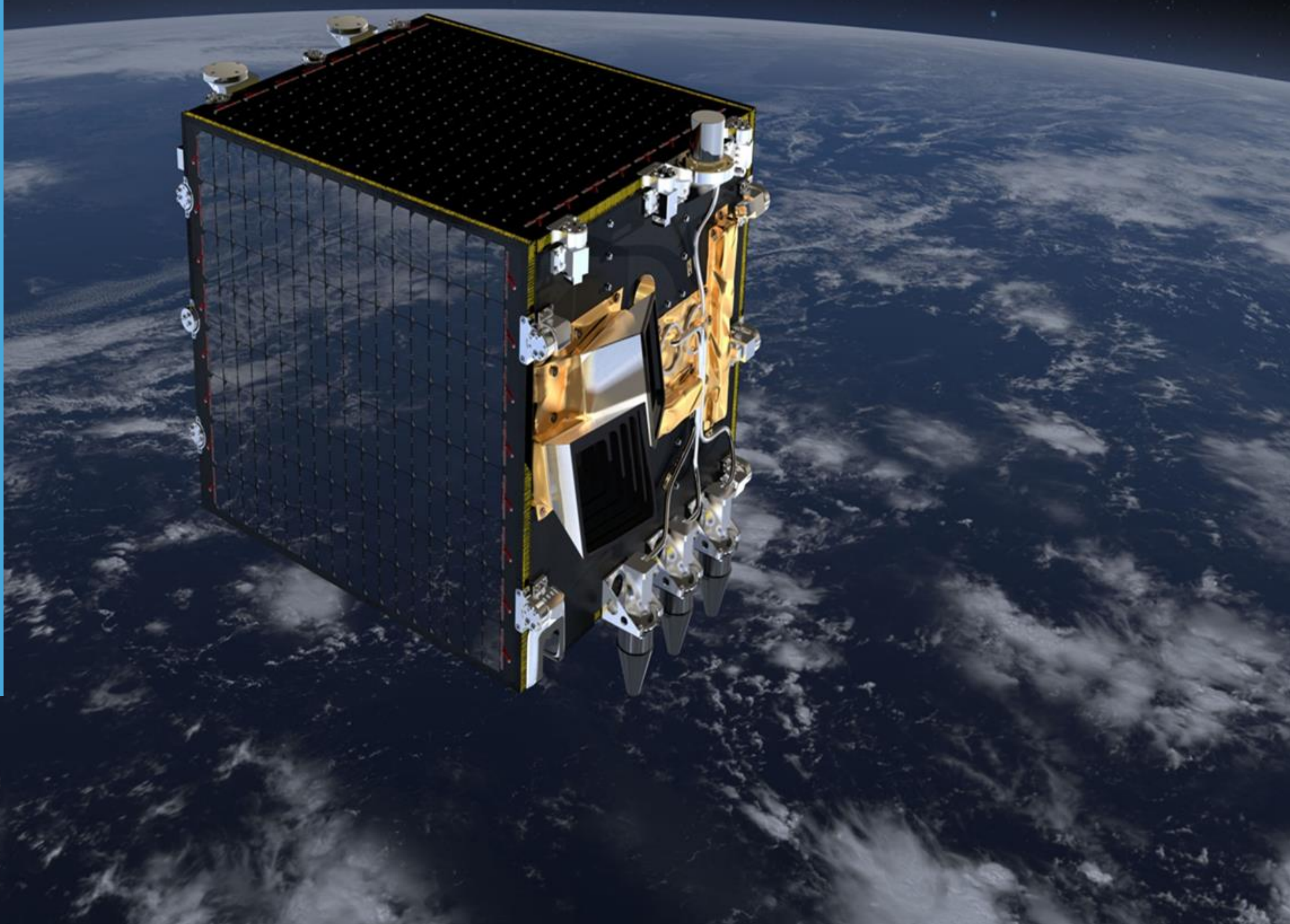
CROP MODELLING AND MONITORING FOR AGRI-CLIMATE SERVICES

Anne Gobin

vito

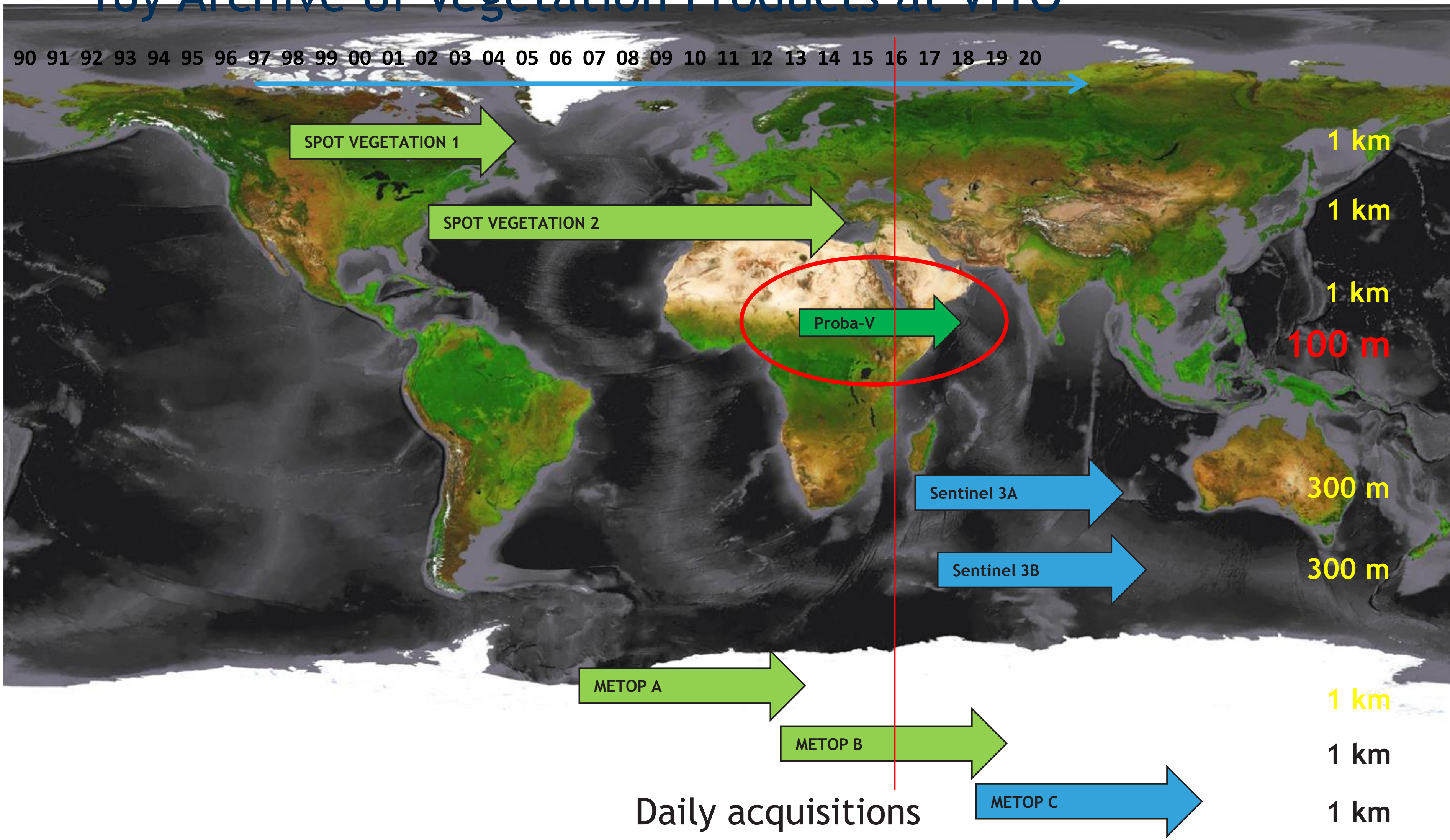
Agri-Met Workshop

9-10 November 2016, Ljubljana



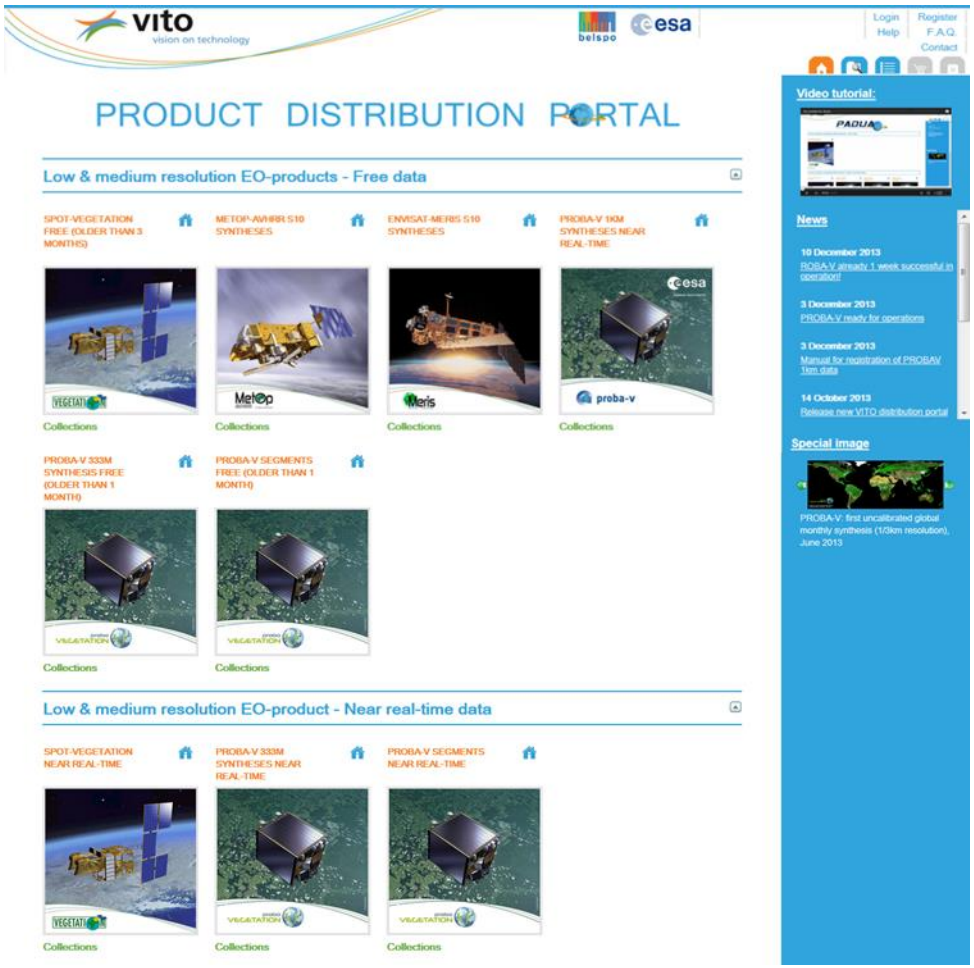
Current Services @ Vito

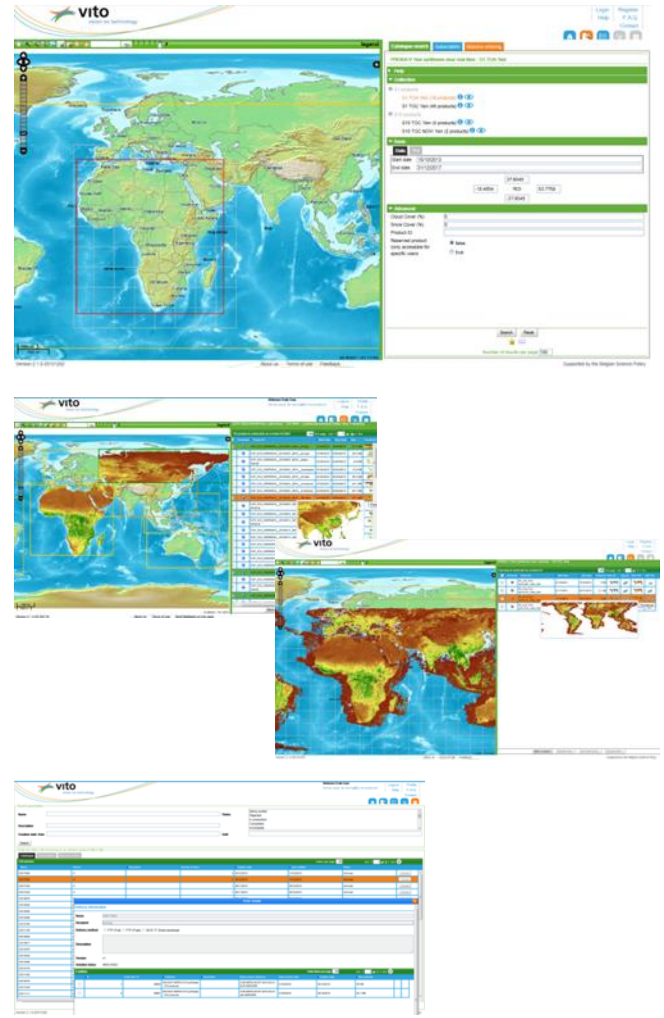
18y Archive of Vegetation Products at VITO



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

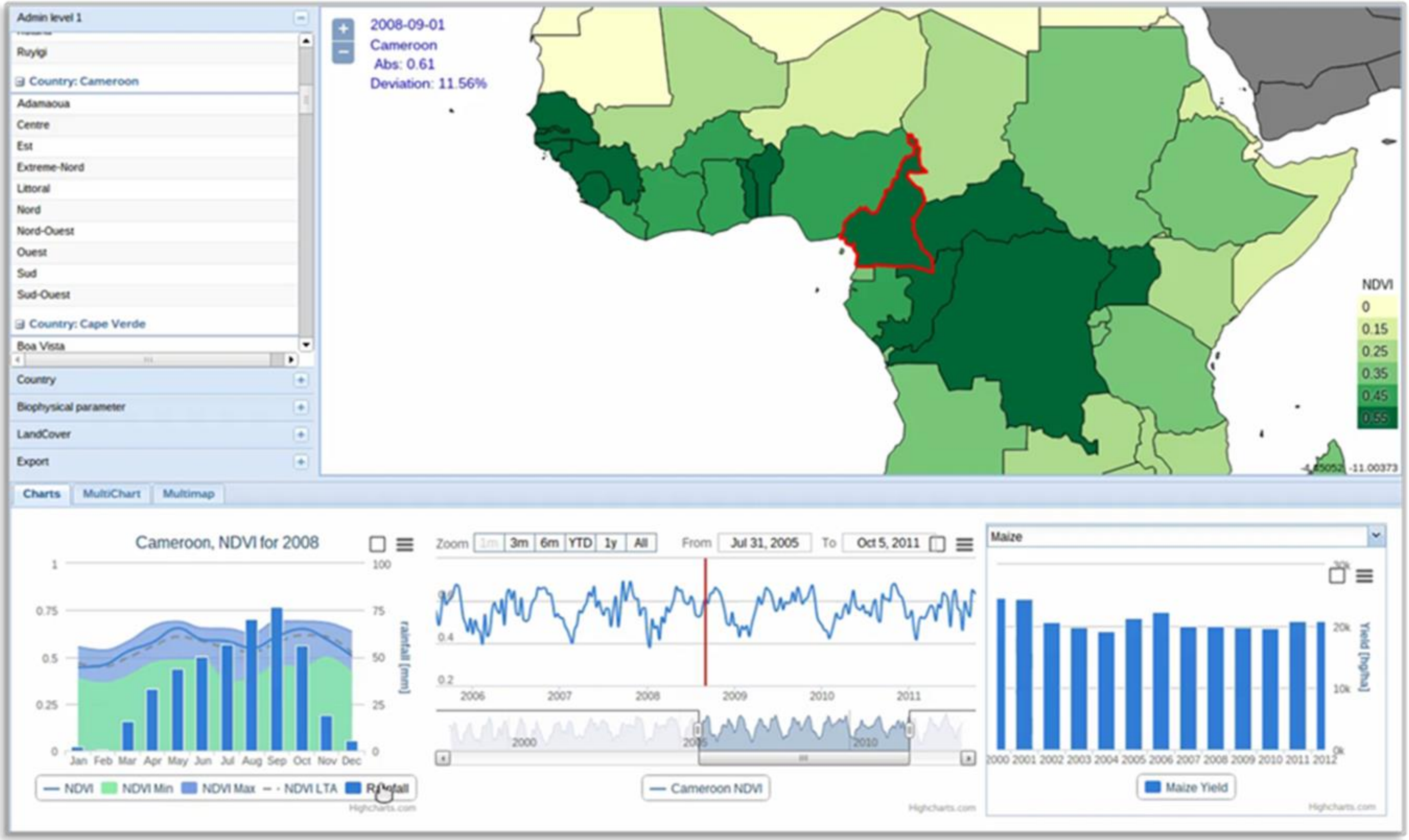
Free downloads of products





http://www.vito-eodata.be

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



https://proba-v-mep.esa.int/

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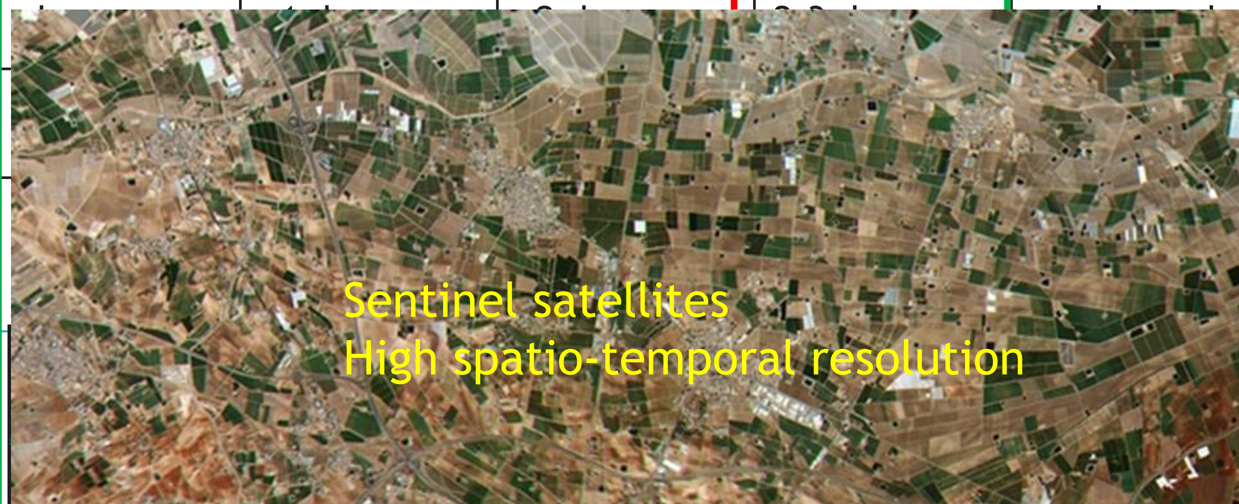
MONITORING WITH DIFFERENT TYPES OF SENSORS

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 ←

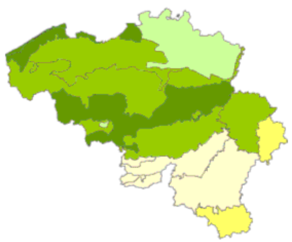
Field + ***UAV***

CURRENT SERVICES: COPERNICUS GLS

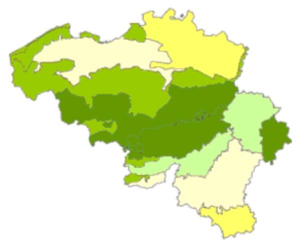
http://land.copernicus.eu/global/

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

Example: Belgian Yields - 1998

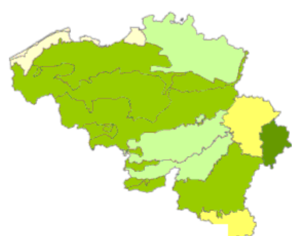


Winter wheat

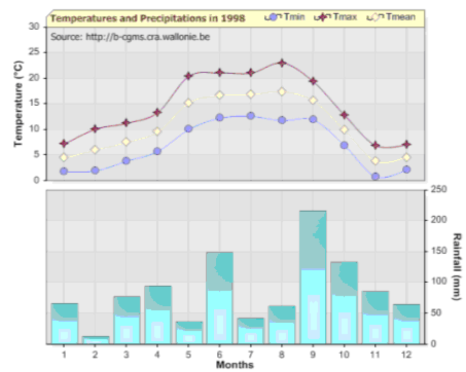


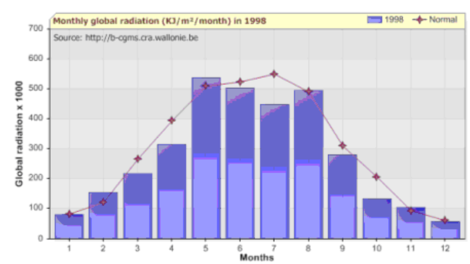
Winter Barley

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

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INTRODUCTION - EXTREME EVENTS AND THEIR IMPACT ON CROPS

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

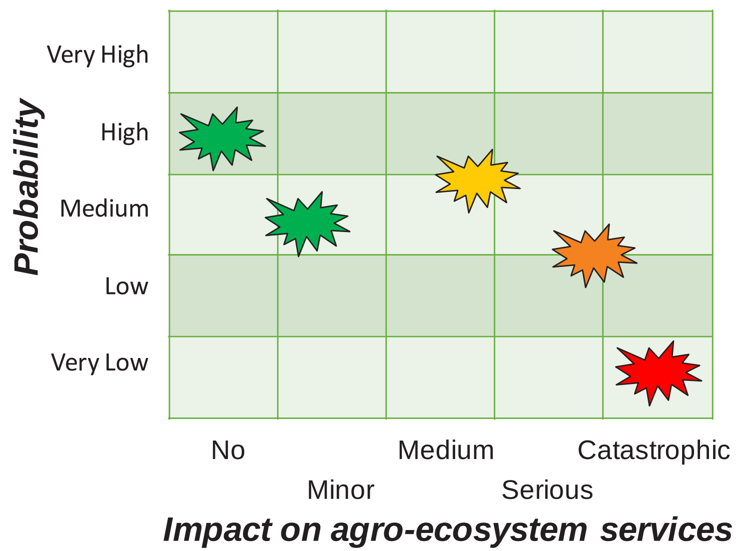
(1) the nature of the event; (2) the occurrence in relation to the farming calendar; and, (3) the type of agro-ecosystem service (biomass, yield, soil quality).

Heat stress

Waterlogging

Frost

Drought



(yield, biomass, soil quality & moisture)

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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 advere 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.

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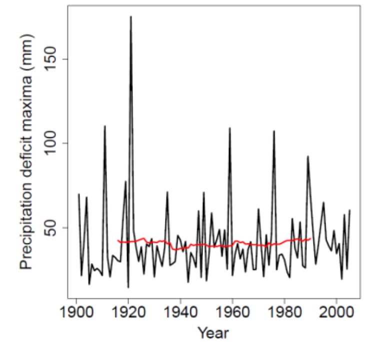
CROP MODELLING & MONITORING

Methodology

CHARACTERISATION OF EXTREME (AND ADVERSE) WEATHER CONDITIONS

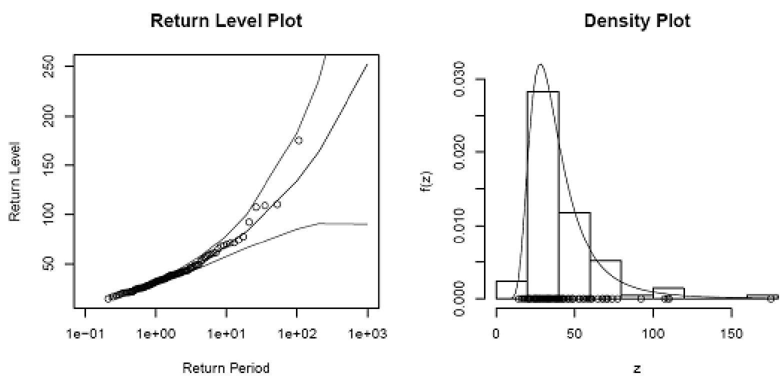
1. Trend analysis for all stations and fitting GEV distributions for individual stations

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

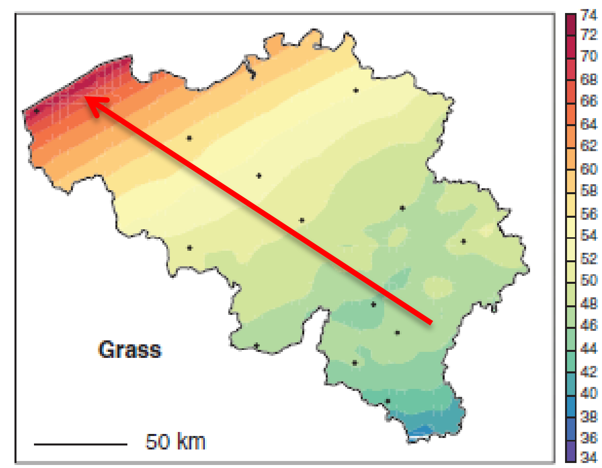


2. Return periods (T) and associated return level (z_T)

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



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



20y RP for precipitation deficit

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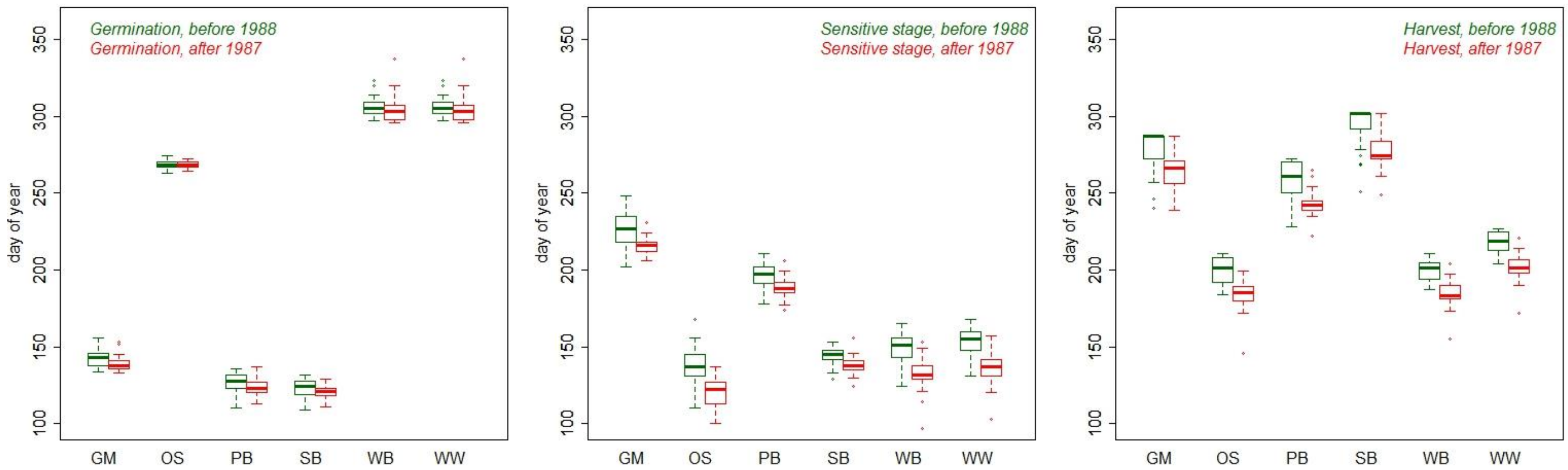
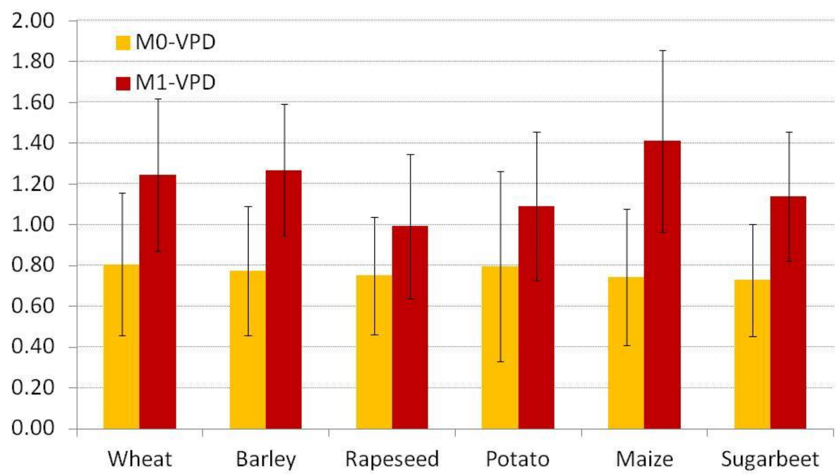
OCCURRENCE OF CROP SENSITIVE STAGES





Growth stages occur significantly earlier after 1987

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

(Gobin, 2012)
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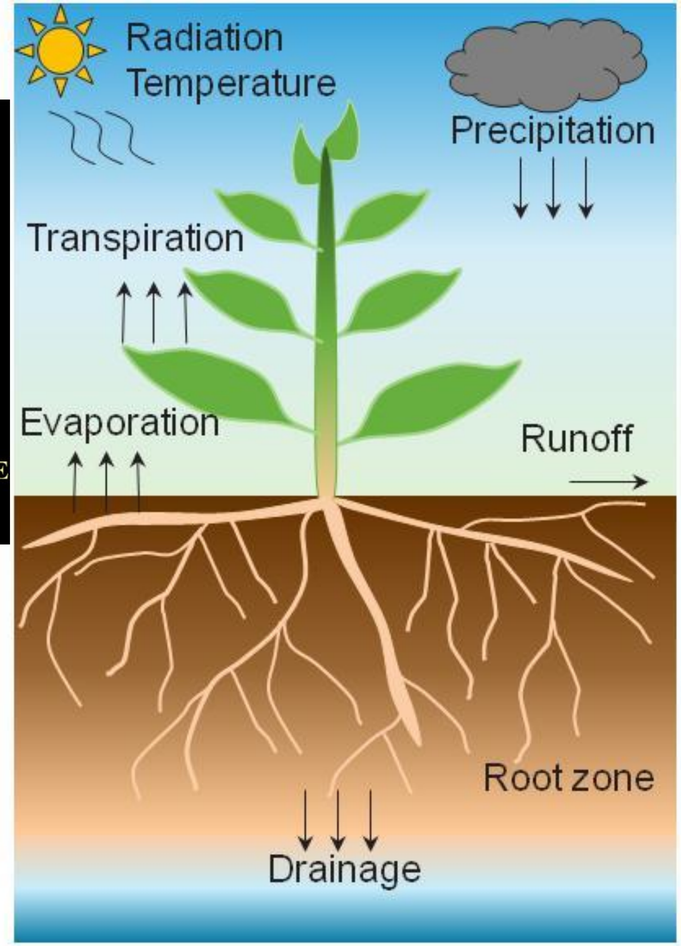
CROP MODELLING TO CAPTURE DYNAMICS

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)

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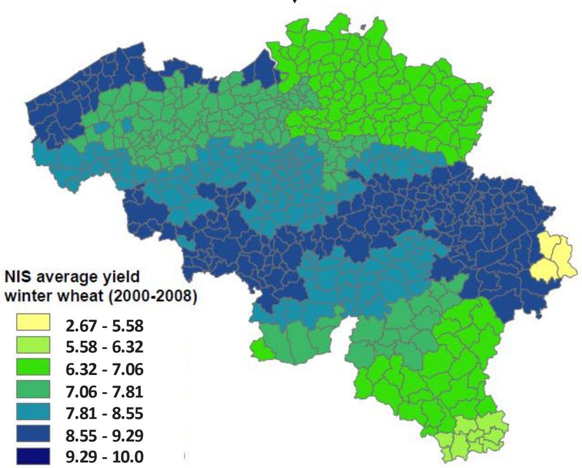
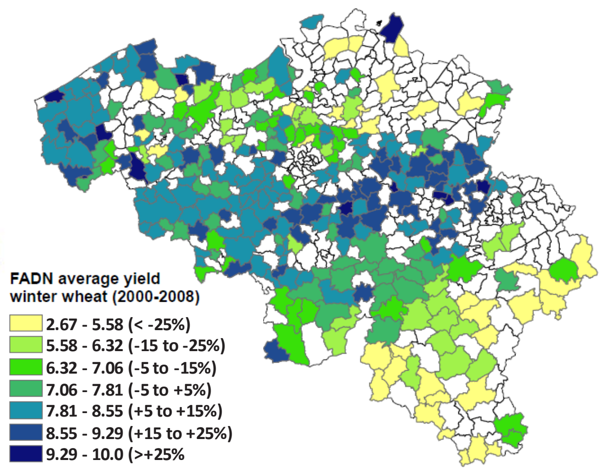
YIELD VARIABILITY

Different yield datasets were used:

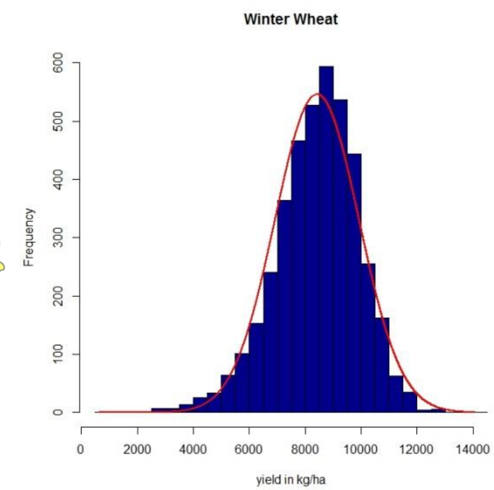
- Spatial yield variability increases at different scales agricultural regions - communities - parcels
- Distributions at the parcel level were used to define low yields for different arable crops



Belgian agricultural regions



Selected farms in communities



Parcels (n~6450)

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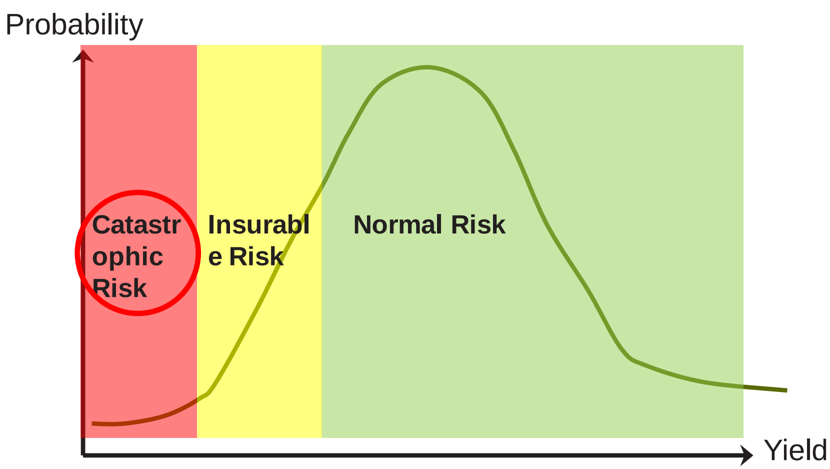
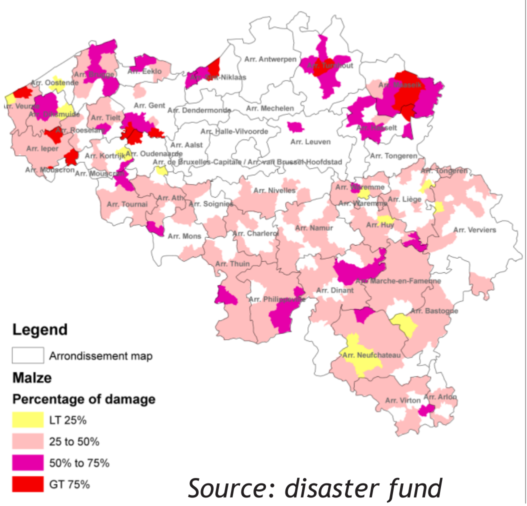
CROP MODELLING & MONITORING

Examples of agri-climate projects and services



RISK AND INSURANCE – DISASTER FUND

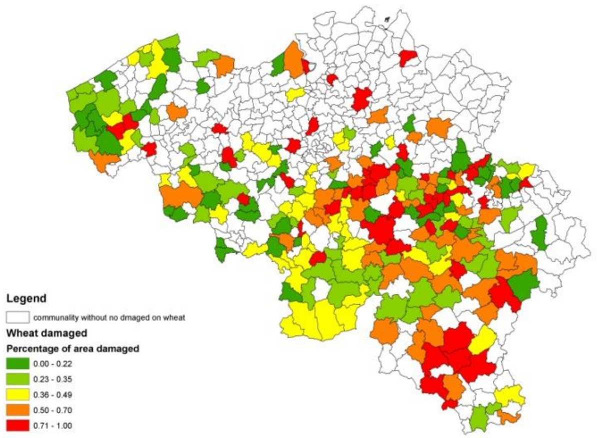




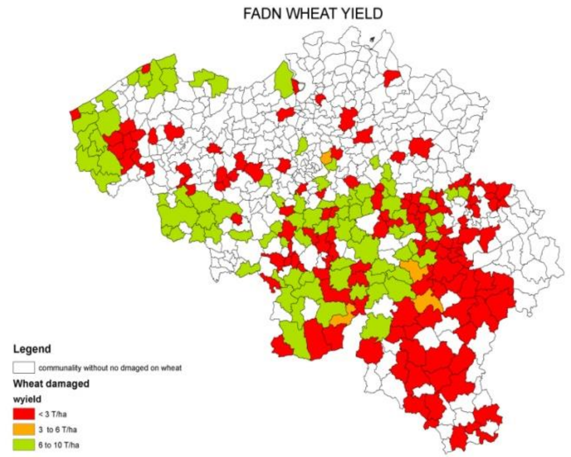
Source: disaster fund

- Risk Segmentation
  - Normal risk
  - Insurable risk
  - Catastrophic Risk
- Disaster funds
  - Distinction natural disaster – agricultural disaster
  - Event with exceptional character
  - Since 1996 drought is eligable
  - Sufficient claims!
  - Extreme low yields based on FADN are confronted with claims

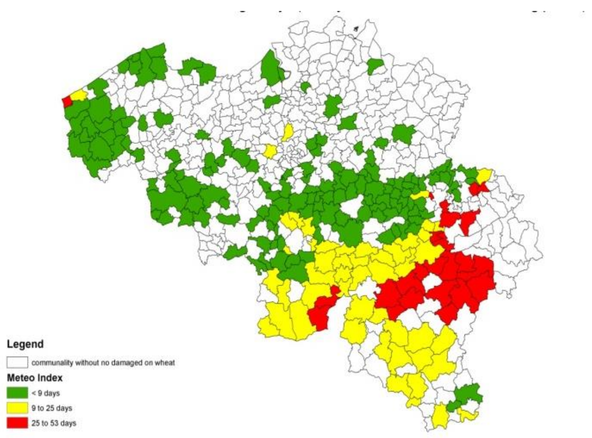
RISK AND INSURANCE – DISASTER FUND



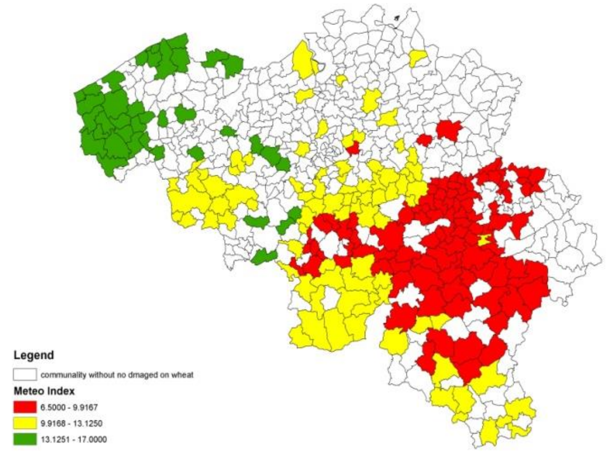
Claims



Yield anomalies



Drought



Extreme rainfall & waterlogging

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

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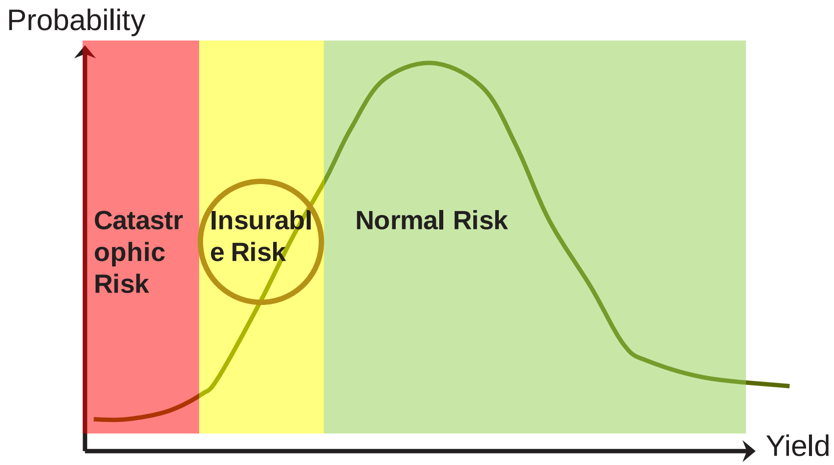
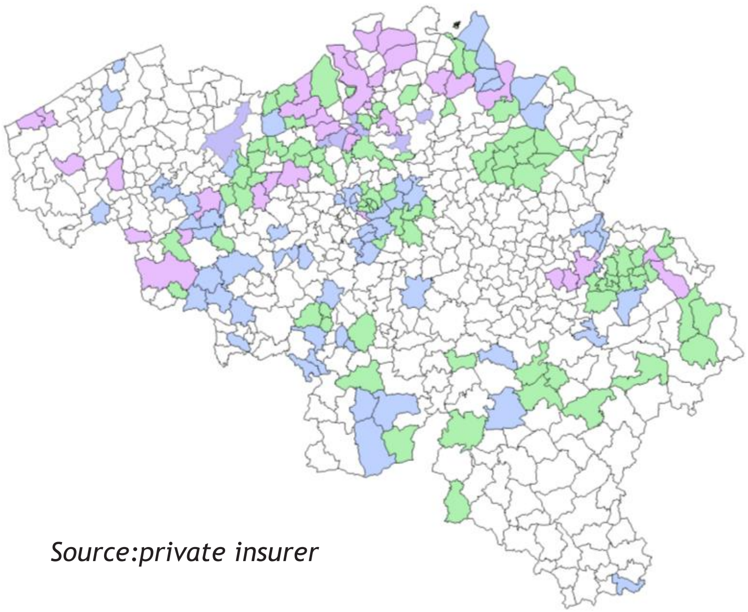
PRIVATE INSURANCES FOR AGRICULTURAL RISKS



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



Source:private insurer

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

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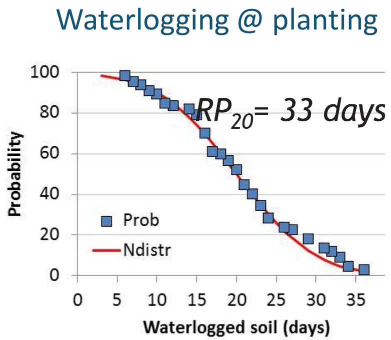
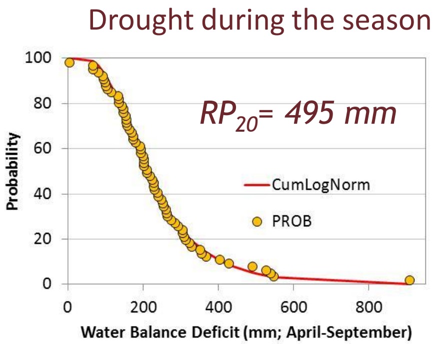
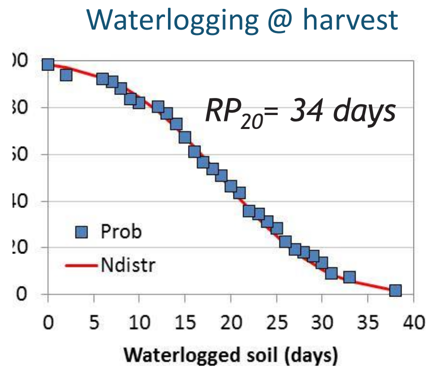
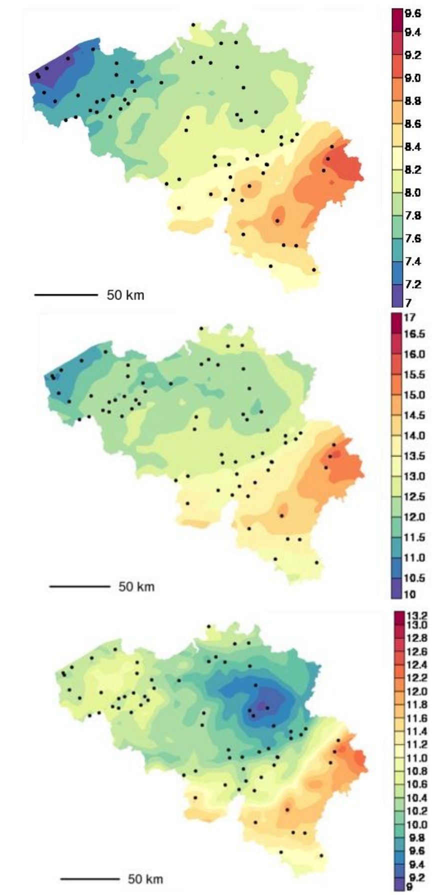
Potato cultivation @ risk in Belgium?

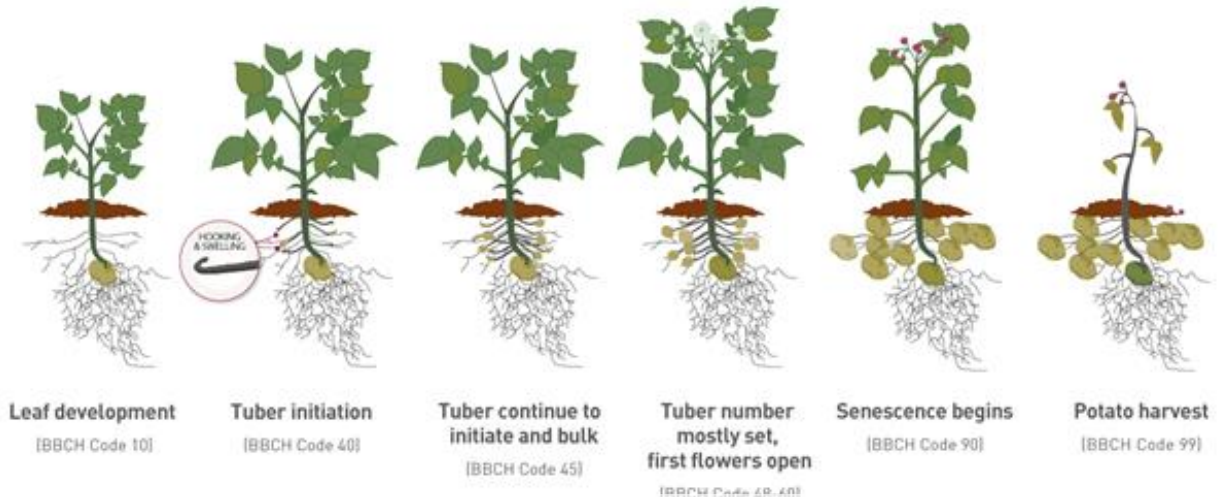
Number of consecutive rainy days











Probability of exceedance and 20-year return periods

20-year return periods

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IPOT 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)

Vegetation index

Weather info

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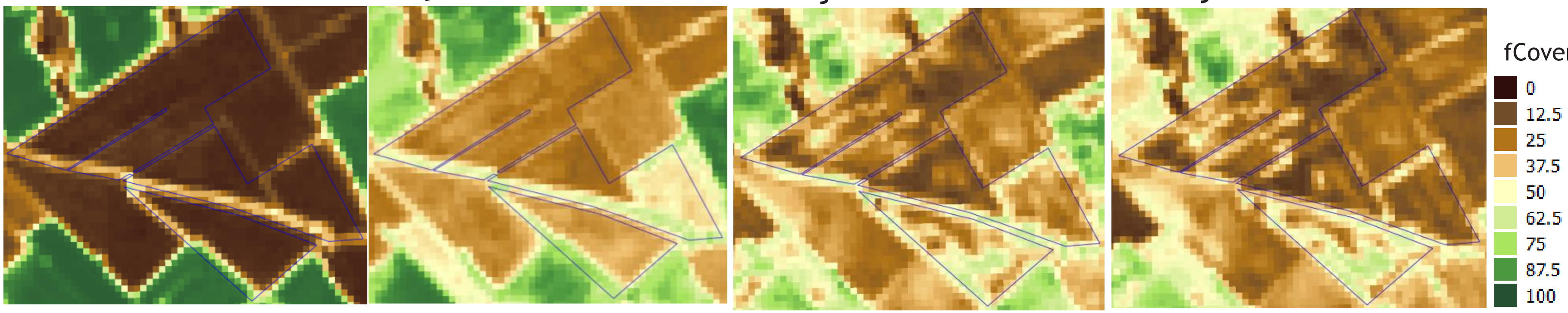
BELCAM PROJECT: CROP DAMAGE BY WEATHER EVENTS

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

8 mei 7 juni 10 juli 20 juli



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

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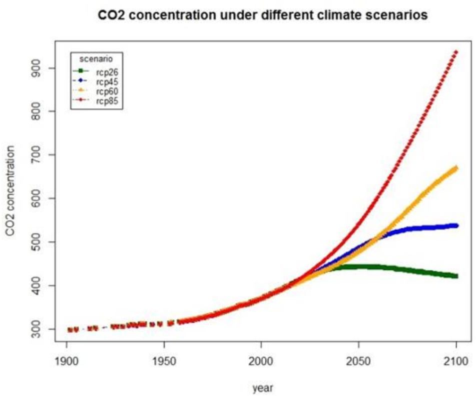
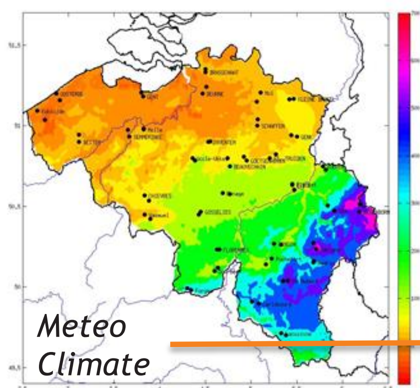
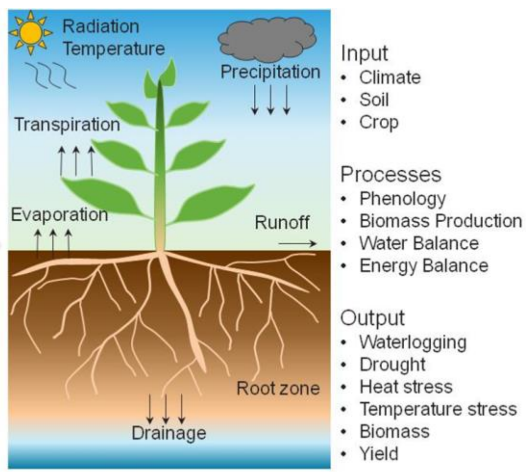
CORDEX.BE: CLIMATE IMPACT ON CROP GROWTH (CORDEX.BE)

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.



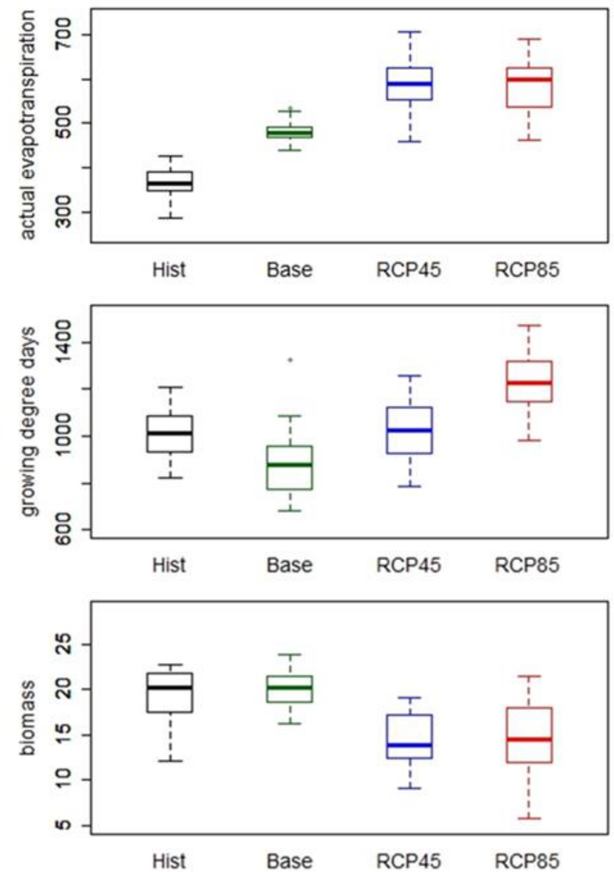


(Van Schaeybroeck)



(Gobin, 2010, 2012)

Agri-Climatological Functions



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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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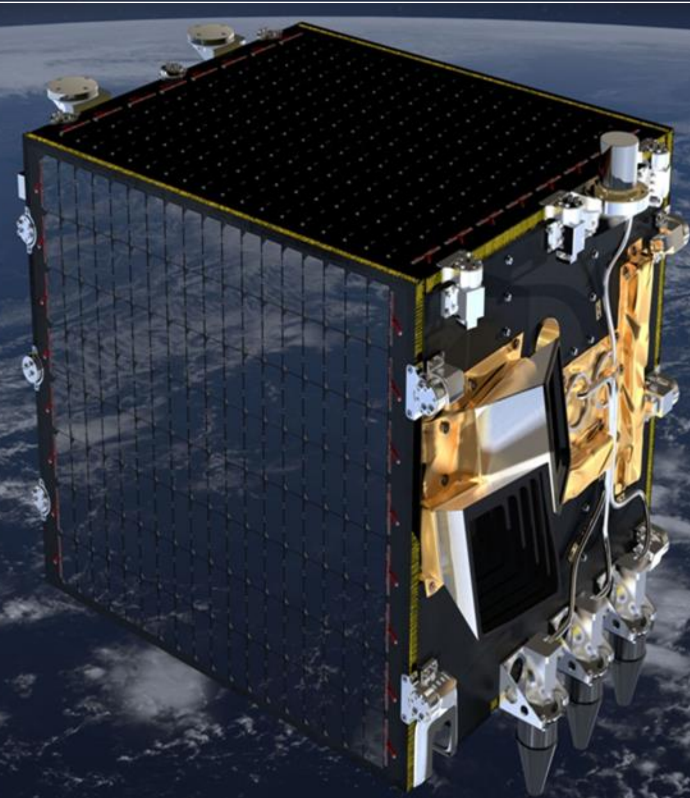

Projects: Merinova, Cordex.be, iPOT, BELCAM