Chapter 10
Detection of Ephemeral Sand River Flow Using Hybrid Sandpiper Optimization–Based CNN Model

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ABSTRACT

Ephemeral sand rivers are a major supply of water in Southern Africa that flow continuously all year. The fact is a sizeable fraction of this water permeates the silt in the riverbed, protecting it from evaporation and keeping it available to farmers throughout the dry season. This study set out to investigate the usefulness of satellite optical data in order to assess the possibility for discovering unexpected surface flows. The spatio-temporal resolution required to identify irregular flows in the comparatively small sand rivers typical of dry regions. A hybrid pre-trained convolutional neural network is used to execute data categorization using the hybrid sandpiper optimization technique. Sentinel-2's higher spatial and temporal resolution allowed for accurate surface water identification even in conditions where river flow had drastically decreased and the riverbeds were heavily hidden by cloud cover. The model suggested in this study fared better than rival models in this field, obtaining a remarkable accuracy rate of 99.77%.

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1. INTRODUCTION

Ephemeral rivers, often referred to as non-perennial rivers, have a special seasonal pattern in which they have a hidden stream in the dry season and an exposed riverbed in the rainy season. Due to causes including climate change, changes in land use, and water abstraction, this trait is becoming more and more important on a worldwide scale (He et al., 2019). Due to the variety of sediment particle sizes, these rivers often have sandy riverbeds with high permeability and varied porosity along their courses (Liang et al., 2021; Baswaraju et al., 2023; Aprisal et al., 2019). These dry transitory alluvial streams, especially in arid and semi-arid areas, are crucial for replenishing local and regional aquifers despite their patchy flow (Su et al., 2019). One method for addressing water shortage concerns is changing the design of the river channel to improve axial connection and increase the distance for flood route (Chen et al., 2021). This approach improves the whole river ecosystem as well as the riparian and urban surroundings. In this situation, it is essential to accurately anticipate flood movement under various circumstances, particularly route lengths.

Flood routing models frequently employ equations like the Saint-Venant equation or its simplified variants (Ngoma et al., 2021; Thirumalraj et al., 2023) and the Muskingum equation (Mpala et al., 2020), although commonly used software tools like MODFLOW (Huang et al., **2020**) and HYDRUS (Sacre et al., 2020) are mostly focused on groundwater movement. To account for flood routing with leakage (Hughes, 2019), these models contain infiltration models such as the Green-Ampt model, the Philip model, Kostiakov's empirical formula, and the Horton solution (Gong et al., 2020). Accurately estimating transmission loss is a major difficulty in the development of groundwater flow models for characterising liquid equilibrium inside alluvial deposits (ISRIC World Soil Information (2023) WebsiteS. https://www.isric.org/. Accessed 1 May 2019). The phrase "transmission loss" refers to streamflow reductions brought on by evaporation from streams, infiltration into riverbeds, and reductions in streamflow to upstream embankments or floodplains. Through gearbox loss studies, flood-induced vertical patterns of water content in riverbed sediments have been investigated (Issoufou et al., 2023). Infiltrometers have also been used to determine if particles from the riverbed may re-enter the river channel during dry spells (Kendon et al., 2019). These techniques provide insightful analyses of geographical and temporal data at small sizes. However, there is still need for further study and improvement in terms of enhancing these indicators for catchment water balance calculations.

The main contributions of this paper are:

- This study proposes satellite optical images, in particular Sentinel-2's high spatial resolution, as a practical approach for sand river surface flow detection.
- The study uses a hybrid pre-trained CNN for classification, showcasing how well deep learning methods can identify these sporadic and intermittent surface flows.
- In order to acquire accurate findings in surface flow detection, it is crucial to effectively fine-tune the model. This study introduces the Hybrid Sandpiper Optimization Technique (HSPOA) optimisation for hyperparameter optimisation.
- For their examination along the Shingwidzi River in Limpopo, researchers used Sentinel-2, a satellite with a stunning 10-meter spatial resolution, to get around this restriction.
- Results are evaluated using five parameter metrics such as accuracy, precision, recall, specificity and F-measure.

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