

General Comments:

The manuscript explores drought propagation, taking into account various meteorological factors and watershed characteristics. This study aims to expand existing knowledge by incorporating the effects of a changing environment and watershed features. While many studies have focused on drought propagation using stationary drought indices, research like this, applying non-stationary drought indices, is increasingly important in the context of climate change. The manuscript is well-structured and clear, making it of interest to readers of the NHESS Journal. However, there are a few comments that should be addressed to further improve the manuscript:

Review Comments:

Major comments:

L 128: Fig. 1(c): Please include a paragraph in the Study Area and Data section about the subdivision of the river basin. It's crucial to detail these administrative divisions, specifying which are upstream, midstream, and downstream. You've mentioned considering watershed characteristics such as slope and land use type. It's important to clarify whether these characteristics were applied to the administrative regions or based on watershed boundary subdivisions. Also, please provide information on the sources of data for slope, evapotranspiration, soil moisture content, etc. Adding these details will enhance the clarity and depth of the manuscript.

L 149: Since you've mentioned that summer precipitation accounts for about 70% of the total, zero precipitation events would be common during the non-monsoon period. How did you deal with this? A two-parameter gamma distribution isn't defined for zero values. Have you considered using a mixed cumulative distribution function?

L208-211: In equation (10) for the copula model, you've expanded it in the survival form. Could you clarify the logic behind this? since we are primarily interested with $W \leq v$ and $Z \leq u$ form. So mentioning it in survival form seems inconsistent with the explanation and equation. Please revisit the equation, as the left-hand side has the CDF form, while the right-hand side uses the survival function form.

L 456: Discussion: The discussion section seems underdeveloped. It would be beneficial to expand it to offer readers valuable insights. Although you've touched on the influence of watershed characteristics on propagation thresholds, the discussion remains somewhat generic. Since this is a key focus of your paper, consider providing a more detailed analysis to fully engage your audience.

Overall, I suggest providing supplementary material that includes additional plots, tables, and figures not included in the main article to maintain conciseness. This will allow interested readers to gain comprehensive information about your study.

Minor Comments:

L 20- 23: You mentioned "...upstream and midstream regions, with...". You could specify it further by stating "...upstream and midstream regions of the Luanhe River Basin, China...".

L 44: Could you specify if you mean "Markov models"?

L 79: Change "...Basin. And..." to "...Basin and..."

L 115: Please rephrase the sentence: "Under the... more complex," as "evolution law" seems unnecessary in this context.

L 137-140: Rephrase “Finally, based... hydrological drought.” Were the drought conditions computed, or were the drought propagation probabilities calculated based on the copula function?

L 145- 146: Rephrase for better clarity “Taking precipitation as the object.. relatively simile calculation”

L171: non stationary? -> non- stationarity

L 183-184: You can clearly mention here that the meteorological variables (wind speed, temp and specific humidity) were considered as covariates for the non- stationary model of hydrological drought index.

L 187: You have explained the link function $g_1(\alpha_t)$. You could also add $g_2(\beta_t)$ to this.

L 192: Akaike information criterion -> Akaike Information Criterion

L 197: Since you have mentioned in equation (9) that u and v represent the two variables respectively. This looks strange to me as u and v are the marginal distributions of the two variables rather than the variables itself?

L 203: “...tails. And..” -> “...tails and..”

L 224: “...conditions.” -> “...conditions, respectively.”

L 235: As you mentioned, AMO-1 and AMO-24 were selected as covariates for the precipitation series based on the correlation test results. You could add a line explaining the rationale for selecting AMO-1 and AMO-24. Additionally, including the correlation test results for other climate indices across all lead times in the supplementary material would be beneficial.

L287: Table 7: Winter AIC value looks a bit strange.

L 291: “...non-stationary..” -> “...non-stationary model..”

L 324: Could you provide a comparison of SPI and NSPI across different seasons in the CDS region from 1961 to 2014?

L 478: Lead area index -> Leaf area index