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TITLE: Drought Dynamics and Food Security in Ukraine

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ABSTRACT BODY: In recent years food security became a problem of great importance at global, national and regional scale. Ukraine is one of the most developed agriculture countries and one of the biggest crop producers in the world. According to the 2011 statistics provided by the USDA FAS, Ukraine was the 8th largest exporter and 10th largest producer of wheat in the world. Therefore, identifying current and projecting future trends in climate and agriculture parameters is a key element in providing support to policy makers in food security.

This paper combines remote sensing, meteorological, and modeling data to investigate dynamics of extreme events, such as droughts, and its impact on agriculture production in Ukraine. Two main problems have been considered in the study: investigation of drought dynamics in Ukraine and its impact on crop production; and investigation of crop growth models for yield and production forecasting and its comparison with empirical models that use as a predictor satellite-derived parameters and meteorological observations.

Large-scale weather disasters in Ukraine such as drought were assessed using vegetation health index (VHI) derived from satellite data. The method is based on estimation of green canopy stress/no stress from indices, characterizing moisture and thermal conditions of vegetation canopy. These conditions are derived from the reflectance/emission in the red, near infrared and infrared parts of solar spectrum measured by the AVHRR flown on the NOAA afternoon polar-orbiting satellites since 1981. Droughts were categorized into exceptional, extreme, severe and moderate. Drought area (DA, in % from total Ukrainian area) was calculated for each category. It was found that maximum DA over past 20 years was 10% for exceptional droughts, 20% for extreme droughts, 50% for severe droughts, and 80% for moderate droughts. Also, it was shown that in general the drought intensity and area did not increase considerably over past 10 years. Analysis of interrelation between DA of different categories at oblast level with agriculture production will be discussed as well.

A comparative study was carried out to assess three approaches to forecast winter wheat yield in Ukraine at oblast level: (i) empirical regression-based model that uses as a predictor 16-day NDVI composites derived from MODIS at the 250 m resolution, (ii) empirical regression-based model that uses as predictors meteorological parameters, and (iii) adapted for Ukraine Crop Growth Monitoring System (CGMS) that is based on WOFOST crop growth simulation model and meteorological parameters. These three approaches were calibrated for 2000-2009 and 2000-2010 data, and compared while performing forecasts on independent data for 2010 and 2011. For 2010, the best results in terms of root mean square error (RMSE, by oblast, deviation of predicted values from official statistics) were achieved using CGMS models: 0.3 t/ha. For NDVI and meteorological models RMSE values were 0.79 and 0.77 t/ha, respectively. When forecasting winter wheat yield for 2011, the following RMSE values were obtained: 0.58 t/ha for CGMS, 0.56 t/ha for meteorological model, and 0.62 t/ha for NDVI. In this case performance of all three approaches was relatively the same.

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