

Supplementary material

Table S1: The historical droughts and drought-hit regions in Ethiopia. It is obtained from the Emergency Events Database (EM-DAT) accessed last time in June 6, 2021 (<https://www.emdat.be/>).

| Location | Drought onset year | Drought end year |
|--|--------------------|------------------|
| Wollo, Gondor, Tigray, Shoa, Harerge, Sidamo | 1983 | 1984 |
| Ogaden, Tigray, Wollo, Shewa, Gofa, Sidamo, Gondor and Bale | 1987 | 1987 |
| North Ethiopia, Tigray, Wollo, Gondar and Harerge | 1989 | 1994 |
| Borena, Bale, South Omo and Somali state | 1997 | 1997 |
| North Wollo, South Wollo, Oromia, Wag Himira district, Tigray, Beneshangul Gumuz, Gambela and Somali state | 1999 | 2000 |
| Tigray, Oromia, Amhara, Somali and Afar states | 2003 | 2004 |
| Liben districts, Gode zone and Borena district | 2005 | 2006 |
| Oromia, Somali, Amhara, Afar, Tigray and South nation and nationalities provinces | 2008 | 2009 |
| Somali, Oromia, Afar, Tigray, Amhara, South nation and nationalities and Gambela province | 2009 | 2010 |
| Somali, Oromia, Afar, Tigray and Amhara provinces | 2011 | 2012 |
| Dire Dawa, Gambela, Hareri, Oromia, Somali and South nation and nationalities provinces | 2012 | 2012 |

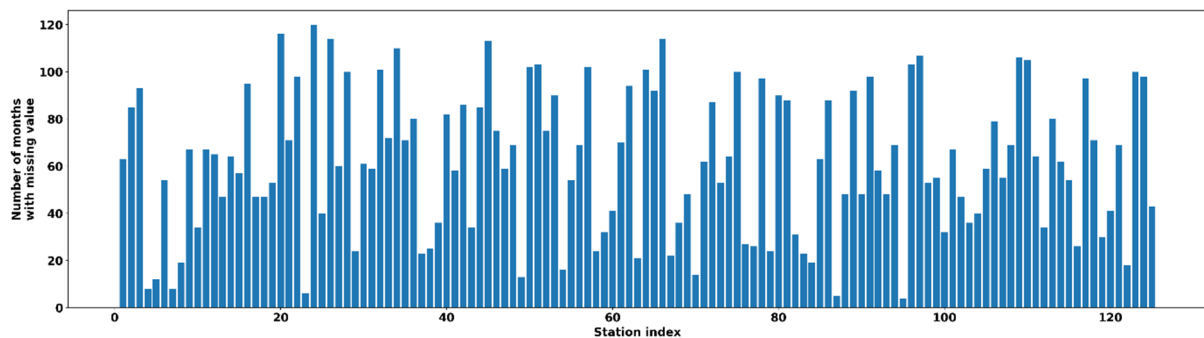


Figure S1: The number of months with missing precipitation data for all 125 gauging stations that are analyzed. The maximum number of months with missing precipitation data is limited to 10 years; otherwise, a given gauging station is not considered in the analysis.

Table S2: SPEI values and the corresponding severity groups

| SPEI value | Drought category |
|---------------|------------------|
| 2+ | extremely wet |
| 1.5 to 1.99 | very wet |
| 1 to 1.49 | moderately wet |
| -0.99 to 0.99 | near normal |
| -1 to -1.49 | moderately dry |
| -1.5 to -1.99 | severely dry |
| -2 or less | extremely dry |

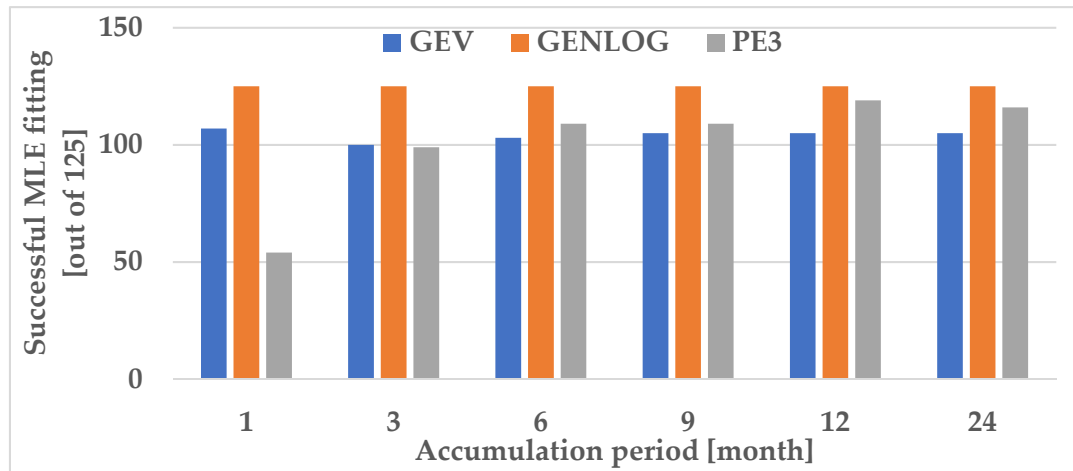


Figure S2: The number of successful fittings (out of 125) using maximum likelihood estimation (MLE) for each distribution for each accumulation period. This is estimated for above 30 years of data.

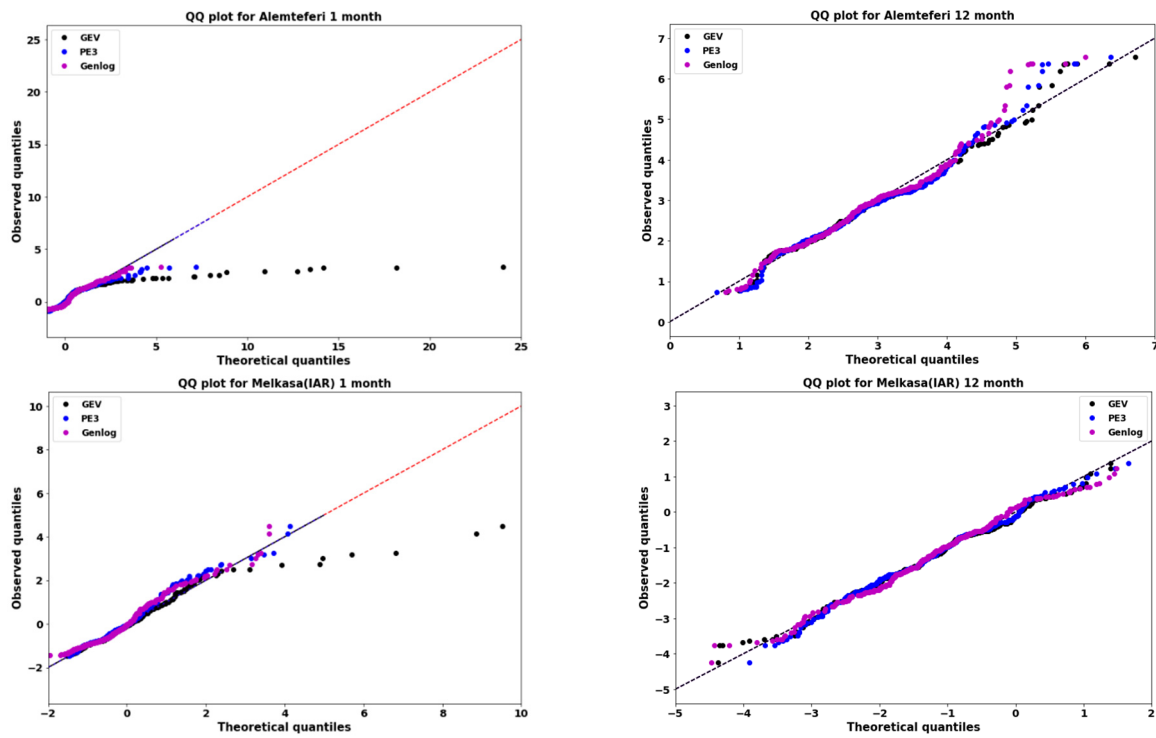
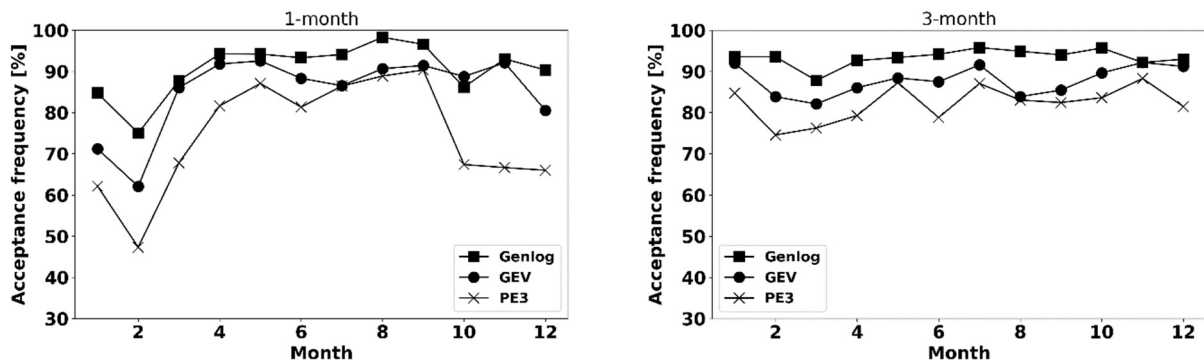


Figure S3: QQ plot for two gauging stations (Alemteferi and Melkasa (IAR)) water balance values fitted with Genlog, GEV, and PE3 for 1 and 12-month accumulation periods.



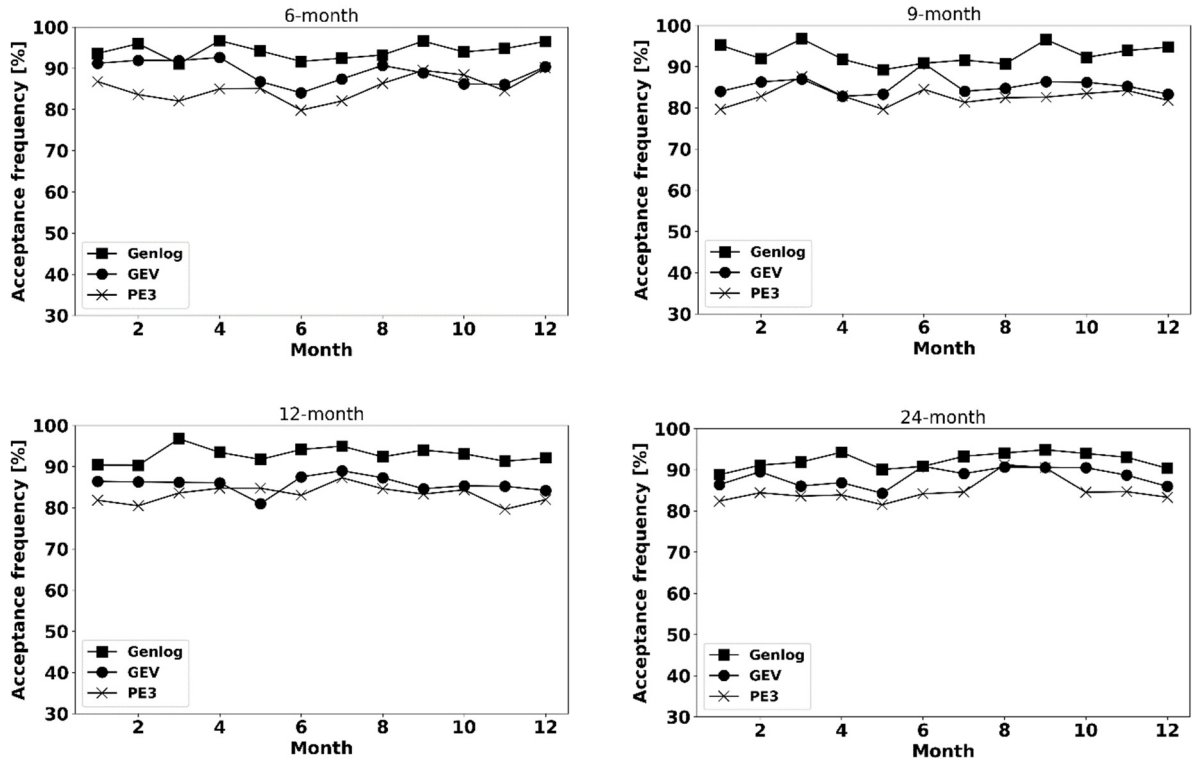


Figure S4: The acceptance frequency per month for each aggregation level and distribution function.

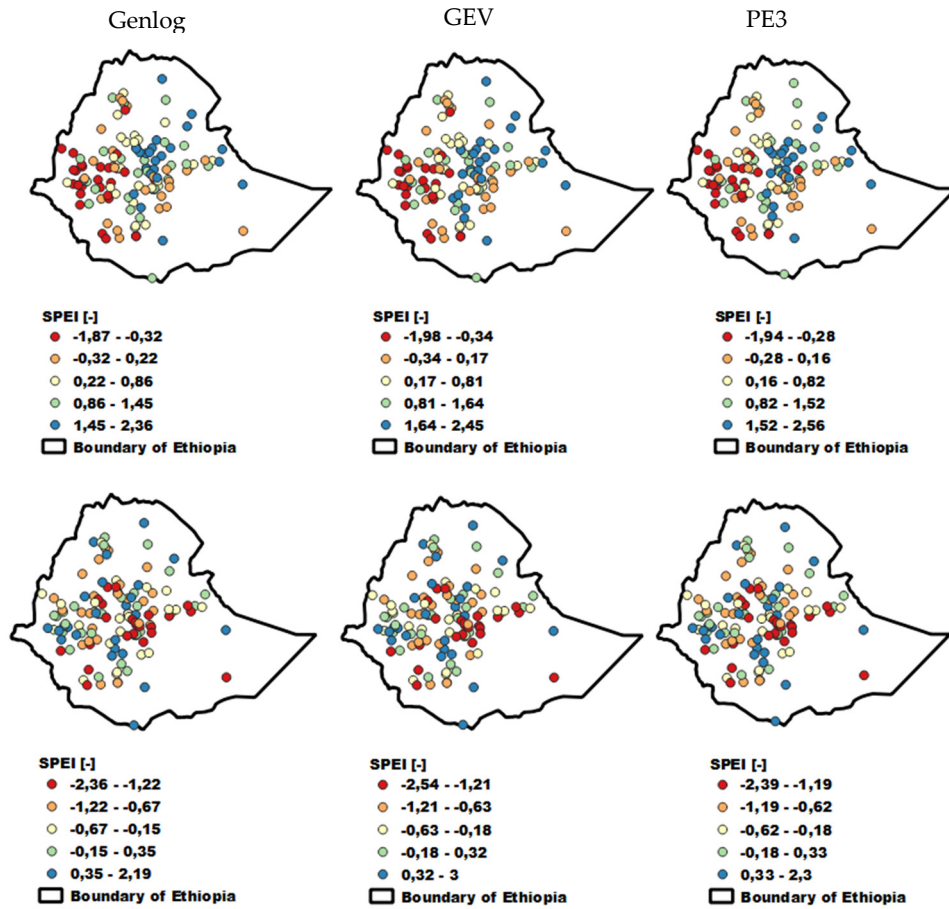


Figure S5: The SPEI values estimated from the three distribution functions for drought event in 1987-06 (top three plots) and 1988-05 (bottom 3 plots) for 24-month aggregation level.