

Projected Changes in Compound Drought and Hot Events under the Climate Change in the upper Blue Nile River basin, Ethiopia

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P-37

Introduction

- Compound drought and hot events (CHDE) are the concurrent or successive occurrence of drought and hot, leading to impacts more severe than either hazard alone (Hao et al., 2022a).
- CDHEs are increasing due to climate change, and East Africa is particularly vulnerable.
- In recent years, compound extremes have gained significant attention due to the increasing frequency and severity of their impacts (Guo et al., 2025).
- In this study, we investigate the projected changes in the characteristics of compound drought and hot events in the upper Blue Nile Basin, Ethiopia.

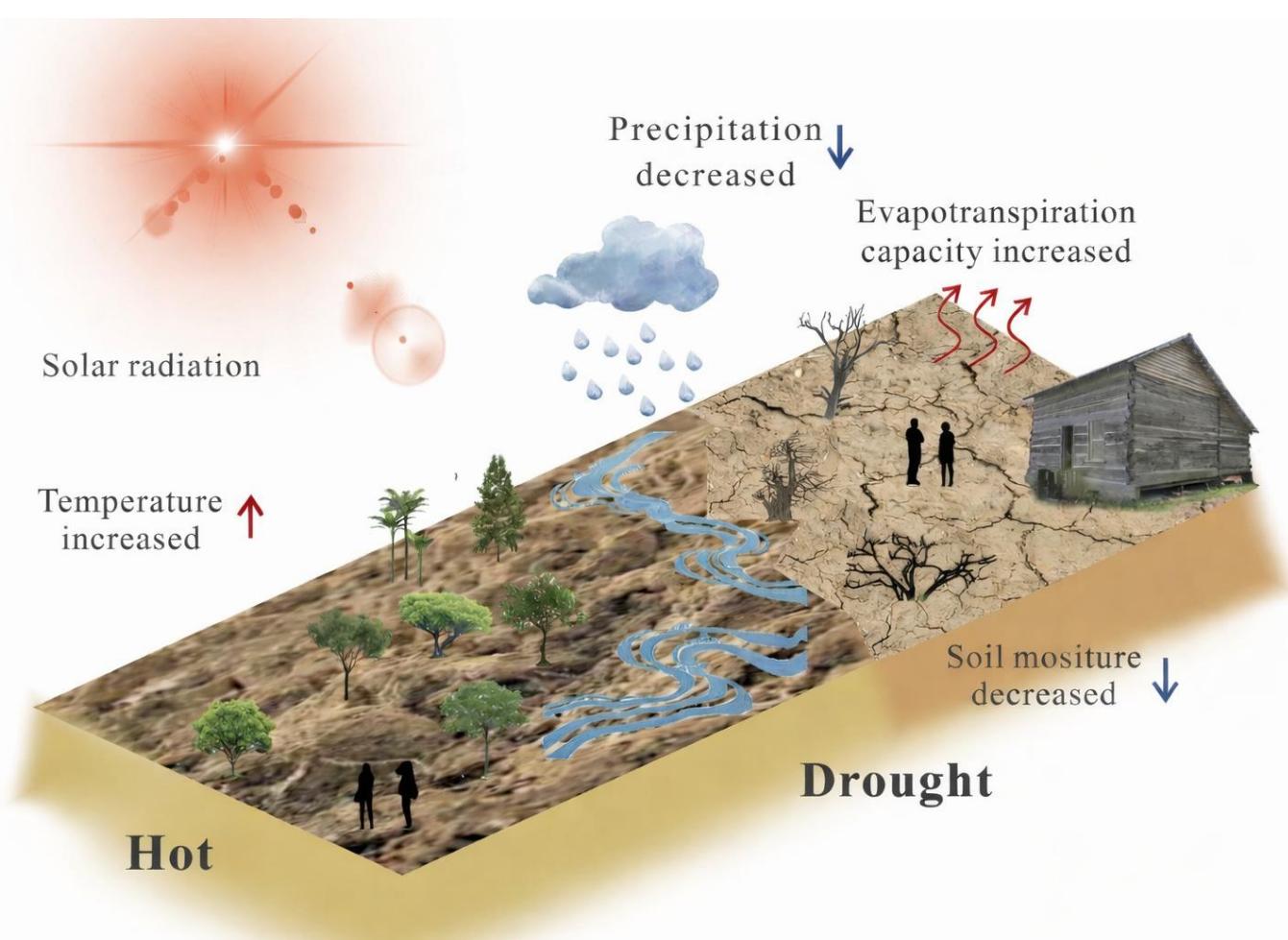


Fig. 1. Compound drought and Hot events (Wang et al., 2021)

Data and Methods

Study Area

- This study was conducted in the upper Blue Nile River basin.
- The drainage area covers 176,000 km².
- It contributes about 60% of the average annual stream flow of the Nile River.

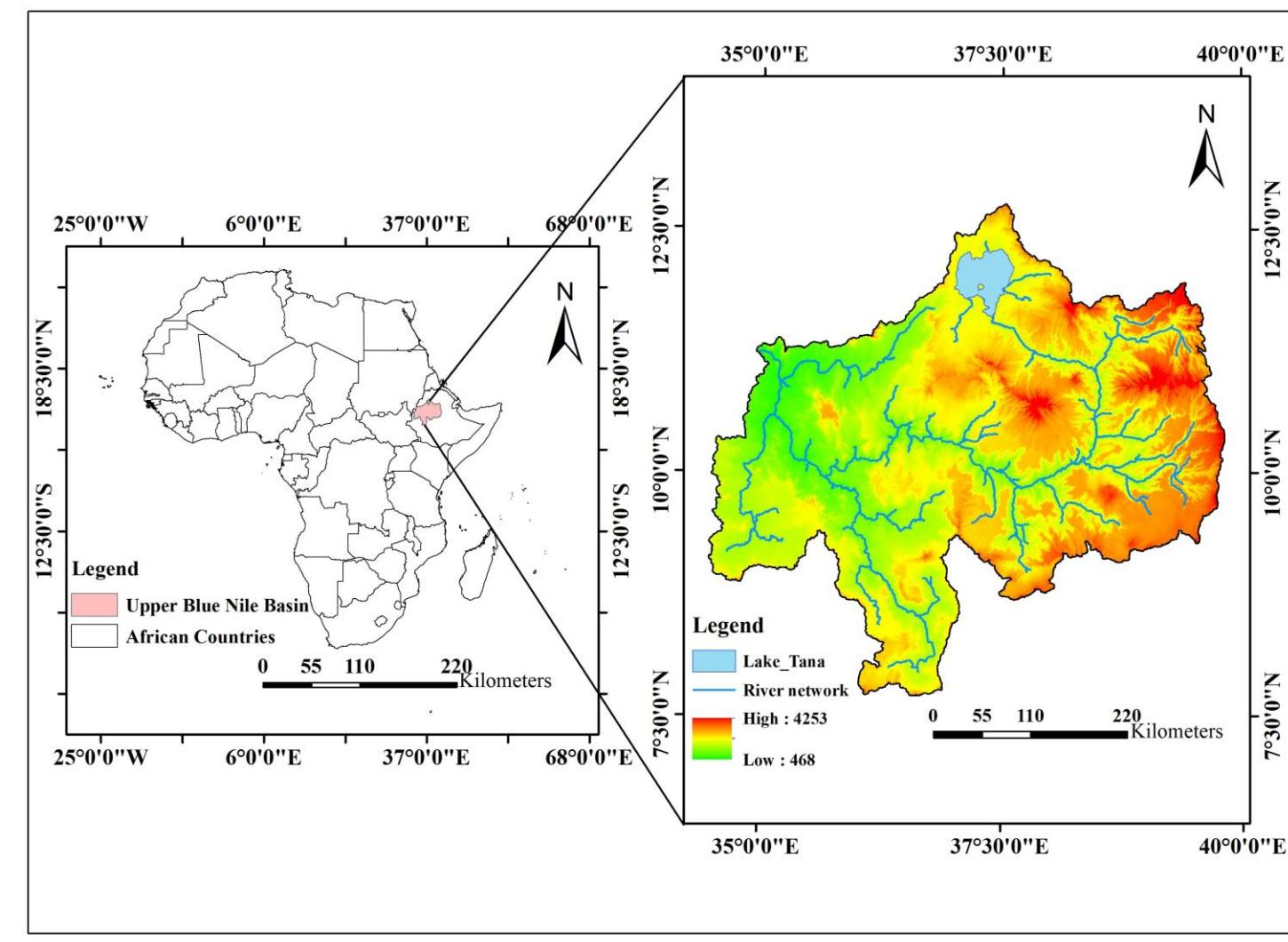


Figure 2. Map of the study area

Data

Table 1. Data used in this study

Data Source	Spatial Resolution	Period	Variable	Reference
MSWEP	0.1°	1982-2014	pr	Beck et al., (2019)
MSWX	0.1°	1982-2014	tas, tasmax, tasmin, relahum, solar rad, wind speed	Beck et al., (2022)
NEXGDDP ACCESS-ESM1-5 MRI-ESM2-0 MPI-ESM1-2-LR EC-EARTH	0.25°	1982-2014	pr, tas, tasmax, tasmin, Thrasher et al., relahum, solar rad, wind speed	Thrasher et al., (2022)

MSWEP: Multi-Source Weighted Ensemble Precipitation

MSWX: Multi-Source Weather

NEXGDDP CMIP6: NASA Earth Exchange Global Daily Downscaled Projections Coupled Model Intercomparison Project Phase 6

NEXGDDP CMIP6 was regridded to 0.1° 0.1° using bilinear interpolation

Methods

- Potential evapotranspiration (PET) was estimated using the FAO-56 Penman-Monteith method (Allen et al., 1998).

- The climatic water balance (Precipitation - PET) was fitted to a log-logistic distribution to compute the Standardized Precipitation Evapotranspiration Index (SPEI).

Compound Drought and Hot events(CDHE)

- CDHEs were identified using a threshold-based approach combining temperature and drought indices.
- Compound drought and hot events were identified when $SPEI \leq -1$ and monthly $tmax$ exceeds the 75th percentile, respectively.
- CDHE frequency was calculated as the ratio of event months to total months.

Results and Discussion

Spatial distribution of the frequency of Compound Drought and Hot events

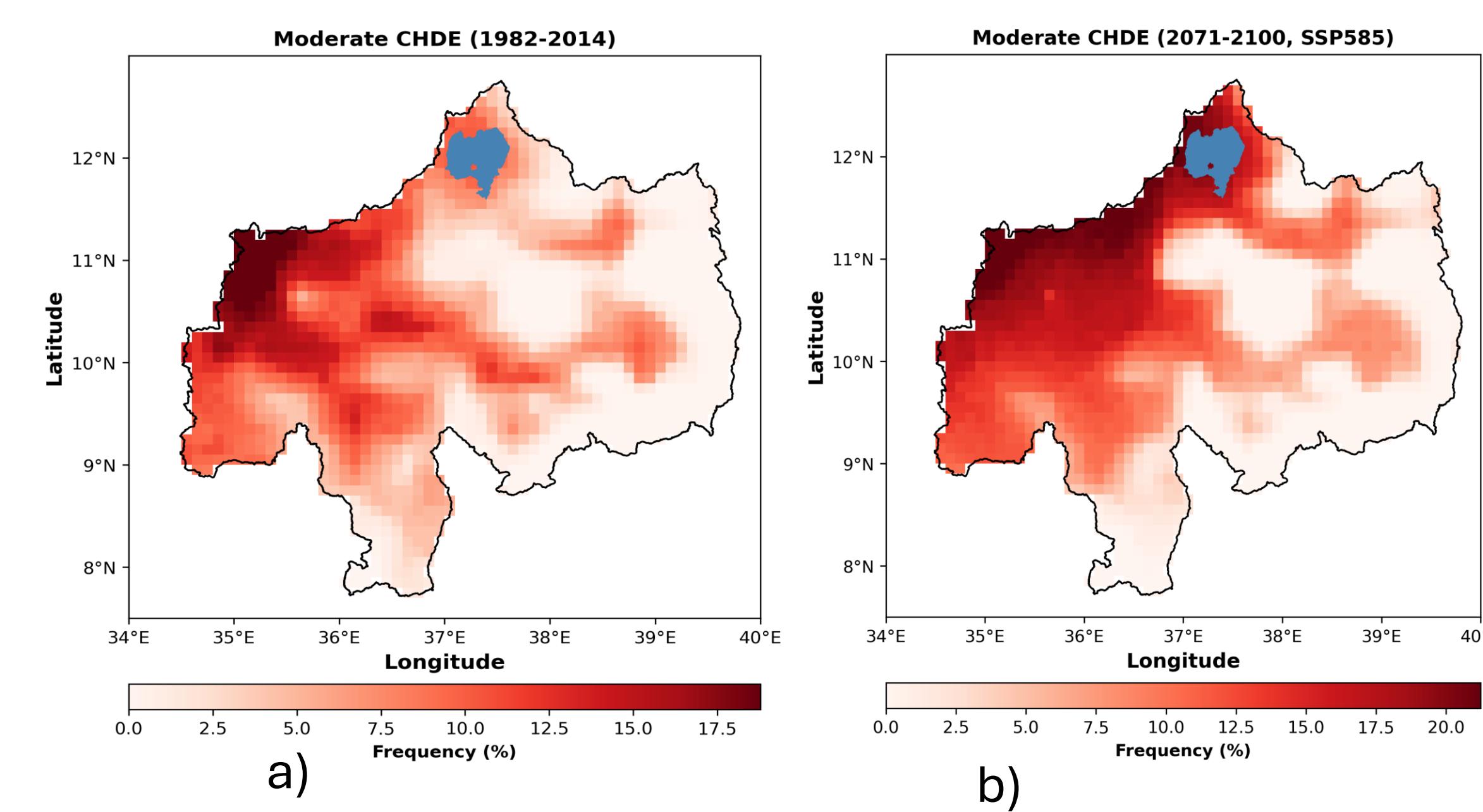


Fig. 3. Spatial Distribution of the frequency of moderate compound drought and hot events a) Historical period b) Future period

- The spatial distribution of the frequency of compound drought and hot events was detected in the basin at different levels of frequency in the basin.
- In the historical period, western parts of the basin showed a high frequency of CDHEs while the eastern part of the basin shows lower frequencies (Fig. 3a).
- Future projections show a significant increase in moderate CHDEs, especially in the western and northern Upper Blue Nile Basin, under a high-emissions scenario (Fig. 3b).

Spatial extent of Compound Drought and Hot events

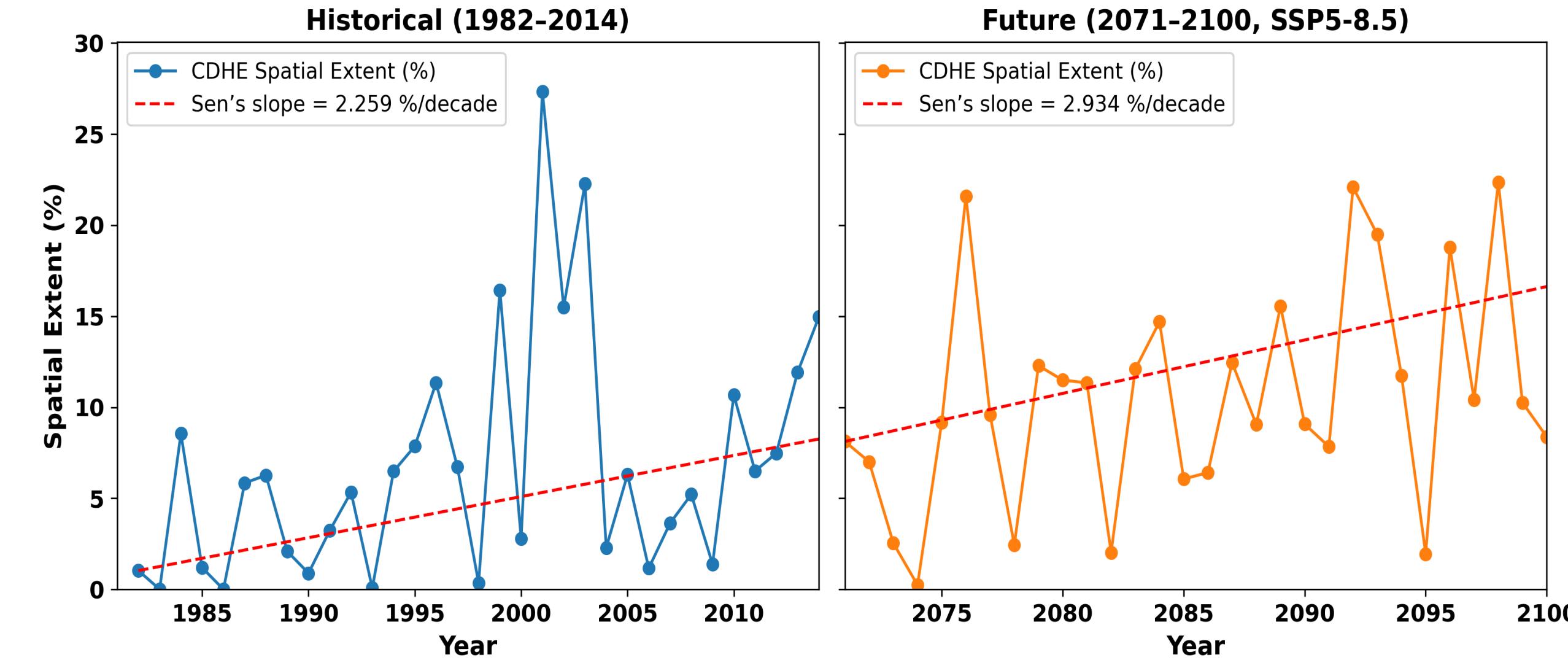


Fig. 4. Temporal changes in the spatial extent of moderate compound drought and hot events

- The area affected by CDHEs shows a clear increasing trend in both periods, with a stronger expansion in the future (SSP5-8.5), indicating accelerated intensification under climate change (Fig. 4).

Conclusions

- Moderate CHDEs are increasing in both frequency and extent. Hotspots expand from the west to the central and northern areas.
- The spatial extent rises from +2.26% to +2.93% per decade, indicating stronger and more widespread future events under high emissions.

Future work

- To investigate the population's exposure to the CDHEs under climate change

References

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