SCHOOL OF
SCIENCE, ENINEERING
& TECHNOLOGY

RMIT UNIVERSITY

Development of Vegetation and Water-Related Ecosystem Monitoring Application

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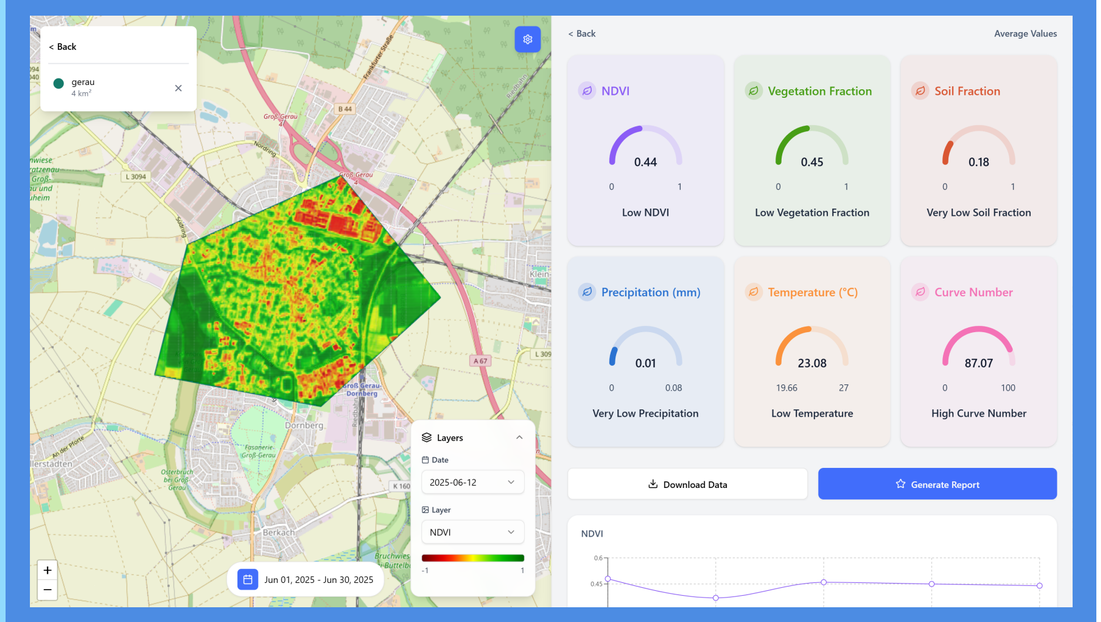
RSS-Hydro

OBJECTIVE

- The growing occurrence of extreme environmental events and the rapid decline of ecosystems underscore the pressing need for scalable, data-driven monitoring solutions.
- This project sets out to build a full-stack web application that incorporates the HydroSENS algorithm, an Earth Observation-based model, into a user-friendly and interactive platform. The system will process satellite imagery using HydroSENS and deliver the outputs through an intuitive interface tailored to the needs of farmers, conservationists, and environmental agencies.

BACKGROUND AND MOTIVATION

- The growing impacts of climate change and environmental degradation have heightened the demand for efficient and accessible tools to monitor ecosystems. Traditional monitoring approaches are labor-intensive, limited in coverage, and unable to effectively capture changes across time and space.
- The HydroSENS algorithm, developed by RSS-Hydro, offers a significant advancement in this domain by applying spectral unmixing techniques to multispectral satellite imagery to estimate surface runoff. Furthermore, it provides actionable metrics that are directly relevant to ecosystem services and water-related monitoring, offering substantial value for conservation agencies, policymakers, and farm holders.



METHODOLOGY

Frontend:
- Built using React 19 with TypeScript, styled with Tailwind CSSfor consistent, accessible design.
- Integrated Leaflet for interactive maps, enabling region selection, shapefile rendering, and geospatial visualization.
- Developed five main views: Map View, Detailed Region View, Region Drawing View, Settings View, and Report View, following Figma-based UI designs.
- Implemented state management via Redux to handle settings, selections, and asynchronous data operations.
- Supporting PDF and CSV outputs.

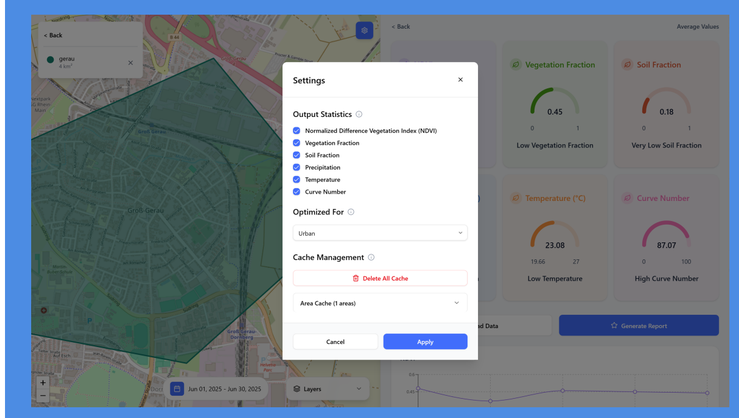
Backend: Architected two main containerized services:
- Web API : Handles business logic, HydroSENS version selection, and routes requests to computational services.
- HydroSENS API: Runs the HydroSENS algorithm on near-real-time EO imagery from trusted data providers.
- Enabled Generative AI integration for natural language report summaries.
- Optimized the HydroSENS algorithm to reduce computation time without affecting data accuracy using Docker volumes for shared caching

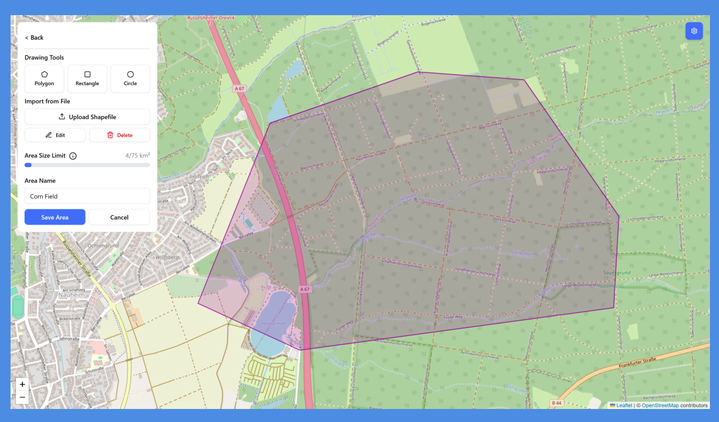
EXPERIMENT AND RESULTS

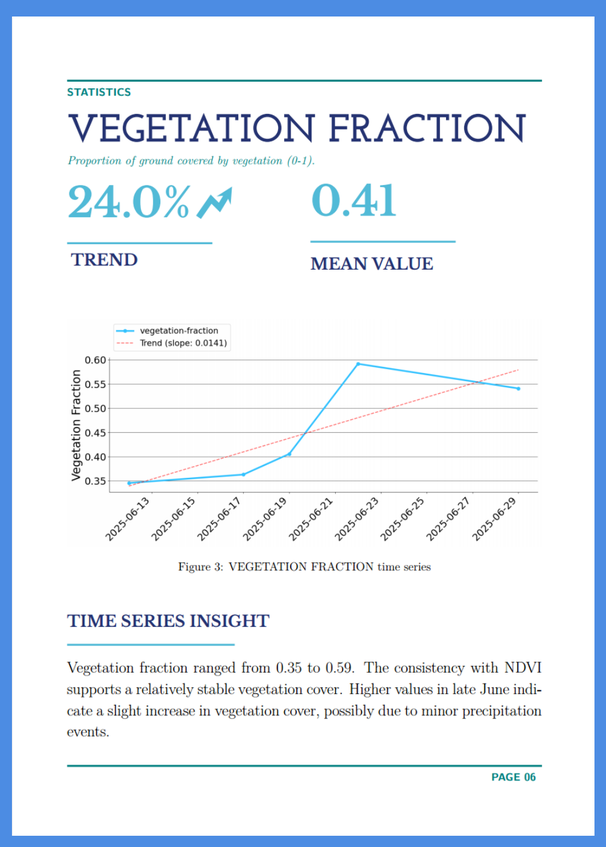
The HydroSENS web application was developed with all defined and additional agreed features. It achieved a 100% pass rate across all test cases, with no major bugs detected. Optimization strategies reduced HydroSENS algorithm processing time while maintaining accuracy, confirming the system's readiness for stakeholder deployment. The application has also been used to analyze different regions across Europe and Vietnam, and provide useful statistics

CONCLUSION

The HydroSENS web application delivers a complete, high-performance solution for monitoring vegetation health and water-related ecosystem changes using near-real-time EO data. All scoped features were fully implemented and passed in testing. Performance benchmarks were met or exceeded, with rapid data retrieval, low-latency processing, and optimized algorithm execution. The system is robust, user-friendly, and ready for deployment to support informed environmental decision-making.






STATISTICS

VEGETATION FRACTION

Proportion of ground covered by vegetation (0-1).

24.0% TREND

0.41 MEAN VALUE

Figure 3: VEGETATION FRACTION time series

TIME SERIES INSIGHT

Vegetation fraction ranged from 0.35 to 0.59. The consistency with NDVI supports a relatively stable vegetation cover. Higher values in late June indicate a slight increase in vegetation cover, possibly due to minor precipitation events.