Python-Based Renewable Energy Resource Analyser (RERA): a Multi-Criteria Decision Support Tool for Renewable Energy Site Suitability in Namibia

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SUMMARY

Objectives

Namibia faces a persistent national energy deficit where only about 56% of the population has access to electricity, and the country continues to import nearly 60% of its power. This situation presents both an economic and developmental challenge. The objective of this project was to design and develop the Renewable Energy Resource Analyser (RERA)—a Python-based, cross-platform Geographic Information System (GIS) tool to support renewable energy site suitability analysis. The application integrates multiple spatial datasets and implements the Analytic Hierarchy Process (AHP) to evaluate and rank suitable areas for renewable energy projects, specifically solar, wind, and green hydrogen developments.

Results

RERA was developed using Python 3.12 and key geospatial libraries such as Tkinter, Rasterio, Geopandas, and NumPy. It integrates data from authoritative sources including Digital Namibia, the Global Wind Atlas, and the Global Solar Atlas. The system architecture features two core modules:

Data Viewer – allows users to load, visualize, and toggle vector and raster datasets interactively using TkinterMapView with OpenStreetMap basemaps.

AHP Suitability Module – enables users to conduct pairwise comparisons of spatial criteria such as land tenure, roads, powerlines, substations, terrain (DEM), and solar irradiance (DNI). The module then calculates criterion weights, applies spatial decay functions to proximity datasets, and generates normalized suitability rasters

(heatmaps).

Conclusions

The project demonstrated the effectiveness of integrating multi-criteria decision analysis (MCDA) within a GIS-based desktop environment. By implementing AHP and spatial transformation techniques, RERA provides a reproducible and transparent workflow for site selection. The tool operates offline, making it suitable for regional institutions with limited internet connectivity. Its modular design also allows for scalability, including potential integration with cloud databases or national energy planning systems.

Significance of the Work

RERA contributes a locally adaptable decision-support framework for Namibia's renewable energy planning efforts. It bridges the gap between spatial data availability and energy policy implementation by providing planners, researchers, and policymakers with a functional, open-source platform for evidence-based decision-making. Beyond Namibia, the tool demonstrates how open geospatial technologies and AHP methodologies can be leveraged to promote the United Nations Sustainable Development Goals (SDG 7 – Affordable and Clean Energy and SDG 13 – Climate Action).