

# Usage of remote sensing derived data for drought monitoring in Slovenia

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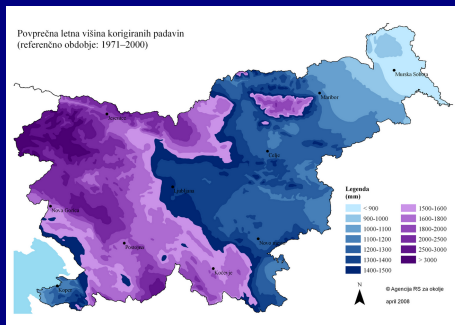


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## Climate in Slovenia

- Slovenia's climate is due to its geographical position favourable in terms of precipitation amounts in all seasons.
- In mountainous regions of western Slovenia orographic enhancement causes yearly rainfall accumulations exceeding 4000 mm/year.



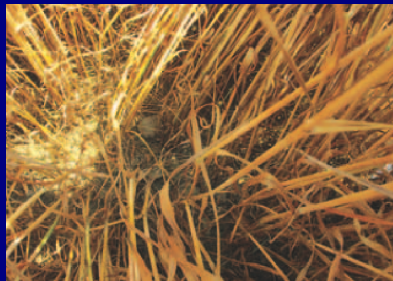
Map indicating average yearly rainfall accumulations in 1971–2000 in Slovenia (M. Dolinar, Slovenian Environment Agency).

## Drought severity in Slovenia

- In the last decade there have been several occurrences of severe droughts causing more than 200 million EUR of economic damage in agriculture.
- Particularly SW and NE parts of Slovenia are prone to drought impacts.
- These drought occurrences necessitate a careful monitoring of drought evolution, its severity and its spatial extent.



Withered state of sugar beet during 2003 summer drought (published in UJMA, 2004).

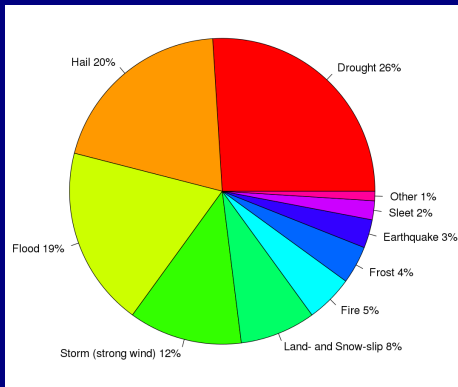


Wheat fields in E Slovenia affected by 2010 summer drought, photo by A. Jamšek (published in UJMA, 2011).

## Damage by natural disasters in Slovenia

### ESTIMATED DAMAGE CAUSED BY NATURAL DISASTERS IN SLOVENIA 1994–2008

Source: Statistical Office of the Republic of Slovenia

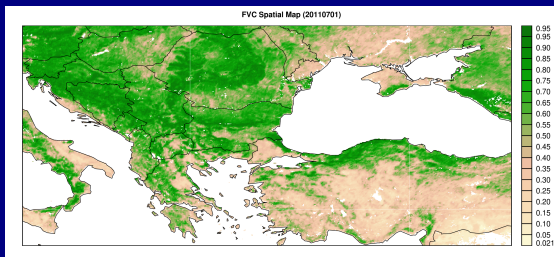


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## LSA SAF's LAI and FVC vegetation products

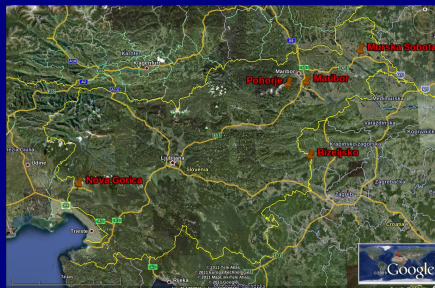
- LSA SAF's **LAI** and **FVC** are important indicators of the state and evolution of the vegetation cover and offer an opportunity to monitor drought conditions.
- FVC characterises the fraction of vegetation on a flat background covered by vegetation.
- LAI is dimensionless variable defined as the total area occupied by the leaves per unit area.
- Both two parameters represent the structural characteristics of vegetated surfaces.
- The parameters are compared against drought indices such as Standardized Precipitation Index (SPI) and reports on drought related agricultural damage on the ground.



The value of FVC index over SE Europe in early July 2011.

## FVC and LAI drought monitoring over Slovenia

- LSA SAF's vegetation products have spatial resolution of approximately 5 km over Slovenia and are archived at Slovenian Environment Agency since 2006 in April–October vegetative period.
- Evolution of drought monitoring is studied at pixel level for a few selected locations over Slovenia.
- These locations are chosen over larger areas with homogeneous land use (vineyards, forests, wheat and corn fields).

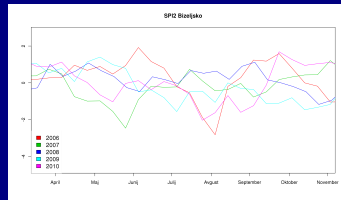
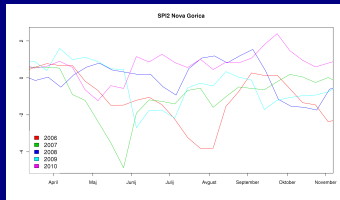
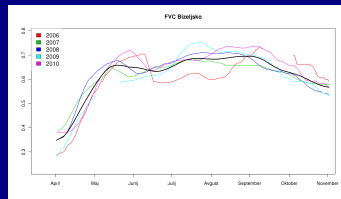
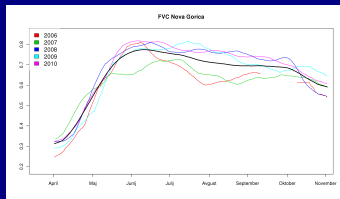


Selected Slovenian locations having homogeneous land use as a part of our drought monitoring system.



## FVC and LAI yearly evolution curves

LSA SAF's FVC and LAI evolution is calculated since 2006. Error and quality flag assessments need to be taken into account. Mean vegetation evolution is obtained by averaging all the available yearly curves (2006–2012) and serves as a reference for drought/no drought signal. Thus, positive departures from the reference curve indicate vegetation is greener and vice versa for negative departures.

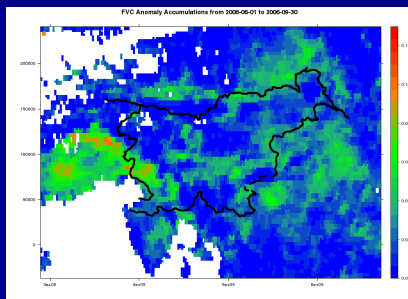


FVC 2006–2010 yearly evolution (top) and 2-monthly SPI for the same period (bottom) in Nova Gorica.

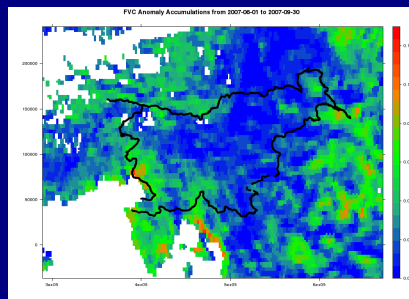
FVC 2006–2010 yearly evolution (top) and 2-monthly SPI for the same period (bottom) in Buzeljsko.

## FVC and LAI anomaly accumulations over Slovenia

- Accumulation of anomalies from reference daily values of LAI and FVC indices are calculated over Slovenia for each pixel.
- Operational at Slovenian Environment Agency for May to October period.



FVC anomaly accumulations over Slovenia in  
June–September 2006.



FVC anomaly accumulations over Slovenia in  
June–September 2007.

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## DMCSEE timeline from initiative to operability

- 1998 need for SE European subregional centre
- 2004 centre initiative – **“top-down” approach**  
(International Commission on Irrigation and Drainage (ICID) adopted a declaration which expressed the need to establish this centre to alleviate problems caused by drought in the area “Balkan Drought Workshop” in Poiana/Brasov (RO), co-sponsored by the UNCCD)
- 2006 **triangle approach**: UNCCD focal points, permanent representatives with the WMO + observers from UNCCD and WMO)  
(Workshop for national experts and representatives of National Meteorological and Hydrological Services where they agreed on DMCSEE within context of UNCCD)
- 2006 **decision on DMCSEE host institution** (procedure lead by WMO).
- 2007 **political commitment of Slovenian government** (permanent budget for the governance)
- since 2009 **first drought monitoring products and fund raising**
- April 2009 – March 2012 **Transnational cooperation programme** (TCP), cooperation with EuroGEOSS project and EDO portal
- 2013 Operational work + WMO cooperation

# DMCSEE status

Currently, DMCSEE is in its **“BRIDGE PROJECT”** phase aiming at permanent functioning centre.

- Most suitable project framework (in the frame of Slovenian Environment Agency) was found to be:

## Transnational Cooperation Programme for SE Europe [www.southeast-europe.net](http://www.southeast-europe.net)

- Main aim to foster a balanced territorial development and territorial integration within the cooperation area
- > **common infrastructure, not research!**
- 15 partners from 9 countries



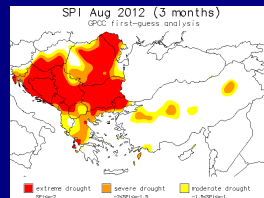
# DMCSEE activities

## Regional drought monitoring activities in the scope of DMCSEE

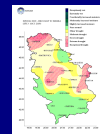
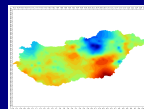
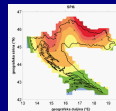
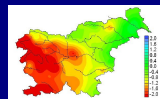
- overview of existing procedures for climatological mapping
- implementation of drought indices (SPI, PDSI, PAI, ...)
- online regional maps of SPI, percentiles and precipitation
- using GPCC data, available since January 1986

## From regional to local implementation

- Calculation of SPI
- Mapping of SPI
- Dissemination



Standardized precipitation index (SPI), computed from GPCC data.



Local implementation of SPI by DMCSEE partners.

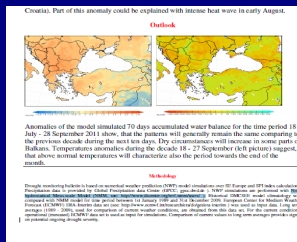
# DMCSEE activities

## Monthly drought bulletins for SE Europe

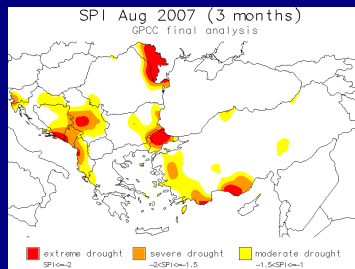
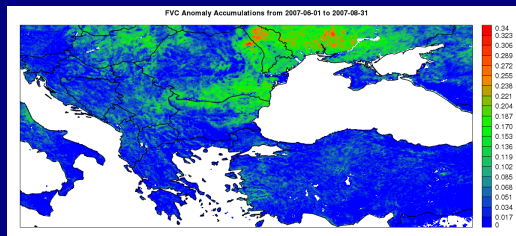
- [www.dmcsee.org/en/drought\\_bulletin/](http://www.dmcsee.org/en/drought_bulletin/)
- A short summary aiming at very short insight of drought circumstances.
- Anomalies in air temperature, surface water balance, SPI index.
- Report on impacts (electronic media).
- Vegetation status: LSA SAF's FVC, EUMETSAT's NDVI in testing phase.
- Outlook with NWP simulations (NMM).

## GIS application and Web Mapping Service

- [www.dmcsee.org/GISapp](http://www.dmcsee.org/GISapp)
- Enables DMCSEE partners to upload their products, composites are calculated automatically.
- Climatological maps and SPI.



# FVC and LAI anomaly accumulations over SE Europe



FVC anomaly accumulations over SE Europe in June–August 2007 (top) and GPCC 3-month SPI calculations over the same domain and for the same period (bottom). In both cases the most severe drought hit regions are denoted in reddish colour.



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# The SatDroughtMon project

- The **SATDROUGHTMON** project was launched in February 2013 by Slovenian Centre of Excellence SPACE-SI in cooperation with Slovenian Environment Agency and DMCSEE, funded by **ESA**.
- The main aim of the research is to develop an **automatic system** for satellite drought monitoring.
- This is to be done with machine learning for building classification and prediction systems and will be based on **satellite data** as well as **ground measurements** collected by different authorities in Slovenia.
- The results of the project will have an impact on drought monitoring with a particular applicability in diverse landscapes.
- Work will be focused on Slovenia, but its implications are much broader and could be transferred to any other region of the world.



Polar-orbiting ESA's ENVISAT satellite. Mission duration: 1 March 2002 – 8 April 2012.

# Preparation of satellite and ground measurements data bases

## Satellite data base

- MERIS full resolution 250 m (usually one image daily) + possibly VIIRS and VITO/VEGETATION in 2006–2012
- cloud mask, satellite radiances, thermal radiation, calculation of NDVI and EVI indices

## Ground measurements data base

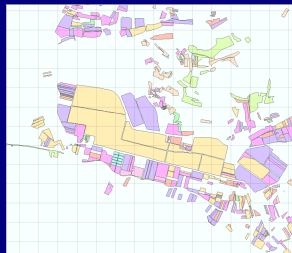
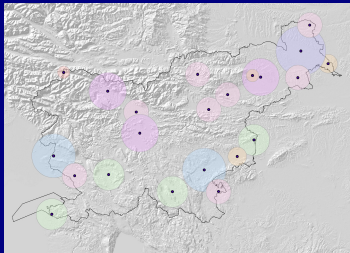
- collected in 2006–2012, vegetative period only
- meteorological measurements from monitoring stations: precipitation and maximum temperature
- calculation of evapotranspiration
- crop modelling to determine water balance and water stress for specific land types
- agrometeorological archive: field reports on agricultural drought damage on the ground

## Auxiliary data base

- classification of land use into 13 dominant land types
- fields: wheat; corn; potato; grass and clover; vegetables; hops
- meadows and boggy meadows
- plantations, olive groves, vineyards, coniferous and deciduous forests
- topography

# Drought detection

- Selection of sample points from different Slovenian regions with meteorological observations has been chosen – each having its own radius of influence where meteorological measurements are considered. The size of the sphere of influence is dictated by the local topography.
- Satellite data is interpolated onto fixed  $250 \times 250$  m grid.
- For each grid pixel a percentage of 13 dominant land use types is calculated + unknown & no data.



Monitoring stations with their dedicated radii of influence (left). An example how land use types are sliced by  $250 \times 250$  m grid (right).

## Statistical model for drought detection will be based on different sources!

- satellite signal, particularly NDVI and EVI indices
- meteorological data and crop modelling output
- field drought reports

# THANK YOU FOR YOUR ATTENTION!

## Acknowledgements

*Parts of this research have been funded by EUMETSAT as a part of ARSO/EUMETSAT cooperation project.*

*Archive LSA SAF data was obtained with the kind assistance of the EUMETSAT's LSA SAF team.*