Pemodelan Kekeringan Hidrologis Skala Pulau Sumatra Menggunakan Model Hidrologi Berbasis Data Satelit

Penelitian dan Pengabdian kepada Masyarakat

Faizal Immaddudin Wira Rohmat, S.T., M.T., Ph.D [1], Yasyfa Kharima, S.T[1], Ardy Nur Ahmadito, S.T., M.T[1]

[1] Faculty of Civil and Environmental Engineering, Institut Teknologi Bandung, Indonesia

Introduction

Flooding is a major problem throughout the world. Rare extreme weather events that are aggravated by climate change could drive floods to larger frequency of occurrence. Cyclone Senyar for example, destroyed the northern part of Sumatra, sweeping a large area of forests and habitable areas with floods and landslides. An understanding of these events requires a hydrologic regional scale model that can capture watershed dynamics in large extent in short and long-term.

Objective

This study aims to develop a long-term hydrological model for Sumatra, particularly to capture rare hydrological events. The details are as follows:

1. Simulate river discharge in two of Sumatra's watersheds that includes a calibration and validation attempt using VIC – RAPID coupled model
2. Assess its calibration and parameter transferability performance, and
3. Assessing VIC's potential to be used as regional scale model in Sumatra

Research Method

the research flowchart conducted in this study started with input data and its preprocessing, then to VIC modelling. The workflow continued to the coupling of RAPID itself, then calibration and validation.



Picture 1. The four main steps of this study illustrated by a simplified research flowchart

Result & Discussion

Calibration achieved a satisfactory NSE of 0.42 and a good KGE of 0.60 during calibration. The simulated discharge visually aligned with observed data and captured seasonal patterns, despite discrepancies in peak magnitude and timing. The model also indicated a major hydrological response in late November 2025, coinciding with the major Sumatra flood event.

Validation performance declined significantly in the Batanghari watershed achieved NSE of 0.07 and KGE of 0.60, indicating limitations in parameter transferability. Differences in watershed characteristics and hydrological responses may explain why the calibrated VIC parameters could not adequately represent another watershed.

However, calibrating VIC using only a single watershed may not represent the entire regional extent due to variations in land cover, soil, and other watershed characteristics. Model limitations include uncertainties in observed streamflow data, simplified spatial variability of rainfall, homogeneous soil parameters, and insufficiently refined RAPID river reaches.

Conclusion

VIC's parameter was applied directly, whereas RAPID is recalibrated to match the new validation watershed. This could indicate an anomaly during surface runoff generation. Presumably, the generated runoff volume from VIC was not sufficient, so that RAPID's recalibration resulted in a highly volatile river routing model. Because of this, an improvement regarding the choice of watershed for calibration is needed. It must be the most representative watershed with similar characteristics. A multiple calibration run in multiple watersheds could also be implemented for better spatial variability.

Picture 2. VIC-RAPID coupled model result. (a) Sei Wampu-Stabat River Basin for Calibration (b) Batanghari watershed for Validation.

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