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Amsterdam's Quay Walls: Methods for Connecting Past, Present and Future

Carola Hein, Regina Klinger, Christel Voncken, Prapti Gupta & Vincent Baptist

Abstract
The much-needed repair and rebuilding of Amsterdam's historical quay walls and bridges coincides with growing demand for innovation, ranging from improved logistics and energy systems to enhanced biodiversity and climate resilience. These technology-driven transformations are unfolding in the heart of a World Heritage property known for its distinctive architectural and urban character. This article explores the complexities of integrating heritage into transdisciplinary design processes, focusing on the Canal Ring Area inside the Singelgracht. It proposes three axes for planning interventions that draw meaningfully on the past while addressing future needs, including those related to climate change. In particular, the article considers how historical analysis, spatial mapping and narrative-based approaches can strengthen the integration of historic spaces and practices into locally grounded, sustainable, climate-responsive design.

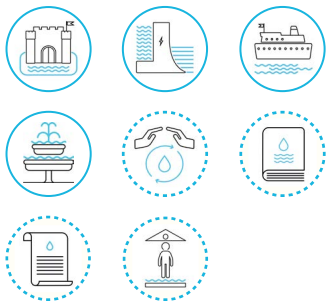
Policy Recommendations

- Reframe heritage as a shared design resource. Designers and decision-makers should promote approaches that treat heritage not as a constraint or afterthought, but as a source of inspiration that supports sustainable, climate-adaptive and circular design.
- Improve access to historical information. Municipal leaders and cultural institutions should make heritage knowledge easier to access and use by investing in digitization, clear organization, visual tools and a glossary that helps non-specialists navigate key terms.
- Use heritage narratives to guide site-specific design. Designers and decision-makers should draw on place-based narratives to contextualize historical knowledge, ensuring that interventions respect local histories, values and trajectories.

KEYWORDS

UNESCO World Heritage
quay walls and bridges
climate change
narratives
sustainable design

WATER ICONS



CLIMATE

A B **C** D E

Cfb: Temperate oceanic climate

< Fig. 1 At the Singelgracht waterway looking towards Marnixkade street, during SAIL 2025 maritime event (Source: Regina Klinger, 2025).

Introduction

Amsterdam, like many historic cities, is a layered urban fabric shaped by successive stages of development. Much of this historic palimpsest lies hidden underground and includes sewage lines, canal foundations and dams, which affect what can be repaired, reused or rebuilt. The collapse of parts of the Grimburgwal, a small canal in the center of the city, in 2020 and construction delays due to the discovery of old sewage lines (Korff, Hemel and Peters 2022) illustrate this continuity. Today, new electrical systems and other infrastructures rest on the foundations of old windmills and industrial buildings along the Singelgracht, the semi-circular canal that borders the city center and was once at the city's outer edge.

In 2021, the NWO KIEM grant project Amsterdam Time Travel laid the groundwork for heritage-based analysis. Insights from this research, which focused on the analysis and inventory of historical datasets and included a case study of Amsterdam's underground infrastructure, were published by Kremer, Scheffers and Geven (2023). The project also provided the foundation for the World Heritage Work Package of the Multi-Functional Quay Walls (MFQW) project (2024–2028) funded by the Dutch National Growth Fund of RVO.[1] The MFQW project aims to deliver innovative designs for the renewal and renovation of quay walls, tested in a living lab (AMS 2025), while taking into account the UNESCO World Heritage status of Amsterdam's inner city.

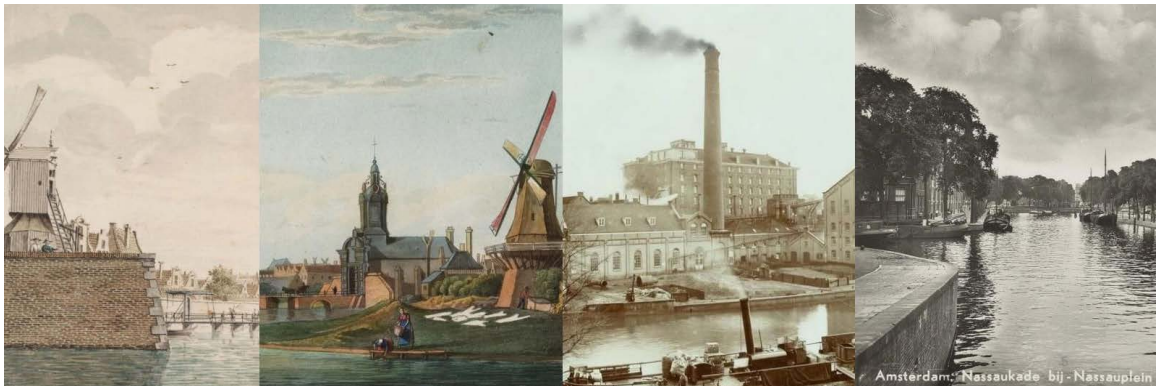
The Work Package argues that sustainable design innovation requires long-term, multi-scalar and multi-stakeholder analysis. It combines: (1) archival and field-based study of historical and local conditions; (2) integration of heritage within social, economic and policy frameworks, aligned with UNESCO and municipal guidance; and (3) development of shared terminologies and narratives linking past, present and future. Together, these approaches form the foundation for sustainable design practices, which are tested in a living lab through iterative prototyping and evaluation with interdisciplinary teams.

This article outlines the approach of the MFQW's World Heritage Work Package in the context of Amsterdam's historic canal belt. It explores the main challenges and opportunities for the first living lab case of the Marnixkade, a quay wall strip along the Singelgracht in western Amsterdam.

Bringing Historic Quay Walls into the Future

The City of Amsterdam faces urgent challenges in water management, alongside the pressures of the energy transition, climate change, tourism and broader societal change. The repair or replacement of the city's quay walls is becoming increasingly pressing as their load-bearing capacity is tested by heavier electric vehicles, intensified logistics and growing urban activity. Contemporary requirements for traffic loads, new urban infrastructures such as data cables, and climate adaptation add further complexity to the renewal of Amsterdam's water edges. In addition, the growing call for biodiversity introduces new ecological considerations for how these spaces are rebuilt and managed. Yet, large-scale interventions affecting the form and function of the quay walls risk undermining both Amsterdam's livability and its World Heritage status. Acknowledging Amsterdam's historic engineering ingenuity and UNESCO

1. RVO (Rijksdienst voor Ondernemend Nederland) is the Netherlands' Enterprise Agency, which aims to boost business growth.



^ Fig. 2 Transformation of the Singelgracht (Sources, left to right: Verrijk 1786; De Kruyff, Lutz, and Buffa & Sons 1825; Amstel Suikerraffinaderij gezien over de Singelgracht 1905; Nassaukade tussen Nassauplein en Eerste Nassaustraat en links Marnixkade 2-5, Afb ANWU01721000004 1925).

World Heritage status calls for equally innovative, context-aware interventions.

The "Seventeenth-Century Canal Ring Area of Amsterdam inside the Singelgracht" obtained World Heritage status in 2011, notably for its outstanding engineering, architecture and urban form. The Outstanding Universal Value of the property is described as "exemplary hydraulic and urban planning on a large scale through the entirely artificial creation of a large-scale port city. In the 17th and 18th centuries, Amsterdam was seen as the realization of the ideal city that was used as a reference urban model for numerous projects for new cities around the world" (World Heritage Centre 2014).

The MFQW's World Heritage Work Package proposes heritage-led design practices that use the city's historical and cultural context as a foundation for innovation. These are guided by cultural and historical insight rather than by purely technological or economic drivers. In line with Amsterdam's goals to promote circular processes (AMS 2022; Municipality of Amsterdam 2024a), we argue that circular building practices require knowledge of historical materials, technologies and practices, as well as the continuous documentation of interventions. This includes the reuse of historical data to inform planning for the future.

We put these principles into practice in the MFQW Project, in which engineers and landscape architects are developing modular design solutions based on a generalized canalscape. This synthetic representation of the spatial, technical and cultural elements that define Amsterdam's canal environment allows for optimized interventions. These designs need to be adapted to specific sites and contextualized within the city. In the project's first design phase, designs will be implemented through a living lab at the Marnixkade. Our work package therefore started with an analysis of the history and heritage of this area.

This outer canal of Amsterdam's nineteenth-century ring exhibits distinctive pattern of transformation. Unlike the iconic inner canals, the Singelgracht has been continually reshaped over time, adapting its form to the changing needs of Amsterdam's residents and urban environments. These changes include the introduction of floating vegetable markets and changes in quay wall construction materials and

shipping-related elements along the water (figs. 2–4). Working at this site has highlighted the challenges of integrating heritage knowledge with sustainable, future-oriented design.

Challenges of Linking Heritage Knowledge to Sustainable Design

Amsterdam's quay walls are not only in need of repair but also serve as high-potential test sites for technological innovation, involving, for example, prefab concrete elements, climate-adaptive systems with heat exchangers, digital service cables, waste facilities, parking spaces and biodiversity measures. These interventions often compete with heritage values; In test designs, alignment with World Heritage features is not always a central concern. Over the course of the project so far, we have identified four key challenges.

First, engagement with technically oriented colleagues reveals the dominance of sectoral thinking and the absence of a shared value system that includes heritage as a foundation for sustainable innovation. A heritage walk and subsequent survey during the starting phase of the MFQW project demonstrated that many participants perceive heritage as static and obstructive, closely associated with "preservation." As a result, heritage is often considered an obstacle or afterthought in the design process, addressed only at the end to comply with basic regulations. Such an approach risks marginalizing historical values in new designs.

Second, one of the underlying reasons for this limited engagement with heritage is a lack of standardized methods, vocabulary and clear guidance on how to design for heritage. In response, design and engineering colleagues in search of such instructions seem to implicitly "reverse-engineer" UNESCO's OUV, beginning with the formal criteria that define a site's heritage value. They then work backward to interpret which cultural, social or material attributes need to be preserved and how these relate to the broader canal system. While UNESCO's OUV and HUL (Historic Urban Landscape) frameworks emphasize the distinctiveness and protection of heritage sites, they offer limited practical direction concerning how to integrate modern infrastructural requirements into these settings.

Third, the absence of analysis and visualization of historic features and future challenges further complicates collaboration. Yet, the value of such visualization is evident from the MFQW project practitioners' widely acknowledging the usefulness of the Beeldkwaliteitsplan (Municipality of Amsterdam 2024b), which successfully communicates spatial heritage features. Such guidance can be further improved and implemented through interactive and digital mapping, as in the UNESCO Urban Heritage Atlas (UNESCO 2023), which visualizes the complex architectural, urban and landscape features of UNESCO designated properties and highlights climate-related challenges, while also visually illustrating the UNESCO HUL approach.

Finally, the lack of integration between archival sources and contemporary design tools makes it difficult to implement digital and circular practices. Historical materials remain fragmented across municipal, institutional and private archives, many of them undigitized or incompatible with modern design software. Organized according to past systems or terminology, these records risk being overlooked as outdated or restrictive. Improved digitization and interoperability can help link historical data to contemporary decision-making and translate lessons from the past into sustainable, future-proof design.

^ Fig. 3 Appeltjesmarkt Singelgracht (Stadsarchief Amsterdam, n.d.).

Delivering Heritage-Based Solutions for Design Professionals

Building on the challenges identified in the MFQW project, we propose three axes of intervention for integrating heritage knowledge into design practice. These axes – historical analysis, narrative creation and spatial mapping – provide complementary approaches for connecting spatial and material practices of the past with future-oriented, climate-adaptive design. Together, they establish a framework for engaging historical knowledge as an active component of sustainable urban transformation.

1. Historical Analysis: Developing Methods and Vocabulary for Data Circularity

The first axis concerns the analytical use of historical materials to inform contemporary design decisions. Current canal models in the MFQW project categorize waterways by technical parameters such as width and structural type, which limits recognition of the cultural and ecological diversity embedded in each site.

By enriching these datasets with canal-specific historical evidence, linking archival sources to past material practices, uses and maintenance cycles, heritage can be operationalized as an active form of knowledge. Establishing a shared vocabulary and metadata structure across disciplines enables this information to circulate within design processes, creating feedback loops between historical precedents and contemporary innovation.

Historical analysis thus becomes a mechanism of data circularity, transforming archival research from static documentation into a dynamic tool for sustainable, climate-resilient design. It demonstrates that understanding the life cycle of materials, infrastructure and practices provides insights for both technical and social dimensions of urban adaptation.

2. Narrative Creation: Activating Heritage Values for Design Inspiration

The second axis uses heritage narratives to connect cultural memory with contemporary urban challenges. In the MFQW project, narrative-thinking reveals a site's development by highlighting past decisions, embedded cultural stories, and narratives that guide future interventions. The following Singelgracht examples illustrate how heritage can inform climate-adaptive, context-sensitive design.

The Appeltjesmarkt (apple market)

This historic market (1895–1934) exemplifies how waterborne trade (fig. 3) supported short food cycles and localized economies, with farmers delivering produce directly by boat to urban residents (Bakker 2007). It offers a precedent for multifunctional waterways and suggests opportunities to reintegrate water-based logistics and community spaces in contemporary climate-adaptive planning.

The former green belt along the Singelgracht

When Amsterdam's city walls were decommissioned in the nineteenth century, ramparts became green promenades serving recreational and ecological functions. Industrialization eroded this green belt, provoking civic protest and revealing its social and cultural value (AmsterdamHV, n.d.). Today, this narrative can inspire green infrastructure and the strategic revival of lost urban green spaces.

Reuse of ballast stones from maritime trade

Stones transported by Scandinavian and northern German ships were reused to stabilize quay walls (Schelling 1946; De Waard 1947), exemplifying early circularity. The walls themselves preserve a material record, which risks being lost if replaced. Contemporary design can draw on reclaimed materials while maintaining historical continuity.

Together, these narratives show that the Singelgracht evolved through culture-based changes, responding to shifting environmental and social conditions. Embedding such narratives in design processes translates historical data into actionable insights for sustainable, climate-responsive urban development.

3. Spatial Mapping: Visualizing and Sharing Heritage Knowledge

The third axis emphasizes spatial mapping to connect archival sources with contemporary design tools and planning systems. Visualizing material and cultural layers helps designers understand how past structures and practices can inform climate-adaptive interventions.

UNESCO's Urban Heritage Atlas demonstrates not only how heritage can be visualized, but also how contributions from World Heritage properties can be collected, organized and made publicly accessible in visual and biographical form. While this platform enhances understanding and accessibility, it does not provide a foundation for site-specific interventions or repairs. Effective design requires juxtaposing contemporary proposals with the multiple physical and cultural layers present at each location, revealing the palimpsest of historical practices.

Geospatial analysis supports this by linking archival material to city plans and expertise. Large-scale projects such as Time Machine Organization (2019, 2025) show how digitized data and 3D reconstructions create a "Google Earth of the past," enabling designers to navigate urban structures and cultural patterns over time. This approach transforms archival inventories into actionable knowledge for urban development and climate adaptation.

Our curated ArcGIS StoryMap[1] for the Singelgracht links historical photographs, drawings, and records to specific canal locations (fig. 4). Contextualized with metadata and source notes, it produces a spatial index of narratives and material traces. It makes heritage accessible to non-historians, facilitating cross-disciplinary collaboration and grounding interventions in the historical and material realities of the site.

Conclusion

The MFQW project demonstrates that climate-adaptive, heritage-sensitive interventions are achievable when design engages with the layered history of Amsterdam's quay walls. Liv-

1. https://storymaps.arcgis.com/stories/88a7f55927f147c4a723d2e14edb7b0b.

^ Fig. 4 Screenshot of our StoryMap collection. The print of the Prinsengracht in 1773 shows the quay as a multifunctional urban edge: washing and water steps at the canal, mooring and unloading, and foot, cart and coach traffic across the bridge. Our StoryMap uses scenes like this to geolocate small land-water artifacts and to show how they supported everyday practice along specific canal stretches.

ing lab testing treats the urban environment as a palimpsest, where past material, social and infrastructural practices continue to shape future solutions.

Analysis of design proposals and interdisciplinary collaboration revealed challenges, including fragmented archival data, a lack of shared vocabulary, and delayed integration of heritage considerations. The obstacles also highlight opportunities to put heritage knowledge to work through three complementary approaches. Historical analysis transforms archival materials into reusable datasets, guiding circular and site-specific interventions. Narrative creation activates cultural memory, providing context-sensitive design inspiration. Spatial mapping visualizes and shares heritage knowledge, facilitating cross-disciplinary collaboration and informed, locally grounded decision-making.

Together, these axes enable interventions that are historically informed and future oriented. The MFQW project provides preliminary insights on how heritage can guide contemporary design, offering a methodological model for historic urban environments that aligns sustainability, cultural continuity and adaptive development. These insights will continue to evolve as they are tested in the Marnixkade living lab and further fine-tuned in a second living lab planned elsewhere within Amsterdam's historic ring.

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