65. Modelling sugar beet water use in Spain

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Crop production has a great contribution to water use and abstraction. Sugar beet is an important crop in irrigated land in Spain and covers 70,000 ha. Crop and resources management are key factors for a sustainable agriculture. The aim of this work is to model the sugar beet crop growth and water consumption in order to quantify crop water use and virtual water content in different growing conditions.

In site daily meteorological data from SIAR (Magrama, 2011) automatic weather stations network were downloaded for the time period 2001-2010 for the main sugar beet growing provinces in Spain. Average farmers' data for sowing date were considered. Seedling emergence was computed using a thermal time model from literature data (120 °C.day with a base temperature of 0 °C). Biomass production of the crop was then estimated computing leaf and canopy development as a function of a thermal time model and the subsequent photosynthetically active radiation interception. Radiation use efficiency was estimated as a function of meteorological daily values of maximum temperature and vapour pressure deficit, despite neither water nor nutrient limitation (Arroyo-Sanz, 2002). Sugar yield was estimated considering an average harvest index (Arroyo-Sanz, 2002). Crop growth was then modelled with daily values of mean temperature and mean solar radiation until farmers' average harvest date for the 10 year period (2001-2010). A soil water balance was modelled and then green and blue water were estimated. Soil water balance included crop ET, drainage, rainfall, irrigation and soil moisture content. Crop ET was the product of reference ETo, from daily meteorological data (Penman-Monteith method), and evaporation or crop coefficients. Evaporation coefficients were estimated before and after harvest as a function of rainfall frequency and ETo. Crop coefficients were estimated considering canopy development. Rainfall daily values were included. In site soil texture defined readily available soil moisture as the difference of soil water content at 10 and 45 kPa (Arroyo-Sanz, 2002). A daily soil water balance was computed considering the drainage water the excess of rainfall over field capacity, effective rainfall that stored in the soil and used by the crop and irrigation water as the amount of water applied to refill the soil moisture until field capacity. Blue water was estimated as the irrigation needs divided by the system application efficiency. Green water was estimated as the sum of soil evaporation before sowing and after harvest, crop evapotranspiration from emergence until the first irrigation and effective rain during the irrigation period. Grey water was considered as the polluted water, and was calculated with the site specific nitrogen fertilisation of the crop, estimated nitrate leaching and water quality standards. Virtual water content was computed adding daily blue, green and grey water for the 10 year period (2001-2010). The modelled biomass accumulation in Valladolid province in the period 2001-2010 is shown in Figure 1. The temporal trend of crop growth during the growing season shapes a sigmoid curve. Biomass at harvest is the last value of the curve. The most producing years are 2005 and 2007, so the value of the water footprint is relatively lower. The estimated value of sugar virtual water content is shown in Figure 2. The largest values are reached in year 2002 and 2003, the two wettest years. So, green water footprint (mm) is positively and highly correlated with annual rainfall. This relatively high rainfall does not affect the water consumption in irrigation nor the blue water footprint.

References

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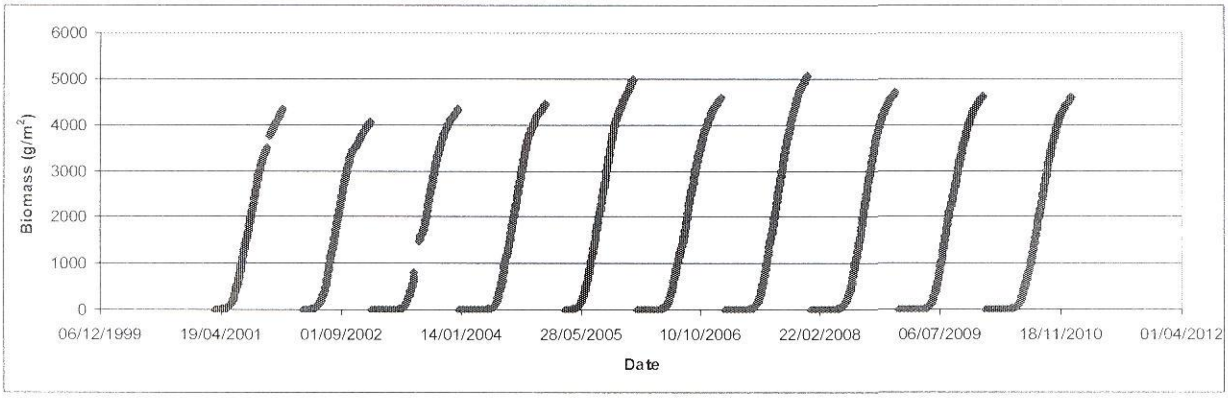

Figure 1. Simulated biomass accumulation of sugar beet crop in Valladolid province (Spain) from 2001-2010.

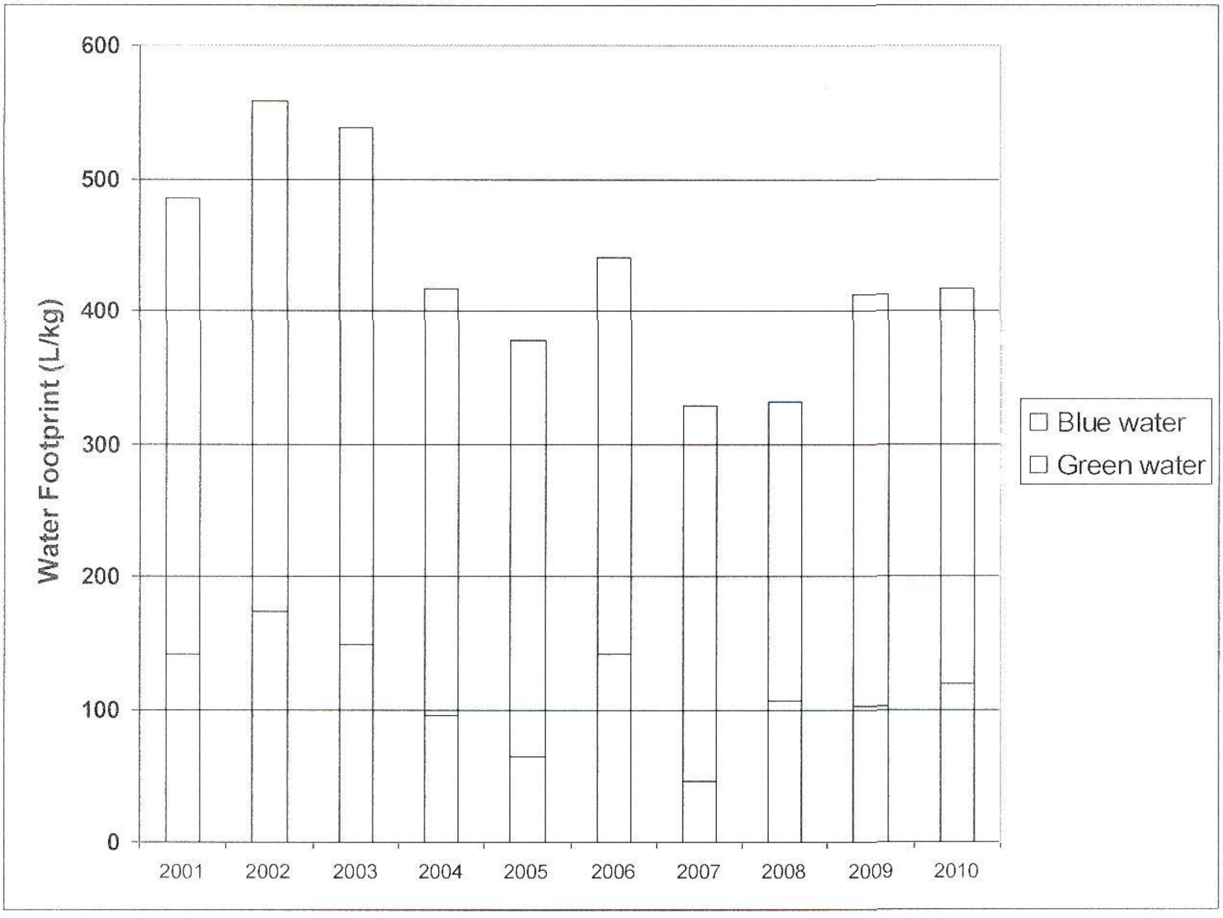

Figure 2. Estimated yearly virtual water content of sugar in Valladolid province (Spain) during the period 2001-2010.