

Hydrol. Earth Syst. Sci. Discuss., referee comment RC2
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Comment on hess-2021-64

Anonymous Referee #2

Referee comment on "Improved understanding of regional groundwater drought development through time series modelling: the 2018–2019 drought in the Netherlands" by Esther Brakkee et al., Hydrol. Earth Syst. Sci. Discuss., <https://doi.org/10.5194/hess-2021-64-RC2>, 2021

General comments

This paper presents a time series modelling-based (TSM-based) data preparation approach to a 30-year groundwater time series from the Netherlands. The TSM-based approach is evaluated for its reliability and potential for groundwater drought prediction.

The authors combine this evaluation of the data preparation method with a discussion on and analysis of the 2018-2019 groundwater drought in the southeastern Netherlands in terms of drought propagation and drivers of its spatial cohesion.

The topic of this work is of high interest to the research community, as it discusses important points on data reliability, methods to overcome these hindrances, and presents a timely and interesting overview of recent drought developments in the Netherlands. The manuscript follows a clear structure, and I commend the authors to its good overall structure and readability. Some improvements to the method description are required in regards to choosing thresholds and cut-off values, and adjustment of figures to allow for better comparison between measurement based SGIs and model-based SGIs (see specific comments below), but overall, I recommend this manuscript for publication after revisions.

Specific comments

Title/focus of the manuscript – The text itself is focussed on the TRM-based approach, while the title is drawing more attention to the drought analysis. I would reconsider the title to reflect better on the manuscript's content. I am also not sure about the use of the

term "data-based" approach (most studies are based on data?).

Figures – The figures are easy to read and support the conclusions. On Figure 9 though, it would be more useful to present the SGIs of the measured time series for the same months as for the simulated time series (Figure5).

Methods – The methods are clearly explained in principle, but in some instances, it would be helpful to elaborate a bit on why specific cut-offs were chosen. Please add some more information e.g. on:

L165 – 'one or a few', Did you use a specific threshold for 'a few'? If yes, this should be added.

L175 – Please elaborate on which basis you decided on the cut-off at 20 cm.

L183 – As in L175, a bit more explanation on how procedures (in this case repeating outlier removal twice) would be helpful.

L131-132 – Why were those series with > 10 years of data selected? I would be helpful to elaborate a bit the cut-offs. Do the 10 years refer to the amount of datapoints, or to 10 years of consecutive data? Did you also consider a maximum length of allowed data gaps?

L204-206 – The selection of the time series could be explained a bit more in detail; e.g. why 'around 120 series were selected at first.

L191 – 4 consecutive years? Also add why data from June-August 2018 was considered as particularly crucial.

L235 – Elaborate on why you chose the three-month-aggregated SPEI

L255 – Why did you chose $1/n$ instead of $1/2n$?

Table1 – Please add the reference for drought classification. It might be good to discuss in the text, why this classification was chosen. In other literature (e.g. Svoboda, M., Hayes,

M., and Wood, D.: Standardized precipitation index user guide, World Meteorological Organization, Geneva, Switzerland, 24 pp., 2012.) drought periods are only defined if the index is continuously negative and reaches an intensity of -1.0 or less.

L270 – Why January 1993?

L272 – Please add the type of regression analysis

L321 – Please reiterate based on what the dry, normal and wet conditions are defined.

Minor specific comments:

L10 – Could mention limited quantity along with limited data quality?

L13 – As later discussed in the text, the groundwater drought continued into 2020 in much of the area, so the term 2018-2019 *groundwater* drought could lead to some confusion. Maybe just leave it with 2018-2019 drought/ 2018-2019 meteorological drought.

L32 – Add in which regions droughts are expected to become more frequent.

L33 – ‘most hit by the weather extremes’, By those of the 2018-2019 drought or in general?

L54 – ‘Bloomfield et al, 2018’, you could add ‘Brauns, B., Cuba, D., Bloomfield, J. P., Hannah, D. M., Jackson, C., Marchant, B. P., ... & Schubert, G. (2020). The Groundwater Drought Initiative (GDI): analysing and understanding groundwater drought across Europe. Proceedings of the International Association of Hydrological Sciences, 383, 297-305. <https://doi.org/10.5194/piahs-383-297-2020>’ for full paper.

L61 – ‘in the Netherlands and elsewhere’, could be more specific. For which type of (hydrogeological?) settings is this particularly applicable?

L98 – ‘with some skill’, this is slightly vague. Maybe clarify if this depends on skills, or other factors (data availability and quality? Hydrogeological setting?)

L102 – ‘abnormal drought conditions’, do you mean during drought conditions in general, or during particular (abnormal) droughts?

L108 – ‘usefulness’ seems a little vague here, maybe ‘reliability’ or ‘accuracy’ could be a better term?

L110-114 – This may be a matter of taste, but you could also leave this paragraph out in my opinion.

L118 – ‘Higher elevation’, higher elevation than 30 m AMSL (if yes, what is the maximum), or ‘The higher elevations’?

L120 – How high is the precipitation surplus?

L120-122 – You could consider swapping the last two sentences of this paragraph (the abstractions tie in quite well with the afore-mentioned agricultural activities). Also, do you have any information if irrigation of the agricultural land is similar across the region, or are there some areas that have particularly high water demand (if yes, then this might contribute to the later discussion on groundwater drought development).

L129 – You could add the start of the time series (‘from XXX to 2019’)

L135 – What was the distribution of the weather stations? Are there more data-dense areas, or are they distributed quite homogenously?

L136 – If data from another station was used, what was the furthest distance to it, i.e. would you expect any impacts on data quality from this?

L148-149 – Also potentially overlain by abstractions?

L155 – ‘relocation of wells’; do you mean renaming?

L254 – ‘aggregated’ by averaging?

Table2 – Please spell out true/false positives/negatives or add to table description. From my perspective, it would also be easier to interpret the performance data is given for percent of the total time series rather than number of series. This would also tie in better with the manuscript’s main text. You could also consider

L235 – This is in contrast to the overall observation on positively bias during low groundwater levels?

Table3/4 – It would be beneficial here to add in the MAE as in Table4. In both tables, a standard deviation could be used instead of the range (though this might be a matter of taste).

L330 – It is later stated (e.g. L562) that the drought peaks in Oct/Nov, so in autumn. Please correct accordingly.

Figure3 – Minor y-axis breaks (e.g. quarterly) would be helpful

L340 – In which part of the study area did the heave rain occur?

Figure6 – Please add water table depth to caption (as you did in Figure5).

L401-405 – If the overestimations are larger in southern Noord-Brabant, is the prediction performance than really independent of the catchment characteristics?

L440 – Please add the approximate depths of ‘very deep groundwater tables’, as this is categorization is clearly very region/country-specific.

L444 – ‘large proportion’, how large in %?

L445 – Please give an indication of approximate thickness in m for ‘thick unsaturated zones’.

L445-446 – How long would you recommend?

L452-455 – Very nice discussion.

L515-517 – During which months did the drying up of the stream occur?

Technical corrections

L12 – This is very minor, but I ‘especially with’ would read a bit easier than ‘with especially’.

L35 – ‘getting rid of water surpluses’, ‘avoiding flooding’ might sound a bit more elegant.

L37 – ‘IenW’, supposed to be ‘Ien, W.’?

L39 – ‘related to deep drawdowns’, consider replacing with ‘declines in groundwater levels’

L58 – ‘done based on’, ‘made based on’ might be more elegant.

L65-67 – Consider splitting the sentence at the semicolon.

L82 (and others)– ‘Time series modelling’, this was already introduced as TSM. Use abbreviation throughout the manuscript for consistency.

L92 – ‘surface water influence’, consider rephrasing as groundwater-surface water interaction?

L116 – 'Pleistocene-era', only 'Pleistocene' would be sufficient

L118 – 'AMSL', could be spelled on first use.

L148 – 'yearly cycle', 'annual cycle' may be more common to use.

L150 – You might want to replace 'shifts' with 'step changes'?

L197 – Needs spaces around larger/smaller signs ($p < 0.05$ and $r^2 > 0.15$)

L222 – Change to 'data becomes available'.

L285 – Revise to 'on transforming a time series' or 'on the transformation of a time series'

L319 – I may have missed it, but I think 'EVP' was not previously spelled out.

L334 – 'less dry conditions', replace with 'fewer dry conditions'

L351 – 'also' can be removed from the sentence

L360 – '50 %', remove space ('50%')

L361 – 'found' can be removed from the sentence.

L387- '31 %', remove space before '%'

L534 – Adjust 'late, long-lasting' to 'later, longer-lasting'.

L557 – Adjust to 'may be impossible **to obtain** with'

L595 – Adjust to 'Bloomfield, **J.P.**'

L642 – Page number and year out of order.