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Crop water productivity under increasing irrigation capacities in Romania. A spatially-explicit assessment of winter wheat and maize cropping systems in the southern lowlands of the country

Diana Dogaru

Dept. Environment & GIS, Institute of Geography of the Romanian Academy, Bucharest, ROMANIA (dianadogaru77@yahoo.com)

Improved water use efficiency in agriculture is a key issue in terms of sustainable management and consumption of water resources in the context of peoples' increasing food demands and preferences, economic growth and agricultural adaptation options to climate variability and change. Crop Water Productivity (CWP), defined as the ratio of yield (or value of harvested crop) to actual evapotranspiration or as the ratio of yield (or value of harvested crop) to volume of supplied irrigation water (Molden et al., 1998), is a useful indicator in the evaluation of water use efficiency and ultimately of cropland management, particularly in the case of regions affected by or prone to drought and where irrigation application is essential for achieving expected productions.

The present study investigates the productivity of water in winter wheat and maize cropping systems in the Romanian Plain (49 594 sq. km), an important agricultural region in the southern part of the country which is increasingly affected by drought and dry spells (Sandu and Mateescu, 2014). The scope of the analysis is to assess the gains and losses in CWP for the two crops, by considering increased irrigated cropland and improved fertilization, these being the most common measures potentially and already implemented by the farmers.

In order to capture the effects of such measures on agricultural water use, the GIS-based EPIC crop-growth model (GEPIC) (Williams et al., 1989; Liu, 2009) was employed to simulate yields, seasonal evapotranspiration from crops and volume of irrigation water in the Romanian Plain for the 2002 - 2013 interval with focus on 2007 and 2010, two representative years for dry and wet periods, respectively. The GEPIC model operates on a daily time step, while the geospatial input datasets for this analysis (e.g. climate data, soil classes and soil parameters, land use) were harmonized at 1km resolution grid cell. The sources of the spatial data are mainly the national profile agencies/institutes, providing the data at fine resolutions. The increased irrigated area was accounted according to the reported increased percentages of the irrigated area out of the total area equipped for irrigation, as an expected outcome of public irrigation systems rehabilitation schemes (MADR, 2011), while the optimum Nitrogen fertilizer rates for wheat and maize were established according to several field experiments made on irrigated and rain-fed wheat and maize plots in south Romania (Hera and Borlan, 1980). The effects of such farming measures on yields were compared to a baseline condition given by actual irrigated area and fertilization rates.

The preliminary results show that potential gains in CWP could be obtained through improved fertilizer management and water allocation in winter wheat cropping systems, particularly in the dry periods, while in maize cropping systems CWP is more sensitive to water than to optimum fertilization rates. Irrigation water supply increases the stability of yields in both cropping systems, although regional differences can be observed across the study area, thus augmenting the relevance and the need for investigations on sustainable use of irrigation water in Romania. As such, this study could represent an information base for further analyses on yield potential under current and future climatic conditions, on impacts of land use patterns and farming practices on crop production in Romania, etc.

Keywords: agricultural water use, crop water productivity, irrigation water, GEPIC, Romania

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