

# Monitoring of the crop water stress in Belgium. The case of the 2003 heat wave

S. Horion, B. Tychon and F. de Longueville



Dept. of Environmental Sciences and Management  
University of Liege, Belgium  
Contact: shorion@ulg.ac.be



## Plan

- Presentation of 3 drought monitoring tools
  - Relative Soil Moisture Index, RSMI
  - NDVI
  - NDWI
  
- Application : the 2003 heat wave

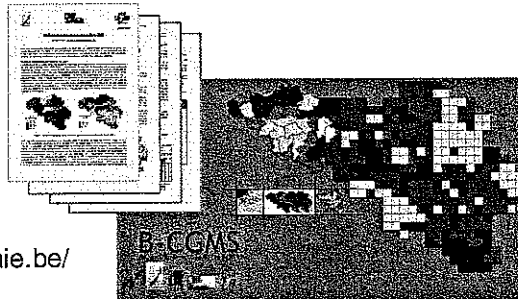
CGMS Expert Meeting , Arlon, 24<sup>th</sup> October 2006

# Presentation of 3 drought monitoring tools

CGMS Expert Meeting , Arlon, 24<sup>th</sup> October 2006

## (1) Relative Soil Moisture Index, RSMI

- One of the outputs simulated by the **Belgian Crop Growth Monitoring System, B-CGMS**
  - Since 1998, collaboration between:
    - CRA-W (Gembloux)
    - VITO (Mol)
    - ULg (Arlon)

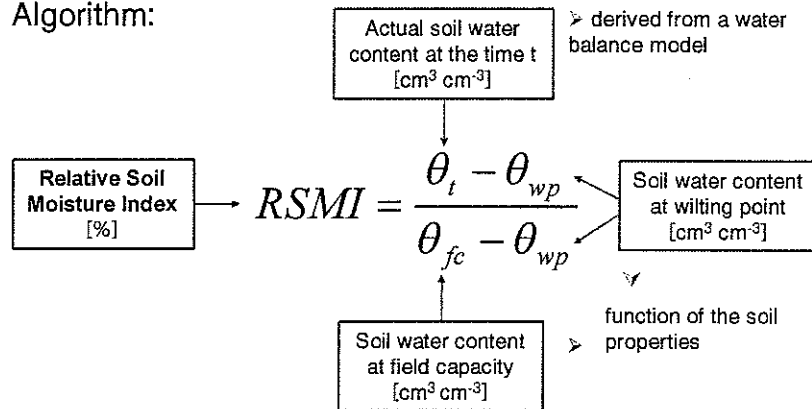


⇒ <http://b-cgms.cra.wallonie.be/>

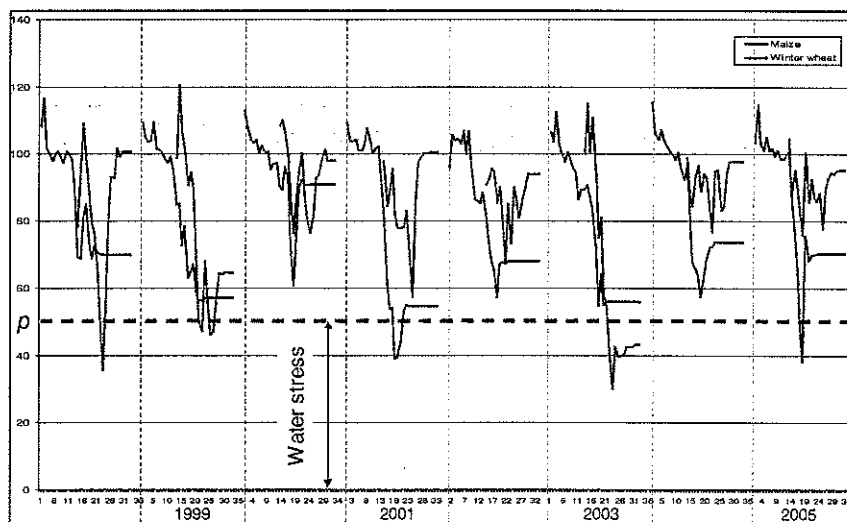
CGMS Expert Meeting , Arlon, 24<sup>th</sup> October 2006

# (1) Relative Soil Moisture Index, RSMI

■ Algorithm:



# (1) Relative Soil Moisture Index, RSMI



CGMS Expert Meeting, Arlon, 24<sup>th</sup> October 2006

## (2) Normalized Difference Vegetation Index, NDVI

- ☑ with green vegetation
- Algorithm: 
$$NDVI = \frac{NIR - RED}{NIR + RED}$$
- INPUT: S10 SPOT-VGT from 04/98 onwards
- Regional Unmixed Mean (H. Eerens, VITO)
  - Pixels covered at least by 50% of crops
  - Municipality scale

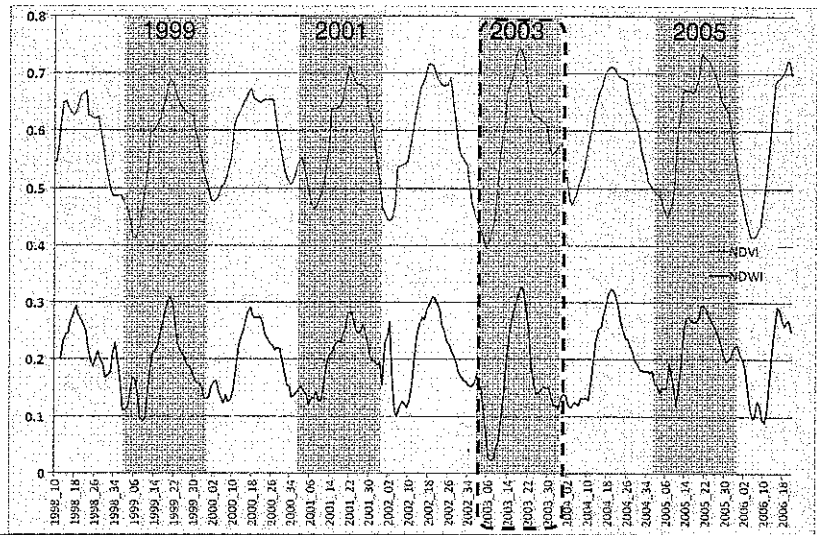
CGMS Expert Meeting , Arlon, 24<sup>th</sup> October 2006

## (3) Normalized Difference Water Index, NDWI

- ☑ with vegetation water content
- Algorithm: 
$$NDWI = \frac{NIR - SWIR}{NIR + SWIR}$$
- INPUT: S10 SPOT-VGT from 04/98 onwards
- Regional Unmixed Mean (H. Eerens, VITO)
  - Pixels covered at least by 50% of crops
  - Municipality scale

CGMS Expert Meeting , Arlon, 24<sup>th</sup> October 2006

## (2-3)NDVI (upper) & NDWI (lower)



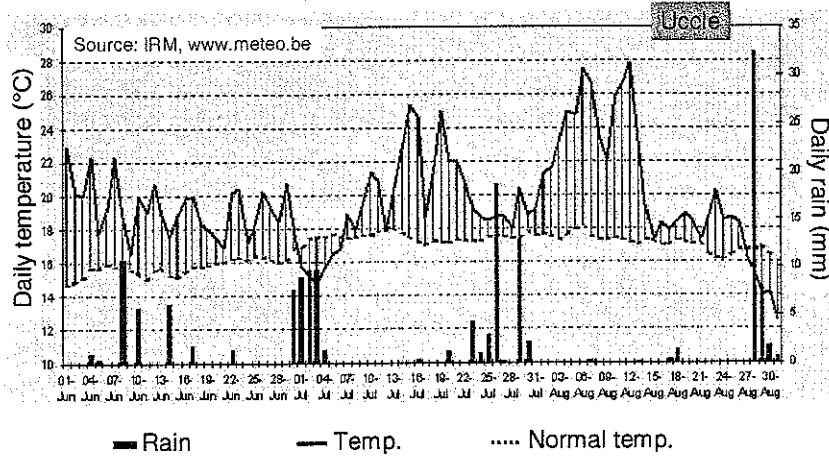
CGMS Expert Meeting , Arlon, 24<sup>th</sup> October 2006

## APPLICATION: The 2003 heat wave

CGMS Expert Meeting , Arlon, 24<sup>th</sup> October 2006

## The case of the 2003 heat wave

- The summer 2003 was abnormally hot, sunny and dry



CGMS Expert Meeting , Arlon, 24<sup>th</sup> October 2006

## [RSMI] Drought stress index

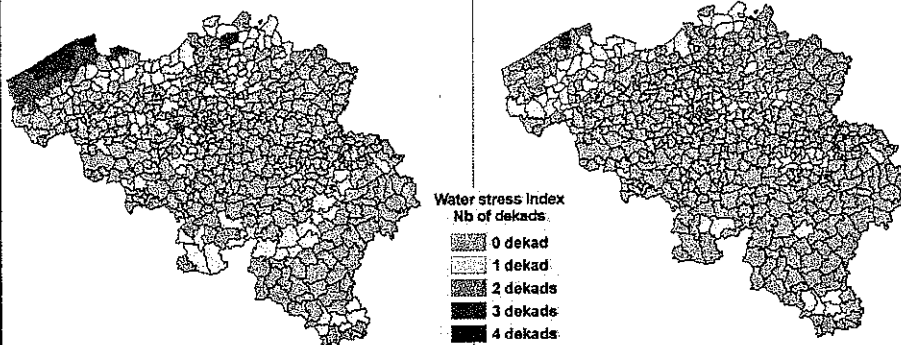
= nb of dekad with  $RSMI < p$

### Winter wheat

« Moisture-sensitive » period = 1st dekad of June to 1st dekad of July

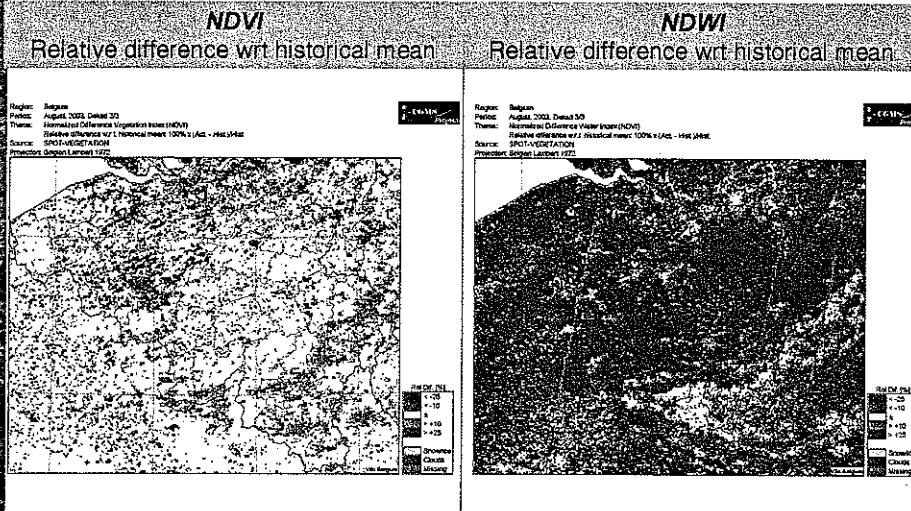
### Fodder maize

« Moisture-sensitive » period = 2nd dekad of June to 3rd dekad of July



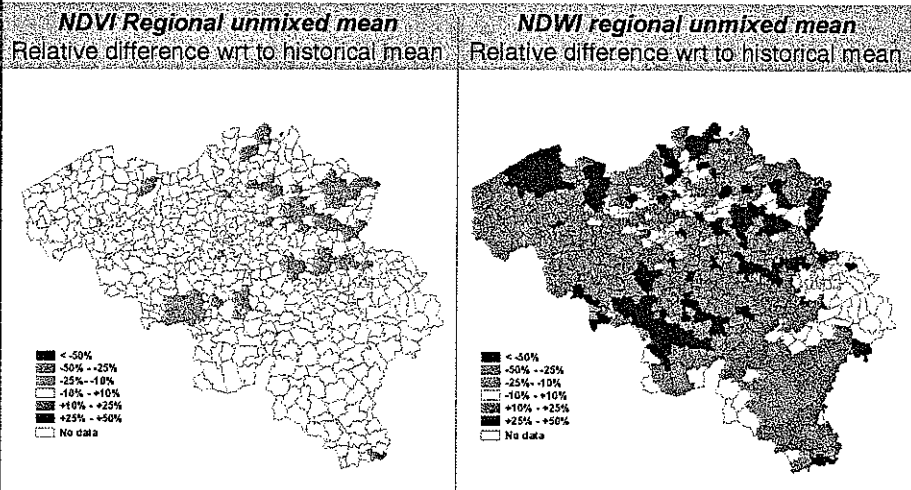
CGMS Expert Meeting , Arlon, 24<sup>th</sup> October 2006

# [NDV & NDWI] 3rd dekad of August 2003



CGMS Expert Meeting , Arlon, 24<sup>th</sup> October 2006

# [NDV & NDWI] 3rd dekad of August 2003



CGMS Expert Meeting , Arlon, 24<sup>th</sup> October 2006

## Comparison of indices anomalies in 2003

- Standardized anomaly :

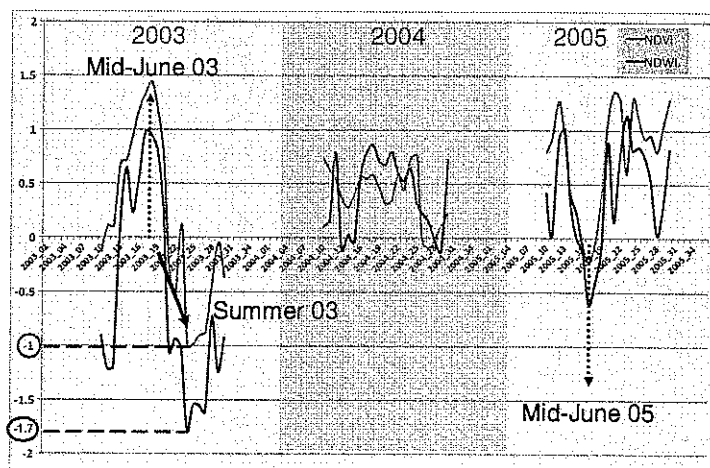
$$Index_{anomaly}(d, m) = \frac{Index_{2003}(d, m) - Index_{hist}(d, m)}{Index_{std}(d, m)}$$

Where:

- $Index_{2003}$  is the index value per dekad  $d$  in 2003 and per municipality  $m$
- $Index_{hist}$  is the historical mean of the index per dekad  $d$  and per municipality  $m$  for the period 98-05
- $Index_{std}$  is the standard deviation of the index per dekad  $d$  and per municipality  $m$  for the period 98-05

CGMS Expert Meeting , Arlon, 24<sup>th</sup> October 2006

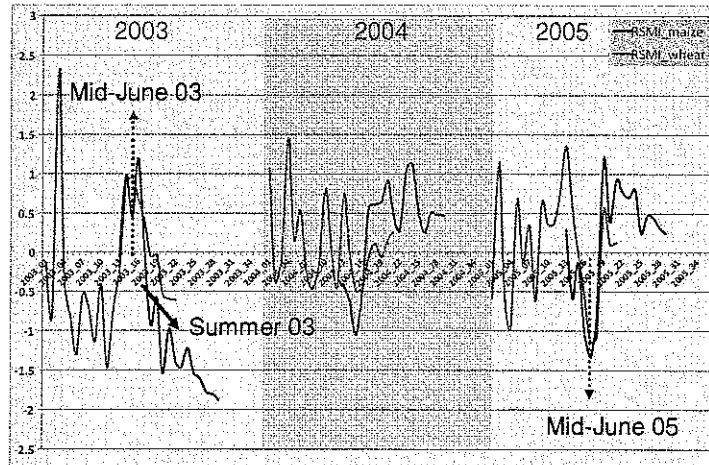
## Anomalies of NDVI and NDWI at national scale



CGMS Expert Meeting , Arlon, 24<sup>th</sup> October 2006



## Anomalies of RSMI for winter wheat and fodder maize at national scale



CGMS Expert Meeting , Arlon, 24<sup>th</sup> October 2006

## Strengths and weaknesses of indicators

Index	+	-
RSMI	<ul style="list-style-type: none"> <li>■ Estimation of water stress</li> <li>■ Crop specific index</li> </ul>	<ul style="list-style-type: none"> <li>■ Depending on the quality of model calibration</li> <li>■ Potential location of damaged crops</li> </ul>
NDVI	<ul style="list-style-type: none"> <li>■ Information on vegetation health/status</li> <li>■ Real location of "damaged" crops</li> </ul>	<ul style="list-style-type: none"> <li>■ Mixing of all crops</li> <li>■ Less sensitive than NDWI ?</li> </ul>
NDWI	<ul style="list-style-type: none"> <li>■ Information on leaf water content</li> <li>■ Real location of "damaged" crops</li> </ul>	<ul style="list-style-type: none"> <li>■ Mixing of all crops</li> </ul>

CGMS Expert Meeting , Arlon, 24<sup>th</sup> October 2006

## Conclusions

- All these indicators can be used for the detection and the monitoring of drought affected areas
- Complementarity of approaches/diagnostics
  - NDVI/NDWI = detection of regions where croplands suffer from a water stress
  - RSMI = Discrimination of drought by crop types according to their ability to manage their water needs
- Perspectives = combined approach for crop water stress monitoring at regional scale

CGMS Expert Meeting , Arlon, 24<sup>th</sup> October 2006

*Thanks for your attention...*

CGMS Expert Meeting , Arlon, 24<sup>th</sup> October 2006