Drought Threshold Determination for Cambodia －A Satellite-Based Study－
カンボジアの干ばつ閾値の決定－衛星ベースの研究－

○Ol Kimsor*, Junichiro Takeuchi*, Chung Sarit*, and Masayuki Fujihara*
○オルキムソ*・竹内潤一郎*・チョンサリト*・藤原正幸*

1. Introduction

Drought is a major environmental challenge in Cambodia, leading to significant economic losses, particularly in the agricultural sector. As a country where a large portion of the population depends on farming, prolonged dry periods can severely impact livelihoods. Rice production, which requires substantial water, is especially vulnerable, as many farmers rely solely on rainfall for irrigation. In some regions, traditional farming practices further increase the risk of crop failure during droughts. Given the strong dependence on rainfall, understanding precipitation patterns is essential for improving drought monitoring and preparedness. This study focuses on identifying rainfall thresholds that indicate drought severity, helping to enhance mitigation efforts.

2. Study area and methods

Cambodia, located in Mainland Southeast Asia on the southern Indochinese Peninsula, shares borders with Thailand, Laos, Vietnam, and the Gulf of Thailand. The country covers a total area of 181,035 km², with 176,515 km² of land and 4,520 km² of water. Influenced by tropical monsoons, Cambodia experiences a hot and humid climate with two main seasons: the dry season (November–April) and the wet season (May–October). Annual rainfall ranges from 1,200 mm to 2,000 mm, with coastal regions receiving up to 3,000 mm (Phy *et al*., 2022). The average annual temperature is 28°C, with extremes of 38°C in April and 17°C in January (Thoeun, 2015). The country has five major river basin groups: Tonle Sap, Three S, Upper Mekong, Lower Mekong, and Coastal Catchments (Salvadore *et al*., 2017).

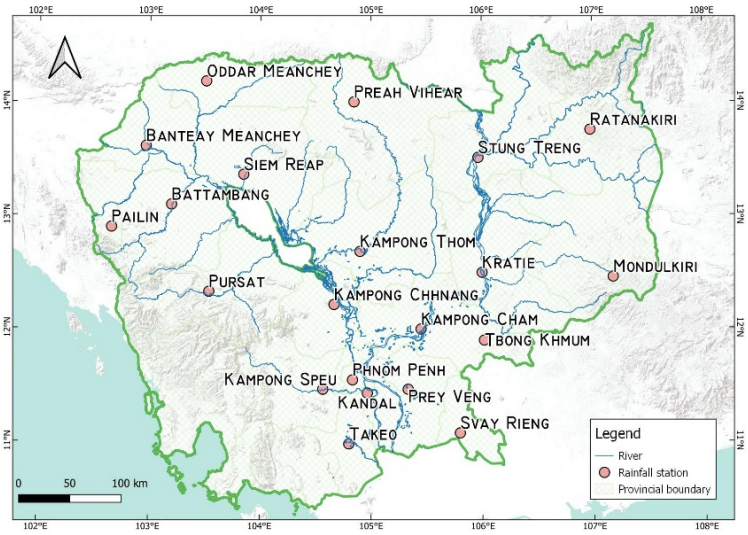

Fig. 1 Study area with the 21 rainfall stations

We utilized daily rainfall data from the IMERG Version 7 satellite, specifically extracted for Cambodia's geographic boundary. Within this boundary, 21 stations were selected for analysis. The dataset spans from January 1, 2001, to December 31, 2022. Of the 21 stations, 15 showed an increase in average rainfall trend, though most experienced only a slight rise or no signification change. Additionally, almost two third of the stations experienced a minor standard deviation increase trend. Using this data, the Standardized Precipitation Index (SPI) was calculated across multiple timescales. The 3-month SPI was employed to identify historical drought events, highlighting their duration and severity, while the 1-month SPI was used to establish drought thresholds.

$$SPI = \frac{X - \mu}{\sigma}$$

where X is the precipitation for the given period, μ is the mean precipitation of the period, and σ is the standard deviation of the precipitation for the period.

*京都大学 農学研究科 Graduate School of Agriculture, Kyoto University
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3. Results and discussion

Cambodia has faced severe droughts for many years, with varying frequencies across provinces, most notably affecting Kampong Speu, Takeo, and Battambang, while nationally, major droughts occurred in 2002, 2003, and 2004—the longest and most damaging until 2006—as well as in 2016 (Open Development Cambodia, 2016). These events have disrupted water availability, crop yields, and rural livelihoods, highlighting the vulnerability of rainfed agriculture. The trend is also reflected in **Fig. 2**, which further emphasizes the recurrence and severity of drought conditions in these regions over time.

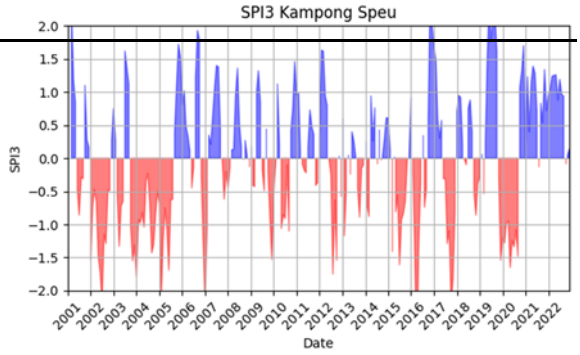


Fig. 2 3-month timescale SPI

Table 1 Classification of SPI value (McKee *et al*., 1993)

SPI values	Class
0 to -0.99	Mild drought
-1.00 to -1.49	Moderate drought
-1.50 to -1.99	Severe drought
≤ -2.0	Extreme drought

Table 1 categorizes drought severity based on SPI values, where lower SPI values indicate more intense drought conditions.

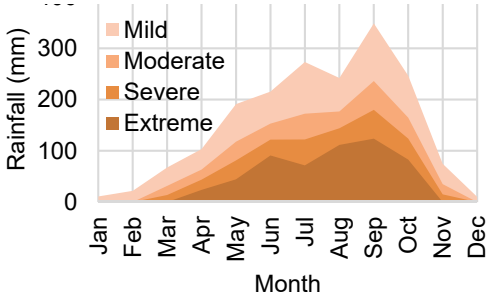
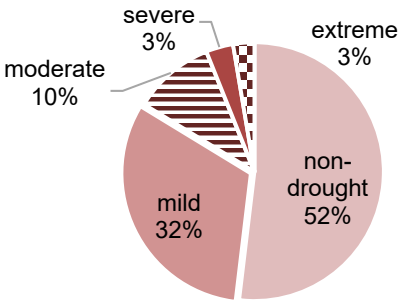


Fig. 3 Drought threshold on 1-month timescale in Battambang

Battambang is one of Cambodia's top rice-producing provinces, renowned for its high-quality rice. According to the **Fig. 3**, the country experiences peak rainfall in September, with a gradual increase starting in May and a sharp decline after October. At this station, a minimum of approximately 100 mm of rainfall is required to avoid being classified as an extreme drought condition only in terms of rainfall or as an extreme meteorological drought during peak rainfall months.



Based on **Fig. 4**, drought conditions occur nearly half of the time at Takeo station, with the highest incidence of extreme drought compared to the other rainfall stations. Severe and extreme drought events each account for approximately 3% of the total occurrences. This highlights that while extreme droughts are rare, drought conditions as a whole are still a common occurrence at this station.

Fig. 4 Drought frequency in Takeo station

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