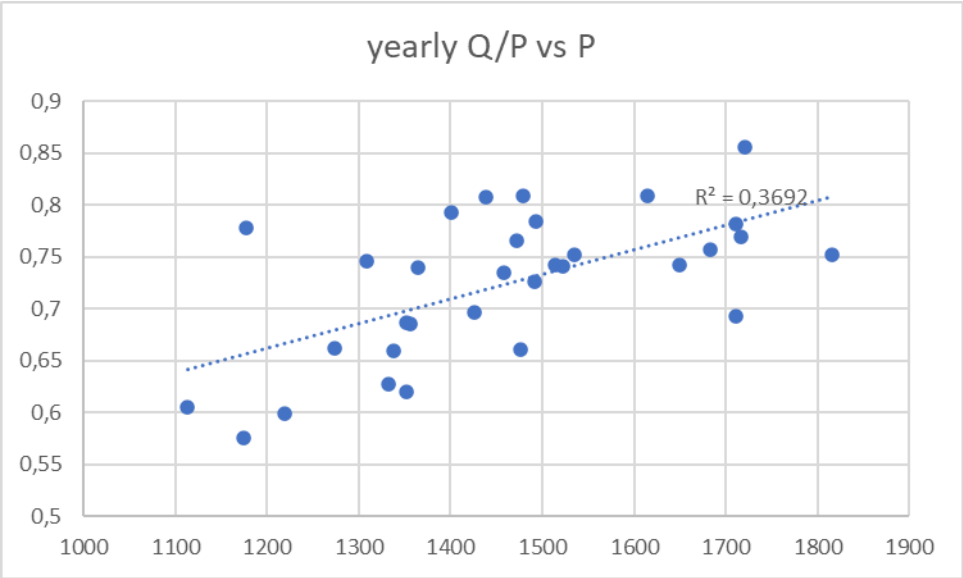
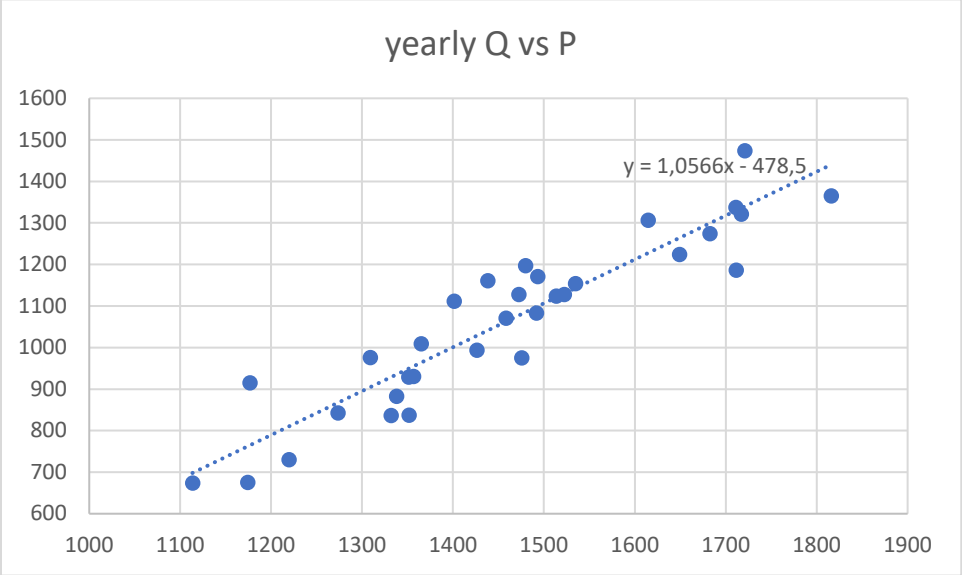
Review of “Drought decreases streamflow response to precipitation especially in arid regions” by Matanó et al.

The manuscript by Matanó and co-workers focusses on the response of catchment streamflow to precipitation, and how this response is changed by drought conditions. The authors analyze data from a large number of catchments globally, that allows for general conclusions on catchment behavior during drought. I enjoyed reading the manuscript, not in the last place because some of the findings have potential implications for our understanding of catchment functioning. However as with many studies on catchment observations, analysis can be complicated by the fact that these are not made under controlled conditions. In my view, some of the main conclusions of the manuscript are subject to a wrong interpretation of sensitivity, and to a lack of consideration of the natural variability in P that might affect the interpretation of changes in Q/P. These issues are discussed in more detail below.

The authors’ work focusses on “the Q-P relationship”, however the authors do not clearly define whether this should be seen solely as a catchment property, solely as a property of weather/climate forcing, or perhaps as a combination of both. This is important, because much of the interpretation of the results depends on this definition. Based on the wording in the manuscript, it seems that the authors implicitly assume the Q-P relationship to be a catchment property, which might change during or following drought, where the effect of climate is removed because P is used for normalization. A first problem with focusing on the Q-P relationship without clearly defining it, is that this relation by itself is not an established concept. It is not generally considered to be a catchment property, nor is the concept used in any predictive hydrological model (for a good reason). Streamflow generally originates from storage, making it tricky to discuss a relationship between P and Q without directly involving S. In has been shown by numerous studies (perhaps most notably by Kirchner, WRR, 2009) that the S-Q relationship rather than the P-Q relationship is a useful predictive model and that the sensitivity of discharge to storage, but not the sensitivity of discharge to precipitation, can be seen as a (nonlinear) catchment property. This means that the (yearly) Q/P ratio will depend on more than just catchment characteristics, and given the importance of catchment storage and its relation to discharge, it might also depend on the value of P itself in spite of the normalization used. I have quickly checked this on data from a catchment with long-term observations, and found that indeed there seems to be a clear relation between Q/P and P itself:



The dependency of Q/P on P itself has two implications for the results presented in the manuscript. First, it undermines the interpretation of single Q/P values in terms of sensitivity. In my view, sensitivity is the slope of the relation between Q and P as illustrated in the graph below (based on the same data):



This relation might well be continuous and linear over drought and non-drought periods with the same effective sensitivity or slope dQ/dP (here 1.06, so effectively 1). This example also illustrate that the conceptual framework in Figure 1 contains an important error: a yearly observation of Q/P is not the same as the sensitivity of yearly discharge to P. The real sensitivity is rather constant over the observed range in spite of the ratio Q/P getting smaller under dry conditions. Secondly, it means that, following the principle of Occam's razor, changes in P should first be ruled out as a possible explanation for any of the conclusions (particularly when discussing shifts and non-stationarity). Only when the shifts cannot be explained by changes in P, it is meaningful to discuss potential other mechanisms such as mentioned in the discussion. In summary, while the manuscript deals with an interesting and relevant topic, it currently suffers from a lack of clear definitions and consistency. In order for the manuscript to become a significant contribution to the understanding of drought impact on streamflow, in my view the authors will need to: a) investigate the real sensitivity of Q to P (from a

linear fit as in the second figure) and to what extent drought years might differ from the relation as given by non-drought years, and b) exclude the possibility that shifts in Q-P behavior are attributed to catchment processes whereas in reality they are simply induced by changes in P (for instance due to circulation changes). I realize this will require additional analysis, but given the potential significance of the findings it is important that they are based on careful analysis of all factors involved, so including dependency of Q-P on P itself.