AGRICULTURAL DROUGHT RISK MONITORING AND YIELD LOSS FORECAST WITH REMOTE SENSING DATA

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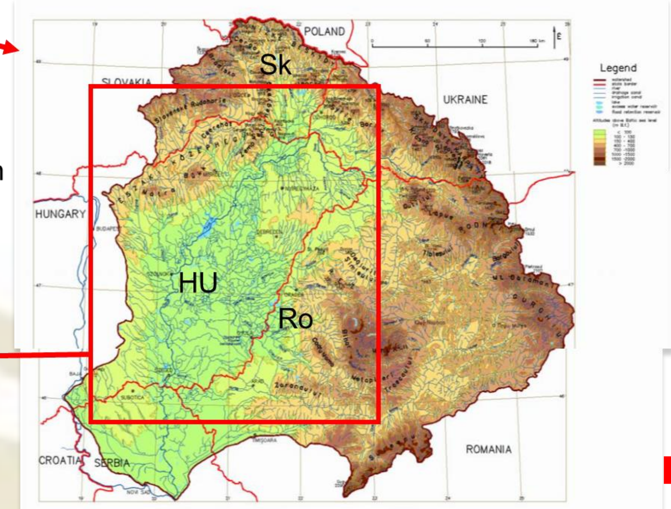
ABSTACT

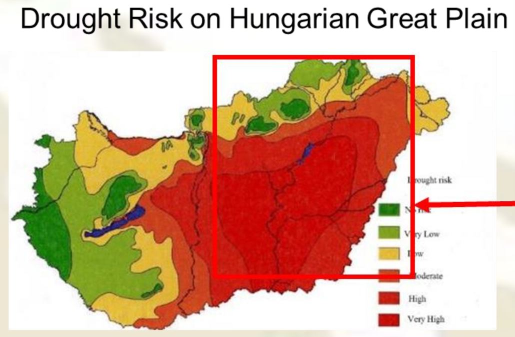
The World Meteorological Organization (WMO) and Global Water Partnership (GWP) have launched a joint Integrated Drought Management Programme (IDMP) to improve monitoring and prevention of droughts. In the frame of this project this study focuses on identification of agricultural drought characteristics and elaborates a monitoring method (with application of remote sensing data), which could result in appropriate early warning of droughts before irreversible yield loss and/or quality degradation occur. The spatial decision supporting system to be developed will help the farmers in reducing drought risk of the different regions by plant specific calibrated drought indexes. The main result is the Agricultural Drought Monitoring and Yield Loss Forecasting Method, with which the yield loss of maize and wheat can be predicted 4-6 weeks before harvest and drought effected sites can be delineated more accurately. The impact of drought on agriculture can be diagnosed far in advance of harvest, which is the most vital need for stakeholders concerning food security and trade. This information can facilitate drought intervention activities reduce impacts of drought on possible stock uncertainty and can facilitate decision makers in more accurate mitigation measures and preparedness plans for a specific region.

STUDY AREA-SITE SELECTION

The Tisza River Basin is the largest sub-basin in the Danube River Basin, covering 157,186 km² (19.5%) of the Danube Basin.



Drought Risk on Hungarian Great Plain



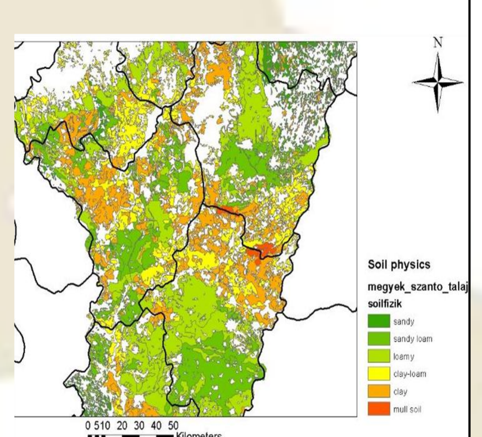
Database Building

The case study will utilize the available database prepared for the Tisza River Basin.

Crop data – Remote sensing time series
- Selection of training sites
- Spectral data noise filtering
- Rectification (UTM system)
- Cropping and mosaicing of reference area
- Indexing
- Statistical time series data of yields

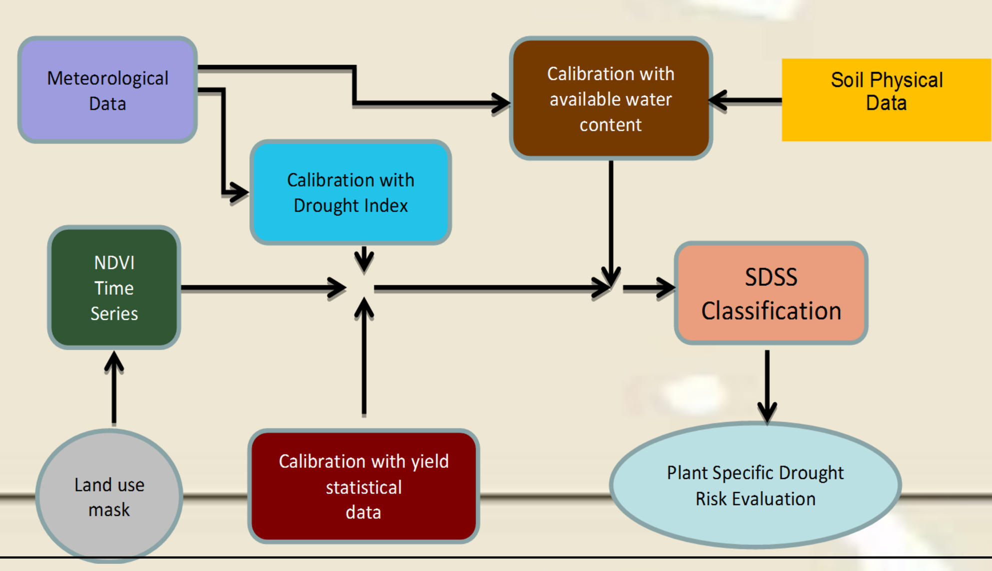
Soil data- digital soil map
- Common soil physical database of reference area
- Common topology and coordinate system of reference area
- Calculation of available water capacity
- Calculation of water balance on watersheds

Meteorological data – Drought Index SPI, fAPAR



Sources: USGS, ESA, Literature, Scientific reports, Publications, Media, Statistical reports, Owner data,

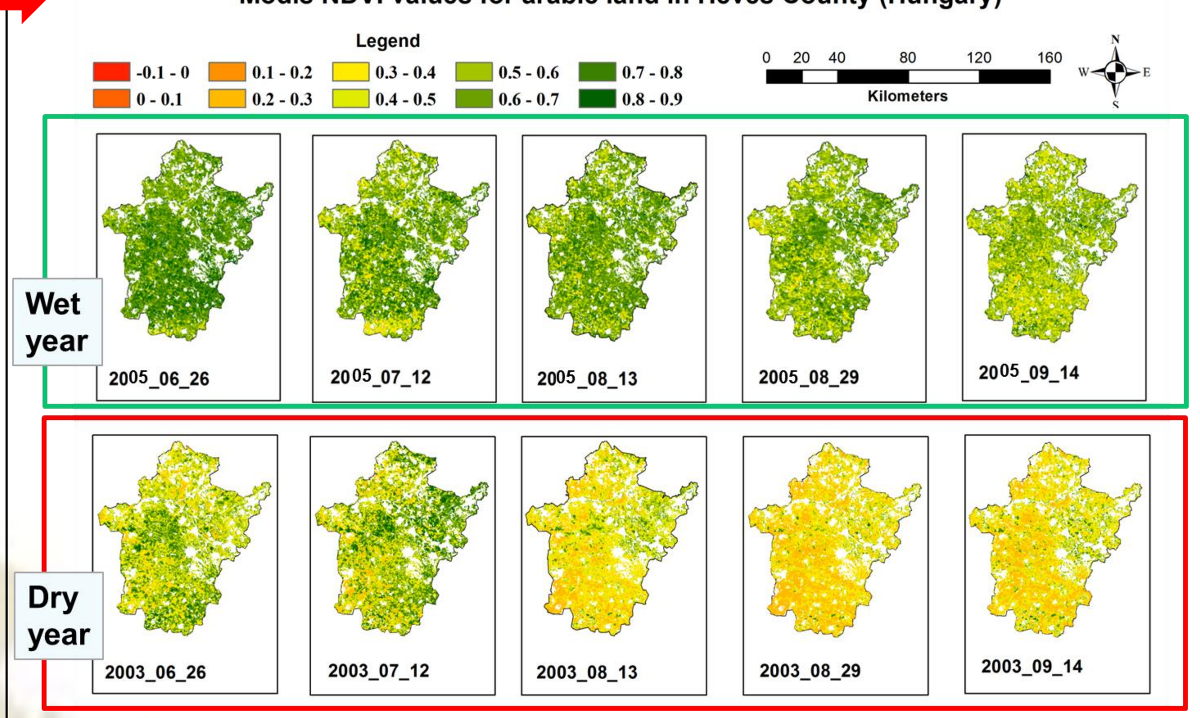
Process flow of RS based Agricultural Drought Monitoring and Yield Loss Forecasting Method

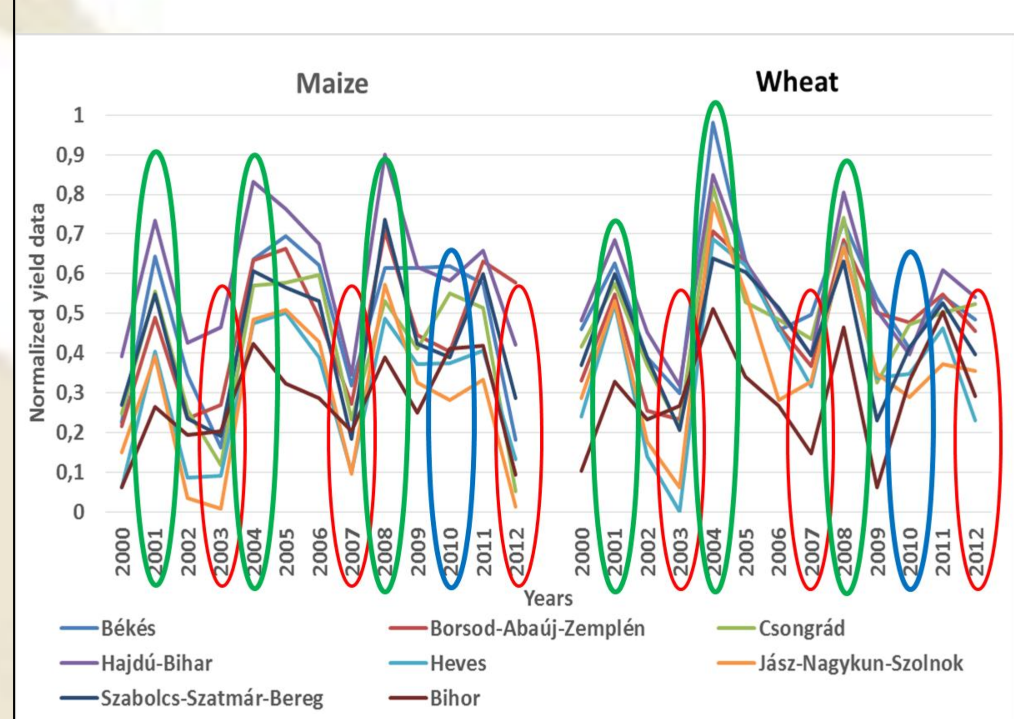


MAJOR STEPS WERE DONE IN ORDER TO PROMOTE THE MODIS NDVI CALIBRATION:

- ***Data acquisition and processing***
  - ***Reprojection** of MODIS data*
  - ***Mask building** for data extraction*
  - ***Extraction of MODIS NDVI** time series by arable land and crop masks*
  - ***Acquiring** data matrix from NDVI images*
  - ***Normalization** of extracted NDVI data matrix and yield data*
- ***Identification and calibration of drought risk level***
  - ***Regression analysis between NDVI and yield data***
  - ***Determining NDVI threshold levels for drought risk levels***

Modis NDVI values for arable land in Heves County (Hungary)





Green: optimal (wet) years

Red: drought affected years

Yield changes of maize and wheat (2000-2012)

(Source: KSH and INSSE)

IDENTIFICATION AND CALIBRATION OF DROUGHT RISK LEVELS

- **Analysing of NDVI on arable lands, drought can appear at the middle of June in the Southern part of Hungary, but in the case of East Slovak Lowland the drought appears in the middle of July.**
- **The calibration of NDVI dataset were carried out by calculating correlation and regression between yield and NDVI datasets.**

MAIZE
significant correlation were found between normalized NDVI values and maize yield from the middle of June, to the end of August, including the most drought sensitive blooming period (July)

WHEAT
only June is found to be reliable for yield prediction and forecasting

In July NDVI values were about 0.5-0.6 in 2003, meanwhile 0.6-0.8 in 2010, and in August the average difference NDVI was 0.3- 0.4.

Reference spectral curves were generated in order to determine the Watch, Early warning, Warning, Alert and Catastrophe levels of NDVI

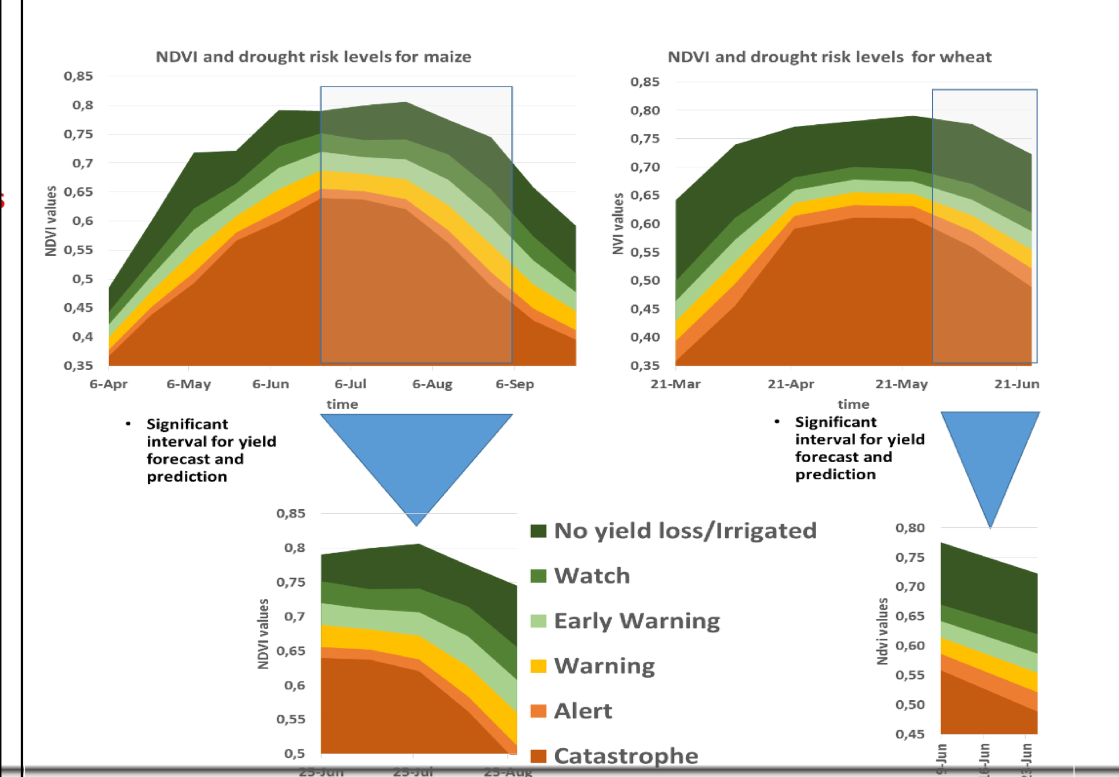
Watch: When plant water stress is observed in sensitive phenological phases

Early Warning: When relevant plant water stress is observed. The available soil moisture is close to critical, and it is suggested for farmers to start preparation of intervention. Predicted potential yield loss is up to 10%.

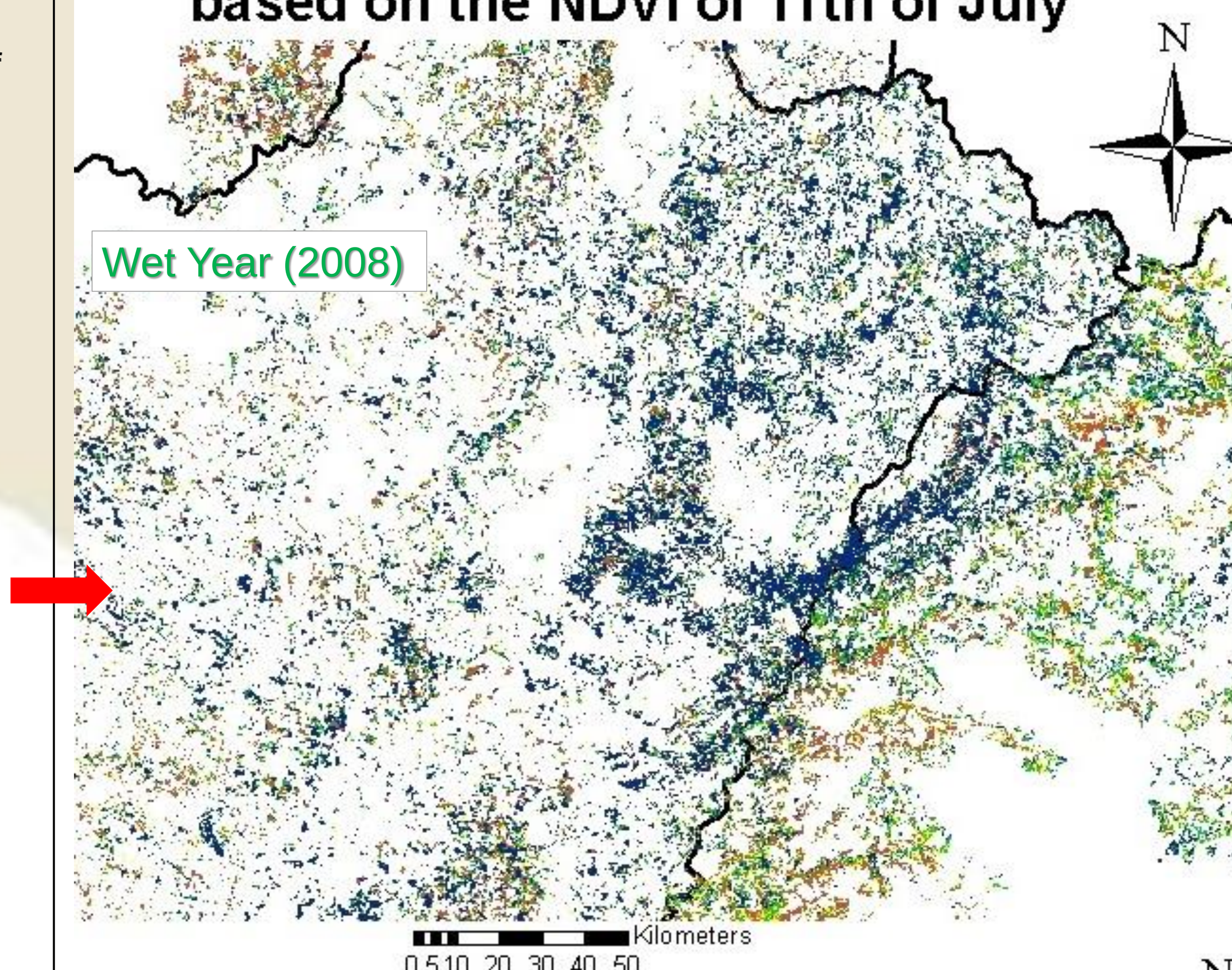
Warning: When plant stress translates into significant biomass damage, and there is time to start the intervention actions. Potential yield loss is up to 20%.

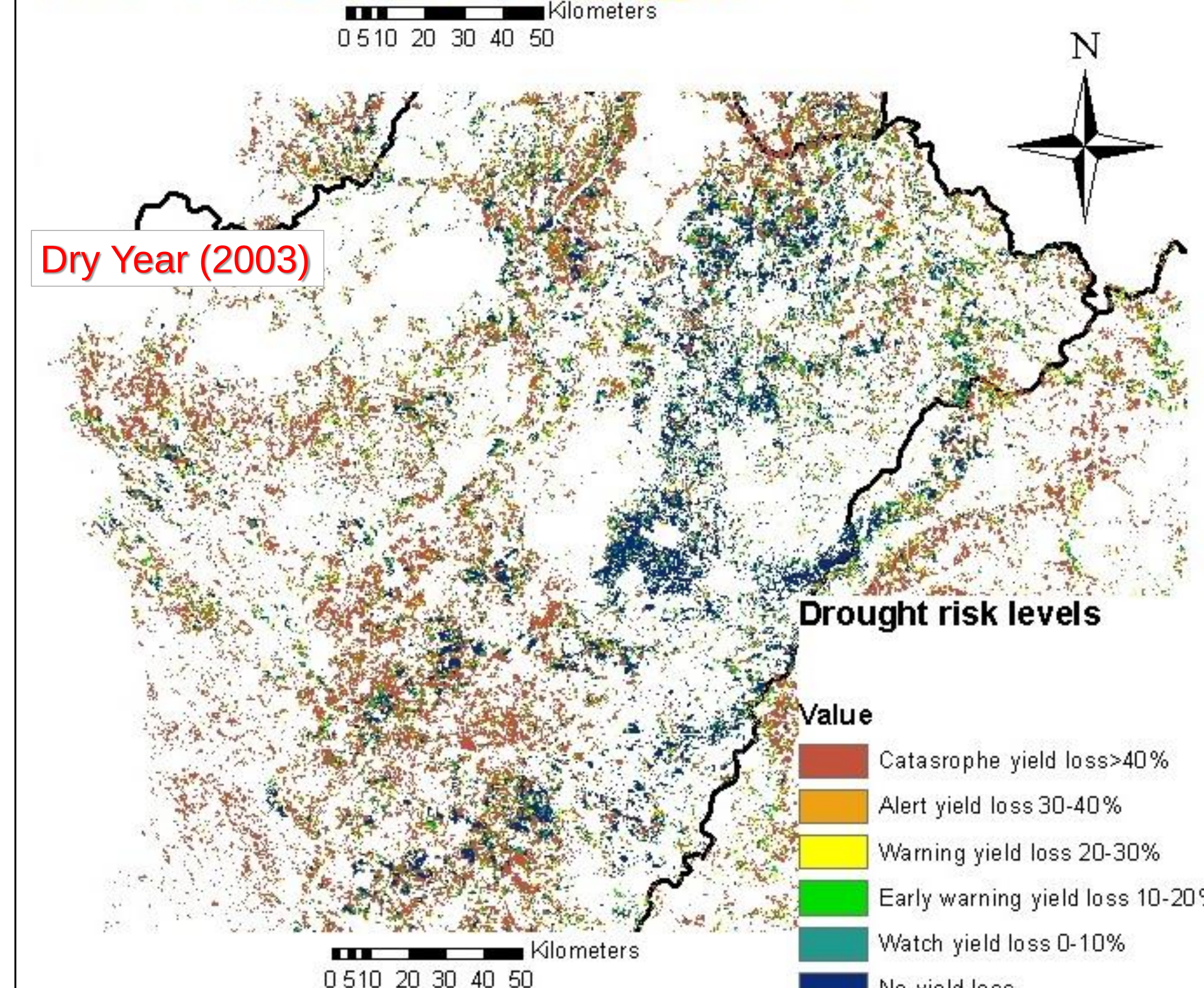
Alert: When farmers expect irreversible vegetation damage with real negative profit, and they have to consider to give up additional cultivation actions in crop production in that actual vegetation period. Potential yield loss is up to 30%.

Catastrophe: When serious damages and profit loss mitigation is necessary. Potential yield loss is up to 40%.



Drougth maps for maize yield forecast, based on the NDVI of 11th of July





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Global Water Partnership
Central and Eastern Europe