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The influence of farmers climate change adaptation strategies on crop irrigation requirements

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Introduction:

The climate change scenarios for Portugal foresee an increase in air temperature and a decrease in precipitation, which will lead to an increase in crop irrigation requirements.

In the Mediterranean environments water is the most limiting factor in agriculture, and it is expected that this situation will worsen due to climate change, highlighting the increasing importance of developing adaptation measures in irrigated agriculture.

The aim of this study is to evaluate the effects of different farmers' adaptation measures on the crop irrigation requirements.

Methodology:

Three adaptation strategies were defined:

i) maintenance of the **current crop varieties**, which corresponds to doing nothing to adapt, assuming yield loss due to the shortening of the crop cycle;

ii) the use of **new crop varieties** with longer crop cycles, on irrigated fields, to maintain the current crop yields;

iii) **production intensification**, taking advantage of the crop cycle shortening that may allow the production of two crops in the same year, thus increasing the production volume.

This study was conducted in the Alentejo region, Portugal, considering for "current crop varieties" and "new crop varieties" strategies two crop rotations used in this region: Sunflower-Wheat-Barley (S-W-B) and Sugar beet-Maize-Tomato-Wheat (SB-M-T-W). For the "production intensification" strategy the crop sequence Wheat-Maize (W-M) was considered.

The climate data of Évora and Beja weather stations (1961-90) were used. Regional climate models data (2071-2100) used were: HadRM3P (A2 and B2 scenarios), HIRHAMh (A2 scenario) and HIRHAMhh (A2 scenario).

The soils considered were vertisols (VR) for Beja and luvisols (LV) for Évora.

The IrrigRotation Model, was used to compute crop irrigation requirements for the different climate change scenarios and adaptation measures considered. A schematic representation of the simulations performed is shown in Fig.1.

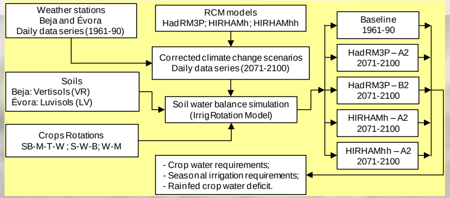

Figure 1 - Schematic representation of the simulations set performed.

Results and discussion:

The results obtained for the climate change scenarios (2071-2100) for the three adaptation strategies were:

I) Current crop varieties: If the current crop varieties are maintained, the results show a slight reduction or maintenance of the present irrigation requirements values, with the change in the irrigation requirements ranging between -13 % and 7%, with the shortening of the crops cycle compensating the ET_c increase (Fig.2).

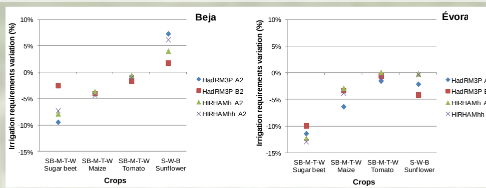

Figure 2 - Average variation of the seasonal irrigation requirements, for the 2071-2100 period, for Beja and Évora – **Current crop varieties.**

II) New crop varieties: When new crop varieties are used, with longer crop growing season lengths, a considerable increase in the irrigation requirements of the summer crops is obtained, ranging between 13% and 36%. (Fig.3).

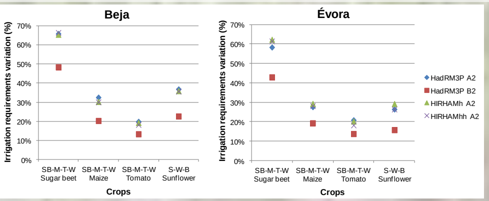

Figure 3- Average variation of the seasonal irrigation requirements, for the 2071-2100 period, for Beja and Évora. – **New crop varieties.**

III) Production intensification: In the case of the Wheat-Maize crop sequence, corresponding to production intensification, a great increase in the irrigation requirements was obtained, ranging between 43% and 52% (Tab.1).

Table 1 - Average seasonal irrigation requirements (IR) and
Average variation of the seasonal irrigation requirements, for the 2071-2100 period, for Beja and Évora. – **Production intensification.**

Location	Crops Rotation	Baseline 1961-90 IR (mm)	HadRM3P A2 IR (mm)	ΔIR	HadRM3P B2 IR (mm)	ΔIR	HIRHAMh A2 IR (mm)	ΔIR	HIRHAMhh A2 IR (mm)	ΔIR
Beja	Wheat-Maize	743	1111	49%	1066	43%	1103	48%	1099	48%
Évora	Wheat-Maize	697	1057	52%	1006	44%	1046	50%	1040	49%

Regarding the use of crops rotations as an adaptation measure, in a previous study, performed by the authors, was assessed the influence of crops rotations in the management of the water stored in the soil. Two additional simulations were performed for the wheat crop cultivated as monoculture, for Beja (vertisols), considering the baseline (1961-1990) and the HadRM3P A2 scenario (2071-2100).

The results show that for the Beja vertisols, with high values of soil water storage capacity, the crops rotations can decrease the water deficit of the rainfed crops (Fig.4 and Fig.5). The storage of water in the deepest soil layers, during the irrigated crops with shallow roots, increase the available soil water at the wheat planting date.

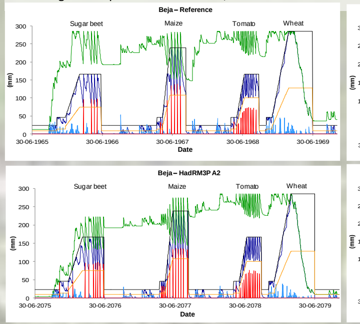

Figure 4 - Simulated curves of the soil water content for the Beja region considering the clay soil Bpc and the crops rotation SB-M-T-W.

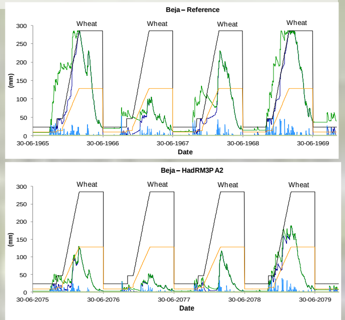

Figure 5 - Simulated curves of the soil water content for the Beja region considering the clay soil Bpc and the wheat crop (monoculture).

(—) water available in the root zone; (—) available soil water to the deepest root of the rotation; (—) TAW; (—) threshold of the soil water easily extracted by the plants; (—) precipitation; (—) irrigation events.

Conclusions:

The results achieved for the climate change scenarios (2071-2100) show that the climate change impacts on irrigation requirements are highly dependent on the adaptation measures adopted by the farmers.

If the **current crop varieties** are maintained it is projected the reduction or the maintenance of present crop irrigation requirements, with the reduction of the crops growth season compensating the ET_c increase and the reduction in precipitation.

The adoption of **new crop varieties**, with longer cycles, will lead to an increase in the irrigation requirements. In the case of the **production intensification** strategy it can be projected a strong increase in the irrigation requirements. The results for these two adaptation strategies will lead to an important rise in water demand for agriculture.

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