Earth Observation to support Agricultural Damage Assessment in Crop Insurance Schemes

dascis

Belgian Earth Observation Day – Chaudfontaine, 6 May 2010

The use of remote sensing and agrometeorological modelling for crop damage & risk assessment in support of the Belgian Calamity Fund

Isabelle Piccard (VITO), Catherine Marlier & Robert Oger (CRA-w), Bernard Tychon & Bakary Djaby (ULg), Marielle Foguenne (FPS Economy)

economie

CRA-W Gembloux

Université de Liège ULg

vito vision on technology

BELGIAN SCIENCE POLICY

Context

- Climate change:
  - ✓ more extreme climatic events (drought, excessive rainfall, storm,…)
  - ✓ larger yield variations
- Changed European legislation:
  - ✓ progressive diminution of agricultural subsidies and suppression of guaranteed prices
  - ✓ European regulation (1857/2006): from 1 January 2010 compensation in case of calamity must be reduced by 50% unless the farmer has taken insurance

increased yield & price risk → increased need for agricultural risk management...

Current situation in Belgium

- No agricultural insurances on the Belgian market (except for hail)
- Compensation for crop losses by the Calamity Fund
  - Conditions:
    - ✓exceptional weather event (1/20 yrs)
    - ✓ total amount of damage > 1.24 M€
    - ✓ only for production losses of > 30%
  - Problems:
    - ✓ damage assessment: differences between municipalities…
    - ✓ long period between damage occurrence → official recognition as 'calamity' → payments
    - ✓ future regionalisation of the Calamity Fund

ADASCIS objectives

- Development of an information system for crop damage & risk assessment in support of the Calamity Fund, providing timely and objective geospatial information:
  - ✓ To allow fast recognition of the calamity
  - ✓ To control received damage claims
- Potentially useful for the development of agricultural insurances

  → Flemish & Walloon agriculture administration, insurance sector (Assuralia) and farmers organisations are represented in the Steering Committee

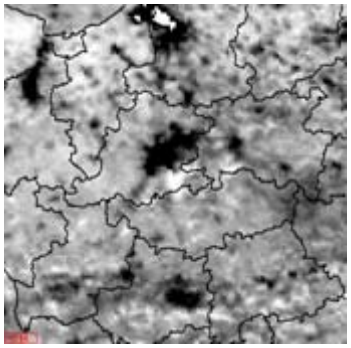
ADASCIS methodology

- Crop damage caused by:
  - ✓ Drought
  - ✓ Excessive rainfall & floodings
  - ✓ Storm, incl. hail
  - ✓ Frost

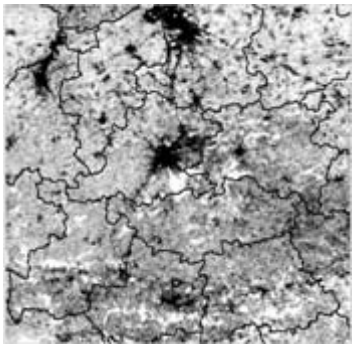
- Crop damage indices, derived from
  - ✓ Meteorological data
  - ✓ Agrometeorological models
  - ✓ Remote sensing (mainly satellite images)

The use of remote sensing

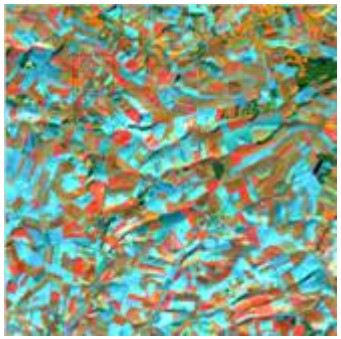
- At regional level (municipalities):
  - ✓ Continuous crop monitoring → detection of problem areas
  - ✓ Risk mapping
- At field level:
  - ✓ Crop damage assessment (before-after disaster)



VGT (1km)



MODIS (250m)



Landsat (30m)

IKONOS (4m)

videodata (10cm)

Part 1

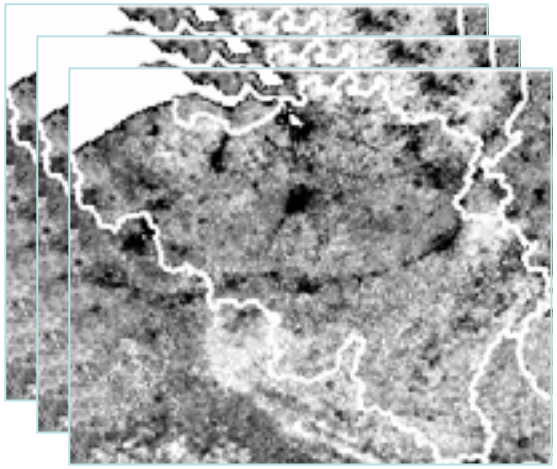
Regional monitoring, crop damage and risk assessment

Using crop-specific fAPAR values per municipality derived from 10-daily SPOT-VEGETATION (1km) satellite images

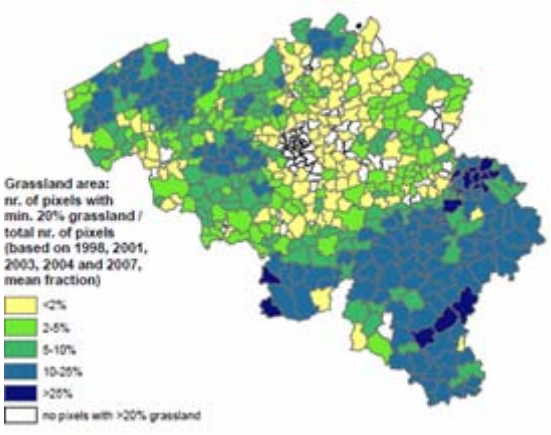
→ Example: 2006 drought

Unmixing

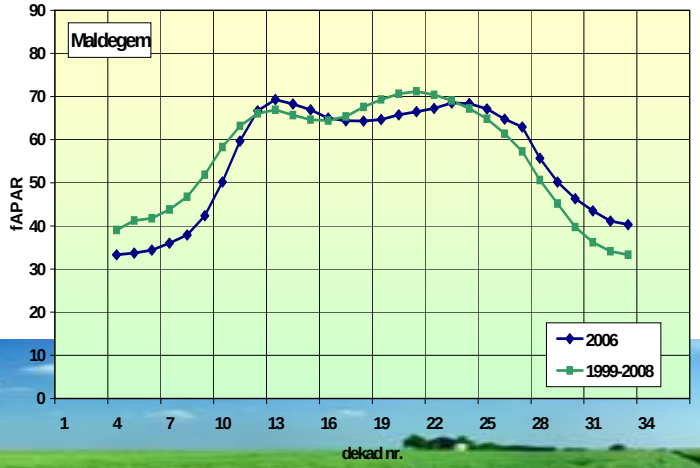
Satellite images



Area Fraction image
(derived from SIGEC-EPR)



Regions image
(municipalities)



Database with fAPAR per municipality and per crop (weighted means)

Anomaly detection

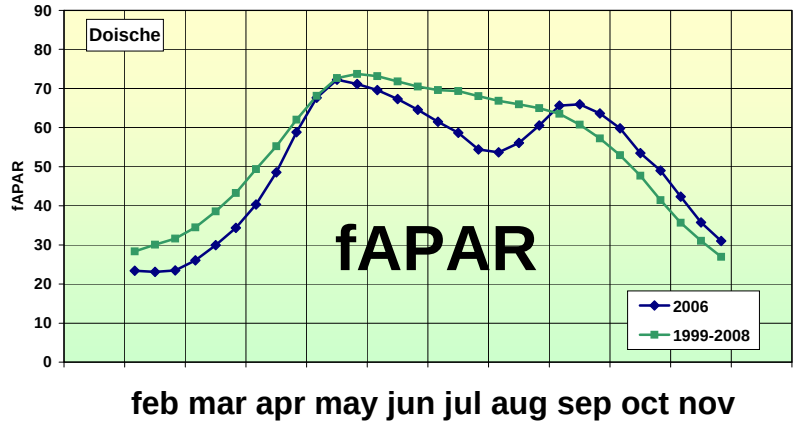
Anomalies? Comparison of fAPAR index with long term average…

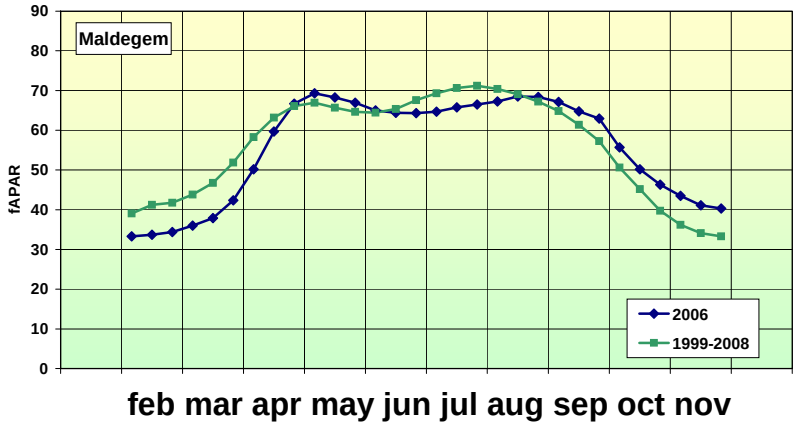
SDVI (Standardized Difference Vegetation Index) or **Z-score**

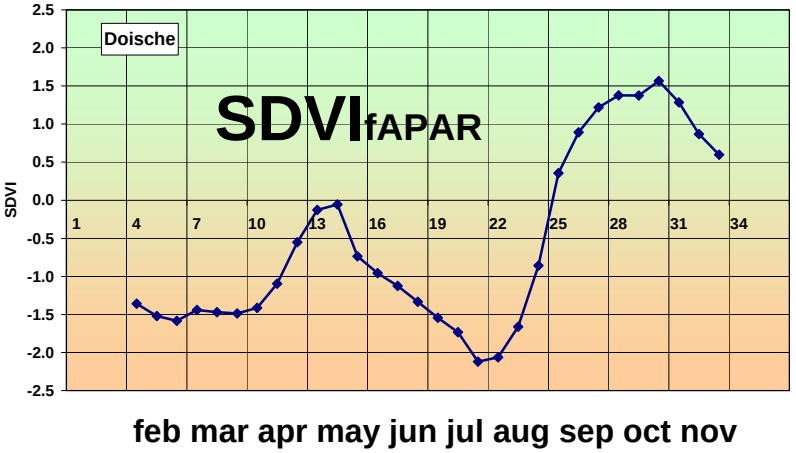
$$SDVI = \left(\frac{fAPAR\ actual - fAPAR\ mean}{fAPAR\ stdev}\right)$$

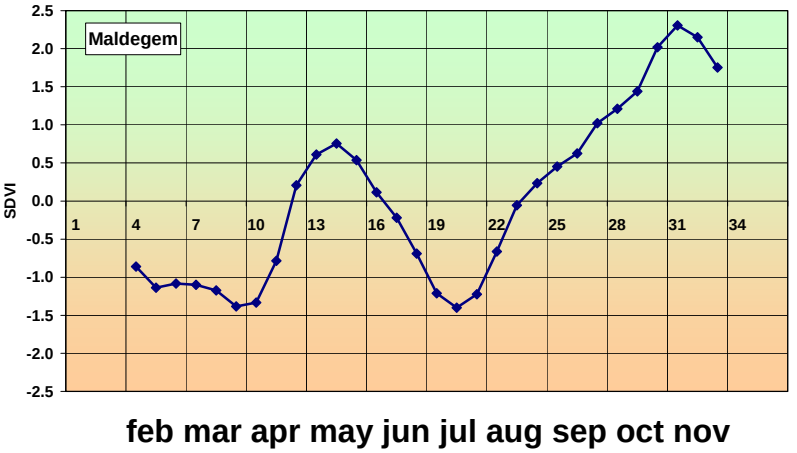
fAPAR & SDVI fAPAR graphs

fAPAR & SDVI fAPAR for 2006 (drought), for 2 municipalities, unmixed for grassland



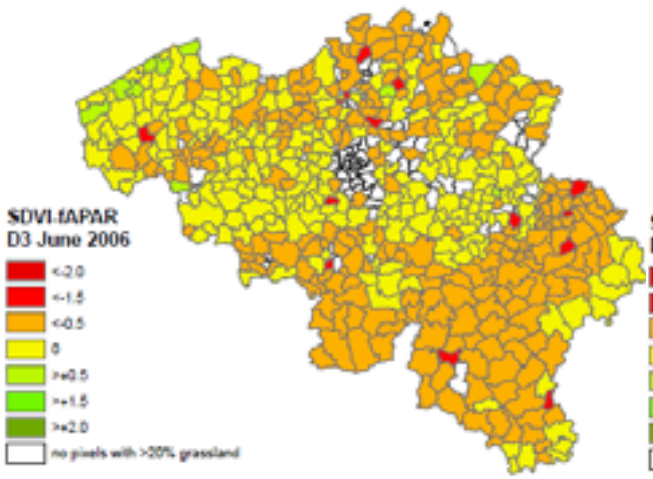


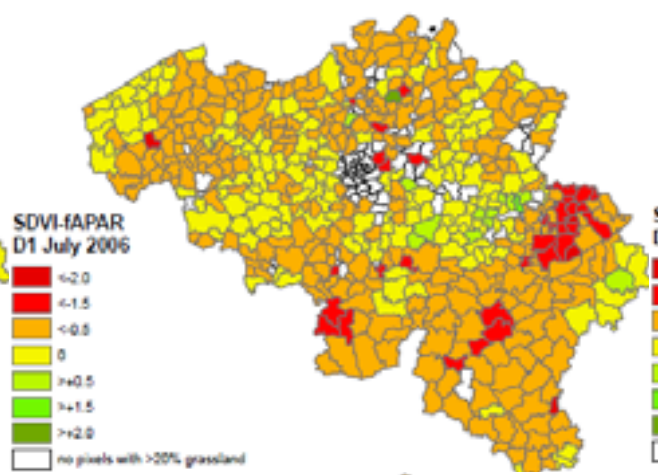


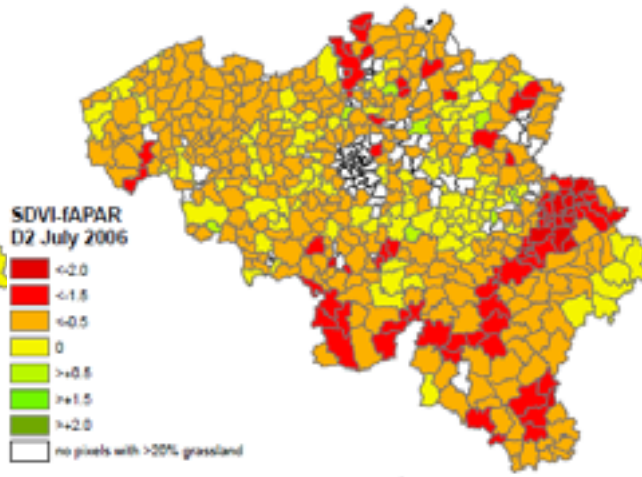


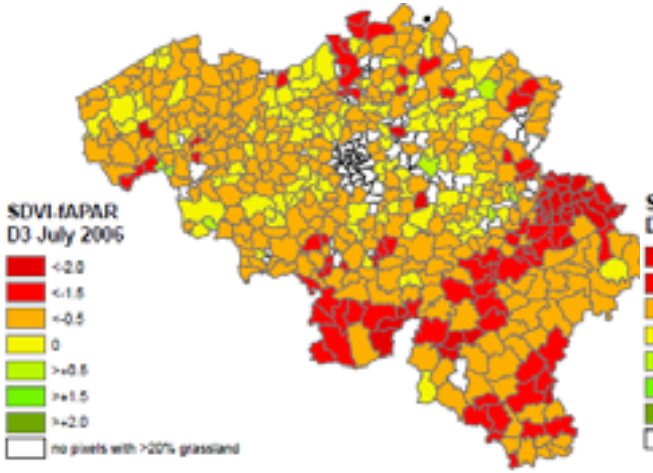
Anomaly maps (SDVI fAPAR)

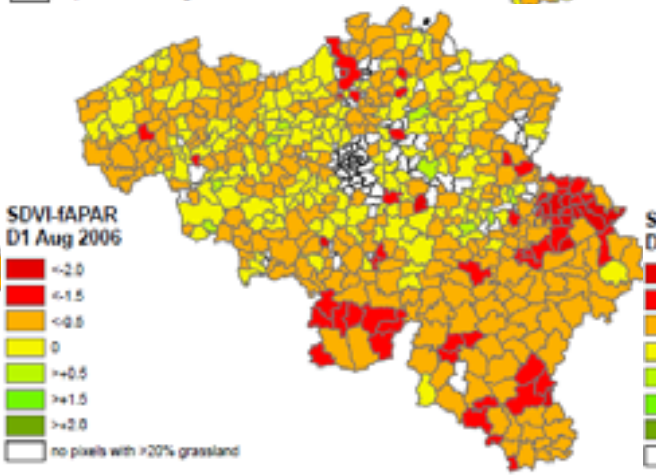
SDVI fAPAR, end of June – mid August 2006, per municipality, unmixed for grassland

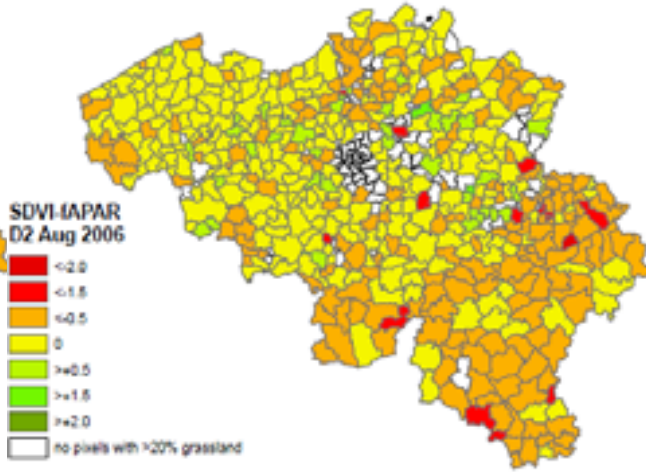








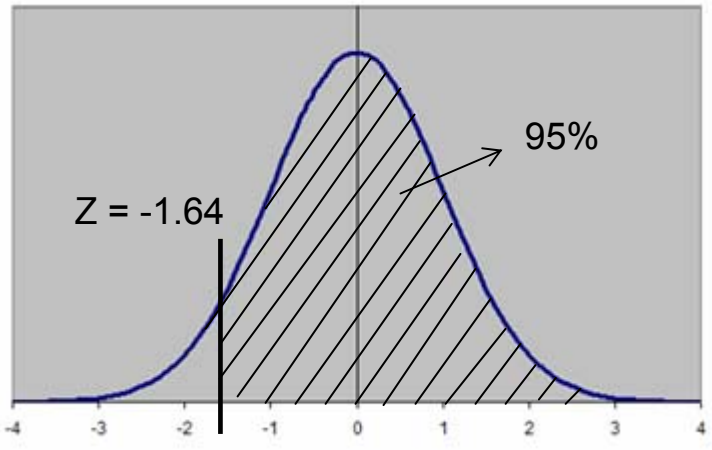




Anomaly maps

Deviations: exceptional or not?

From Z-scores (SDVI) to probabilities and return frequencies…



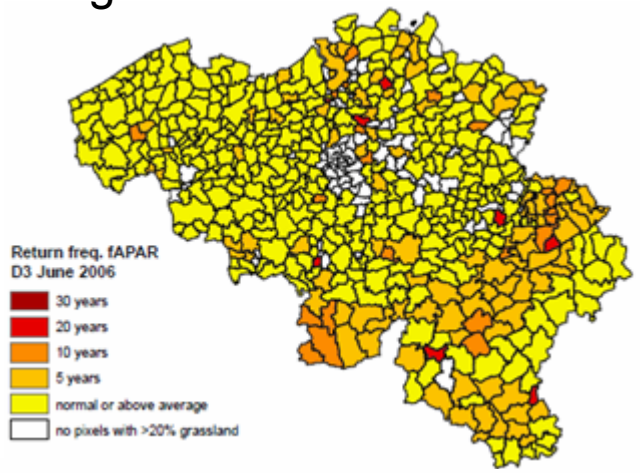
Assumptions:

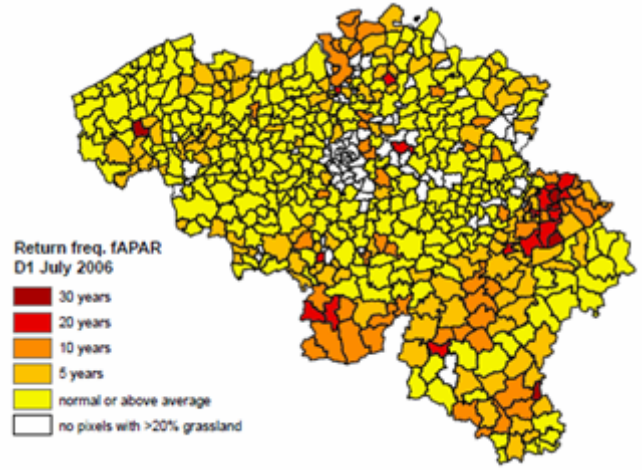
- fAPAR: normal distribution
- z-scores: standardized normal distribution (mean = 0, stdev = 1)
- Associated probabilities (1-sided) and return frequencies:

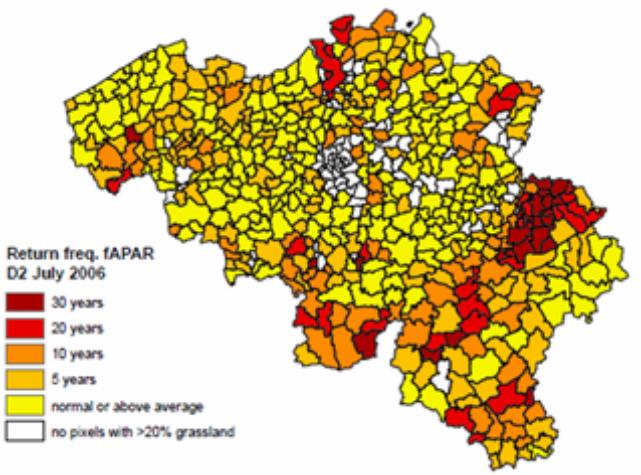
  e.g. z-score of -1.64 → probability of obtaining this z-score is 95%
  or 5% chance of getting a lower score: “once in 20 years”

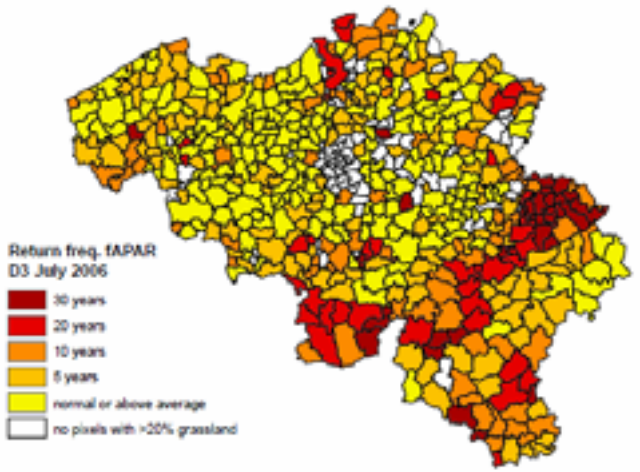
Anomaly maps (return frequency)

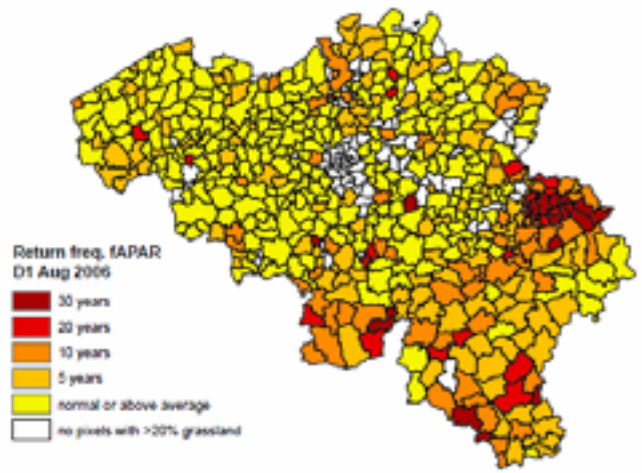
fAPAR return frequency, end of June – mid August 2006, per municipality, unmixed for grassland

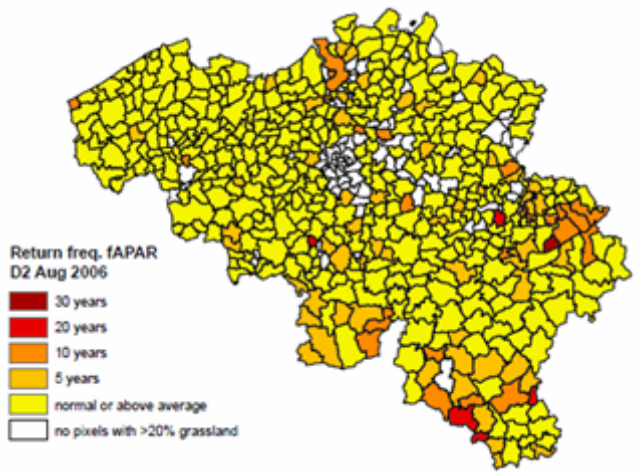










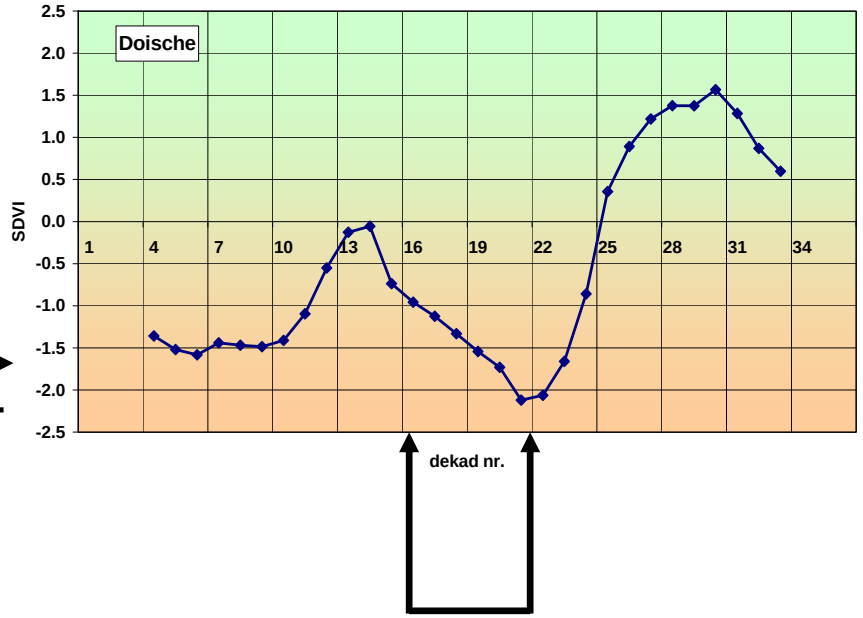


Damage assessment

From anomaly detection to crop damage assessment…

SDVI fAPAR

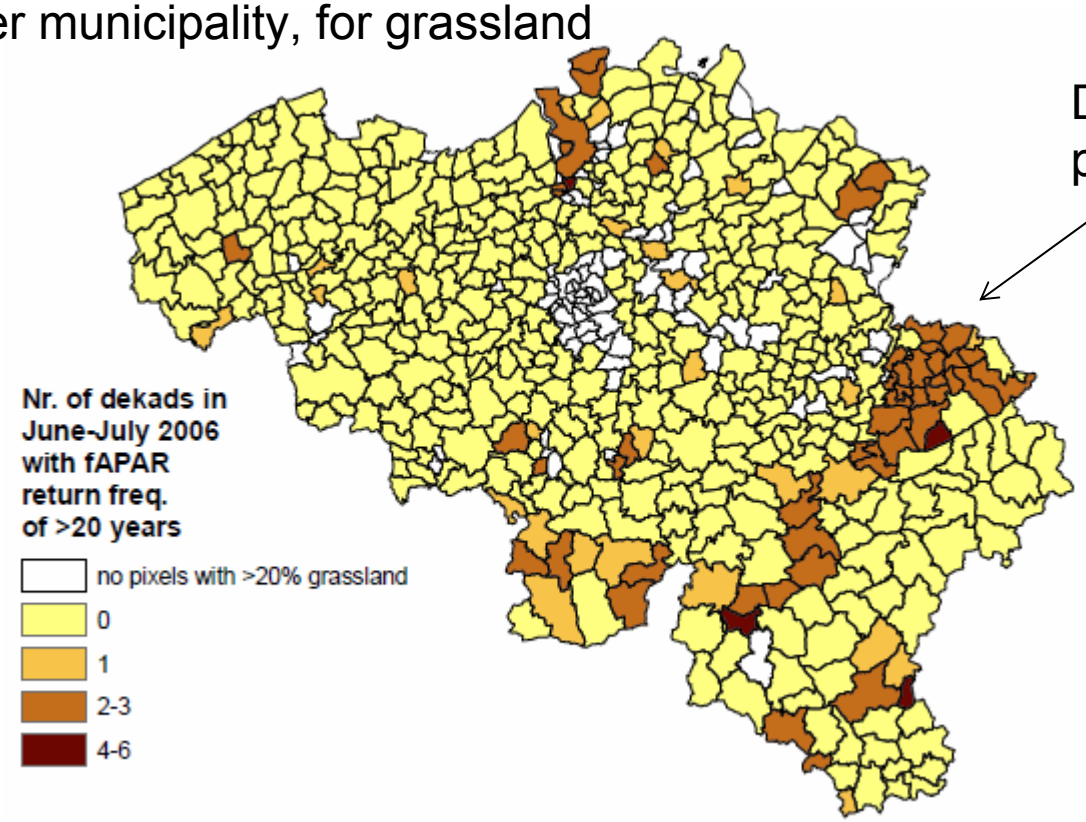
threshold: -1.64



“sensitive period”: June-July …

Damage assessment

Potential damage map: number of dekads in June-July 2006 (at a total of 6 dekads) with SDVI fAPAR value below -1.64 threshold (return frequency of >20 years), per municipality, for grassland



Dark areas: potentially damaged

Risk mapping

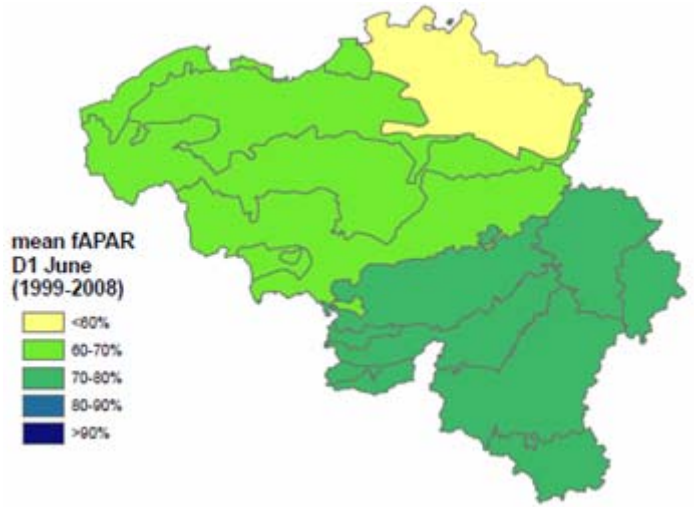
High risk areas? Municipalities showing a higher frequency of (large) fAPAR deviations?

Comparison of fAPAR of municipality with mean fAPAR of agricultural region:

$$\frac{\text{fAPAR actual, MUNI} - \text{fAPAR mean, REG}}{\text{fAPAR stdev, REG}}$$

per dekad, for historical time series
(11 years: 1999-2009)

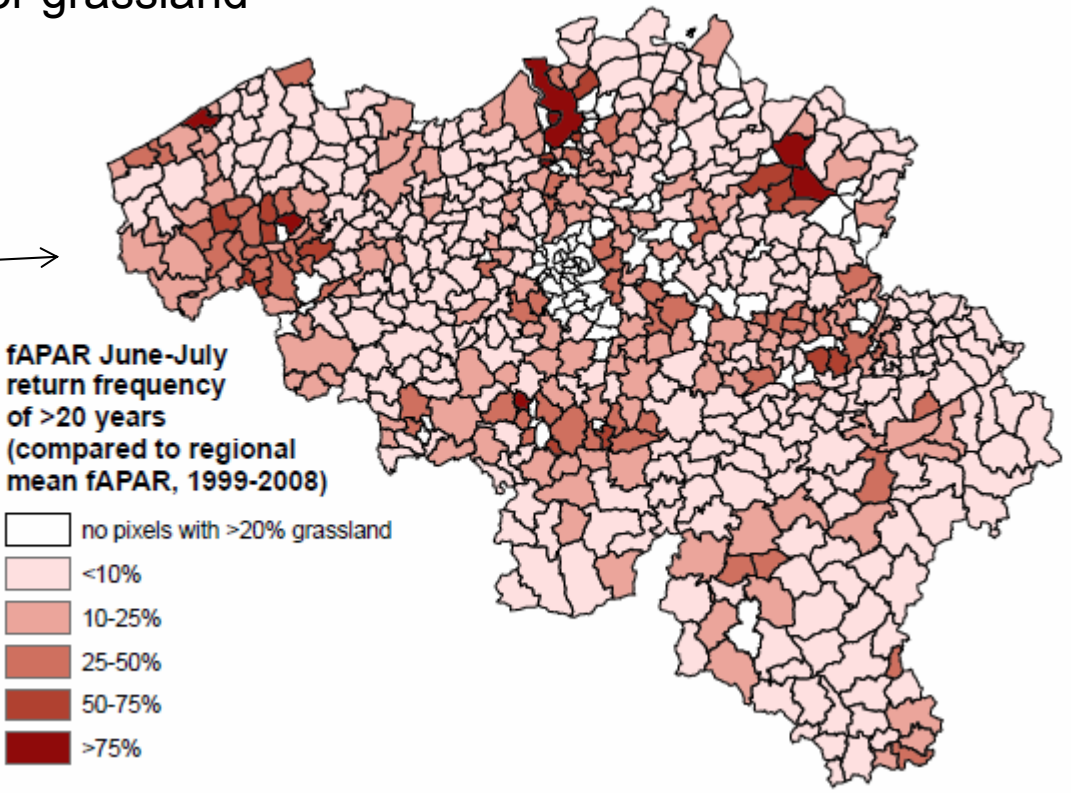
Risk assessment: count deviations
below damage threshold in “sensitive period”



Risk mapping

Risk map based on deviations of fAPAR MUNI with fAPAR REG in June-July over a period of 11 years: frequency of deviations > -1.64 (return frequency of >20 years), per municipality, for grassland

Dark areas: higher risk

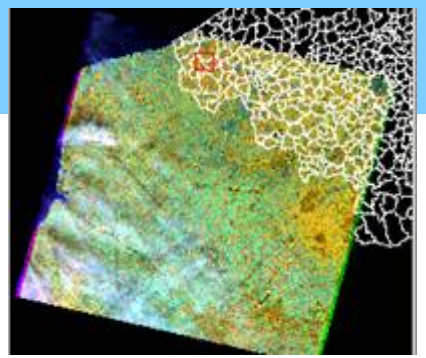


Part 2

Crop damage assessment at field level

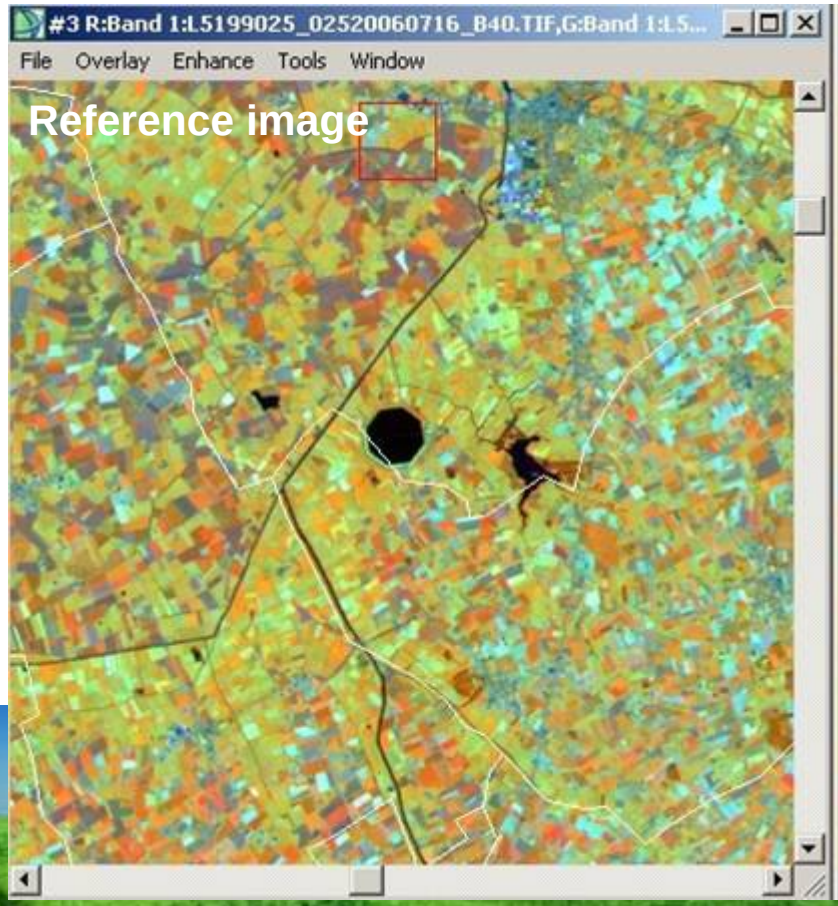
some examples…

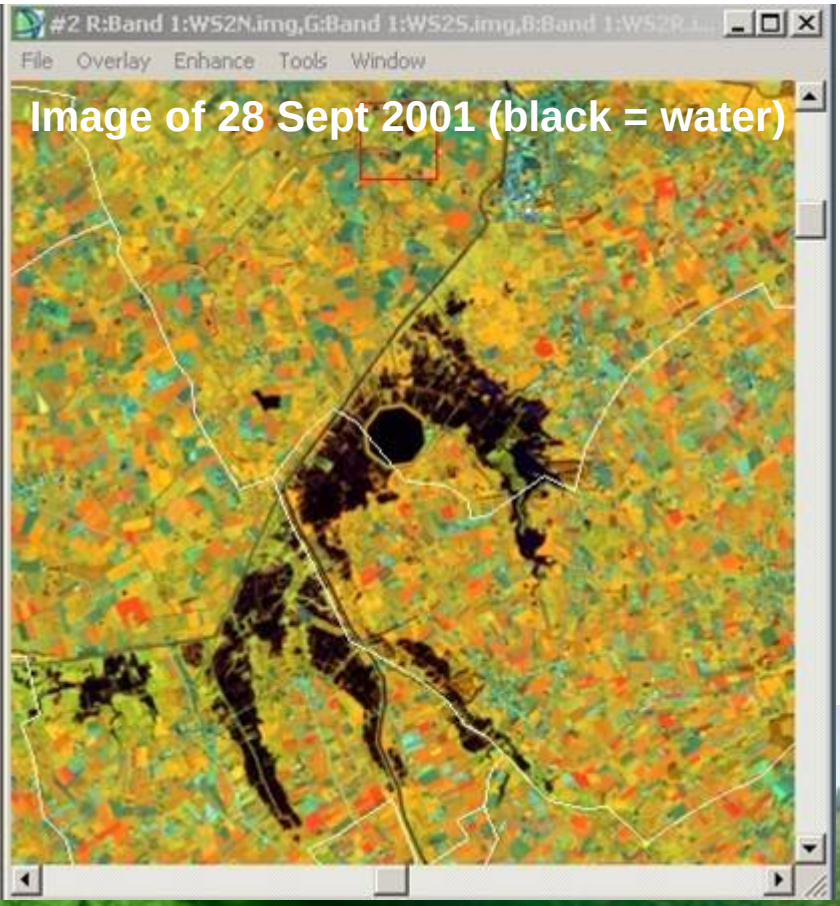
Flood mapping



Floodings of September 2001, Westhoek, on high resolution satellite images (Landsat-TM, 30m)

→ Identification of affected fields/farmers by overlay with SIGEC/EPR data





Mapping of local damages

- Use of very high resolution (VHR, <1m) images for “a posteriori” detection of crop damage caused by very local phenomena:
  - ✓ Hail
  - ✓ Wind
  - ✓ Inaccessible fields – impossible to harvest crops
- Test with VHR (10cm) video images (helicopter platform): rather expensive but “cloud free” coverage of disaster area

Thank you for your attention!