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Adapting the Polder-Boezem System to Climate Change: Designing Inner-boezem Landscapes and Revitalizing the Polder-boezem System in the Dutch Lowlands

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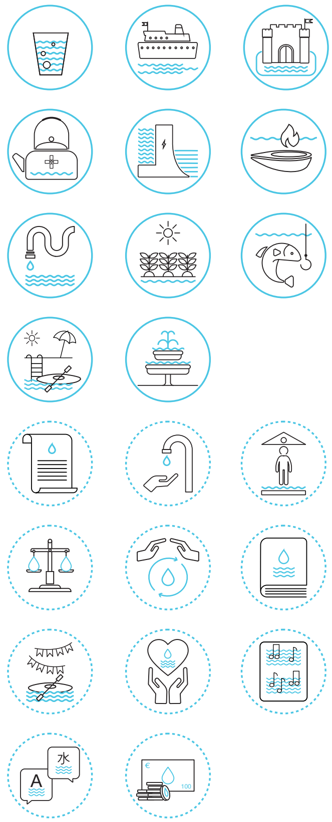
Abstract
This paper proposes a systemic re-evaluation of the Dutch polder-*boezem* system through the introduction of inner-*boezem* landscapes: newly designed, large-scale green-blue infrastructural areas enclosed by dikes that provide additional water storage capacity and enhance ecology as part of the existing polder-*boezem* system. Just as important, beyond their hydrological and ecological functions, inner-*boezem* landscapes are conceived as multifunctional cultural spaces that reconnect communities with the dynamics of water management. By integrating utility, ecology and experience, these landscapes aim to revitalize the cultural heritage of the polder landscape, transforming it from a symbol of control and defense into one of coexistence, adaptability and shared stewardship.

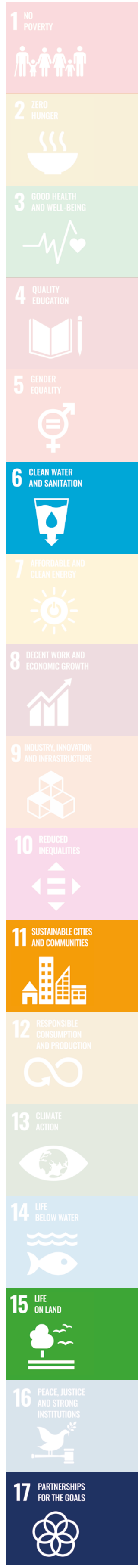
Policy Recommendations

- Provinces, water boards and stakeholders should revitalize the polder–*boezem* system as part of climate adaptation strategies by strengthening ecological resilience, supporting circular land use and integrating adaptive design.
- Water boards and provinces should use inner-*boezem* landscapes to combine water storage, biodiversity and sustainable agriculture in the Dutch lowlands.
- Provinces, water boards and stakeholders should coordinate water retention and water quality measures across the polder landscape.
- Guided by the EU Water Framework Directive and the EU Nature Restoration Law, policymakers should develop the extended polder–*boezem* system as an integrated socio-ecological infrastructure for water management, biodiversity and sustainable land use.

KEYWORDS
polder-*boezem* system
inner-*boezem*
drainage and irrigation
water retention
new farming

WATER VALUES





< Fig. 1 One of the 19 mills at Kinderdijk, a UNESCO World Heritage Site, historically used to drain the Alblassrwaard polder complex in the Netherlands (Source Michiel Pouderoijen, 2008).

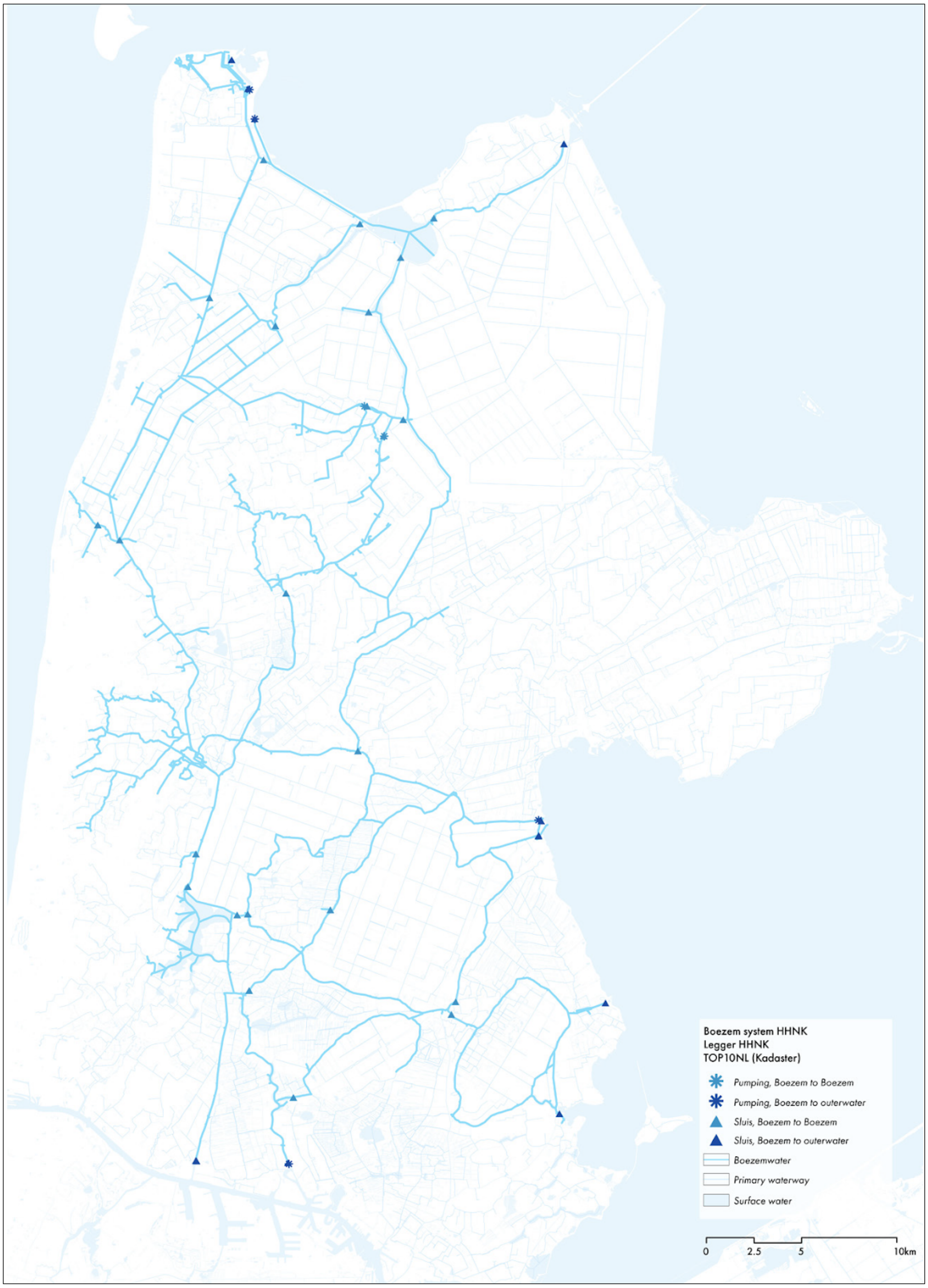
The Polder-*boezem* in the Making

The cultural identity of the Dutch polder landscape is deeply rooted in the relationship between people, water and land, a relationship shaped over centuries and involving continual negotiation between natural forces and human ingenuity (van de Ven 2003). The swampy peatlands of the Dutch lowlands were gradually transformed into a highly engineered cultural landscape. What began with the incremental construction of ditches, dikes and rudimentary drainage networks to discharge water into rivers and the sea evolved into a sophisticated hydraulic infrastructure. Continual labor and technological innovation made permanent settlement in the delta possible yet also set in motion a process of land subsidence that gradually lowered large areas below sea level (NAP[1]). The maintenance and regulation of water levels became increasingly dependent on sluices, windmills and, later, mechanized pumps. In parallel, large-scale reclamation projects transformed lakes and even parts of the sea into new land, extending the agricultural areas while simultaneously protecting those previously drained (Bobbink et al. 2017). The polder thus embodies a societal model of collaboration, negotiation and long-term stewardship, in which maintaining a balance between land and water is both a physical and moral undertaking, also expressed in the layout of the *Dutch Water Cities* (Hooijmeijer et al. 2005).

Institutionalized in the thirteenth century through the establishment of regional water boards (*waterschappen*), Dutch water management represents one of the earliest forms of collective environmental governance. The efficiency and scaling up of this governance structure over many decades contributed to transforming the originally site-specific and adaptive polder–*boezem* system into a rationalized, highly efficient “water machine.” This rationalization was further intensified in the twentieth century through land consolidation, which facilitated industrial farming by scaling up, straightening watercourses, removing ditches and eliminating many hedgerows and trees. Urbanization compounded these processes by erasing water patterns through sand replenishment and altering the spatial configuration of *boezems* and rivers, thereby reducing the permeability and flexibility of the system. While these interventions produced a technically reliable water infrastructure, they simultaneously diminished the landscape's ability to adapt. In terms of resilience, the system shifted from a flexible, adaptive regime, capable of absorbing disturbances, to a narrowly optimized regime that functions efficiently under stable conditions but is vulnerable to variability and shock. This rigidity has become increasingly apparent under contemporary climatic pressures: prolonged spring droughts and recurrent summer dry spells expose the limitations of a system designed for predictability rather than flexibility.

The polder landscape itself reflects this functional narrowing. Once a mosaic of diverse land uses and ecological gradients, it has become largely monofunctional, with a focus on intensive agriculture. Efforts to counter ecological decline and reintroduce diversity, such as the transformation of parts of polders into nature reserves, have provided essential habitats and recreational opportunities, but often at the cost of cultural landscape continuity, building on historical interventions to design

1. NAP (Normaal Amsterdam Peil) is the official reference level for measuring elevation in the Netherlands. All heights (both above and below sea level) in the Netherlands are expressed relative to NAP.

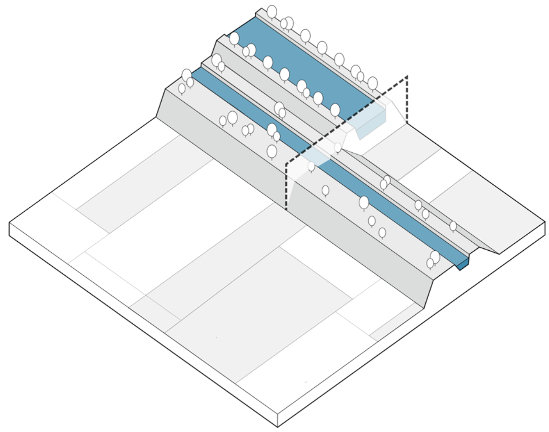


^ Fig. 2 The polder-boezem system of North-Holland above the Amsterdam-Rhine Canal. Water from the polders is discharged by pumping stations (not depicted on the map) into the boezem system, from which it is subsequently conveyed through boezem pumping stations toward the outer water: to the north into the sea, to the east into the IJsselmeer and to the south into the Amsterdam-Rhine Canal (Source: Inge Bobbink and Michiel Pouderoijen, 2016. Based on TOP10NL (Kadaster) maps from HisGIS, Fryske Akademy © HisGIS open data, www.hisgis.nl).

future solutions in line with local conditions. The result is a paradox: while ecological and cultural heritage values are increasingly recognized, they remain fragmented within a larger framework of efficiency. The duality between control and adaptability, human design and natural process, is forgotten. The cultural identity should no longer be limited to defense and reclamation, but also encompass adaptation, circularity and ecological renewal – a living testament to the Dutch capacity to reimagine heritage as a foundation for future resilience. While the polder landscape remains defined by its geometric order and spatial clarity, these forms no longer fully express the dynamic relationship between people, water and nature that originally shaped it. Reimagining the polder as a living, adaptive system requires a renewed aesthetic and functional understanding, one that recognizes the continual interaction between human activity and natural processes as central to its cultural significance.

Time for Appropriation

From the perspective of landscape architecture, the Dutch polder–*boezem* system exemplifies both the achievements and limitations of infrastructural landscapes as agents of territorial organization. It demonstrates how engineered systems can shape settlement, ecology and culture at a national scale, while also illustrating how such systems must evolve to remain resilient in the face of climate change. The challenge is therefore not merely technical but systemic: How can we appropriate and transform the polder-*boezem* system into a multifunctional landscape infrastructure that restores adaptive capacity while reinforcing its



^ Fig. 3 The inner-*boezem* may be configured either as an extension situated adjacent to the existing *boezem* or as an independent, freestanding structure (Source: Inge Bobbink, Ken Chen and Javier Sánchez Jiménez, 2022).

role as a defining element of Dutch geographical and cultural identity?

This question builds on doctoral research – "The Landscape Architecture of the Polder–*Boezem* System" (Bobbink 2016) – on the possibility of appropriating the existing water system through the introduction of an inner-*boezem* landscape, based on earlier versions of the system. Further research was conducted at the Faculty of Architecture and the Built Environment at TU Delft, in the Landscape Architecture section, to explore this idea. The Province of North Holland[2] invited the author in 2022 to test the implementation of the inner-*boezem* landscape concept in three distinct regions, where each site presented different conditions in terms of soil composition, water levels and site-specific challenges. While preparing a well-defined design assignment for master's students in Landscape Architecture (2022–23), we collaborated with Oliver Hoes, a civil engineer, an expert on polders. His expertise was instrumental in assessing

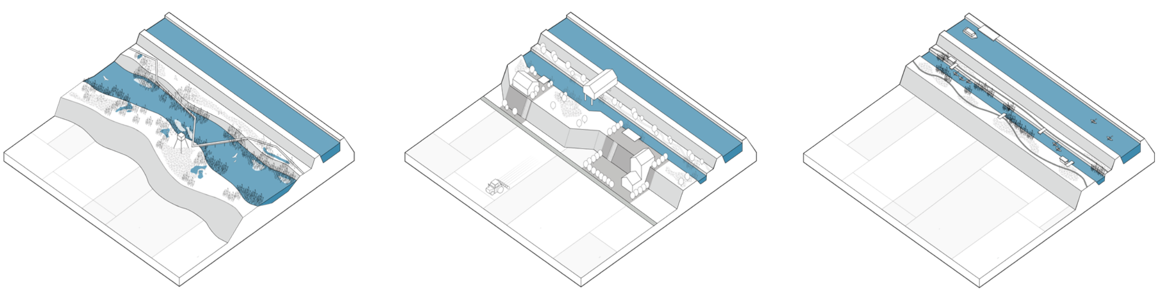
2. Represented by its provincial advisor, Parks, Steven Slabbers.

the potential and required volumes of water storage at each location as a starting point for social-ecological change. Partly due to his findings, a series of principal sections, including measurements (fig. 5) were developed by me and some students helping to draw them. The inner-*boezem* is a linear, intermediary water structure at a landscape scale, situated between or above the polder and the *boezem* water levels. Its capacity to host multiple water levels side by side enables the system to buffer variability and enhance adaptive capacity. Banks planted with trees and aquatic vegetation function as ecotones, zones of transition that support biodiversity, facilitate natural water purification and provide corridors for recreation and engagement. These ecological edges are not incidental amenities but integral components of resilience, creating redundancy and diversity within a water system that has otherwise been rationalized into a monofunctional one. The design of the inner-*boezem* landscape is site-specific.

From a hydraulic perspective, the inner-*boezem* operates as a flexible storage regime. It prioritizes the collection of rainwater and fresh seepage, with the possibility of absorbing surplus polder water, while maintaining the option to discharge excess volumes through the existing *boezem* system. In exceptional circumstances, it can take in filtered *boezem* water. By embedding this operational logic within a spatial design framework, the inner-*boezem* exemplifies what Ahern (2011) and others have termed *adaptive infrastructure* – infrastructures that are explicitly designed to cope with variability and uncertainty rather than stability and control.

In contrast to the current polder-*boezem* system, the inner-*boezem* is deliberately designed to tolerate significant fluctuations in water level, up to 1 m, depending on the soil conditions, enhancing its adaptive capacity. Beyond water management, the inner-*boezem* landscape would serve as a climate buffer and catalyst for transitioning agricultural areas toward more sustainable, circular systems. These could include alternative forms of cultivation, such as paludiculture (wetland agriculture), aquaculture and managed peat growth, thereby reinforcing ecological resilience while supporting new economic and cultural practices.

As such, the inner-*boezem* landscape can be understood as both a climate buffer and a cultural project. It reframes the polder-*boezem* system as a living infrastructure, one that restores ecological resilience, expands public engagement and sustains cultural identity in the face of climate change. In doing so, it demonstrates how the appropriation of historical systems can generate innovative models of circular and multifunctional landscapes, aligning water management with broader agendas of sustainable agriculture, biodiversity restoration and adaptive urbanization.



^ Fig. 4 The diagrams illustrate potential programs for a newly constructed inner-boezem landscape: (1) emphasizing nature development, (2) serving as a new residential context and (3) providing recreational opportunities. Ideally, these functions are designed to interact synergistically (Source: Inge Bobbink, Ken Chen and Javier Sánchez Jiménez, 2022).

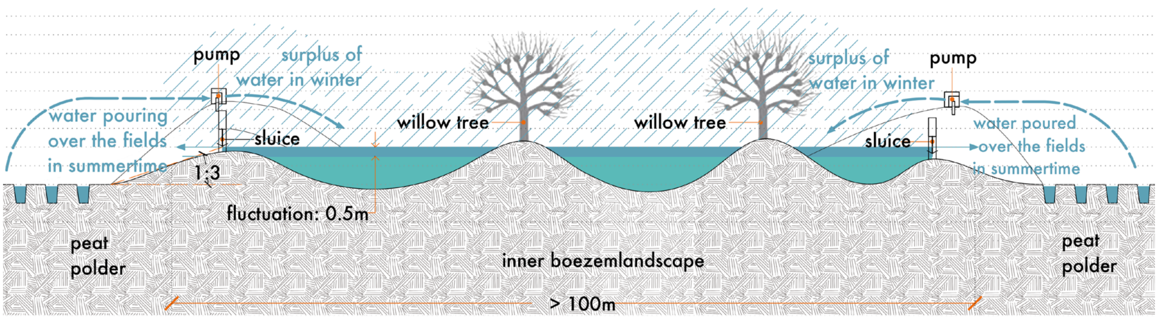
Designing Inner-*Boezem* Landscapes in Waterland

The region of Waterland, a 115 km² low-lying peat meadow area located north of Amsterdam, illustrates how designs for inner-*boezem* landscapes can be implemented. The landscape is primarily composed of grassland used for dairy farming, with average water levels between −2.0 and −2.5 m NAP. It is intersected by a dense network of ditches, canals and lakes, and includes a few small lake-bed polders used for crop farming. Eight historic villages and several nature areas add cultural and ecological value, making Waterland both a productive agricultural region and a recreational landscape for the citizens of Amsterdam. This valued landscape is threatened by ongoing land subsidence, climate change issues, salt seepage, eutrophication resulting from farming practices and, consequently, ecological decay.

^ Fig. 5 Preliminary sketch of inner-boezem landscapes in Waterland. Roughly, the storage capacity of these strips corresponds to the volume of water required to maintain adequate moisture levels in the peatlands during periods of drought (Source: Inge Bobbink, 2022).

To guide the design process, the tutors of the course provided principal sections to the students to work with as a basic understanding on how to create an inner-*boezem* landscape. The inner-*boezem* landscape in this area should accommodate seasonal water level fluctuations of around 0.5 m, while maintaining ecological viability with a minimum summer depth of 0.4 m to support flora and fauna.

Each inner-*boezem*, which can consist of different basins, is expected to have a storage capacity large enough to flood 10 times its own surface area with 5 cm of water – for example, a 50 ha basin should be able to serve 500 ha of surrounding land. This amount of water is necessary to keep the peat moist during dry periods, thereby preventing further subsidence. Depending on what the client and project



^ Fig. 6 Principal section of an inner-boezem landscape for a peat polder. (Source: Inge Bobbink, Javier Sánchez Jiménez and Keng-Ching Chen, 2022).

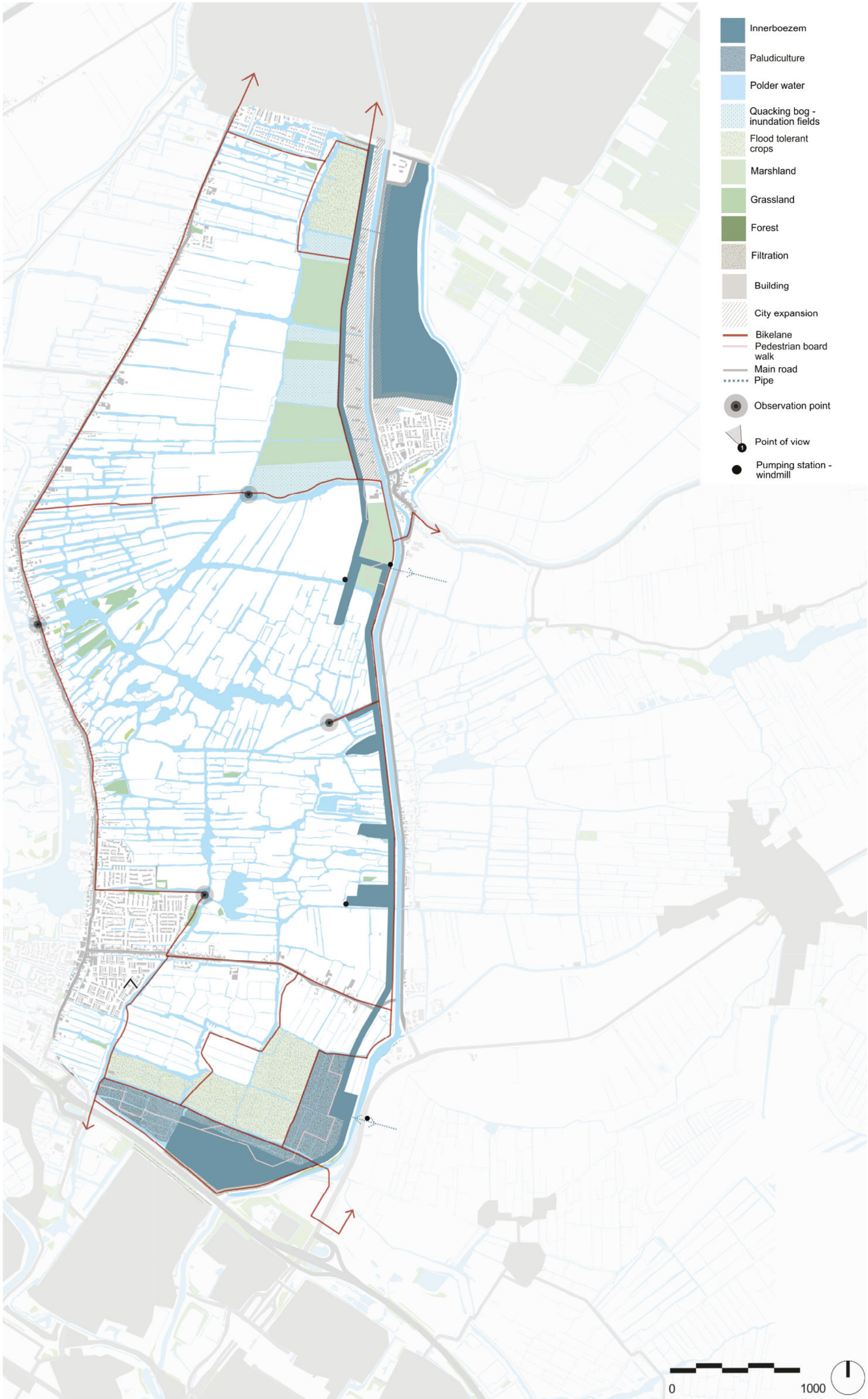
^ Fig. 7 A group of 14 students, working in pairs, designed very diverse, site-specific inner-boezem landscapes for Waterland (Source: Master track students of Landscape Architecture, Q2 course Dutch Landscape 2022/23).

requirements ask the designer to achieve, the water is also used to enhance peat growth.

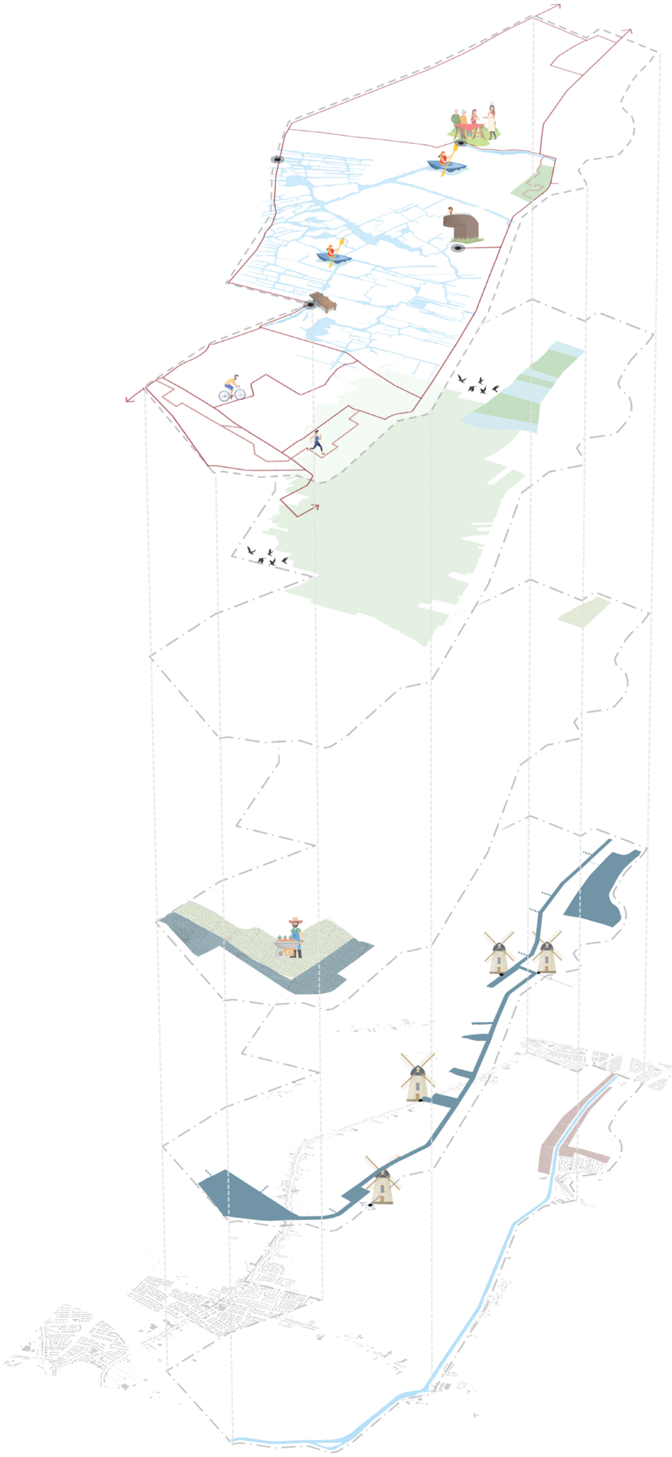
In my role as a teacher, I asked the master students to think about connecting the basins to adjacent plots, distinguishing between clean supply channels and dirty discharge channels. A closed soil balance was required, meaning that soil had to be redistributed locally rather than transported in or out on a large scale, to keep construction economically and environmentally feasible. Finally, the instability of peat soil demanded lightweight dikes with gentle slopes (1:3), ensuring structural resilience without imposing excessive pressure on the ground.

Two selected projects, Waterland Kidneys and Polder Renewing, illustrate how inner-*boezem* landscapes in peat polders offer multifunctional spaces that enhance ecological resilience while simultaneously fostering public engagement with water management, thereby strengthening the cultural identity of the polder landscape.

The project Waterland Kidneys (figs. 8, 9, 10 and 11) explores the potential of filtering Amsterdam's surface water in reed fields before it is let into a clean water inner-*boezem* landscape. The clean water can subsequently be utilized for crop irrigation and for the introduction of paludiculture, wetland agriculture that simultaneously provides biomass products and maintains high groundwater levels in peat soils, thereby mitigating further land subsidence as well as carbon dioxide (CO_2) and methane (CH_2) emissions. Farmers need to be part



^ Fig. 8 In the Waterland Kidneys project, the inner-boezem landscape consists of the inner-boezem neighboured by all kinds of paludiculture and peat-growing fields, creating attractive conditions for living (Source: Svana Rún Hermannsdóttir and Charlotte Delobbe, 2023).

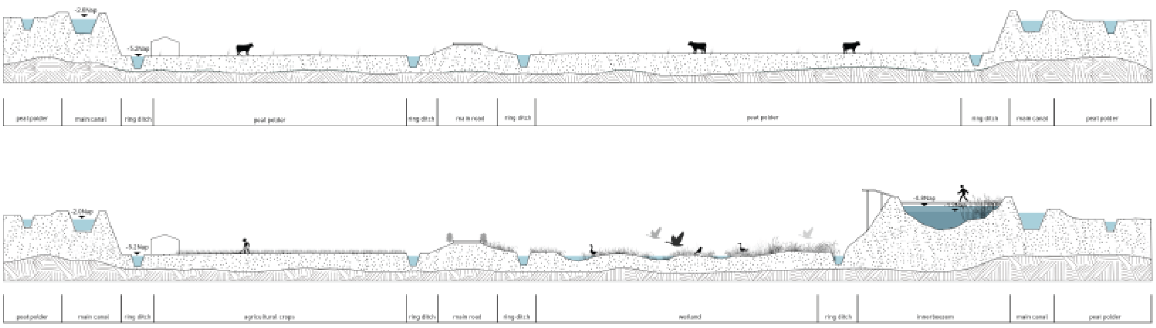


^ Fig. 9 Exploded view of the inner-boezem landscape (Source: Svana Rún Hermannsdóttir and Charlotte Delobbe, 2023).

^ Fig. 10 View into the inner-boezem landscape (Source: Svana Rún Hermannsdóttir and Charlotte Delobbe, 2023).

of this transition. The inner-*boezem* landscape is accessible to cyclists and other recreational users. Moreover, carefully articulated water–land edge conditions create opportunities for enhancing ecological diversity. At the boundary between water and land, species from both ecosystems coexist, inviting people to engage with nature.

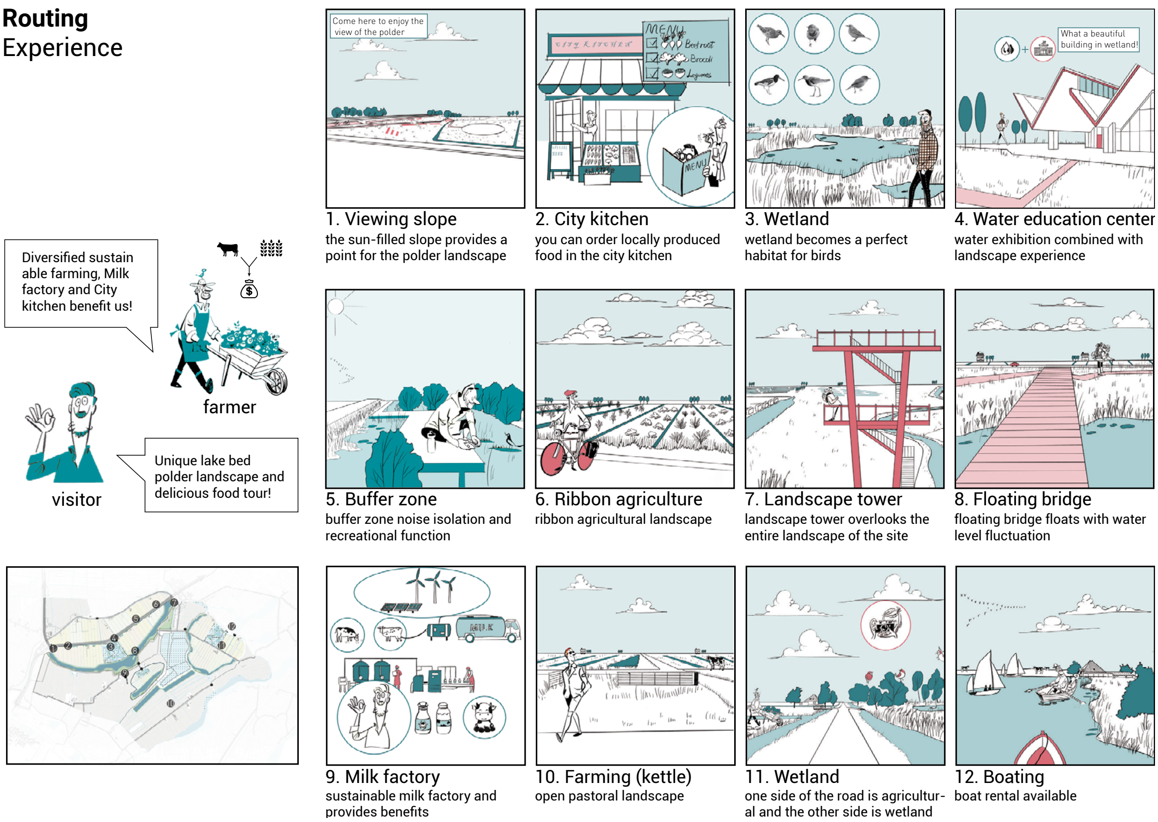
The site of the Polder Renewing project (figs. 12 and 13) comprises a peat-polder landscape that features lake-bed polders situated approximately 3 m below the surrounding terrain, resulting in continuous drainage of water from the peatlands. Along the inner edges of these lake-bed polders' dike, the inner-*boezem* landscape is introduced. Positioned at a higher elevation than the existing *boezem* system, these landscapes facilitate a gravity-fed water supply while preventing seepage from the peat into the agricultural land located in the lake-bed polders. The different inner-*boezem* landscapes are hydrologically, not visually linked to ensure ecological continuity. In addition, a newly introduced recreational program accentuates the geometric and spatial patterns



^ Fig. 11 View into the inner-boezem landscape (Source: Svana Rún Hermannsdóttir and Charlotte Delobbe, 2023).

of the polder landscape, offering an experiential perspective from a strategically positioned viewing tower that overlooks the enhanced environment, including its expanded bird habitats. Locals are invited to reclaim the landscape as a part of daily life.

^ Fig. 12 Birdseye view of the Polder Renewing project showing the three lake-bed polders (-4.5 m NAP) with the newly implemented inner-boezem landscapes and two additional water storage basins in the peat polder landscape (-1.5 m NAP). The basins are connected, creating an ecological corridor (Source: Jingwei Gua and Chenye Yang, 2023).



^ Fig. 13 The visual story depicts user experiences and the new programs within the inner-boezem landscapes design (Source: Jingwei Gua and Chenye Yang, 2023).

Revitalization of the Polder-Boezem Landscape

Waterland served as a testing ground for reimagining an extended version of today's polder-*boezem* system. Students explored through design research how inner-*boezem* landscapes could operate as climate buffers, while simultaneously enhancing ecological diversity, agricultural innovation and recreational value in one of the Netherlands' most iconic peat meadow areas. These designs of inner-*boezem* landscapes integrate spatial, ecological and hydrological functions to strengthen the resilience and sustainability of the polder system. By facilitating the exchange of water, minerals and organic matter, these landscapes enhance soil productivity and support adaptive water management through flexible levels that respond to seasonal and climatic variations. Constructed using a cut-and-fill approach that maintains a closed-ground balance and utilizes local materials, the elevated dikes retain larger water volumes while promoting circular and regenerative land-use practices. The resulting wet conditions enable forms of paludiculture, including the cultivation of peat moss, reed, bulrush, flax, hemp, *Typha*, *Azolla* and other wetland crops alongside aquaculture systems for fish and mussels. Collectively, these strategies contribute to carbon sequestration, enhance biodiversity through the restoration of habitats for insects and birds and mitigate hydrological extremes such as flooding and drought. Moreover, they improve water quality, stabilize groundwater levels to protect heritage structures and enrich the cultural landscape by providing accessible waterfronts that support recreation and ecological engagement.

We presented the work of the students at the Province House of North Holland in Haarlem to government officials and regional designers. The audience was impressed by the concept and the students' work, illustrating its long-term benefits for the environment. As a result of the research, the Province picked up spatial ideas based on the research results and advised the department of public works and the water board to use the inner-*boezem* concept.[3] Unfortunately, the project was already too far along in its development for the concept to be integrated. Nevertheless, inner-*boezem* landscapes are on the agenda, since Dutch farming practices need to change. Already, Wageningen University is doing a lot of testing focused on restoring vast peat landscapes and exploring alternatives to farming in them. More water retention is needed, and much more than that, which inner-*boezem* landscapes can offer. To revalue the cultural identity and spatial logic of the polder–*boezem* system, this research explores strategies of appropriation and adaptation through the introduction of inner-*boezem* landscapes. Rather than approaching water infrastructures merely as technical devices for regulation and control, this perspective positions them as multifunctional landscape infrastructures that operate across hydrological, ecological and sociocultural dimensions. Within the framework of landscape architecture, the inner-*boezem* landscape is understood not as a discrete intervention but as a spatial typology capable of reconfiguring relationships between water, land use and settlement at the territorial scale.

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3. Documented in the report: Reinforcement of the Regional Barrier Polder Zeevang, Versterking Regionale Kering Polder Zeevang, Provincie Noord-Holland.

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References

Bobbink, Inge. 2016. De Landschapsarchitectuur van het Polder-Boezemsysteem: Structuur en vorm van waterstelsel, waterpatroon en waterwerk in het Nederlandse laagland [The landscape architecture of the polder-boezem system: Structure and form of water system, water pattern and water work in the Dutch lowlands]. *A+BE | Architecture and the Built Environment* 6 (15): 1–356. https://doi.org/10.7480/abe.2016.15.1401.

Bobbink, Inge, and Michiel Pouderoijen. 2017. "De ruggengraat van het laagland: De boezem als schakel in de cultuurhistorische samenhang van het veengebied" [The backbone of the lowland: The boezem as a link in the cultural-historical coherence of the peat area]. *Bulletin KNOB* 116, no. 3: 123–38. https://doi.org/10.7480/knob.116.2017.3.1849.

Hooimeijer, Fransje, Han Meyer and Arjan Nienhuis, eds. 2005. *Atlas of Dutch Water Cities*. Amsterdam: SUN.

Steenbergen, C. M., W. Reh, S. Nijhuis and M. T. Pouderoijen. 2009. *The Polder Atlas of the Netherlands: Pantheon of the Lowlands*. Bussum: Uitgeverij THOTH.

Ven, G. P. van de, ed. 2003. *Leefbaar laagland: Geschiedenis van de waterbeheersing en landaanwinning in Nederland* [Habitable lowland: History of water management and land reclamation in the Netherlands]. 5th rev. ed. Utrecht: Matrijs.

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