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Conventional and remote sensing techniques for determination of conditions for vegetation development - Climatic Water Balance vs. satellite derived vegetation status

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Within the framework of COST Action 734 (Impacts of Climate Change and Variability on European Agriculture: CLIVAGRI) the project "Correlation between Climatic Water Balance and Estimate of Plant Development Stage Based on Satellite Technologies" is realized by Polish members, as a case study. Because of the existing policy of the Polish Ministry of Science and Higher Education, to support scientific projects of COST Action members, this project has been awarded ministerial funds (619/N-COST/09/2010/0).

The main purpose of this project is to evaluate just how accurately Climatic Water Balance reflects the actual plant development stage. The study is based on the 1998-2009 dataset. Climatic Water Balance (CWB) is one of the indices characterizing atmosphere humidity. In agrometeorology, CWB is an indicator of weather conditions during growth season and as an indicator of drought. CWB is a value derived from water input, i.e. precipitation and water loss caused by evapotranspiration which is determined by the actual weather conditions in short periods of time or long term climate conditions in a given area. CWB, therefore, is a very general indicator of actual conditions for vegetation development. Standardized values of CWB (expressed in dimensionless units) provide objective assessment of climatic water shortage and make comparisons of different regions and different time periods possible.

Satellite technologies, on the other hand, allow for the near real time estimation of vegetation status and detection of impact of water deficit stress. Determination of the plant development state is based on AVHRR/NOAA data, from which NDVI indices are determined for each day of the analyzed period. Clouds occurrence is a main limiting factor obstructing scene. To minimize cloud influence, data are grouped into decades (10 days periods) and MVC (Maximum Value Composition) technique is applied. The most important factor related to actual vegetation state is anomaly of actual values regarding to multi-annual mean for each individual decade. For determination of such an anomalies, VCI (Vegetation Conditions Index) was determined for each decade of analyzed period.

The study is carried out on data collected from two environmentally distinct areas in Poland: the Prosna River catchment and the Dunajec River catchment. The Prosna catchment is a lowland area with predominantly agricultural land use. The Dunajec catchment, is located in a highland and mountainous region (mostly forests with some presence of pastures and arable land). The catchments are characterized by different climate conditions.

At the present phase of the project we have completed calculations of evapotranspiration. Using the Penman-Monteith equation (FAO56) we calculated the daily values of reference evapotranspiration. Satellite product "Evapotranspiration" developed by the EUMETSAT Land-SAF operationally disseminated via EUMETCast system, allowed us to calculate the actual evapotranspiration values. The received reference and actual evapotranspiration values show correspondence to plant vegetation status, as well as to the run of meteorological elements (air temperature, precipitation, sunshine duration, wind speed, air humidity) and soil moisture profile within the calendar year.

The results will be used, among others, for comparison of application of satellite products and Climatic Water Balance results calculated using the conventional methods, and to gain further experience in application of satellite remote sensing techniques for real-time objective assessment of plant development stage. The results will also provide a valuable tool for drought monitoring.