C202

Comparison of the flash droughts analysis using reanalysis and SiBUC LSM data

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Introduction

Flash droughts differ from typical droughts in their rapid onset and short duration, which may have a significant impact in regions dependent on stable water resources. The diverse land use patterns in Uzbekistan, including intensive farming zones and natural areas with sparse vegetation, present special challenges for accurate assessment and prediction of flash droughts.

The study focuses on the Kashkadarya River Basin, which is entirely within the borders of Uzbekistan. The region's arid climate and intensive agricultural activities are key factors in understanding the challenges posed by flash droughts. The region is facing increasing water management challenges due to the combination of droughts and flash droughts, especially during the growing season. This underscores the necessity of identifying indicators of flash droughts and developing a tool to assess their severity and potential impact.

Objectives

The objective of this study is to validate datasets and identify the most accurate representation of the regional characteristics for flash drought in the Kashkadarya region. Additionally, the study involves a comparative evaluation of drought index patterns calculated from the SiBUC model and ERA5 reanalysis data. This comparison is conducted across various land use categories, such as irrigated and rainfed zones, to examine the consistency and variability of drought behavior under different conditions.

Methodology

The Simple Biosphere including Urban Canopy (SiBUC) model (Tanaka, 2004) is based on the Simple Biosphere (SiB) model (Sellers *et al.*, 1996). The model utilizes a "mosaic" approach to integrate various types of land use into the land surface representation. In the SiBUC model, each grid area is divided into three land-use categories. ERA-5 reanalysis, provided by ECMWF, offers broad spatial and temporal coverage, albeit with coarser resolution. This dataset provides hourly meteorological conditions from 1981.

The Flash Drought Intensity Index (FDII) (Otkin *et al.*, 2021), based on the soil moisture (SM), was used to identify flash droughts. This index analyzes the percentiles of SM relative to 30 years of climatology. FDII includes two components: the rate of intensification and the drought severity, that are calculated relative to baseline values that signify the minimum criteria for identifying flash drought.

The methodology involves a comparative analysis of ERA5 and SiBUC outputs with observational data at locations where all datasets overlap. The region is stratified into zones based on land use types, such as agricultural, and natural landscapes. A variety of statistical measures are employed to quantify the agreement between datasets.

Initial Analysis and Findings

A comparison of evapotranspiration (ET) data from the SiBUC model and ERA5 reanalysis reveals notable discrepancies in irrigated and non-irrigated zones. Both datasets capture the seasonal dynamics of ET (

Fig 1). In irrigated zones, SiBUC outputs align with the expected impact of irrigation, showing higher ET rates compared to non-irrigated areas.

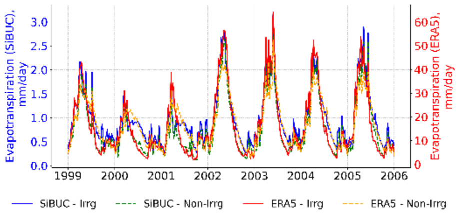

Fig 1.Weekly averaged evapotranspiration comparison (SiBUC vs ERA5) for irrigated and non-irrigated areas

Conversely, ERA5 demonstrates an unexpected trend, with lower ET rates in irrigated zones, which may indicate a slight deficiency in ERA5's accuracy in representing irrigation processes and water availability. A comparison of SM outputs from the SiBUC model and ERA5 reanalysis reveals notable discrepancies between the two datasets in irrigated and non-irrigated regions (Fig 2). Both datasets demonstrate an ability to capture seasonal fluctuations, with peaks corresponding to periods of higher water availability.

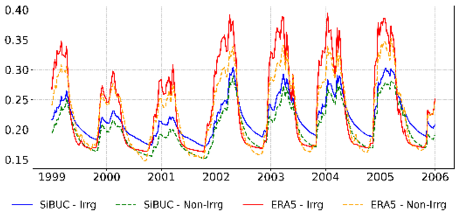

Fig 2. Weekly averaged soil moisture comparison (SiBUC vs ERA5) for irrigated and non-irrigated areas

However, ERA5 tends to overestimate SM values compared to SiBUC in both irrigated and non-irrigated zones. As anticipated, SM is consistently higher in irrigated zones across both datasets. Therefore, ERA5 tends to underestimate the severity of flash drought events, while SiBUC would be more effective. It is worth noting that the index demonstrated high efficiency in capturing long-term drought conditions during known significant drought years, such as 2000–2001, 2008, and 2011 with pronounced peaks (Fig 3). These peaks correlated with documented precipitation deficits during these periods, providing further validation of the index's utility in drought monitoring (Khikmatov *et al.*, 2020). However, discrepancies are observable in the context of short-term events, in both irrigated and natural zones.

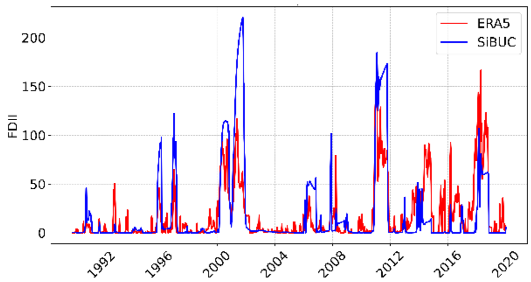

Fig 3. FDII timeseries based on SiBUC and ERA5

Conclusion

The findings underscore the significance of incorporating reanalysis data, observational datasets, and SiBUC model outputs for a thorough examination of flash droughts. While reanalysis datasets provide broad-scale insights, their resolution constraints and deficiencies in capturing irrigation limit their applicability in regions with diverse land use. SiBUC enhances this understanding by providing fine-scale hydrological details. Subsequent research is going to concentrate on adapting the drought index to the region's specific conditions and applying it to assess changes in water demand. This approach will enable a more precise evaluation of drought impacts.

References

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