



# United States Department of the Interior

U. S. GEOLOGICAL SURVEY

OREGON WATER SCIENCE CENTER

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Portland, Oregon 97204

**January 9, 2024**

## **MEMORANDUM**

To: Ben Scandella  
Groundwater Data Chief, Oregon Water Resources Department, Salem, OR

From: Adam Stonewall  
Hydrologist, USGS, Oregon Water Science Center, Portland, OR

Stephen Gingerich  
Research Hydrologist, USGS, Oregon Water Science Center, Portland, OR

Subject: Colleague Review of memorandum: "Analysis of Oregon wells correlated with precipitation," by Ben Scandella

Ben,

Thank you for the opportunity to review your OWRD memorandum "Analysis of Oregon wells correlated with precipitation". The memo is well-crafted and contains a lot of useful analysis. We feel as if we learned quite a bit about groundwater well evaluation, and much of the analysis is thorough and well-documented.

Most of our suggested edits are relatively minor and can be found within the tracked comments and edits of the draft document (one copy from each of us). However, one major reservation about the methodology used is notable, and that is the choice to detrend the groundwater data before those data are used in the analysis.

The report states that "to better represent long-term stability, water level records were "detrended" by removing the least-squares best-fit linear trend. This detrending was performed before evaluation of the correlation with water levels and of the characteristic magnitude and rate." No other justification for the detrending was presented.

The major concern is that by detrending these data before analysis you are biasing which wells are used in the analysis. For example, imagine a scenario in which both precipitation levels and groundwater levels are decreasing with time. By detrending the groundwater-level data, the correlation between the two may be weakened, and a well that would have been used without

detrending is not used when detrending is applied. Now imagine a scenario in which the precipitation levels are not trending but the groundwater levels are trending downward. In this case, wells that are marginally not well-correlated enough without detrending are included when detrending is applied. In other words, by detrending the data we are excluding some marginal wells that show the least amount of decline, and including more wells that exhibit more decline in groundwater levels.

If there is further justification for detrending the groundwater levels it should be stated more explicitly and any references that can be attributed to this approach cited. As used, the concern is that the Pearson's correlation coefficient and Mann-Kendall values are not true representation of the correlation between precipitation and groundwater levels.

Adam contacted a statistics professor from a local university for confirmation of this concern. After going over the analysis he appeared to have similar misgivings about the approach. His biggest concern (paraphrasing here in the quotes as best as can be remembered) is that "the changes through time is what binds these variables together". He also suggested these two links that discuss [cross-correlation](#) and [pre-whitening](#) (which appears to be another name for detrending) with lagged data.

Our suggestion would be to either 1) re-run the analysis without detrending the data, or 2) provide a more rigorous defense for this approach.

We're more than happy to discuss this point or how you might reapproach this analysis if that would be beneficial.

Another notable point to make is about the style of the text in regard to the intended audience. If the intended audience is an informed layperson, the memo could benefit from some additional editing to improve clarity and further explain some of the more difficult concepts. With such a complicated analysis, the more transparency you provide the better.

Please don't hesitate to contact either of us with any questions about our review comments.

Regards,

Adam Stonewall

Stephen Gingerich