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Hydrology and Earth System Sciences
Discussions

# *Interactive comment on* "Attribution of detected changes in streamflow using multiple working hypotheses" *by* S. Harrigan et al.

**Anonymous Referee #1**

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The paper investigates the evidence of changes in streamflow in an Irish catchment and the possible drivers of such changes. Arterial drainage, rather than the NAO Index oscillation, is indicated as the most likely driver of change. The paper elaborates on Merz et al. (2012)'s idea that the attribution of trend is a fundamental step in order to develop correct management responses and adaptation strategies. Attribution of trend is indeed a key question, and the authors present an interesting case study, for which they identify a new main driver of change, compared to previous studies. The paper is well written and structured: the work-flow is understandable and sufficiently easy to follow.



I have some doubts on the high hopes the authors seem to have on the Multiple working hypothesis framework: I see that the framework helps in identifying the potential drivers of change, but my main concern is that we might not be able to think about all possible drivers of change beforehand (or we might not have measurements on potential drivers). The framework works fine if one can really identify all possible drivers of change and then make a judgement on their effects. If the real driver is out of the framework, we would still be imagining effects of some variables based on probably vague results (exactly what Merz et al. (2012) would want to avoid). Although I appreciate the idea of the MWH framework, there might still be a certain level of subjectivity from the scientist in the choice of the WH which should be taken into consideration. Moreover at page 12378 the authors discard the WH2 and WH9 based on the fact that the effect of these drivers would be against the direction of the detected trend. What if these drivers would still have played a role, but due to the interaction with other drivers their effect is not visible? In this particular case substantial Water abstraction/diversions are likely to be noted in the history of the gauging station, and it should be possible to detect substantial changes of PET at the Dublin airport, but if one is to take the idea of hard proof for any WH, more evidence would be needed to prove that WH2 and WH9 can not be accepted. Also, each driver could have an effect at different time scales.

Unluckily, as the authors point out, to have better understanding of other potential drivers a large amount of data would be needed, so I see that it would be hard to improve on what the authors present here. This is even more true when looking at the large amount of data the authors have available for this study: very few catchments will have such rich series.

Some more detailed comments follow:

- At page 12387 the authors mention that trends were applied to the TFPW series if serial correlation was found. It seems from what the authors say in 4.2.1 that

this mostly affect the tests for the March and August mean flow. In Figure 8 it seems that the TFPW has a larger effect for the test of the observed monthly August flow. Any idea of why the difference is much bigger for August than for March? It also seems that the test statistic for the modelled data has a higher variability in August than in March. In general, I find the large scatter of the test statistic values interesting.

- Page 12391, Line 2-3. Calling a trend significant because the MKZ=1.97 heavily relies on the Normal approximation of the test statistic. If a MKZ=1.93 deserves to be called "near significant", a MK=1.97 deserves to be called "just significant", I believe. This doesn't change the final discussion, and shows how showing the value of the test statistic rather than an acceptance/rejection value is indeed more informative.
- Page 12393, Line 3-4 states "This discrepancy is particularly evident for high flows (Q10) and during winter months." The winter month discrepancy holds for the modelled monthly flows of Figure 7, but significant change is also found in summer months mean flows of the observed series (Figure 8). This indicates a more complex change.
- Figure 8: wrong understanding of what the whiskers in a boxplot are (or something is not well explained). If the whiskers are the minimum and the maximum of the observed statistics how can there be extreme outliers outside? If the default of most boxplots functions were used the whiskers extend to the most extreme data point which is no more than 1.5 times the interquartile range from the box (as can be seen, for example, in the R help file http://stat.ethz.ch/R-manual/R-devel/library/graphics/html/boxplot.html). This is based on properties of the normal distribution. If another choice was made on how to draw the whiskers, more details are needed on how outliers are defined.

Finally the correct citation for the FEH (cited at page 12378 - line 1) is:



Institute of Hydrology. Flood Estimation Handbook (five volumes), Centre for Ecology & Hydrology, Wallingford, UK, 1999.