

Nature-based Building Blocks (NB³) Framework to support upscaling restoration through NbS in coastal adaptation: Theory, practice, and lessons learned

Cengiz Arslan¹, Jeroen Warner², & Jantsje M. van Loon-Steensma¹

¹Wageningen University & Research, Environmental Sciences, Earth Systems and Global Change, the Netherlands

²Wageningen University & Research, Social Sciences, Sociology of Development and Change, the Netherlands

1 BACKGROUND

Coastal ecosystems are biodiversity-rich and of profound societal importance—home to ~40% of the global population and generating nearly two thirds of annual global ecosystem services value. Yet they face escalating, intertwined pressures from climate change, biodiversity loss, and pollution (the Triple Planetary Crisis).

Nature-based Solutions (NbS) offer integrated co-benefits addressing these interconnected challenges and are endorsed by global policy frameworks (UN 2030 Agenda · EU Green Deal · Kunming-Montreal GBF).

Scaling NbS for effective, long-term coastal adaptation remains a critical challenge.

2 CHALLENGES TO UPSCALING

Participation bias

- Disciplinary silos; social sciences underrepresented
- Inadequate stakeholder engagement

System complexities

- Dynamic coastal processes
- Habitat connectivity
- Competing land use

Pilot dilemma

- Fragmented, isolated pilots
- Short-term, project-specific design



3 CONCEPT OF THE NATURE-BASED BUILDING BLOCKS

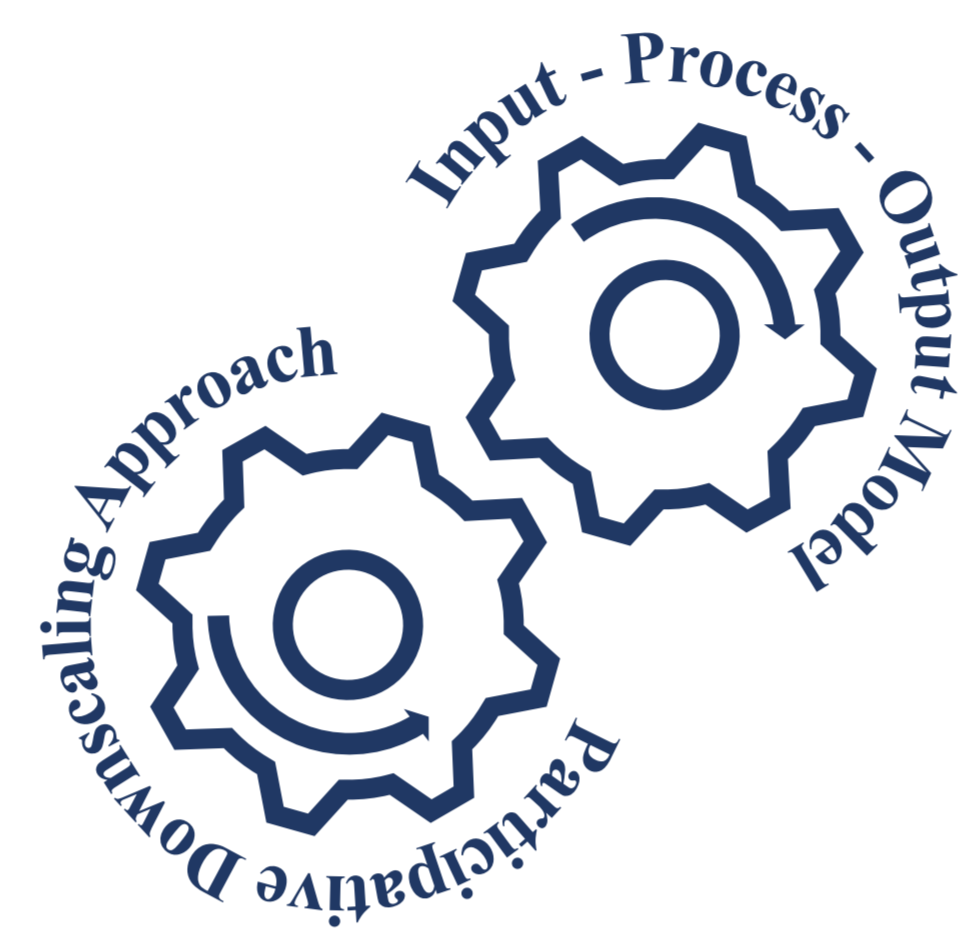
- Drawing on NbS pilots as the evidence-base for successful implementation
- Integrating systems theory, stakeholder engagement, and policy frameworks
- Aligning local context with broader environmental goals
- Balancing biophysical, ecological, and socio-economic dimensions
- A novel NB³ definition as the conceptual foundation:

Nature-Based Building Blocks (NB³) are basic units of construction or composition that are identified from downscaling of large-scale coastal restoration sites. Bounded by/limited with the key biophysical and socio-economic parameters of those sites, these units are associated with delivery of enhanced Ecosystem Services (ESS) and improved Biodiversity (BDV). Put together either as stand-alone or in harmony with each other, NB³ are the essential constituents in building up and developing larger scale coastal restoration through upscaling at target sites (Arslan & van Loon-Steensma, 2025).

4 FOUNDATIONS OF THE NB³ FRAMEWORK

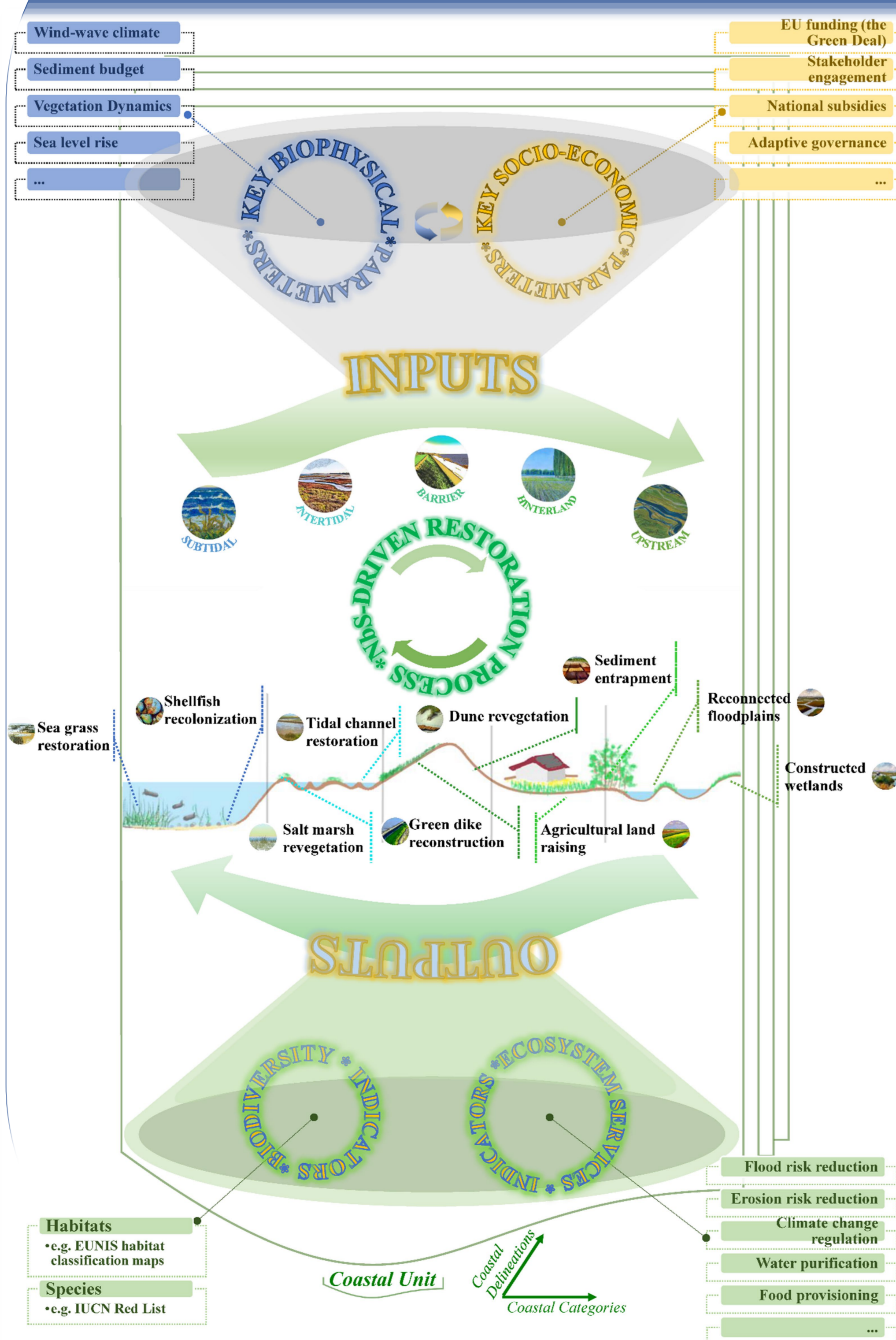
Two complementary methods systematically translating the definition into a structured basis for supporting NbS upscaling.

The Participatory Downscaling Approach guides stakeholders to spatially delineate smaller, homogeneous Coastal Units across two conceptually orthogonal axes, integrating locally informed knowledge and expertise



The Input-Process-Output (IPO) model reduces complex coastal systems to three functionally linked compartments, embedding local dynamics into NbS-driven solutions aligned with broader climate adaptation goals

5 THE NB³ FRAMEWORK



- Participatory and locally explicit by design.
- Stakeholders map broader coastal landscapes as interconnected socio-ecological systems
- The Participatory Downscaling Approach incubates Coastal Units, combining landscape-level perspective with improved resolution through scale reduction
- The IPO model is applied within each unit;
 - *Diagnose inputs*—biophysical and socio-economic parameters explaining degraded state
 - *Project outputs*—expected biodiversity and ecosystem service delivery defining restored state
 - *Select process*—most suitable NbS intervention through inclusive decision-making
- Together, these methods constitute the NB³ Framework—a scalable, integrated, and transferable structure for coastal NbS upscaling

Graphical overview of the NB³ Framework (Arslan & van Loon-Steensma, 2025)

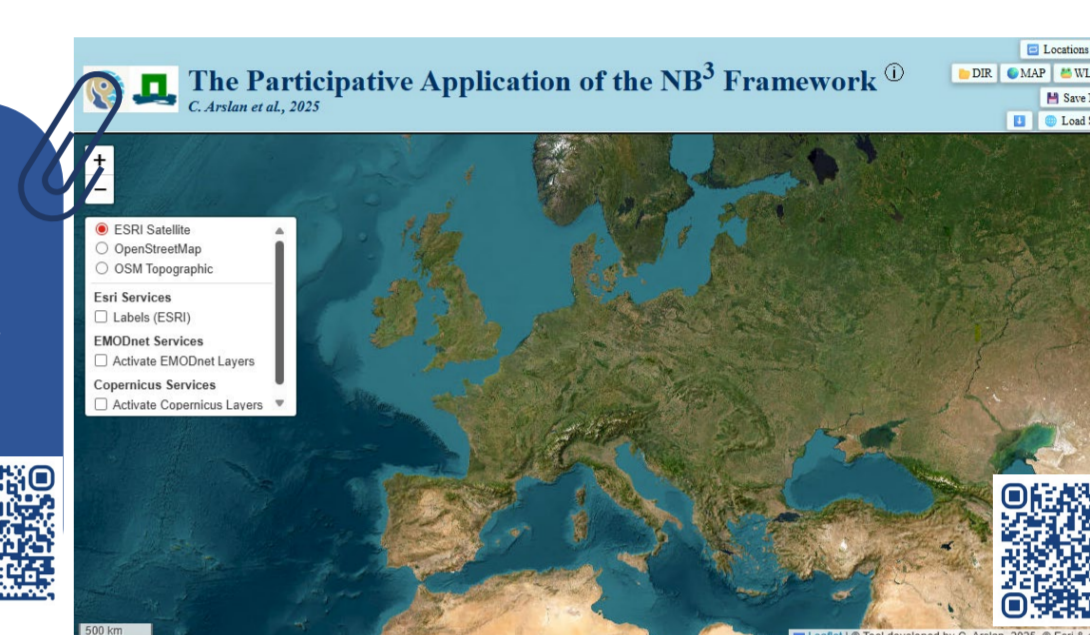
6 PARTICIPATORY APPLICATION ACROSS REST-COAST PILOTS



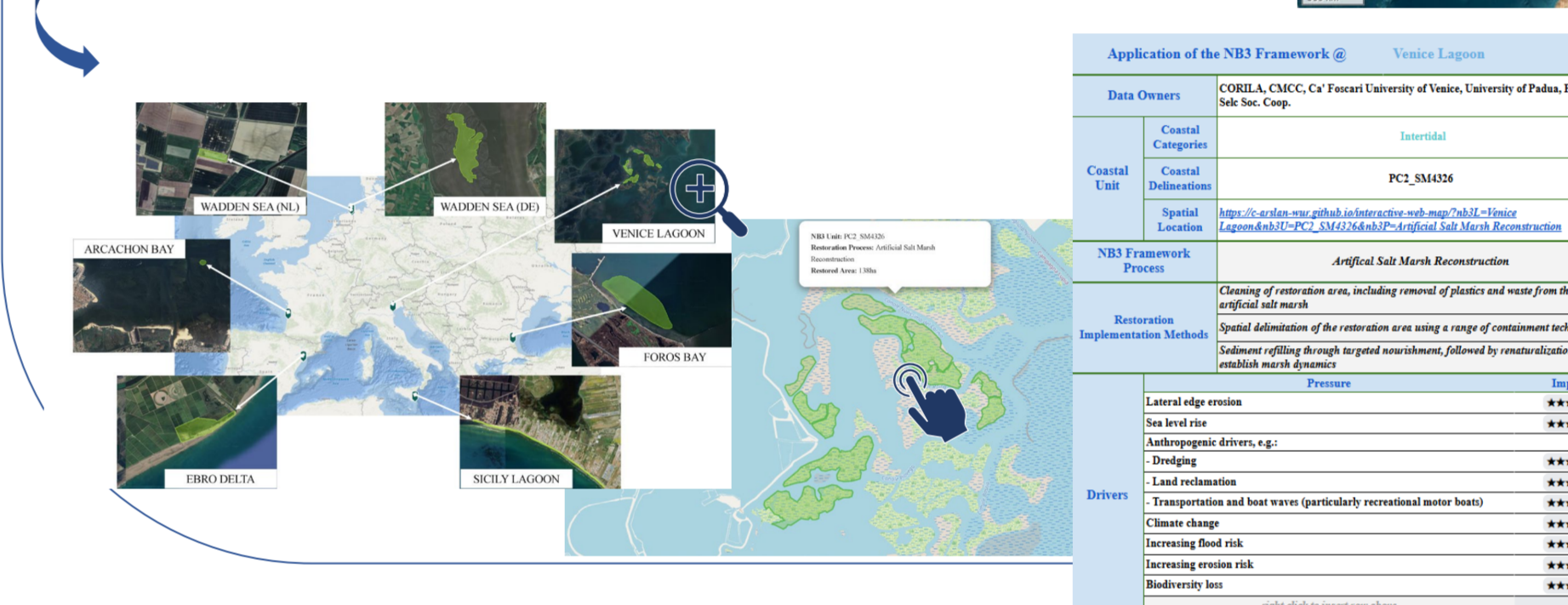
EU H2020 REST-COAST coastal restoration pilots—diverse coastal environments, restoration challenges, and socio-ecological context

Shared target: demonstrating large-scale coastal restoration to enhance biodiversity and ecosystem services delivery

- The Interactive Web Map—geospatial tool embedding the NB³ Framework
- Streamlines collectively working on spatial data & participatory mapping
- Openly accessible via GitHub Pages—full documentation available (Arslan, 2025)



An ideal testing ground for the participative application and cross-pilot validation of the NB³ Framework



- Spatial map elements linked to an IPO-structured data table for each Coastal Unit
- Full dataset for three pilot applications published on Zenodo

7 MAIN OUTCOMES & LESSONS LEARNED

- Spatially identified NB³ portfolio across EU pilots—a scalable, replicable input for multi-criteria restoration comparison
- The Participatory Downscaling Approach and IPO model bridge theory and practice through context-sensitive, operable restoration units
- Collaboration is foundational—from framework co-development to pilot application; large consortia like REST-COAST are key enablers
- Sustained stakeholder engagement demands disciplinary impartiality—balancing natural and social sciences—alongside careful planning and anticipation
- Practical insights from diverse coastal contexts inform adaptable and flexible upscaling strategies

8 OUTLOOK

WATERLANDS
 Vision: Scaling out the NB³ Framework beyond coastal zones across the EU
 Scope: Application to inland wetlands—peatlands, mires, and wet forests
 Approach: Collaboration across sister projects and methodological knowledge transfer

GEDIZ DELTA
 Vision: Scaling out the NB³ Framework across coastal zones beyond the EU
 Scope: Application to the Gediz Delta—a Ramsar-listed coastal wetland in Turkey
 Approach: Testing framework transferability and promoting adoption by local stakeholders

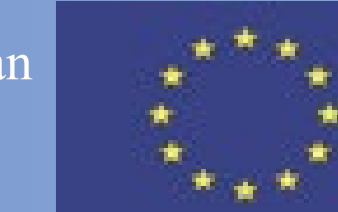
The NB³ Framework delivers transferable methods and tools, responding to the global urgency of scaling up NbS.

Key References:

- Arslan, C., & van Loon-Steensma, J. M. (2025). Nature-based building blocks (NB³) framework for scaling up nature-based solutions in coastal adaptation. *Nature-Based Solutions*, 8, 100259. <https://doi.org/10.1016/j.nbsj.2025.100259>
- Arslan, C., Warner, J., & van Loon-Steensma, J. M. (2026). Participative application of the nature-based building blocks (NB³) framework to support upscaling coastal NbS. *Ocean & Coastal Management*, 272, 107988. <https://doi.org/10.1016/j.ocecoaman.2025.107988>
- Arslan, C., Horneman, F., Stocco, A., Furlan, E., Hineva, E., Andreeva, N., Rózyński, G., & van Loon-Steensma, J. (2026). *The NB³ Framework application dataset: biophysical, socio-economic, and ecological characterization of spatially explicit, participatively derived Coastal Units across three EU coastal restoration pilots [Dataset]*. Zenodo. <https://doi.org/10.5281/zenodo.19452085>

We would like to acknowledge the support by the European Union Horizon 2020 project REST-COAST: Large-scale recovery of coastal ecosystems through rivers to sea connectivity for providing funding for this research. We would also like to acknowledge in particular our REST-COAST project partners for their support and contribution in conceptualizing and developing the NB³ Framework during several meetings online and in person. Background imagery in 2) Challenges to Upscaling sourced from Microsoft 365 Stock Images and used under the Microsoft Content License. All other figures and maps are original works by the authors.

This research receives funding from the European Union's Horizon 2020 Research and Innovation action under grant agreement No 101037097



Cengiz Arslan
 PhD Candidate
 Earth Systems & Global Change Group
 Wageningen University & Research
 ORCID: 0000-0002-3243-8985
cengiz.arslan@wur.nl

