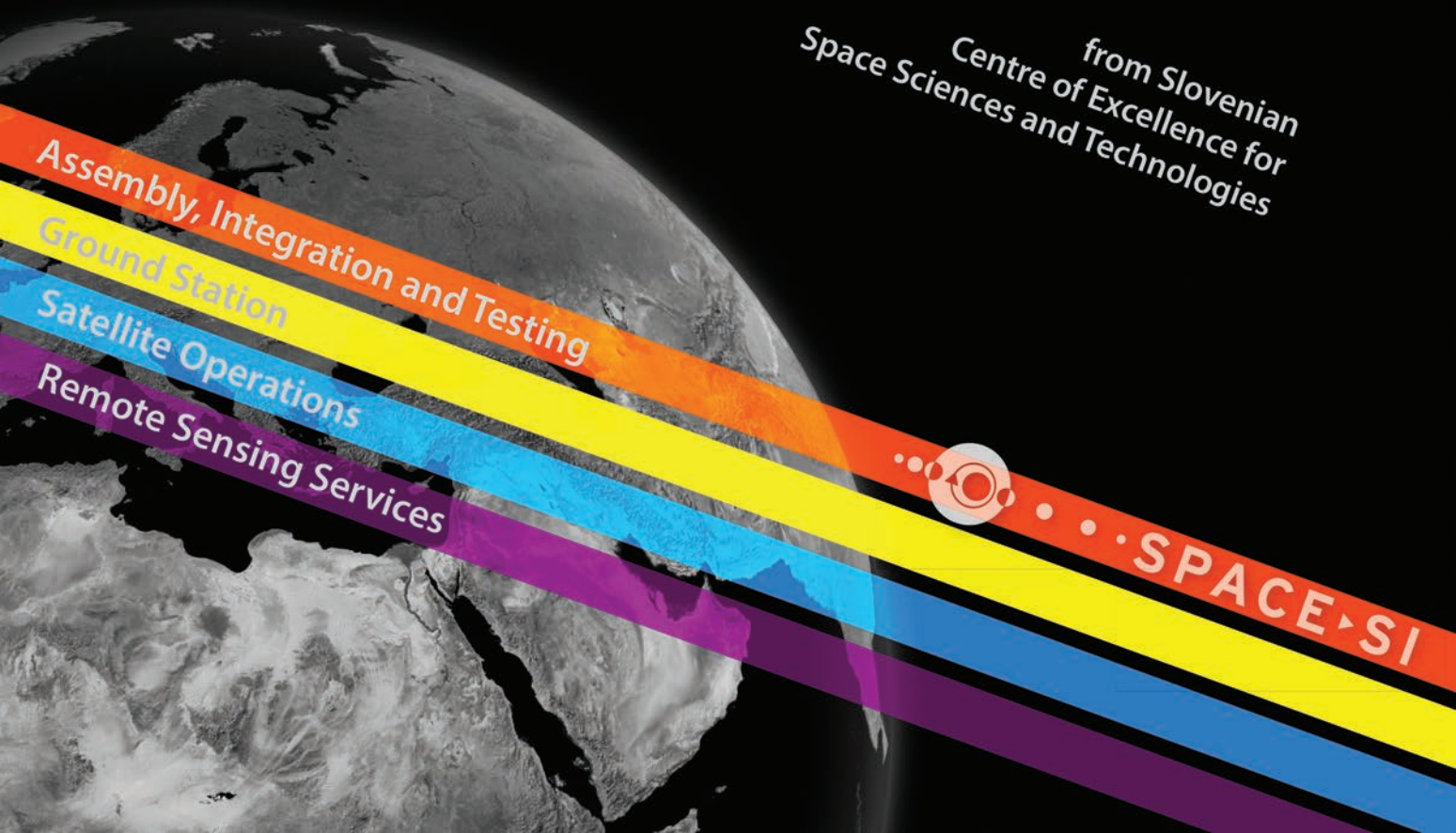
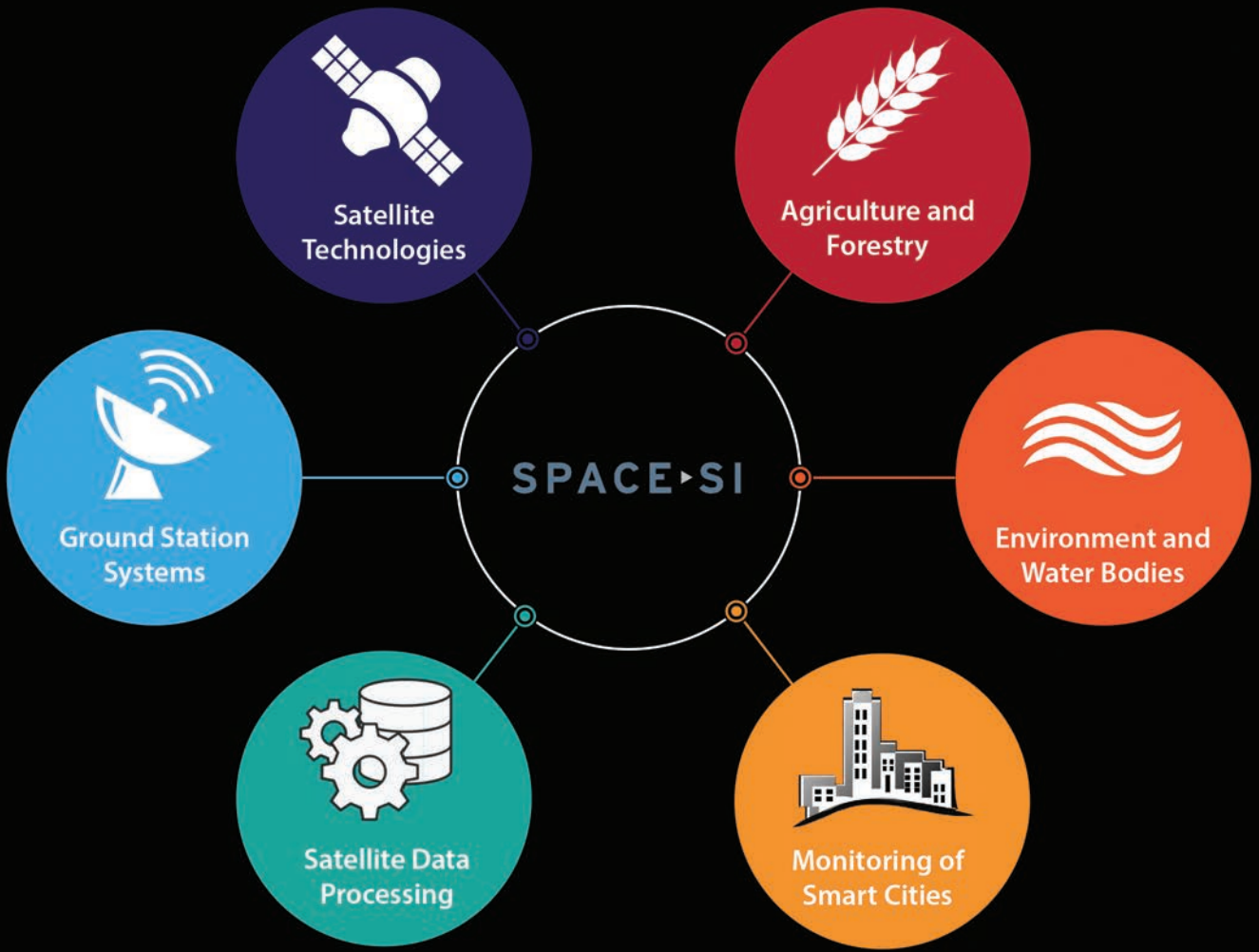
SPACE-SI SATELLITE SYSTEMS AND SERVICES

from Slovenian
Centre of Excellence for
Space Sciences and Technologies



Technologies and Services



Foreword

The Slovenian Centre of Excellence for Space Sciences and Technologies SPACE-SI has been established in 2010 by a consortium of academic institutions, high-tech SMEs and large industrial and insurance companies in order to benefit from the advantages of small satellite technologies and applications in Earth observation, meteorology and astrophysics.

The RTD activities of SPACE-SI are focused on high resolution interactive remote sensing and formation flying missions. These goals are supported by the development of an advanced microsatellite for Earth observation and RTD infrastructure that includes ground control infrastructure, satellite integration facilities as well as a multidisciplinary laboratory for testing of satellite systems and components in simulated space environments.

The data sources from small satellite missions have been combined with the data from large space programs such as Copernicus to enable frequent and cost-effective remote sensing applications in ecology, agriculture, forestry, land cover mapping, urbanism and maritime, as well as for monitoring climate changes, natural disasters and use of natural resources.

Prof. Tomaž Rodič, PhD
Director of SPACE-SI

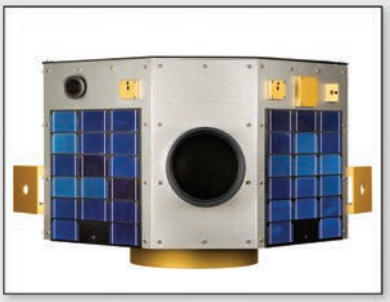
Ljubljana, April 2018

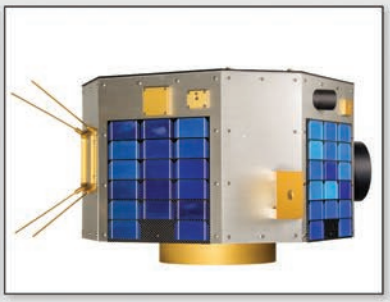
Interactive Remote Sensing

Applications

- real time video and multi-spectral imaging from space
- support of search and rescue operations
- observations of events in smart cities, ports, logistic centres, etc.
- real time monitoring of natural and man-made disasters
- natural resources, agriculture and forestry
- sea and coast monitoring
- biodiversity (ecosystems, invasive plants)
- change detection
- climate change
- urbanism
- insurance

SPACE-SI has developed a high precision interactive remote sensing mission for acquiring multispectral images and real time HD video. The mission is based on NEMO-HD microsatellite for Earth Monitoring and Observation, STREAM 54 ground control station and STORM system for automatic processing of satellite images to generate web-delivered end-user-oriented thematic maps. The unique combination of NEMO-HD real time video streaming and multispectral imaging enables very advanced remote sensing applications of interest to the NewSpace economy.

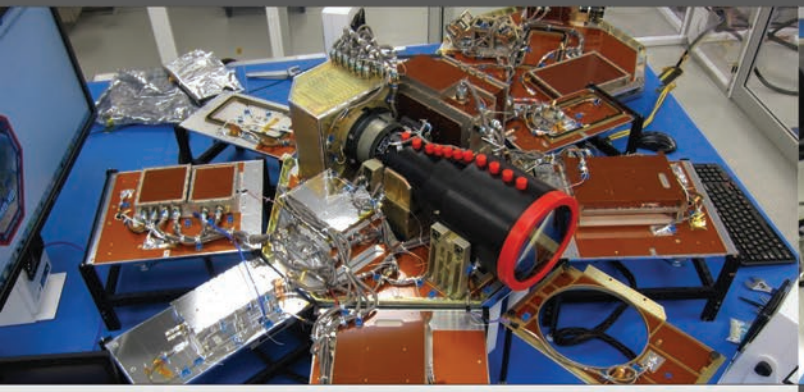


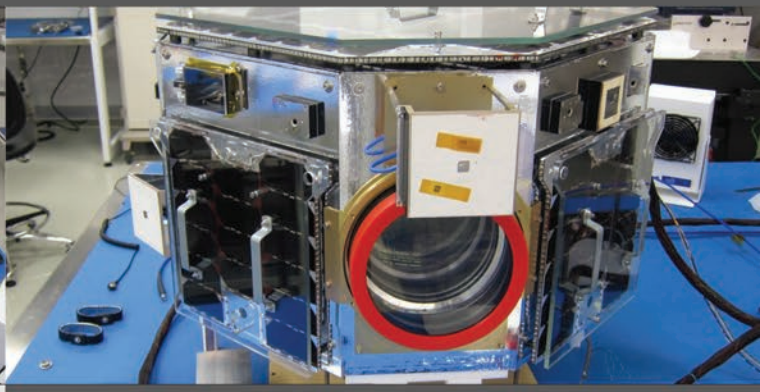


NEMO-HD still imagery observation bands

Channel	Spectral band	GSD	Swath
HRS-PAN	400 - 900 nm	2.8 m	10 km
HRS-MS1	420 - 520 nm	5.6 m	10 km
HRS-MS2	535 - 607 nm	5.6 m	10 km
HRS-MS3	634 - 686 nm	5.6 m	10 km
HRS-MS4	750 - 960 nm	5.6 m	10 km

NEMO-HD Microsatellite

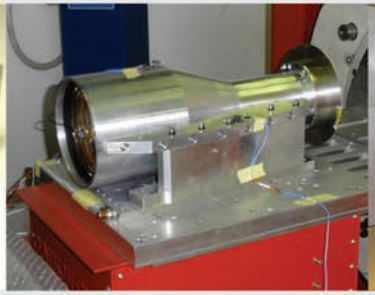


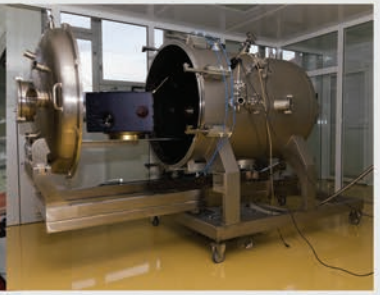


Features

- 2.8 m PAN and 5,8 m MS GSD cowering a swath width of 10 km from a reference altitude of 600 km
- Four spectral channels (420–520 nm, 535–607 nm, 634–686 nm, and 750–960 nm)
- High-Definition real time video at 1920 by 1080 pixels
- Three-axis stabilized bus
- 50 Mbps X-band downlink
- 279.4 GB of on-board strage
- Peak energy production 770.9Wh
- Peak power production: 55W
- Solar cells capacity: 180W (at -10deg C)
- 300 Wh Li-ion battery

NEMO-HD microsatellite is an agile three-axis stabilized spacecraft with mass 65 kg and high pointing accuracy. It carries two optical instruments The primary instrument is capable of imaging in four spectral bands at a pan-sharpened GSD of 2.8 m covering a swath width of 10 km while the secondary instrument produces images at a GSD of 40 m in a much wider field of view up to 75 km. Both instruments can record high definition video at 25 frames per second. The spacecraft is capable of real-time imaging and video streaming when in contact with a ground control station.



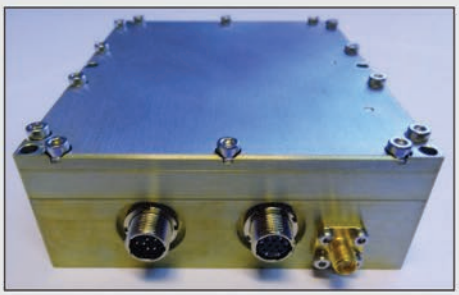


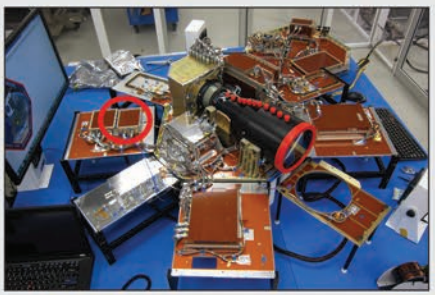
X-band Transmitter for Small Satellites

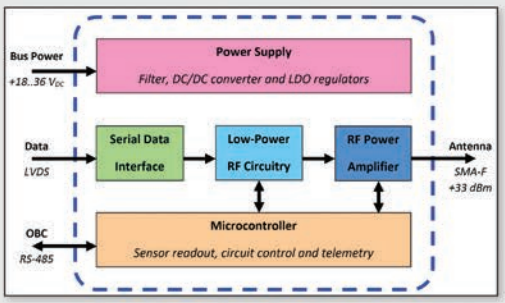
Features

- Power consumption: typ. 10 - 15 W
- Frequency: 8.0 - 8.4 GHz
- Output RF power: 1 - 2 W
- Data rate: up to 200 Mbit/s
- Modulation type: O-QPSK
- Low phase noise and excellent spectral purity
- Input VBUS voltage: 9 - 36 Vdc
- LVDS synchronous data interface
- FEC: CCSDS convolutional (option)
- Data encoding: Differential (option)
- In-flight frequency adjustment
- Dimensions: 95 mm x 95 mm x 50 mm
- Mass: 400 g

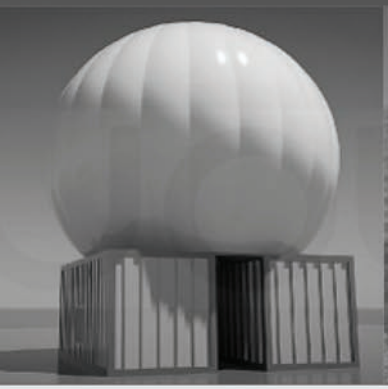
For the modern small satellites an effective transmitter for high-speed data transfer is crucial. With the remote sensing technology progress even very small satellites collect increasingly large amount of data. Therefore the problem of data transfer is more and more pressing while the restrictions on mass, power consumption and volume remain the same. Addressing this challenge, SPACE-SI has developed a compact satellite transmitter for the transmission of large amounts of data with low power consumption, low mass and volume. The transmitter is available in two sizes – for micro satellites and for CubeSats.







Ground Station




Characteristics

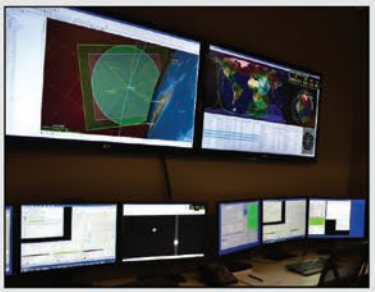
- Dish diameter: 3.7 - 10 m
- Bands: S & X up to Ka/Ku
- Radome loss: < 0.2 dB (up to 40 GHz)
- Pointing accuracy: < 0.01 degree
- Max. wind: 250 km/h (operational)
- Power (antenna): < 1kW

Features

- High precision LEO tracking
- Ka/Ku-band ready
- Full hemispherical coverage without keyholes
- Carbon fibre dish
- Extremely low-loss ultra wide-band radome
- Fully automated, published API

STREAM represents the next generation of high precision LEO tracking ground control stations for broadband and multiband communications at frequencies up to 40 GHz. Its state-of-the-art design capitalizes on key innovations such as new thin membrane radome material, new three axis geometry having full hemispherical coverage without keyholes, new high precision single motor drive system, use of carbon fibre materials for lighter, stiffer components and precise operation as well as modular design including portable and mobile versions with high use of COTS equipment and open source software to minimise operational and maintenance costs.



Assembly, Integration and Testing

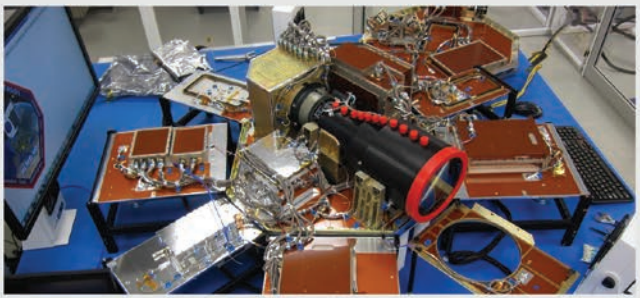
Features

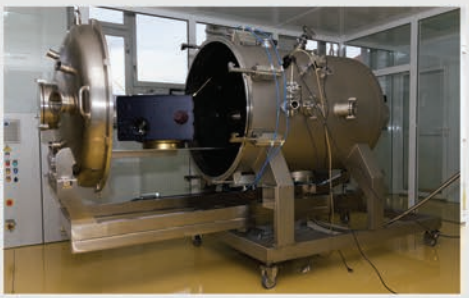
- thermal-vacuum chamber
- ISO 8 clean room
- nanoindenter
- vibrating table
- air bearings
- Helmholz cage

Applications

- testing of small satellites
- testing of satellite components
- testing of subsystems
- material testing

The goal of our multidisciplinary terrestrial laboratory for research of highly accurate closed loop solutions is to raise the efficiency of micromechanical actuators characterization and to test micro- and nanosatellite interactive visual based guidance by merging them into a common connected solution. This will enable comprehensive research of all control elements for orbital manoeuvres, from actuators to platform responses (modelling spacecraft dynamics and space environment) and sensors.





Thermal-Vacuum Chamber

Features

- vacuum up to 10^{-5} mbar
- temperature range from -70°C to +140°C
- feed-throughs tailored to customer's needs

Applications

- small satellite testing
- testing of satellite components and subsystems

Thermal-vacuum chamber is one of the most comprehensive risk mitigation components of the integrated spacecraft environmental test program. Centre of excellence SPACE-SI and its industrial partners have developed a series of thermal-vacuum chambers for small satellite and satellite components testing in the simulated space environment. In the chamber the different vacuum stages can be combined with thermal cycles from lower to upper temperature extremes. In the table below two chambers are presented.

Dimensions	0,85m dia x 1m	0,35m dia x 0,35m
Vacuum	10-5 mbar	10-5 mbar
Thermal system	Temp. control unit	Peltier cooler
Temp. range	-70 to +140°C	-5 to +20°C
Control system	• Control and measuring plate • Vacuum sensors and instruments • Temperature sensors and instruments	
Feed-throughs	• SUB-D 25 pins • N-connector • SMA connector • RS-232 • see through window	

Aluminium Alloys for the Aerospace Industry

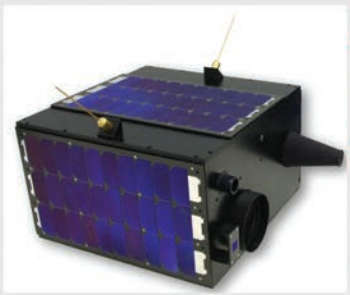
Features

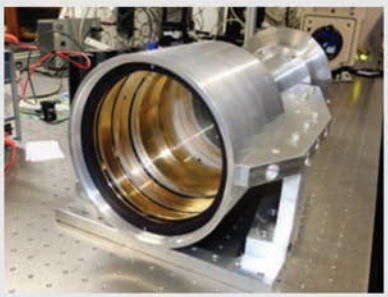
- small grains in the microstructure
- better homogeneity without micro segregation
- improved mechanical properties of the alloys
- direct extrusion without heat treatment
- 20% increase in productivity, up to 15 % energy savings

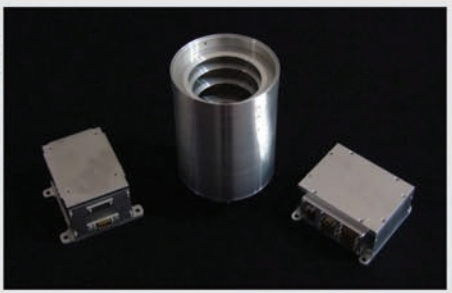
Applications

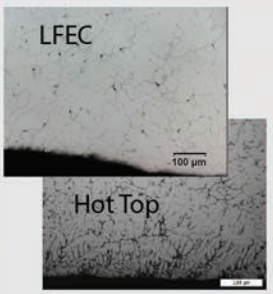
- satellite components and subsystems
- satellite technologies
- automotive, aerospace and space industry

SPACE-SI in cooperation with consortium partner Impol d.o.o. develops advanced aluminium alloys with targeted thermo-mechanical properties. We are specialized in the design and manufacture of structural components and subsystems for micro/nano satellites. Participation in the consortium resulted in the development of a low-frequency electromagnetic casting (LFEC) device. The device enables casting of special alloys, shortens the processing time and improves the thermo-mechanical properties of alloys. Impol d.o.o. produces more than 170 different aluminium alloys including alloys from the series 7000 – the most commonly used alloys for space applications.









Web and Mobile Applications

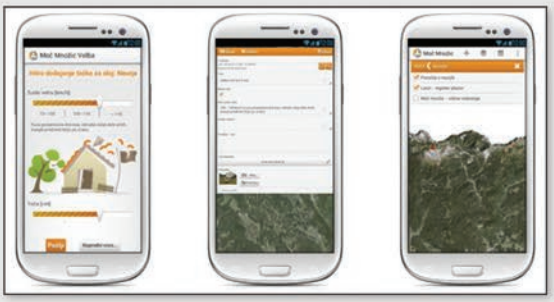
Features

- more than 1000 layers of spatial data
- raster and vector layers
- further data editing options
- crowdsourcing

Applications

- spatial analyses
- communicating and informing
- data forwarding
- monitoring of extreme weather events

Spatial data used in GIS (Geographic Information Systems) applications is becoming more and more important part of everyday life. Years ago GIS applications were only used within the institutional frameworks (cadastre, agricultural subsidies, and infrastructure). Nowadays they can be found in almost every smart phone. For the simplest possible access to the information our online GIS viewer is based on the Geopedia.si technology. It enables viewing of vector and raster data, editing of vector data and a variety of spatial analyses. In addition, with the selection of suitable layers from the database of 1000 different layers of spatial data users can build their own GIS applications according to their needs.



Automatic Satellite Data Processing

Applications

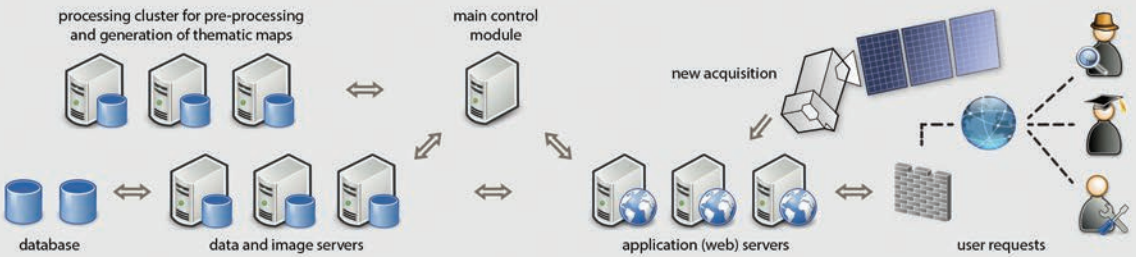
- automatic generation of orthoimages (which present an alternative to the aerial orthophotos) from optical satellite images of medium, high and very-high resolution
- automatic generation of thematic maps
- monitoring seasonal activities and sudden changes

Benefits

- rapid processing of satellite data
- prompt automatic interpretation, which makes satellite data a valuable source for forestry, agriculture, natural disasters prevention, hydrology, biology, insurance business
- autonomy of processing and an increasing volume of available satellite data enable continuous monitoring of many processes on the Earth's surface

Automatic satellite data processing is a dream of every remote sensing professional. Our STORM processing chain is a first step towards fulfilling this dream. The processing chain automatically executes all the necessary processing steps from raw optical satellite data to end-user-oriented web-delivered thematic maps.

A satellite image is positioned into the chosen coordinate system, and atmospheric and topographic corrections are applied to ensure comparability of multitemporal images. Finally, the image is interpreted into a thematic product which is easily understood by experts from different fields.



Automatic processing of optical satellite data (the STORM processing chain) enables fast availability of accurate and exact spatial information. It is therefore one of the key elements of advanced processing systems, such as rapid mapping of natural disasters.

Geometric Corrections

Applications

- automatic generation of orthoimages (which are an alternative to aerial orthophotos)
- processing optical satellite images from multiple sensors of medium, high, and very-high resolution

Benefits

- geometric corrections position a satellite image into a chosen coordinate system
- orthorectification enables spatial comparability with other spatial data
- automatic processing (in the frame of the STORM processing chain)

Geometric distortions of a raw satellite image are a result of height, speed, position and orientation of the satellite, sensor optics, rotation and curvature of Earth and terrain. Geometric corrections remove all these effects.

If the image is not geometrically corrected it is practically useless for mapping, interpretation or analysis. On the other hand, each pixel of the corrected image, i.e. an orthorectified image, possesses geometric fidelity. This means we can make direct and accurate measurements of distances, angles, positions, and areas directly from the image. The measurements are essentially the same as if they were taken on Earth's surface.

An important part of the automatic geometric correction process is automatic extraction of ground control points. It is performed with image matching based on reference road data (left).

River Drava (NE Slovenia) on a raw (middle) and an orthorectified image (right). Rotation and displacement of the relief can be clearly seen.

Atmospheric and Topographic Corrections

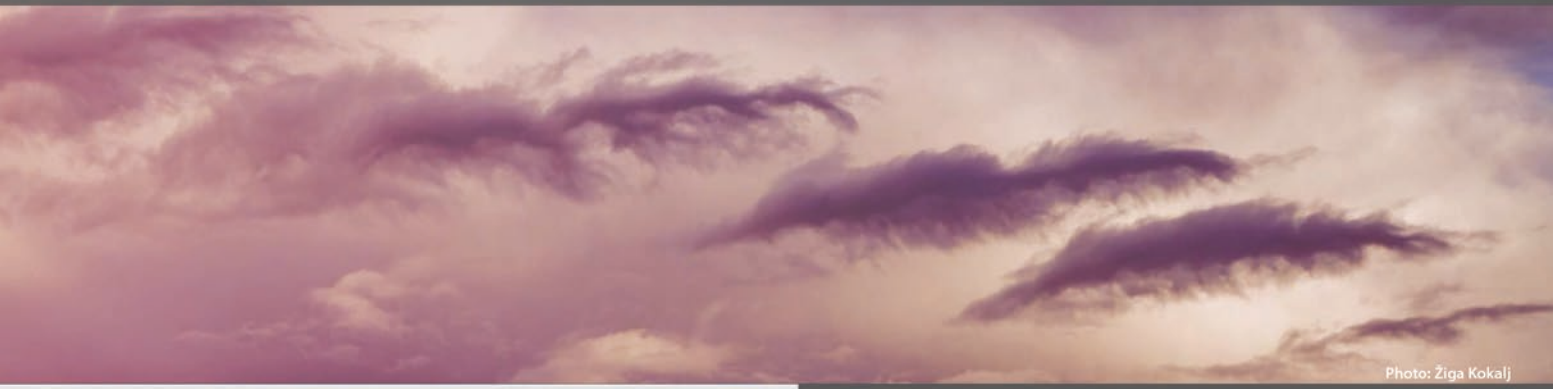


Photo: Žiga Kokalj

Applications

- generation of atmospherically and/or topographically corrected optical satellite data of medium, high, and very-high resolution
- enables direct comparison between satellite data of the same or different sensors

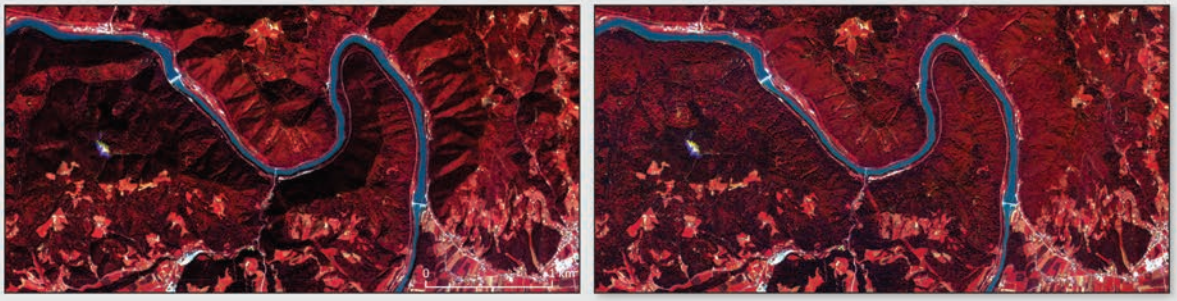
Benefits

- enhanced temporal comparability of satellite imagery
- improved interpretation
- image pixel values represent reflectivity
- adequate monitoring of landscape changes are possible only on atmospherically and topographically corrected images
- automatic processing (in the frame of the STORM processing chain)

Due to several reasons, pixel values of a raw satellite image are not entirely precise; effects of atmosphere and relief have the biggest impact. These effects are minimised with the atmospheric and topographic corrections.

Atmospheric corrections minimize the effect of atmosphere, such as haze and scattering, and determine the positions of clouds and their shadows.

Topographic corrections minimize the differences between illumination of surfaces exposed to Sun and surfaces in shadows. They are dependent on the Sun incidence angle and relief.



Appearance of an image is more homogeneous and two-dimensional after corrections. An area along the river Drava (NE Slovenia) is shown on a RapidEye image with 6.5 m resolution. An uncorrected image is shown on the left and corrected image on the right.

Monitoring Invasive Plants

Applications

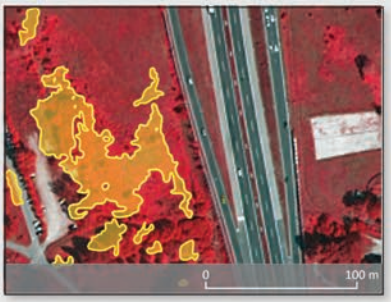
- detection of invasive species growing sites
- monitoring the level of spread and environmental damage
- monitoring the effectiveness of eradication

Benefits

- high accuracy of detection of sites
- planning assistance of eradication activities
- simultaneous inspection of the entire area of a municipality or region

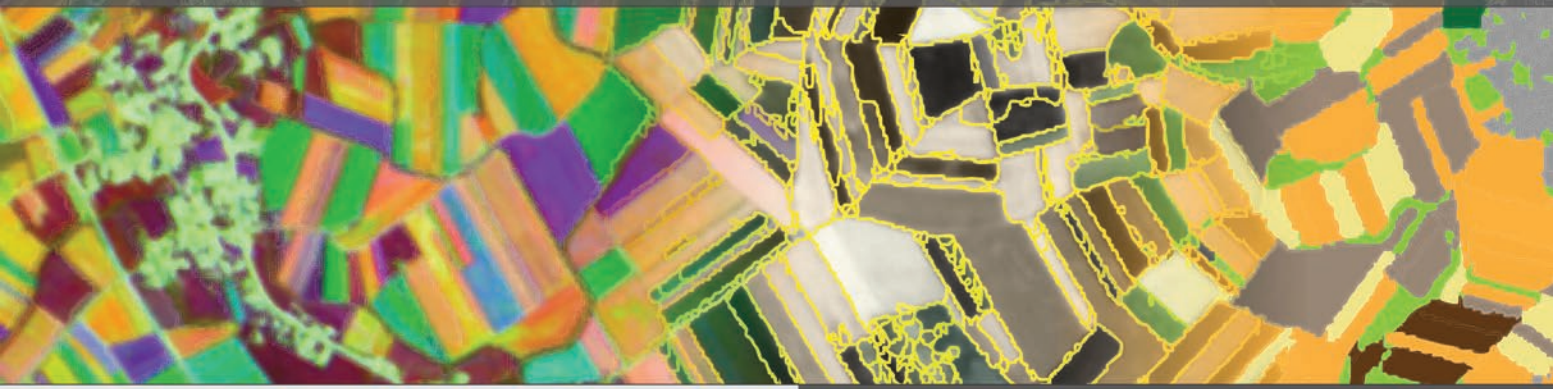
We often hear that Slovenia is a European crossroad. This also brings a rapid spread of non-native invasive plant species. One of the worlds' most intrusive plants is Japanese knotweed that thrives well along streams, roads, and construction sites, but is also spreading increasingly on meadows and fields.

We designed a mapping method of its occurrence sites in all stages of growth. We can also monitor its sprawl and the effectiveness of eradication. The accuracy of detection of Japanese knotweed is almost 90 %, which is much better than previously known methods. Most of the undetected sites are either too small or are located under tree canopies.



Japanese knotweed growing sites along the eastern Ljubljana bypass and the Ljubljanica river. The plant is rapidly spreading across Slovenia due to insufficient eradication and restriction measures. The same applies to other non-native invasive plant species (Canadian goldenrod, Himalayan balsam *etc.*).

Classification of Agricultural Land



Applications

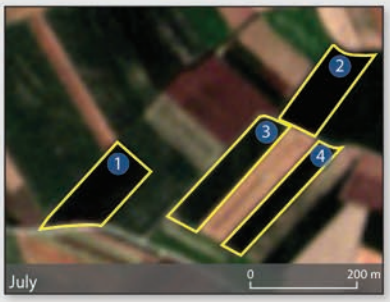
- monitoring crop type, location, area, and stress
- transparent and timely information on agricultural land
- consistent and product-oriented infrastructure for observation of crop dynamics

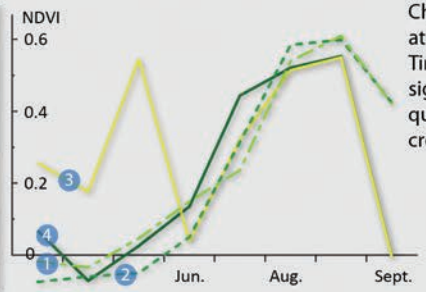
Benefits

- automatic farmland detection processes
- less manual vecto risation and visual interpretation
- fast processing of larger areas (country scale)
- all-seasonal data display
- additional temporal dimension of data
- multilevel operation, simultaneous learning, iterative verification
- advanced and robust procedure

Remote sensing is a well-established source for monitoring agricultural land, as it provides transparent, timely, and clear information on some of the key indicators.

In Slovenia, the location of agricultural land and its classification are determined by visual interpretation of aerial photographs. Such a procedure is time consuming and uncertain for most crops. We have therefore designed a method for producing high-quality land cover maps from raw images without the intervention of the operator. Important additional information is data of phenological phases of vegetation obtained from time-series of satellite images.





Change of growth properties at four different fields. Time-series of satellite images significantly improve the quality of determination of crops characteristics.

Determination of Ineligible Land Use

Applications

- eligibility control of agricultural subsidies
- increase of effectiveness of risk analysis
- support for visual control and field verification

Benefits

- fast verification of large areas
- fewer and better targeted field checks
- survey of an entire region not just trial areas
- determination of ineligible land use categories which cannot be checked visually

Agricultural subsidies in Slovenia are paid per area of agricultural land. Farmers have a right to obtain a subsidy if their farmland is used e.g. as field, grassland or orchard (eligible land use). Land use categories that are not eligible for subsidies are e.g. overgrowing fields, built-up areas, or forest. The control is currently done by visual image interpretation and field verification, where trial areas are selected randomly and with infringement risk analysis. It is thus time consuming and partial.

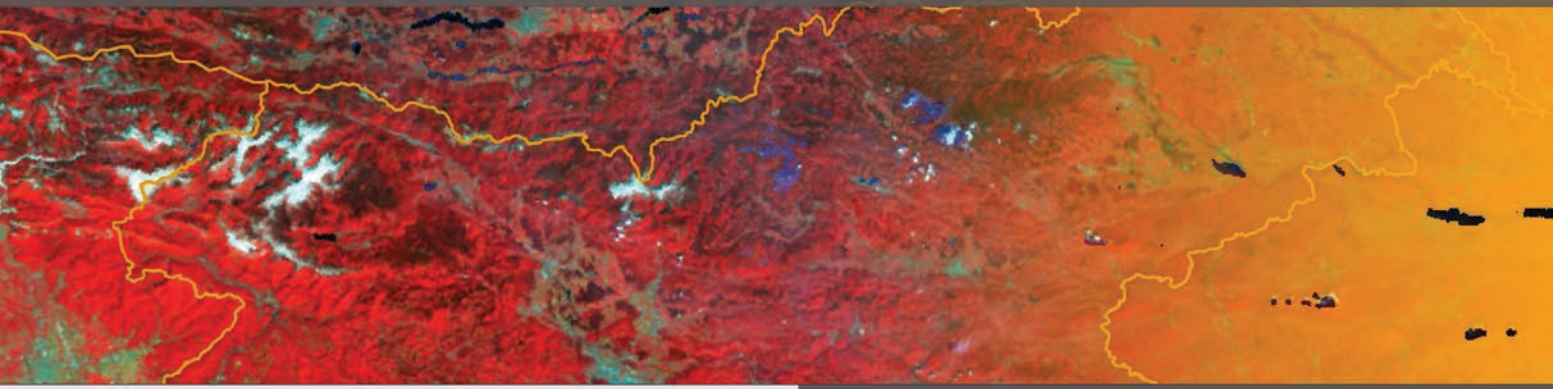
We are developing a process for automatic identification of particular types of ineligible land use. The results will serve as an aid to visual inspection and as an parameter in the risk analysis.

Areas of ineligible land use have to be correctly identified and mapped on aerial or satellite images to properly distribute the agricultural subsidies

farmland registered for subsidy

farmland ineligibly registered for subsidy

Drought Monitoring



Applications

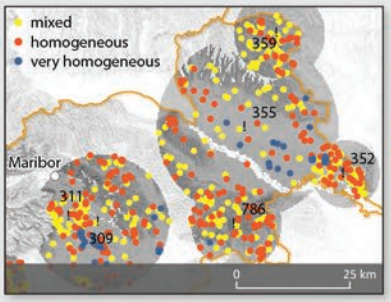
- rapidly available drought maps
- occurrence maps of droughts in the past
- analysis of the drought incidence depending on the type of vegetation
- planning of irrigation systems

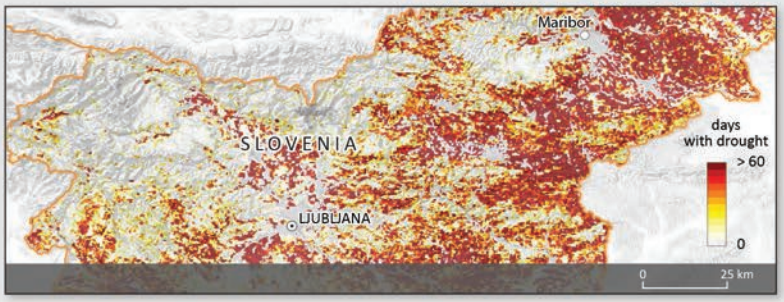
Benefits

- the system is calibrated on local data
- multiyear satellite and meteorological observations are used together with best available ancillary data
- drought recognition accuracy is 92 % overall
- the system can be relatively easily upgraded to new sensors that will have higher spatial, temporal, and/or spectral resolution

We are establishing a system for automatic detection of the vegetation state, which is the basis of an integrated system for identifying drought conditions. The system is based on machine learning methods, satellite data, meteorological measurements, and other spatial data.

In the preparation for new European satellites Sentinel-2 and Sentinel-3 we currently support MODIS and MERIS satellite data. The obtained results are relevant to the area of Slovenia and its surroundings, but the method is designed so that the model can be easy recalibrated to other regions and is particularly suitable for variable landscapes.





Training points for calibration of the system for automatic detection of drought condition (far left). Cumulative image of detected drought conditions for year 2013, when Slovenia was hit by a catastrophic drought (left).

Mapping the Effects of Major Disasters

Applications

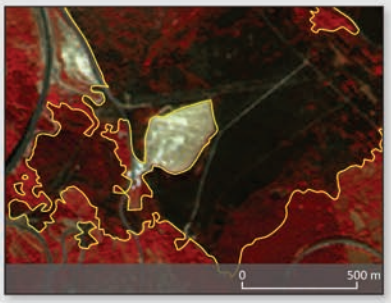
- situational maps of large areas
- study of the dynamics of a disastrous event in a wider area
- damage assessment
- preparation of mitigation and prevention management plans for extreme natural processes

Benefits

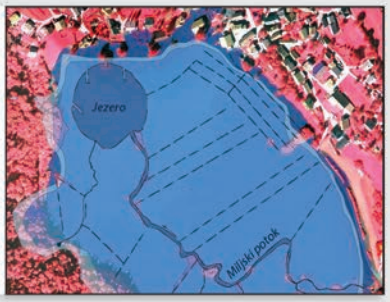
- rapid mapping
- time series maps (monitoring the development of a disaster in time)
- radar data are weather independent
- optical data give better spatial distribution of the phenomena

The largest space agencies and other satellite data providers have committed their resources to the International Charter Space and Major Disasters for providing space data acquisition and delivery in the case of major natural or man-made disasters.

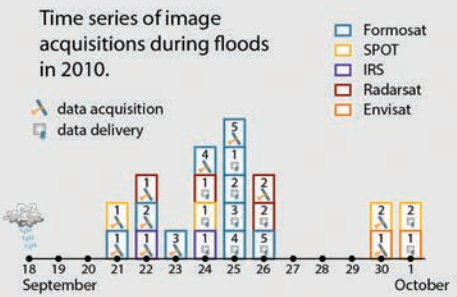
The Charter is activated by authorised users – in Slovenia this is the Administration for Civil Protection and Disaster Relief. Remote Sensing Centre participated as a local data processing partner, performing mapping and analysis in all past Slovenian activations, including the first ever activation of the Charter, immediately after its establishment in autumn 2000 .



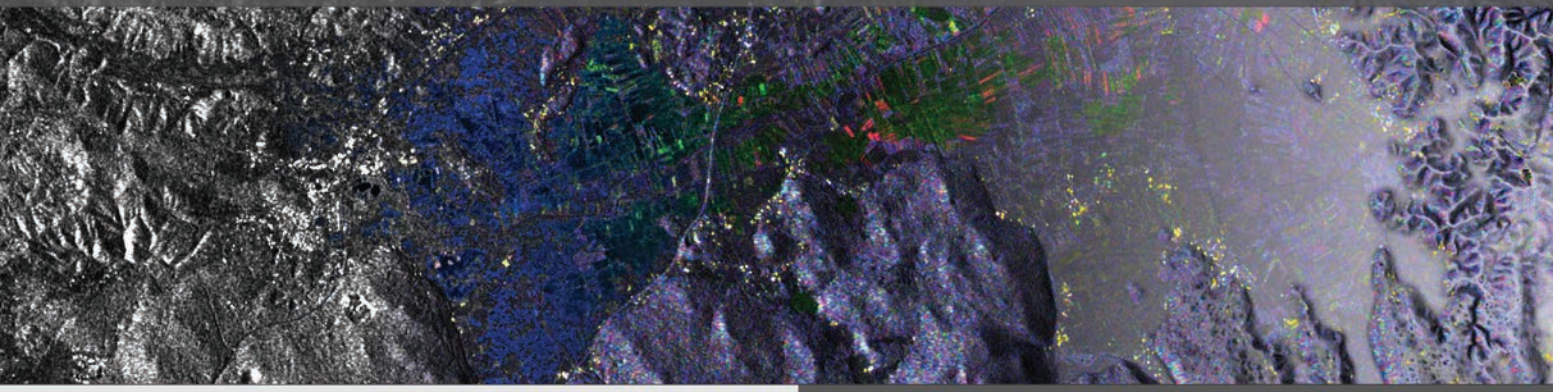
Fire extent estimation at Črni Kal (SW Slovenia) from a 6.5 m RapidEye image (left).



A usual water level and flood conditions of Podpeško jezero, as detected by different systems in September 2010.



Mapping Water Bodies



Applications

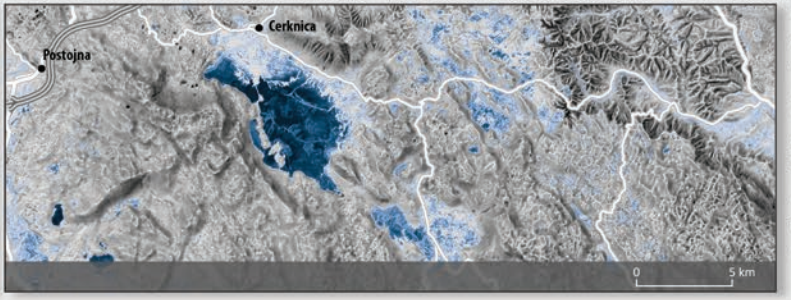
- continuous monitoring of water levels and water volume
- verification of hydrological models
- flood monitoring
- flood risk assessment

Benefits

- daytime and nighttime observations
- independent of weather conditions
- fully automatic operation
- short processing time

We developed a system for detection of water bodies from Sentinel-1 radar data. The system is triggered as new data becomes available. The algorithm automatically detects water bodies and prepares the results for distribution. The best available terrain model is used in the process of detection and filtering where neighbouring operations are applied to determine the presence of water at each pixel.

Observations of each part of Europe are available every 6 days (3 days with both satellites), which enables continuous monitoring of the extent of water bodies, and fast response in the case of a natural disaster.



Heavy rains in autumn 2014 caused catastrophic floods in much of central and western Slovenia. Broken tree crowns caused by a record ice storm in spring of the same year can also be seen on the far left image.

Cumulative image of detected water bodies in central Slovenia during floods in autumn 2014 (left).

Monitoring Forests

Photo: Žiga Kokalj

Applications

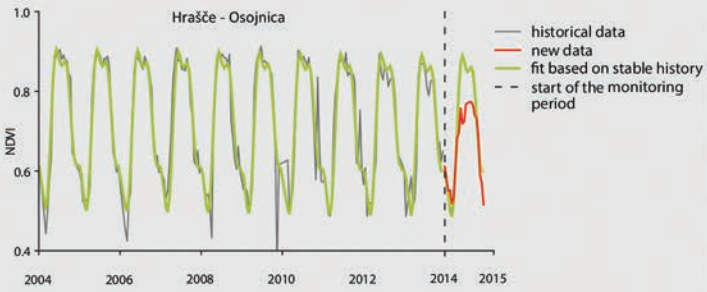
- large area forest observation
- dynamics of processes in forest through vegetation parameters
- analysis of the forest state, monitoring natural vegetation processes, and timely detection of harmful processes
- monitoring adverse events and hazards, and assessment

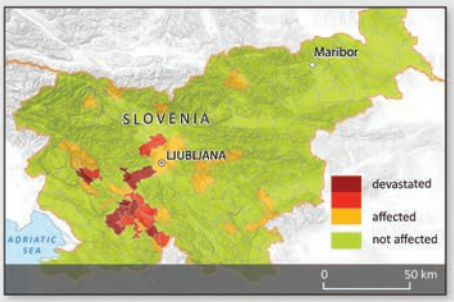
Benefits

- quick access of forests state maps
- time-series observations (monitoring development)
- timely detection of deviations and adverse processes
- establishment of an early warning system

Satellite observations provide continuous quantitative measurements of forest parameters and enable real-time mapping, change detection, and early detection of developing trends. We can obtain information on photosynthetic activity, stress, moisture content, and other biophysical properties of plants, and estimate structural characteristics of forest stands.

Satellite observations complement field surveys in large-scale forest monitoring and in remote areas. They contribute to understanding the complex relationships and recognition of processes in forest ecosystems, as well as to planning and monitoring forest management measures.





Vegetation index (NDVI) dynamics for the forest management unit (FMU) Hrašče - Osojnica (central Slovenia) that was distressed by sleet. Vegetation index is calculated from MODIS satellite data for a ten-year period and an average in the area of forest within a FMU (far left).

FMUs most heavily affected by 2014 ice storm (left).

Urban Heat Island

Applications

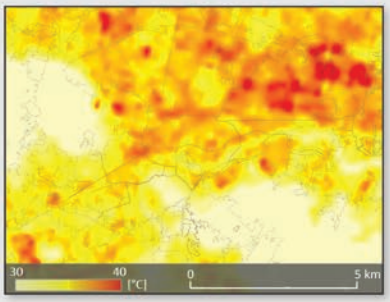
- production of hot-spot maps, that enable identification of
- annual and seasonal comparisons (including daily and hourly comparisons in lower spatial resolution)
- creation of detailed heat maps of individual buildings from aerial observations, allowing a creation of energy efficient reconstruction plansof consequences

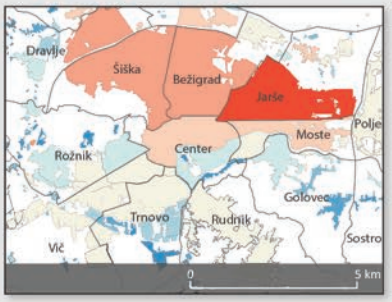
Benefits

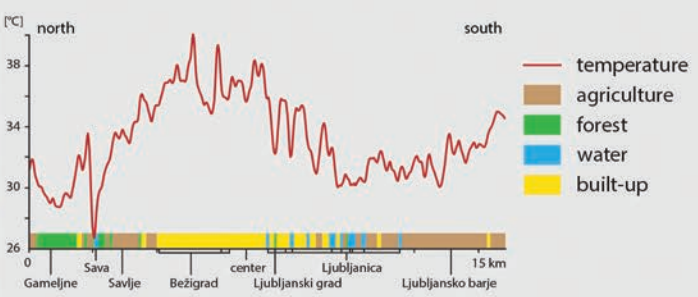
- relatively high spatial resolution
- continuous temperature measurements across the observed area
- various detailed spatial analysis are possible
- flexibility according to the purpose of observation

Increase of the average temperature in urban areas has a strong impact on people who live there. To maintain the same quality of life, an urban heat island and its characteristics must be taken into account for efficient planning of urban activities and infrastructure.

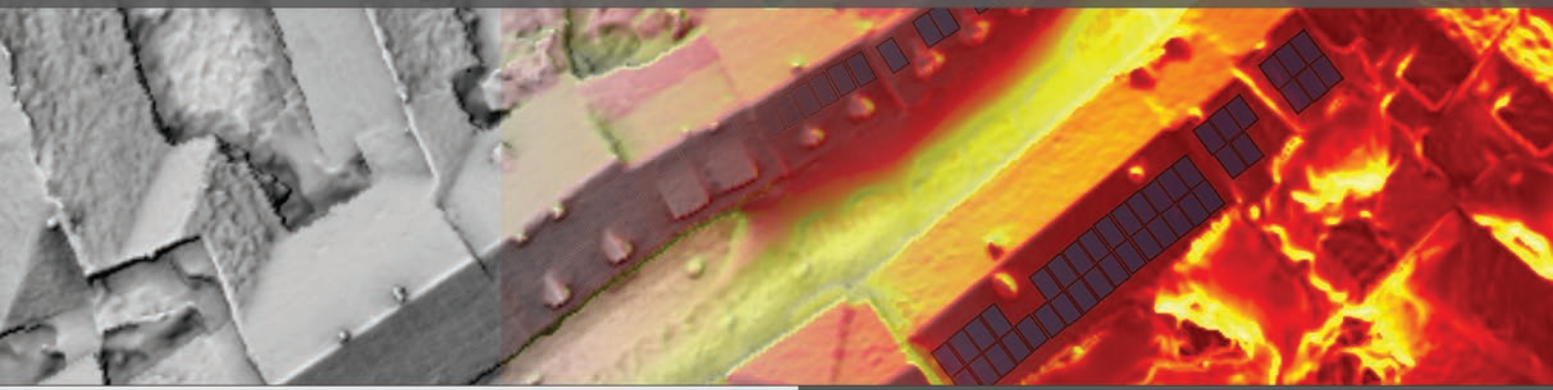
Temperature differences can be observed with a series of satellite images. Observations of the Slovene capital Ljubljana showed a presence of the urban heat island; temperatures of the ground in the city are much higher than in rural areas. On a hot summer day the di erence may exceed 10 °C. The most heat-polluted areas are major industrial facilities and shopping centres.







Solar Insolation Modelling



Applications

- evaluation of locations for solar power plants
- assessment of solar power plant profitability
- viability of placement of the solar domestic water heating panels
- estimation of optimal orientation of solar panels

Benefits

- very high temporal and spatial accuracy of the results
- calculations are tailored for a particular building
- models incorporate effects of nearby vegetation and other factors, which influence insolation

The measurements of solar energy in Slovenia are only available for a few meteorological stations. We therefore calculated the amount of received solar energy for the whole Slovenia with our own algorithms that are based on physical laws and incorporate detailed information about the terrain and ground albedo. This way we obtained solar insolation maps for every month and for the whole year. We also calculated the optimal orientation of solar panels at individual location. The maps are freely available on the internet (gis.zrc-sazu.si/zrcgis).

For high-precision insolation mapping we use advanced algorithms based on detailed models of buildings.

We modelled the insolation received by a ground surface for the entire country. We also produce highly detailed city models so that we can accurately determine the optimal position and orientation of solar panels on roofs of individual buildings, taking into account vegetation, chimneys, roof windows, and other obstacles.

Advanced Maritime Surveillance

Applications

- detection and identification of vessels
- classification of vessels
- monitoring coastal areas and deep waters

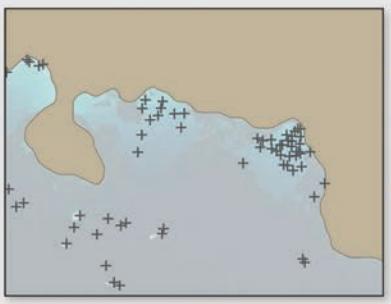
Benefits

- effective and universal method – it works with different very high resolution optical systems
- employment of spectral and spatial characteristics of vessels
- successful operation also on rough seas
- fast performance
- substantial reduction of time effort for manual certification

Ship detection with remote sensing is an important segment in ensuring maritime safety, fisheries control, observation and prevention of oil spills, oversight on unauthorized migration on the sea, and similar.

We have developed a simple, universal, and efficient method for detection and classification of vessels from optical data. The method is useful in particular when there is a need to provide results in real-time, which is of major importance in maritime domain.

The accuracy of detection on images of different sensors and in varied regions exceeds 80 %.



Detection and identification of vessels on the coast of Lampedusa island (S Italy). The image with a spatial resolution of 0.5 m was acquired by GeoEye satellite on July 14th 2013.

+ not a vessel
+ small vessel
+ medium sized vessel
+ large vessel

Observation of Archeological Sites

Applications

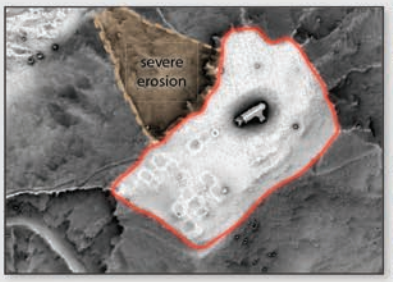
- effective interpretation of lidar data
- identification, mapping, and monitoring archaeological sites
- lidar data is usable also in many other fields, e.g. detailed hydrological modelling, observation of forests, 3D modelling of cities, and production of topographical maps

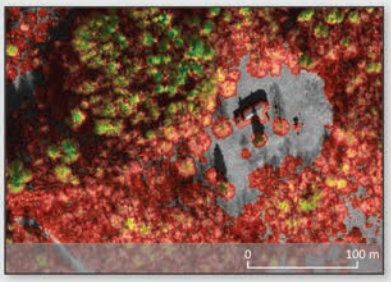
Benefits

- very detailed information about the shape of terrain and natural and man-made objects lying on it
- surveying challenging terrain, for example densely overgrown and steep ground
- extensive areas can be covered rapidly
- field examination can be more targeted and better planned

Aerial laser scanning (lidar) has a great potential in archaeology because it provides not only deeper understanding of already known sites, but also gives a unique way of searching for new ones. With data processing we can virtually remove the vegetation cover and get a product that exposes natural and anthropogenic objects, both modern and ancient, also under a dense forest canopy.

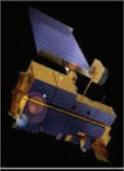
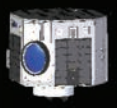
We focus on development and testing of techniques for lidar data processing, visualization, and preparation of suitable products that help with assist archaeological interpretation. Our tools (iaps.zrc-sazu.si/en/rvt) are used in everyday operational work in many countries, from Europe to China and USA.



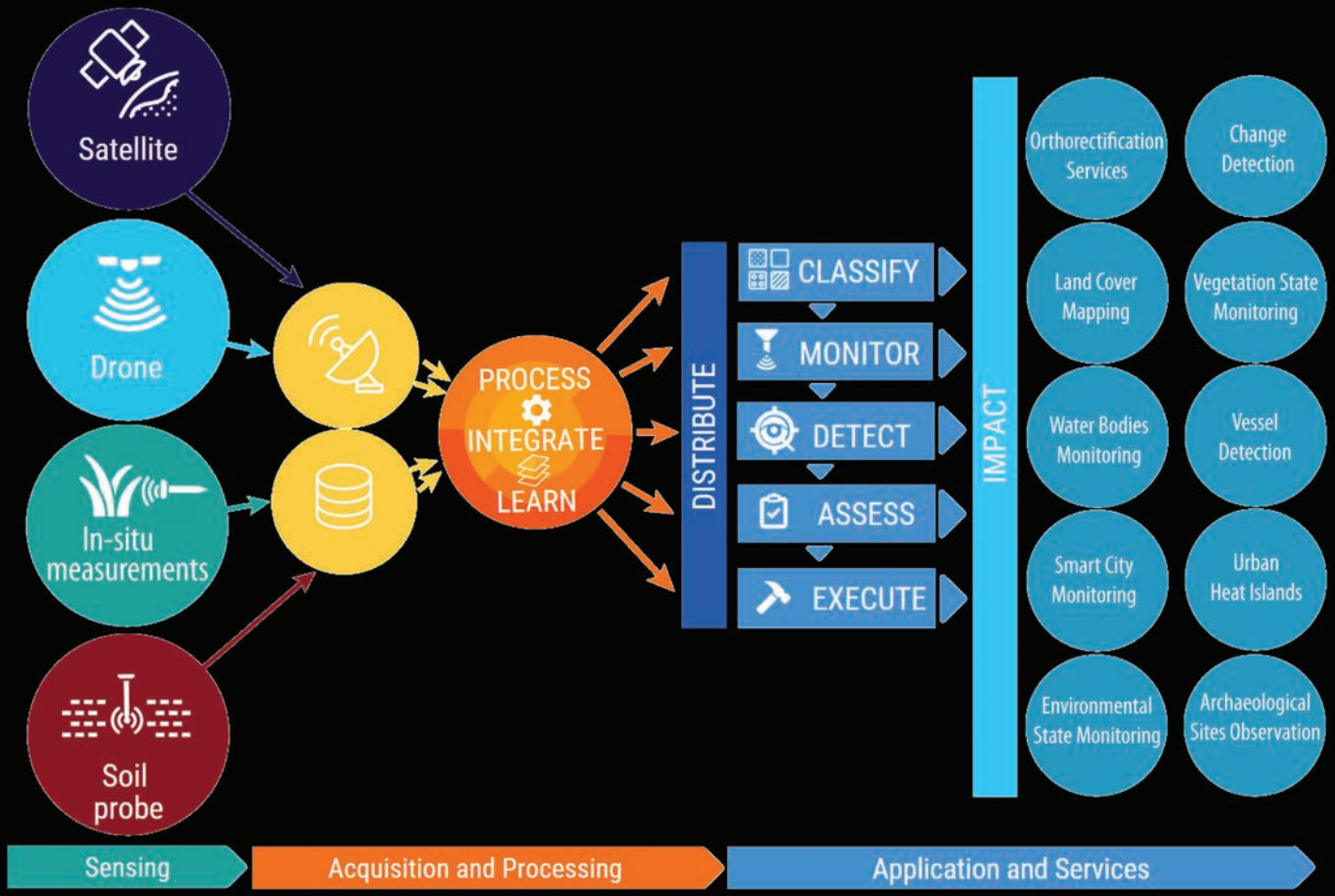


Roman settlement traces have been found on a levelled hilltop with a church of St. Helena (W Slovenia). The images show a helicopter orthophoto, the area of the archaeological site with visible outlines of ancient houses and a slope endangered due to erosion, and heights of trees around the site.

Satellite data sources

Satellite	MODIS	Sentinel-3	Landsat 8	PROBA-V	Sentinel-1	Sentinel-2	NEMO-HD	WorldView 2	Pleiades	Lidar
Image										
Data access	Open	Open	Open	Open	Open	Open	Own	Commercial	Commercial	Commercial
Spatial resolution [m]	250	250	15 (PAN), 30, 100 (TIR)	100, 333	20	10, 20, 60	2.8	0.5	0.5	< 1
Spectral Bands (Number, interval [nm])	36, 405 – 14385	21, 393 – 1040, and SAR	11, 435 – 12510	4, 447 – 1650	C-SAR	13, 450 – 2323	5, 420 – 960	8, 400 – 1040	5, 430 – 940	≈ 1 µm
Orbit	705 km SSO, LTDN 10:30 (Terra), LTAN 13:30 (Aqua)	814 km SSO, LTDN 10:00	705 km SSO, LTDN 10:11	820 km SSO, initial LTDN 10:45	693 km SSO, LTAN 18:00	786 km SSO, LTDN 10:30	500 km SSO, LTAN 10:30	770 km SSO, LTDN 10:30	694 km SSO, LTDN 10:15	airborne
Revisit time	1 day	1 days	16 days	2 day	6 day	5 days	10 days	3.7 days	1 day	On demand

Satellite services



SPACE-SI SATELLITE SYSTEMS AND SERVICES

SPACE-SI
Aškerčeva 12
SI-1000 Ljubljana
Slovenia
w: *www.space.si*
e: *info@space.si*

Investing in your future
Operation Part Financed By The European Union
European Regional Development Fund

April 2018