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Hydrology and Earth System Sciences Discussions

# *Interactive comment on* "Climate change effects on irrigation demands and minimum stream discharge: impact of bias-correction method" *by* J. Rasmussen et al.

**Anonymous Referee #1**

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Title: Climate change effects on irrigation demands and minimum stream discharge: Impact of bias-correction method

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General comments

The authors address an important topic, which is of interest to a broad audience. The authors aim is to assess the effects of downscaling methods on the impact of climate changes on irrigation demands and low flow of streams. So, the main focus is on differences in results in downscaling methods and their ability to predict extremes. However, the authors also compare the future to the current climatic conditions. For the current climate, however, it is not clear if observations or simulations are used. The comparison may therefore be not valid, as i) the observations comprises a period of only 20 years and the future climate a period of 30 years, and probably more important ii) different methods to calculate evapotranspiration (Makkink vs. Penman-Monteith) have been used. From the text, it is not clear if the comparison is valid. Additionally, I have some concerns on the parameterization of ET in the model, and on the method that is used to describe the irrigation demand. These, and some other issues that I explain below, need to be addressed before this paper can be considered for publication.

Specific comments

p. 4993, l. 14-15 The authors state that the aim of the study is to assess the effects of downscaling methods on the impact of climate, but in p. 4994, l. 3-5 the authors also state that the study focuses on the changes from the current climate to the far future. These are two different goals. For the first aim, comparison with the current climatic conditions is not needed, and for the second one, the methods used for the current and future climate should be the same. This holds, for example, for the period used (20 vs 30 years) and for the methods used to calculate ET (Makkink vs Penman-Monteith). 30 year periods are generally considered to represent the climatic mean.

p. 4995, l. 20-28; p. 4996, l. 1-10: the authors state that ETact is direct RCM output, but that they prefer using ETref, with the output variables of the RCM. These output variables, however, correspond to the atmospheric conditions related to the actual/real vegetation that is present. The air temperature, for example, is determined by the actual vegetation: a dry site will have a relatively low cover and low ETact, which results in higher Tair. The ETref represents a grass cover of 12 cm height etc, optimally provided with water. Tair of the reference grass will be different from that of the actual vegetation. This also holds for other variables as the vapour pressure deficit. So, if the variables given by the RCM refer to the atmospheric conditions above the actual vegetation, these should not be used to simulate the ETref. The authors need to clarify the validity of their calculations of ETref.

p. 4996, l. 20-22; table 4: A RCM simulation of the historic climate has been done, which presumably represents a 30 year period, and simulates ETref using Penman-Monteith. Instead of using the observed climatic conditions for the comparison between current and future climate, the RCM's of the historic climate and future climate (both 30 years) should be used. So, the comparison should be RCMhistoric to RCMfuture (both with ETref according to Penman-Monteith), instead of observed to RCMfuture (Makkink and Penman-Monteith, respectively). This also holds for the results section and/table 4. Maybe the authors did do the right comparison (in Figure 5 for example, they mention a 'current scenario'), but this is not clear (at least, this 'current scenario' only represents 20 years, see conclusions-section).

p. 4996, l. 26-19: relative change factors are derived using observations for the current climate. For ETref this may be problematic, because ETref_Makkink will be different from ETref_PenmanMonteith. For a sound bias correction, the methods used to calculate ETref should be the same for the current and the future climatic conditions.

p. 4998, l. 23: ETref is not observed, but calculated (see p. 4994, l. 13), also for the current climate. So, it would be better to replace this by 'ETref for the current climate…'.

p. 5001, l. 16-9: The authors indicate that irrigation is described using a demand given scheme. The demand, however, is calculated indirectly, using soil moisture contents. In agro-hydrology, it is common practice to relate relative crop yield to the relative transpiration rate, Yact/Ypot $\approx$ Tact/Tpot (De Wit, 1958;Ben-Gal et al., 2003). The



water demand is given by the potential transpiration Tpot, which reduces to the actual transpiration Tact if water availability is limiting. As the hydrological model involves the calculation of transpiration, it would be reasonable to focus on Tpot-Tact to identify the need for irrigation. Tpot-Tact also provides direct information on the amount of irrigation that is needed to allow optimal transpiration. By focusing on Tpot the focus is on both water availability and water demand, which is reasonable to consider as both will change with the changing climate.

Additionally, the available water for crop transpiration is not the difference between the actual soil moisture content and the soil moisture content at wilting point (soil water pressure head of -16000cm), because the reduction of root water uptake and transpiration already starts at much lower soil water pressure heads (about -500cm for grass, linearly reducing to -8000 cm). In hydrological models this reduction is often given by the function of (Feddes et al., 1978).

All in all, the authors should improve the description of irrigation demand in the model.

p. 5002, l. 11-15: Additionally, how climate-robust are crop factors and should these be used for trees, for which interception is large? In general, crop factors are derived based on measurements, where soil evaporation, transpiration, and interception are involved. The crop factor approach may be preferred for model simplicity, but the empirical crop factors can only be applied under the environmental conditions in which they were determined (and probably not for future climatic conditions). The use of crop factors especially is a problem for trees (also for the current climate) for which interception (see e.g. (Savenije, 2004) is much larger than for the reference grass. Some discussion on the climate-robust estimation of ET is given, but the focus mainly is on the effect of CO2. More discussion is required on e.g. changes in vegetation characteristics, the water and energy balance, use of empirical crop factors, growing season.

Technical corrections

p. 4990, l. 13: flow in -> flow is p. 5000, l. 15: add a reference to the SWAP model, e.g. (Van Dam et al., 2008) Table 3: Root depth grass -> root depth agricultural grass (to be consistent with table 2) Fig 6, caption: for the current climate, and for the future climate according to the DC method and the DBS method. p. 5008, l. 26: that the while -> that while p. 5009, l. 22: Vidaa -> Vidå p. 5010, l. 14: a decrease -> decreases p. 5014, l.8: limiting the transpiration -> limiting the potential reference evapotranspiration

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