



# CORDEX.be

## CORDEX.BE WORKSHOP ON AGRICULTURE

CLIMATE IMPACTS ON AGRICULTURE - *Anne Gobin*

- WEATHER IMPACTS
- CLIMATE IMPACTS
- VULNERABILITY AND RISK PERCEPTION

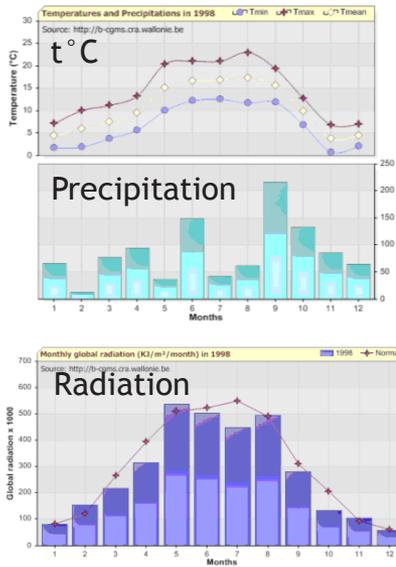
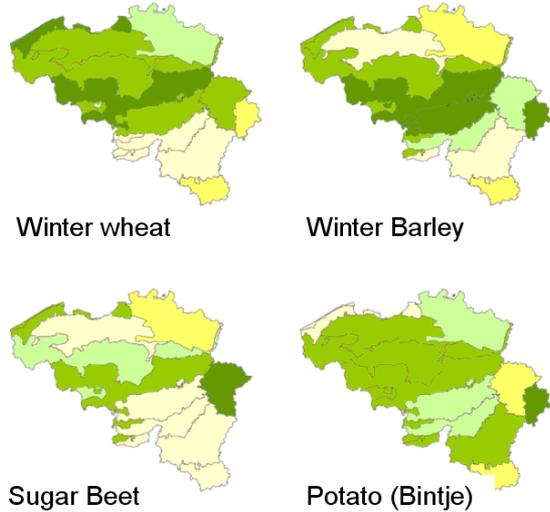


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## WEATHER IMPACTS

- Extreme and adverse weather conditions
- Impact on crop performance

# RELATION BETWEEN YIELD AND WEATHER



- » Variability between years, crops and between regions!
- » Variability depends on crop type, crop stage, **weather** during the cropping season
- » **Weather** and **Climate** have a large impact on agricultural crops

Drought



Heat stress



Hail

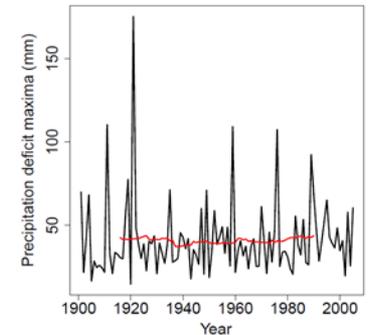
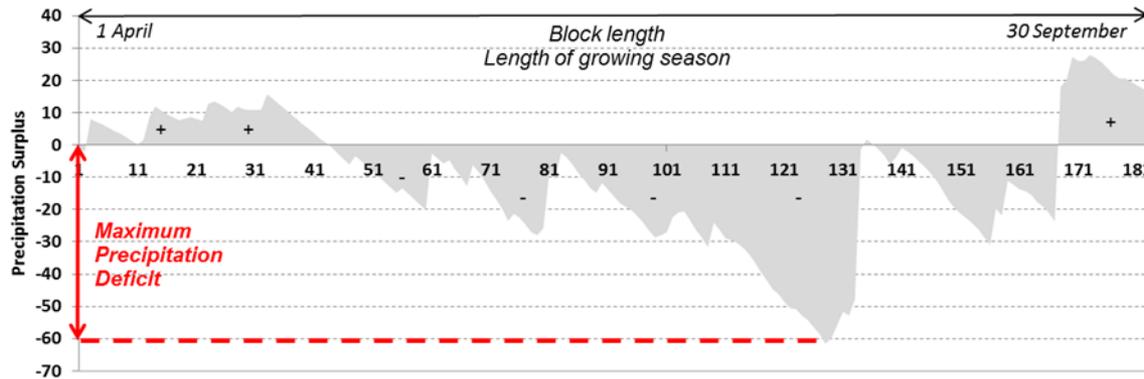


Waterlogging

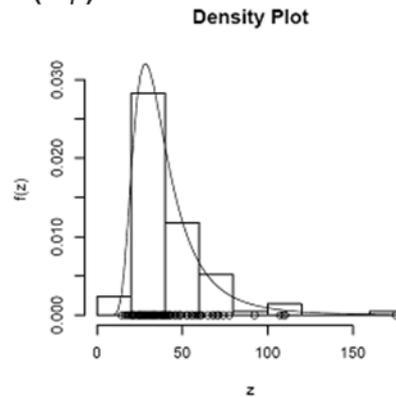
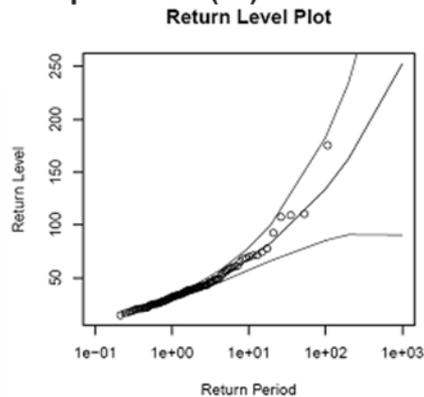


# EXTREME WEATHER EVENTS AND ADVERSE WEATHER CONDITIONS

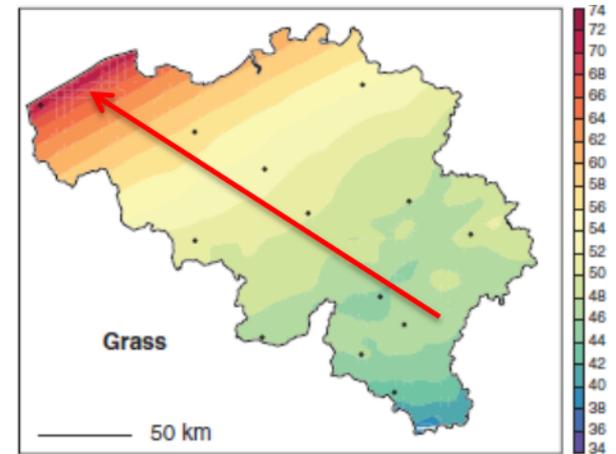
Trend analysis of time series and fitting distributions of individual stations



Return period ( $T$ ) and value ( $z_T$ )

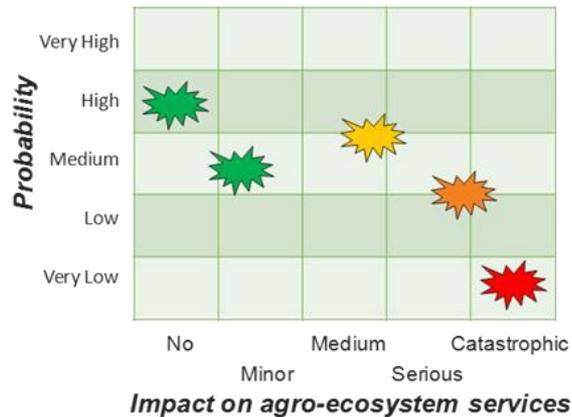


Cumulative precipitation deficit =  $f(ET, P)$   
(Zamani et al., 2015)



20y RP for precipitation deficit  
20y RP = adverse condition!

# MAGNITUDE OF IMPACT ON AGRICULTURE



*yield, biomass, soil quality, soil moisture*

- Impact depends on
  - the **occurrence** of the event during the agricultural season
  - the **location** of the event vs system
  - the **magnitude** and duration of the event
  - the **vulnerability**/resilience of the system

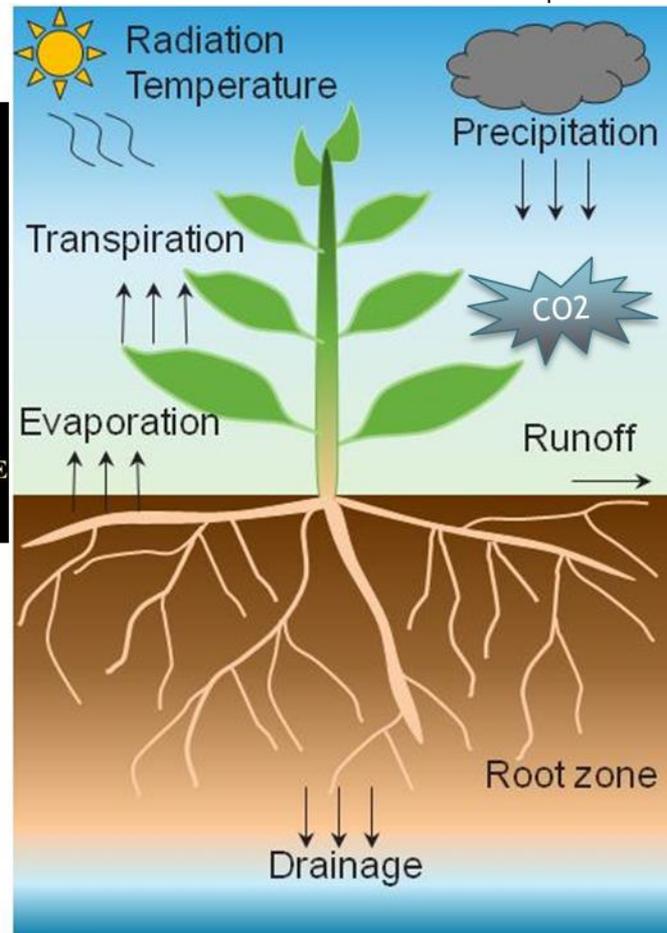
← Farming calendar →



# ADVERSE WEATHER/CLIMATE CONDITIONS DURING THE GROWING SEASON



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



## Input

- Climate
- Soil
- Crop
- CO<sub>2</sub>

## Processes

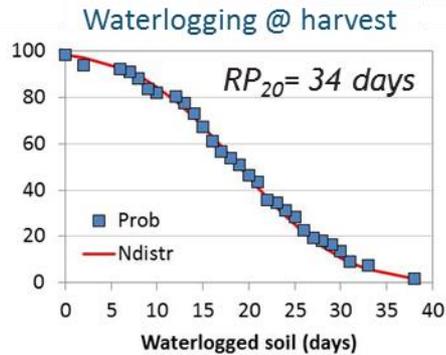
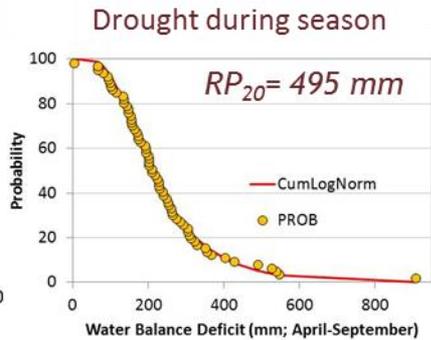
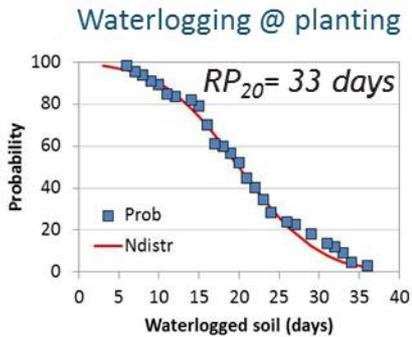
- Phenology
- Biomass Production
- Water Balance
- Energy Balance

## Output

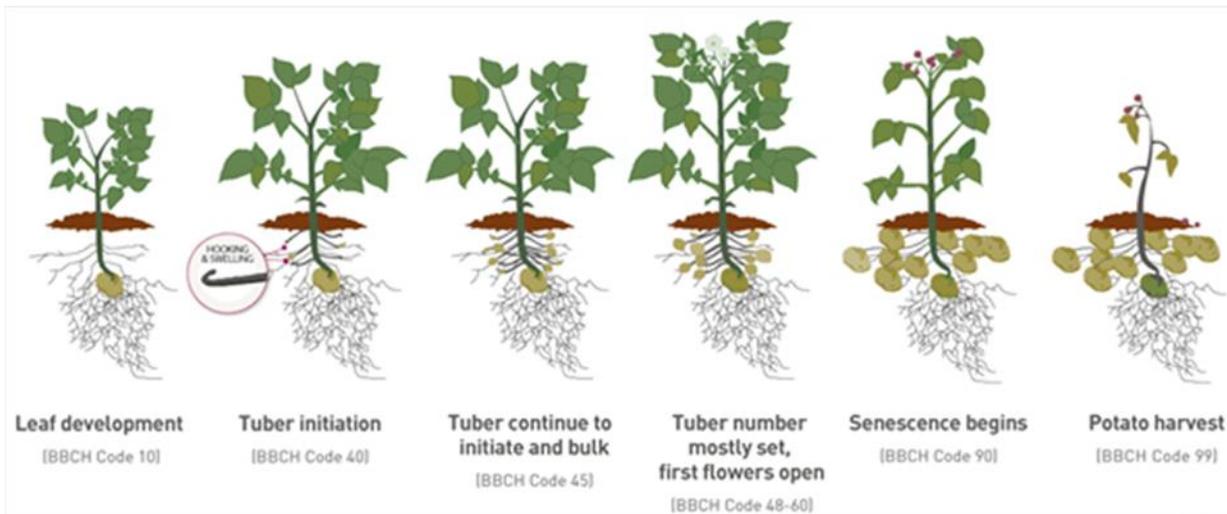
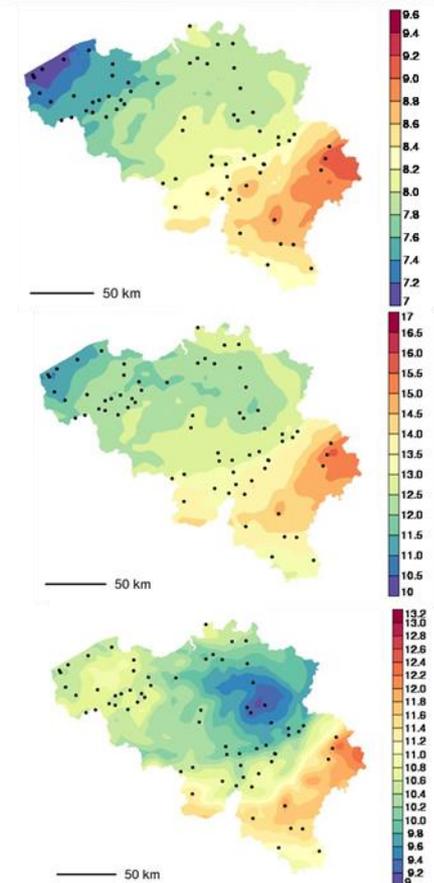
- Waterlogging
- Drought
- Heat stress
- Temperature stress
- Biomass
- Yield

(Gobin, 2010, 2012, 2015, 2017)

# EXAMPLE: RISKS FOR POTATO CULTIVATION IN BELGIUM



## Consecutive rainy days



Probability of exceedance and 20-y return period

Spatial return period

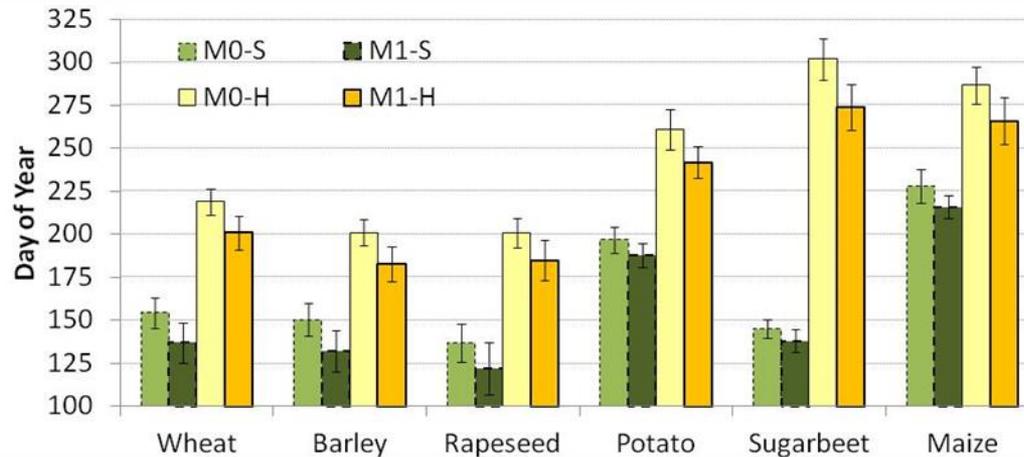


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## CLIMATE IMPACTS

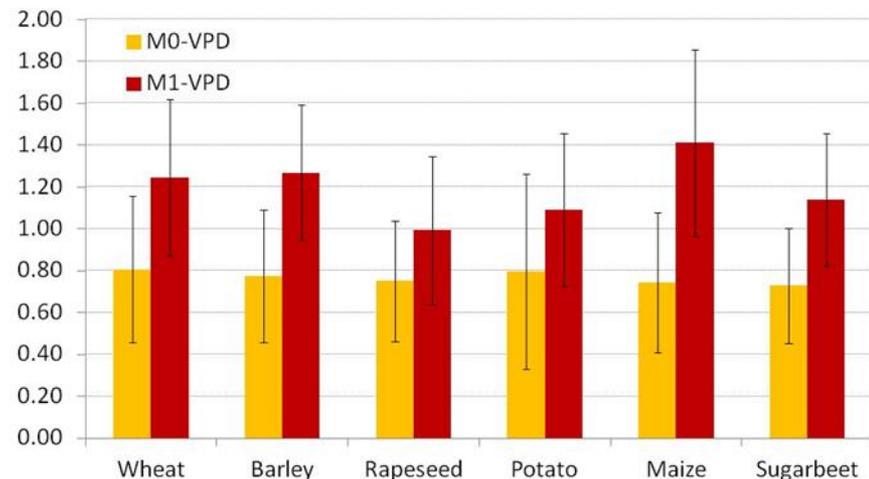
- GCM & Downscaling
- Projected time series
- Impact on crop performance

## MAGNITUDE OF EVENTS DURING SENSITIVE STAGES ACROSS MULTIPLE YEARS



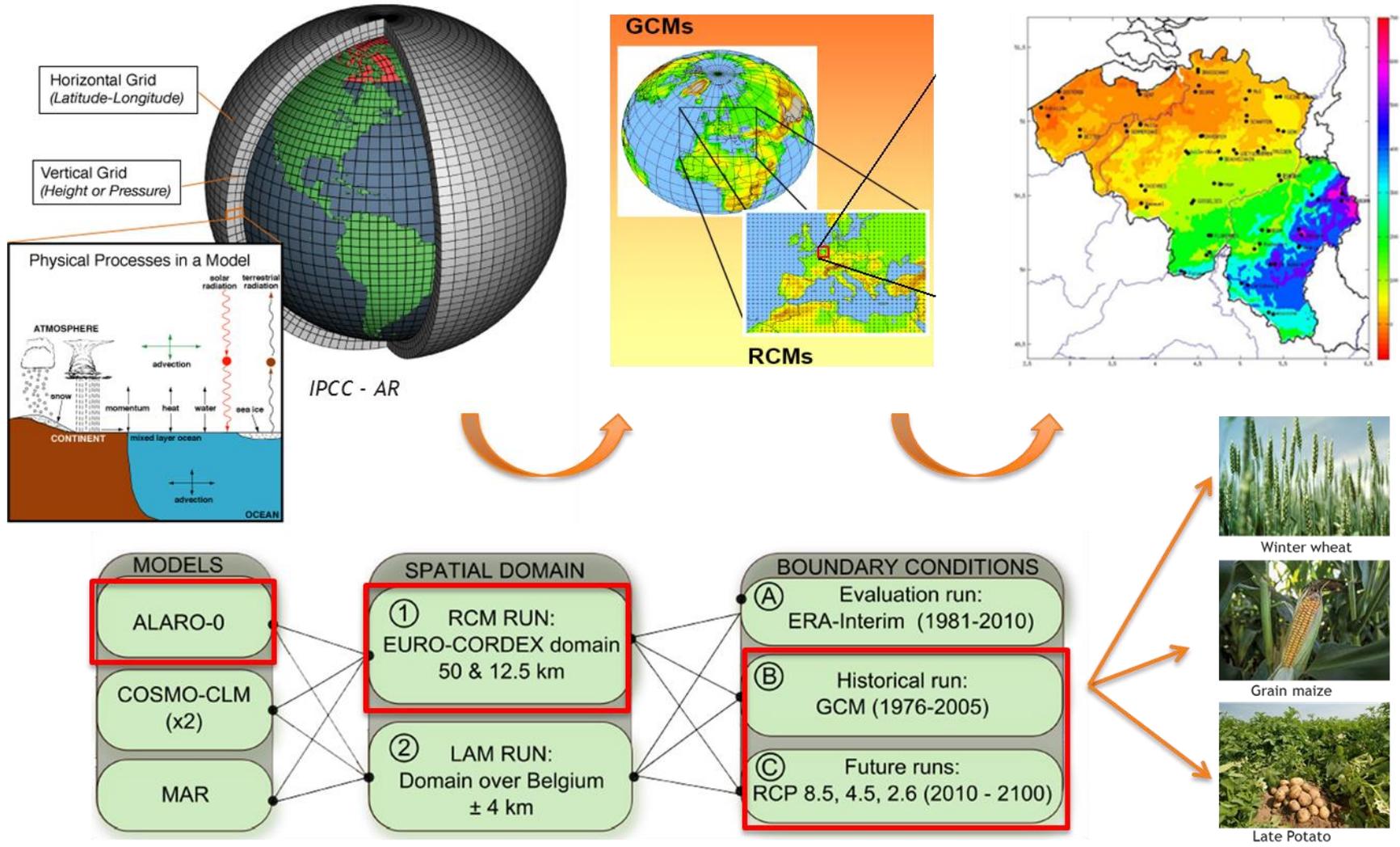
- » M0: < 1988; M1: >1988
- » Occurrence of **S**ensitive stages and **H**arvesting
- » Variability between years is captured, growth stages occur significantly **earlier** during the 1988-2008 growing seasons

- » Magnitude of heat stress during sensitive stages: increased heat stress during 1988-2008 period
- » Implication for the **coincidence** between a meteorological hazard and the sensitive stage

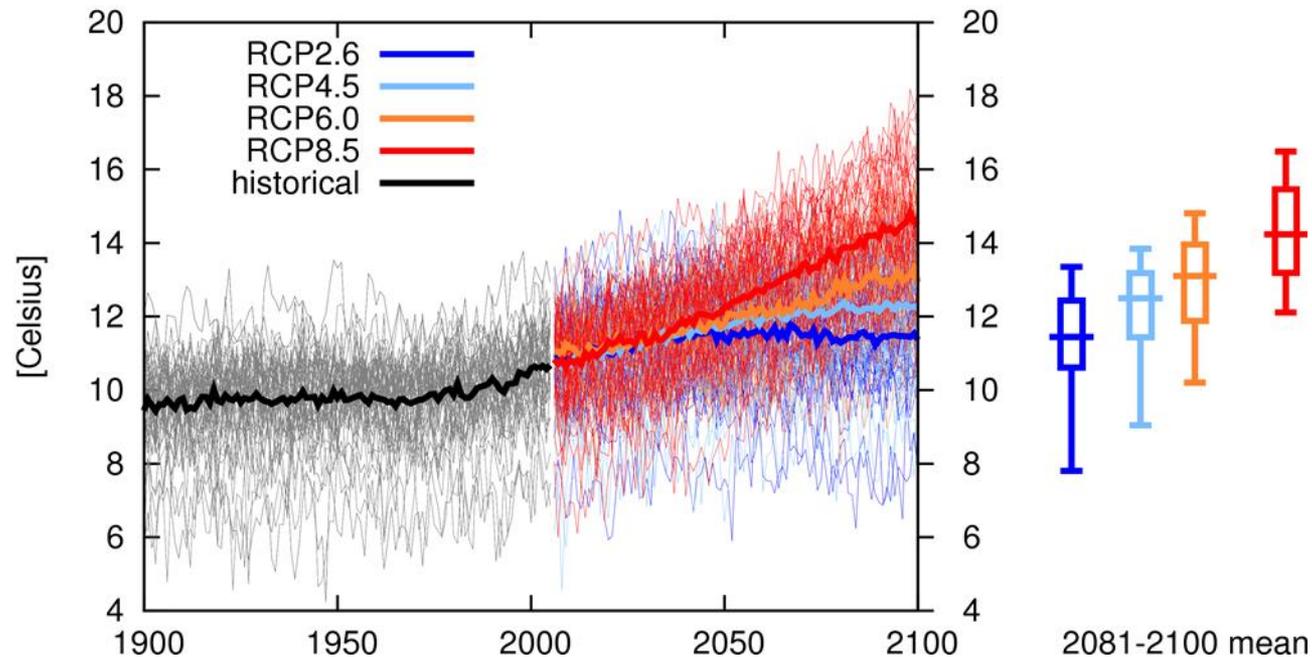


(Gobin, 2012)

# CLIMATE DATA

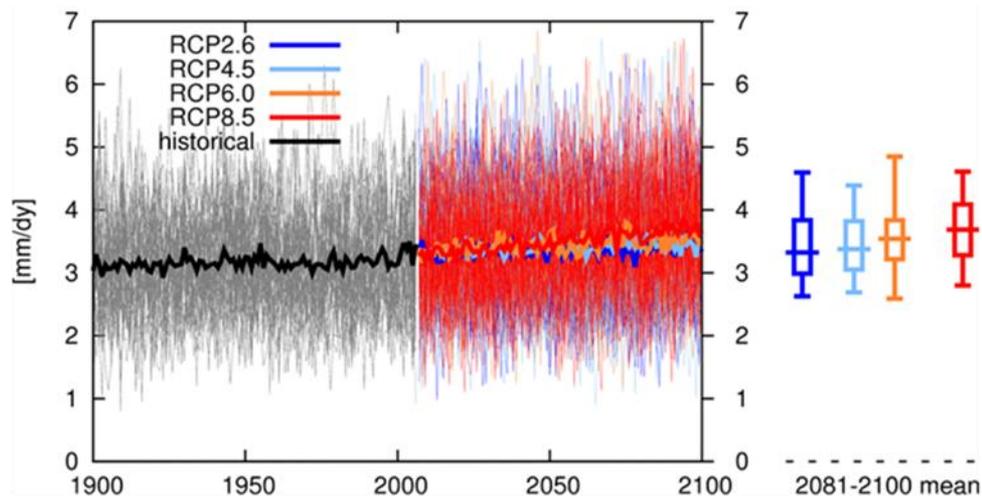


## PROJECTED TEMPERATURE

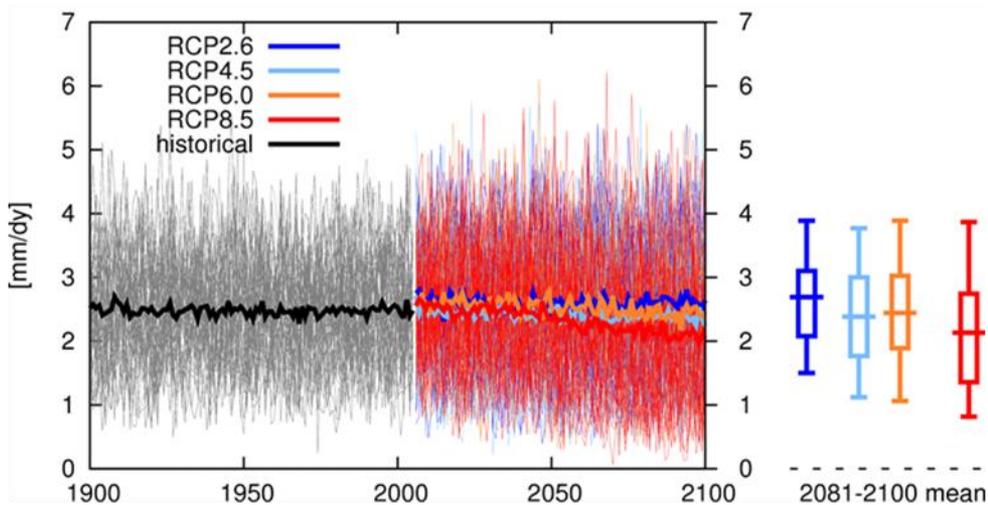


Higher annual mean temperatures with  
higher minimum- and maximum temperatures during all seasons  
extreme maximum temperatures during the summer  
increased heat stress!

# PROJECTED PRECIPITATION



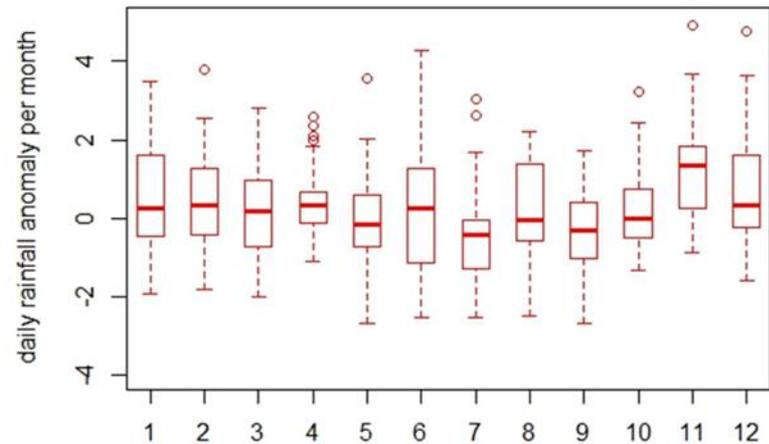
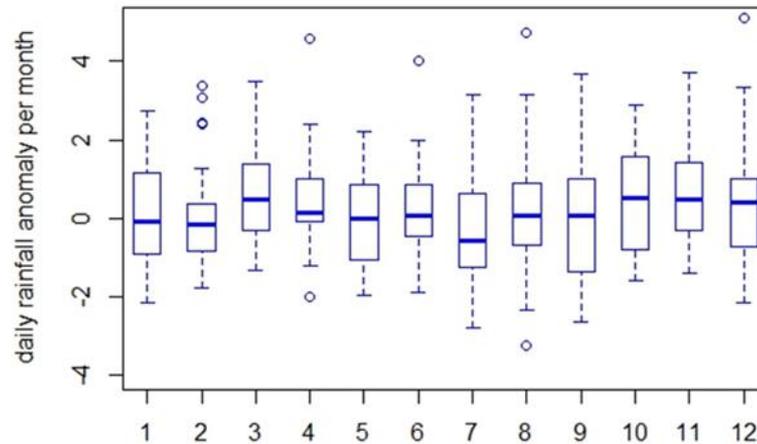
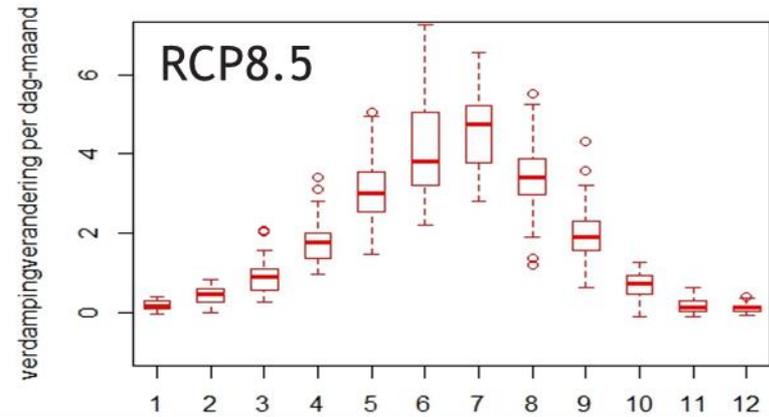
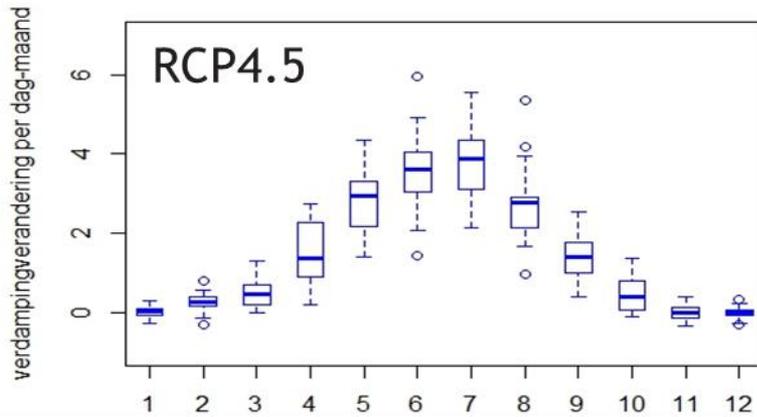
Winters will be wetter



Extreme rainfall events during summer storms.

Extreme rainfall does not replenish the soil water nor does it fulfil crop water requirements.

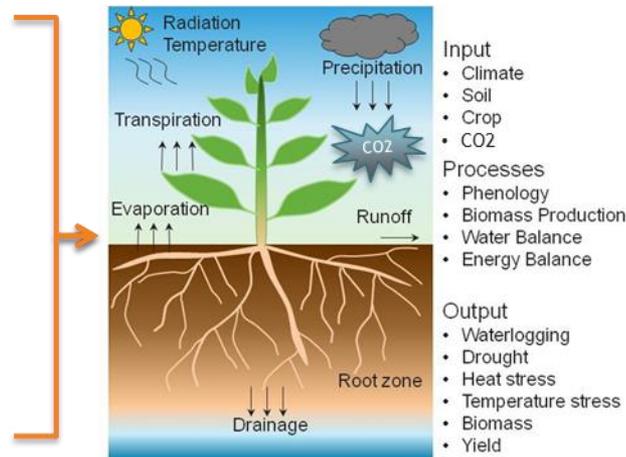
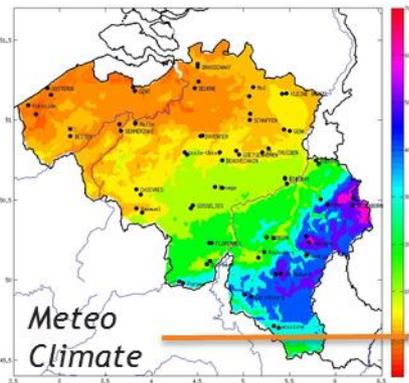
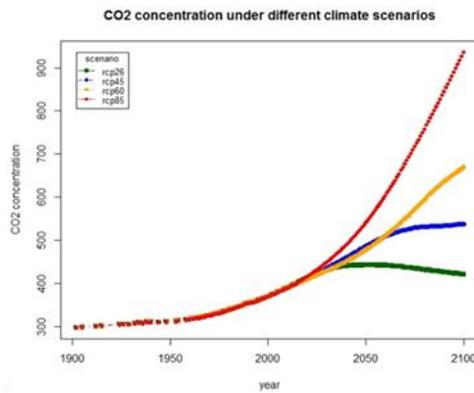
# PROJECTED RAINFALL AND EVAPOTRANSPIRATION



Water requirements increase with rising temperatures.

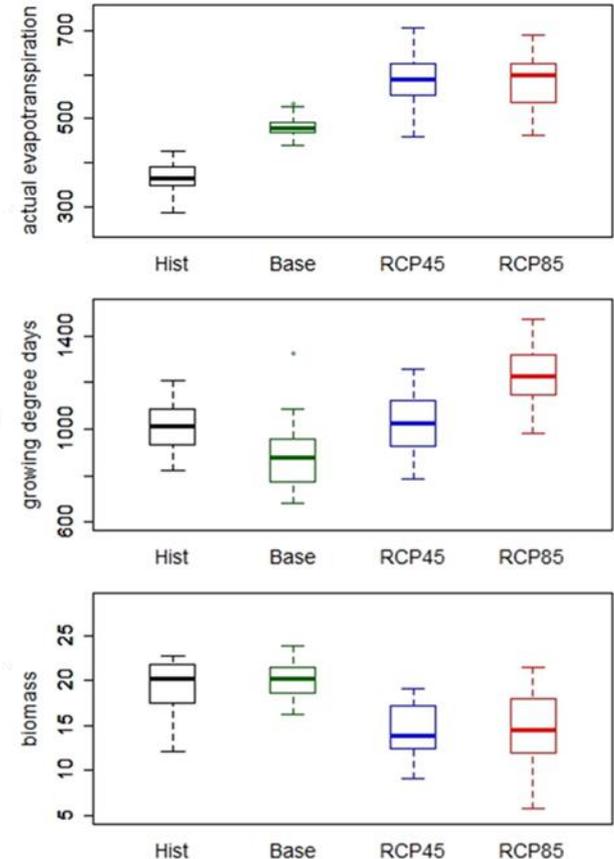
# CLIMATE IMPACT ON CROP GROWTH (CORDEX.BE)

- 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.



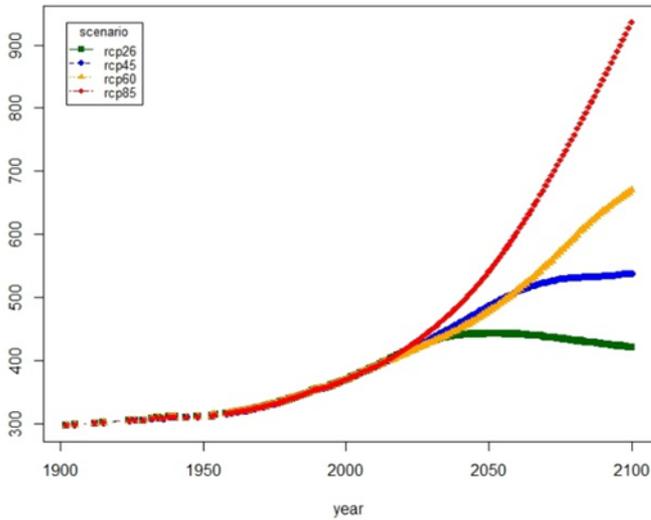
(Gobin, 2010, 2012, 2015)

Agroclimatological Functions

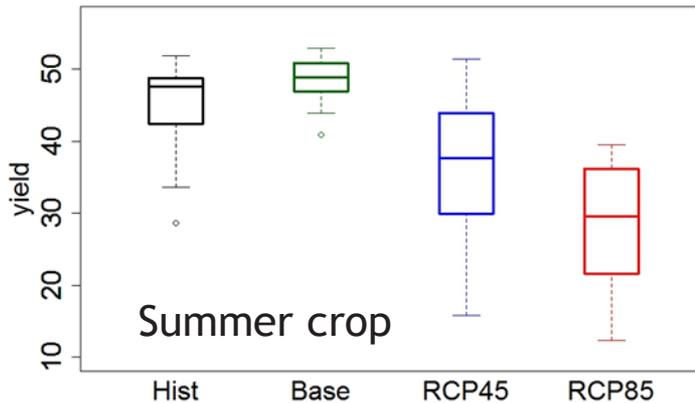
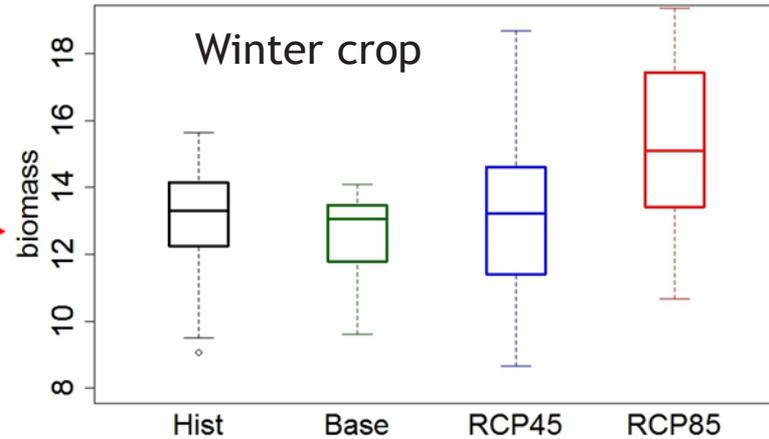
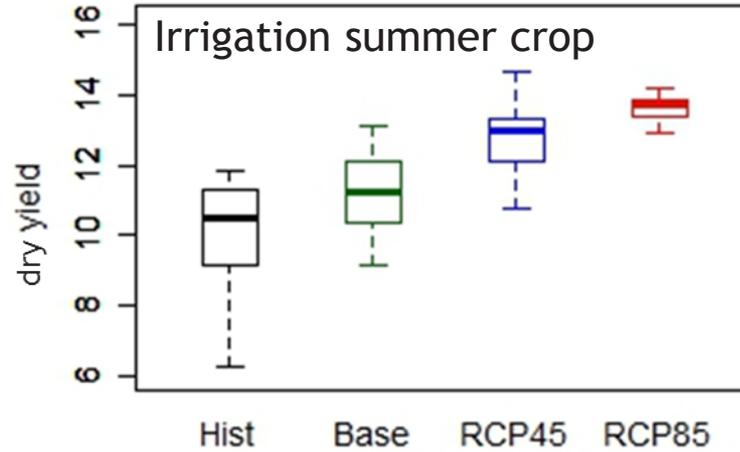


# EFFECTS OF INCREASED [CO<sub>2</sub>] CONCENTRATION AND CHANGING CLIMATE

CO<sub>2</sub> concentration under different climate scenarios



Carbon concentration & effects



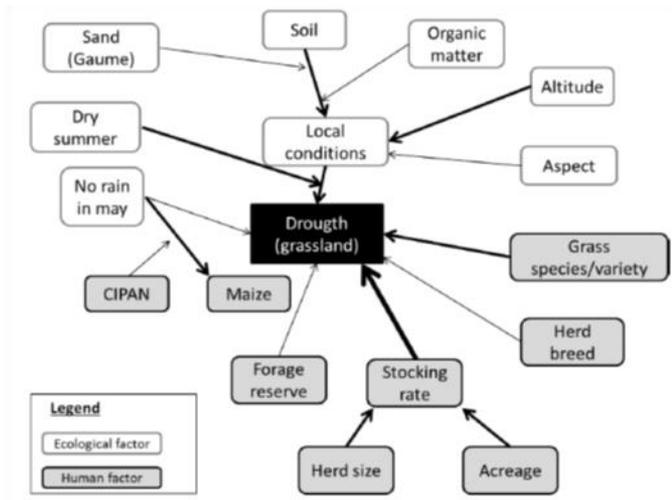


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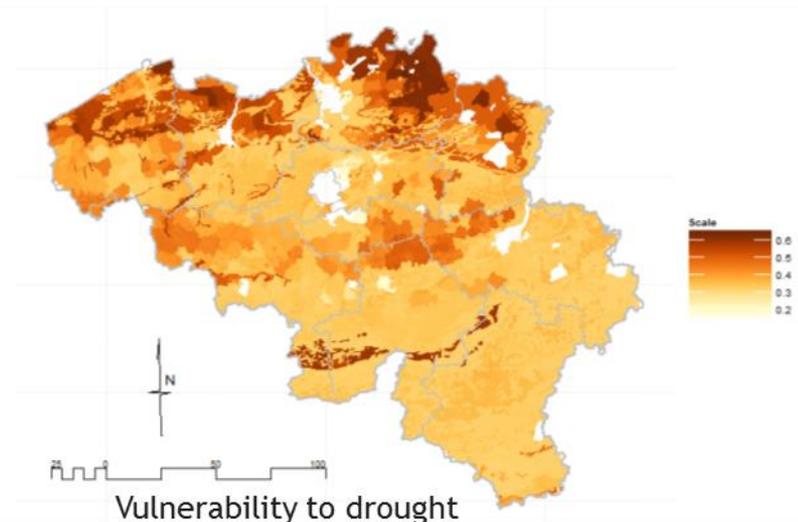
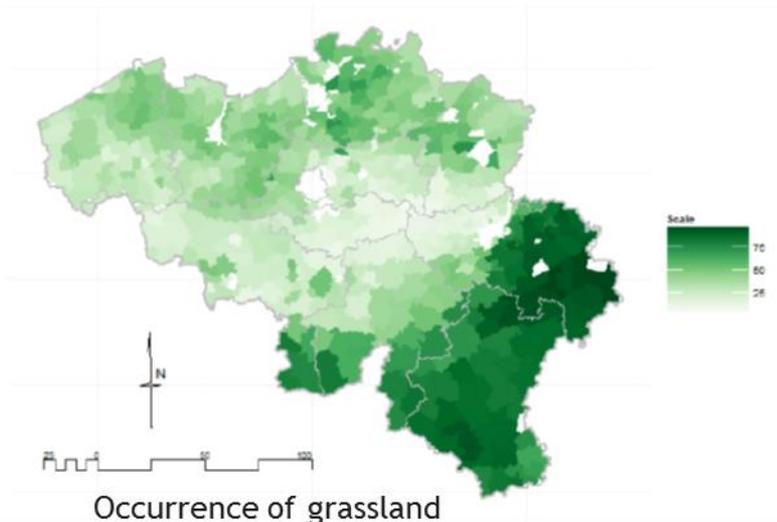
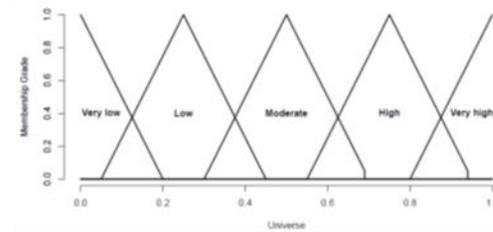
## VULNERABILITY AND RISK PERCEPTION

- Vulnerability
- Risk perception

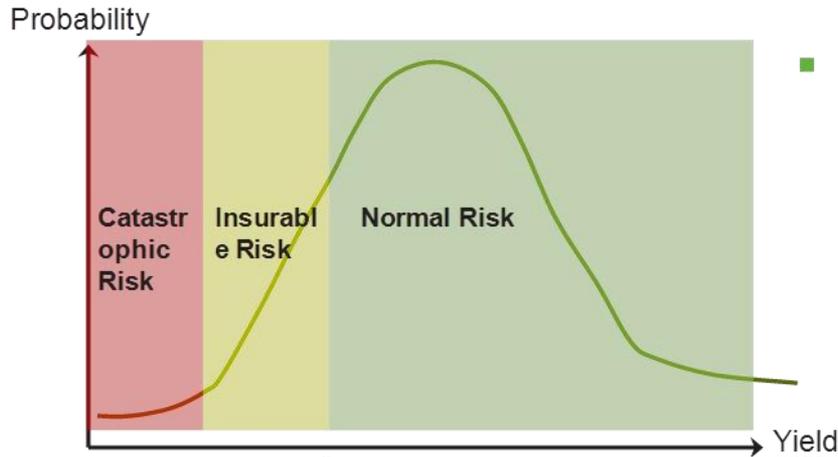
# VULNERABILITY



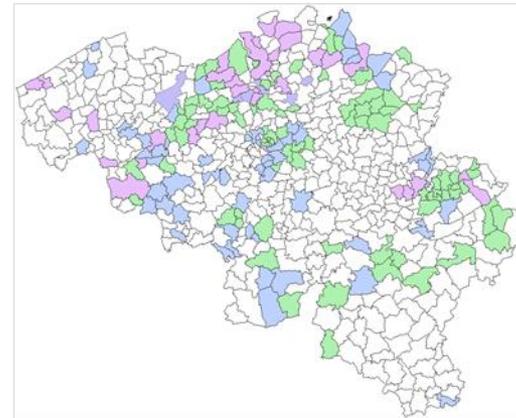
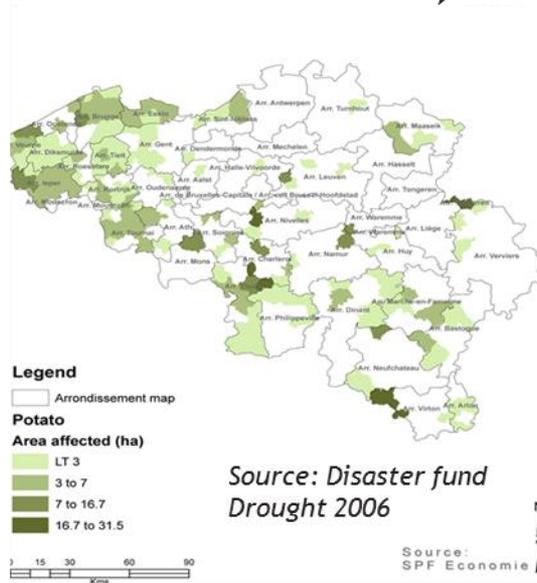
- (Cognitive) map of vulnerability factors
- Vulnerability map: Fuzzy Inference systems + GIS in R
  - membership functions
  - Rules to combine membership data



# RISK PERCEPTION: INSURANCES



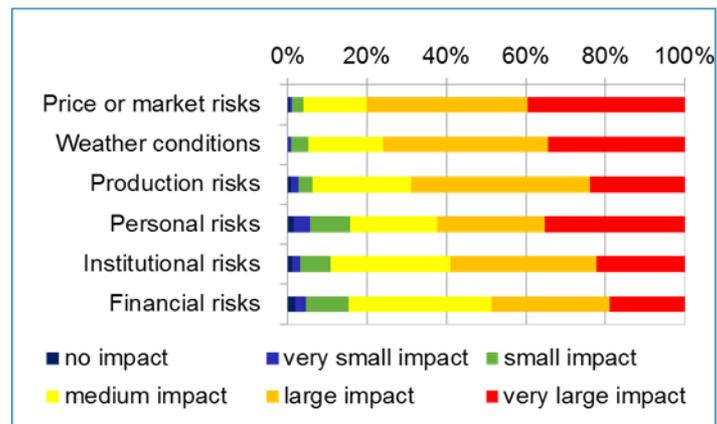
- Risk segmentation
  - Disaster risk
  - Insurable risk
  - Normal to zero risk



## RISK PERCEPTION: FARMERS



- Farmers perceive an **increased risk**:
  - Increase in extreme weather and adverse weather conditions in a changing climate
  - Decrease in direct income support
  - Directive on agricultural damage
    - Payment is reduced to 50% unless the farmer has a private insurance





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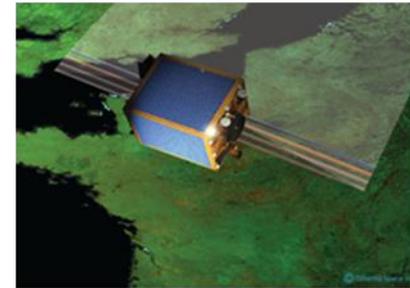
**CONCLUSIONS AND PERSPECTIVES**

## CONCLUSIONS

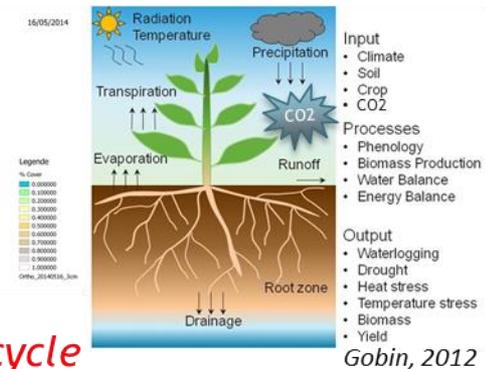
- From weather to climate is a shift in spatio-temporal scale.
  - Climate change is visible in long-term weather series (**extremes, adverse conditions**)
  - Adverse weather conditions have a large impact. Methods exist for the characterisation of adverse weather conditions.
- Climate impact on agriculture requires modelling methods to establish overlap between crop sensitive stages and adverse weather conditions.
  - Weather series belonging to a future climate show a **larger projected variability** in crop productivity
  - CO<sub>2</sub> **fertilisation** does not compensate for this variability.
- **Vulnerability**/resilience and **risk perception** of involved stakeholders are important to establish measures and options.
- **Observations** of yield, weather and impact allow for elucidating meaningful relationships and projections! **BIG DATA** encompass remote sensing, meteo data, yield observations and modelling results.

# PERSPECTIVES: CLIMATE SMART FARMING

- **Satellite imagery** *BIG DATA* encompass crop phenology, crop performance, remote sensing, meteo, yield observations and modelling methods to understand climate impacts on agriculture.
- **Meteo data** rainfall excess, high temperatures, drought extreme events & adverse weather conditions



- **Agri-environmental Modelling** crop development, resources use



*Interaction crop growth with water, carbon & nutrient cycle  
“Resilience to climate extremes, sustainable intensification”*



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*THANK YOU!*

