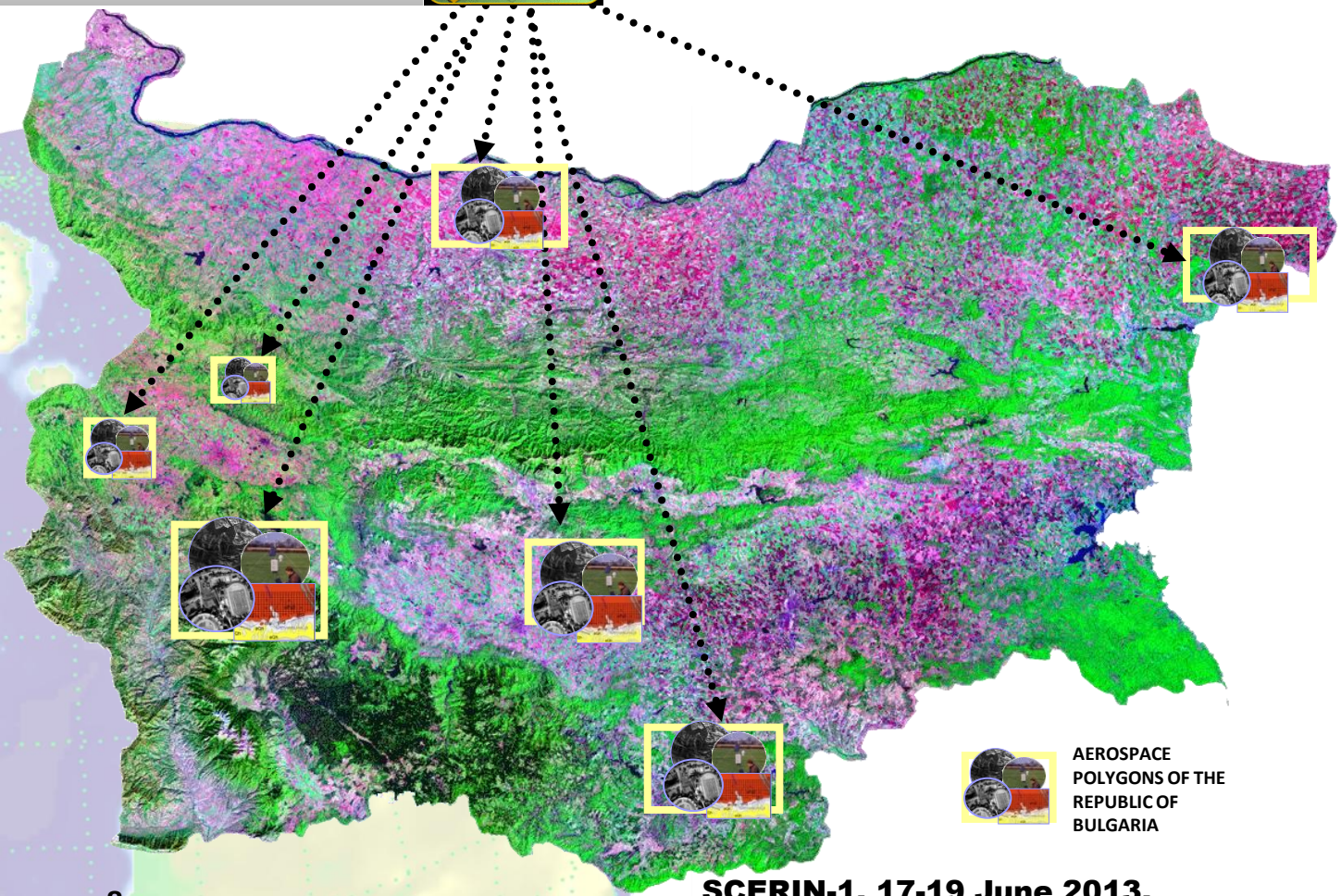
Distribution of the surface soil moisture (%) measured by RM-1C at 11:30 AM on 14.10.1983, the *Bolyarino* test site, Bulgaria.

Contract N-НИК-003/07. *Establishment of a Scientific-Information Complex for Aerospace Polygons on the Territory of Republic of Bulgaria.* Contract between the SRTI-BAS and the Scientific Research Fund at the Ministry of Education and Science. Project PI: Prof. E. Roumenina, Ph.D.

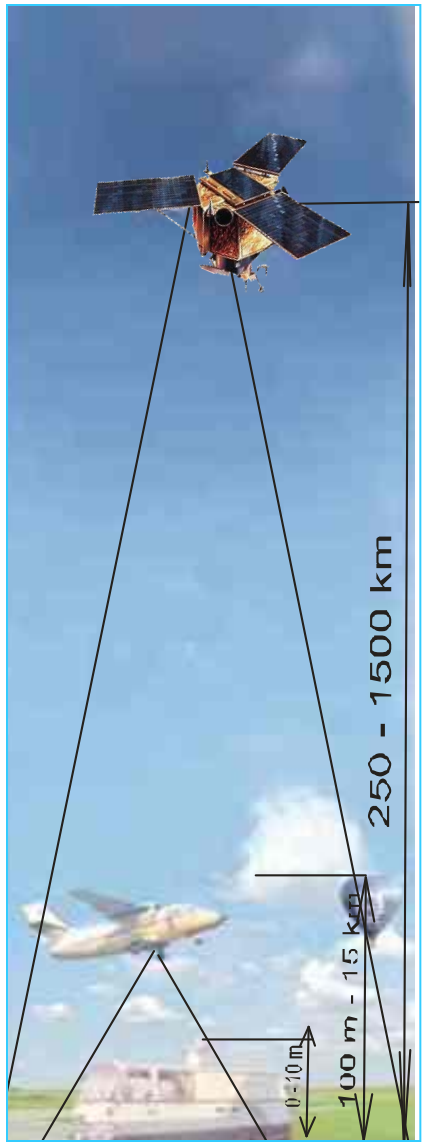
MOSAIC OF BULGARIA, COMPOSED USING 11 SCENES OF LANDSAT TM



AEROSPACE TEST SITES ON THE TERRITORY OF BULGARIA



AEROSPACE POLYGONS OF THE REPUBLIC OF BULGARIA



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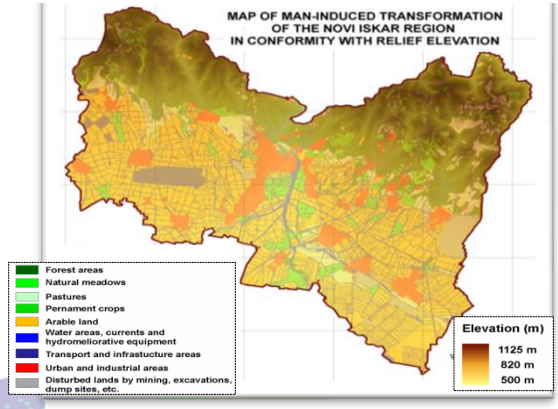
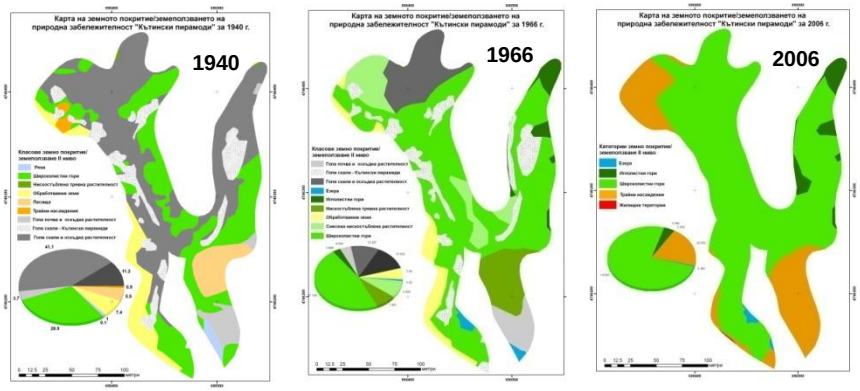
NOVI ISKUR Aerospace Test Site

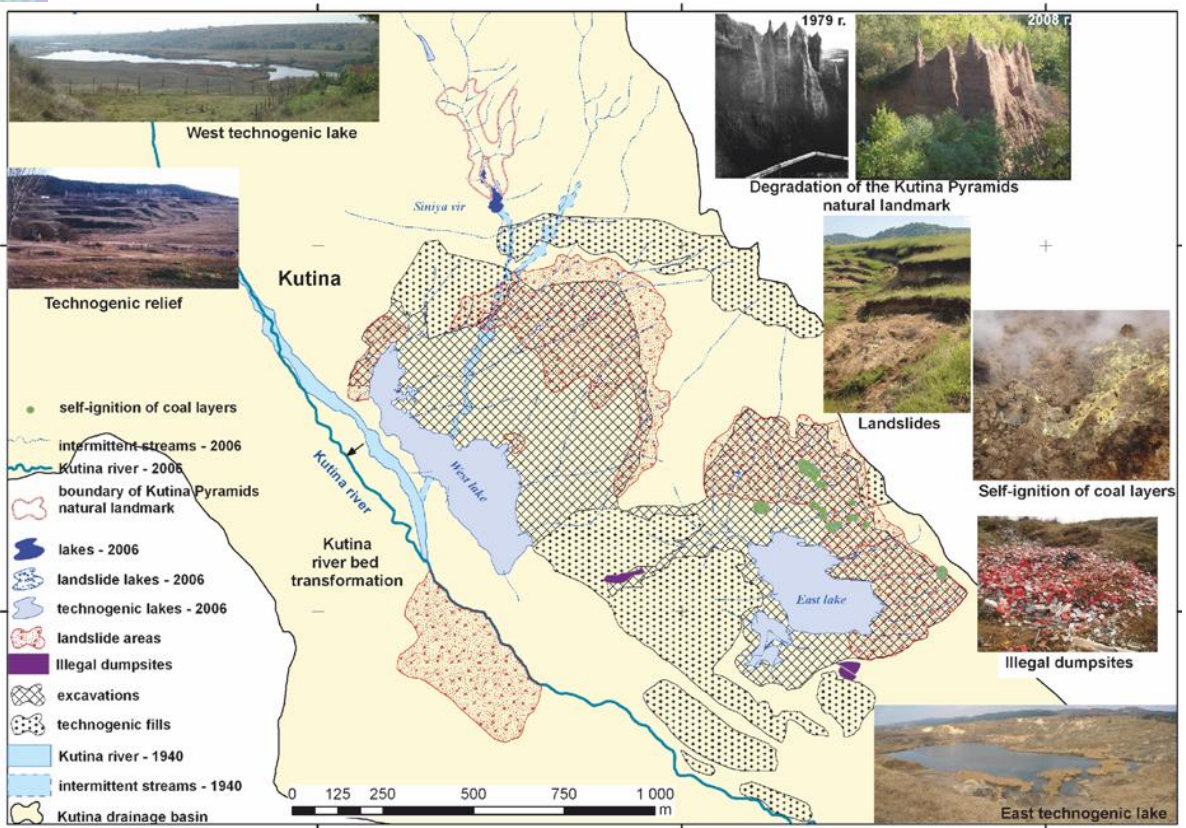


LANDSCAPE-ECOLOGICAL MONITORING USING GEOINFORMATION TECHNOLOGIES

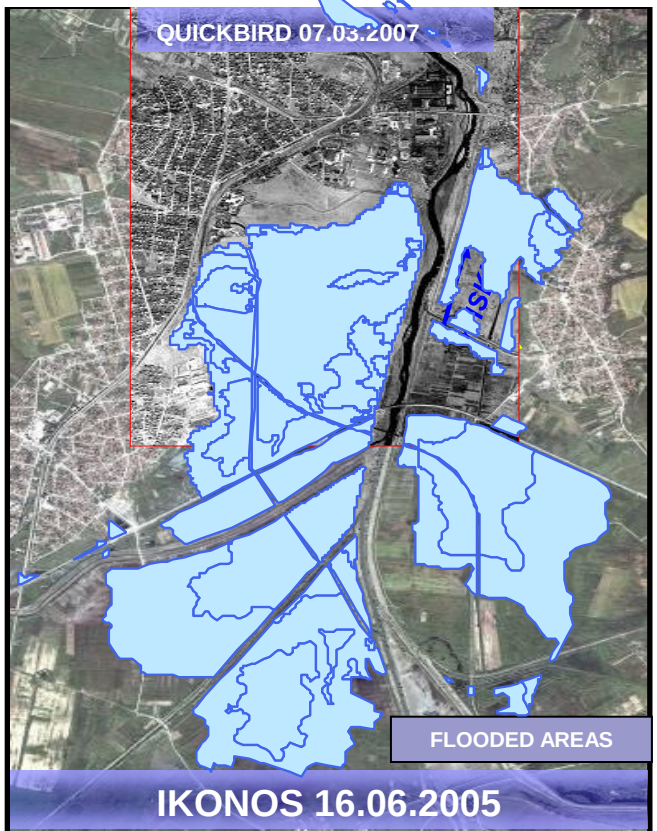


LAND COVER CHANGE AND DEGRADATION OF KUTINA PYRAMIDS NATURAL LANDMARK

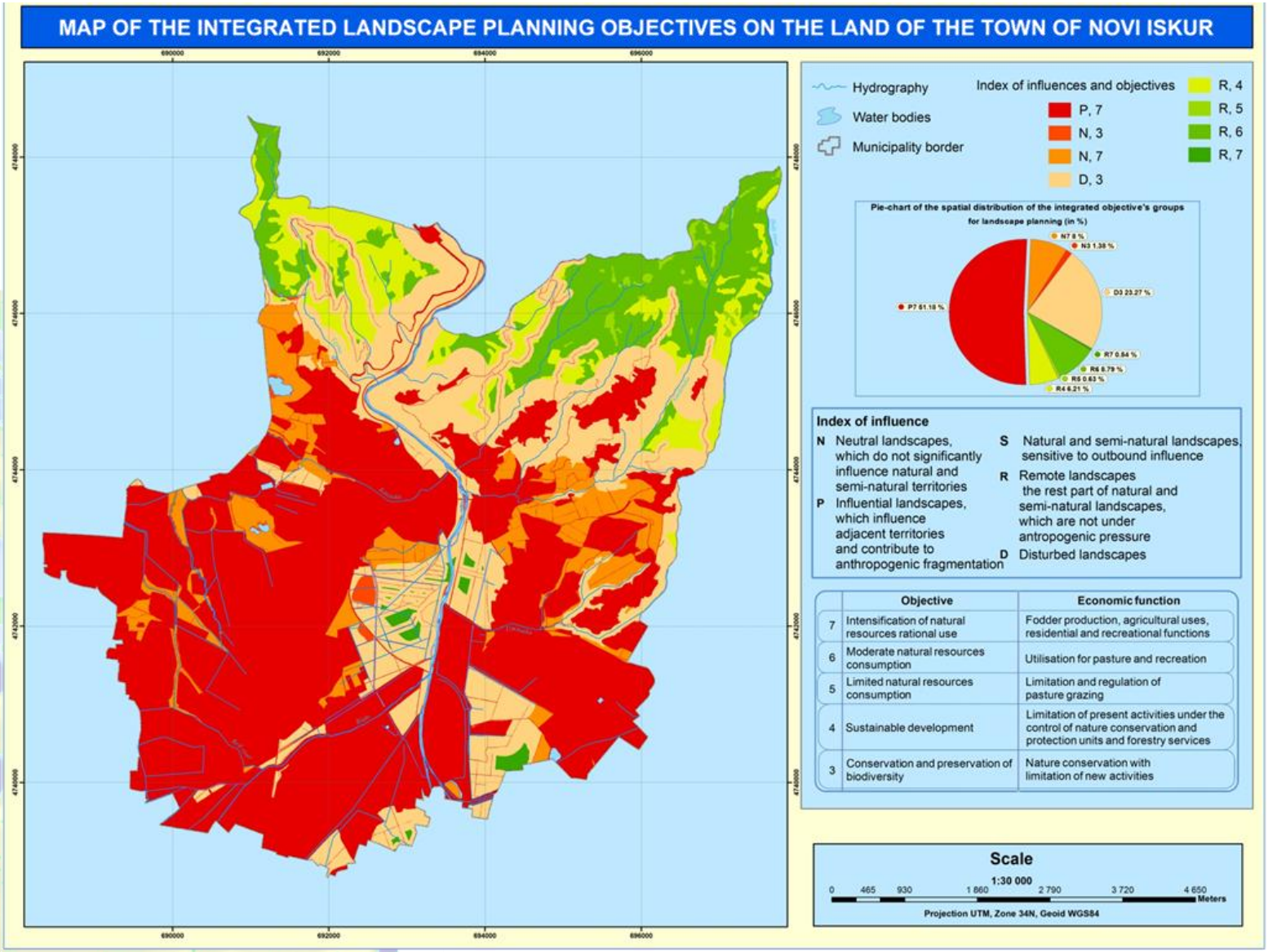
IDENTIFICATION AND MAPPING OF THE EFFECTS OF MINING ACTIVITY



CONSEQUENCES FROM THE FLOOD ON 09.06.2005

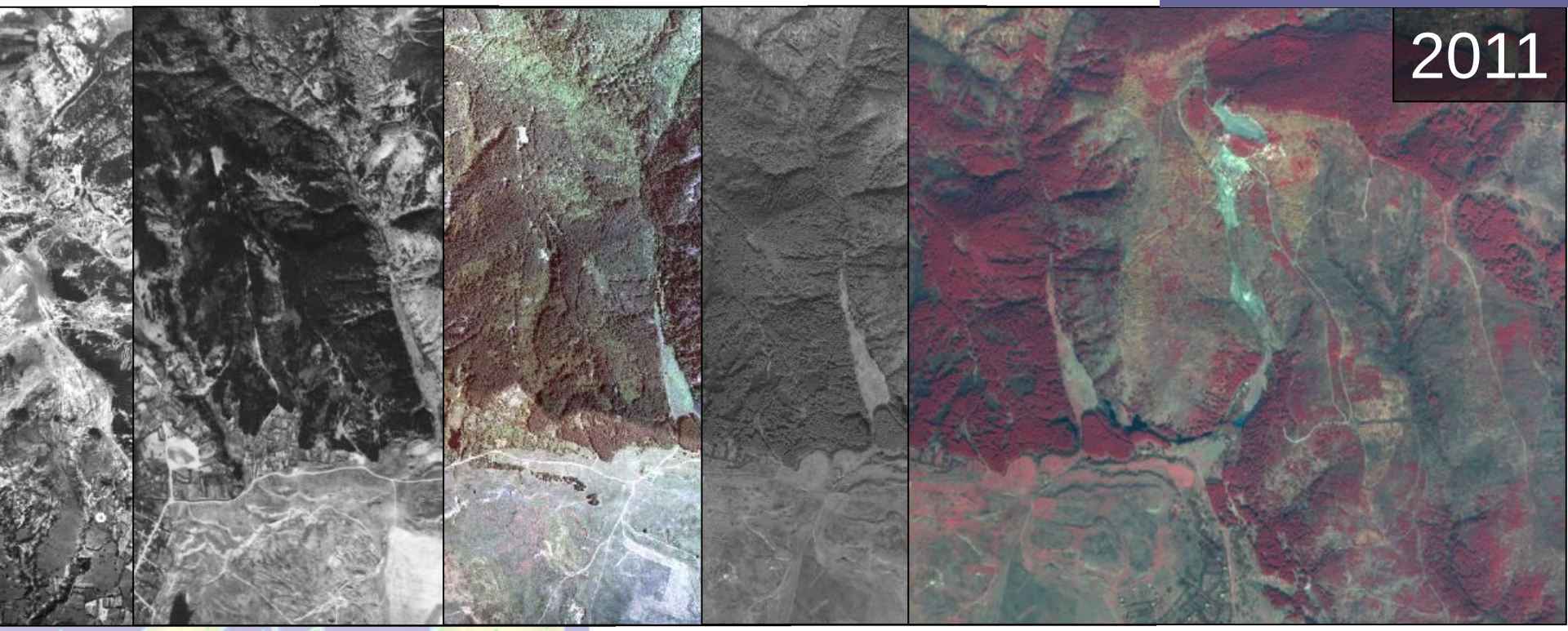


NOVI ISKUR AEROSPACE TEST SITE



NOVI ISKUR AEROSPACE TEST SITE

Uranium-ore extraction area until 1992



Archive air-photos and contemporary satellite images

NOVI ISKUR AEROSPACE TEST SITE

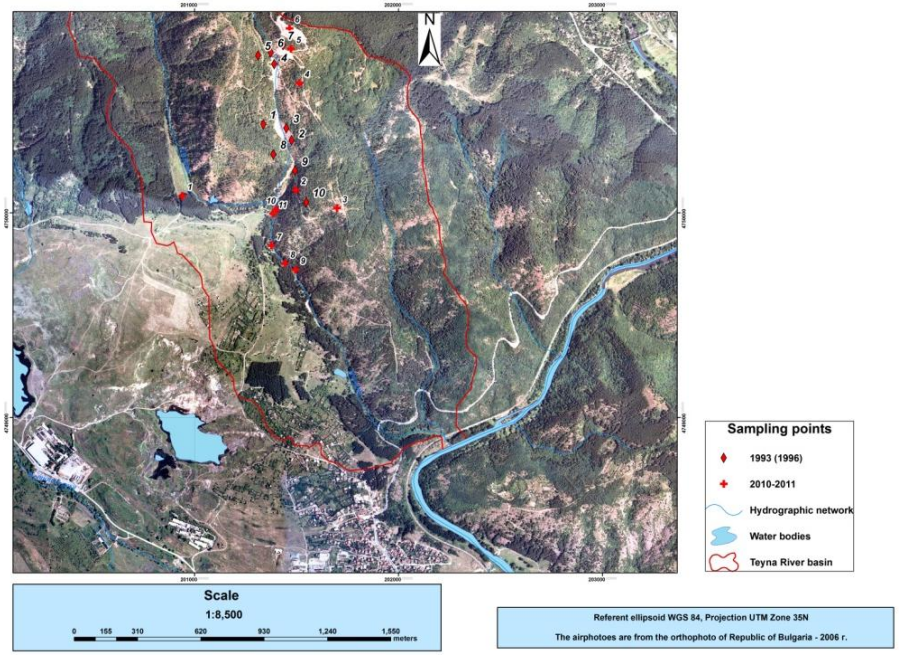
Detection and assessment of abiotic stress in coniferous landscapes

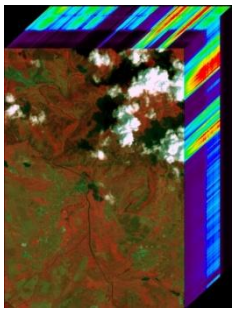
Nonspecific stress reaction or „exstress" – i.e. increase of the total chlorophyll content and the carotene with increasing of the total pollution coefficient Z_c (Saet *et al*. 1990) have been found;

The narrow-band VIs EO-1/Hyperion, such as TCARI/MCARI, MTVI2, and PRI (R^2=0.56÷0.80), as well as the pigments (chlorophyll-*a*, chlorophyll-*b*, and carotene) can be used for detection and assessment of abiotic stress in coniferous landscapes;

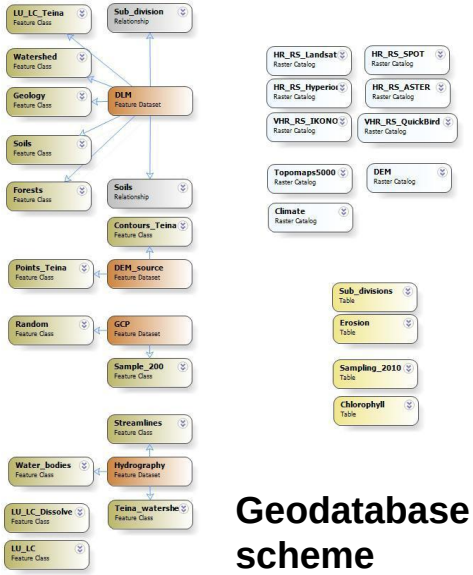
Very high resolution multispectral satellite data (QuickBird) and VIs (NDVI, MSAVI) can be used for detection and assessment of abiotic stress caused by uranium mining (R^2=0.72) (Filchev 2012, Filchev and Roumenina 2012).

Map of ground truthing collected in *Teyna* River Basin





3D spectral cube from EO-1/Hyperion

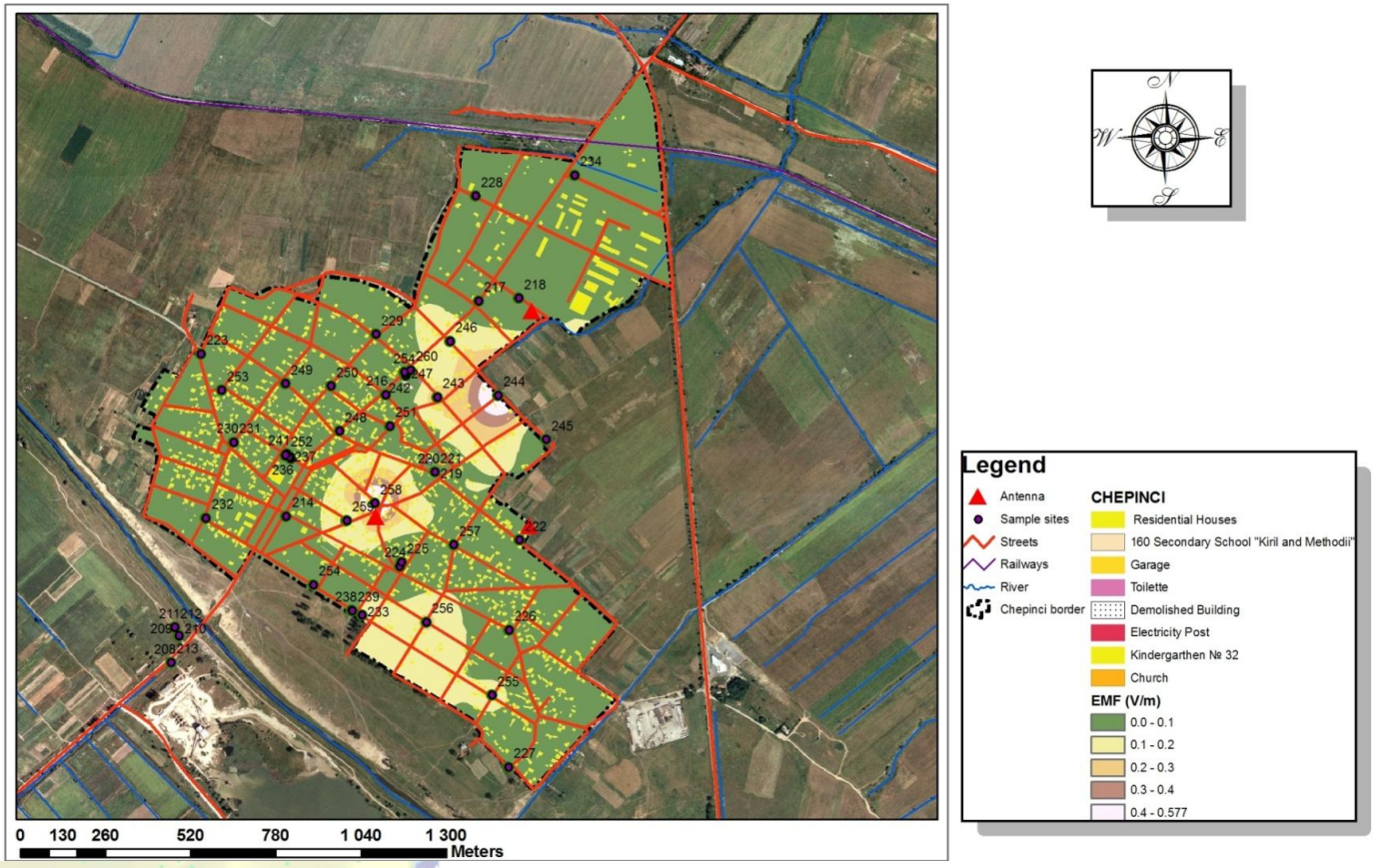


Geodatabase scheme

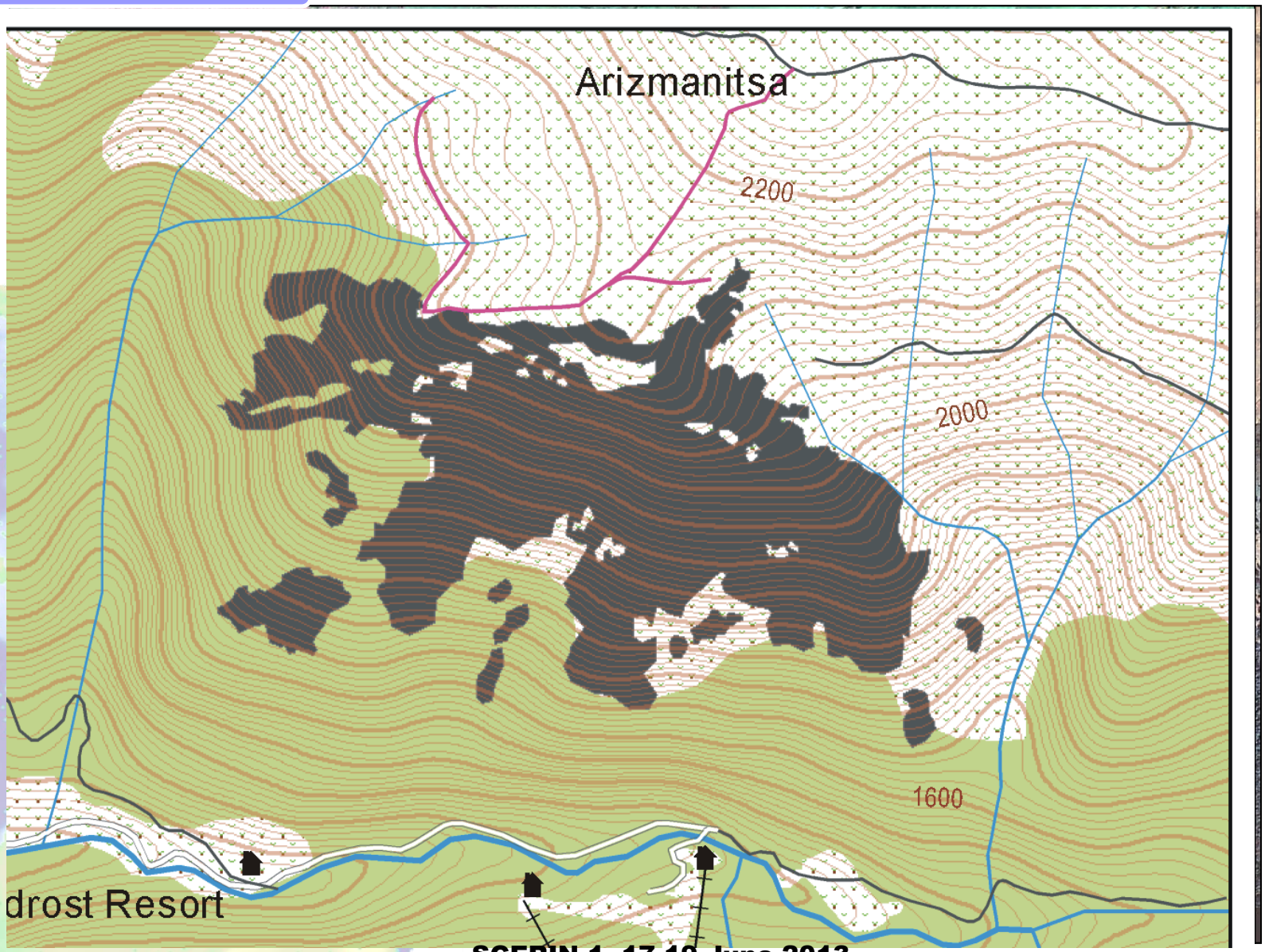
NOVI ISKUR AEROSPACE TEST SITE

INTAS Ref. Nr 06-1000031-10374 *Development of Strategy and Methods for Monitoring of Elecromagnetic Pollution in the Environment of the Western Balkans*. EU Programme, SEE-ERA.NET. Contract between the SRI-BAS and the Scientific Research Fund at the Ministry of Education and Science, 2007-2008. Project coordinator: Prof DSc Petar Getsov

Map of High Frequencies, Maximum Values - E (EMF) V/m for the Village of Chepinci

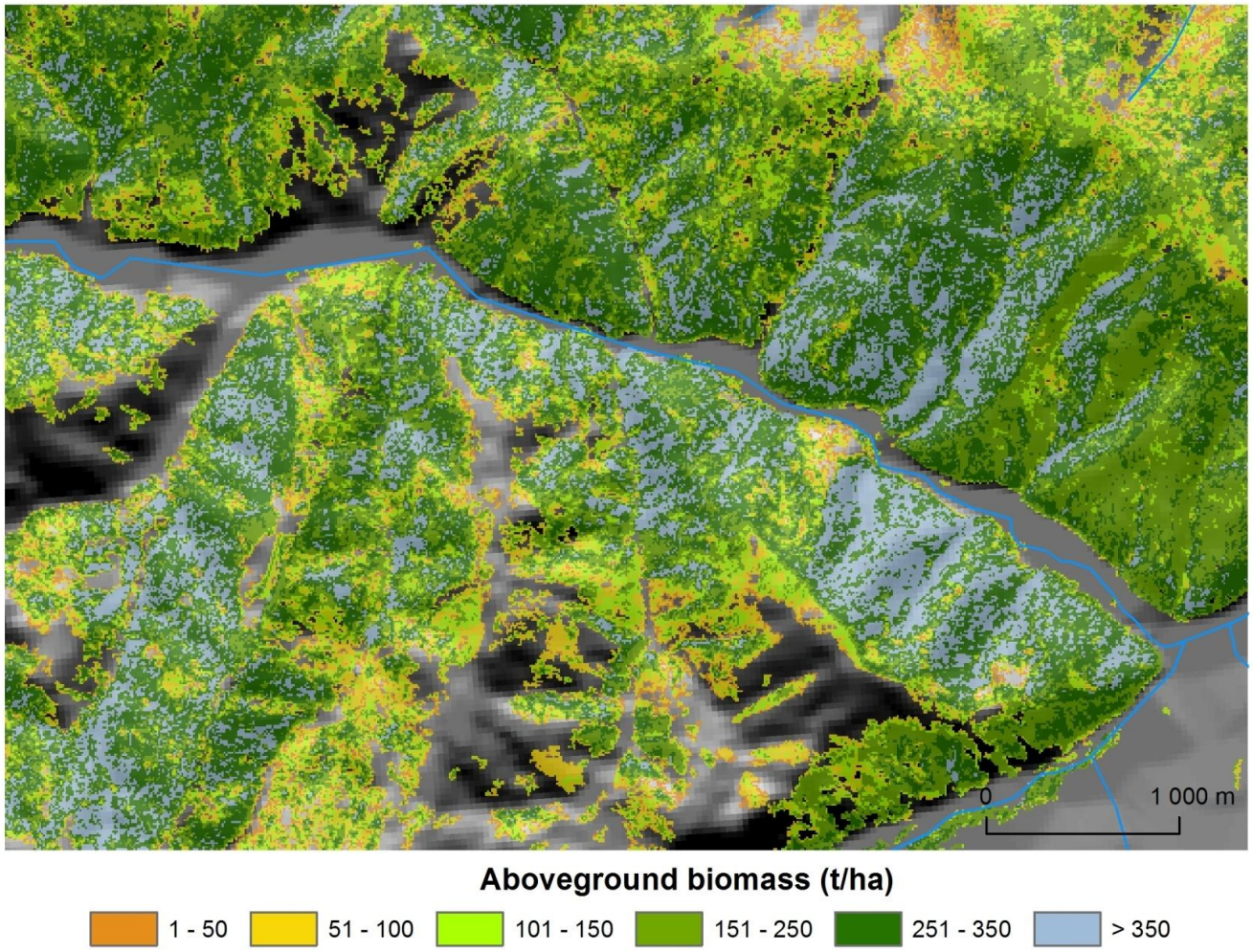


RILA Aerospace Test Site



RILA Aerospace Test Site

Map of the aboveground biomass (AGB) of coniferous forests created with the aid of GIS and SPOT 5 image



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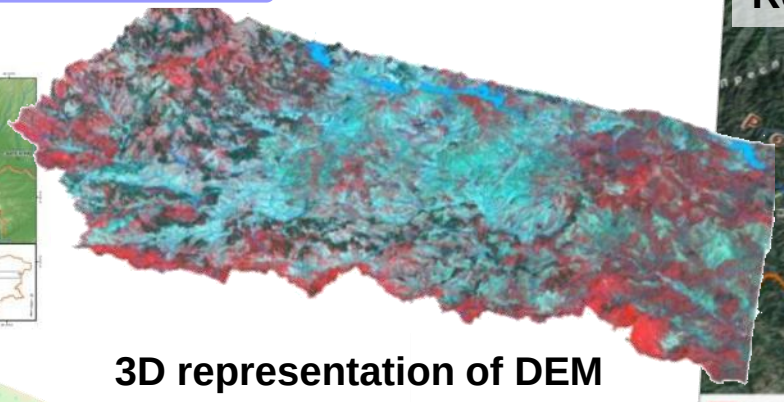
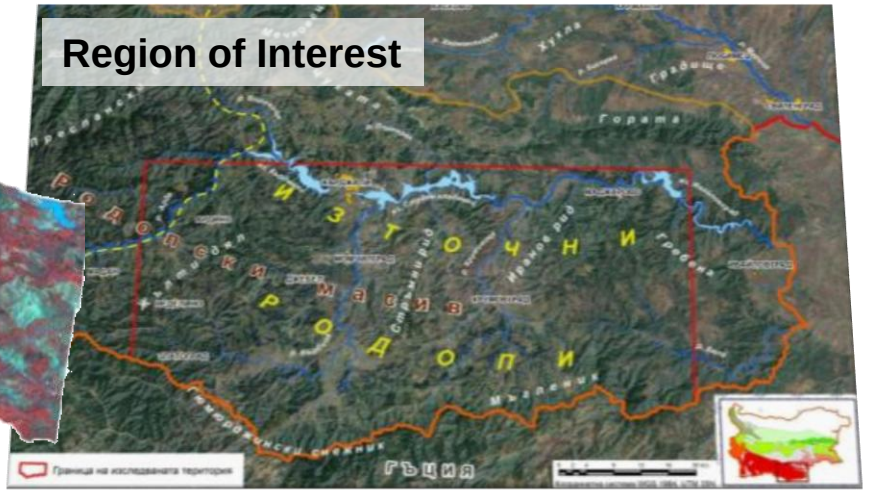
EAST-RHODOPES Test Site

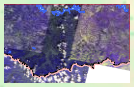


3D representation of DEM



Remote Sensing Data

 Landsat 5

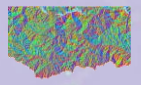
 MODIS/ASTER

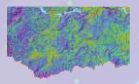
 MODIS/TERRA

Raster Data

 Topographic maps

 Digital Elevation Model

 Aspect

 Slope

 Solar Radiation

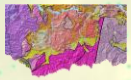
Vector Data

 Administrative units

Settlements

 Road network

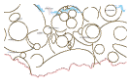
Rivers/Streams

 Geology

Tectonics

GEODATA BASE

 Lineaments

 Ring structures

 Soils

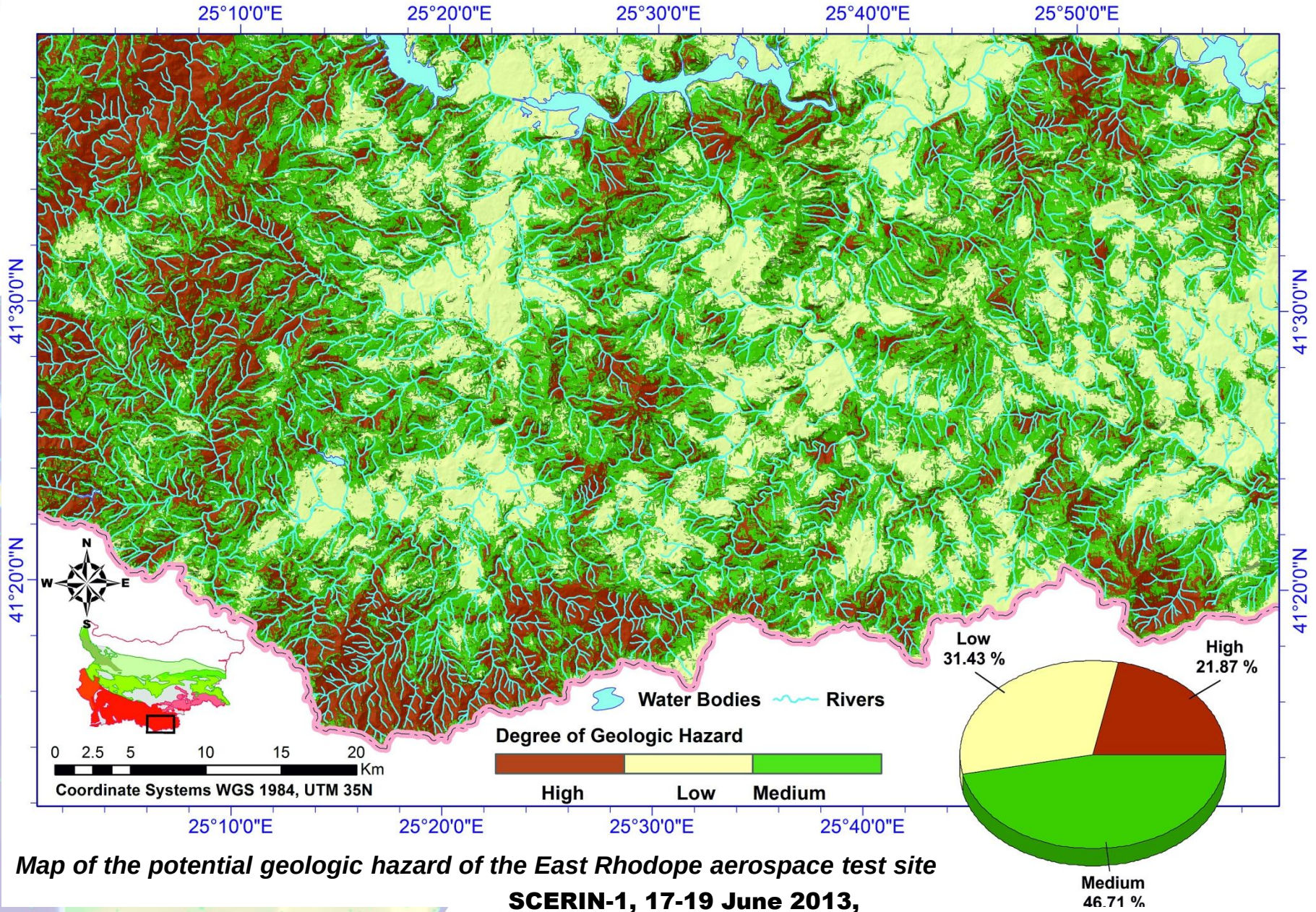
 Land Cover

Fields Experiments

 Geology and Geomorphological Data

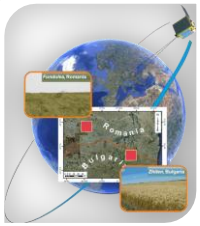
 Photo images of specific objects

GPS points 



Map of the potential geologic hazard of the East Rhodope aerospace test site

SHUMEN Aerospace Test Site



Contract Ref. No CB/XX/16 *Testing PROBA-V and VEGETATION data for agricultural applications in Bulgaria and Romania (PROAGROBURO)* between the SRTI-BAS and the Belgian Federal Science Policy Office (BELSPO), under the PROBA-V Preparatory Programme.

Project PI and Promoter: Prof. E. Roumenina, Ph.D.

Project partners are:

- ✓ The Space Research and Technology Institute – Bulgarian Academy of Sciences (SRTI–BAS),
- ✓ The Romanian National Meteorological Administration (RNMA)
- ✓ The National Institute of Meteorology and Hydrology – Bulgarian Academy of Sciences (NIMH–BAS)

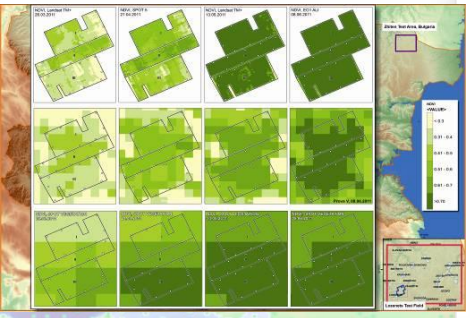
PROAGROBURO web site

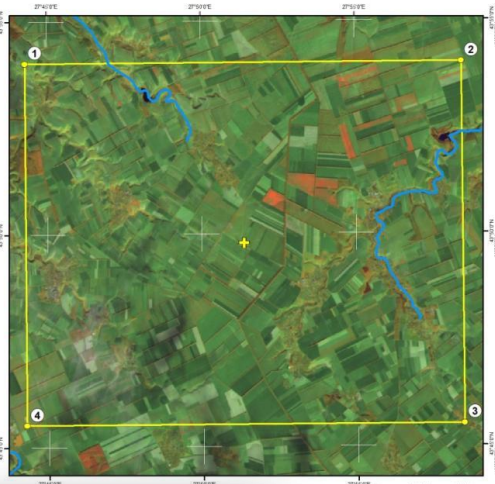
http://proagroburo.meteoromania.ro

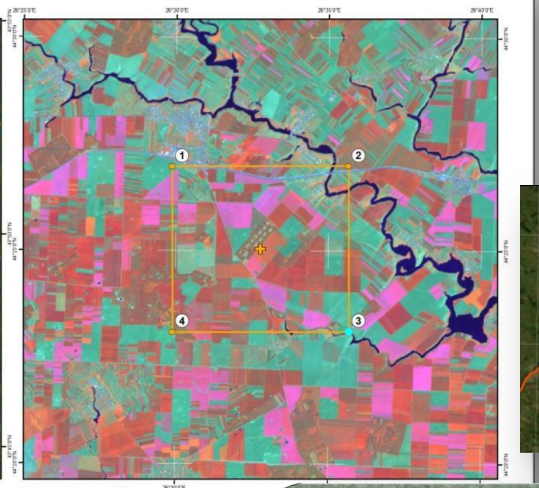
The main objective of the PROAGROBURO Project is to assess the quality of the PROBA-V mission as a continuity mission to VEGETATION 1 & 2 by comparison and validation of SPOT-Vegetation and PROBA-V simulated data for assessing crop condition on chosen test sites for the territory of Bulgaria and Romania.

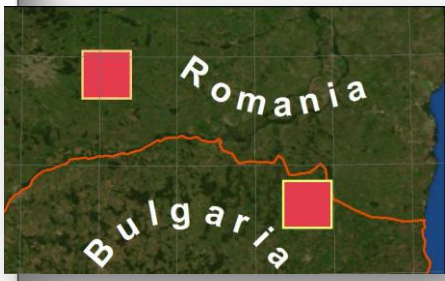
SHUMEN Aerospace Test Site

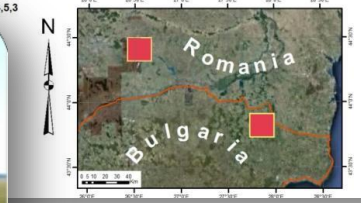
Study area











Zhiten, Bulgaria

The test area of *Zhiten* proposed for Bulgarian territory pertains to the Bulgarian Aero-Space Test Sites (BASTS) is located in *Dobrich* Region, North-East Bulgaria, and represents intensively cultivated area sowed mostly with cereals and sunflower. Geology is presented mainly by Miocene limestone, clay and marl covered by loess. The region is about 200 m a.s.l. It's relief is characterized by wide, flat ridges and steep-sided dry valleys.

Fundulea, Romania

The *Fundulea* test area on Romanian territory is located in *Bargan* Plain, South-East Romania, and represents intensively cultivated area sowed mostly with cereals, maize and sunflower. The choice of *Fundulea* test area was also made because it was used for SPOT VEGETATION validation site. The region is about 200 m a.s.l., with relief characterized by a flat plain.

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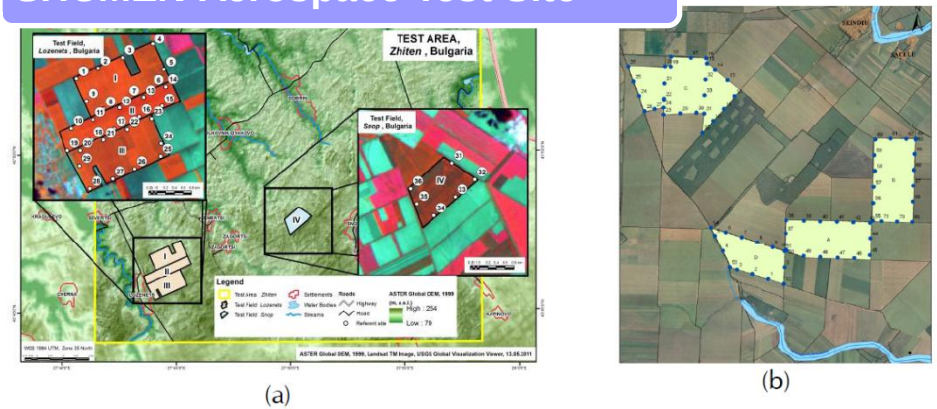
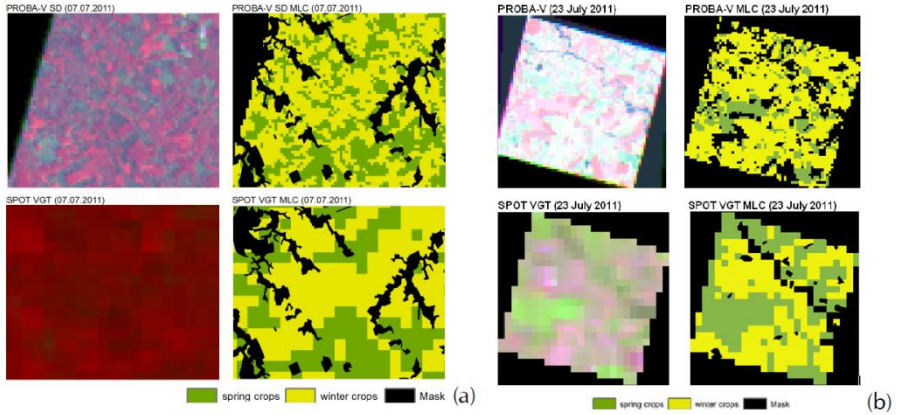
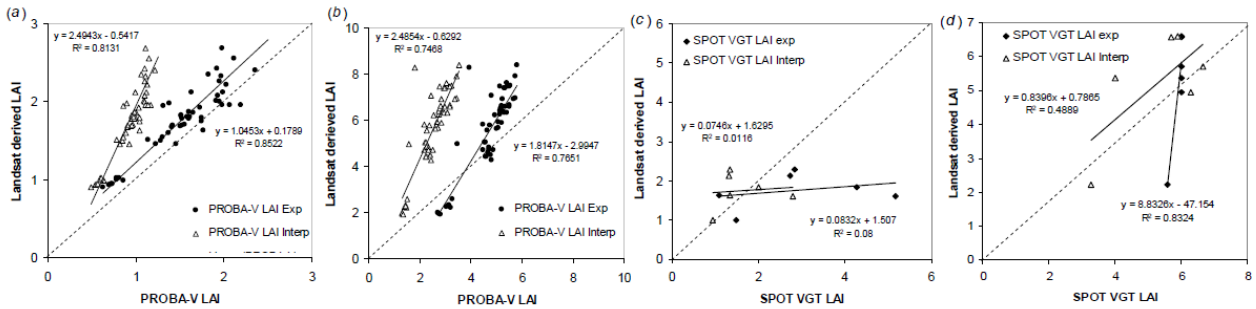
SHUMEN Aerospace Test Site



Spatial distribution of the reference sites in the test fields of Zhiten test area (Bulgaria) (a), and Fundulea test area (Romania) (b). Four sub-satellite experiments were conducted for Zhiten test area and three for Fundulea test area



Supervised MLC of LU/LC on PROBA-V SD and SPOT VEGETATION images for Zhiten test area (Bulgaria) (a) and Fundulea test area (Romania) (b)



Relationship between PROBA-V SD LAI, SPOT VEGETATION LAI, and LAI derived from the Landsat TM reference maps for *Tillering* (a) and (c) and *Stem elongation 100%* phenological stages (b) and (d)

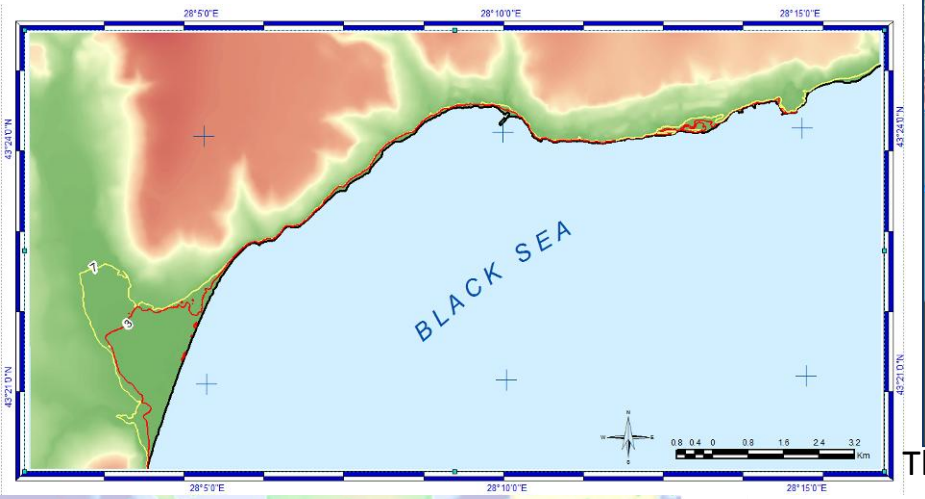
In conclusion, it may be asserted that the PROBA-V mission will provide better results in LU/LC classifications of agricultural environments compared to SPOT VEGETATION. The significant correlations of PROBA-V SD, VIs, and biophysical products with ground-measured biophysical and biometrical parameters provide to extend the monitoring of winter crops with additional products from PROBA-V. In addition, PROBA-V data is envisaged to be accessible at the same frequency as SPOT VEGETATION data. This will provide for its fusion with high SR satellite data and data assimilation into crop-growth models, such as WOFOST, for the purpose of creating time series of vegetation indices and other biophysical products for assessment of crop yield and status .

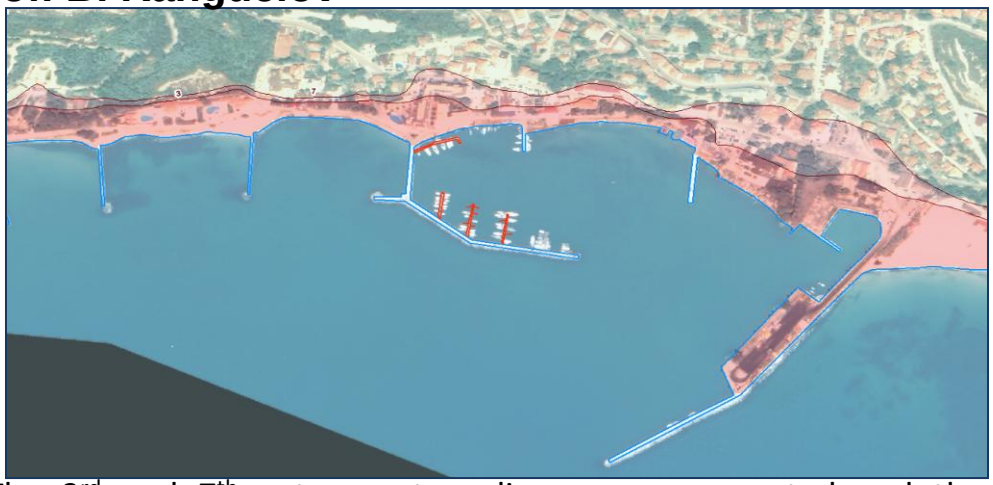
SHUMEN Aerospace Test Site

Contract No.453/11.06.2010. *Development of primary geodatabase and GIS of the Outer town of the Medieval Bulgarian capital Pliska* between the NAIM-BAS and SSTRI-BAS, 2010-2012.
Head of the project: Prof. E. Roumenina, PhD.

SHUMEN Aerospace Test Site

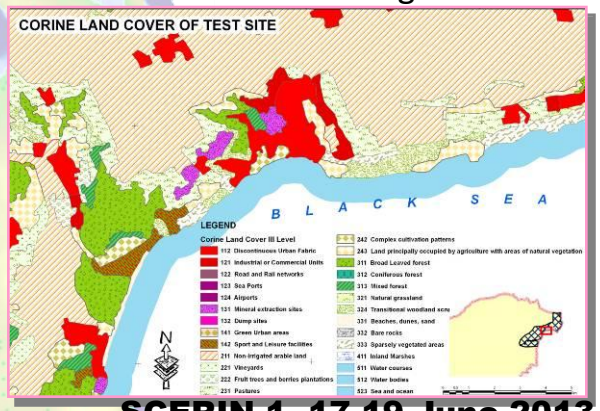
SCHEMA – SCENARIOS FOR HAZARD-INDUCED EMERGENCIES MANAGEMENT, 6-th EU FRAMEWORK PROGRAMME. Project Coordinator: Prof. DSc Petar Getsov, Prof. G. Mardirossian, Prof. B. Ranguelov





The 3rd and 7th-meter contour lines were generated and the coastal infrastructure and installations, potentially endangered by high waves were identified.

A Digital Elevation Model – DEM for the test site of *Balchik* was generated using the methods developed by the GEOSCIENCES CONSULTANTS for the need of UNDP and the Department of Risk and Disaster Management of Seychelles (Ranguelov *et al*. 2010).

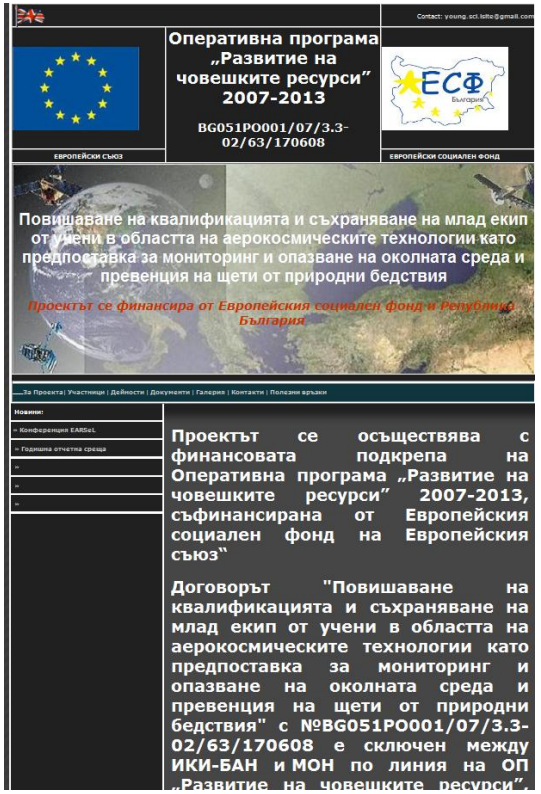


Contract No. ДВ 08/001.12.06.2008. *Development of Methodology and Creating a National Data Base for NDVI, NPP and LAI Based on Satellite Data from NOAA AVHRR and MODIS.* Contract, between SRTI-BAS and *Kontrax* Company, June 2008 – September 2008. Head of the project: Prof. E. Roumenina, Ph.D.

A methodology for monitoring vegetation cover was developed and approbated for the territory of the Republic of Bulgaria. As a result of the applied methods, a series of assessment maps for the year 2008 were elaborated conforming to the created reference images. The created geodatabase and the developed methodology were implemented in the Aerospace Monitoring Center at the Ministry of Interior (Roumenina *et al*. 2011).

Enhancing the Qualification and Retaining a Young Scholars' Team in the Field of Aerospace Technologies as a Prerequisite for Monitoring and Preservation of the Environment and Prevention of Damages Caused by Natural Disasters. Contract No. BG051PO001/07/3.3-02/63/170608 between the SRI-BAS and the Scientific Research Fund at the Ministry of Education of the Rep. of Bulgaria under the Human Resource Development Operative Programme, 2008–2010. Project coordinator: Prof. DSc Petar Getsov

Beneficiaries of the project were 11 Ph.D. students and post-docs from SRTI-BAS and Institute of Oceanology "Fridtjof Nansen" at the BAS (IO-BAS)



Project web site

http://young.sci.space.bas.bg/index.html

Proposal for SCERIN

Establishing a network of test sites on the territory of SCERIN countries.

SCERIN Work Group (WG) "Validation of satellite and airborne data and products"

SCERIN WG structure will conform with the focus areas: Biophysical, Phenology, Land Cover, LST Emissivity, Snow Cover, Soil moisture, SurfRad/Albedo of Land Product Validation (LPV) sub-group of the CEOS Working Group on Calibration and Validation (WGCV).

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