A COMPREHENSIVE ANALYSIS OF MACHINE LEARNING AND REMOTE SENSING TECHNIQUES IN STUDYING CLIMATE HAZARDS-INDUCED CROP YIELD VARIATIONS

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INTRODUCTION

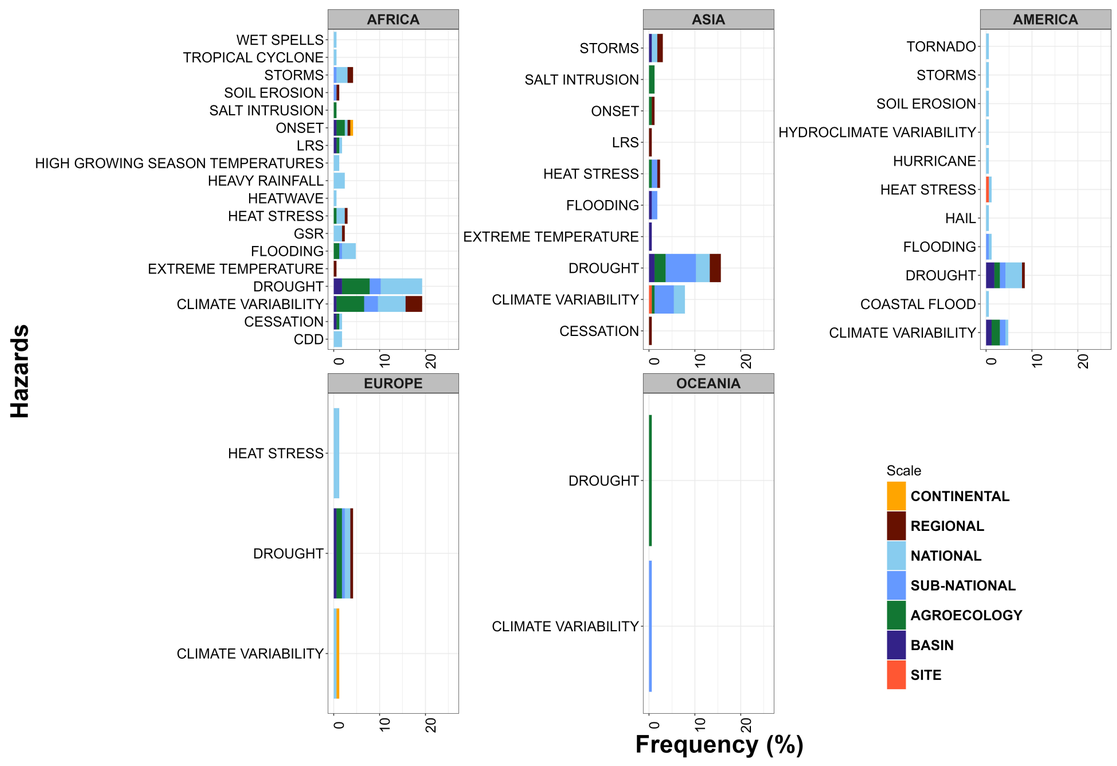
The use of machine learning (ML) techniques and remote sensing (RS) products in climate hazard detection has grown over the past decades. However, there is no comprehensive review of what methods work best at which scale to detect single or compounded climate hazards and their impact on crop production systems across scales. The objective of this study was to carry out a systematic review of the use of ML and RS in assessing climate hazards impacting crop yields.

DATA AND METHODOLOGY

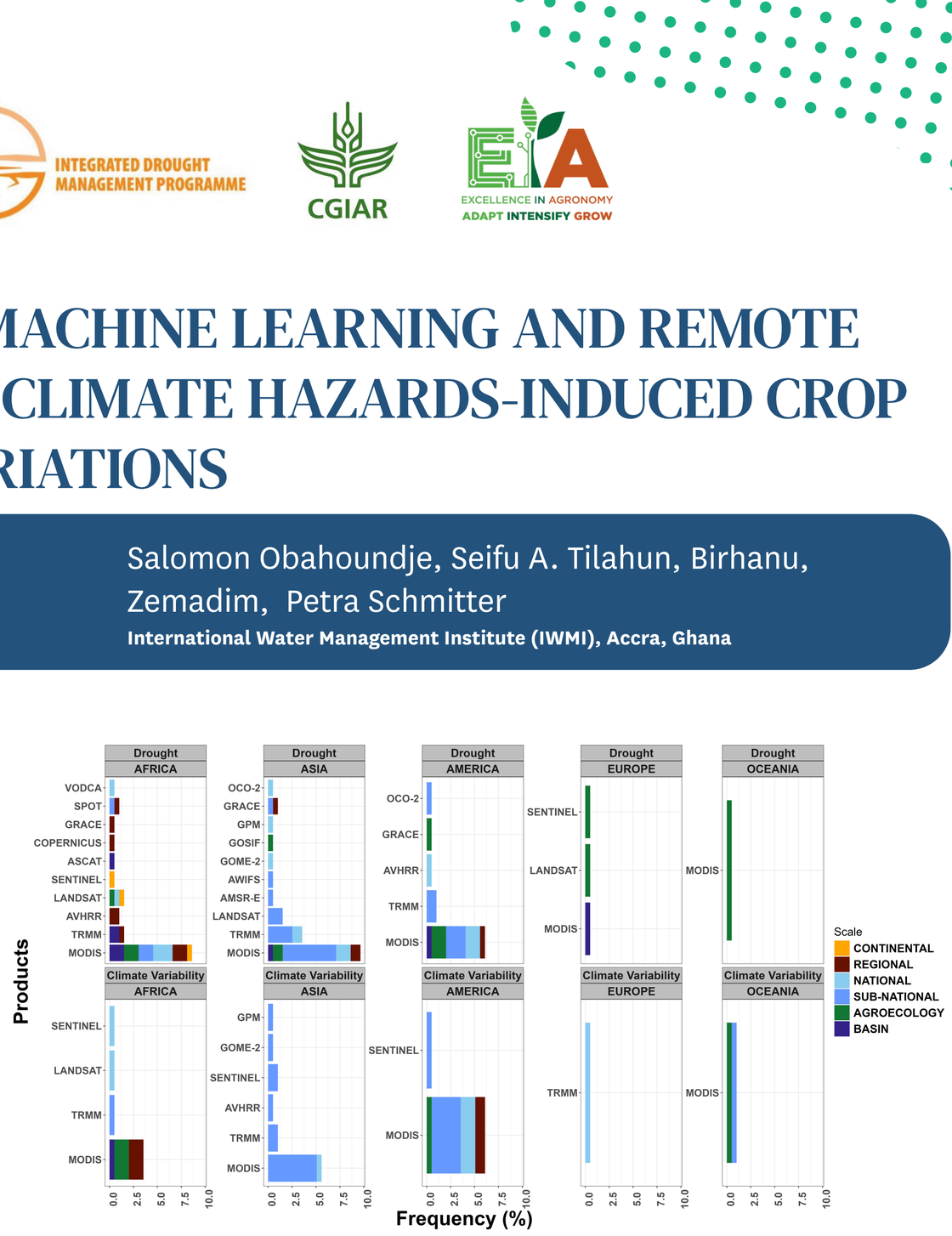
- A systematic review using the PRISMA approach to address key questions on climate hazards, their quantification using AI/ML/RS methods, and their impact on crop yield.
- A total of 380 publications were screened using keywords "Climate hazards" AND "crops yield" AND ["Machine Learning" OR "Remote Sensing"] from which 197 were used based on relevance.

RESULTS

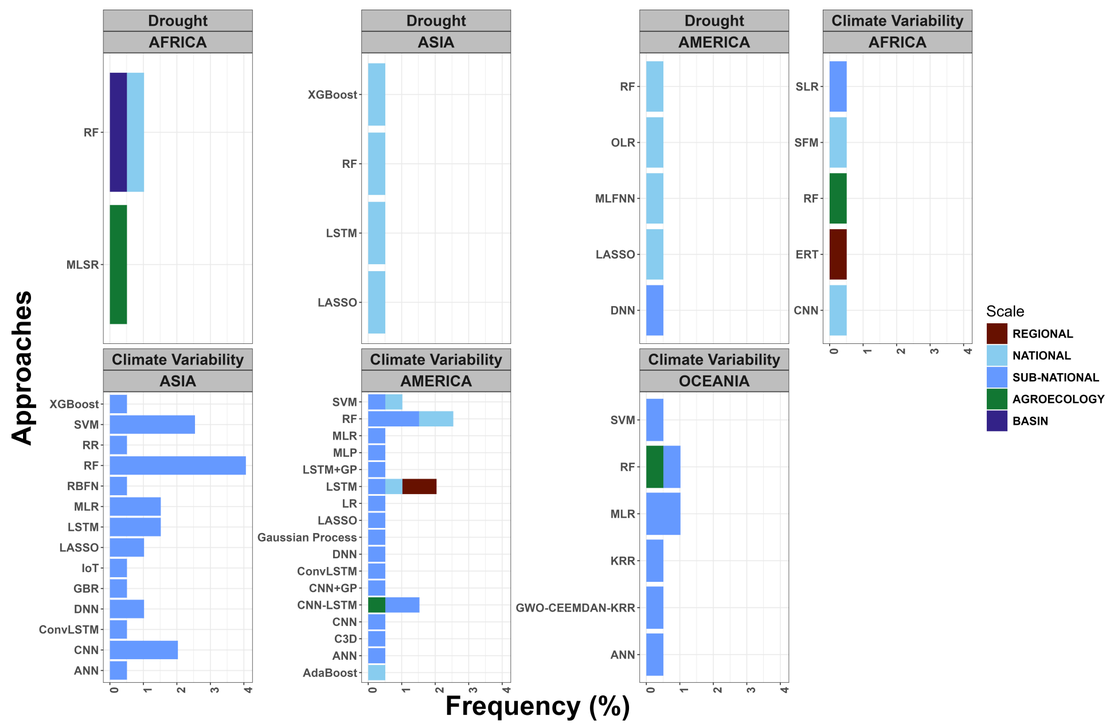
- Increase trend in the scientific literature from 2015 to 2023 addressing climate hazards detection and the use of ML/RS techniques in assessing their impacting crop yields
- Drought and climate variability were the wide climate hazards addressed across continents and scales.



- MODIS and TRMM were the most extensively used RS products to study drought and climate variability hazards and their implication for crops yield across scales



- RF and SVM were the most extensively ML approaches used to model the drought and climate variability impacts on crops yield across the scale
- Most applied at sub-national scale in Asia and America.



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CONCLUSION AND PERSPECTIVES

- Droughts and climate variability are the most frequently studied hazards in Africa and Asia. However, Africa lacks detailed sub-national studies, and important indicators like rainfall onset and wet/dry spell duration are often overlooked. Implement policies targeting the management of droughts and climate variability in vulnerable regions like Africa and Asia to enhance food security.
- ML techniques such as SVM, RF, and deep learning methods (CNN, LSTM) are widely used in drought prediction and crop yield modeling, but there is a limited application of these methods at the sub-national level in Africa. Encourage the broader adoption of ML and RS technologies to improve predictions of climate hazards and their impacts on crop yield, supporting agricultural risk management.
- MODIS and TRMM were the most extensively used RS products, but they face limitations in spatial and temporal resolution, hindering accurate climate hazard predictions and micro-climate assessments for locally-led climate adaptation. Ensure better quality and availability of training data to improve the accuracy of ML algorithms for crop yield modeling and climate hazard predictions.

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