Quantification of Climate Change impacts on the Srepok River, Mekong River Basin

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Abstract

Quantifying the extent of drought and flood magnitude and frequency under the climate change impacts is essential for an effective water resource management. In this study, we utilize the Soil and Water Assessment Tool (SWAT) hydrological model, drought indices as well as the Interquartile Range (IQR) method for a comprehensive analysis of the river flow response to projected climate change scenarios.

Four General Circulation Models (GCMs) under two Shared Socioeconomic Pathways (SSP2-4.5 and 5-8.5) have been used for our analysis (2023-2090). Our objective is to reveal the future projected drought and flood events in terms of intensity, frequency, and potential consequences for local livelihoods in the Srepok River basin (SRB), a tributary of the Mekong River basin (MRB), Southeast Asia. Our findings serve as the scientific basis for stakeholders and decision-makers to develop adaptative strategies and sustainable plans to promote the region's resilience.

Motivation

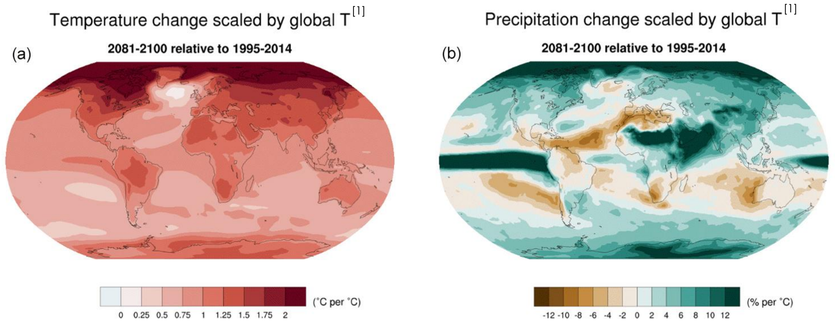


Fig. 1. Patterns of temperature (a) and percent precipitation change (b) normalized by global average temperature change (averaged across CMIP6 models and all Tier 1 plus SSP1-1.9 scenarios)[1].

Data and Methods

NASA Earth Exchange Global Daily Downscaled Projections (NEX-GDDP-CMIP6)[2], Soil & Water Assessment Tool (SWAT)[3] model, and Interquartile Range (IQR)[4] method

Drought frequency	SPI/SSI values
Extreme wet	Index ≥ 2
Severe wet	1.5 ≤ Index ≤ 2
Moderate wet	1.0 ≤ Index ≤ 1.5
Near normal/mild wet	0 ≤ Index ≤ 1.0
Near normal/mild drought	−1.0 ≤ Index ≤ 0
Moderate drought	−1.5 ≤ Index ≤ −1.0
Severe drought	−2.0 ≤ Index ≤ 1.5
Extreme drought	Index ≤ −2.0

Standardized Precipitation Index (SPI) & Standardized Streamflow Index (SSI) would be used for drought analysis in pre-defined future periods, including near future (2023-2044), mid future (2045-2069), far future (2070-2090).

SPI, SSI-3 & SPI, SSI-12 month: seasonal and annual meteorological and hydrological drought

Srepok River basin

(1) A main tributary of the **Mekong River**, originates from the Dak Lak province in the Central Highlands of Vietnam
(2) Biological importance and key routes for fish migration, home of over 2 million people
(3) Hydropower and agriculture potential
(4) River's length: 406 - 450 km; area: ~18,200 km²

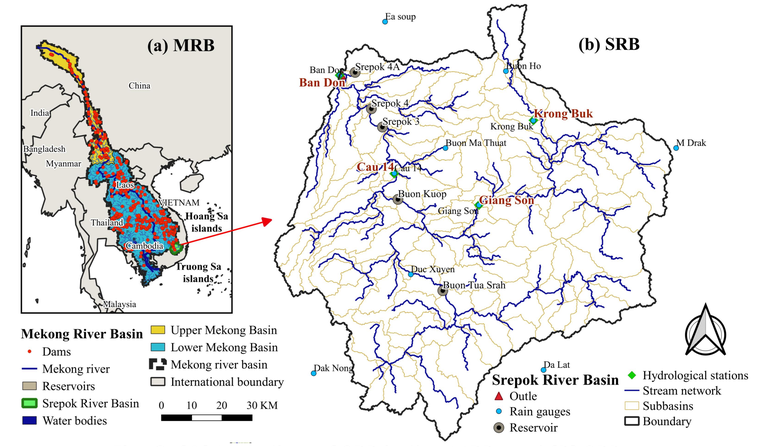
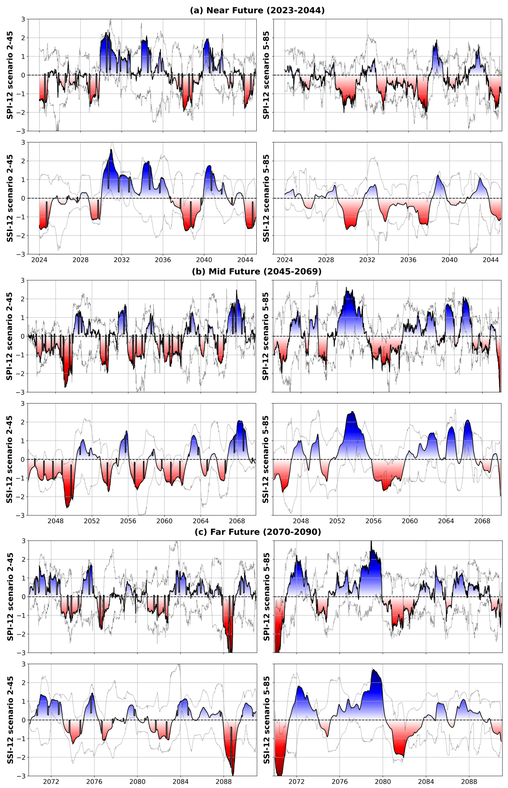


Fig. 2. (A) Location of SRB in the MRB and **(B)** SRB.

Results and discussions

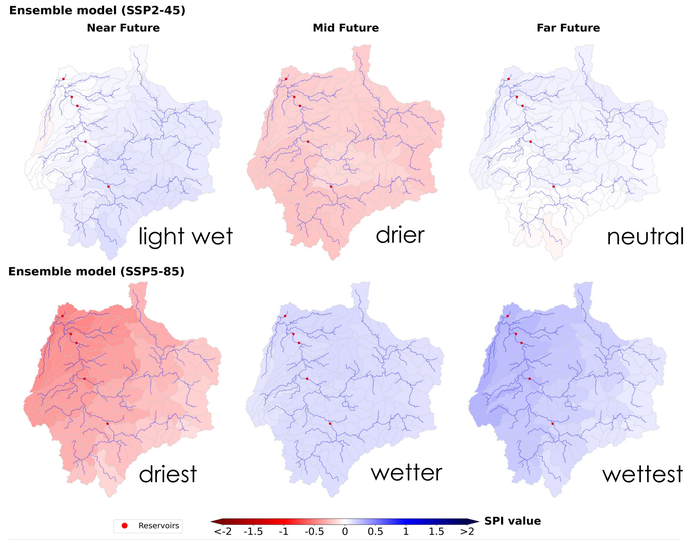


The **red** color represents dry period while **blue** color represents wet period. **Black dotted line** represents the SPI-12 and SSI-12 range of GCMs while the red and blue colors represent SPI-12 and SSI-12 values of the ensemble model.

Near future: 2-45 wet trend (2030-2042), 5-85 dry trend (2029-2038)
Mid future: 2-45 dry trend (2045-2062), 5-85 wet trend (2050-2067)
Far future: 2-45 & 5-85 light to severe wet trend (2070-2071; 2080-2083; 2088-2089)

Fig. 3. (A) Near (2023-2044), **(B)** Mid (2045-2069), **(C)** Far future (2070-2090).

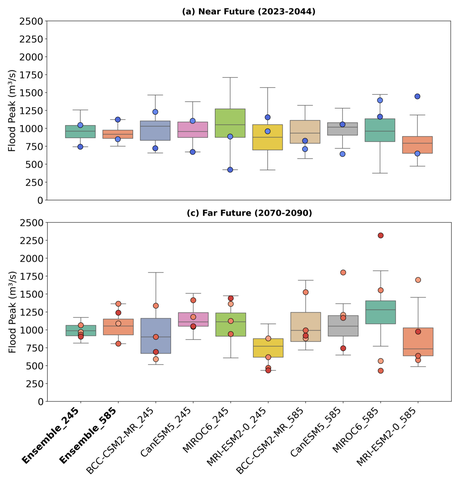
Spatial distribution of future drought and floods



More drought found close to the SRB's outlet, highest during the mid future (2-45) and near future (5-85).

Higher greenhouse gas emission shows higher magnitude of flood and drought.

Fig. 4. Drought intensity using SPI-12.



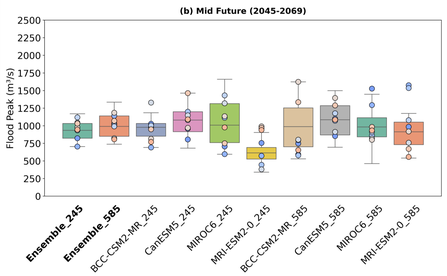


Fig. 5. Projected flood peaks.

Findings

- Substantial shifts in weather patterns are found, leading to more drought and flood events
- Prolonged durations of meteorological, hydrological drought and flooding are indicated from a transition towards more humid seasonal weather patterns

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