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Hydrology and Earth System Sciences Discussions

Interactive comment on "Risk of water scarcity and water policy implications for crop production in the Ebro Basin in Spain" *by* S. Quiroga et al.

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AR: Authors responses

General comment

1. I found somewhat inconsistent the title of the paper and its more or less explicitly stated aims, with the content of the paper itself. Water policies are mentioned in the title; focus on the demand side is defined as very important in the introduction. Accordingly, the reader would then expect analyses/suggestions of optimal water management among different crops or of changes in crop mix to minimize losses in the presence of water scarcity, but both aspects are only marginally developed. What

the paper does is in fact an (interesting) impact assessment exercise quantifying the implications on agricultural value added of water restrictions. I agree that this is the necessary first step to discuss then possible policies, but just the first step. I would suggest to state very clearly since the beginning the very goal of the work.

AR: We have modified the title following the reviewer advice and add some discussion on policy implications to the conclusions: New title: "Crop yields response to water pressures in the Ebro basin in Spain: risk and water policy implications" "Risk": We present cumulative distribution functions of yield in response to water. "Water policy implications": We present crop responses to different policy scenarios of reductions on irrigated area. In a climate change context, more and more severe drought events are expected to happen in the Ebro basin. This could lead to the river basin management authority to reduce water availability. Although the national irrigation plan consider increases in irrigated land and some efforts are being made to make the irrigation systems more efficient, trying to reduce water consumption for agriculture, such an increase won't be likely to occur. Instead of this, we have considered the consequences for crop production of three policy scenarios where irrigated area is reduced. We quantify the implications on crop productivity and agricultural value added. To assess optimal water management among different crops it is necessary to know the priorities of policy-makers, since the large loss of production is not the main economic loss. Some crops are linked to rural landscapes or customs that sometimes is important to maintain, water demand is different for each crop and also economic revenues, so there is not a unique crop mix that minimize losses, since the definition of loss depends on the objectives. A multicriteria analysis can be performed in a further step, but it has not been addressed here.

Specific comments -

2. Line 19 page 5898. The term "social capital" to describe labour and technology in a production function is not the most appropriate. It recalls and may confuse with the jargon of the sustainable development literature referring to institutional capacity,

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social safety nets and mutual trust among people. Also the use of the term "technology" as other from labour is ambiguous and partly imprecise. In standard economics, "technology" refers to factors of production (capital, labour etc.) and to how they are combined to produce. Thus saying "labour and technology" is not appropriate as labour is already incorporated in the concept of technology. I would rather use the words economic component (labour and capital) as opposed to the natural component. But this is just a suggestion. What is important is to be clear in the definitions.

AR: We agree with the reviewer and we have rewrite the sentence as: "The goal was to analyse economic component (labour and capital) as opposed to the natural component (water for irrigation and irrigated area components of the production function) together."

3. Lines 11 - 28 page 5899 and lines 1 - 5 page 5900. The extended theoretical justification of the choice of the production function is not really necessary. I would simply say that the functional specification developed thereafter is based on a Cobb Douglas specification with estimated elasticity of substitutions and address the reader directly to the following section for the description of the estimation procedure. Nevertheless, if authors feel necessary to explain in detail they should be more rigorous. For instance why if K tends to infinite R should tend to zero? I know the theory behind this, but this is not at all clear from equation (2). Some additional motivations should be provided.

AR: We have rewriten this discussion as follows: "Estimation of production functions is always controversial and each approach has strengths and limitations. In order to put our work in the viewpoint of the productivity literature we used the Solow-Stiglitz perspective. We follow Solow (1956) in the sense that we are modelling a production technology in order to identify productivity change. Some experts have criticized this function because of the assumption that R and K are substitutes, what is not true, since, they are complementary (Daly, 1997). However, nowadays it is extensively used to represent production processes (Stiglitz, 1997). Our approach diïňĂers from Solow's initial model from that we use more than two factors of production to obtain output. It

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is good to say that based in this model we specifically use the usual Cobb-Douglas specification, as it allows a simple estimation and the coefficients obtained have a very intuitive interpretation in terms of elasticities. There are empirical studies that have shown that in agriculture, statistical models of yield response have been proven useful to estimate input requirements at different locations for selected crops (Lobell et al., 2005; and Lobell et al., 2005, 2007; Parry et al. 2004)."

4. Line 8 page 5901. I found quite surprising that in the specification of the production function both fertilizer use and technological progress are missing. They are both essential components explaining yield performances. The role of fertilizers is also described as an important add up in the conclusions. And, the inclusion of a time trend to capture technological improvements in the production processes turns out to be usually highly statistically significant in those kind of regression. Their exclusion should thus be motivated. Is it a problem of data availability? Does it depends on weak explanatory power? Etc.

AR: We agree with the reviewer comment and we have added extended discussion and Figure 2 to the text: "Agricultural time series are nonstationary since they always present a trend. When variables are nonstationary, normal regression analysis requires a transformation of the data. When there is not enough information about the causes of a such trend, the transformation needed to generate a stationary variable may be attained by simply removing deterministic trends (that is by directly subtracting the trend value from the observations or "detrending"); by taking first-differences (that is the variable in year t (Yt) minus the variable in year t-1 (Yt-1); or by introducing and autoregressive term as a the independent or explanatory variable. (Iglesias, Quiroga, 2007). In our case, we assume that there is a causal relationship between yield increase and technological change, and therefore we consider a management variable, the farm equipment power (Mac), to explain yield trend. A range of management indicators such as farm equipment power (Mac), tractors (Trac), nitrogen fertilizer (Fert), pesticide consumption (Pest), or seeds improvement (Seed) have a high correlation

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(Quiroga, Iglesias, 2010) since they can be considered as a proxy variable for technology and investment in a farm or in the farming sector of a district or country. (See Figure 2)."

Figure 2. Evolution of management indicators: farm equipment power (Mac), tractors (Trac), nitrogen fertilizer (Fert), pesticide consumption (Pest), or seeds improvement (Seed). Source: Quiroga, Iglesias, 2010.

5. Lines 22 page 5902 to 2 page 5903. All rather messy. I would suggest to say simply that as usual the choice of the explanatory variables to include in the final specification follows a deductive approach based on the Akaike and Schwartz criteria. In that, please consider my comment above on fertilizers and technological progress.

AR: We have added the following explanation to the choice of the explanatory variables: "As usual the choice of the explanatory variables to include in the final specification follows a deductive approach based on the Akaike (1973) and Schwarz (1978) criteria and adjusted R squared criteria, which are widely used to describe the goodness of model parameterization. A full description of the methods can be found in Greene (2003). To complete this process of variable selection, we observe a strong relationship between some of the explanatory variables which might be a source of collinearity problems. To detect a potential problem in each regression, we calculated the variance inflation factor (VIF) for each of the explanatory variables:

VIF represents the squared standard error (or sampling variance) of in the estimated model divided by the squared standard error that would be obtained if were uncorrelated with the remaining variables (Chatterjee and Hadi, 2006). So we have a VIF factor for each variable. Then, we follow the following criteria: (i) values larger than 10 give evidence of collinearity and, (ii) a mean of the VIF factor considerably larger than one suggests collinearity. We then proceed to eliminate variables which have a VIF value larger than 10. The criteria for elimination of variables when collinearity exists have been to eliminate the variable presenting lower impact on the goodness of model. We

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proceed in an iterative way when collinearity persists."

6. The role of the value added equation is not completely clear to me. If it is meant to be explanatory, its specification should be much richer including at least crop prices among the independent variables. If it is just a way to link value added and yields, thus it is manly a descriptive device, it could be acceptable. But this should be clearly stated. In addition, even under the descriptive view point the explanatory power is extremely weak. Justification should be provided both on the specification used and on its use within the study.

AR: Crop prices does not vary across the Ebro basin, so cannot be used as explanatory variables. So, we agree with the reviewer that the role of the value added equation is just a way to link value added to yields in order to suggest that yields reduction and economic losses are different concepts but in some way they are related.

7. Lines 14 to 16 page 5907 not needed. They are just a repetition of what already stated.

AR: We removed lines 14 to 16 as suggested.

8. Line 11 page 5910. Not clear that and why the loss is larger when irrigation is reduced the 10 20% than when it is reduced the 30%. In fact as far as yields are concerned (table 8) this is not the case. And because of the positive relationship between yields and value added this should be also true in monetary terms. Perhaps I'm missing some point, but further explanations could be useful.

AR: Changes shown on Table 8 in general shows a slightly smaller decrease between 20-30% than between 10-20% in almost all the cases.

9. In table 5 apparently the use of machineries has a negative impact on alfalfa and wheat yield, whereas labour has a negative impact on maize and barley production. Am I wrong? If not this is quite surprising and important explanation for this should be provided.

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AR: We have added the following interpretation to the results section: “The quantity of machineries has a possitive effect after one period (Mac(-1)) or even two periods (Mac(-2)). That can respond to a lag in the investments on machinery. In the case of agricultural labour, the variable is at macro level and the negative effect is responding to the decreasing returns to scale when additional labour force move to agricultural sector.” Minor comments:

10. I suggest numbering all the equations in the text.

AR: We have numbering all the equations as suggested.

11. There are some typos to correct. In general the paper would benefit from an English revision.

AR: We have revised the paper edition.

Please also note the supplement to this comment:
http://www.hydrol-earth-syst-sci-discuss.net/7/C2928/2010/hessd-7-C2928-2010-supplement.pdf

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Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 7, 5895, 2010.

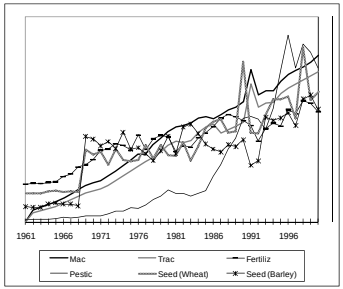

Figure 2. Evolution of management indicators: farm equipment power (Mac), tractors (Trac), nitrogen fertilizer (Fert), pesticide consumption (Pest), or seeds improvement (Seed). Source: Quiroga, Iglesias, 2010.

Fig. 1.

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