Interactive comment on "Projection of irrigation water demand based on the simulation of synthetic crop coefficients and climate change" by Michel Le Page et al. Anonymous Referee #1
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In this manuscript, synthetic crop coefficients were used to resolve irrigation demands in Southern Mediterranean area, Morocco. In general, the manuscript is well-written and I believe the proposed results could be useful to local engineers. However, I don't really see much contribution in terms of scientific novelty to the academic community. It is closer to an engineering practice with climate change scenarios. Therefore, I have to suggest reject from publication.

Dear reviewer,

first, thank you for the reading of our manuscript. Your two comments about the fact that the manuscript is well-written and could be useful for local engineers are welcome but we obviously disagree with the second part of your assessment. The rationales of the proposed method, that probably were not properly explained in the previous version of the manuscript's introduction are as follow:

- There are relatively few articles which take into account both the anthropogenic and the climatic trend for estimating irrigation demand in the future. Those are generally studied separately **(March et al., 2012a; Titeux et al., 2016)**.
- Most of the works are based on land cover change approaches and deterministic models of crop functioning or of plant water needs. **(**see for example **Fader et al., 2016; Malek et al., 2018)**. This means that those approaches are rather complex to implement, in particular for managers. They also need a large and representative data set of "training" data for the land cover change implementation. In addition, they are not suited to represent change of practices such as intensification.

We propose a simple semi-empirical method based on the observed agricultural trend that can be easily assessed from coarse-scale remote sensing time series freely available from MODIS for instance and, more recently from Sentinel-2 instruments. These trends can be modified in response to alternative scenarios that could be triggered by public policies for instance. To our knowledge, there are no similar empirical approaches based on observed time series in the literature and we believe this contribution could be relevant both to the academic community and local engineers. Of course, the strong limitation of the proposed approach is that the area of study must be subject to agricultural trends which is very likely in several agro-systems in the world facing conversion to cash crops or intensification.

In response to the reviewer's comment, the introduction has been significantly rewritten to detail the rationales of the proposed approach and its domain of application.

First, the approach is motivated by the important growth of irrigated areas both in terms of cropping density and cropped area in the Mediterranean zone and more specifically in the Tensift watershed in Morocco:

To satisfy the continuous increase in food demand associated with population growth, the agricultural sector has been asked to pursue its already initiated process of conversion towards agricultural intensification and above all towards a sharp increase in yields. This context goes hand in hand with the increase in food trade. The replacement of traditional crops by more financially attractive crops is already underway **(Jarlan et al., 2016)**. In the "growth" scenario (which is more or less the actual trend), presented by **(Malek et al., 2018)**, the annual production of cultivated land increases by 40% and, the production of permanent crops increases by 260%. In the "sustainable" scenario, annual crop production and tree production increase by 30% and 38%, respectively. As a consequence, irrigation water needs are expected to increase **(Fader et al., 2016)**. The expansion and intensification of tree crops will also further rigidify the demand for agricultural water and increase the pressure on groundwater reservoirs **(Jarlan et al., 2016)** in order to keep tree crops alive during drought events **(Le Page and Zribi, 2019; Tramblay et al., 2020)**. This study is carried on in the Tensift basin in Morocco, where the increase in the irrigated area and the intensification of irrigation during recent decades have caused a long-lasting drop in the groundwater table **(Boukhari et al., 2015)**. A multi-model analysis of the area **(Fakir et al., 2015)** has shown that the groundwater table falls from 1 to 3 m/year and that the mean annual groundwater deficit (about 100 hm^3 since 2000) is equivalent to 50% of the reserves lost during the previous 40 years. Among the main causes of this depletion, is a reduction and higher irregularity of precipitation **(Marchane et al., 2017)** for crop growth and groundwater recharge, a reduction of snow water storage **(Marchane et al., 2015)**, an increase and intensification of irrigated areas, and a progressive conversion to arboriculture due to national strategy. Since irrigation relies increasingly upon groundwater abstraction, questions are inevitably raised concerning the future of local agriculture and groundwater.

Secondly, the rationale for making this approach is now explained as follow:

There is a significant amount of literature about the estimation of land use and land cover changes **(Mallampalli et al., 2016; Noszczyk, 2018)**, with various techniques to estimate or predict them. Many land cover change approaches are based on the transition probability concept which was introduced by **Bell, (1974)**. They have been eventually connected to Cellular Automata to account for geographical interrelationships **(Houet et al., 2016; Marshall and Randhir, 2008)**. A very interesting technique consists of combining the top-down (demand-driven) and bottom-up (local conversion) processes of land cover change by proceeding to a simplification of local processes **(van Asselen and Verburg, 2013; Verburg and Overmars, 2009)**. Despite a large bibliography both in climate change and land cover change, scenario analysis over the past 25 years has mostly focused on climate change projections, while the impact on land use and land cover has been neglected to a large extent. **(Titeux et al., 2016)** found that only 11% of the 2313 studies analyzed have included both land cover and climate change. Also, based on a large review, March et al. (2012) have called this a "hegemony" of climate as a driver of change. Furthermore, the implementation of land cover change techniques appear to be tedious and does not account for the intensification of cropping patterns. The motivation of the present work is to take into account both land cover change and crop intensification in future scenarios of irrigation water demand while taking into account the impact of climate change.

In addition, its potential application to other agro-systems is also further discussed in the conclusion. This was also a comment of reviewer 2:

The approach is relatively simple and can be easily applied to other regions where there is a high growth of irrigated areas. The MODIS products are available over all the globe so that the retrieval of a 20 years long time series of crop coefficients can be done everywhere. Different alternative techniques exist to retrieve Kc so that it is possible to switch between methods. A caveat of using this data is however its relatively low spatial resolution(250 m), which might miss some details. The separation of the territory between different irrigated areas seems adequate in particular when moving to a model of water allocation. The synthesizing algorithm is efficient and can be easily applied in different regions. The model itself is mainly linear, even if it is corrected by yearly precipitation and an eventual saturation due to the extension of tree crops. In other situations, like for example a late expansion of irrigated areas, or where a reduction of the expansion is already noticeable, it will be necessary to switch to a non-linear system. A simple ordinary least square adjustment has been used to fit the coefficients, other more advanced techniques could be used. Those different questions are being taken into account in the mark of the AMETHYST project aver the Merguellil watershed in Tunisia