Monitoring drought conditions in Slovenia using satellite-derived vegetation indices

Gregor Gregorič, Mateja Iršič Žibert

Slovenian Environment Agency

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Drought monitoring

Drought is usually defined as deviation of precipitation from long-term average

-> climate-based indices are traditionally used to monitor drought development

-> can be based on in-situ measuerments or NWP models

Most interest is focused on drought impacts

-> detection of vegetation status using remote sensing data

Drought indices

Climate-based drought indices

- **“Percent normal”**
- **SPI (Standardized precipitation index)**
- **PDSI (Palmer drought severity index)**
- **Water balance deficit**
- **… (confusion among drought and aridity indices)**

Vegetation status detection indices

- **NDVI**
- **FVC**
- **fAPAR**
- **…**

Combined indices

- **VegDRI**
- **CDI**

Standardized precipitation index

SPI value is "measure of departure of precipitation amount from "normal" conditions in unit of std. deviations"

SPI	Classification	Probability (%)
2.00 >	Extremely wet	2.3
1.50 to 1.99	Very wet	4.4
1.00 to 1.49	Moderately wet	9.2
0 to 0.99	Mildly wet	34.1
0 to -0.99	Mild drought	34.1
-1 to -1.49	Moderate drought	9.2
-1.50 to -1.99	Severe drought	4.4
-2.00 <	Extreme drought	2.3

- **SPI advantages:**
  - Simplicity (only rainfall data required)
  - Variable time scale
  - Standardized value (can be applied in different climate regimes -> WMO "Lincoln" declaration!)

- **SPI disadvantages:**
  - "Forced-fitting" of theoretical probability distribution
  - Extreme droughts (over longer period) occur with same frequency on all locations – SPI can't identify drought prone regions
  - Problems with small values

Application of NWP for drought monitoring

DROUGHT RELATED VARIABLES

Water Balance anomaly

Soil moisture

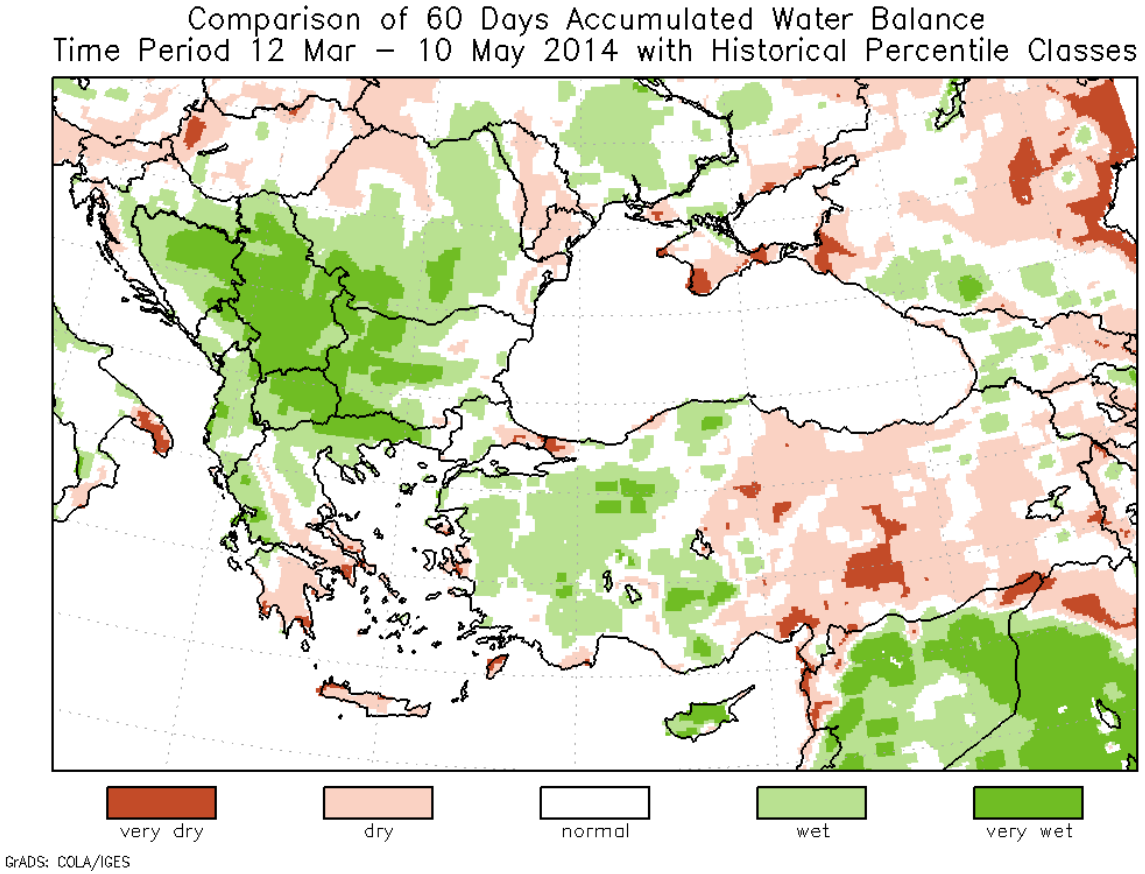
Temperature (degree days)

DROUGHT RELATED TIME SCALE

60 day accumulation, 10 day update

DROUGHT RELATED INTERPRETATION

Deviation from normals, percentiles



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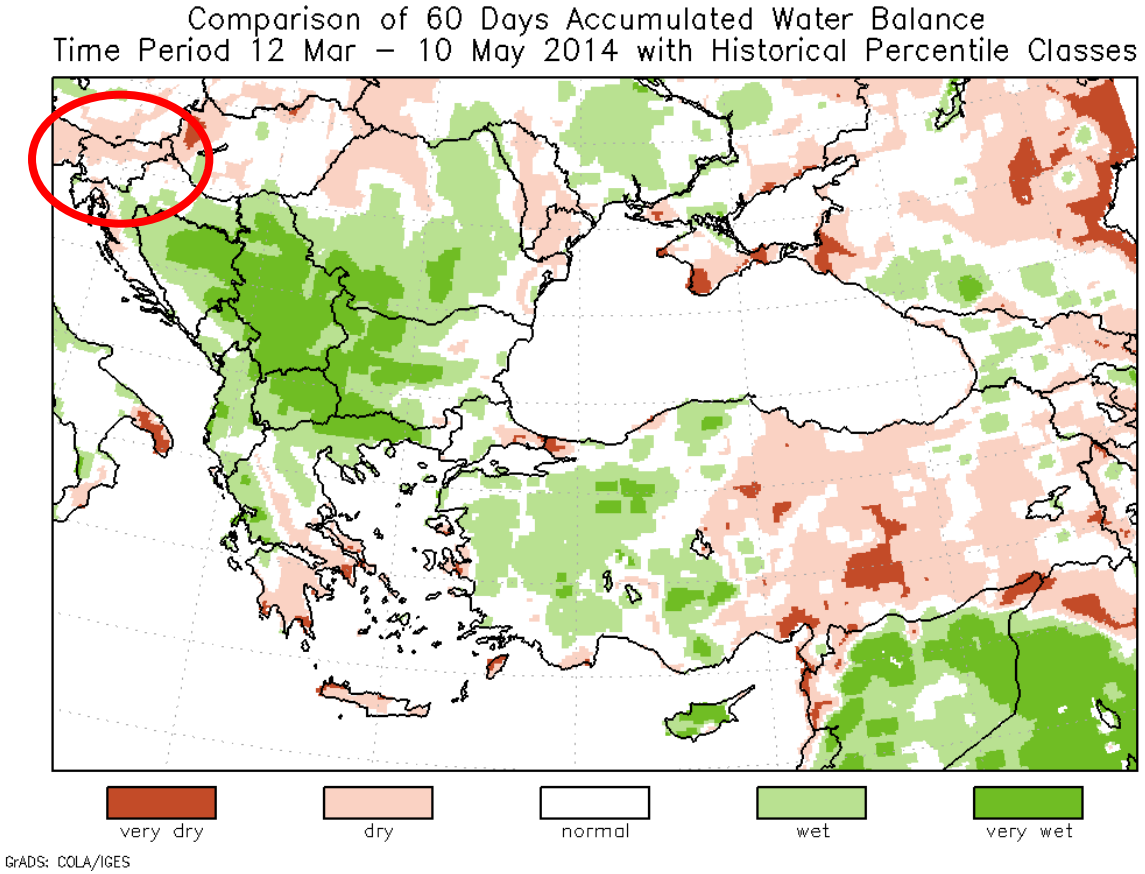


Vegetation drought response index - VegDRI

Combined drought index

In-situ data:
Standardized Precipitation Index (SPI)
Palmer Drought Severity Index (PDSI, self-calibrated version)

Remote sensing data:
Percent of Average Seasonal Greenness Satellite (PASG)
Start of Season Anomaly (SOSA)

Other (supporting) data:
Land Cover
Soil Available Water Capacity
Irrigated Agriculture
Ecological Regions

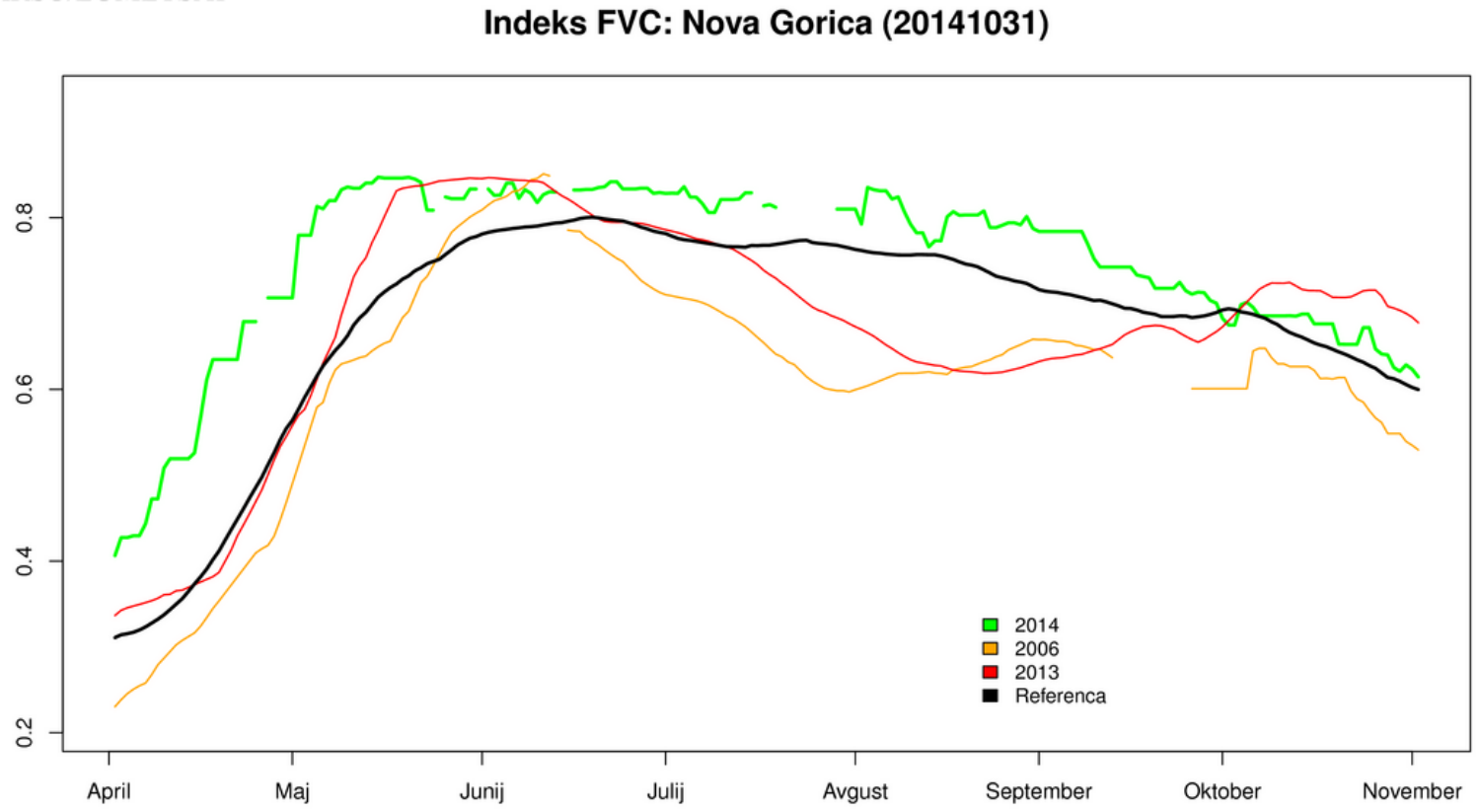
Drought monitoring in Slovenia application of LSA-SAF data

Data provided by EUMETSAT LSA-SAF (Indices: FVC, LAI, FAPAR)

Spatial resolution is limiting factor– homogenious surface ~ 1500 ha
(successfulexample: vineyards around Gorica, W Slovenia)

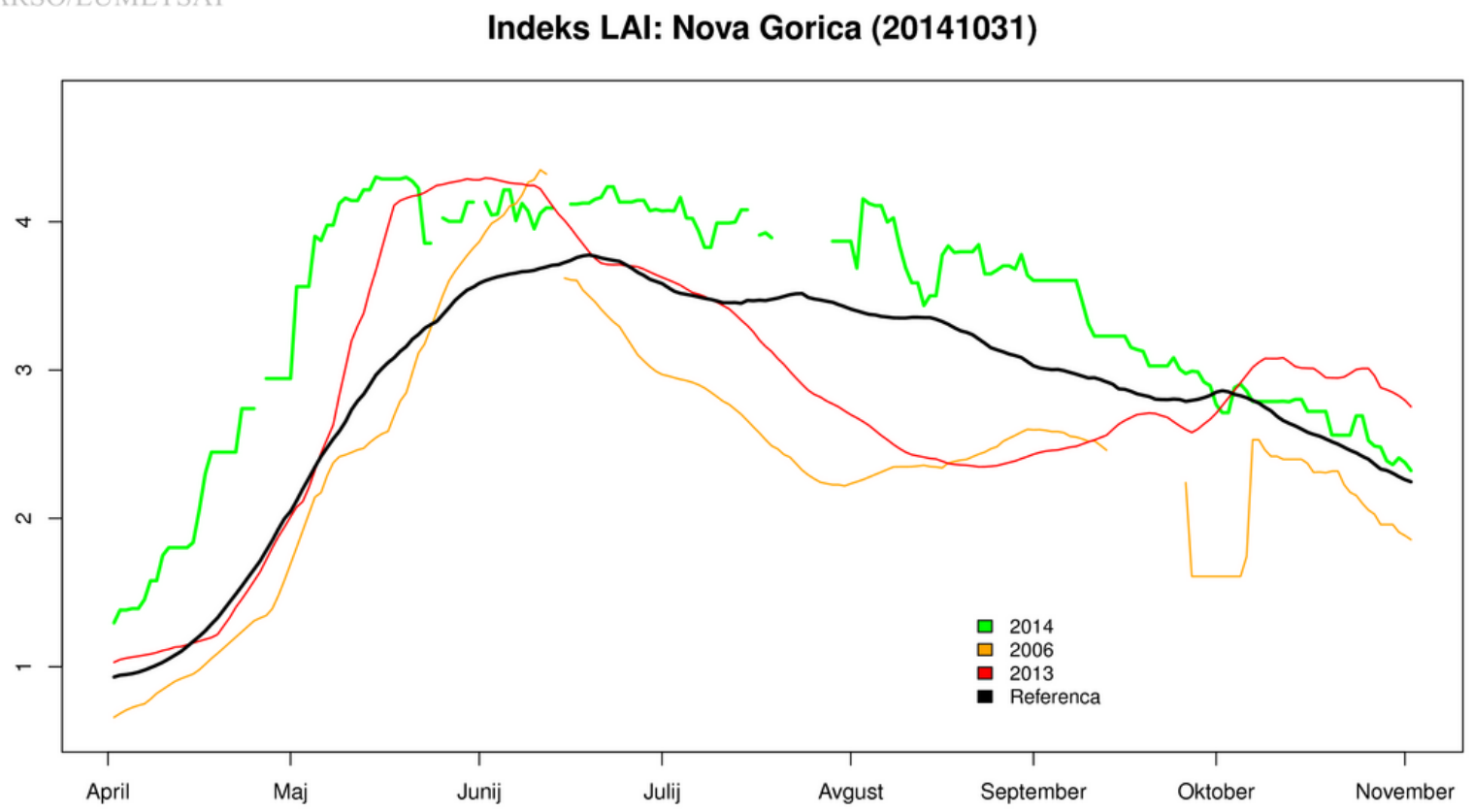
Drought monitoring in Slovenia application of LSA-SAF data

Implementation in Slovenian Environmental Agency: FVC point time series
FVC by EUMETSAT LSA-SAF



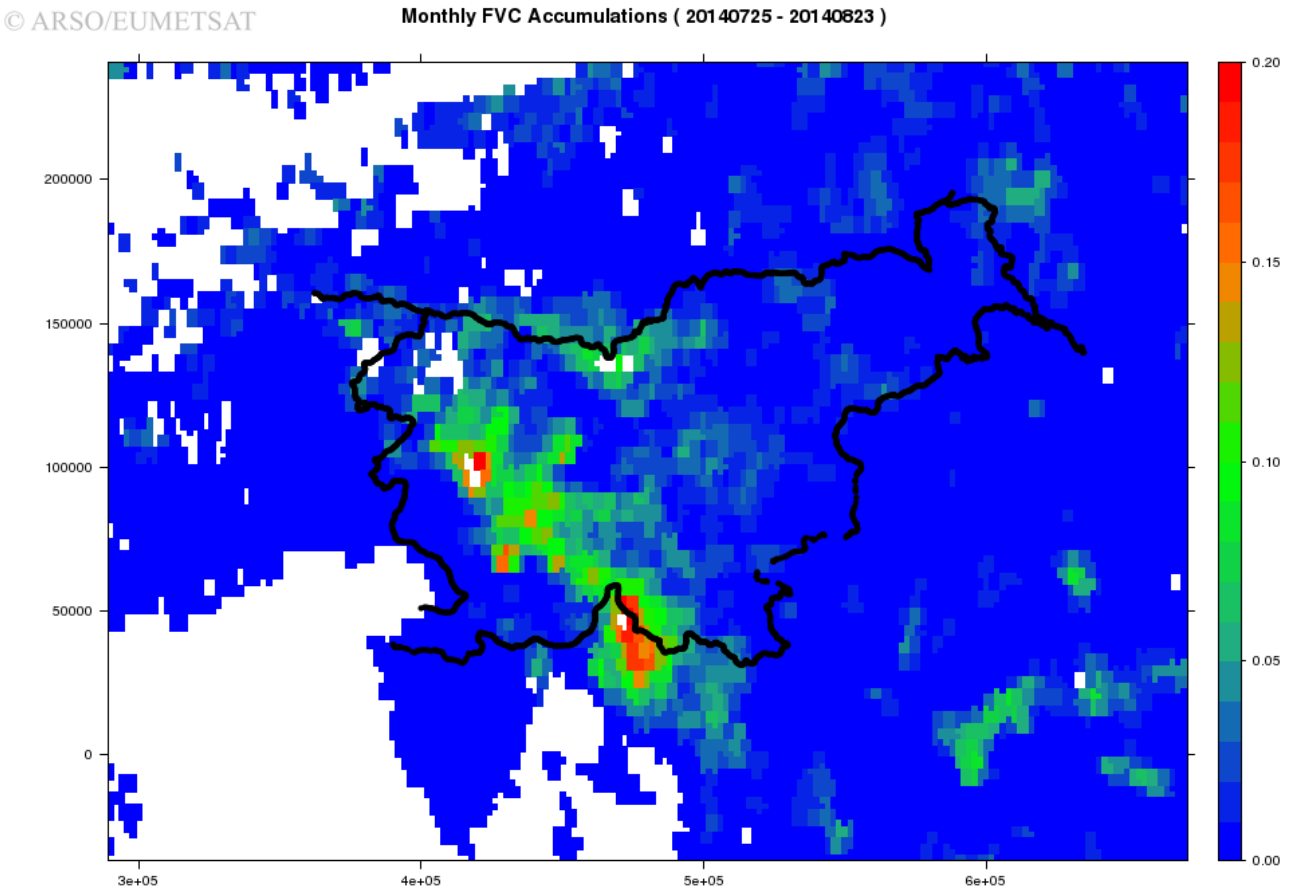
Drought monitoring in Slovenia application of LSA-SAF data

Implementation in Slovenian Environmental Agency: LAI point time series EUMETSAT LSA-SAF



Drought monitoring in Slovenia application of LSA-SAF data

Implementation in Slovenian Environmental Agency: average anomaly of FVC
FVC by EUMETSAT LSA-SAF



Drought monitoring
application of LSA-SAF data

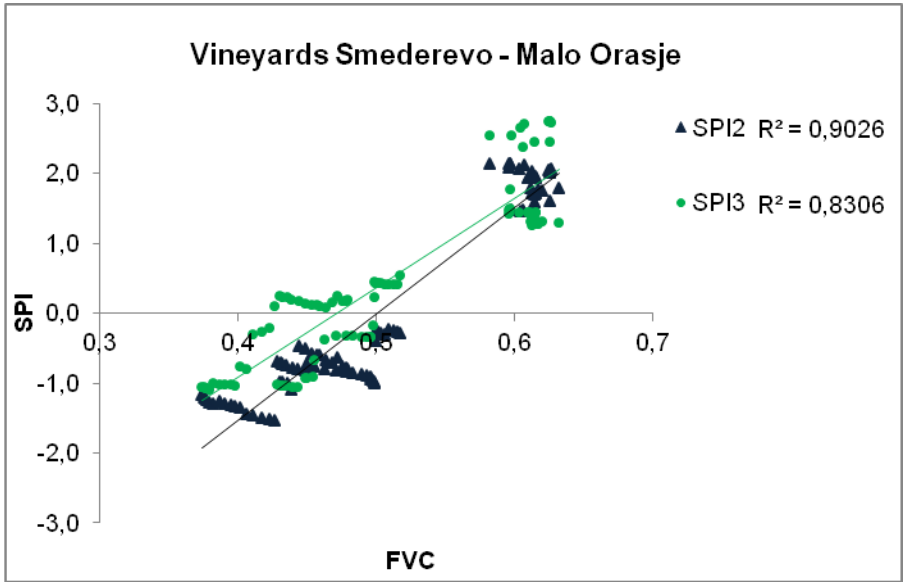
WMO-IPA project: Building resilience to disasters in Western Balkans and Turkey
Secondment of experts to slovenian environmental agency office

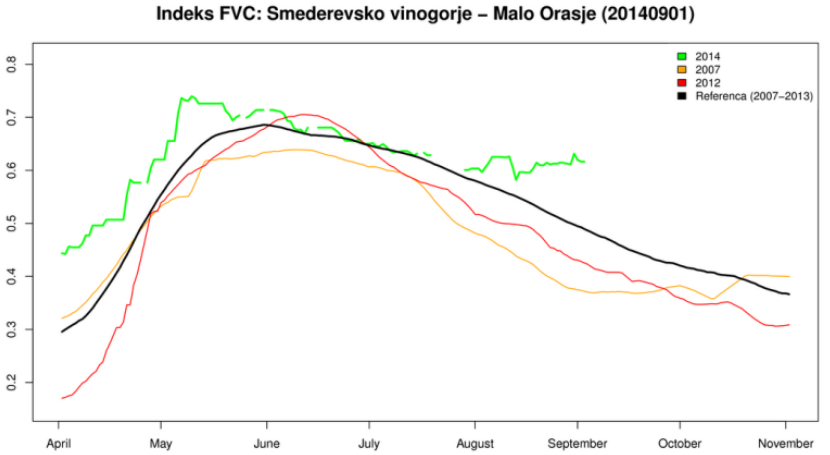
- 9 agricultural locations identified (3 in FYROM, 1 in MNE, 2 in SRB and 3 in BiH-RS)

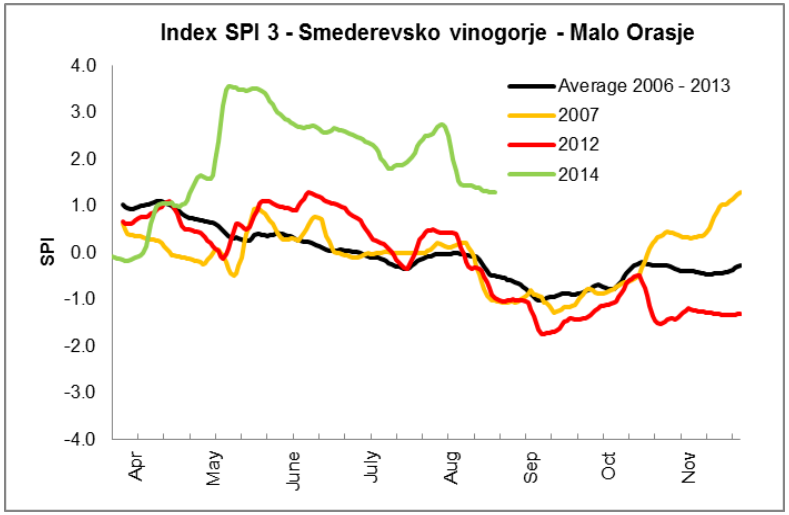
- FVC and LAI indices compared to meteorological records (SPI, ET, …)

Drought monitoring application of LSA-SAF data

Example from Serbia







Drought monitoring in Slovenia application of Copernicus LAND data

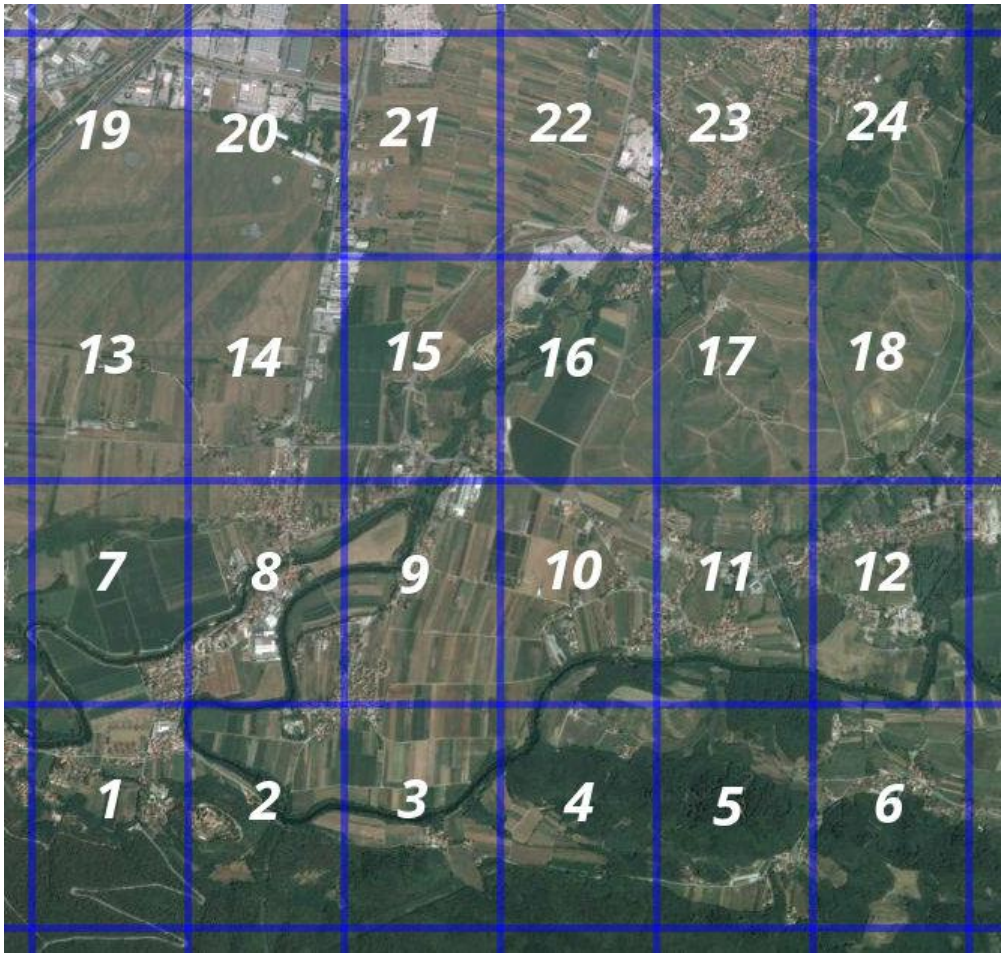
Recent developments – application of Copernicus LAND products

\+ improved spatial resolution (~ 300x1000m)

Easier location of homogene surfaces

\- potential problems with large time steps

reference under construction



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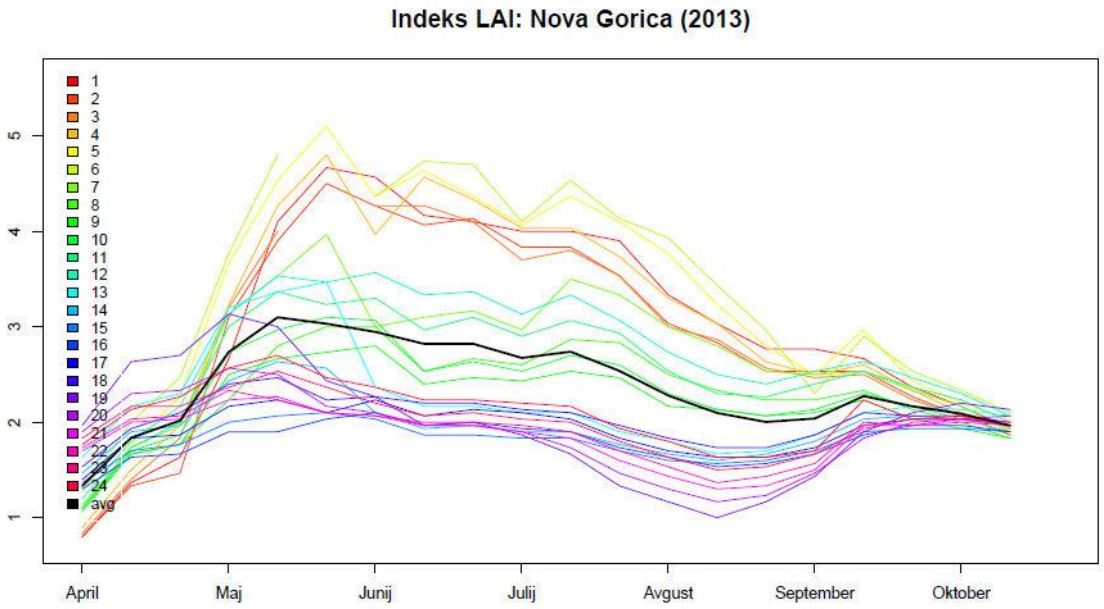


LAI time series for one corresponding LSA-SAF pixel

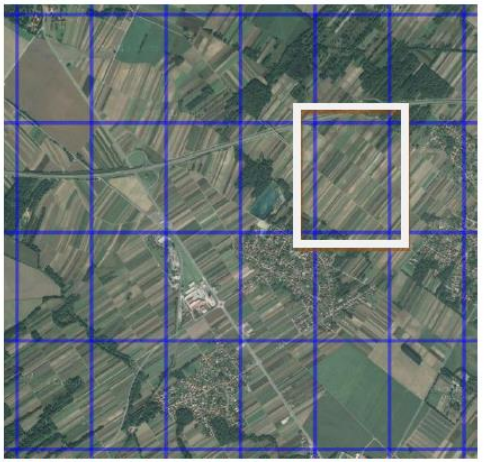
Drought monitoring in Slovenia application of Copernicus LAND data

Application of Copernicus LAND products
Preparation for parallel point time series production


Slika 2: NOVA GORICA 45,9017° S 13,6339°V


Slika 5: MARIBOR 46,4197° S 15,7054° V


Slika 3: BIZELJSKO 46,0447° S 15,7143° V


Slika 6: MURSKA SOBOTA 46,6639° S 16,2321° V

Selection of pixels from corresponding LSA-SAF grid; two vineyard areas (left column) and two crop growing areas (right column)

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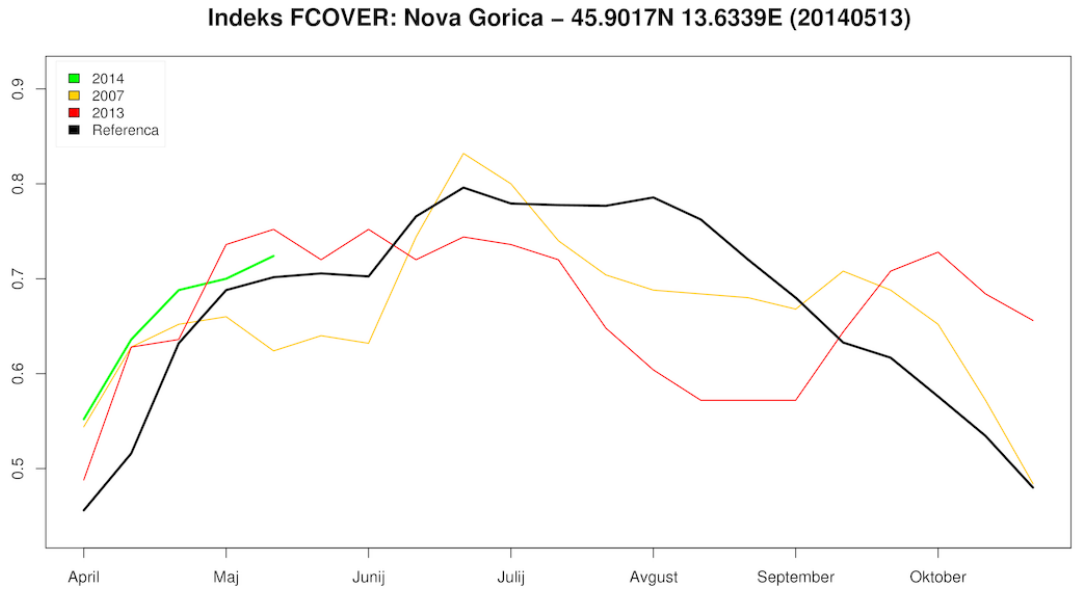

FCOVER (=FVC) time series for selected vineyards in W Slovenia

Drought monitoring in Slovenia application of Copernicus LAND data

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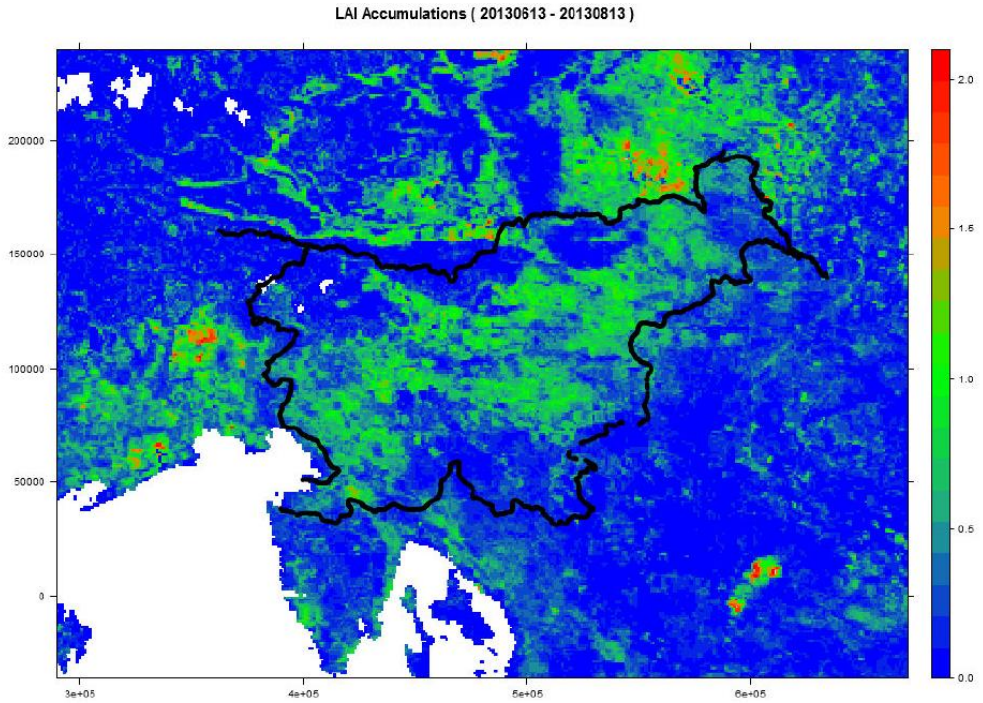
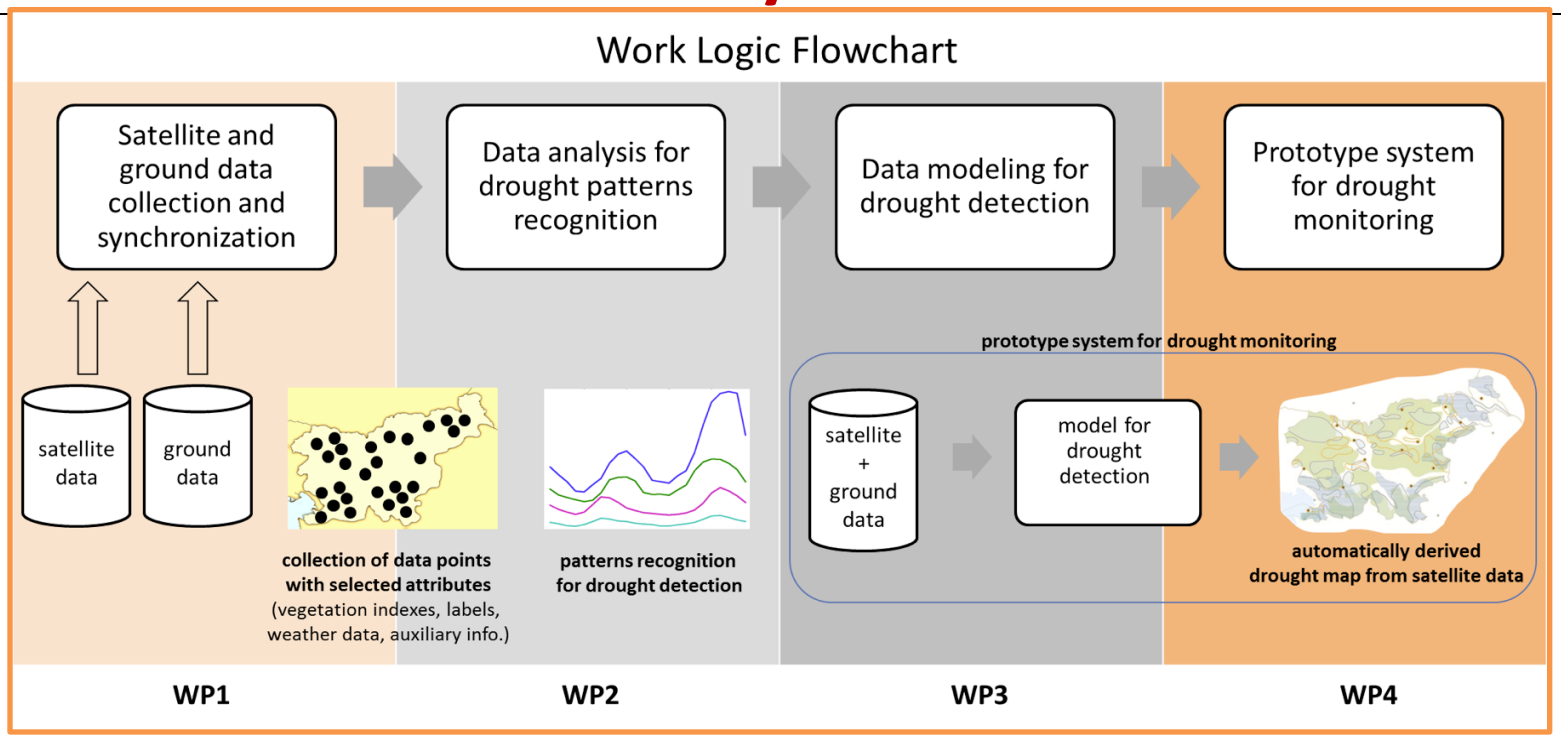


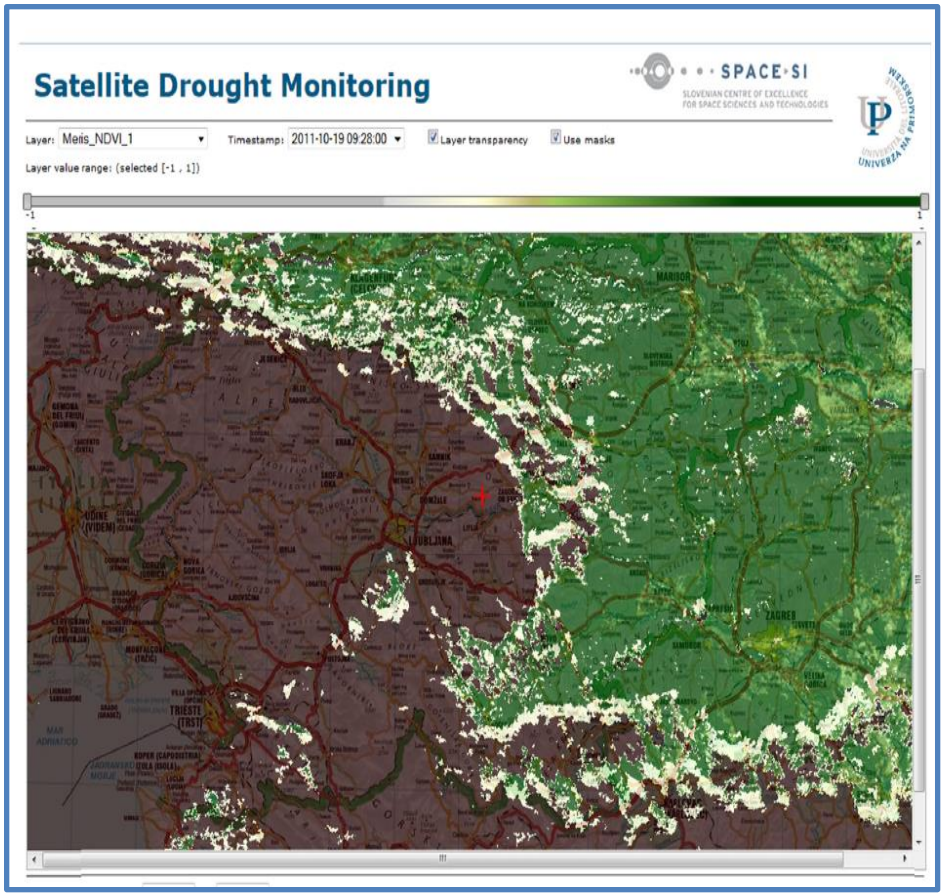
LAI monthly average anomaly over Slovenia

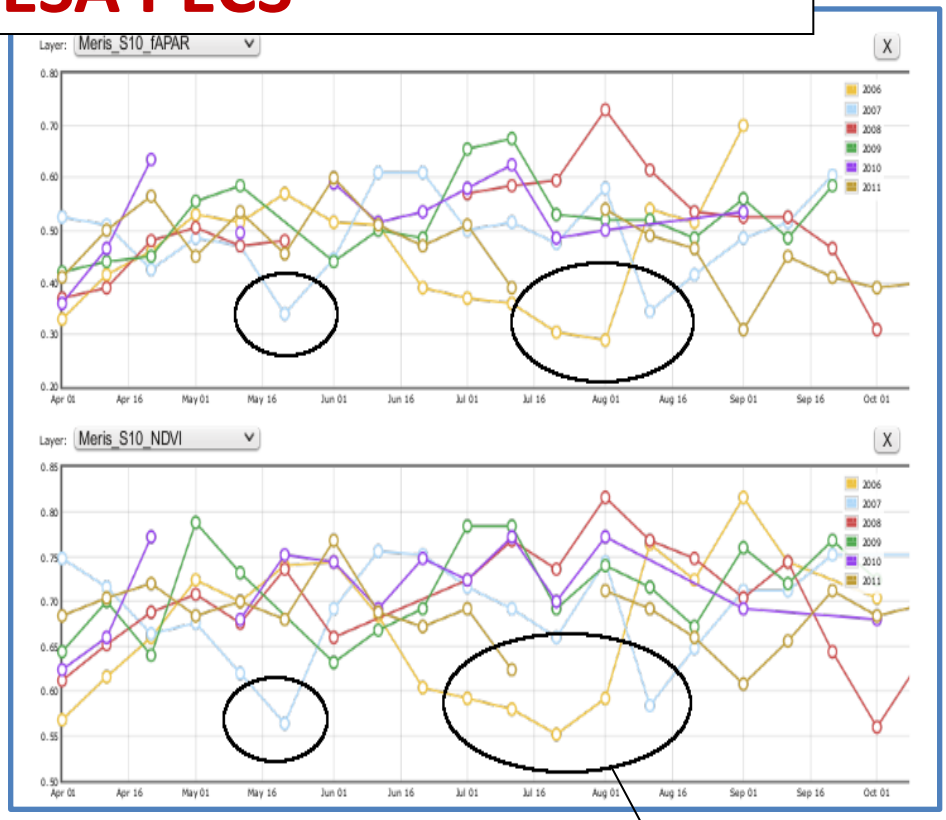
Recent developments - The SatDroughtMon project funded by ESA PECS



- project was launched in February 2013 by Slovenian Centre of Excellence SPACE-SI in cooperation with Slovenian Environment Agency, **DMCSEE** and University of Primorska, 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.

Recent developments - The SatDroughtMon project funded by ESA PECS





Drought detection

Satellite data:

- ✓ MERIS full resolution 250 m (usually one image daily)
- ✓ VITO/VEGETATION in 2006-2012

Conclusions

Vegetation indices found useful for monitoring possible drought-induced vegetation stress

FVC/FCOVER and LAI preferred over NDVI (possible ground truth)

LSA SAF valuable auxiliary information (despite coarse resolution)

Currently, most valuable information deduced from point time series. Need for objective recognition of drought patterns.