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Apprehensive Drought Characteristics over Iraq: Results of a Multidecadal Spatiotemporal Assessment

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Apprehensive Drought Characteristics over Iraq:Results of a Multidecadal Spatiotemporal Assessment

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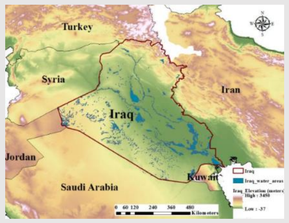
Abstract

Drought is an extreme climate phenomenon that happens slowly and periodically threatens the environmental and socio-economic sectors. Iraq is one of the countries in the Middle East that has been dealing with serious drought-related issues in the 21st century. Here, we investigate meteorological drought across Iraq from 1948 to 2009 at 0.25◦ spatial resolution. The Standardized Precipitation Evapotranspiration Index (SPEI) has been utilized as a multi-scalar drought index accounting for the effects of temperature variability on drought. Four of the main characteristics of drought including extent, intensity, frequency and duration are studied and the associated spatiotemporal patterns are investigated for each case. Results revealed a significant drought exacerbation over Iraq during the period of 1998–2009. Two significant drought periods of 1998–1999 and 2007–2008 are identified during which severe to extreme droughts covered about 87% and 82% of Iraq, respectively. Analyzing the trends of drought intensity reveals that the central and southwestern parts of Iraq have experienced aggravated intensifying patterns among other regions. In general, droughts are found to be more frequent but shorter at the western, central and southeastern parts of Iraq

Study Area



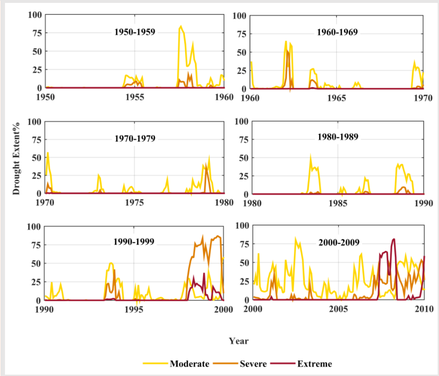
- Iraq is located in the southwestern Asia
- Area ~ 435,000 km^2
- 60% of the country receives less than 100 mm/year (southern parts of Iraq) whereas the mountains regions (north-eastern parts of Iraq) receive the highest amount of precipitation up to 1200 mm/year
- Summers are dry, hot in the northern parts and extremely hot (higher than 48 ◦C) across the rest of Iraq. Spring and fall are very short in Iraq.
- The Tigris watershed area is about 371,562 km^2 that surrounds about 38% of Iraq
- The Euphrates watershed is about 579,314 km^2 and covers about 49% of Iraq
- Grid cells covering the basin for each dataset:
  - 0.25 Deg. → 2132 grids

Data

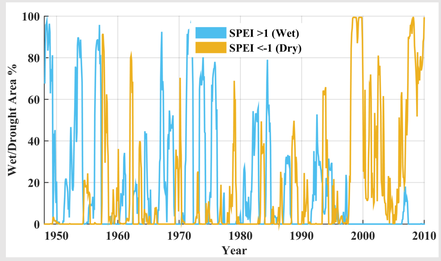
- The Global Land Data Assimilation System Version 2 (GLDAS-2) monthly data with a 0.25◦ spatial resolution is used in this study
- The components of GLDAS-2 are the GLDAS-2.0 that is forced entirely with the Princeton meteorological forcing data and the GLDAS-2.1 that is forced with a combination of model and observation-based forcing datasets
- the monthly precipitation and temperature data were extracted and utilized for 62 years historical period of January 1948 to December 2009

Meteorological Drought

Extent

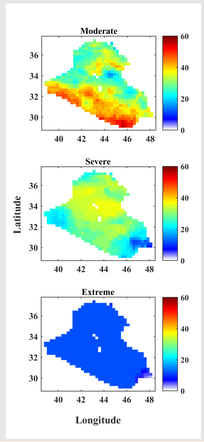


Category	SPEI Values (min–max)
Extremely dry	Less than −2
Severe dry	−1.99 to −1.5
Moderate dry	−1.49 to −1.0
Near normal	−1.0 to 1.0
Moderate wet	1.0 to 1.49
Severe wet	1.50 to 1.99
Extremely wet	More than 2

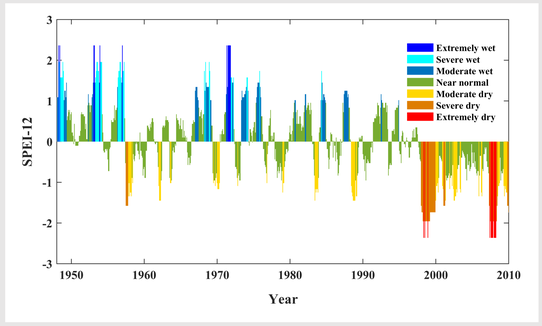


- Severe drought reaches its maximum in the late 1990s with about 87% drought extent recording the worst drought in Iraq by the end of the 20th century.
- The 2007–2008 period seems to be the worst drought with about 55–82% of Iraq experiencing extreme drought.
- the wet condition governs the period of 1948 to 1997, whereas from 1998 to 2009 dry conditions are being experienced across Iraq

Duration

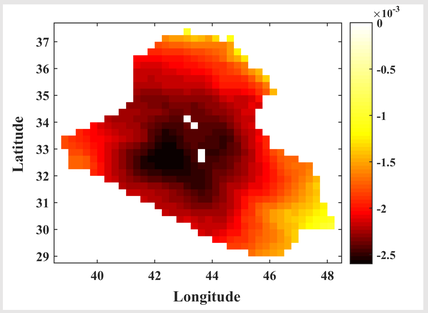


- Most of the drought that has happened over Iraq during 1998–2009 is moderate drought of up to 56 months at the southwestern parts of Iraq



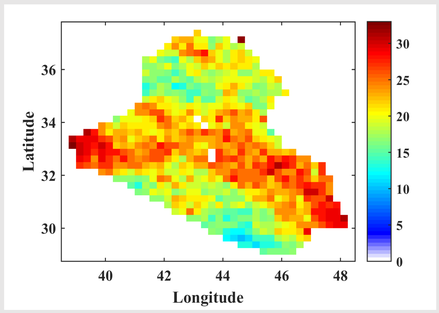
Time series of spatially averaged SPEI-12 over Iraq during 1948–2009

Intensity



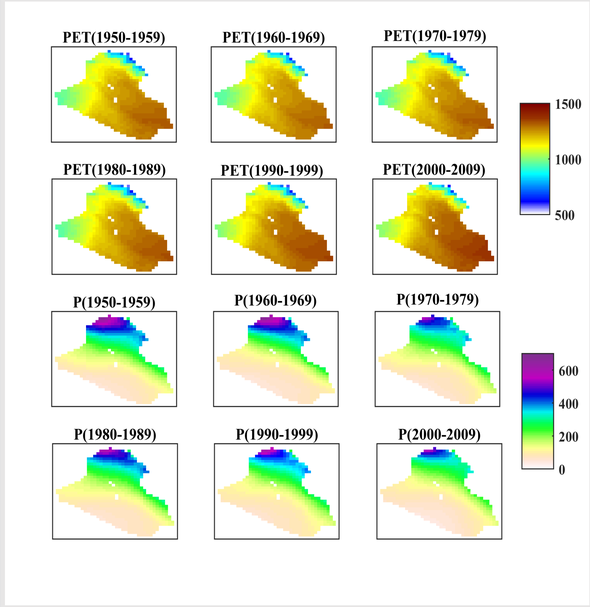
- The most intensified drought trend of −0.0026 is detected mostly over the mid-west parts of Iraq

Number of Events



- The drought occurrence is more frequent at the western, central and southeastern parts of Iraq

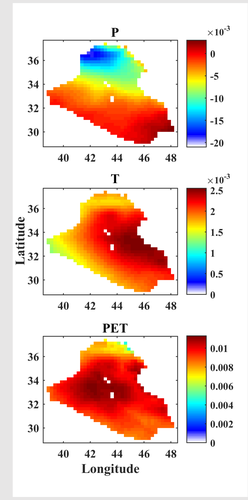
Potential Evapotranspiration (PET), Precipitation (P), and Temperature ()



The decadal variations of annual PET and P for the period of 1950–2009

- Precipitation has decreased in the northern parts pf Iraq
- Temperature has increased over the region mostly on the eastern part of Iraq
- Most of Iraq has experienced increasing PET especially in the mid-west parts of Iraq

- PET has increased dramatically in the 1990s and 2000s with the highest PET values of 1349 mm/year and 1374 mm/year, respectively
- The increase in PET is found mostly at the central, eastern and southeastern parts of Iraq
- Precipitation has decreased noticeably in the northern and northeastern parts of Iraq (the mountains region) and slightly over the rest of Iraq



Long-term trends of P (mm/month), T (◦C/month) and PET (mm/month) for the period of 1948–2009 according to the SPEI-12

Conclusion

- A drying trend is detected over Iraq with severe to extreme drought conditions governing the first decade of the 21st century
- The worst drought condition has occurred during 2007–2008 when severe and extreme drought covered about 25% and 60% of Iraq, respectively
- The intensity of drought has exacerbated during the past decades, with the most aggravation happening in the central regions of Iraq
- Droughts are found to be more frequent but shorter at the western, central and southeastern parts of Iraq

Acknowledgement

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Reference

- Ahmadalipour, A.; Moradkhani, H.; Svoboda, M. Centennial drought outlook over the CONUS using NASA-NEX downscaled climate ensemble. Int. J. Climatol. 2017, 37, 2477–2491