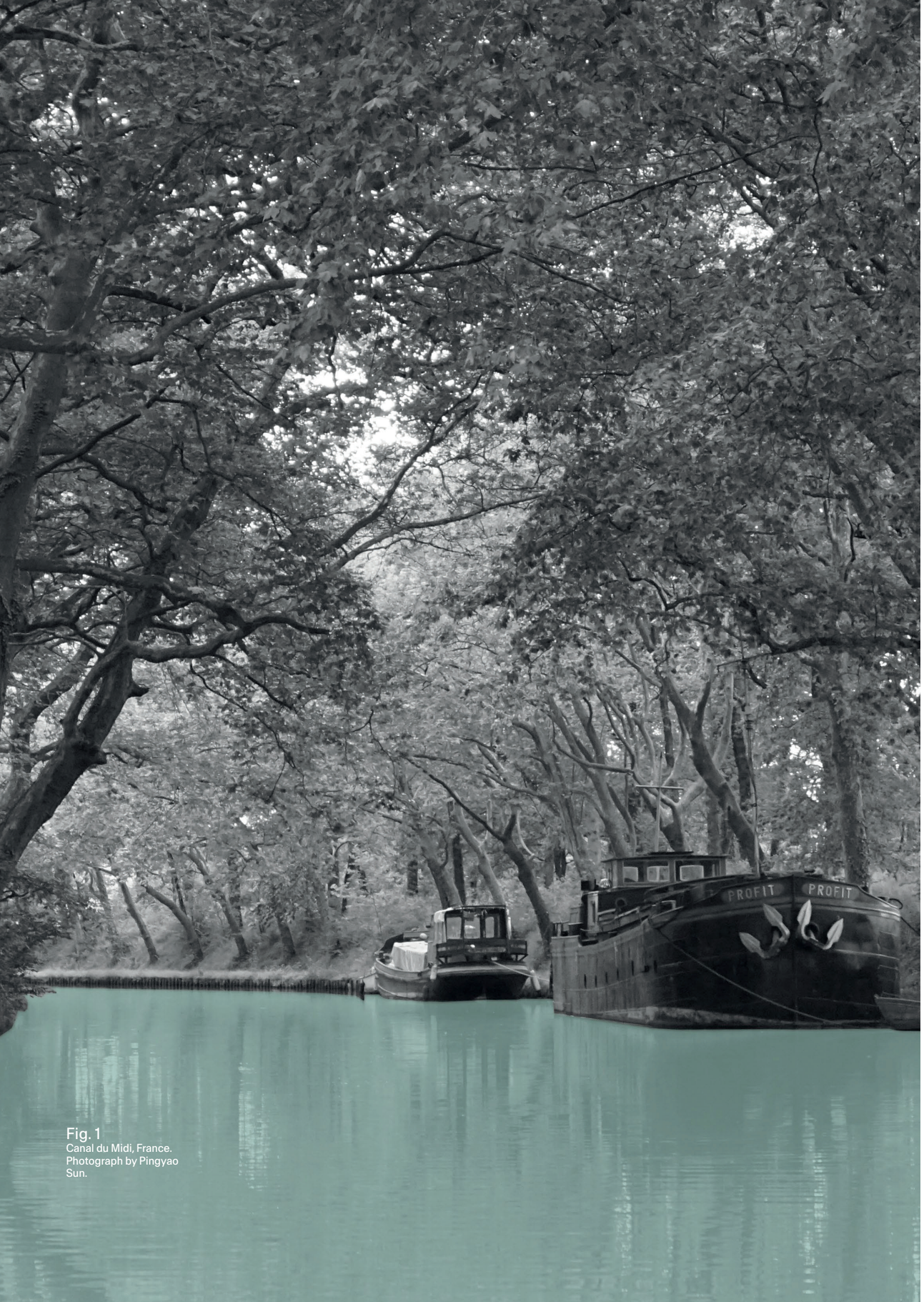

Fig. 1
Canal du Midi, France. Photograph by Pingyao Sun.

Grand Projects

Water as Infrastructure

Pingyao Sun[1], Keng Ching Chen[2] and Nicole Filippoli[3]

Traditional water systems are rooted in local needs and site-specific knowledge. However, certain water infrastructure projects also transcend borders, shaped by transnational and transboundary factors. These grand water projects combine large-scale engineering with local and regional insights. They often serve multiple purposes: supplying water, facilitating trade, supporting freight transport and stimulating cross-border economic activity. In doing so, they reshape vast territories and leave enduring marks on the landscape. This essay explores three such projects studied in the Circular Water Stories (CWS) lab: the Navigli Canal System in Milan, Italy; the Canal du Midi in the Languedoc and Aquitaine region of France; and the Industrial Zaanstreek in the Netherlands. These examples illustrate how water infrastructure of immense scale and ambition responds to geopolitical aspirations, shapes regional identities, and faces challenges of adaptation.

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Nevertheless, as global dynamics evolve, the original drivers behind these projects may lose relevance, rendering their infrastructure less functional in new local contexts. A useful theoretical lens for reading grand infrastructural projects is offered by landscape-infrastructure scholarship, which reframes canals and water networks not as neutral, closed engineering artefacts, but as dynamic territorial systems that organise socio-economic life through flows of water, sediment, energy, labour and capital. Pierre Bélanger argues that modern infrastructures have historically normalised standardisation, mono-functionality, and permanence, logics that externalise ecological processes and render their wider biophysical dependencies effectively invisible, producing rigidity and vulnerability as context shifts (Bélanger, 2013). Against this, 'landscape infrastructure' proposes an expanded, cross-scalar operating system in which watersheds, soils, and living systems are understood as essential services that support urban economies, and in which design works through flexibility, interconnection, and the reclamation of ecological flows rather than end-of-pipe control (Bélanger, 2013).

As Bélanger (2009) argues, landscape infrastructure exceeds the provision of utility, functioning as an operative system that mediates ecological processes, economic productivity, and cultural meaning over time. This perspective is particularly apt for transboundary water corridors, whose relevance is periodically re-scripted by changing geopolitical ambitions, technologies, and regimes of mobility, foregrounds their territorial footprint beyond the canal prism, their life-cycle fragility, and their capacity to be reprogrammed as multifunctional socio-ecological infrastructures. Methodologically, it also legitimises the use of drawing and mapping as analytical instruments for revealing submerged relations—between hydraulic works and regionalisation, maintenance and obsolescence, environmental externalities, and cultural attachment—thereby enabling these European systems to be interpreted as landscapes that both materialise power and remain open to adaptive, contemporary rearticulations (Bélanger, 2013).

REFRAMING WATER INFRASTRUCTURE: PERSPECTIVES ON THREE EUROPEAN SYSTEMS

'Water infrastructure' refers broadly to systems for water supply, treatment, storage, management and energy generation, including transport systems such as canals (IGI Global, n.d.). While this term highlights engineering and functional aspects, landscape architecture has long interpreted infrastructure as landscapes, and vice versa (Strang, 1996). Redefined beyond its utilitarian role, the water infrastructure facilitates aesthetic, functional, social, and ecological relationships between natural and human systems (Nijhuis et al., 2015).

From this perspective, we present three cases—Navigli in Italy, Canal du Midi in France, and Industrial Zaanstreek in the Netherlands—each with unique values and a deep influence on regional landscapes. Unlike water projects based solely on local conditions, these infrastructures are notable for their scale; regional governance; and political, environmental, cultural, and financial relevance. However, like other traditional water projects discussed in the CWS lab, they are also susceptible to decline and underuse.

The Navigli System is an ensemble of navigable waterways in Italy, comprising six routes connecting Milan to the Alps, the Swiss waterways, and northwestern Europe. A total of 1,800 kilometres of existing rivers were navigable and extended through parallel canals. This water system ensured a direct connection between the continental hinterland and the sea routes from the east (Navigli Reloading, n.d.-a). Built between the 12th and 19th centuries, it brought prosperity to the medieval cities. Today, most canals are covered and now serve as motorcar lanes, while others are no longer in use.

The Canal du Midi is a significant trading route in southern France. Originally constructed to consolidate the power of King Louis XIV and boost the French economy, it created a permanent waterway that linked the Mediterranean Sea with the Atlantic Ocean (Sun, 2021). Built in the 17th century, this monumental hydraulic infrastructure stretches across half of France and is named after the administrative regions it traverses, Midi-Pyrénées and Languedoc–Roussillon. The canal comprises 328 hydraulic works including staircase locks, aqueducts, siphons, spillways, feeders, dry docks, and tunnels (UNESCO World Heritage Convention, n.d.). It showcases the ingenuity of French civil engineering (French Waterways, n.d.) and remains an important site for recreation and historical preservation. (Figure 1)

Industrial Zaanstreek[1] is a water system located northwest of the Amsterdam Metropolitan Area (AMA) in the Netherlands. The region originally covered approximately 8,300 hectares of polders[2]—land drained by ditches in the late Middle Ages. This water network was later connected to the Schermerboezem, making 27,000 ha of North Holland accessible to water. Zaandam, the region's commercial and cultural center, played a crucial role in establishing Amsterdam as a global trading hub during the Dutch Golden Age[3].

AT THE SOURCE OF THE WATER STORY: POWER, TRADE, AND SOIL

Grand water infrastructure is primarily constructed for navigation, but it often serves multiple purposes such as water supply, drainage, and discharge. To make these complex systems function effectively, humans have long modified the landscape by digging canals, building dikes, and installing engineered waterworks to shape the terrain according to hydraulic needs.

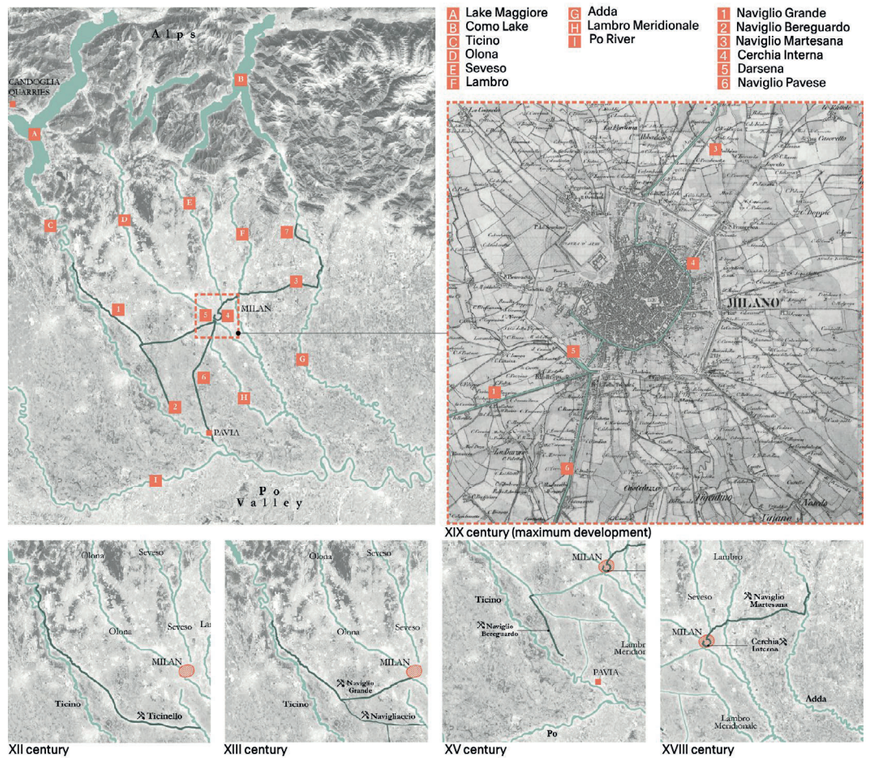


Fig. 2
The development of the Navigli system in the Milan region. Map by the authors, based on Arcanum Maps (n.d.).

Milan's waterways, including the Olona, Seveso, Lambro, Adda, and Ticino rivers—have played a vital role since the city's founding by the Romans in the 3rd century B.C. Initially used for irrigation, these rivers became strategic defensive features in the 12th century, with the construction of the Ticinello Canal in 1152 and a moat encircling the city in 1156, which later evolved into the Cerchia Interna (Monti, 1945). The term Navigli emerged in 1272, during the construction of the Duomo di Milano, when Ticinello was expanded into the 50-kilometre-long Naviglio Grande, used to transport marble for the cathedral (Treccani, n.d.). By the 15th century, additional canals, such as Naviglio Martesana and Naviglio Bereguardo, were excavated, connecting Milan to key trade routes. These connections enhanced Milan's commercial reach to cities such as Pavia and enabled access to Venice and the Mediterranean (Navigli Reloading, n.d.-b). The canals facilitated the movement of goods from the Alps to the sea, transforming Milan into a major commercial hub. Leonardo da Vinci's contributions further enhanced the navigability and water management of the canal system (Navigli Reloading, n.d.-c). (Figure 2)

The story of the Canal du Midi in France follows a different trajectory. Conceived as a royal initiative by King Louis XIV, the project aimed to connect the Atlantic Ocean to the Mediterranean Sea, thereby stimulating trade in southern France. Built between 1665 and 1681, the 242-kilometre canal linked mountainous inland towns to the coast through a series of advanced hydraulic innovations. Notably, the Montagnes Noires region[4] was transformed into a large reservoir to ensure a steady water supply, and a sequence of locks was installed to manage the elevation of the canal. These interventions enabled a stable water flow and reliable navigation capabilities that the region's natural rivers could not provide (Labat et al., 2006). (Figure 3)

In the Dutch lowlands, functional adaptations to water infrastructure have been continuous and transformative. In Zaanstreek, around the 13th century, ditches and canals were excavated to drain wet peat soils, converting them into arable land through a dense and ordered network. With ongoing soil subsidence, it became necessary to regulate the water table, leading to the construction of dikes to protect low-lying land from flooding. This has marked the development of a broader landscape. As peat rivers such as the Zaan and Amstel subsided, they were dammed to prevent water from IJ Bay from flooding the hinterlands.[5] These former rivers have become *boezems*.[6] Dams soon became crucial trading points, enabling goods carried by sea vessels to be transferred to the inland boats. Over time, these water networks have become the region's primary mode of transport. (Van den Berg et al., 2017; Van Sijl & Beukers, 2012) (Figure 4)

Fig. 3
Canal du Midi's water system. Adapted from Sun (2021).

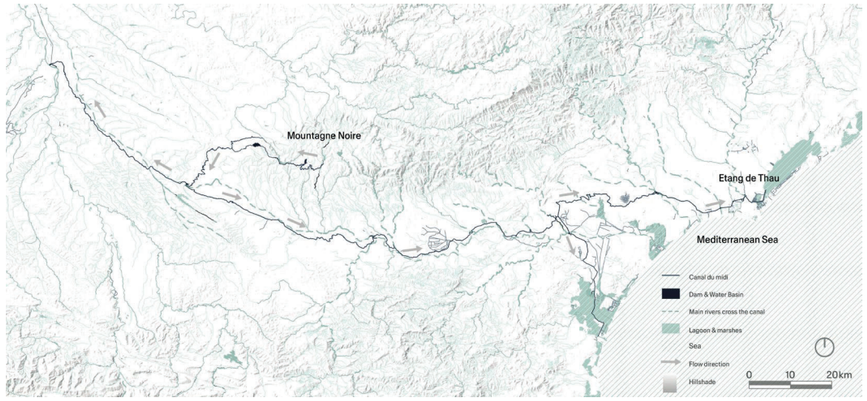
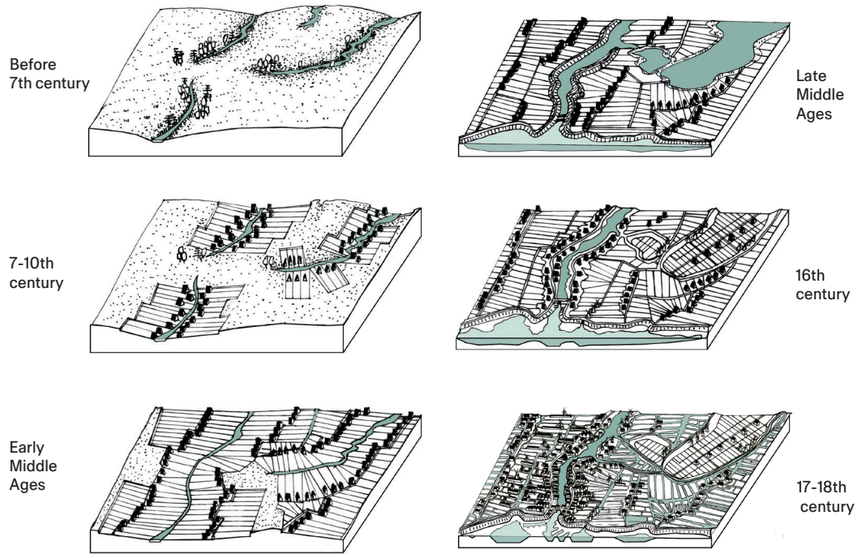


Fig. 4
Land reclamation process in Zaandam: the peatland is constantly subsiding, threatening the hinterland with flooding and storms and leading to the development of dike–dam systems. Adapted from Chen (2023b).



THE SHIP LOCK: A KEY TO TRADING FORTUNE

Among the most essential waterworks, ship locks play a central role in all three examples. It is fundamental to enable water infrastructure to function as an efficient bidirectional transport system. Locks are designed to overcome elevation differences, making waterways navigable in both the directions. Two gates enclose a chamber that can be filled or emptied with water, raising or lowering the vessels to match the water level on the adjacent stretch of the canal.

A total of 35 locks were constructed across the Navigli Canal System. The first, the Viarenna Lock, was built in 1438 to transport massive marble blocks from the Candoglia quarries[7] to Milan for the construction of the cathedral (Houseboat.it, n.d.). This lock had a height difference of three metres. During his stay in Milan in 1482, Leonardo da Vinci studied the lock system and designed several improvements, including two locks that connected Naviglio Martesana to Cerchia dei Navigli, effectively linking the Adda River to the Ticino River. These enhancements, most notably the Incoronata Lock built in 1496, were pivotal for transforming Milan into a key node in the internal waterway network (Fontane di Milano, n.d.; Navigli Reloading, n.d.-c). These innovations enabled efficient transport between the Alpine lakes, Po River, and Mediterranean, establishing Milan as an important inland port. (Figure 5)

In Canal du Midi, the ship locks accommodated considerable elevation changes, amounting to 246 m across their full length (Canal du Midi, 2024; Ministère de l'Intérieur, n.d.).

In Zaanstreek, the ship lock was built into a dike adjacent to the dam, separating the outer water of the IJ from Zaan. Only smaller vessels can pass through this lock to sail from Zaan into the polder. Larger ships remain in the outer waters, requiring cargo to be transferred to smaller boats. Within the polder, the water levels were kept uniform, eliminating the need for locks. As elevation changes were minimal, usually only a few centimeters, the locks constructed here were relatively small but numerous, distributed throughout the low-lying regions of the Netherlands.

Locks are critical waterworks, particularly when canals must traverse uneven terrain. Over time, ship lock design has evolved significantly from timber to steel construction, from rudimentary mechanisms to sophisticated

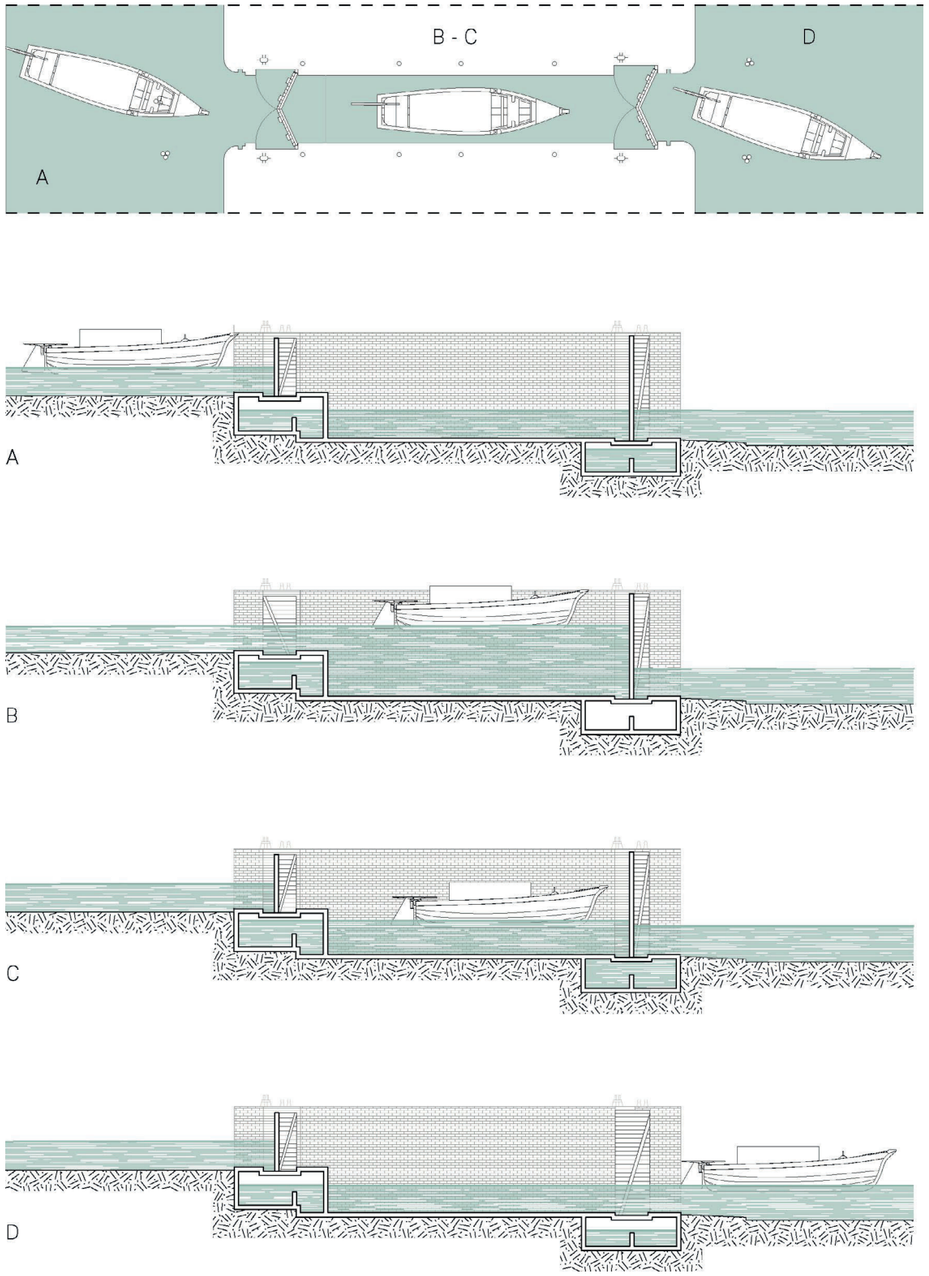


Fig. 5
Section and schematic diagram of the Incoronata Lock. Phases:

(A) Filling of the chamber and opening of the upstream gates;
(B) Entry of the boat into the lock and closing of the upstream gates;

(C) Opening of the valves to drain water and lowering the water level inside the lock;
(D) Opening of the downstream gates and exit of the boat. Adapted from Filippoli (2023).

engineering solutions, and from modest to large-scale capacity. Locks are now being built worldwide. Without them, many lowland regions would be inaccessible; many canals would either become unnavigable or allow travel in only one direction. Their absence also leads to far longer and less efficient shipping routes.

LIVING TRADITIONS: WATER, URBANITY, AND LOCAL CULTURAL IDENTITY

The capacity of humans to adapt to water has played a crucial role in shaping the expansion of settlements. Three distinct urban forms emerged in the cases examined, each profoundly influenced by its water infrastructure. Before roads became central to urban planning and transport, water infrastructure was the backbone of spatial organisation. Beyond their urban extent, the Navigli, Canal du Midi, and Zaanstreek systems shaped regional development by generating specific socio-economic configurations, historical identities, and site-specific festivals and rituals. Ways of living with and alongside water have deeply informed local customs, traditions, and everyday practices. Together, these three cases illustrate a reciprocal relationship between water infrastructure and cultural formation. (Figure 6)

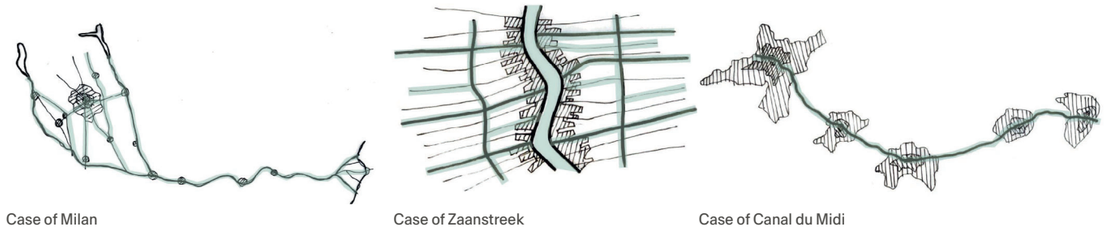
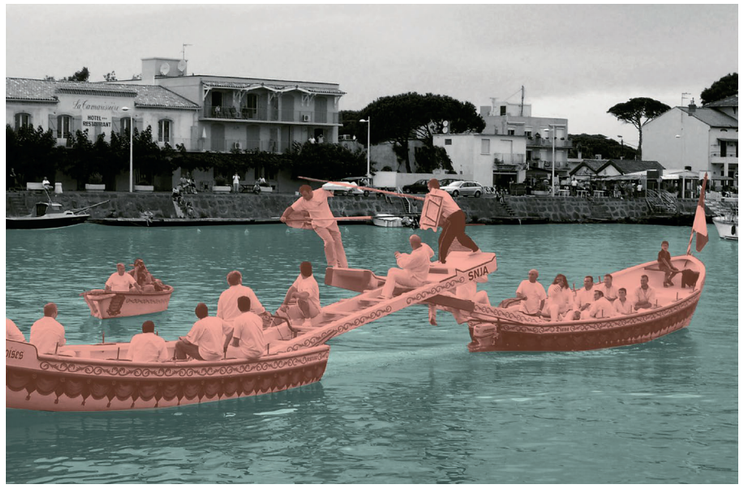


Fig. 6
Three urban fabrics developed in relation to water infrastructure. The water network influences the urban pattern of Zaandam; the Navigli centres on Milan as the system's core; and the Canal du Midi acts as a linear thread along which cities developed. By the authors.

Both Navigli and Canal du Midi are characterized by multi-centric urban development along a central waterway. At that time, these canals were the principal infrastructure for transporting goods and people, and they played a defining role in urban growth. In Italy, the Navigli System facilitated urban expansion from the Alps to the Mediterranean. Similarly, in southern France, numerous villages and towns have developed along the Canal du Midi. New settlements such as Sète emerged, capitalizing on the canal's enhanced trading potential and enabling the export of regional goods to international markets. The town of Castelnaudary grew so closely with the canal that it became known as 'the city of the Canal,' with the Saint-Roch lock basin becoming integral to its identity (Jefferson, 2014). Compared to the more evenly distributed pattern of Canal du Midi, the Navigli system focused on urban development around Milan, a city located equidistant between the Alps and the Mediterranean in the swampy Po Valley. By the late 19th century, owing to the concentric layout of its waterways, Milan was referred to as a water city, akin to Venice and Amsterdam.

In Milan, the Navigli system reflects the city's historic prominence as a centre of art, religion, and commerce. As historical sources suggest, 'Milan became an important river port, which enabled it to receive grain, iron, and especially timber at less expense [...] in short, to make up for the flaw of being a city amid land'(Boatti & Prusicki, 2018). From 1272 onwards, the Navigli waterways were used to transport marble blocks for the construction of

Fig. 7
The Water Jousting Festival in Sète, France. Adapted from a photograph by Felix Koenig.



the Milan Cathedral. This architectural masterpiece remains a symbol of religious authority and artistic excellence. Over time, the canal network expanded and refined into a sophisticated system that facilitated the movement of goods and enabled intercity waterborne connectivity. One notable element was the Cerchia dei Navigli—a 6.5 km-long, 9 m-wide ring of water that encircled Milan's medieval centre (Riaprire i Navigli, n.d.). This infrastructure helped establish Milan as a major inland port, and nurtured a distinctive economic culture rooted in waterborne trade.

The Navigli system has long been remembered as a place of everyday intimacy and vibrant social life, a setting where friendships formed, markets bustled, marriages took place, and leisure activities such as hunting, fishing, games, and informal gatherings unfolded regularly. The navigation itself was remembered with poetic clarity: 'The sailing was as smooth as can be imagined, smooth, along the bank: it seemed like sailing in the middle of meadows' (Boatti & Prusicki, 2018). These recollections highlight how the waterways were woven into daily life, not only for transport and commerce but also as places of gathering and community. (Figure 9)

In contrast, the Canal du Midi was an ambitious royal project designed to forge a commercial route between the Atlantic and the Mediterranean in southern France. The region known as le Midi (Lyons, 2022), renowned for its wine, cuisine, and thriving agricultural economy, was historically the first part of France to be annexed by the Romans around 125 B.C., and traces of Roman civilization remain visible to this day (Mukerji, 2009). The construction of the Canal du Midi fused Roman water management knowledge with emerging modern techniques just before the dawn of the Industrial Revolution. Military engineers were trained in Roman structural principles, whereas local peasants retained practical knowledge of Roman hydraulics. Thus, this canal represents not only an engineering feat but also a cultural convergence, a kind of reunification of classical Roman heritage with Enlightenment-era French ingenuity (Visentin & Vallerani, 2017).

Along Canal du Midi, the repeated presence of washhouses, lockhouses, cafés, chapels, and waterside paths has created a vibrant social fabric. These public and semi-public spaces were frequented by local inhabitants, boat crews, and travellers alike, making the canal not just a means of transport but a lived and performative space. Beyond everyday life, water has also inspired celebrations. In the port city of Sète, a long-standing tradition continues with the Water Jousting Festival at the eastern end of Canal du Midi. Two jousters, each standing on a raised platform at the stern of a rowing boat, compete to attempt to knock their opponent into the canal with a shield and wooden lance (Go Languedoc, 2026). This exuberant spectacle, steeped in local identity, remains a cherished and widely attended festival today. (Figure 7)

In contrast, the water pattern in the Zaandam area emerged directly from land reclamation efforts. Ditches were dug perpendicular to the peat river, allowing water to drain and land to be cultivated. Zaan became the main navigable and drainage channel for the area, offering higher edges that served as favorable locations for housing. Factories, often accompanied by windmills used to saw timber or generate mechanical power, were positioned along ditches in open fields. Over time, this activity led to a densely built landscape. The accessibility of the area declined somewhat after the construction of a dam and sluice between Zaan and IJ, but the network continued to function. Later, owing to continued peat subsidence, a dike had to be constructed along the Zaan River. This transformed low-lying land into polders. However, this process disrupted the expansive water network, contributing to the decline of shipbuilding towards the end of the 18th century. The increase in sluices, each needed to manage different water levels between Zaan and the surrounding polders, made shipping slower and more expensive. (Figure 8)

In the 17th century, Zaandam became a living expression of Dutch cultural identity, defined by its relationship with water. The town is known for its shipyards, marine infrastructure, and status as a hub in the global free market, with more than 700 ships sailing annually to the Baltic Sea (Van Braam et al., 1970). This prosperity was made possible by amphibious culture and an acute understanding of how to inhabit and thrive in a water-dominated landscape (Van Dam, 2016). Waterways were everywhere, lined with floating rafts, drifting logs, and skeletal frames of ships under construction.

Fig. 9
Production and living by water in Milan. Includes drawings adapted from Filippoli (2023).

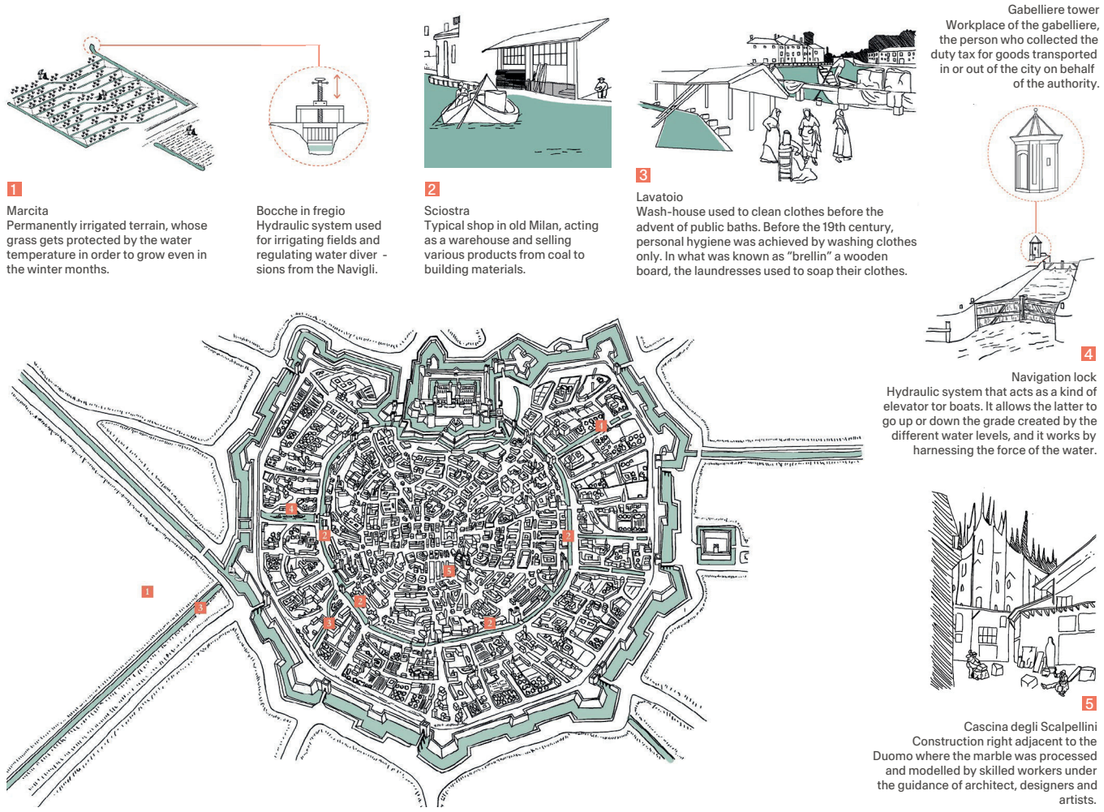


Fig. 8
The water system and urban fabric of the Zaanstreek region. Dam cities developed around dams constructed where peat rivers met larger waterways. In the surrounding villages, settlement expanded along the existing water infrastructure, with development following the linear pattern of river dikes and polder drainage ditches. Together, these hydraulic structures shaped the characteristic spatial layout of the region. Adapted from Chen (2023a).

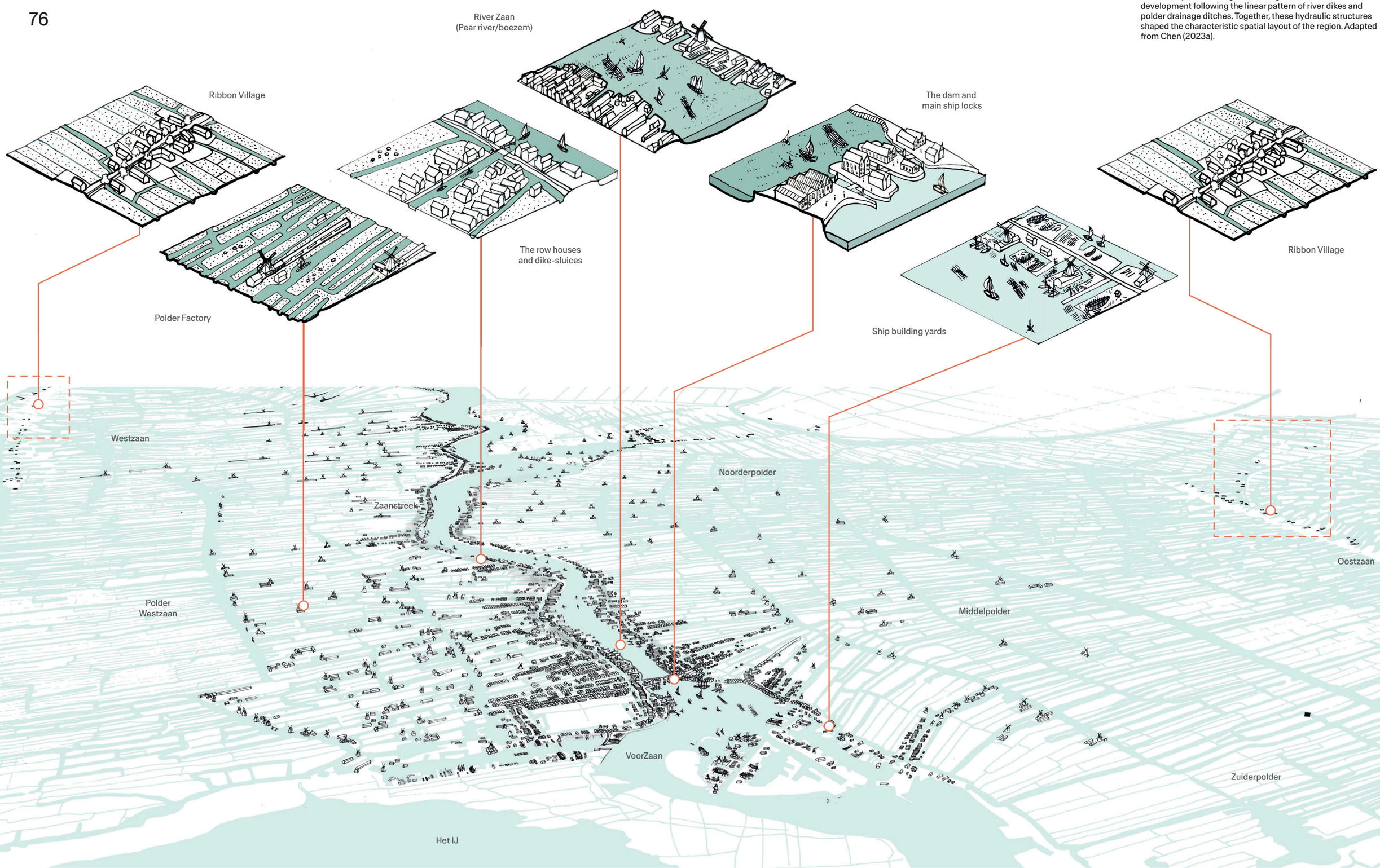


Fig. 10
Living by water in the Zaanstreek. Ships used in international trade (especially timber, on the left-hand side of the engraving) and for regional transport. Adapted from an engraving by Andries de Leth and Hendrik de Leth (1726).

Hundreds of windmills dotted the horizon, driving industrial activities such as timber sawing and grain processing. This landscape, shaped by mercantile ambitions, gradually gave rise to a dynamic industrial and commercial identity. (Figure 10)

In Zaanstreek, a similar close interaction between water and people has shaped the region's culture. Here, every household traditionally possessed a boat, used not only for fishing, but also for local and regional mobility. Over generations, many fishermen have evolved into international traders and deep-sea navigators. The region's thriving economy, anchored in lumber and other waterborne industries (Van Braam et al., 1970), is inseparable from the fluid connectivity enabled by water transport.

The role of water as both a navigational route and a productive resource made these infrastructure magnets for economic and social interaction. The interplay between technical innovation and everyday life has long defined such systems. Traditional water networks became centres of commerce and craftsmanship, shaping the rhythms of village life and instilling each with a distinct character. Water was part of the daily urban experience; laundresses, swimmers, rowers, and fishermen were woven into the fabric of public life. Waterways were also perceived as safer than land routes, less vulnerable to brigand attacks, and thus better suited for fostering relationships and trade. This sense of security, combined with transport efficiency, enabled merchants and traders to flourish, largely unburdened by the temporal or logistical constraints associated with overland travel.

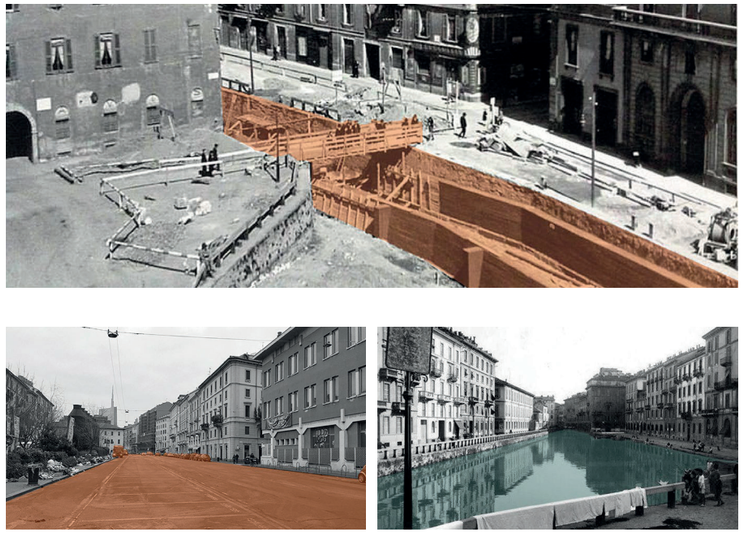
ADAPTATION AND POTENTIALS, FROM TRADING CORRIDORS TO COMPLEX SOCIO-ECOLOGICAL SYSTEMS

With the rise of railways and expansion of air and road transport networks, many historic waterways have lost their economic primacy. Grand infrastructure projects that had driven regional development and global trade began to fade in relevance. Despite their diminished utility, these infrastructures retain cultural and historical significance and today prompt renewed interest in their capacity for transformation.

In Milan, the industrial boom of the 19th and 20th centuries brought rapid urban growth. The surge in population and lack of modern sanitation systems have turned the Navigli canals into open-air drains. Their polluted waters became a civic burden, especially once the railway network replaced the canals as the dominant mode of transport. By the mid-20th century, many of Milan's waterways had been culverted, converted into sewer channels, or entirely covered by roads. (Figure 11)

Canal du Midi underwent a series of modifications to modernize its infrastructure. The Agde lock, which was originally a circular design, was extended to accommodate larger vessels. However, these changes came at cost. These alterations were expensive and perceived as damaging the canal's historical and aesthetic integrity. Critics argued that modernization compromised the heritage value of the locks, prompting renewed discussions about preservation and use. (Figure 12)

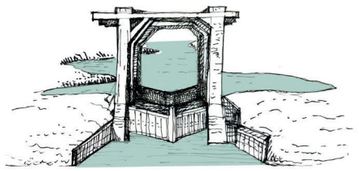
Fig. 11
Evolution of the urban fabric of Milan: the water basin known as the Laghetto di San Marco, connecting the surrounding canals (bottom left). The gradual infilling of the basin (top). The modern landscape, now car-oriented, with underground parking replacing the basin (bottom right). Composite image by the authors, based on historical photographs by unknown photographers (before 1930, public domain) and a contemporary photograph by Roberto Arsuffi.



In Zaandam, the challenge arose from the increasing size of the ships. The locks connecting Zaan to the IJ had to be regularly enlarged to accommodate the growing cargo vessels. While the main infrastructure, including sluices, dikes, dams, and pumping stations, was continually upgraded, many smaller polder ditches remained unchanged (Hijdra, 2017). Cleaned every three to five years, these ditches have retained their original form and are now recognized as part of the region's cultural heritage. (Figure 13)

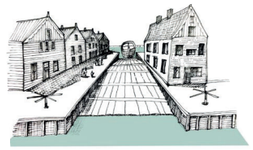
Although these historic waterways have lost their central function in trade and freight transport, they continue to play a valuable role in contemporary life. Their ongoing presence offers opportunities for diverse reinterpretations ranging from agriculture to leisure and tourism. These examples illustrate how water infrastructure, although no longer central to commerce, remains deeply embedded in the evolving life of cities and landscapes.

Fig. 12
Evolution of the Round Lock of Agde in the Canal du Midi before (left) and after (right) its enlargement. Composite image by the authors, based on a historical postcard by an unknown author (c. 1900, public domain) and a contemporary photograph by Miguel Espada (2022).



1544

The Grote Sluis (Great Sluice) was built.



1608

The construction of the Overtoom, for dragging large ships cross the dam.

1722

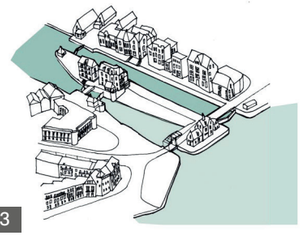
Rebuild the Grote Sluis/Hondsbossche Sluis

28m x 5.1m x 2.6m(depth)

1500 1600 1700 1800

1876

Opening of the North Sea Canal



1903

Wilhelminasluis was constructed

120m x 12m x 3.7m(depth)

1900 2000

Wilhelminasluis renewed/enlarge

2020

156m x 14m x 4.7m(depth)

Fig. 13
The enlargement process of the main lock in Zaandam. Includes drawings adapted from Chen (2023a).

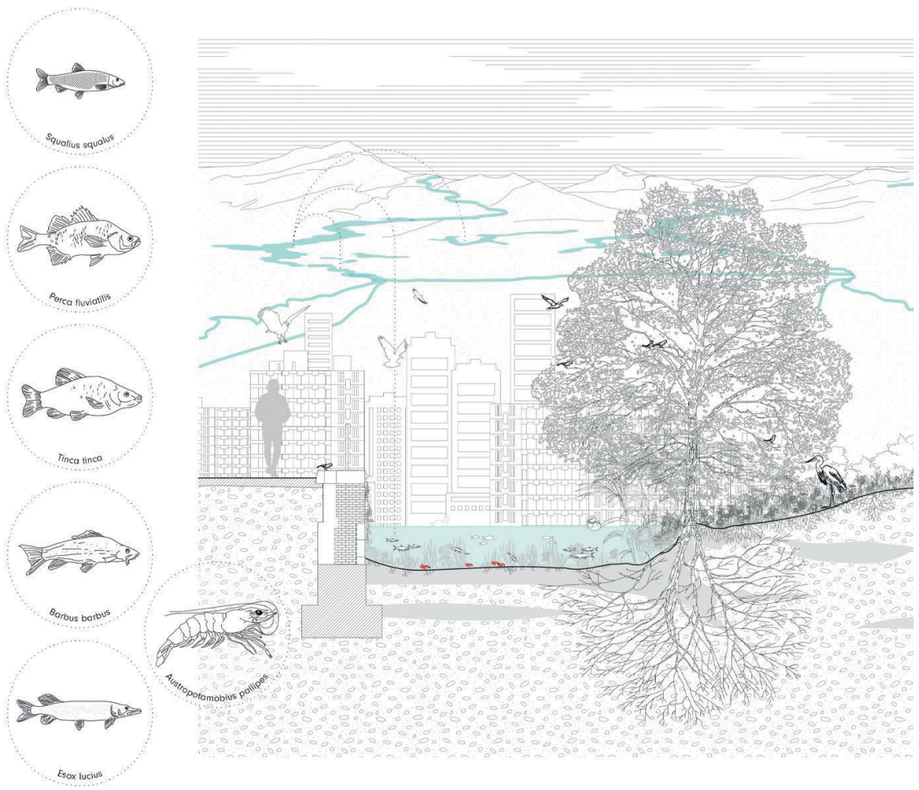
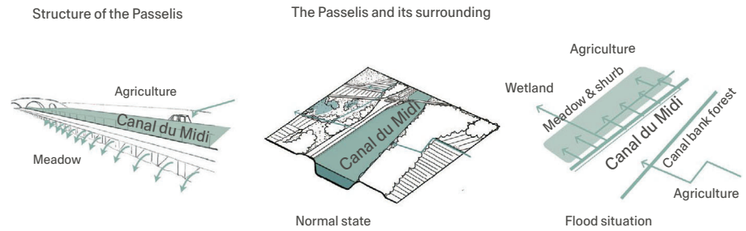


Fig. 14
The naturalisation of canal banks in Milan. Adapted from Filippoli (2023).

Fig. 15
The *passelis* system along the Canal du Midi. By the authors.



In Milan, Naviglio Grande and Naviglio Pavese now serve as picturesque backdrops for nightlife and local gatherings. Despite their marginalisation in terms of infrastructure, they have gained renewed attention for their potential for irrigation, tourism, and recreation.

Meanwhile, the Canal du Midi officially ceased transporting freight in 1989. The railway and the two world wars have long since diverted major traffic. In response, the canal was reimagined as a tourism and leisure site. By the 1980s, it had been promoted as a linear park ideal for slow travel, boating holidays, and heritage tourism. Since 1973, the canal has also been used for agricultural irrigation and the provision of drinking water, now serving approximately 185 communes. These adaptations show how a single infrastructure can evolve to serve multiple-layered functions over time.

In Zaandam, the water system has gradually been redefined as a recreational and natural resource. The polder landscape, threaded with canals and ditches, now hosts rowing and leisure boats. These slow-paced activities allow residents and visitors to experience an almost medieval water landscape, which is complete with windmills rising on the horizon. The familiarity and persistence of this waterscape provides a strong sense of place and historical continuity.

While the ecological potential of historical water infrastructures has rarely been considered at the time of their construction, the decline in their transport functions has opened new opportunities. As shipping faded, ecological values began to emerge, as communities rediscovered the role of canals and polders in supporting biodiversity, habitat restoration, and climate resilience. In Milan, natural processes have begun to reshape Navigli Canals into unexpected reservoirs of biodiversity. Their expansive connectivity allows species from alpine lakes and surrounding rivers to

migrate, sometimes in search of refuge from predators or pollution. Naviglio Martesana provides a clear example: In the absence of industrial disturbance or freight traffic, the canal now supports calm waters in which aquatic plants take root. These plants create habitats for a wide range of wildlife, from amphibians and fish, to birds and small mammals. Over time, these canals have attracted migratory species and insects, thereby forming a layered and dynamic ecosystem within the urban fabric. Along Navigli, residents and visitors now enjoy walking and cycling routes that pass through green corridors, teeming with life. This transformation speaks not only to the resilience of natural systems, but also to Milan's evolving vision of sustainability, one in which historical memory and environmental awareness coexist. (Figure 14)

In the case of Canal du Midi, the water system was embedded in a broader network of rivers, canals, and wetlands. These interconnections provide a water supply to the canal while also creating valuable floodplains and riparian habitats. In recent years, ecological thinking has been integrated into new design interventions, particularly in response to the increased flooding linked to climate change. One such innovation is the passelis[8], a spillway system that allows water from high-lying rice fields to flow across flat land into the canal. These areas were intentionally left as floodplains, functioning as dynamic wet zones that support both flora and fauna (Sun et al., 2023). (Figure 15)

In Zaandam, the polder water system supports ecologically valuable peatlands that are now actively managed as conservation landscapes (Sweco, 2023). Polder Westzaan, on the city's western edge, is a prime example: a diverse mix of brackish waters, bird meadows, and insect habitats is gradually reestablishing itself. Through natural succession, sphagnum moss is a key indicator of peatland health and a vital component of long-term CO_2 storage. Because the soil conditions in these landscapes depend heavily on water quality and regulation, historic polder canals have taken on a renewed environmental role as mediators of ecological restoration.

These transformations led to a larger shift in perception. Water, once seen only as a functionalistic infrastructure designed for navigation and drainage, is now being understood as an agent within a larger blue-green infrastructure, creating space for deeper and more complex socio-cultural contamination. The historic waterways of Milan, southern France, and Zaandam have been transformed into hybrid systems that support biodiversity, ecological networks, and human well-being, while revealing how long-standing infrastructure can serve as a laboratory for ecological adaptation. As pressures from urbanization and climate change grow, these living systems offer valuable models for more integrated landscapes. (Figure 16)

INFRASTRUCTURES AS LANDSCAPES AND LANDSCAPES AS INFRASTRUCTURES

When considered beyond their engineering functions, these grand projects reveal new layered meanings. The complementary perspectives on Navigli in Italy, Canal du Midi in France, and Zaanstreek in the Netherlands demonstrate that water infrastructure plays a fundamental role in shaping not only the physical landscape but also the cultural identity of a region. Although no longer central to trade or industry, these systems continue to contribute meaningfully to contemporary society. They enhance the quality of life through leisure and tourism, reveal the multifunctional potential of water, support ecological diversity, and preserve essential historical and cultural narratives.

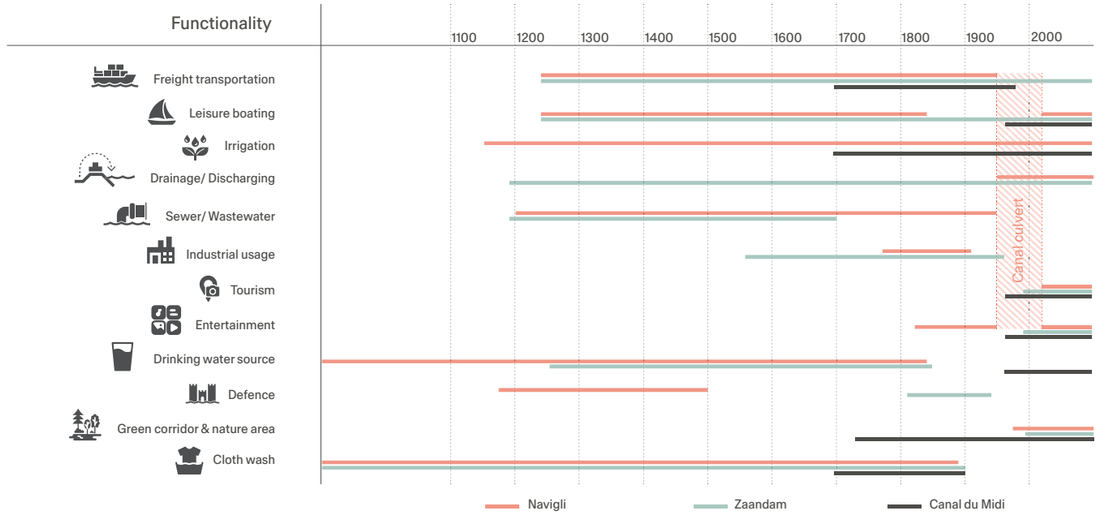


Fig. 16
Comparison of the functions of the three cases over time, showing shifts in the use and meaning of water infrastructures. By the authors.

Reading through political ecology, however, the three systems also reveal how infrastructure connects nature, society, and power. Their construction reorganized landscapes around particular flows of water, labor, materials, and trade, generating prosperity for connected cities and industries, while making local economies dependent on wider political and commercial networks. When railways, larger ports, and global trade routes redirected these flows, physical infrastructure remained, but the livelihoods and economies that had sustained them weakened. Their decline and later transformations, therefore, cannot be understood as purely technical processes: they reflect the changing distributions of investment, access, environmental burden, and political priority. Hence, reassessing the values embedded in these infrastructures allows us to see them as reservoirs of knowledge that hold spatial, ecological, and cultural insights that can inform the future planning and design of large-scale infrastructure and cities.

In this sense, Navigli, Canal du Midi, and Zaanstreek stand as archetypes of what we now call blue-green infrastructure. They demonstrate how infrastructure can be read and designed as landscapes, just as landscapes can function as infrastructure. Bélanger's concept of landscape infrastructure helps explain this reciprocal relationship: their value lies not in individual canals, locks, or ecological features, but in the way water, soils, habitats, settlements, economies, and cultural practices operate together. Further, as cities increasingly explore a shift towards blue-green infrastructure, the transformation and continued adaptation of these grand water projects offer operational precedents for aligning local ecological and socio-economic adaptation with macro-level forces of governance, investment, trade, and mobility.

NOTES Grand Projects

1. The word 'streek'in Dutch means 'region.'
2. Polders are the land which is surrounded by dikes which have an enclosed inner water system.
3. Approximate 1588–1672.
4. The Montagnes Noires is a mountain range in central southern France, known as the 'Black Mountain' in English.
5. The 'IJ' is an inner sea in between Amsterdam and Zaandam in province North Holland, it is conncected to the Zuider Zee and further the North Sea. The IJ has been reclaimed into polders and where the North Sea Canal was also built. (Engel et al., 2017)
6. A network of larger water bodies, mainly canals, that drains water from the polder system towards the sea. Today, most *boezem* systems are also situated below mean sea level (NAP) and need pumps to discharge the water (Hooimeijer, 2015).
7. In the north-west Alpine area, in Piedmont, are located the quarries from which the marble that makes up the Cathedral comes.
8. The passelis, a type of specially designed spillway system.