Sustainable Blue Energy: Advancing Marine Renewable Energy Assessment and Nearshore Suitability Pathways in the Western Indian Ocean

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1. INTRODUCTION

The Western Indian Ocean (WIO) exhibits substantial marine renewable energy potential from ocean currents, waves, and offshore winds.

Despite increasing interest in Blue Economy development, regional-scale environmental intelligence products supporting marine energy planning remain limited.

This study develops a scalable framework integrating Earth Observation (EO), oceanographic datasets, hydrodynamic modeling, and particle tracking to identify and characterize candidate marine renewable energy zones across the WIO.

2. OBJECTIVES

Characterize the spatial and temporal distribution of ocean current, wave, and offshore wind resources across the Western Indian Ocean.

Identify candidate marine renewable energy hotspots through integrated suitability assessment.

Refine nearshore suitability pathways using high-resolution hydrodynamic and particle-tracking simulations.

Support evidence-based marine energy planning and sustainable Blue Economy development.

3. METHODOLOGY

- **Data Acquisition**

Ocean Currents, Waves, and Offshore Wind (Copernicus Marine)

- **Regional Climatologies**

Long-term resource characterization and energy indicators

- **Suitability Assessment**

Resource scoring and multi-criteria integration

- **Hotspot Identification**

High-potential regions and candidate development zones

- **High-Resolution Modeling**

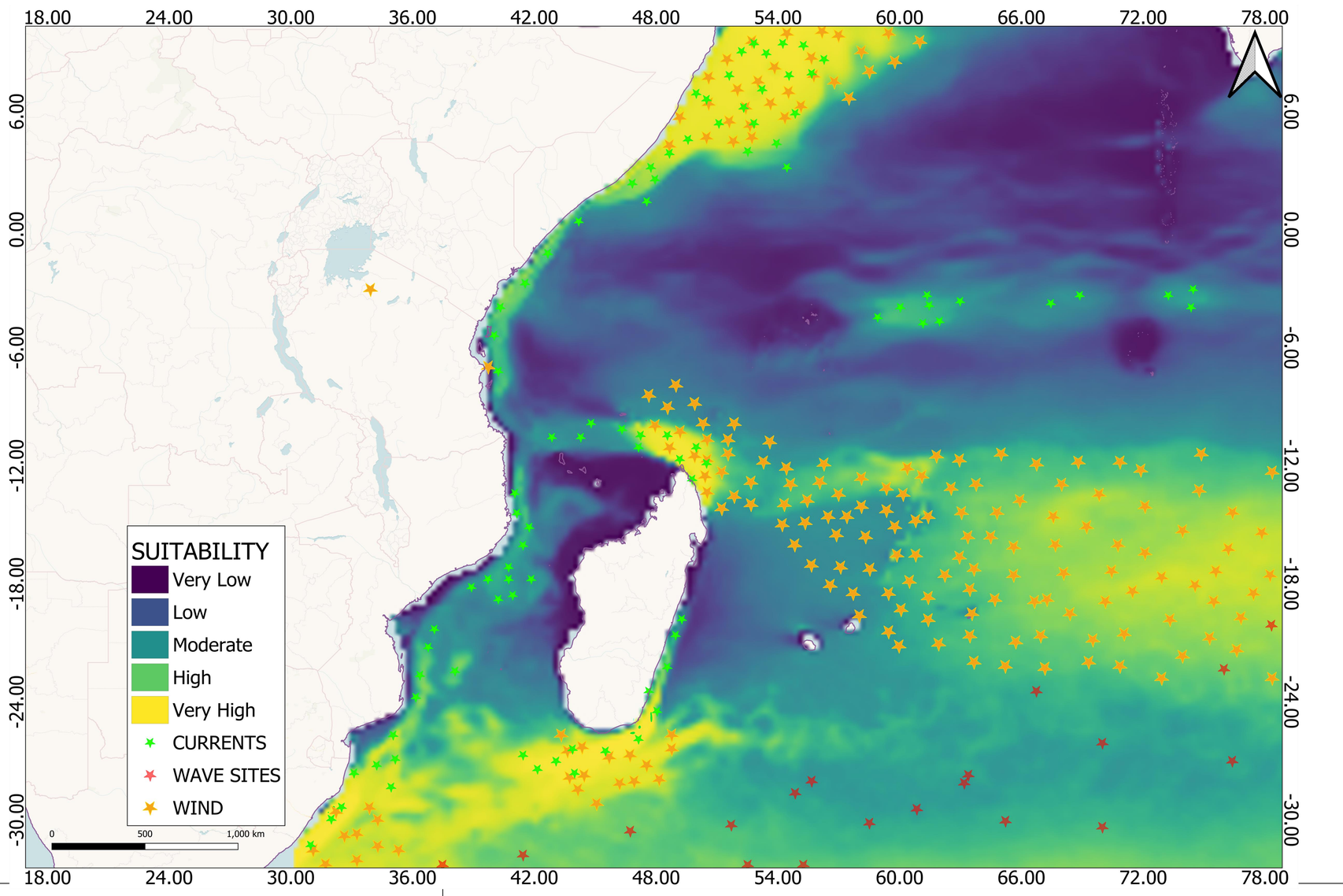
CROCO hydrodynamic modeling and Open Drift simulations

- **Decision Support**

Site screening, planning, and marine renewable energy development

4. RESULTS

Integrated Marine Renewable Energy Suitability : Western Indian Ocean



5. DISCUSSION

The assessment identified several promising marine renewable energy hotspots across the Western Indian Ocean, including the Somali Current System, Mozambique Channel, South Madagascar, Agulhas Extension, and the Equatorial Western Indian Ocean.

Results demonstrate the value of integrating ocean current, wave, and offshore wind climatologies for regional-scale resource screening and hotspot identification.

However, available Earth observation and reanalysis datasets remain too coarse for detailed nearshore characterization, highlighting the need for high-resolution modeling and field-based investigations to improve resource assessments and support future marine energy development.

6. WAY FORWARD

Future work will apply CROCO and OpenDrift simulations to refine hotspot characterization, improve power estimates, and support site-scale suitability assessments.

Model outputs will be validated through in-situ measurements and field investigations.

Interactive assessment outputs and future simulation products will be accessible through dedicated web portals.

7. REFERENCES

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