

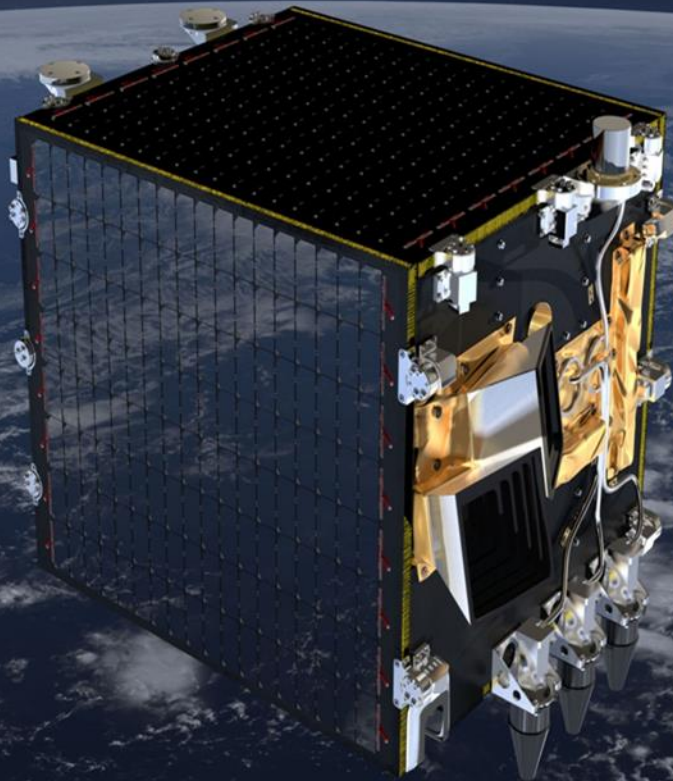
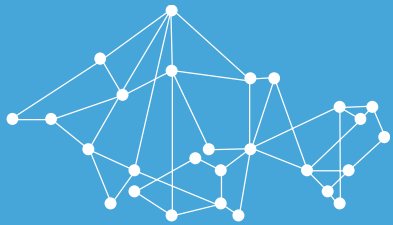


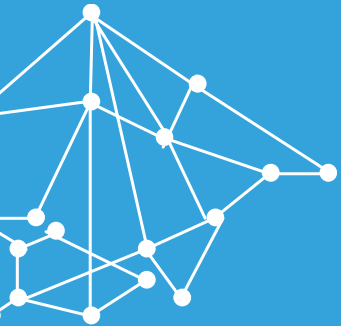
CROP MODELLING AND MONITORING FOR AGRI-CLIMATE SERVICES

Anne Gobin

Agri-Met Workshop

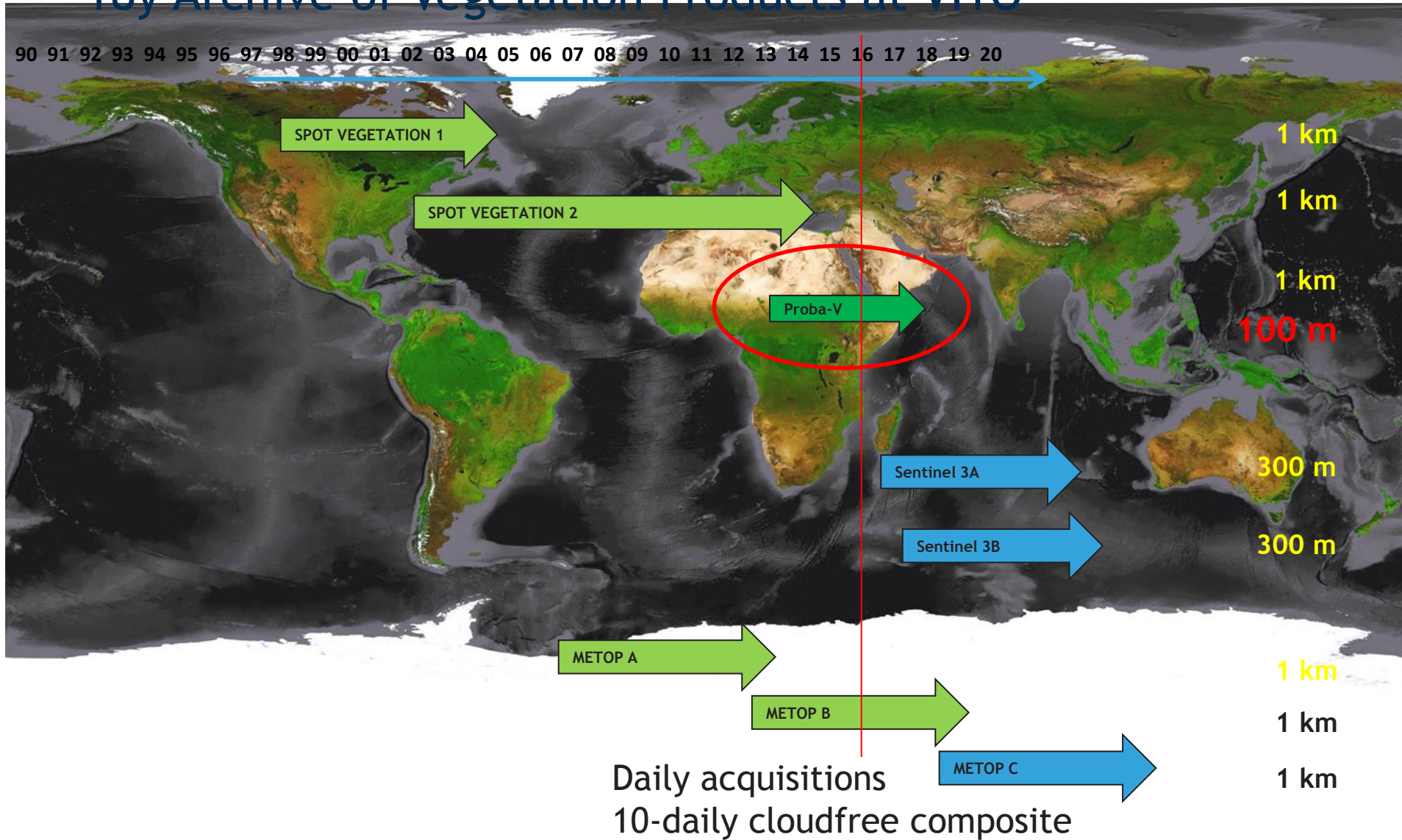
9-10 November
2016, Ljubljana





Current Services @ Vito

18y Archive of Vegetation Products at VITO



Used for many services: ASIS, MARS, ...

Free downloads of products

The screenshot shows the VITO Product Distribution Portal homepage. At the top, there are logos for vito (vision on technology), belspo, and esa. The main heading is "PRODUCT DISTRIBUTION PORTAL". Below this, there are two main sections: "Low & medium resolution EO-products - Free data" and "Low & medium resolution EO-product - Near real-time data". Each section contains several product cards with satellite images and text describing the products and their availability. The "Free data" section includes SPOT-VEGETATION FREE (OLDER THAN 3 MONTHS), METOP-AWARRS S10 SYNTHESSES, ENVISAT-MERIS S10 SYNTHESSES, and PROBA-V 100M SYNTHESSES NEAR REAL-TIME. The "Near real-time data" section includes SPOT-VEGETATION NEAR REAL-TIME, PROBA-V 333M SYNTHESSES FREE (OLDER THAN 1 MONTH), and PROBA-V SEGMENTS FREE (OLDER THAN 1 MONTH). A sidebar on the right contains a "Video tutorial" for PADUA, a "News" section with dates from 10 December 2013 to 14 October 2013, and a "Special image" section for PROBA-V's first uncalibrated global monthly synthesis.

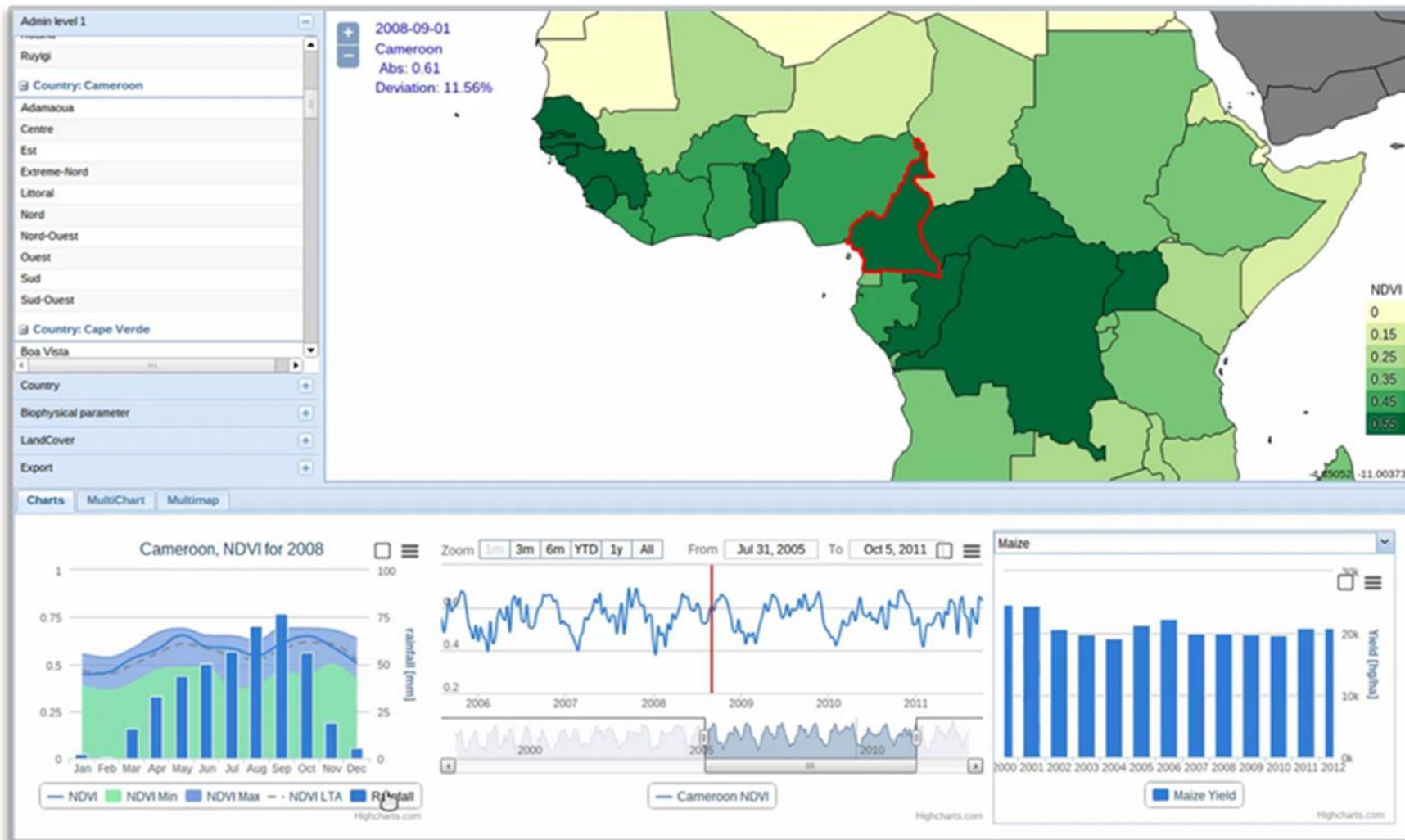
This screenshot shows the VITO web interface with a world map. The map has a red rectangular selection box over Europe and Africa. To the right of the map, there are search and filter options, including a search bar and several dropdown menus. The interface is clean and professional, with a green and blue color scheme.

This screenshot shows the VITO web interface with a world map. The map is overlaid with a color-coded data layer, likely representing vegetation indices. The interface includes a sidebar with search and filter options, and a main area with the map and data overlay.

This screenshot shows the VITO web interface with a data table. The table has multiple columns and rows, displaying various data points. The interface includes a sidebar with search and filter options, and a main area with the data table.

<http://www.vito-eodata.be>

MEP PLATFORM (PRIMARILY FOR PROBA-V) CURRENT PROJECTS: BIG DATA (RS COUPLED TO DATABASES) THE FUTURE... PROCESSING ON DEMAND



MONITORING WITH DIFFERENT TYPES OF SENSORS

Current services range from very high to very low resolution monitoring, increasingly combined with statistical information and modelling results

RESOLUTION	VERY LOW	LOW	MEDIUM	HIGH	VERY HIGH
Pixel size	±5 km	±1 km	250-500m	20-30m	1-5m
Frequency					
Image size					
Examples					

Scales: Global ← Continental ← National ← Regional ←

Field + UAV



CURRENT SERVICES: COPERNICUS GLS

Copernicus Global Land Service

Providing bio-geophysical products of global land surface



Home Products News Product Access Viewing

Water, **Vegetation**, Energy

LAI

VPI

FAPAR

VC1

FCOVER

DMP

NDVI

Burnt Area



Fraction of green Vegetation Cover

The Fraction of Vegetation Cover (FCover) corresponds to the fraction of ground covered by green vegetation. Practically, it quantifies the spatial extent of the vegetation. Because it is independent from the illumination direction and it is sensitive to the vegetation amount, FCover is a very good candidate for the replacement of classical vegetation indices for the monitoring of ecosystems.

FCOVER Alerts

FCOVER version 1 archive completed

Fri, 03 Jul 2015

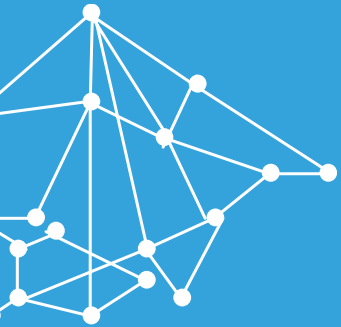
FCOVER version 1 resumes

Wed, 08 Apr 2015

FCOVER v1 temporarily unavailable

Wed, 08 Apr 2015

First FCOVER products from PROBA-

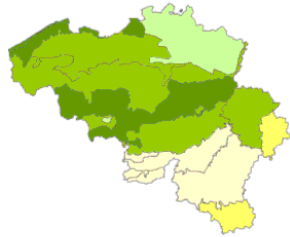


CROP MODELLING & MONITORING for agri-climate services Introduction & Objectives

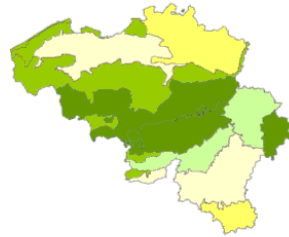


INTRODUCTION - YIELD AND SEASONAL WEATHER VARIABILITY

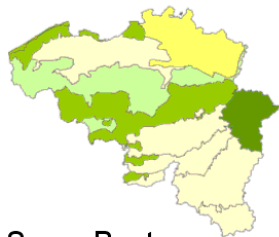
Example: Belgian Yields - 1998



Winter wheat



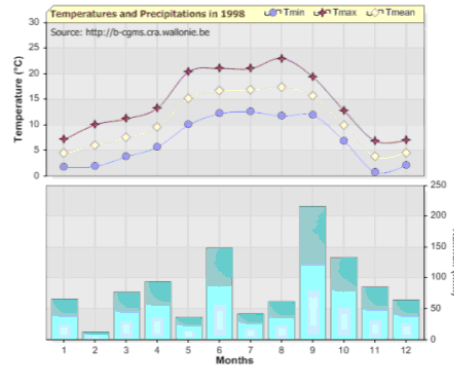
Winter Barley



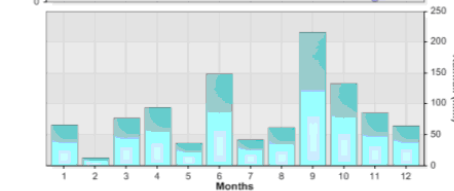
Sugar Beet



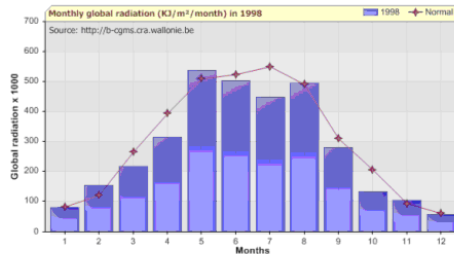
Potato (Bintje)



t °C
min, max, mean



Precipitation
Year, normal



Rad
Year, normal

- » Variability between years and between crops and between regions!
- » Variability depends on crop type, crop stage, weather during the cropping season

INTRODUCTION - EXTREME EVENTS AND THEIR IMPACT ON CROPS

The impact of **extreme weather events on cropping systems** depends on:

(1) the nature of the event; (2) the occurrence in relation to the farming calendar; and, (3) the type of agro-ecosystem service (biomass, yield, soil quality).



Heat stress



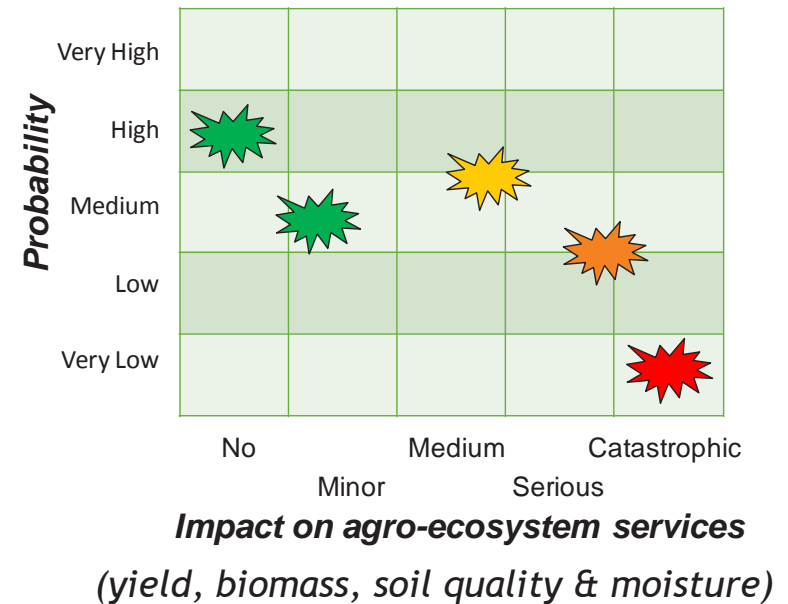
Waterlogging



Frost



Drought



OBJECTIVES FOR AGRI-CLIMATE SERVICES

The **objectives** for agri-climate services are to:

1. Characterise adverse weather conditions during the cropping season;
2. Characterise spatio-temporal yield variability;
3. Assess the impact of adverse weather conditions on crops; and,
4. Establish agri-climate service needs (stakeholders).

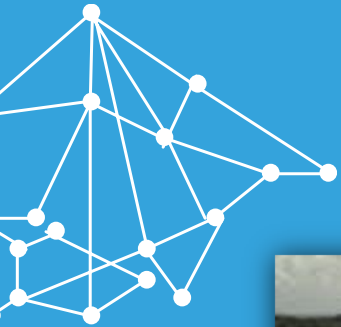
Examples from Belgium - Major arable crops

The impact of **extreme/adverse weather events** on cropping systems requires a combined modelling & monitoring approach to capture the interactions between the crop, its environment and the occurrence of the meteorological event.





CROP MODELLING & MONITORING Methodology



CHARACTERISATION OF EXTREME (AND ADVERSE) WEATHER CONDITIONS

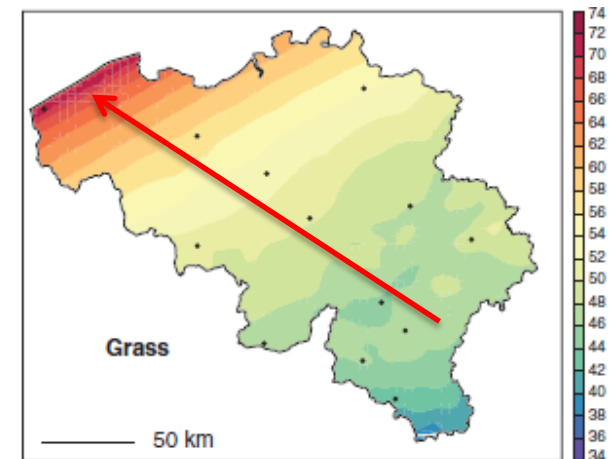
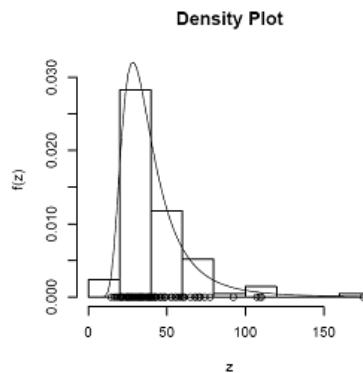
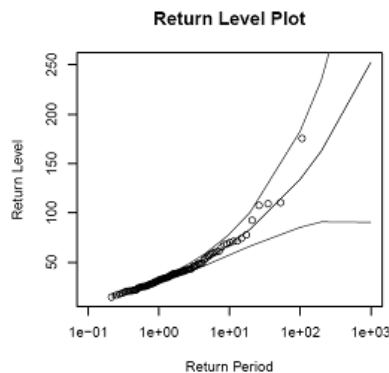
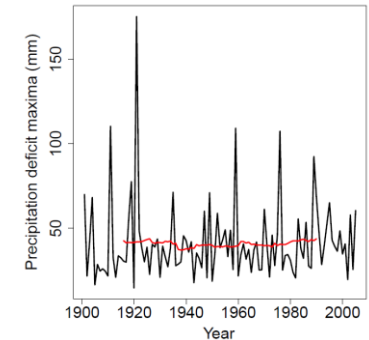
1. Trend analysis for all stations and fitting GEV distributions for individual stations

$$G(z; \mu_i, \sigma_i, \xi_i) = \exp[-(1 + \xi_i(z - \mu_i)/\sigma_i)^{-1/\xi_i}]$$

2. Return periods (T) and associated return level (z_T)

$$z_T = \mu_i - \sigma_i/\xi_i(1 - [-\log(1 - 1/T)]^{-\xi_i})$$

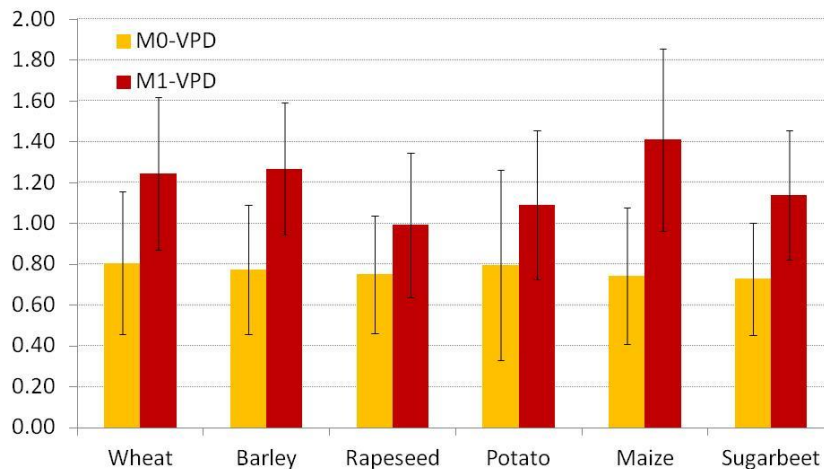
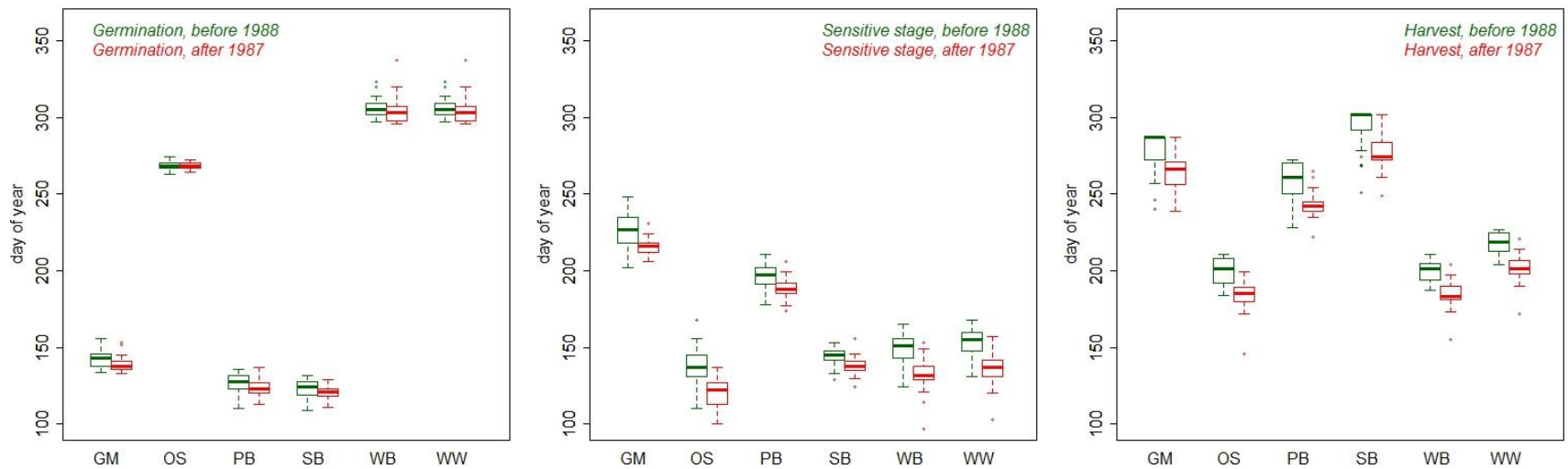
$$T = 1/(1 - G(z_T))$$



Cumulative precipitation deficit = $f(ET, P)$
(Zamani et al., 2015)

20y RP for precipitation deficit

OCCURRENCE OF CROP SENSITIVE STAGES



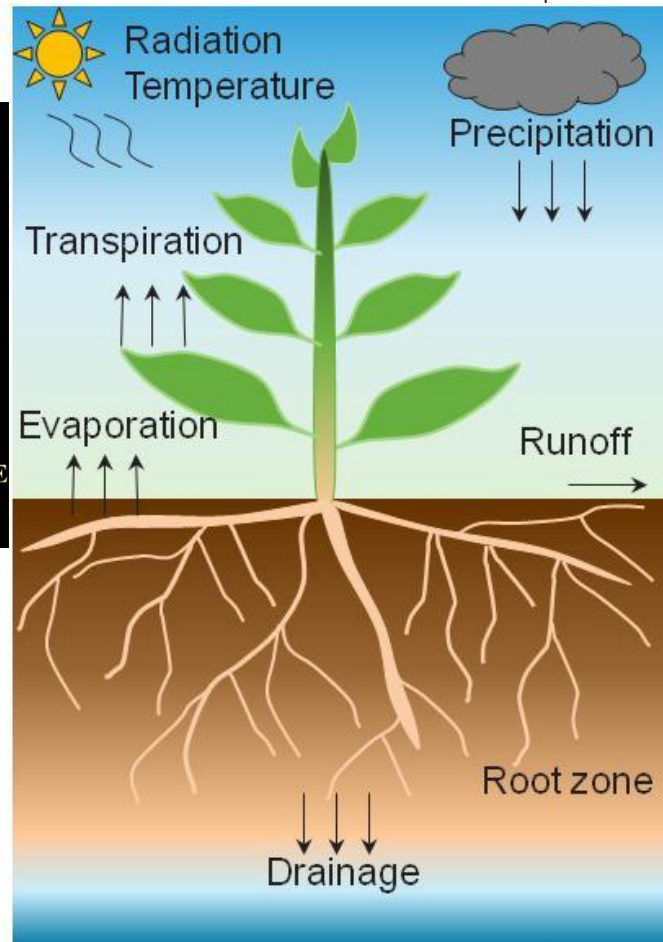
Growth stages occur significantly **earlier** after 1987

Implications for the coincidence between an extreme event and the sensitive stage

CROP MODELLING TO CAPTURE DYNAMICS



Biomass growth & Phenological stadia: in cumulative temperature days with base and maximum temperature & daylength as boundaries of phenological activity



Input

- Climate
- Soil
- Crop

Processes

- Phenology
- Biomass Production
- Water Balance
- Energy Balance

Output

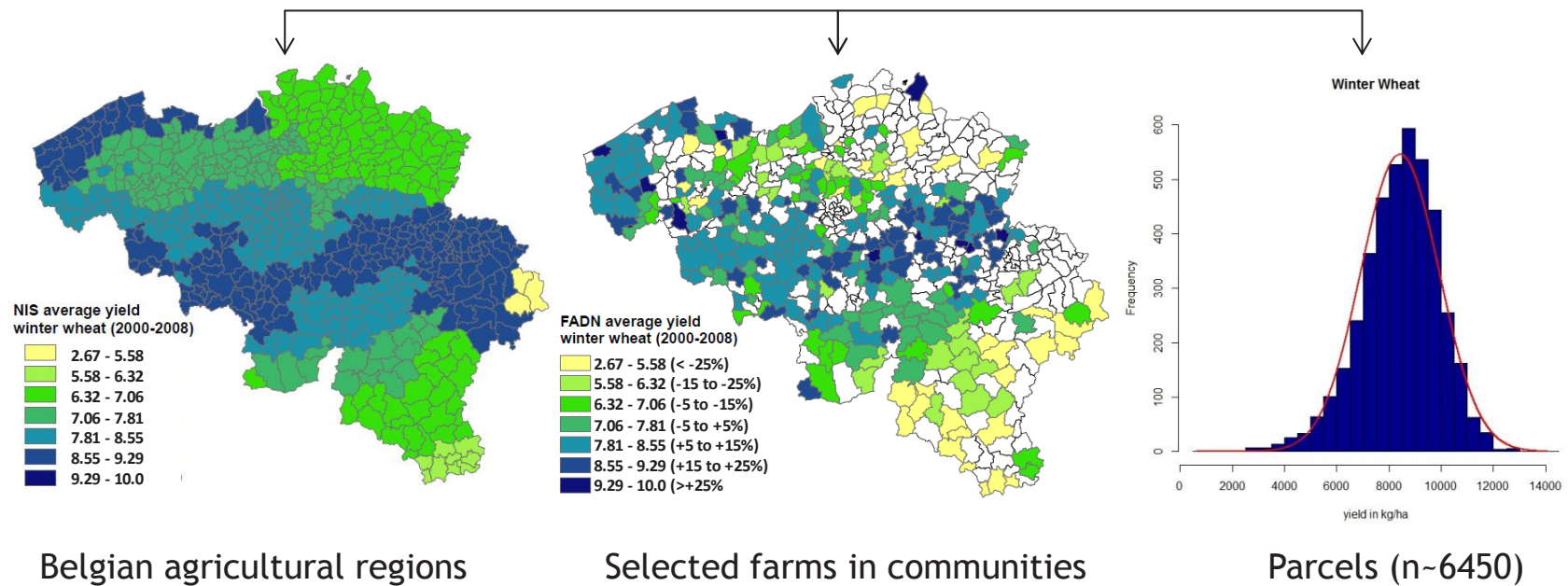
- Waterlogging
- Drought
- Heat stress
- Temperature stress
- Biomass
- Yield

(Gobin, 2010, 2012, 2015)

YIELD VARIABILITY

Different yield datasets were used:

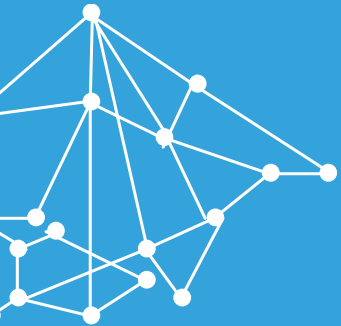
- Spatial yield variability increases at different scales
agricultural regions - communities - parcels
- Distributions at the parcel level were used to define **low yields** for different arable crops



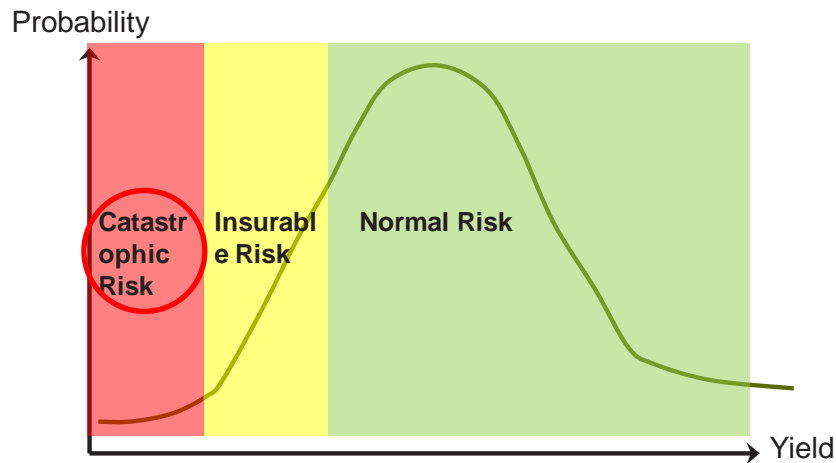


CROP MODELLING & MONITORING

Examples of agri-climate projects and services



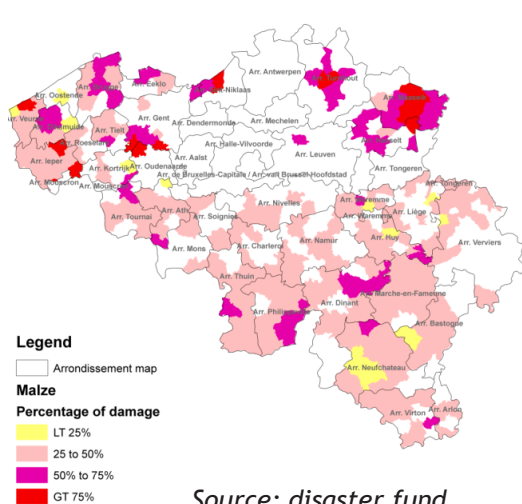
RISK AND INSURANCE - DISASTER FUND



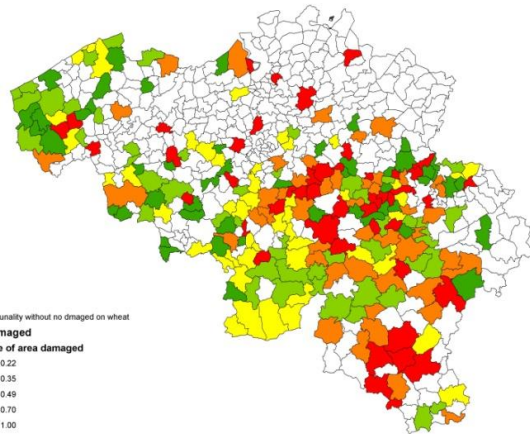
- » Risk Segmentation
 - » Normal risk
 - » Insurable risk
 - » Catastrophic Risk

» Disaster funds

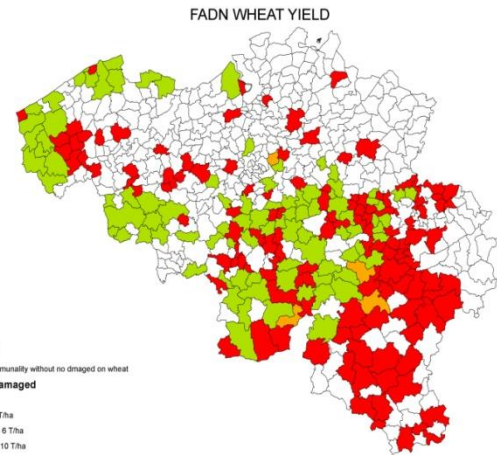
- » Distinction natural disaster - agricultural disaster
- » Event with **exceptional** character
- » Since 1996 drought is eligible
- » Sufficient claims!
- » Extreme **low yields** based on FADN are confronted with claims



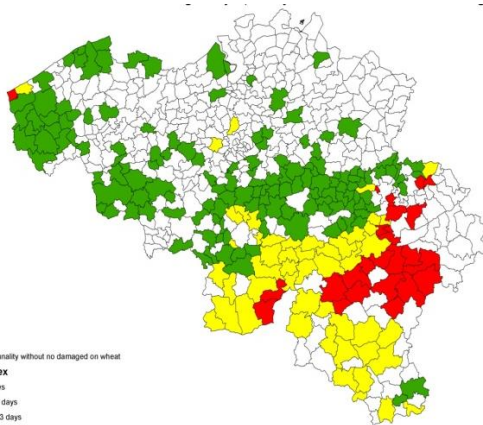
RISK AND INSURANCE - DISASTER FUND



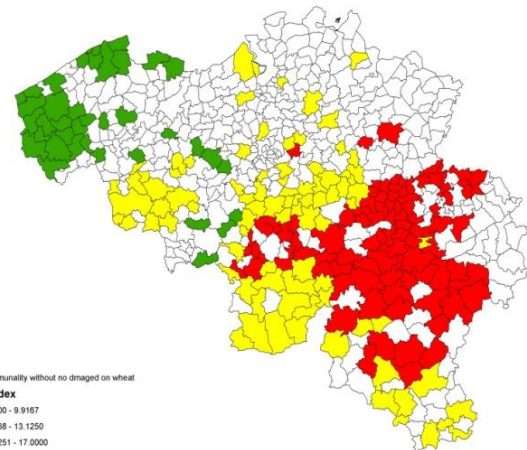
Claims



Yield anomalies



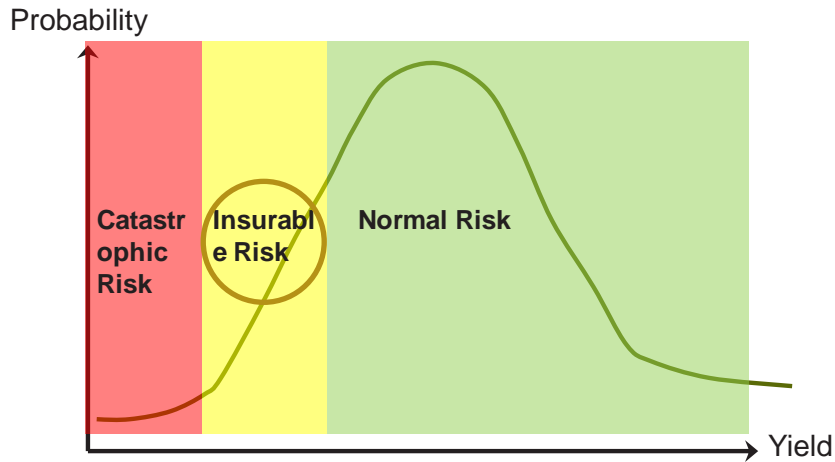
Drought



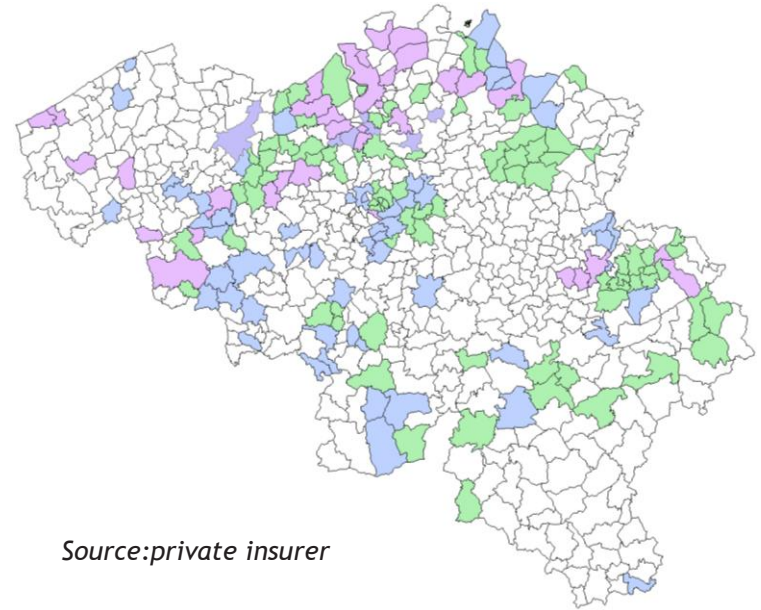
Extreme rainfall & waterlogging

- » Variability in claims
- » Relation with yield ?
- » Model allows for analysing weather impacts during sensitive growth stages
- » Relation with extremes during the growing season is clear

PRIVATE INSURANCES FOR AGRICULTURAL RISKS

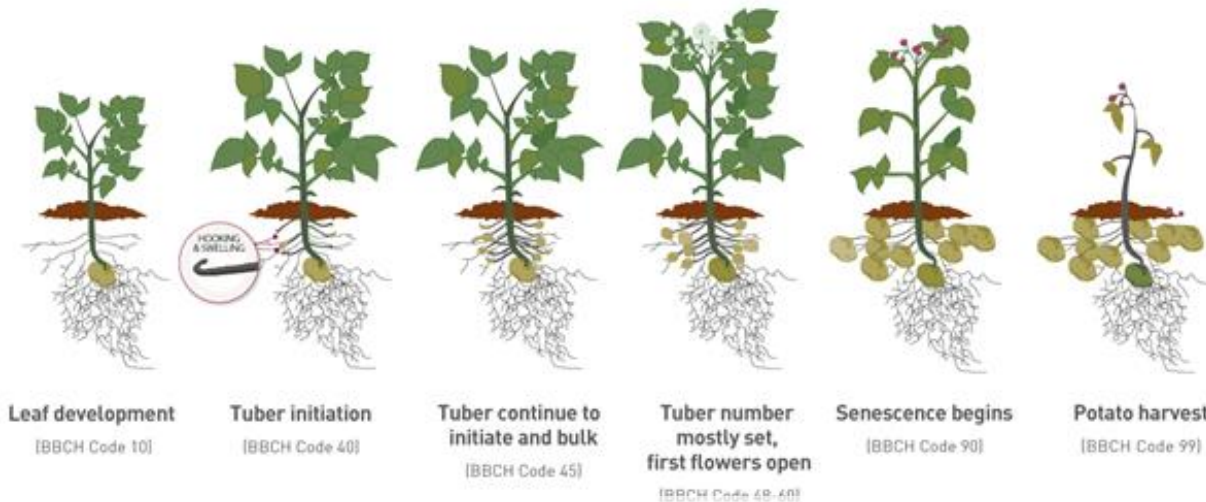
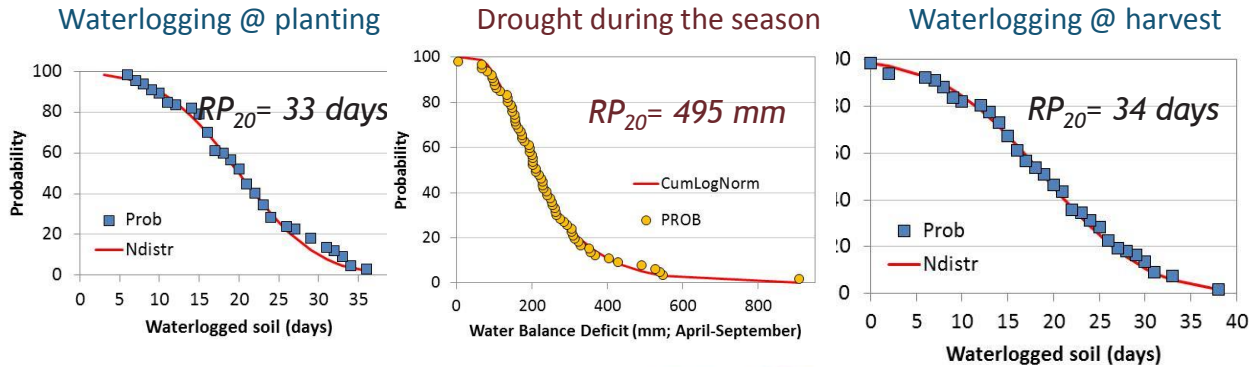


- » Private insurers: claims related to **flooding, hail & excessive rain**



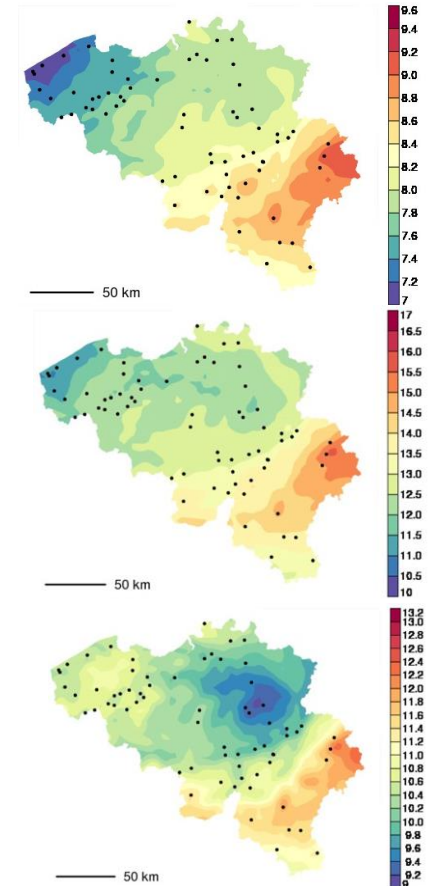
- » Focus on **extreme character** of the weather event ~ exceedance of 1:20 return period

Potato cultivation @ risk in Belgium?



Probability of exceedance and 20-year return periods

Number of consecutive rainy days

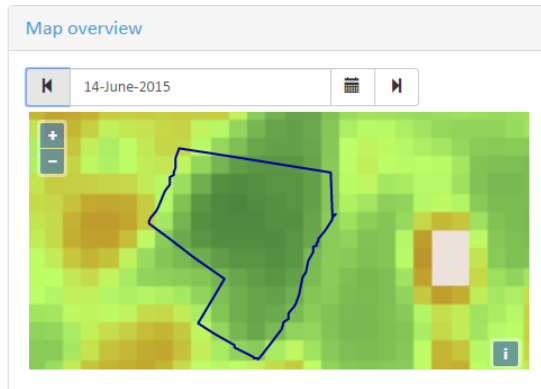


20-year return periods

IPOP PROJECT: FIELD AND CROP CONDITION OF POTATOES USING DMC AND S2

Normal conditions for crop growth?

Risk of production or quality losses? (delayed crop growth)



DataViewer

Metadata

Field name	Community
Latitude	Longitude

General parameters

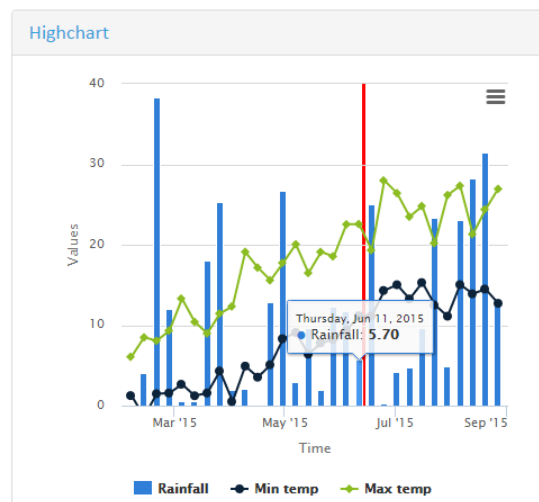
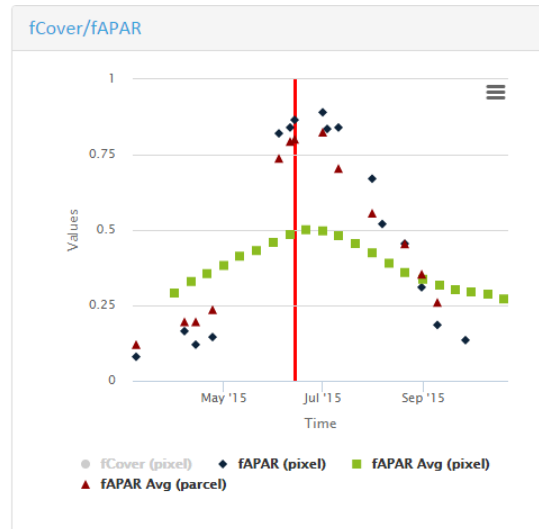
Planting date	Harvest date
Plant separation	Row distance

Fenologies

Type	Date	Remarks
------	------	---------

MapLayers

<input checked="" type="checkbox"/> fields	1
<input checked="" type="checkbox"/> Parcels	1
<input checked="" type="checkbox"/> Field borders	1
<input checked="" type="checkbox"/> fAPAR	1
<input checked="" type="checkbox"/> fCover	1



Vegetation index



Weather info

BELCAM PROJECT: CROP DAMAGE BY WEATHER EVENTS

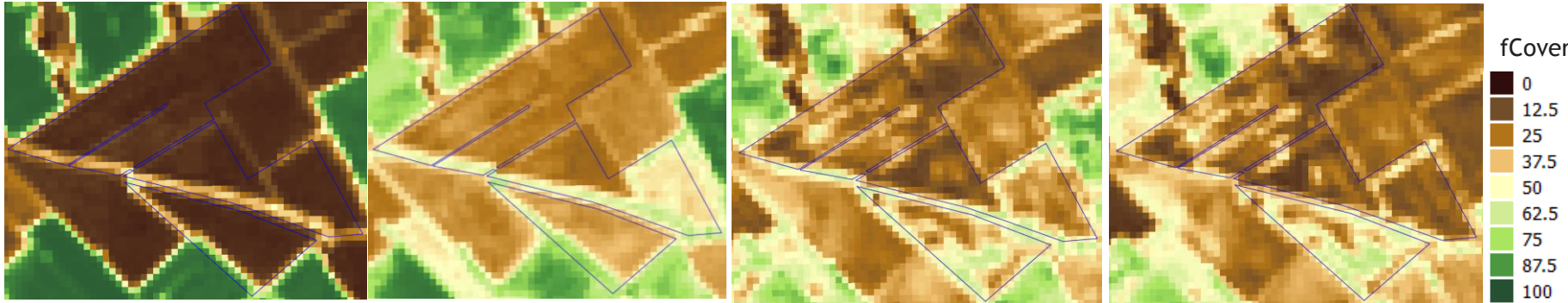
Heavy rainfall end May, 21 Juni and 23-24 Juni 2016; ($P > 50\text{mm/day}$)

8 mei

7 juni

10 juli

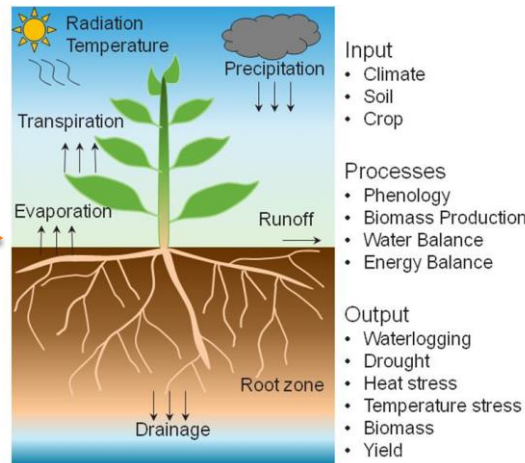
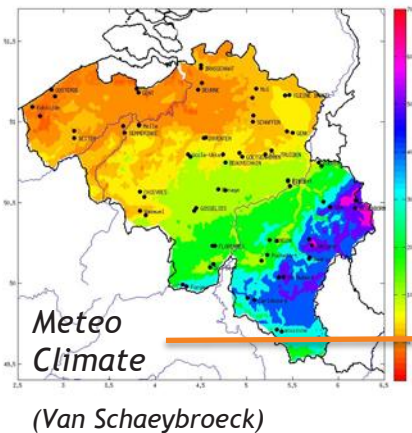
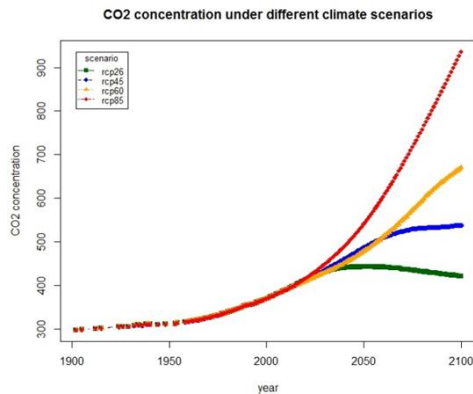
20 juli



UAV (Lewycky, Meulemans, 2016) & S2 (Piccard, 2016)

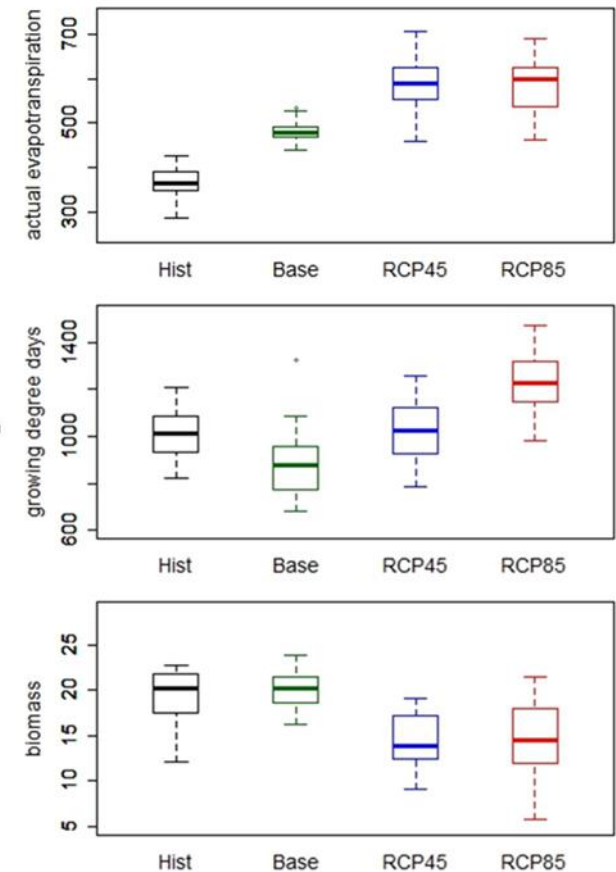
CORDEX.BE: CLIMATE IMPACT ON CROP GROWTH (CORDEX.BE)

Projected shifts - observed weather 1960-1990 (*Hist*), GCM 1976-2005 (*Base*), and 2070-2100 (*RCP45*, *RCP85*). ALARO 12 km Downscaling. Model runs on locations of synoptic stations across Belgium.



(Gobin, 2010, 2012)

Agri-Climatological Functions



ULTIMATE PROOF: TALKING TO STAKEHOLDERS (FARMERS)

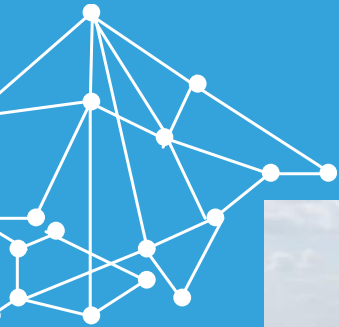
Participatory techniques: focus groups, group exercises, interviews, risk matrix





CROP MODELLING & MONITORING

Conclusions



CONCLUSIONS

- » A **combined methodology** of field observations, crop modelling and monitoring with remote sensing seems most promising; not to forget participatory approaches to ensure stakeholder involvement.
- » **Physically based crop models** assist in understanding the links between different meteorological risks to crop yields.
- » The impact of single events on crop yields is difficult to capture, as **yields integrate weather variability** during the growing season. Extremely low yields can be explained by extreme weather events!



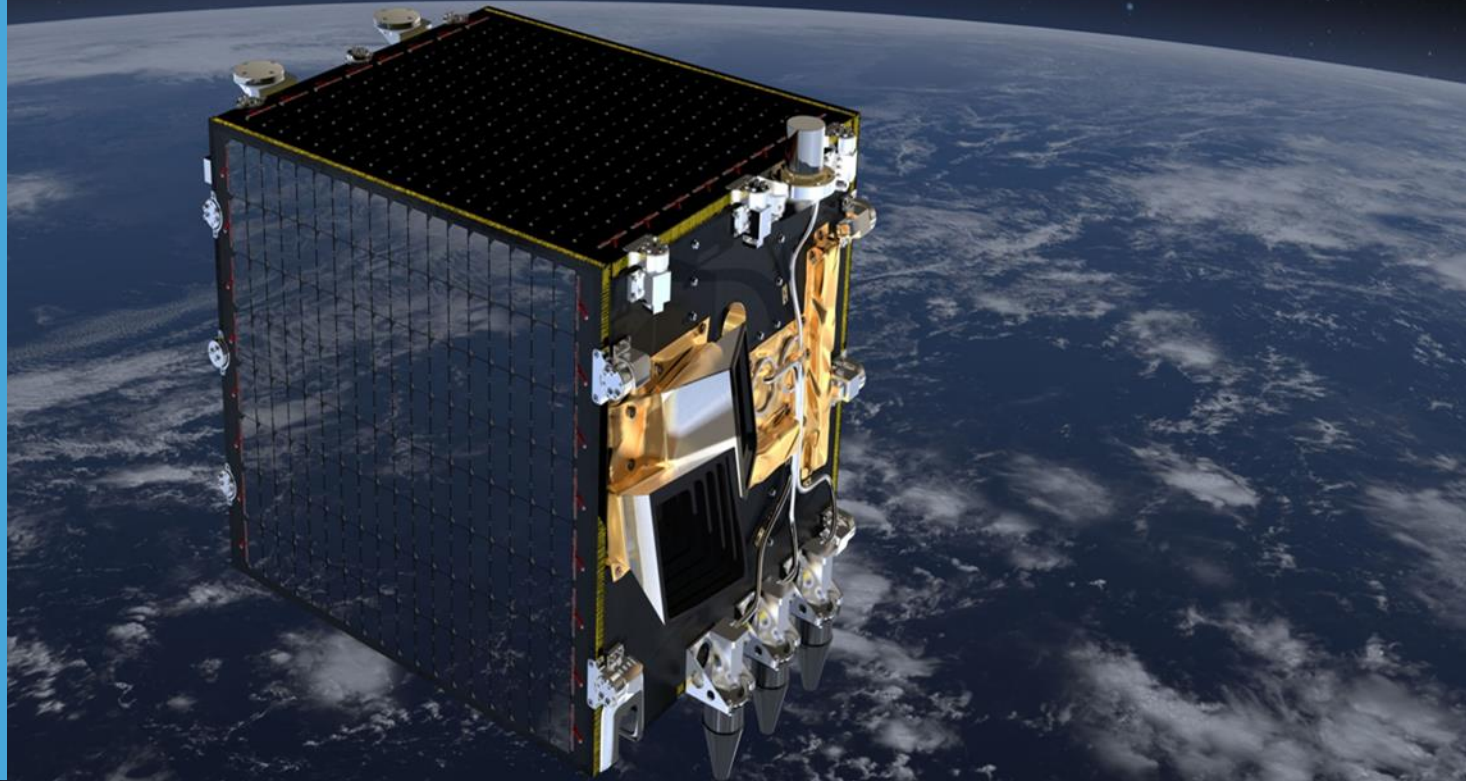
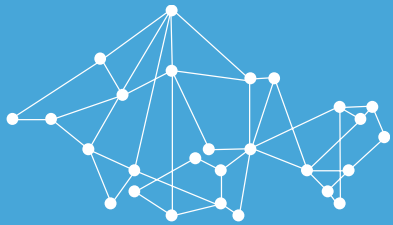


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9-10 November
2016, Ljubljana



Projects: Merinova, Cordex.be, iPOT, BELCAM