

AquaForest: Nature-based-Solutions for restoring and developing new mangrove habitats through eco-engineering

Stratigaki Vicky¹, Evenepoel Jelle², Ligoit Noa², de Meyer Margot², Wille Mathieu³, Lemery Emile³, Stols Ignace², De Prins Dominic², Chejin Andrea⁴, Berd Herremans³, Blondeel Evelyn⁵, Ibanez María⁵, De Sutter Renaat⁵, Bohorquez Boris⁶, Temmerman Stijn⁷ and Farid Dahdouh-Guebas⁸

¹ Ghent University

E-mail: Vicky.Stratigaki@jandenul.com

² Jan de Nul Group, Belgium

³ Mantis Consulting, Belgium

⁴ Escuela Superior Politécnica del Litoral, Ecuador

⁵ Haedes, Belgium

⁶ Fundación Calisur, Ecuador

⁷ University of Antwerp, Belgium

⁸ Vrije Universiteit Brussel, Belgium

Mangrove ecosystems are crucial for coastal resilience, biodiversity, and carbon storage. However, more than half are at risk of collapse due to human activities, sea-level rise, and severe storms, as highlighted by the IUCN Red List of Ecosystems. At the same time, vast volumes of dredged sediments could be repurposed to sustain mangrove habitats in tropical and subtropical regions. The AquaForest project addresses these dual challenges by demonstrating for the first time the circular reuse of dredged material to restore and create mangrove habitats.

Jan De Nul Group leads the consortium of eight partners, including private consultants, universities, and NGOs. The AquaForest project is located in the Guayas Delta in Ecuador. This region, characterized by mangrove ecosystems, has suffered severe habitat loss, heightening risks of coastal flooding and erosion. Since 2018, the Jan De Nul Group has maintained the Access Channel to Guayaquil's port, providing a unique opportunity to reuse dredged sediments innovatively. After over a year of extensive investigations, including data collection and eco-engineering studies, the project successfully secured permits and identified an intertidal flat near the Access Channel as the most suitable location for a new mangrove habitat.

The habitat, designed as a 50-hectare landmass, comprises a J-shaped sand bund and a semi-permeable structure and is filled with silty sediments. Hydrodynamic modelling verified the landmass's hydraulic stability, while sediment analyses and mangrove nursing experiments confirmed its suitability for supporting mangrove growth. Construction was completed in September 2024, following four months of operations. Local workers built a 3-kilometer semi-permeable wall using natural materials to contain the sediment and protect the 1.5-kilometer sand dike. The wall's wave-breaking effect is under study in collaboration with Gent University.

Although the habitat is designed to facilitate natural mangrove recruitment, 10,000 propagules and 14,000 saplings spanning three local mangrove species were planted to initiate afforestation efforts. Early results from monthly drone monitoring indicate good survival rates for the mangrove saplings together with sediment compaction on the land mass. The University of Antwerp is tracking carbon sequestration as part of the cSBO WetCoast project, incorporating advanced technologies such as LiDAR to assess the mangrove canopy architecture. Projections suggest a net negative carbon balance of the project reaching 5,000 tCO₂e over ten years. Monthly biodiversity assessments conducted by the local university, ESPOL, will further refine the evaluation of ecosystem services, which are currently estimated to generate an average of €650,000 annually upon the full maturation of the mangrove habitat. AquaForest's rich biodiversity will also be showcased through the creation of a bird guide, developed in collaboration with local NGOs and fishing communities, to enhance ecological awareness and support the growth of potential eco-tourism initiatives.

Community engagement has been integral throughout the project. Local stakeholders, including residents and authorities, have been trained in nursery management, planting, and long-term habitat stewardship, ensuring the sustainable management of the new habitat while fostering socio-economic benefits. AquaForest exemplifies a Nature-based Solution that delivers flood protection, ecosystem restoration, and climate adaptation.

This living lab offers critical insights into the practical implementation and scalability of mangrove-based Nature-based Solutions globally. AquaForest provides a replicable model to address the interconnected crises of mangrove loss and climate change.

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Keywords

Nature-Based Solution, Mangrove Restoration, Eco-engineering, Sustainability, Ecuador