Reply to reviewer – NHESS-422-2020

Flood and drought risk assessment for agricultural areas (Tagus Estuary, Portugal)

The reviewer's comments are in italic. Changes from the original manuscript are marked in blue.

RC2: *Please make a broader and more detailed explanation to figure 3 and 4. Please check figure 4 itself versus figure text (not in accordance). Please explain the lines drawn within various subgraphs of figure 3.*

Following the reviewer's comment, further details were added to the discussion about figures 3 and 4 as follows:

"Figure 3 presents the different scenarios projected in the consequence/probability diagram for the water unavailability; the horizontal and vertical bars represent the expected uncertainty for consequence and likelihood, respectively. The uncertainty of the consequence was estimated considering that the model overestimates the measured salinity by up to 2 psu. Hence, for each scenario the uncertainty was calculated assuming the maximum tolerable salinity in the water for irrigation as 3 psu (i.e., the maximum tolerable salinity, taken as 1 psu, plus the maximum error).

Consequence is low for all the scenarios in the first week, since the water available fulfils all the needs for irrigation. As time progresses (and the river flow remains constant) the consequence increases for all the scenarios with exception of scenario SD1 (climatological, mean river flow of 132 $m^3. s^{-1}$), in which water is always available for irrigation. For scenario SD2 (river flow of 44 $m^3.s^{-1}$) the consequence is moderate in week 3 and about 90% of the water needed for irrigation is available. In week 4 the water available for irrigation decreases to about 20% of the needs in this scenario (Fig. 3). The consequences are also more severe when the river flow is lower, as expected. For scenarios SD3 (river flow of 22 $m^3.s^{-1}$), SD4 (river flow of 16.5 $m^3.s^{-1}$) and SD5 (river flow of 8 $m^3.s^{-1}$) freshwater is unavailable for irrigation in week 3 (Fig. 3). However, the very low river flow scenarios (SD4, SD5) have low likelihoods. The estimated consequences for the scenarios agree with the observed occurrences during recent droughts (2005, 2012), as described by the risk owner. During July and August of both 2012 and 2005, droughts represented by scenarios SD2 and SD3 respectively, salinity reached concentrations at the Conchoso water intake that were inadequate for irrigation. In 2012, in particular, water with salinity of about 1.1–1.2 was used for irrigation, which reduced the production. However, the adverse impacts of the 2005 drought were more severe for the farmers in the Lezíria, since the drought itself was more severe and the ABLGVFX had fewer resources and was less prepared to deal with these events. More severe consequences are also estimated for scenario SD3 comparatively to scenario SD2 (Fig. 3). The comparison between scenarios SD3 (river flow of 22 $m^3.s^{-1}$) and SD6 (river flow of 22 $m^3.s^{-1}$ and mean SLR of 0.5 m) suggests that, for the same river flow, SLR increases the consequences (Fig.3).

Since the consequence of all the scenarios is estimated based on numerical simulations there is an associated uncertainty. ~~To estimate the uncertainty of the consequence, the maximum difference between the data and the model results at the peak salinity (2 psu) was used and the estimations described previously were performed considering the water salinity <3 psu.~~ Results suggest that the uncertainty associated with the numerical simulations on the consequence severity is higher for low river flow scenarios. In some cases, consequences can range from

"Very high" to "Low". However, this larger variability is explained by the criterion used to define the uncertainty (the maximum peak difference).

Regarding the risk diagram, results indicate that for all the scenarios except for the climatological scenario (SD1) the risk is intolerable in the last week (Fig. 4). Risk also grows with the duration of the droughts: for instance, for scenarios SD2 (river flow of 44 $m^3.s^{-1}$; return period of 5-10 years) and SD3 (river flow of 22 $m^3.s^{-1}$; return period of 10-100 years) risk can be medium until the third and second weeks respectively, and intolerable if the drought lasts for longer periods (Fig. 4). In these cases, when the river flow remains low for several consecutive weeks, even using the Risco River as an alternative freshwater source is insufficient to meet the irrigation needs. For the remaining river flow alone scenarios (scenarios SD4 and SD5) the risk is intolerable as early as the second week (Fig. 4); however the return period of these events is estimated to be larger than 100 years and their likelihood is, consequently, low. For events similar to scenarios SD2 and SD3, risk treatment is mandatory to reduce the risk level and may include the use of alternative water sources, the selection of alternative crops, the reduction of the irrigated area and/or the construction of water storage facilities. Mean SLR may represent an additional source of risk (scenario SD6, Fig. 4) and should also be taken into account in the establishment of risk management and climate change adaption plans for this agricultural area.

Figure 4 was corrected because the color scheme for the weeks was not in accordance with the figure's caption and the captions of figures 3 and 4 were also changed as follows:

Figure 3. Consequence/probability diagrams for water unavailability for irrigation during weeks 1 to 4. The river flow is constant during all weeks. The river flows considered in each scenario are: SD1 – 132 $m^3.s^{-1}$; SD2 – 44 $m^3.s^{-1}$; SD3 – 22 $m^3.s^{-1}$; SD4 – 16.5 $m^3.s^{-1}$; SD5 – 8 $m^3.s^{-1}$; SD6 – 22 $m^3.s^{-1}$ and mean sea level rise of 0.5 m. Error bars represent the uncertainty in the likelihood and in the consequence.

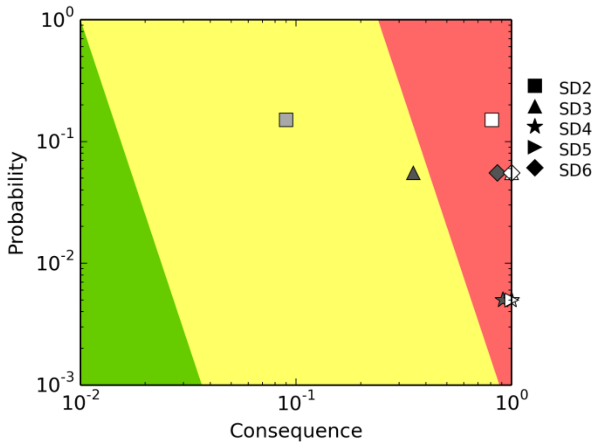

Figure 4. Risk for water unavailability. Colours of the symbols represent the weeks (darker to lighter means week 1 to week 4). The river flows considered in each scenario are: SD1 – 132 $m^3.s^{-1}$; SD2 – 44 $m^3.s^{-1}$; SD3 – 22 $m^3.s^{-1}$; SD4 – 16.5 $m^3.s^{-1}$; SD5 – 8 $m^3.s^{-1}$; SD6 – 22 $m^3.s^{-1}$ and mean sea level rise of 0.5 m. The following events are not represented in the risk diagram because all the water needed for irrigation is available and the consequence is 0: scenario SD1 – all weeks; scenario SD2 – weeks 1 and 2; scenarios SD3, SD4, SD5 and SD6 – week 1.