BLUE PAPERS

Water & Heritage for Sustainable Development

Edited by Carola Hein, Matteo D'Agostino, Carlien Donkor,
Queenie Lin and Hilde Sennema

Leiden-Delft-Erasmus
Universities

2022 (Vol. 1 No. 1)

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Journal Description

Blue Papers: A Journal for Empowering Water and Heritage for Sustainable Development

Water in all its forms is key to human survival and well-being. Humans have created intricate and ingenious solutions to survive and thrive in difficult and complex territories, and adapt to changes in social and environmental conditions. Remnants of past practices, structures and objects are still with us – in the built environment, in our institutions, in our ways of living and in our languages. Sometimes we call these objects and practices heritage, but more often they are so much a part of our everyday lives that we take them for granted.

As emphasized in the *UNESCO Thematic Indicators for Culture in the 2030 Agenda*[1], culture is an important part of the Goals and Targets of the 2030 United Nations' Agenda for Sustainable Development. Stand-alone technological interventions cannot solve the complexities of the social, cultural and economic implications of climate change in the long term. New solutions require engagement of local interested parties and local knowledge to address social and cultural dimensions of water and to create a new embedded water awareness in the built environment, in institutions and culture(s) so that we can preserve and protect our heritage, understand and learn from the past, and activate history and heritage for future sustainable and inclusive living.

The biannual peer-reviewed journal *Blue Papers* explores the complex relationship between water, culture and heritage to assess lessons from the past, to protect heritage sites, to make use of water heritage and to contribute to the development of inclusive and sustainable future water systems. The past can help build a new platform for awareness of water and heritage, which involves shared methodologies and terminologies, policies and tools that bridge disparate fields and disciplines. To achieve this, we also need to rethink the role of water in the UN Sustainable Development Goals (SDGs). Water is not fully captured in *Goal 6: Ensure access to water and sanitation for all*; it is also an integral and inseparable key to all SDGs that carry us forward to a more sustainable future.

All issues of the journal will be loosely based on themes that link to water, culture and heritage, including (but not limited to):

- Transcending the nature-culture divide
- Tangible and intangible aspects
- Integrated discourses and practices

1. The UNESCO Thematic Indicators for Culture in the 2030 Agenda (UNESCO Culture|2030 Indicators). https://whc.unesco.org/en/culture2030indicators/.

- Capacity building for holistic systems
- Long-term (living) history perspectives for comprehensive understanding
- Preservation, protection and reuse of water-related (living) heritage
- Human and non-human stakeholders
- New practices and rituals for water awareness and engagement
- Strategies for inclusive sustainable development, including those drawing on heritage.

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Cover image: Students take an afternoon stroll on the walls at the UNESCO site of Galle Fort, Sri Lanka. The fort has become an inseparable part of people's daily lives and is where people go to enjoy ocean views and feel their lives supported and inspired by water. (Source: Queenie Lin, 2019).

2022 Carola Hein, Matteo D'Agostino, Carlien Donkor, Queenie Lin & Hilde Sennema. SOAP | Stichting OpenAccess platforms, the Netherlands.

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Content

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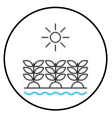
Capturing Water, Culture and Heritage through Icons: A First Attempt

Carola Hein, Matteo D'Agostino, Carlien Donkor, Queenie Lin and Hilde Sennema

Humans have engaged with water in multiple ways, creating physical structures – such as buildings, cities, infrastructures and landscapes–and socio-cultural manifestations – for example, institutions, laws, artistic practices and rituals. They have transformed natural settings in keeping with climate and energy conditions. To understand the diverse conditions of water spaces and heritage, we have created a set of icons to categorize tangible and intangible objects and practices related to water. The icons help us identify different scales, functions and forms of both water management-related heritage objects, as well as generic water-related structures. The categories identified are suggestions and not conclusive or mutually exclusive.

Tangible

Drinking
A key function of water management is the provision of freshwater and access to potable water; infrastructures and techniques to store, pump, redistribute and use drinking water.



Agriculture and Irrigation
Numerous strategies and technologies exist to channel and exploit water resources for food production, including the irrigation of agricultural land and livestock watering.

Drainage and Sewage
The removal of excess water and sewage water – e.g., rainwater and excess surface run-off, and wastewater (black and gray water) – requires extensive infrastructure and cleaning systems.

Food from Water Bodies
Natural and artificial water bodies - including seas, rivers, lakes and ponds - are home to plants and animals and are a source of food, obtained through traditional and industrial fishing techniques as well as aquaculture.

Shelter and Defense
Humans have built shelters to protect themselves from harsh climatic elements (rain, snow, etc), through architectural and urban forms. They have also made structures to defend themselves from and through water, such as dikes, dams, moats and fortification walls.

Health
Clean water is key to human well-being. Water quality is important for individual and public health. The pollution of water bodies through biological and chemical agents has notably influenced the development of spatial planning.

Water, Culture and Heritage Themes

Energy/ Industry
Water is used in industrial processes, e.g., for cooling down machinery, in mining activities and breweries; it is exploited for energy production, such as hydroelectric power. Energy is also key to controlling water and is used to generate energy.

Transport
Water bodies – seas, rivers and canals – are key to transporting people and goods for everyday mobility, tourism and commercial purposes. Specific infrastructures exist to transport people and goods from sea to land and vice versa (e.g., quays, cranes), and for storage (e.g., warehouses).

Places of Leisure
Water bodies, natural or manmade, in cities and landscapes serve leisure practices in multiple ways (e.g., waterfronts, water parks, rivers, swimming pools).

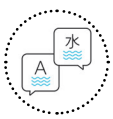
Place of Worship
Humans have created religious spaces for revering water and they may use water to express reverence for or connection with a spirit or deity. Structures such as churches and temples contain elements related to water, or can be part of the management of water resources.

Intangible

Daily Water Practices
Water is part of everyday practices, including drinking, bathing, washing and cooking.

Recreation
Recreational practices use water bodies, natural and artificial. These practices include water sports as well as spending time by the sea.

Rites and Rituals
Water is part of religious and spiritual practices all over the world, including those of major world religions. It is often associated with purification, and in some belief systems, it is revered as a source of all life.



Language/Idioms
Idioms, proverbs and sayings that concern water and water-related societal wisdom and ancestral knowledge.

Laws and Policies
Water management, access, and use have long been regulated through governmental policies and customary laws. Water politics affect and are affected by social, cultural and economic dynamics; they can determine rights and obligations for citizens and community members.

Institutions
Water management laws and policies are often designed and enforced by institutions. These can be political (e.g., a nation-state or a chiefdom), religious or social.

Education
Socialization is key to healthy and sustainable living with water. This can occur through community members, capacity-building programs, schooling, and initiatives to exchange or transmit knowledge and to raise water awareness.

Preservation, Adaptation, Reuse
Diverse traditional and contemporary practices and actions aim at preserving or strategically changing water bodies, related ecosystems, and even the social customs connected to them.

Music, Arts and Dance
Ecological knowledge Is contained in local songs and other oral traditions, poems, illustrations, paintings, and artistic performances that connect life stories to water.

Festivals and Ceremonies
Many special events celebrate, commemorate or inaugurate water-related structures, practices and models. This includes fishing and seasonal festivals, events organized to honor or mourn historic water-related events, and ceremonies to establish/launch new water-related objects or structures.

Leveraging the Past for Better Futures

Henk Ovink

In 1977 the first UN Conference on Water took place in Mar del Plata, Argentina. We were already aware of the need for water security for all, yet unable to figure out how to get there. The effects of pollution and emissions on climate and the interlinkages with water were not left undiscussed. We also discussed the need for action on Water, Sanitation and Hygiene (WASH), Integrated Water Resources Management (IWRM) and more. But there was no clear follow up, no roadmap nor institutional capacity, let alone political or societal ownership. Water, always perceived as a sector, continues to be perceived as a sector. A sector to call on when the pipes fail to function or when water floods our communities or is absent or too polluted to use. That perspective is not only unrealistic, but has led to the abuse of this vital yet scarce resource. The mismanagement and undervaluing of water has helped damage the hydrological cycle, undermining everything we value and want to achieve.

It took 46 years for Mar del Plata to have a successor. The UN 2023 Water Conference in New York, March 22–24, 2023, acts as a midterm review for the Water Action Decade. But its ambition goes way beyond looking back. It aims to change the world with water security by and for all, for good. We must change the economics and politics of water, increase our collective understanding, start valuing water as a global common good and manage it across silos, borders and divides. Water can bring us together but demands radical change. Investment in water trickles down across all SDGs, catalyzes their implementation and scales up inclusive, sustainable and resilient security for communities, our economies and the environment.

The UN 2023 Water Conference will bring together the collective will and action of the world for inclusive, comprehensive and sustainable water action grounded in the geographies and cultures of our societies. The stakes are high: we need concrete commitments for the second half of the decade that ends in 2028. The hiatus between high-level water meetings and insufficient action over the last decades has been marked by extraction, extinction and exclusion. The past, for many, is something to overcome and leave behind.

Learning from the past is not only about looking back. In fact, looking at the past should be about the future. This means that we critically and actively position our past and present actions toward current and future challenges. It allows us to recognize the non-responsive or even reactive approaches that we are engulfed in, and to shy away from them. It allows us to identify vested interests, in which every step is a replication of mistakes. Exploring past practices can and must have positive meaning for today. Many traditional systems are still working and need to continue to support local communities. Indigenous cultures continue to teach us how to value water as a solution broker. Others can be adapted and inspire future practices. The sites we have recognized as

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Preface

World Heritage require careful attention and preservation efforts. Paradoxically, knowing our past mobilizes us to become radically proactive, looking at the future in an inclusive, comprehensive and sustainable manner, as the sum of our previous and current decisions.

Given the current situation, in which we need to act on scarcity, quality and flood risk at the same time, far-reaching strategies are necessary – politically, financially and culturally. We need to match short-term innovative approaches with long-term comprehensive planning, answering today's challenges while consolidating the ground for a sustainable future. Partnerships, collaborations and coalitions become the foundation for this fusion. Meanwhile, we need to achieve these goals with transparency, and make sure we hold stakeholders accountable for the outcomes. To do so, it is necessary to build capacity that is institutional, individual and informal. We need to innovate, invest in each other and build coalitions that hold the change in hearts, minds and hands. Here, shared water identities and practices can activate comprehensive, common scenarios.

The weight of the past should not pull us down, but should act as a lever pushing forward necessary change. This first issue of the journal *Blue Papers* starts a conversation about which practices can and which won't help us. It raises the question: which past should be an example for our sustainable future, and how does it relate to contemporary and future values? As such, the new journal is a welcome addition to the field and one I wholeheartedly support. I expect that *Blue Papers* can leverage sustainable water practices of the past as a strong counterpoint for the future: as an inspiration, but also as a careful reminder not to repeat past mistakes.

Editorial Issue 1/2022: Valuing Water, Culture and Heritage

Carola Hein, Matteo D'Agostino, Carlien Donkor, Queenie Lin and Hilde Sennema

Over the past few decades, like-minded researchers, heritage professionals, field practitioners and activists have started to explore the value of water-related practices, objects and systems from a long-term and heritage perspective – going beyond their financial worth. This network of researchers, water managers, heritage professionals and activists from all over the world, with diverse backgrounds, ages and coming from different disciplines, sees the nexus of water culture and heritage as crucial to achieving the UN Sustainable Development Goals. Meaningful collaboration within this growing network requires discussion of concepts, theories and methodologies and a shared knowledge of case studies.

The *Blue Papers* journal provides a platform for the growing network, with the first issues launched in time for the UN 2023 Water Conference in New York, 22–24 March 2023, which coincides with the Midterm Review of the UN Water Action Decade. A growing number of people have come to realize that valuing water needs to go beyond technological, political and economic changes. The conference provides the background for a broad exploration of the role that culture, heritage and social practices play in current water challenges, and those they can play to support future inclusive and sustainable development. This requires an advanced engagement with the social, cultural and intrinsic value of water, by creating a new embedded water awareness 2.0.

The first three issues of *Blue Papers* pursue this aim by gathering contributions from academics, practitioners and experts who challenge siloed thinking and stand-alone solutions and who reflect on how water, culture and heritage management practices – as well as the constellation of actors and organizations involved – have changed over time. Contributors point out the current challenges faced by water systems and their users and explore how new approaches, concepts and methods can be integrated to achieve sustainable development. Each issue has two parts: Part I sets the scene of the current water and heritage situation, discussing contemporary challenges in global and local contexts, and sharing new strategies from experts in various disciplines around the world; Part II presents working methodologies and case studies that illuminate past and present conditions and challenges.

This first issue, "Valuing Water, Culture and Heritage," explores the complexity of connecting the themes of water, culture and heritage in Part I. Carola Hein reflects on the UN Sustainable Development Goals (SDGs) through the lens of water and culture. Åse Johannessen argues for the need to integrate culture and heritage in water governance and social learning to boost the human ability to bring about needed change. Barbara van Koppen reflects on the role of customary water tenure

to achieve SDG 1, 2 and 5. Brian Davidson and Petra Hellegers dive into the difficulty of valuing water and heritage from an economic perspective. Neelke Doorn introduces water ethics to reflect on the trade-offs between economic and environmental concerns, and as something to prioritize. Arjan Conijn, Maarten Ouboter and Jeroen Oomkens argue that we need to add "Place" to the 5Ps (People, Planet, Prosperity, Peace and Partnership) of SDGs for sustainable water management. Jan Jorrit Hasselaar, Joana Tusznio and Marianna Strzelecka explore the emotional impact of climate change and ecological loss, introducing hope and grief as strategies for coping with and responding to the loss of water heritage. Akifumi Iwabuchi demonstrates how the global underwater cultural heritage of stone tidal weirs is not only a signifier of past tangible and intangible cultures, but also a critical guide to cultural and natural conservation for a sustainable future.

In Part II, contributors address methodological issues and provide insight with diverse case studies. Jean-François Vereecke and Sandrine Deveycx as well as Inge Bobbink, Amina Chouairi and Camilla Di Nicola share their respective innovative and integrative methodologies to analyze water ecosystems, their flows and spaces. Vera D. Damayanti, Punto Wijayanto, Kemas Ridwan Kurniawan, Hasti Tarekat Dipowijoyo, Jacqueline Rosbergen and Peter Timmer add their experience with the UNESCO Historic Urban Landscape (HUL) approach and their Quick Scan Method. Joanna Tusznio and Marianna Strzelecka exemplify the conceptual approach they presented in Part I through an analysis of the case of Sztoła River in Poland. Massoud Ghaderian explores the relation between water and heritage through the lens of the qanat system. Michael Kloos analyzes Heritage Assessment as a tool to achieve inclusive and sustainable development for the World Heritage Site Bryggen in Bergen. Karen Young, Joanne Dahme, Ellen Freedman Schultz, Claire Donato, Victoria Prizzia and Theresa R. Stuhlman conclude the first volume as they present the history of the Fairmount Water Works in Philadelphia and reflect on the unique history of this early waterworks and its role today.

Together, these articles comprise an issue that addresses water heritage challenges at a time of climate change, examining water-related values from diverse perspectives and underlining the importance of understanding past practices to plan sustainable futures.

Carola Hein is Professor History of Architecture and Urban Planning at Delft University of Technology, Professor at Leiden and Erasmus University and UNESCO Chair Water, Ports and Historic Cities. She has published widely in the field of architectural, urban and planning history and has tied historical analysis to contemporary development. Among other major grants, she received a Guggenheim and an Alexander von Humboldt fellowship. Her recent books include: *Oil Spaces* (2021), *Urbanisation of the Sea* (2020), *Adaptive Strategies for Water Heritage* (2020), *The Routledge Planning History Handbook* (2018), *Port Cities: Dynamic Landscapes and Global Networks* (2011).

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Matteo D'Agostino is a researcher at Delft University of Technology, a member of the PortCityFutures research group, and currently affiliated with the UNESCO Chair for Water, Ports and Historic Cities. Matteo is a cultural anthropologist experienced in the analysis of perceptions and relational dynamics between public and private actors. His research focuses on understanding multiple structural, spatial and socio-economic factors as the basis for spatial planning and social interventions. Other interests include policy implementation for granting access to basic resources, such as water, and strategic reinterpretation of heritage by institutional and activist organizations.

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Carlien Donkor is researcher at Delft University of Technology. She is also affiliated with the LDE PortCityFutures research group and the UNESCO Chair for Water, Ports and Historic cities. Carlien is trained as an architect with experience in design, construction, procurement and project management. Her master's thesis focused on the subject of integrated urban water design and how factors not only limited to climate change and urbanism pose a risk to the design and planning of historical water cities like Milan. Other interests include volunteer work.

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Queenie Lin is a PhD Candidate at History of Architecture and Urban Planning, Delft University of Technology, with a research focus on the sustainable preservation of climate-challenged Dutch overseas settlements in VOC Asia. She is currently working under the UNESCO Chair Water, Ports and Historic Cities and the PortCityFutures research group. She was also a PhD candidate of Cultural Heritage and Arts Innovation Studies, Taipei National University of the Arts, and that and her previous MA training in art and architectural history (University of Virginia, USA), conservation of fine art (Northumbria University, UK), and underwater cultural heritage certificate (UNESCO Foundation Course), equipped her for the professional experience in academia, museums, research institutes and thinktanks in Asia, America and Europe.

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Editorial Team

Hilde Sennema is a historian with a master's degree in architectural history. After working in the field of urban planning and heritage, she is now finishing her PhD on post-war reconstruction in port cities at the Erasmus University Rotterdam. Between 2018 and 2021 she wrote a weekly column in the Dutch newspaper *Financieele Dagblad*. In 2022 she joined the UNESCO Chair of Water, Ports and Historic Cities at Delft University of Technology to work as a researcher and lecturer. Besides port cities, her research interests include public-private relations in public space, and the cultural meanings and representations of water.

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Zuzanna Sliwinska is an Msc Architecture student, and currently an editor at independent periodical of the Architecture Faculty (*Bnieuws*) at Delft University of Technology. Zuzanna has professional experience in large-scale urban projects focused on sustainable manufacturing and food production. Her research interests focus on countryside conservation in fast-developing Asian countries with a focus on southern China. Her current master's thesis explores the potential of adaptation and persistence of cultural heritage among rural communities through the perspective of water-related practices in Northwest New Territories, Hong Kong.

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PART I Challenges, Concepts and New Approaches

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Water, Culture and the SDGs as Living History

Carola Hein
Delft University of Technology, UNESCO Chair Water, Ports and Historic Cities

At a time of climate change, sea level rise, flooding, drought, and changing groundwater and rainwater patterns, water managers need to adjust their current practices and develop new approaches. Technological innovation remains a key element in adaptation and mitigation; but technological innovation is not enough. Changing water patterns will affect everyone and every structure. How we manage water depends on local conditions, spatial and social developments and cultures as well as decisions of the past. That is why water management needs to go hand in hand with sustainable practices that are connected to the context of specific places, social systems and cultures and their changes over time. Sustainable development also requires recognizing the long-term impact of buildings and human-made structures. They may have been erected in the past for specific purposes and functions that have disappeared or are no longer welcome, yet the buildings and landscapes still exist. Sometimes they are valued cultural heritage; sometimes they are considered a nuisance, standing in the way of future development. Finally, water managers and other decision-makers may need new tools and methodologies for a holistic approach to sustainable development, which accounts for local particularities, achieves buy-in from society at large, and acknowledges historic path dependencies. Culture has shaped ecology and water systems. As a first step toward such an approach, this chapter reflects on the UN Sustainable Development Goals through the lens of water and culture.

KEY THEMES

< *Fig. 1 Aerial view of Bhorley waterfall and Tamakoshi River, Dolakha district, Nepal (Source: Nammy H. Kirat, 2018;* CC BY 4.0, *via Wikimedia Commons).*

Introduction

Water has long been at the heart of human living and well-being on sea and land. Humans have created locally adapted structures for drinking water, for irrigation and energy generation, for shipping, fishing, and maritime practices. They have addressed the multiple threats that water poses – in the form of floods, tsunamis and sea level rise – to human survival, creating unique artifacts and ways of doing things, developing institutions and laws. Some of these systems have lasted for a long time. Many have changed over time in line with technological, political, economic and social transformations. Once erected, buildings and institutions can have an impact over decades or centuries. To paraphrase Winston Churchill: First we shape our water systems and then our water systems shape us. Understanding how people have worked with or against water and how it has shaped people's lives, work and traditions can help illuminate the possibilities of future water-based ecosystems.

Sustainable Development as Living History

Humans have developed water systems over time and through space; they have also changed them in line with political, economic and technological transformations. Some systems have worked for a long time, creating a balance between different needs and interests of spaces, societies and cultures; others have relied on disbalances, with frameworks of gender and social justice embedded in laws and policies. Some have evolved slowly, others have experienced abrupt change. The existence of socio-cultural frameworks has been key to the long-term existence of historic water systems. Some traditional systems have disappeared, others are today praised for their circularity and sustainability serving local populations as living heritage, yet others have fallen into disuse and are maintained as heritage sites. While we may admire many of these systems today, we would no longer agree with all the socio-cultural conditions that existed at the time, and have made changes to some of them.

Following industrialization, the large-scale construction of public water systems helped improve human health and feed larger populations. It also changed traditional forms of living with water. As water practices developed into larger spatial systems, public systems replaced community-based ones. While the number of people served increased, their involvement in water management decreased. In some parts of the world, the development of public water infrastructures provided a much healthier environment, while in others, notably where colonization or other forms of exploitation took place, this process often led to a decline in living conditions. Today we are again facing a transition toward more circular practices, and the UN Sustainable Development Goals (SDGs) aim to make this transition work for all of humanity. Studying historic space and practices of water and the socio-cultural conditions they entailed can uncover sustainable traditions and avoid the perpetuation of systemic inequality, thus informing a more equal and just future.

To better understand how to live with water in the future, it is helpful to explore the ways humans have lived with water in the past and to draw lessons from both positive and negative experiences. Exploring the past helps us look more holistically at new approaches and explore why specific solutions were chosen at a select moment in time. It helps us explore future scenarios by understanding the trade-offs of the past and their effect on humans and ecosystems. Understanding historic water systems

^ *Fig. 2 Ceremony and festival at a rebuilt riverbed at Arima Onsen in Japan (Source: Carola Hein, 2016).*

through time does not mean that we should repeat the past or that past practices can solve contemporary challenges. The past is not the solution, as the Dutch Water Envoy Henk Ovink poignantly put it (UNESCO 2021). Historic water sites may not be able to serve contemporary needs. Yet, at a time of changing water patterns due to climate change – sea level rise, flooding, new rainwater patterns, drought, etc. – an understanding of historic water systems and the relationships that have linked space, society and culture in the past can serve the future.

Water Systems as Spatial, Social and Cultural Networks

Water in all its forms connects space, society and culture. Infrastructures are more than spatial physical networks that allow for exchange through space; they also have a socio-cultural dimension (Larkin 2013). New water-cleaning technology, bigger and stronger dikes, larger and more powerful water energy generation systems and new porous street surfaces can play a role in adapting to changing water patterns. But determining whether and where these

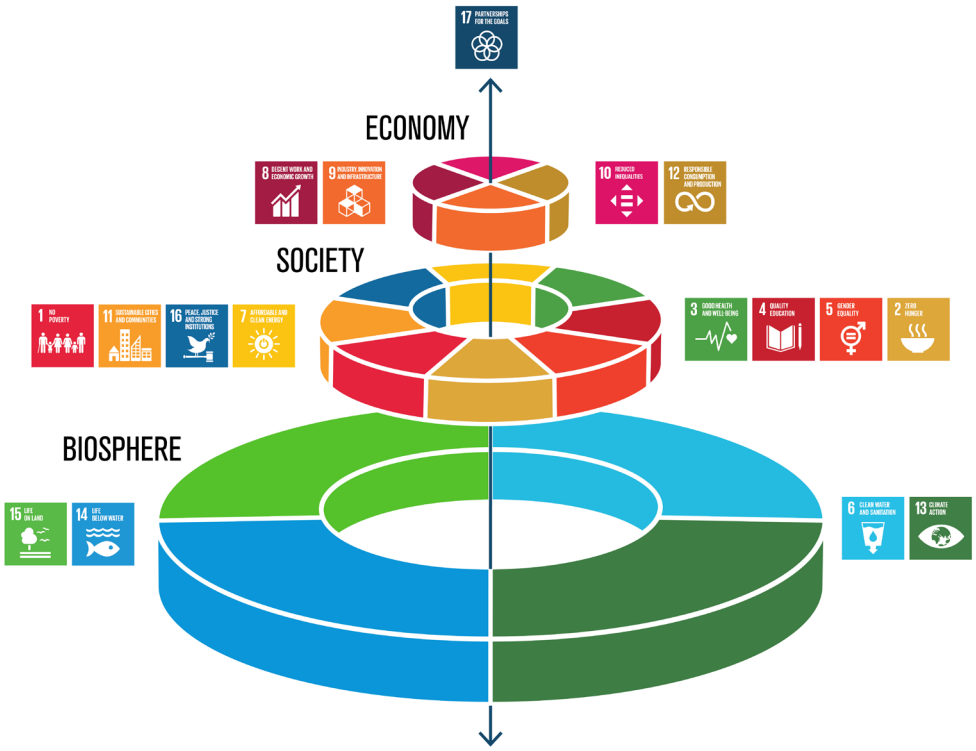
technologies can be beneficial, and to whom and how, requires considering all the affected parties and their socio-cultural perspectives. From basic water access, to recreation related to water – sailing, canoeing, swimming – and transportation and energy generation, changes in water policies need to be made in ways that respect environmental, societal and gender justice. Interdisciplinary planning and the collaboration of local citizens is essential. Yet, experience has shown that water management is not always inclusive and just. In line with the OECD Better Life Initiative (OECD 2020) and the United Nations Sustainable Development Goals (SDGs), we need to develop a society where water in all its forms, fresh and salty, serves human well-being.

Rethinking water and culture in the SDGs from a holistic, socio-cultural, long-term ecosystem perspective can illuminate their interconnection and promote comprehensive/systemic approaches to sustainable development projects. Several authors have conceptualized the SDGs as a group. The "wedding cake" (fig. 1) proposed by the Stockholm Resilience Center is one example. It argues that the biosphere is the foundation for economies and societies and that we need to move away from contemporary sectoral approaches. Other more systemic approaches to the SDGs have since followed, but they do not address the role of culture. UNESCO has therefore developed the 2030 Culture Indicators as a way to understand the role and potential contribution of culture in sustainable development, taking into account tangible and intangible heritage as well as natural heritage (UNESCO 2019).

Building on such approaches, this article aims to rethink the relation between water and SDGs by connecting the biosphere and "water SDGs" (6, 14 and 15) in relation to the others and the larger context of societal and cultural practices and values. Figure 2 is a first attempt at visualizing the SDGs in a broader framework of nature-culture interaction and tangible spaces and intangible practices around water. The visualization shows how people live with water as a result of cultural decisions. This approach can capture different forms of living in a certain place and help us understand how water-related spaces, institutions, practices and their relationships have changed over time. The illustration proposes an understanding of water systems in relation to human activity and nature (blue semicircle). The ways in which humans engage with water is determined by framing conditions of climate and energy. Natural conditions – e.g., those in a desert versus in the Arctic – and societal conditions shape human strategies of climate adaptation, energy production and consumption (green semicircle). In this context, humans have developed built spaces and cultural practices in line with their values (yellow semicircles). Understanding how people have worked with or against water and how water has shaped the way they live, work and celebrate can help illuminate the possibilities of future water-based ecosystems.

A Holistic Approach to the SDGs

Water and culture are considered here in the broadest sense. Water is understood in relation to the hydrological cycle, from groundwater to rain, from snow to mist, from freshwater to saltwater, from drinkable to black water. It is also explored in its full dimension, as something natural and cultural. Similarly, culture is seen here in the broadest sense, including the many ways humans engage with their surroundings and with each other, how they organize society and evaluate different development paradigms. Such an understanding expands on current



^ *Fig. 3 The "wedding cake" (Source: Azote Images for Stockholm Resilience Centre, Stockholm University, 2018;* CC BY-ND 3.0*).*

practices that distinguish, for example, water for drinking and water for shipping, or that distinguish cultural heritage and cultural (artistic) practices from everyday creative engagement. The silos of disciplines and approaches that are typical elsewhere in contemporary society can be found also in approaches to water and culture. Select institutions with their own tools, laws and policies focus on drinking water, irrigation or shipping, others focus on the preservation of heritage or on sustainable development or education. The approach proposed here would encourage interdisciplinary collaboration on integrative and sustainable solutions.

Water (Blue Semicircle): This reconceptualization of the SDGs considers all forms of water, including groundwater, sewage water, rainwater and drinking water. Natural water sites have served as foundations for human life. Water, being essential to life, connects SDG 6, 14 and 15, referring to clean water and sanitation, to life below sea and to life on land, placing them in the broader context of water. Humans have settled near drinking water sources throughout history. We can think of sites such as the Great Barrier Reef or the Everglades as natural water environments to which humans have adapted. Humans have changed water conditions continuously, building channels, dams, pipes and water towers (SDG 15). The provision of drinking water infrastructure (as well as of sewage) has been a key driver for water management throughout history (SDG 6), and we can think of fishery practices and carbon storage as part of life under water (SDG 14).

Framing Conditions (Green Semicircle): Water is a function of climate as well as an agent. Depending on local climates, water can be abundant or rare, associated with floods or drought, and can appear as ice or vapor. It is also closely related to all aspects of energy generation. How humans engage with water depends on the local climate and the availability of energy. Climate is closely related to the hydrological water cycle. Energy is key to how we live with water. SDGs 7 and 13, respectively referring to energy and climate, are therefore considered here as framing conditions for water and culture. We can use water to generate energy and we can use energy to control water. How we react to water challenges is also a cultural decision. Humans have historically adapted to water cycles and the availability or absence of water in different ways. Examples of structures they have employed to do so include water mills, qanats, water meadows and water retention basins. Practical interventions, such as dikes or stilt houses, are cultural at their source. Rather than building them, people could have decided to live in a different location, or to move seasonally as water levels changed. Yet they have made decisions to build against, above, or with water as the result of expertise, often acquired over long periods. At a time of climate change, it is very important to understand our relationship with water and what values it is based upon.

Culture(s) (Yellow Semicircles): Culture(s), understood here as the way in which we organize our spaces and practices, are as encompassing as water. Humans have developed particular spatial, social and cultural practices to live with water. They have erected physical structures and developed practices related to them, captured here in the semicircle of individual survival and community structures. They have also developed practices that are not primarily spatial to facilitate cooperation in water systems. The illustration proposes a distinction between SDGs that are key to human survival, and ones that rely on communities or larger-scale collaboration (SDG 1, 2, 3 and SDG 8, 9, 11), captured in the first yellow semicircle. It also suggests that we think of the other SDGs as socio-cultural (SDG 5, 10, 16) and procedural (SDG 4, 12, 17), where the spatial impact is secondary, captured here in the second and third semicircles. The two spheres are overlapping because physical spaces, institutions and practices overlap.

SDGs 1, 2 and 3 primarily address poverty, hunger and health. Water management has long been key to meet the most basic needs. A small well or cistern can enable a few people to survive; irrigation of a field will help grow crops. People have dug wells for thousands of years, starting in the Neolithic era. The archeological site and UNESCO World Heritage site of Hegra Al-Hijr in Saudi Arabia stands as an example of Nabataean agricultural techniques that include many wells still in use today. It is not surprising that wells also play an important role in folktales, such as in the story of the Frog King, a German folktale captured by the Grimm brothers. Capturing rainwater for drinking purposes is similarly important for human survival (Loen 2020). Providing people with water is a key condition for preventing poverty. People have channeled water to fields for thousands of years. Water meadows are just one example of historical irrigation practices (Renes et al. 2020). Clean water and sewage management, even on an individual scale, are key to avoiding diseases and a key driver of the development of planning (Lopez 2018). Archaeological evidence of cesspits goes back to Babylon, 4000 BC. Some aspects of water management are thus strictly related with the SDGs concerning human survival.

^ *Fig. 4 Conceptualization of the SDGs through the lens of water and culture (Source: Carola Hein, 2022).*

The community-based SDGs 8, 9 and 11 require collaboration among individuals. Historically, cities and communities thrived only once people's fundamental life needs had been satisfied. In the field of water and heritage, we can think of the construction of aqueducts to supply major cities like Rome with enough water for all the daily needs of a metropolis, while also allowing the city to become the center of an empire. The construction of canals, dikes and large-scale irrigation systems is closely related to the emergence of human communities with specific forms of economic development, dedicated funding and laws that can both facilitate or hinder socio-environmental justice. The water systems of Tenochtitlan, rice terraces in Indonesia, and the building of water cities like Venice and Amsterdam required diverse groups of people collaborating to manage water and to establish institutions, regulations and other practices to maintain the water system.

The organization of communities, just or unjust practices and the institutions that facilitated inclusive water management and access are tied to economic and social conditions and spatial patterns. They are captured in SDGs 5, 10 and 16. They are also related to long-term societal practices and anchored in policies, laws and built environments. Both historic and current water practices involve exploitative practices. SDG 5 and the question of gender equality is a key theme both in terms of water and heritage. The lack of access to fresh water supplies and the role of women in transporting water from the source to the village, in washing clothes, or carrying out other basic tasks exemplifies historic inequalities and need to be carefully explored when examining historical models (Zwarteveen and Ahmed 2012). Access to water and water management have historically been part of power relationships, many of which were grounded in exploitation, either

locally or internationally. The control of a water source or exploiting it through the construction of major dams can even lead to national conflicts. The Grand Renaissance dike on the Nile and conflicts surrounding it are just one example. Throughout the world we can find examples of big dams that have destroyed communities to provide water for cities or industries. Often these projects have been sponsored and financed by international institutions such as the World Bank. The UN Water Action decade has aimed to make change, but concrete effects still need to be seen.

Humans have developed many procedures and forms of intervention (SDG 4, 12, 17) to implement water systems that reflect specific values, as well as to create equitable water systems, educate children, produce and consume (SDG 12), and assure the collaboration of diverse partners (SDG 17). To create equitable water systems and to acknowledge sustainable historic water systems, we need to think about how we educate our children, our population and our professionals (SDG 4). Education is key to making people aware of water issues. From serious games to films and free online courses, education is a key factor in shaping water awareness. Museology and the preservation of heritage sites can play an important role. We also need to reflect on how we produce and consume in relation to water (SDG 12). The provision of water for industrial processes can lead to pollution in related water bodies. Large corporations have also changed processes and water use, affecting less powerful stakeholders. Water management and water diplomacy are key to peaceful development, but they can also lead to conflict. Strong (transnational and transborder) institutions (e.g., the International Commission for the Protection of the Rhine) can promote equitable development, but they can also lead to conflict and even war, such as when upstream practices conflict with downstream ones, or when water for urban development takes priority over water for agriculture (or vice versa). Strong institutions like the water courts or the Dutch water boards can help ensure that communities live peacefully. The Earth Commission as part of the Global Commons Alliance may be a way to connect diverse institutions and to empower diverse people for global stewardship (Earth Commission n.d.).

Conclusion

People have used water in all its facets – freshwater and saltwater, water in the ground and in the air – in cultural practices, artifacts, institutions and houses, cities and landscapes. They have responded to needs that were specific to their context, and made decisions based on their values. Water flows through society and culture and the balance between different interests and goals is key to sustainable development in all areas of the world. The visualization of the SDGs through the lens of water and culture provides a foundation for understanding sustainable development more conceptually. The large-scale, one-size-fits-all solutions that have dominated in the last 150 years will no longer be feasible and must be improved and reimagined through place-based approaches that acknowledge local socio-cultural conditions. New water management initiatives are not appearing on a blank sheet; on the contrary, new interventions occur in cities and landscapes that people inhabit and have created, sometimes over millennia, for better or worse. New forms of citizen engagement, capacity building and recognition of the values and cultures that underlie water management are needed to truly advance sustainable development.

Such a reading of SDGs suggests that we

should define our values as we engage in new construction practices. To address often diverging interests in water use, we need partnerships (SDG 17) that ensure the collaboration of diverse members and a balance between different interests. We need partnerships around water – including non-humans – and cultural structures that involve everyone in making choices for water-related heritage. They are key to balancing individual and community needs and closely related to climate action and the much-needed energy transition. A holistic consideration of SDGs as part of a larger value-based approach to sustainable living can help identify transformative actions. Based on the understanding of the relation between water and culture sketched above, I propose that rethinking our approach to culture(s), and developing place-specific approaches that acknowledge long-term development and socio-cultural context is necessary to realize the 2030 SDGs. Through value-based goals, policies and institutions (SDG 5, 10, 16), through transformation actions (education, consumption/production and partnerships [SDG 4, 12, 17]), we can regain agency in implementing and co-creating sustainable water management.

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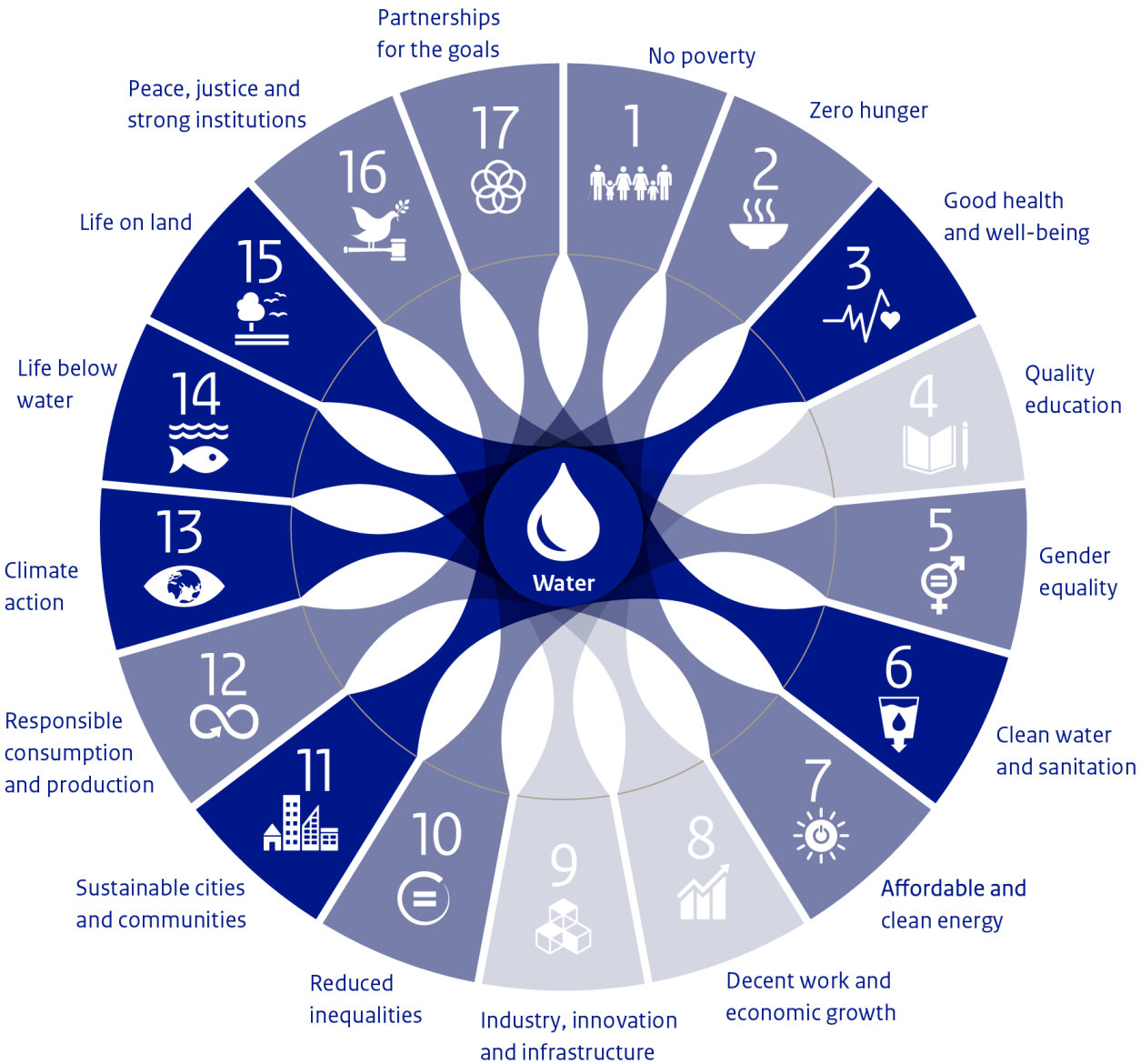
Sustainable Development Goals related to water



- *Group 1 targets: strongly related to water*
- *Group 2 targets: related to water*
- *Group 3 targets: indirectly related to water*

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How Can Culture Help Us Learn and Change? A Key Question in Adapting to Water Challenges

Åse Johannessen
Deltares

More than ever before, there is an urgent need for people to find a path to more sustainable and resilient development. A looming water crisis has reached the top of the international agenda, exacerbated by climate change, which is most acutely expressed through water. The main changes will be in precipitation and evaporation, with extremes of too much and too little water impacting humans and connected ecosystems. Changes in weather patterns and seasonality as well as the melting of ice will affect the availability of water, including during crop growth seasons. With increasing pressure on water systems, this will also affect water quality and put stress on connected ecosystems. Transformations and adaptations are urgently needed to address these issues, and in the search for approaches that accelerate adaptation, social learning has been identified as crucial. However, social learning approaches are often framed as technical or scientific learning, not giving sufficient attention to the important role played by culture and heritage. Integrating culture and heritage in social learning approaches in the area of water governance could boost the human ability to adapt and bring about needed change.

< *Fig. 1 Water is linked to all SDGs - directly or indirectly. The figure illustrates three groups of SDGs that are 1) strongly related to water, 2) related to water or 3) indirectly related to water (Source: Ligtvoet et al., 2018).*

Introduction

Historically, water has defined and enabled human development. Water can enable or limit the way society maintains health, grows food, generates energy, manages the environment, and creates jobs. A lack of clean water already limits economic growth in many developing countries. Climate change and water-related disasters hamper development, and 90 per cent of disasters are weather-related (floods, droughts, storms and heat waves). These risks in turn combine with a wider cocktail of other risks (social unrest, infectious disease, etc.) that mostly affect members of disadvantaged communities, particularly women and girls. With current and future climate change, water will therefore increase in importance as a defining element for development (UNEP 2022).

It has been concluded by many actors that the water crisis is essentially a water governance crisis. Thus, there is a need to strengthen governance structures related to water in general (UNEP 2022). The main issue is that all of the SDGs set out in the 2030 Agenda for Sustainable Development are related to water (directly or indirectly) but because water is included in multiple agendas, it slips down on the priority list and is not sufficiently managed and sustained (Ligtvoet et al. 2018). Addressing this situation will require appropriate policies, institutions with appropriate capacities, regulation, agile planning, and financing. The need for more integrated or systemic governance of water is recognized by several global agendas and international institutions, such as the European Union, the World Meteorological Organization, the European Environmental Agency and the 2030 Agenda for Sustainable Development. The Intergovernmental Panel on Climate Change (IPCC) has also been calling for the need to address the fragmentation of adaptation action, with a transformation of the current approach.

A transformation can be described as a change of identity or a change in the character of a system (fig. 2).

Describing all the needed transformations is beyond the scope of this article, however important steps are listed below (fig. 3):

1. Shift from an approach promoting short-term gains to long-term sustainable development.
2. Change from fragmented to integration and systems approaches, for example in the catchment or river basin.
3. Move from groupthink and other "lock-ins" to adaptive (change) management, policy making as experimentation and embracing failure as learning.
4. Pursue more inclusive governance to learn from all levels and sectors through new platforms, not to make assumptions but to understand contexts and perspectives, such as informal economies and norms and (informal) rules in use (strategic innovative capacity).

Current Approaches: Culture and Heritage as Essential to Transformations

Our current approach to change is very much dependent on access to technical and scientific knowledge and know-how. Evidence-based knowledge is certainly essential for achieving transformations and adaptations. At the same time, it is not clear how effective this approach is, as the current changes to water governance are often incidental and take place slowly (Dryzek 2013). There are many explanations for why the rate of change is so slow compared to the identified need. Theories of policy change ar-

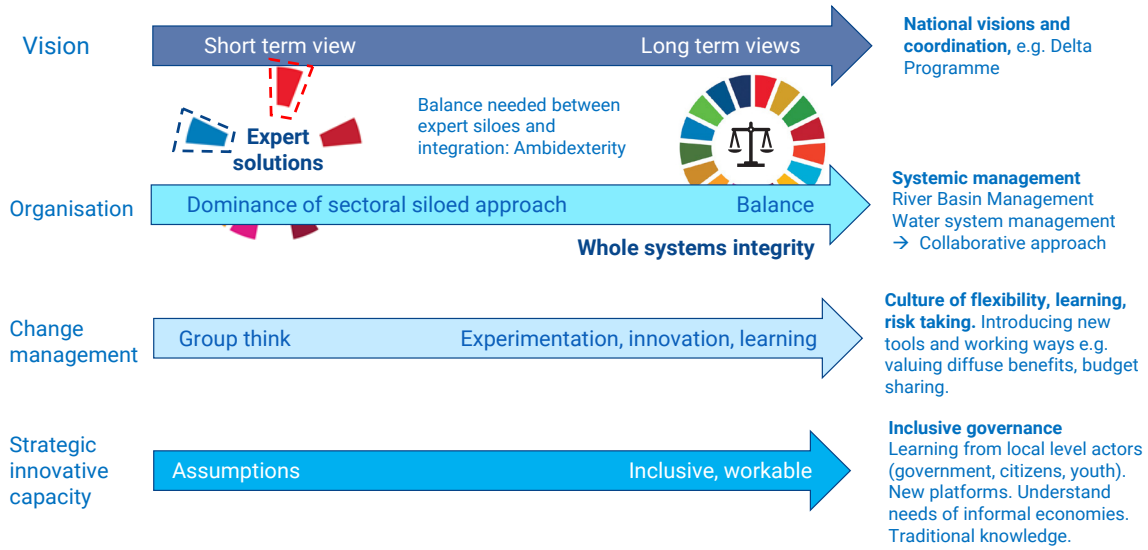
^ *Fig. 2 Transformation as change of identity. This figure illustrates transformation going from a fragmented (siloed) solution, where success is measured by sectoral Key Performance Indicators (KPIs) to a collaborative (systems/integrated) approach (Source: Åse Johannessen, 2023).*

gue that – in addition to knowledge – path dependencies play a role, with existing institutions and working processes constraining adaptation and transformation.

Social learning can help speed up change and unlock path dependencies, with culture and heritage as essential elements. Social learning and multi-actor collaboration are increasingly argued to be critical components of resilience, adaptive management, transformations and a key element in the development of more adaptive and sustainable practices in general (Gerlak and Heikkila 2019). Social learning refers to changes in collective understanding that result from the exchange of knowledge and experiences and lead to changes in practice (Medema et al. 2014). This includes social learning by policymakers, managers and other stakeholders (Gerlak and Heikkila 2019). Social learning is central to culture and heritage management since it is the mechanism whereby culture (ideas, customs and social behavior, comprising the totality of a person's learned and accumulated experience) is transmitted. Social learning has enabled us, for millennia, to gradually accumulate information across generations and develop tools, beliefs and practices that become embedded in our everyday lives or in institutions that are too complex for any single individual to invent in a lifetime (Boyd et al. 2011). Thus, culture and social learning are intrinsically linked. Knowledge accumulated as culture has made it possible for the human species to occupy spaces and geographies in a vast range of climates. As such, social learning is arguably one of the most important adaptive capacities humans possess.

Current and Future Challenges: Social Learning and Culture as Tools for Change

The question is how can we use the insights about social learning processes, in the context of culture and heritage, to address the needed transformations? Multi-stakeholder platforms, it can be argued, are an example of a practical way to boost social learning. Although many such platforms exist, a lot of networking still oc-



^ *Fig. 3 Governance changes and transformations needed to redefine approaches, norms and goals in water governance (Source: Åse Johannessen, 2023).*

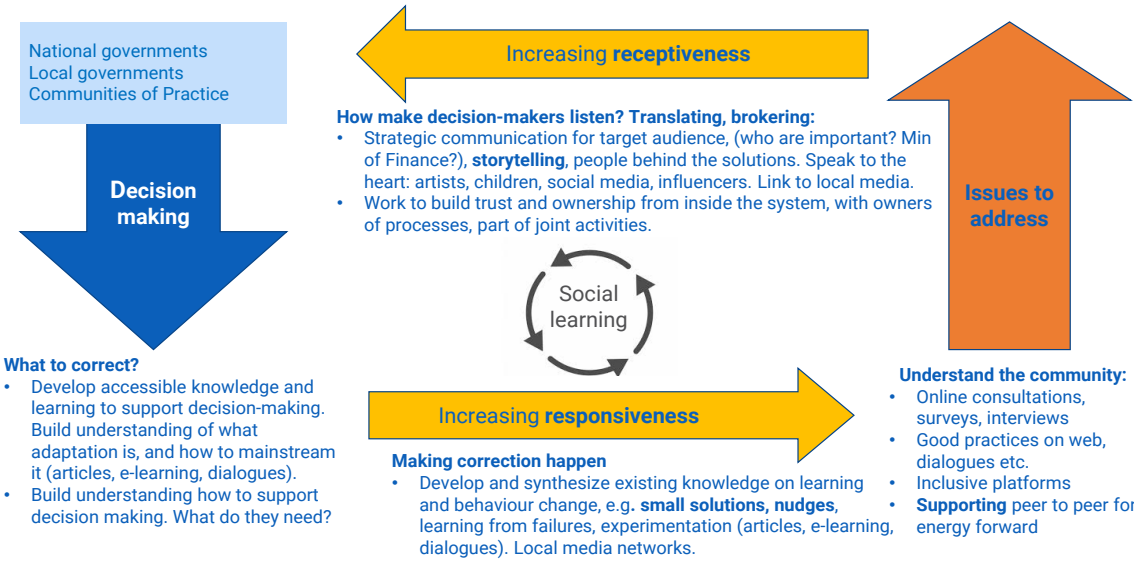
curs among professionals who work in closely related sectors. Research suggests that more radical innovations tend to rely on integrating knowledge that is spread across a range of different networks (Torfing 2016).

Facilitators are important to act as brokers who can help translate different views and language so that actors can relate to each other, coordinate efforts to deal with a common challenge and align perspectives and interests to support or complement each other (Torfing 2016). This can help encourage a particular story line, fundamental ground rules for interaction, and a particular method of mediating conflicts. For example, the Water Adaptation Community (WAC) at the Global Center on Adaptation (GCA) was created to be a multi-stakeholder platform linking actors that normally do not talk to each other, bridging siloed networks and as such accelerating climate adaptation. Its approach to social learning can be seen in figure 4.

Unpacking the Black Box of decision making and the Role of Culture

The model in figure 4 illustrates a social learning cycle. In social learning, the “errors” (or issues linked to the water crisis and inadequate water governance) need to be identified (error detection), for example through consultations. These are communicated to decision-makers who can correct them (that is, make the right decisions). Decision-makers, in turn, need to be receptive, willing and able to act on the information and address the issues (error correction). To avoid having decisions and plans collecting dust on a shelf, increasing responsiveness is needed to encourage and enable the right action with planners, implementers and citizens. This involves, for example, nudging for behavior change.

Culture plays a role here in facilitating collaborative interaction within this system by carrying



^ *Fig. 4 The cycle of social learning. Supporting and influencing decision making involves error detection, increasing receptiveness, error correction and increasing responsiveness (Source: Åse Johannessen, 2023).*

knowledge and giving shape to what is comprehended by humans. Culture and heritage can manifest in many ways, including objects and subjects, people, institutions, concepts, working processes, regulations, documents and story lines. They help connect people because they attract their attention and call for joint action. Culture and heritage also connect to an emotional dimension including insights that can complement evidence-based decision making. Social learning theory acknowledges that deeper learning, for transformation, is linked to values, "the heart" and emotions. This is compatible with findings in neuroscience investigating the wiring of the human brain. An example is research on the human brain's responsiveness to storytelling. Recently, neuroscience has identified that narrative storytelling can be used to capture lay audiences and encourage excitement about important scientific discoveries (Martinez-Conde and Macknik 2017). In a recent study, embedding climate change information in an emotional story structure encouraged pro-environmental behavior (Morris et al. 2019). This is an example of how to increase *receptiveness* of information (fig. 4). Such knowledge of the human brain has been used in product marketing for quite some time, but not as much by environmental and climate scientists. Experts and scientists often believe the right decisions are not taken by decision-makers. However, they typically downplay emotion in their publications.

Conclusion and Future Approaches

Culture and heritage play a role as carriers of accumulated knowledge, as subjects and artifacts, and as facilitators of collaborative interaction. As such, efforts to accumulate knowledge related to water governance and to bring about social learning and transformation could benefit from an understanding of human evolutionary history, human psychology and social

group behavior. The cultural approach also complements a focus on technical and scientific information to better understand how actors are triggered to change. For example, this approach recognizes the important role of emotions in decision making and the important role of storytelling to support scientific evidence. These and other socio-cultural factors would be useful to explore for the benefits of upscaling and accelerating adaptation. With better knowledge of social learning and the role of culture, we can design interventions, organizations and collaborations to better fit the human psyche. This is a promising new and potentially transformative field of research and practice to support climate adaptation and sustainable development.

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Customary Water Tenure: Linking Water, Culture, Heritage and SDGs 1, 2 and 5

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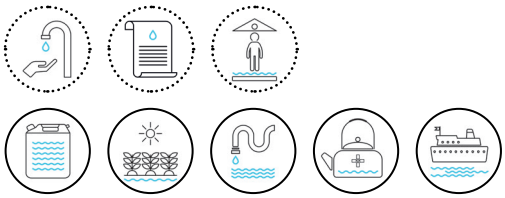
Heritage and culture not only shape the customary tenure of land and forest resources of most indigenous peoples and local communities in low-income rural areas, but also community members' mutual relations vis-à-vis their water resources, or, in other words: customary water tenure (Ramazzotti 1996; FAO 2020). Age-old settlement by farm communities and pastoralists' establishment of nomadic routes vested customary rights to land and the fugitive surface runoff and streams flowing over the lands; soil moisture, wetlands and lakes on the land; and aquifers under the land (fig. 1).

In customary water tenure, orally transmitted norms and practices have governed communities' construction, operation and maintenance of traditional local infrastructure, such as weirs, dams and ponds, to store water as buffer to seasonal variability; wells and lifting devices to tap aquifers, the planet's largest storage; and canals, tunnels and pipes to channel water where and when needed for drinking, other domestic uses, livestock, irrigation of crops, vegetables (fig. 2) and trees, brick making, crafts, small-scale enterprise and ceremonial uses, or to ensure water availability for fisheries and navigation. Customary normative frameworks continue to shape communities' investments in "modern" low-cost plastic pipes, tanks, small motorized pumps and solar energy, also responding to growing populations, markets for water-dependent produce, and higher aspirations (Tapela 2015; Hellum et al. 2015; Van Koppen 2022).

KEY THEMES



< *Fig. 1 Customary furrow irrigation among the matrilineal Wa-Luguru in Tanzania (Source: Barbara van Koppen).*

^ *Fig. 2 Farmer-led irrigation in Ga-Mokgotho, South Africa (Source: Barbara van Koppen).*

During dry seasons and droughts in harsh environmental conditions, when options for supply augmentation or rotation are exhausted, hard choices in sharing the finite naturally available water resource are inevitable (fig. 2–4). Anchored in oral cultural narratives, ceremonies and beliefs, water resources are invariably seen as a commons. As the Boran people of Ethiopia say: "Water is either a source that you 'share in' as a member of a descent-based collectivity, or one that you 'share out' to signify respect" (Dahl and Megerssa 1990). Accordingly, indigenous arrangements set priorities for sharing in water resources within their communities, often respecting social safety nets. With increasing water use and competition, rules also emerge for the "sharing out" of surface streams with upstream and downstream communities (Komakech 2013).

The international recognition of customary water tenure is growing (FAO 2020) and opening up strong links with the SDGs. The IPPC (2022) highlights the critical importance of indigenous knowledge to adapt to climate change. Over the last decade, indigenous peoples in the US, Canada, New Zealand, and Australia (Jackson 2018) and Andean communities in Latin America (Boelens and Vos 2014) have reclaimed their rights to the water and access to it. In rural sub-Saharan Africa, customary water tenure "is without doubt the most important of the sources of law, and of water law in particular, as it is the one which is most known and respected by the population" (Caponera 2007, 92). Policies and interventions that take customary water tenure as the starting point for technical, institutional and financial support according to the priorities of vulnerable community members (fig. 3 and 4), mobilize heritage, culture and existing technical, financial, social and institutional capital. Accordingly, both the WASH sector (Sutton and Butterworth 2021) and irrigation sector (Giordano et al. 2012; Woodhouse et al. 2017; Izzi et al. 2021) recognize and increasingly support self supply and farmer-led irrigation. This recognition and support of heritage and culture but also the vibrancy of customary water tenure accelerates the sustainable achievement of SDG 1 (ending poverty), 2 (food security) and 5 (gender equality by alleviating women's domestic chores).

However, a major threat to customary water tenure lies in the "sharing out" of water resources with powerful high-impact third parties, including foreign and national corporate agribusiness and mining companies. The colonial heritage of water legislation continues to favor formalization of administrative water resource entitlements of these few high impact users, also dubbed "water grabs" (Franco et al. 2013; Van Koppen and Schreiner 2018). Or, worse, foreign companies force investment contracts on governments in which they claim the highest priority for water resource availability, whatever the implications for all other users (Bosch and Gupta 2022). Not surprisingly, RRI/ELI (2020) and Troell and Keene (2022) found that customary water tenure is, indirectly or even directly, better recognized in land, forest and constitutional law, international human rights law and indigenous peoples' laws than in current water legislation. This has sparked a search (Schreiner and Van Koppen 2018; Troell and Keene 2022) for harmonization, new interpretations and operationalizations of existing or new legal tools, to recognize and prioritize customary water tenure.

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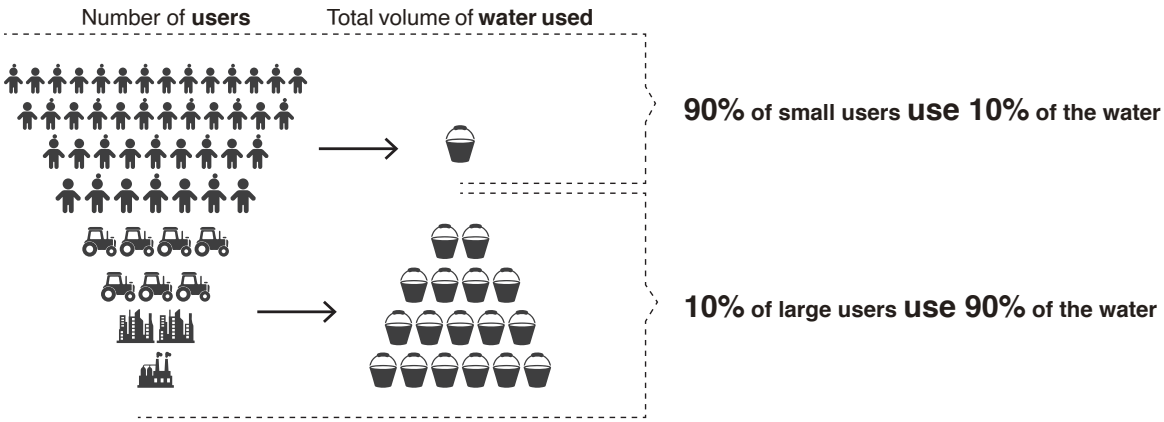
^ *Fig. 3 Women indicating their preferred sites for new communal water points in Ga-Moela, South Africa (Source: Barbara van Koppen).*

^ *Fig. 4 Community members mapping their multiple water sources, infrastructures and uses in participatory planning of improvements in Ga-Mokgotho, South Africa (Source: Barbara van Koppen).*



^ *Fig. 5 Historic inequalities in access to water in South Africa (Source: IWMI).*

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Challenges when Valuing Cultural Heritage Associated with Water

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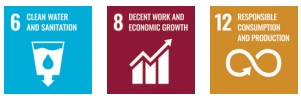
This article outlines some of the difficulties associated with valuing cultural heritage. They include the surmountable problems of pricing cultural heritage and the associated market failures inherent in all water systems. Critical to any attempt to value cultural heritage is the need to quantify exactly what cultural heritage encompasses. While the theoretical concept of economic value is a relatively simple one, applying it to cultural heritage can only be accomplished if it is well defined.



KEY THEMES

< *Fig.1 Gondola repair shop, Venice Italy (Source: Brian Davidson, 2008).*

Introduction

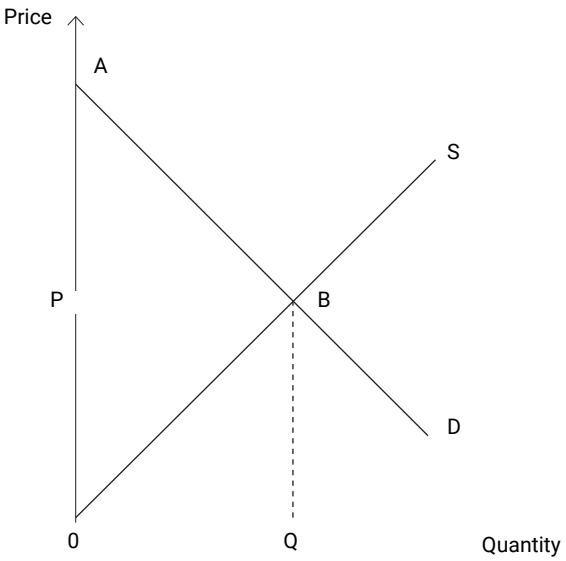
What are the challenges in valuing the cultural heritage of a water system and how might it be incorporated in the total value of a water system? In economics, to answer these two questions initially requires some concept of the quantity of the item (cultural heritage) in question and then how it might be priced and then valued. The aim in this short article is to briefly outline some of the concepts, issues and difficulties surrounding how the cultural and heritage value associated with water could be valued.

The Theoretical Concept of Value

While small marginal changes in the value of any good or service can be calculated by multiplying the prevailing market price by the change in the quantity involved, this is not adequate for measuring the total value of the good or service. The total value of a good or service (in this case cultural heritage) can be defined as the difference between what people are willing to pay for it, minus what they actually pay for it.
To understand the concept of value and the differences between it and the price or the cost of a good, please refer to figure 1. What is being suggested is that there is both a downward sloping demand curve (D), which reveals the declining willingness of people to pay for successive quantities of a good, and an upward sloping supply curve (S), which reveals the increasing cost of producing successive quantities of the good. The assumption is that cultural heritage is just like any other good or service. Where supply and demand intersect (B) the optimum quantity society demands for cultural heritage (Q) is determined, along with the price society would pay for it (P). This point is an optimum because it represents a position where the marginal cost of providing extra units of the good equals the amount people are willing to pay for it. Beyond that point, the costs of provision outweigh what people will pay for extra units of it.

The total value of the cultural heritage, as defined above, is equal to the area under the demand schedule (what people are willing to pay for it), less the area under the supply schedule (what is paid for cultural heritage), out to the optimum quantity. In other words, the total value of cultural heritage is given by the area AB0 in figure 2. It should be noted that its value is different from the price of cultural heritage (P) and the total cost of cultural heritage (area BQ0 in fig. 2) (Hanemann 2006; Young 2014).

While many may only be interested in the demand for cultural heritage, it is important to realize that its provision at all levels comes at some cost. Thus, to assess the value for cultural heritage requires understanding its cost to society, which is embodied in the supply schedule. To calculate the value of cultural heritage what



^ *Fig. 2 The theoretical concept of value (Source: Brian Davidson, 2022).*

is required is some idea of the supply and demand schedules associated with it. If the two schedules are known, then they can be equated to calculate the equilibrium price and quantity. In addition, the slopes of each schedule can be determined, or more importantly the own-price elasticities of demand and supply, to determine the total value. The own-price elasticates of demand and supply are measures of how responsive the quantities demanded and supplied (respectively) of cultural heritage respond to a change in its price. The more inelastic (unresponsive) the schedule, the greater the total value.

Difficulties in Determining the Value of Cultural Heritage

While it is easy to conceive of the value of cultural heritage in purely economic theory terms, the reality of course is a lot more difficult. Heritage is not a traded good with a revealed price. Furthermore, it isn't just a good, but also a service, which represents a different set of problems (Petit 1987). Because the interest is in the cultural heritage of water, it is part of a market littered with a lot of market failures. These issues need to be resolved. The greatest difficulty will be in measuring the quantity of "cultural heritage" available.

Quantifying cultural heritage

Cultural heritage could manifest itself in very tangible (e.g., historical infrastructure) and intangible (ways of thinking and practices) items. Could all the tangible items be classified as the "heritage" and all the intangible items be the "cultural"? Or is it a case that the two are so intertwined that they cannot be separated from one another? All these questions need to be addressed.

Clear definitions of what is involved in the quantity of "cultural heritage" and the contribution it makes to the water system need to be established before any valuation work is undertaken. This cannot be a vague statement, like those that are associated with the term "values" many use to justify some ethical position. Rather, an answer to the question "What are the quantifiable elements associated with water-related cultural heritage?" is needed as a precursor to any economic evaluation of its value.

Like other social values of water, what people mean by culture and heritage and how these are defined will change over time and through space. This change will in part be determined by the political will of those who control water (Hellegers 2018). In the long run, one also needs to consider the possibly perverse impact of creative destruction (as defined by Schumpeter [Hellegers 2021]) on heritage and culture. To illuminate this point, economic theory would suggest that the replacement of windmills with more efficient mechanical pumps is an act of creative destruction and technical progress. As this is beneficial, so cultural heritage (the act of preserving windmills) may need to be defined in different terms than the task it was originally used for.

Pricing cultural heritage and incommensurability

In terms of the valuing factor (the price in the simple analysis outlined above) does not need to be expressed in monetary terms. A solution to this problem is presented by Hellegers and Davidson (Schumpeter 1950). What they suggest is that non-monetary measures of value can be determined assessing the trade-offs from the opportunity costs of sacrificing the value of a monetary measured item with those of a non-monetary measured item.

A greater problem may well be that there is no way of measuring one of the intangible items of cultural heritage that are considered important. Economics does have a number of solutions to valuing things where market prices do not exist (see Sinden and Thampapillai [Sinden 1995] and Sinden and Worrell [Sinden 1979]). Contingent Valuation is also a widely used technique in this field, one that does present some problems.

Market failures

A far greater problem in taking this approach to valuing cultural heritage in the water sector is that the market for water is riddled with market failures. Market failures arise from when the trade in a good or service is affected by a monopoly, externality, a public good, inadequate property rights or asymmetric information (Sloman 2005). In water it could well be the case that the sector suffers from all five malaises. If a market for cultural heritage has its own market failures inherent in it, adding that to those associated with the water sector may well muddy the waters.

Concluding Remarks

Notwithstanding the issues associated with valuation (raised above), the real question that needs to be addressed is whether cultural heritage could be thought of as part of the total value of a water system. Under a classification system specified by Rogers and colleagues (Rogers 1998) social values are identified as a legitimate component of a water system. They would suggest that social values are those elements of the total value that fulfil societies' objectives. If maintaining and protecting parts of the culture and heritage of a water system are justified by fulfilling a societal objective, then they become part of the valuing process. While it is easy to conceptualize the value associated with preserving culture and heritage, a set of problems need to be resolved if the value is to be determined. The first and most difficult of those problems would appear to be those associated with quantifying what cultural heritage is.

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The "Who" And "What" Of Water Ethics

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Water consumption and freshwater supplies are unevenly shared worldwide, while droughts and floods as extreme climate events are becoming more common. Water challenges cannot be addressed by technical means only. We must reflect on the trade-offs between economic and environmental concerns, and identify which water-related risks to prioritize. Thus, water ethics become an important analytical key in posing two critical questions: what values are at stake when we address the world's water challenges, and who is affected by these water challenges? This links to questions of responsibility: to the extent that these water challenges are related to past behavior, the "past" may create a responsibility to address these present challenges, including when they materialize in other regions.

KEY THEMES

< *Fig. 1 High water near Nijmegen, the Netherlands, February (Source: Neelke Doorn, 2021).*

Introduction

Water is increasingly recognized as posing significant ethical challenges (Groenfeldt 2013; Doorn 2019; Meisch 2019). Although people in water-rich countries often take the availability of water for granted, a significant percentage of people in the world do not have access to clean drinking water or sanitation services, and an even higher percentage die from waterborne diseases such as diarrhea. The World Health Organization (WHO) estimated that in 2020, two billion people lacked access to safe drinking water, and over 1.7 billion people lacked access to basic sanitation services (WHO 2022a, 2022b). To put this in a global perspective, the number of people without access to safe drinking water is twice the population of the US, and more people have a mobile phone than a toilet (Doorn 2019).

The WHO has calculated that basic consumption and hygiene needs can be met with 100 liters per person per day, or 36.5 cubic meters per person per year (Howard and Bartram 2003). Whereas an increasing number of people in arid countries have less than that amount, the water footprint of a typical Western liquid consumption pattern (that is, the total amount of water needed to produce our daily consumption of beverages, including soft drinks, alcohol, coffee, tea) is as much as 900 liters per day – enough to fill 10 average size baths (Hoekstra 2013). Depending on where the ingredients are produced, this may involve a transfer of water from water-stressed areas to water-rich countries through these ingredients ("virtual water transfer").

Water can also be available in excess. An increasing percentage of the world's population lives in areas that are at risk of flooding, a situation exacerbated by anthropogenic climate change. Flooding is the deadliest type of natural disaster. Although most often seen as separate issues, water scarcity and flooding are related. Solutions to water scarcity may have a negative impact on safety from flooding, and vice versa. These ethical challenges cannot be solved by technological means only. There are trade-offs to be made between economic and environmental concerns, and we need to assess and prioritize different water-related risks, but also consider the relation between governmental actors and citizens. The work involves value-laden questions, where values can be understood as "lasting convictions or matters that people feel should be strived for in general and not just for themselves to be able to lead a good life or realize a good society" (Van de Poel and Royakkers 2011, 72). Hence, these questions reflect what people consider important in life and for society and they cannot be solved by simple calculation. Elsewhere, I have presented the main questions in water ethics as comprising a "what," in the sense of what values are incorporated into the system, and a "who," as in who should make choices in water policy and who is affected by those choices (Doorn 2018b). In the remainder of this article, I will briefly sketch these two categories of questions.

The "What" of Water Ethics: Value Considerations in the Water Domain

First the "what." A significant aspect of water is the multitude of services it provides. Water is recognized as being essential for life and a basic human need, both in terms of drinking water and in terms of sanitation. Water is equally important for agriculture and, also in some countries, for transportation. In its most simple form, the debate on water scarcity is about prioritizing different kinds of water use. In this discussion, the value of water is primarily instrumental, a

^ *Fig. 2 Low water near Nijmegen, the Netherlands, August (Source: Neelke Doorn, 2022).*

basic human need indeed, yet a relatively tangible one. This also holds for the environmental value of water. If these different services clash, how do we decide which should take precedence and who makes that decision? In ecological economics, a common way to make a trade-off between conflicting services is to express it in one monetary unit – this can be money but does not have to be – and then look for the highest value. In other words, seek to maximize the outcome. This raises a number of questions, however. First, can all services really be expressed using the same measure? From an ethical point of view, we can justifiably say that the values these services might represent – safety, health, ecology, the future availability of water sources, but also the socio-cultural practices related to water – are incommensurable. That is, they cannot be expressed by the same standard of measurement (Chang 1997). Second, we may be overlooking important considerations when we focus on maximization only. Is it not much more important to maintain flexibility (Teodoro et al. 2022), or to prevent irreversible consequences such as the loss of unique ecosystems (Doorn 2018a)? In the past, many technological solutions in the water domain have created lock-ins that are now considered undesirable. Yet, this does not automatically mean that all interventions that create some irreversible impact are by definition undesirable. In the water domain, for example, the traditional Dutch approach to make the land livable and safe from flooding can be considered a lock-in, causing land subsidence and having a negative impact on the aquatic ecosystem, yet the resulting Dutch landscape, with its polders and dikes, is also appreciated by many people as cultural heritage. One of the open questions is how to recognize this heritage value, without being

forced to continue a practice that has become undesirable for other reasons. A possible way to look at this question is by distinguishing the technical function that an object or infrastructure is designed to fulfil from its material properties. Taking the example of the Dutch polders, this would mean that an alternative approach to flood risk management could be implemented, while leaving parts of the physical object intact. While this question is far from fully answered, asking such questions and making trade-offs explicit represents a necessary first step.

The "Who" of Water Ethics: Stakeholders, Actors and Responsibilities

Now for the "who," by which I mean "who is affected" and "who should and can act?" The concept of resilience serves to illustrate this "who." In recent years, and certainly regarding climate change, we have seen increasing calls for resilience. The term resilience in this context is often linked to its ecological definition (Cañizares, Copeland and Doorn 2021); that is, the ability of an ecosystem to recover and adapt after a change. This is an emergent property, an ability derived from the composition of the system as a whole, with all its separate components (Walker et al. 2006). Resilience has come to be seen as a promising alternative to traditional approaches in safety science, which often look quite mechanistically at disasters and incidents. With the introduction of a resilience-based approach to safety science, the emphasis has shifted to flexibility and learning ability, enabling systems to deal much better with unexpected threats.
It is often assumed that, in the context of climate adaptation, resilience policies ask for new responsibility arrangements between central governments and citizens, with citizens getting a more prominent role (Doorn, Brackel and Vermeulen 2021). Analogous with its ecological definition, we can interpret resilience in these domains as an approach in which everyone plays their part, albeit in different ways, so that together we are able to deal with all the unexpected climate and water risks. But is everyone capable of doing this? If a resilient city involves individual citizens having to do more while the government withdraws, this could result in undesirable inequalities.

In short, a resilience-based approach raises questions about who should act and who benefits (Meerow, Newell and Stults 2016), about who is given the responsibility or space needed to do so (Hegger et al. 2017), and about what those involved are actually capable of (Doorn 2016). If these "who" questions are not considered, the approach can create undesirable inequalities and maintain or even strengthen existing vulnerabilities (Davoudi 2012).

Ultimately, the "who" also links to our past and its heritage. Past behavior has led to some of today's grand challenges in the water domain, such as water shortage, water pollution and anthropogenic climate change. It is clear that geographic regions that have contributed most to this – mainly the Global North – are not necessarily the regions that are most impacted by it – mainly the Global South. This means that the Global North's past also involves a responsibility for the "present" it has created.

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In her previous NWO Veni project, she looked at distributive questions in flood risk management. Here she developed a moral framework for distributing flood risks, based on the distinction between reversible and irreversible risks. Her current NWO Vidi project focuses on policies for climate adaptation. Recent book titles include *Water Ethics: An Introduction* (published with Rowman & Littlefield, 2019) and *The Routledge Handbook of the Philosophy of Engineering* (co-edited with Diane Michelfelder, 2021).

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Valuing Heritage for Water Management

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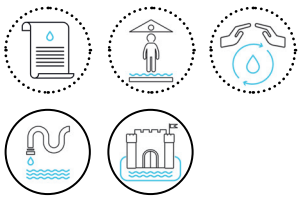
Regional Public Water Authority Amstel, Gooi and Vecht

Adding Place to Balance People, Planet, Prosperity, Peace and Partnership (toward 6Ps of SDGs): *The Dutch landscape contains unique elements resulting from both natural processes and human interventions. To truly understand the Dutch water system, we need to consider how human interventions have impacted it throughout history. This is especially important when it comes to addressing current water challenges as part of the United Nations' Sustainable Development Goals (SDGs). However, the SDGs are not just isolated goals. They should be perceived as interdependent spheres of action, with "place" being a particularly important new pillar to consider. The concept of "place" forces an integrated approach between the five pillars of SDGs (5Ps of SDGs) – people, planet, prosperity, peace and the unique historic characteristics of specific spaces. By acknowledging and understanding the unique historic characteristics of different places and fostering mutual understanding through the sharing of narratives and building partnerships, we can effectively work together to find solutions that address future challenges.*

KEY THEMES



< Fig. 1 Entrance to the fifteenth-century section of the underground canal under Nieuwmarkt, Amsterdam, coming from the seventeenth-century section (Source: City of Amsterdam, Office for Monuments and Archaeology).

The Netherlands as a Living Canvas for People, Water and Nature

The Dutch delta is a natural drainage system composed of the rivers Rhine, Meuse and Scheldt, which flow into the North Sea. It sparked the traditional Dutch focus on the drainage of wetlands, which, combined with extensive peat reclamations, caused significant land subsidence in almost two-thirds of the Netherlands. Ultimately, this approach led to a demand for protection from the same rivers and sea through an elaborate network of dikes, pumping stations and waterworks (Ven 2004). Water management involved people setting up organizations and making decisions together. For centuries, local disputes have centered on water levels, such as the choice between lower water levels draining the land and making it fertile, or higher water levels protecting buildings from collapsing and preventing land from subsiding any further. Significant regional issues in the past were, and will continue to be in the future, the downstream transport of water surplus, the availability of upstream water during droughts and the water quality in our living environment.

In addition to addressing the national, provincial, and municipal levels, the various water authorities are tasked with flood protection, water quantity management and water quality management. In the Netherlands, the regional public water authorities represent the fourth tier of democracy, with a lineage dating back to its founding in the 13th century. The elected boards are responsible for allocating taxpayer funds and determining solutions to water-related issues (van Tielhof 2021). Nowadays, water authorities face increased societal challenges on different spatial and temporal scales, e.g., reducing water quality and quantity risks, and negotiating between the different regional interests. These societal challenges also offer operational and business opportunities within the water cycle, such as the exploitation of thermal energy, the exploitation of raw materials from sewage, along with ecological alternatives for the traditionally less "sexy" maintenance of existing water structures. Maintenance of existing and future water structures requires knowledge of the long history of Dutch water management, and the approaches and achievements that have become the most prominent Dutch legacy and an inseparable part of Dutch identity and culture.

Engineering Nature and the Need for Knowledge of Water Heritage

In the nineteenth century, as industrialization and a sovereign state developed in the Netherlands, water management emerged as a flagship export product. In the twentieth century, the construction projects known as the Zuiderzee Works and the Delta Works represented the pinnacle of Dutch engineering's ability to control and mitigate natural risks. The country's success in this regard can be attributed to the priority placed on water infrastructure and functionality. A prime example is a hidden gem in Amsterdam's city center located at the Nieuwmarkt, at the former city gate known as the Waag (fig. 2). Construction of this "hidden" water defense and canal started in 1488 and the structure has undergone numerous modifications and adaptations to meet changing needs. The city's expansion resulted in the abandonment of the Waag's defensive function in 1599, which resulted in an underground canal (fig. 3, 4). More recently, in 1980, a section of the canal was modernized using concrete construction (fig. 5). At this point, the underground canal serves as a vital part of the city's water infrastructure, because it transports polder water from Amstelland's hinterland through the his-

^ *Fig. 2 Waag in 1880 (Source: Andreas Theodorus Rooswinkel, Stadsarchief Amsterdam, 010005001413).*

^ *Fig. 3 Waag, seen from the Kloveniersburgwal in 1982. Development of the Nieuwmarkt square began in the early seventeenth century, extending the underground canal entrance (Source: B.P. Opschoor, Stadsarchief Amsterdam, OSIM00008002319*).

torical city center and therefore is considered a precious time capsule, with equal importance as cultural heritage and as a water safety feature.

Water management in the Netherlands has been dominated by technological advances designed to control nature. However, engineers have more recently come to the belief that natural systems should inform design. The challenge in the Netherlands lies in the extensive alterations that have been made to the natural system – in this context the concept of "creating natural conditions" appears to be a distant reality as the natural state of an artificial landscape is often hard to distinguish and maintain. For example, the ecological system of the Dutch lake Markermeer is the result of separating the lake and its surrounding areas, as well as a shortage of shallow waters and floodplain areas (fig. 6, van der Geest 2018). The shallow waters and floodplains have been converted into polders (such as the Flevopolder), largely disconnected from the Markermeer.

Spatial planning – now and in the future – must balance technological perspectives with an appreciation for the power of building with nature. Attention to water heritage is critical, as it encompasses the "human factor" in our landscape. Water heritage embodies our impact on water systems and the interplay between society, water and nature. Therefore, we strongly advocate reflecting upon past decision making for present-day practice and robust future design considerations.

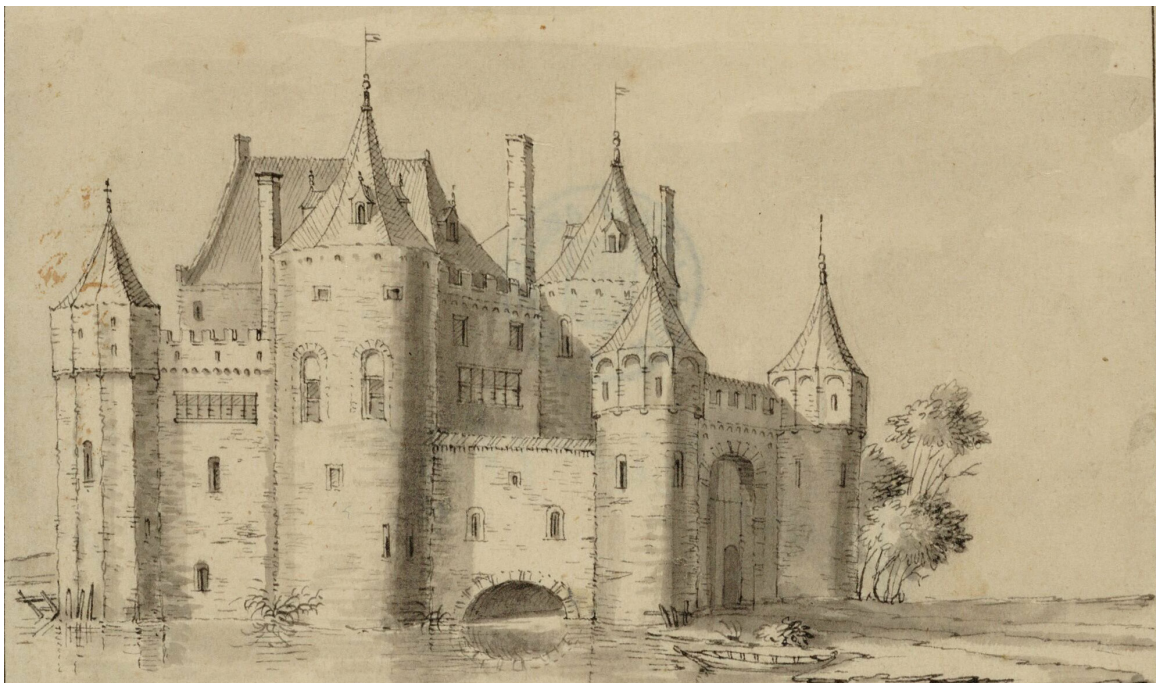
Inventing the Future Needs an Integral Approach to Society, the Natural Environment and Historical Technological Changes

Dutch water professionals are urged to find alternative solutions for future water management as climate change brings new challenges, such as sea level rise, land subsidence, intensified rainfall, increased peak discharges and more frequent droughts and heatwaves. And our location in a low-lying delta makes challenges especially acute. Society's ideas and creativity are crucial in this effort. Engineers need to work together with other members of society, considering both the natural system and the changes that have been made to it. Understanding heritage is a key skill to add to our toolkit. Heritage is not just about preserving isolated objects – it encompasses the entire functional landscape that tells the story of our ancestors' struggles and triumphs in a world that both supports and threatens us. Only by learning from the past can we secure human capital, the environment and our future.

New Solutions are Defined by a Place and its History

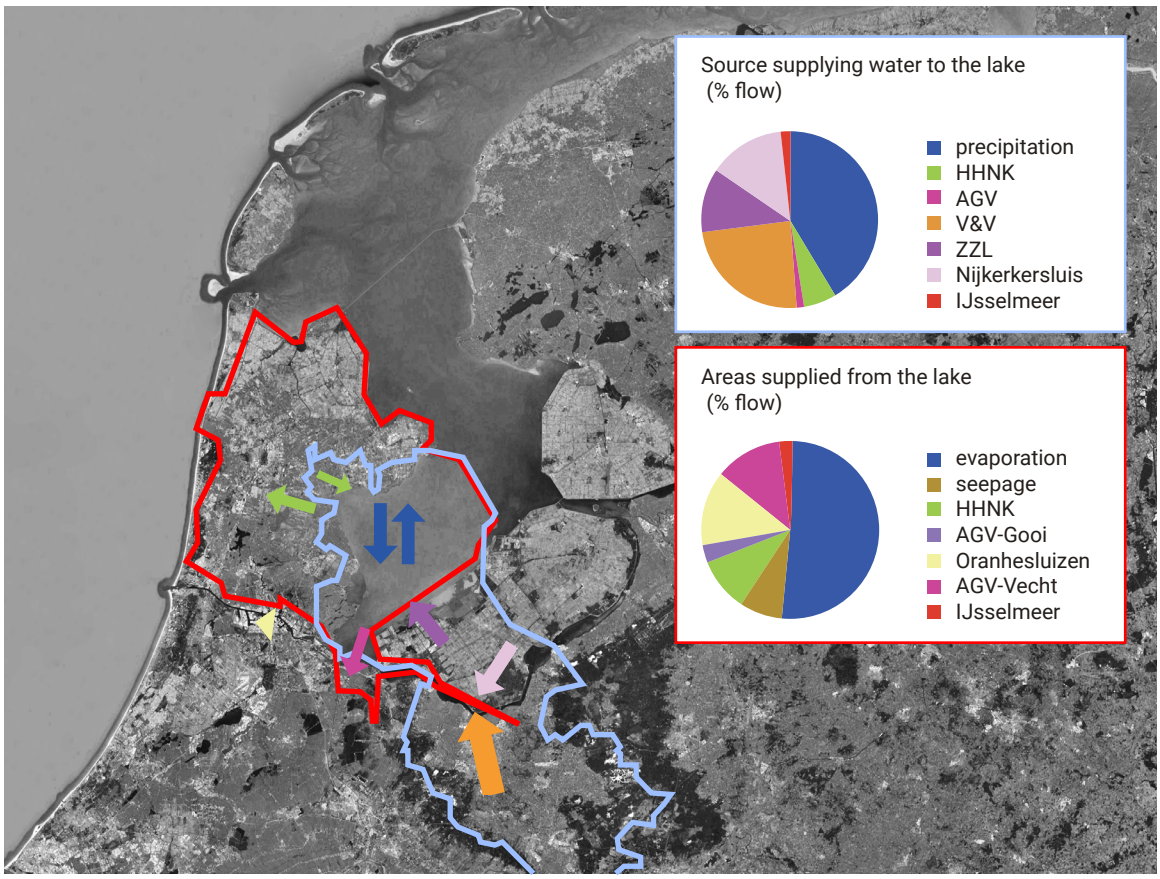
In the Netherlands, regional water boards elected by the public give voice to water and play a vital role in maintaining the delta landscape. The process of balancing the interests of various stakeholders in water management is commonly known as consensus decision making and referred to as the "polder model." Effective water management requires a deep understanding of geomorphology, the water system and the application of a broad range of engineering skills to address the interplay between natural processes, technological changes and historical choices. Water boards are obligated to raise awareness about the identity and value of water to strengthen resilience against increased land use pressures and challenges posed by climate change.

A landscape's narrative holds shared stories of places and people critical to shaping its future.



^ *Fig. 4 Drawing of "the old St. Antoniesgate" in 1604, showing the arch in fig. 1 before the extension of the underground canal (Source: Stadsarchief Amsterdam, 010097001537).*

^ *Fig. 5 1980 reconstruction of the closing doors in the underground canal under Nieuwmarkt, Amsterdam. The canal functions as a connection, eventually transporting water discharge from the Amstelland catchment in the direction of the North Sea. The closing doors protect the city from flooding when outside water levels are high (Source: Maarten Ouboter).*



^ *Fig. 6 Markermeer, in the center of the Netherlands, its catchment (blue line) and the area that is supplied with water from the lake (red line). Arrows indicate inflow and outflow; the graphs show the relation between the two based on the water balance of the lake from 2000–2015 (Source: van der Geest et al., 2018).*

Cultural heritage is integrated into Dutch water management practices, creating opportunities and added value between nature and culture. Distinctive landscape features inherently determine ecosystem functions, providing significant insights into how to balance natural context and cultural influences. Finding local solutions starts with advocating for "place" to be added to the existing five pillars that constitute the SDGs. Only then can we secure our legacy for future generations.

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Hope as Religious Heritage: Toward Hopeful Coalitions for Sustainable Development

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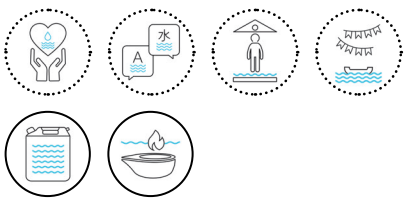
The effects of climate change can evoke fear and a sense of apocalypse. Invoking the apocalypse in discourse about the future, however, can lead to denial or fatalism. This article considers the concept of hope as an attitude and ritual practice that defies the dichotomy between secular and religious. Practicing hope, trust and empathy can stimulate dialogue and cooperation around climate change and upcoming water challenges. The article discusses a case study of a learning exchange between South Africa and the Netherlands on hope regarding climate change and water.

KEY THEMES



< *Fig. 1 Water point Day Zero Cape Town (Source: City of Cape Town).*

Introduction

"How should one respond to climate change? Tata?" asks Irene. In this case, Tata (Polish for father) is the sociologist Zygmunt Bauman and he answers his daughter by stating that it is wrong to divide the world into optimists and pessimists. He says that there is a third possibility: a hopeful response to climate change (van Rootselaar 2014). Bauman's remark merits close attention. In the view of the cultural critic Terry Eagleton, hope "has been a curiously neglected notion in an age which, in Raymond Williams's words, confronts us with 'the felt loss of a future'" (Eagleton 2015, *xi*). Nevertheless, recently, Femke Halsema, the mayor of Amsterdam, and Geordin Hill-Lewis, the mayor of Cape Town, referred to the importance of hope when it comes to the challenging issues in their cities and the future of society (Halsema 2020, 123). In this article I argue that religious heritage can offer guidance for all involved, both secular and religious, as they seek to respond to water issues in times of climate change. No one saw it coming, but suddenly it was there, climate change, expressed in a three-year drought with a 2018 peak in Cape Town, South Africa. In 2018, the Netherlands experienced a serious drought also, but it was nothing compared to the drought of the summer of 2022. On 3 September 2022, the Dutch newspaper *Trouw* presented a survey indicating that fear of the consequences of climate change has grown among the Dutch as a result of the 2022 drought. The survey also indicated concerns about the future. More than six in ten people with (grand)children fear that the world will become less livable for their descendants (Bijlo 2022, 1). The survey is in accordance with the insight that environmental issues like climate change often evoke fear, polarization and a sense of apocalypse about a radical uncertain future (Bruckner 2013, 2).

Water in times of climate change – as described in terms of sea-level rise, changing rainwater patterns, consequent flooding and drought – is often surrounded by an atmosphere of fear and apocalypse. It reminds us of the universal flood narrative in our religious heritage of which the Hebrew version can be found in *Genesis* (chapters 6–9). It may evoke a politics of apocalypse of which we can also find versions in the *Book of Daniel* (Hebrew Bible) and the *Book of Revelation* (New Testament). It is a kind of politics often found in the way climate change is presented in novels such as *Dry* (2018) and *The End of the Ocean* (2020) and movies like *The Day After Tomorrow* (2004) and *Don't Look Up* (2021).

These novels and movies with their apocalyptic images can help to signal a rupture, but they can also easily lead to denial, paralysis and fatalism regarding climate change. Therefore, one can wonder whether storytelling should be left to novelists, filmmakers and poets. There is more than one way of interpreting a radical uncertain future. Water in times of climate change does not carry with it its own interpretation. How, then, do we tell the story?

The American philosopher Martha Nussbaum highlights hope as the opposite of fear (Nussbaum 2018, 211). But she also indicates that philosophers haven't discussed hope extensively (Nussbaum 2018, 202). Where can we find sources for hope?

Maybe surprisingly, it is religious heritage that provides and articulates a profound understanding of hope that goes beyond the Western distinction of secular and religious. A global leading thinker here is the late Jonathan Sacks (1948–2020), British intellectual and former Chief Rabbi of the United Hebrew Congregations of the Commonwealth. Sacks' understanding of hope is derived from religious

heritage, the narrative of the Exodus. This narrative is not only part of the religious heritage of Judaism, but also that of Islam and Christianity. What is more, in the view of Sacks, this narrative is the meta-narrative of hope of Western civilization. The reason for this is that in Western societies for generations people have used this narrative to create perspective in dark times. It was, for example, Dr Martin Luther King Jr who said: "Let us not wallow in the valley of despair. I say to you today, my friends, so even though we face the difficulties of today and tomorrow, I still have a dream" (King 1963). In formulating his dream, King was inspired by words from the Exodus.

Hope as religious heritage is not simply copying truths of generations before us. Hope needs to be born again in every time and generation by interpreting and living sensitively and creatively the assumptions highlighted in the Exodus. Only then can religious heritage enrich and deepen contemporary times and questions. Some key principles are change of identity and empathy (*chessed* in Hebrew). Identity is seen as the images people live by – images of themselves, others and the world. Some identities may have been useful in the past, but that does not mean that they are still useful when it comes to water in times of climate change. The Exodus highlights a journey in which people gradually learn to change the identity they live by. In the first part of the journey, the people have hardly any understanding of what is going on, because their identity is still defined by their past. In the second part of the journey, the people gradually change that identity by themselves. The new identity is based on a shared vision of the future that creates space for all involved. This change of identity takes time, because it is impossible to suddenly change the images people live by. An example here would be the director of an environmental NGO and the CEO of an oil company creating meaning by learning together how to take responsibility for a shared future.

The driving force of this transformation is empathy, a certain type of love. This driving force calls for an opening up of one's identity and learning to see oneself and the other, especially the one not like me, as valuable in themselves, regardless of merits or use for others. Empathy does not seek the affirmation of one specific position. Plurality is of crucial importance for opening up identities that may have been useful in the past but are not useful anymore. Hope then is not the conviction that today will be better than tomorrow. Hope is also not found in a faraway utopia, a promised land. Hope is found in the land of the promise. In the present, parties even with conflicting interests can decide to exchange a promise to learn together how to create responsibility for a shared future.

This understanding of hope is anything but a naïve invitation to a better world. During the journey, the motivation to learn how to create space for oneself and the other (empathy) is constantly in danger of being undermined by the status quo, pure self-interest, fear, doubt, misunderstanding, opportunistic behavior, false turns and so on. Therefore, this motivation can never be taken for granted. It can develop and degrade. In order not to lose one's way in times of transition, Sacks' concept of hope raises questions about how to shape the process of the transformation. What kind of architecture is required to stimulate hope in the midst of reality?

Hope does not only raise such questions, but provides at least two creative answers, namely a covenant and a workplace of hope. Briefly, a covenant is an argumentative association; it does not seek the affirmation of one position but stimulates opposition as a way to open the

identities of those involved in order to create a new and common identity: "In the short term, our desires and needs may clash; but the very realization that difference is a source of blessing leads us to seek mediation, conflict resolution, conciliation and peace – the peace that is predicated on diversity, not on uniformity" (Sacks 2011, 203).

Second, entering into a covenant does not mean that everybody agrees with one another. The covenant is an argumentative association in which the dignity of difference is valued. The differences between people are essential for opening up one's own identity in order to be able to create a new "we." Key to Sacks' understanding of hope is what I have called a "workplace of hope" (Hasselaar 2023, 121). This workplace goes beyond a simple dualism between secular and religious, because it is a ritual to stimulate hopeful cooperation between all involved, because responses to water in times of climate change are never immune to setbacks like difficulties, disappointing summits, opportunistic behavior, feelings of fear, futility or skepticism. A workplace of hope recognizes all of this, but does not surrender to it and facilitates taking small steps forward together based on four dimensions (Hasselaar 2020, 233–34):

Utopia now
a regular moment that celebrates a new "we" that parties may barely glimpse in the present.

Neutral space
a neutral space in the public domain that values differences among the participants, because it is only the experience of sharing a common world with others who look at it from different perspectives that can make people aware of their own identity and open them up to the possibility of developing a new and common identity.

Catalyst of empathy/love
A workplace of hope stimulates practices and, by doing so, protects and strengthens relations of empathy that seek to include the well-being of the other, especially those still excluded, as well as one's own self-interests.

Embodied knowledge
it stimulates the development of meaningful relations between subjects, not only via reflection and practical steps forward, but also via the power of music, poetry, eating together and imagination.

But hope does not live in abstractions. Hope needs to feed on particulars. In 2019, the international symposium *Water in Times of Climate Change: A Values-driven Dialogue*, was organized by the Vrije Universiteit Amsterdam and Ecumenical Patriarch Bartholomew, so-called "Green Patriarch" (Chryssavgis 2015, 12). Focusing on the urban areas of Jakarta, Cape Town and Amsterdam, the symposium aimed to deepen scientific, economic and political approaches by tapping into the richness of cultural and spiritual values to foster societal resilience. To strengthen cooperation between these approaches and between the three cities, the silver "Chalice of Cooperation" (in Dutch: *Hensbeker*) dating back to 1717 and used by water authorities as a symbol to confirm agreements for the greater good, now often preserved in a museum - was reinvented. In the words of Gerhard van den Top, chairman of the Waternet Amsterdam Regional Water Authority: "The old crests of the historic water districts that were engraved in the original silver chalice were replaced by an image of the world. This image of our globe represents cooperation on water issues between cities and utilities worldwide in times of climate

change, and between the 'worlds' of science, economy, politics and religion. The image was printed on a reusable 'Dopper' bottle, to inspire stakeholders to also choose reusable over single-use water bottles" (Van den Top 2021, 126 –27). The old-new chalice was used to support hopeful concrete steps by new coalitions between cities and disciplines.

Let me mention one more concrete step. On 24 November 2022, an agreement was signed for the Blue Deal South Africa Phase 2, which runs from 2023 to 2030. Part of this agreement is a project that aims to decrease the impact of the diffuse pollution of water upstream in Theewaterskloof municipality, part of the catchment area of Cape Town. In this project, concepts like community enrollment, Indaba and the politics of hope are piloted to stimulate and deepen co-design and ownership by all parties involved. Indaba is a model of community building derived from South African traditions, and related, but not limited to Sacks' understanding of hope. As Archbishop Thabo Makgoba, successor of Desmond Tutu, puts it: "God understands isiZulu too" (Makgoba 2019, 226). This pilot will be part of an equal learning exchange between South Africa and the Netherlands, in which concepts from both sides are explored and used to practice hope, trust and empathy to stimulate cooperation around climate change and upcoming water challenges.

I have argued that our religious heritage highlights hope as a third and inclusive way, besides pessimism and optimism, to respond to climate change and water challenges. Such an understanding of hope is neither abstract nor far away. It is just beyond where we are. The only thing we have to do is to respond to its call. To put it in the words of Amanda Gorman's poem, recited at the inauguration of Joe Biden on 20 January 2021:

> *For there is always light, if only we're brave enough to see it, if only we're brave enough to be it.*

That we all may become beacons of hope.

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Mourning Rivers: A Way of Negotiating the Future

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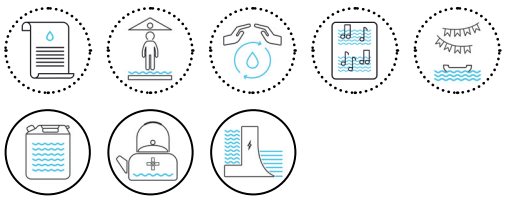
Considering three examples of rivers in Europe, this article examines how ecological grief can trigger environmental discourses and awareness concerning the UN SDGs. We define heritage as a cultural practice involved in constructing and negotiating a range of values and understandings through engagement between people, things and places. Among humans, nature can be mourned and the emotions of loss, sadness and yearning can inspire activism. Organizing funerals for nature has become an important element of mourning the death of "loved ones" and fighting for their revival, thus drawing the attention of the wider society to ecological problems. In discourses seen as central to attracting support and making changes real, nature is represented using powerful metaphors of life and death. We argue that the symbolic mourning for rivers creates a space to collectively express ecological grief, loss and other feelings (Frantzen 2021) in a way that supports struggles for ecological justice. In shared loss, there could be restoration.

KEY THEMES



< *Fig. 1 Protesters at the Mermaid of Warsaw, during the funeral for the Oder River (Source: Aleksandra Klimek Lipnicka, Courtesy of Cecylia Malik;* CC BY 4.0 *, via Wikimedia Commons).*

Introduction

The cultural practice of heritage involves constructing and negotiating values and understandings through engagement between people, things and places (Harvey 2001). Heritage can tell important stories about past disasters to younger generations and in a way that can trigger strong emotional reactions. At the same time, disasters can become a catalyst for reimagining post-disaster futures and places.

A severe ecosystem change can cause the loss of ways of life and personal identity constructed in relation to local places of heritage (Tschakert et al. 2019). Rapid and unexpected change triggers feelings similar to those associated with the loss of a loved one. This sense of loss resulting from ecosystem change is known as ecological grief. Ecological grief involves

1) a strong negative emotion experienced as a consequence of place change and place loss and
2) anxiety, depression or anger in response to interrupted life. That loss must be appropriately mourned, grieved and resolved.

Many societies consider mourning a culturally accepted expression of grief that takes place in community rituals to enable people to acknowledge loss and ease traumatic experiences. However, there are no established Western rituals to grieve ecological loss. Historically, ecological grief has not been considered legitimate in Western cultures. And yet, "weeping" for lost nature has emerged as a form of ecological activism. Mourning as ecological activism can transform Western environmental discourses. This can be seen in three case studies in which people mourned the Tisza, Sztoła and Oder rivers after twenty-first century events devastated these waterways.

Tisza

Pollution of the Tisza River became a public issue in the 1980s. In the spring of 2000, cyanide and other heavy metals were released into the river by an Australian-owned gold mine located in Baia Mare, Romania. This polluted water flowed through several European countries: Romania, Hungary, Serbia and Bulgaria, finally reaching the Danube Delta (Harper 2005). The ecological disaster was referred to as "the largest man-made environmental disaster in Eastern Europe since the Chernobyl leak" (Koening 2000) and was followed by two more spills that year. Later that year, the flood of the century discharged pollutants across the floodplain of "the most Hungarian of all the rivers" (Harper 2005; Lazar and Kiss 2002). All these events resulted in "an outpouring of patriotic sentiment in Hungary," framing environmental pollution as a national crisis (Harper 2005). In response to the transnational damage, Hungarian soccer hooligans threw dead fish at the Romanian team (Harper 2005).

Tisza River funerals, organized in Budapest and other cities in the spring of 2000, resembled funerals of famous political leaders and historical figures (Harper 2005). Thousands of citizens participated in the procession and others hung black flags in their windows. The funeral procession-like protests used three "metaphors of the spill": fish as biological life, gold as a life-supporting system, the golden rays of the sun and finally cyanide as death (Lazar and Kiss 2002). Symbolism referred to both patriotism and solidarity, building upon political transformation narratives ("political lives of dead bodies") as a means of politicizing nature ("political lives of the dead fish"; Harper 2005). The communities affected by the closure of fisheries due to pollution have increased participation in local self-government, NGO activities, and subsist-

^ *Fig. 2 Tisza Cyanide Spill in 2000 (Source: Délmagyarország/Karnok Csaba;* CC BY-SA 3.0*, via Wikimedia Commons).*

ence activities (Lazar and Kiss 2002).

The cyanide spill in Romania is not an isolated incident; similar events occur regularly in less economically developed regions (Lazar and Kiss 2002). Environmental protests in Hungary framed the disaster as "ecocolonialism" and "wild capitalism" – shortcomings of political and economic transformations of post-socialist society resulting in vulnerability to environmentally harmful activities, paired with weakness of civil society and low environmental awareness (Harper 2005).

Sztola

The Sztoła River, affectionately called the Emerald River in the Bukowno mining community in Poland, disappeared in January 2022. In contrast to the transnational Tisza case, the Sztoła was a relatively small local river in Poland. The drying out of the Sztoła resulted from the cessation of mining operations at a nearby zinc and lead mine which was recently acquired by an international company. Experts and members of the local society foresaw this "vanishing" and yet did not organize themselves to keep the river alive. Instead, before the planned disappearance of the river, local communities engaged in a variety of farewell and tribute events organized by local tourist organizations and kayaking groups. Social media posts by these local groups often expressed sadness and anger, as well as gratitude to the river for the chance to experience its beauty over the years. Grieving was blended with "solastalgia" – an environmentally induced distress that impacts people's connection with their home environment (Albrecht et al. 2007) – and passive acceptance for losing

^ *Fig. 3 Funeral for the Sztoła RIver, a protest inspired by Paulina Poniewska; concept by Cecylia Malik; organized by River Sisters Collective (Source: Stan Barański, Courtesy of Cecylia Malik;* CC BY 4.0, *via Wikimedia Commons*).

^ *Fig. 4 River Sisters pouring water into the Sztoła's dry riverbed (Source: Stan Barański, Courtesy of Cecylia Malik;* CC BY 4.0, *via Wikimedia Commons*).

an important part of local culture and heritage. The "artivist" collective River Sisters – using art to push political agendas or achieve social goals by changing minds and raising awareness – organized a symbolic funeral for the Sztoła River right after the river disappeared (fig. 3). Although attended mostly by people from outside the local community, the event called for action to bring back the Sztoła River and to shame the mining company for their part in causing environmental degradation. The protesters symbolically poured water into the dry riverbed (fig. 4) and sang dirges inspired by the feelings of environmental harm and grief and lamenting human responsibility for the loss of the river (appendix 1: S1).

Oder

About six months after the disappearance of the Sztoła, in July 2022, the Oder River was contaminated, leading to massive fish deaths within a few hundred kilometers of the watercourse. The Oder is a river that Poland shares with Germany and the Czech Republic. Highly regulated for inland sailing and river transportation, the Oder flows through the most industrial regions of Poland. The case of the Oder River illustrates a new type of environmental disaster, one grounded in the context of global environmental change and its regional impacts on rivers in Poland. For the first time, the combination of industrial pollution, drought and heat prompted the loss of Oder River ecosystems. There is no doubt that the loss was the result of human activity. According to experts, the ecosystem may need several decades to regenerate, however the ecological damage is irreversible (PAN 2022).

The largest mourning procession was organized in Warsaw, Poland, in August 2022 (fig. 5). It was officially attended by over 30 organizations, included many artists and hundreds of citizens. It was led by a silent procession of warrior-like dancers (inspired by *tessens* – Japanese war fans) in the role of traditional weepers, followed by a wind quartet playing funeral procession music. The head of the procession carried black banners with an epitaph for the Oder River and banners with the names of other Polish rivers. The entire event was carefully planned as an artistic and political performance, with guidelines for participants that included remaining silent and avoiding the use of other banners (Michnik 2022). The event was designed to build a sense of community and organizers encouraged people who could not participate in the main event to engage in online activities, such as posting photos of people lighting candles at the banks of other rivers in Poland as a form of paying tribute to the Oder. The funeral speech poetically expressed the emotional, ecological, community-building and political goals of the mourning ceremony (appendix 1: S2).

The catastrophe of the Oder River has been defined as "ecocide," meaning a crime against nature and people. While the "Oder was killed by humans," the event caused suffering to non-humans. Ecological discourse provided a space for people to express their ecological grief and mourn the loss of the Oder. It is important to note that this ecological catastrophe could have been avoided simply with proper environmental monitoring and the immediate response of public institutions (PAN 2022), without engaging in more-than-human ethics. Unfortunately, to avoid any responsibility, the Polish government at the time argued that the disaster was the result of natural causes (WWF 2022). Mourners' anger and sense of helplessness led to the claim that the Oder River is legally a person, must have rights and can be represented and defended in the court. The initiative is still

^ *Fig. 5 Funeral processions for the Oder River, Warsaw. (Source: Aleksandra Klimek Lipnicka; Courtesy of Cecylia Malik,* CC BY 4.0, *via Wikimedia Commons).*

ongoing with over 8,000 signatures collected for the petition. Celebrities, artists and other famous people have joined "the Oder Tribe" with the motto: "I am the river, and the river is me" (www.osobaodra.pl).

Conclusion

Disasters present opportunities to transform social institutions as well as our understanding of cultural heritage (Harper 2005). In the case of the Tisza River, the disaster stimulated discussion about the ecological, political, and economic conditions of Central and Eastern Europe. It strengthened the ecological movement and demands for better transboundary river governance (Koening 2000). The disaster at the Oder River initiated consideration of rivers as legal persons in Poland and highlighted the need to restore highly altered river ecosystems in the country. Finally, the disaster at the Sztoła River illustrates that emotional engagement alone is not always sufficient to defend community heritage practices. Experiencing loss and expressing grief can lead to passive acceptance and reconciliation on an individual level, however new emerging heritage practices, such as funeral-like protests, attempt to inspire collective action at the community level.

The symbolic representation of nature in changing discourses is central to attracting support and making change real (Harper 2005). In Western cultures, these new mourning rituals have emerged as a form of activism that seeks to create desirable heritage futures. Their broader purpose is to change dominant environmental discourses and discover futures through place-based practices of cultural heritage. Such "mourning activism" is a powerful tool that can bring attention to ecological issues and redefine the future of a community. Its strengths lie in powerful metaphors of life and death, the ability to mobilize people for collective action, and the ability to elicit emotions to facilitate desirable outcomes. Here, feelings and rationality act together to pursue mourning as part of the struggle against political marasmus in the wake of environmental crises (Michnik 2022; PAN 2022).

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Appendix

S1:

[original in Polish]

"(...) Ludzie wody mi zgonili.
Do wyrobisk spuścili.
Jam nie Sztolnia, ale Sztoła.
Po co mi do tego doła?
O ty Sztoło, ty Czartorio!
Gdzieżeś ty ze swą glorią?
Jam w podziemia spać poszła.
Płaczem wody żem zaniosła.
I my po tobie płaczemy.
Ze zwierzęty wyjemy! (...)"

[translated by Deja DeMoss]

"(...) People drained my waters
Into the mining excavation.
I am not an adit, I am the Sztoła!
Why should I go into this hole
Our dear Sztola, our ancient Czartoria!
Where are you in your magnificent glory?
I quietly went to sleep under your feet
as my waters flowed away with my tears.
We also cry for you, oh Sztola.
And now we howl with the animals! (...)"

Zofia Szyrajew, River Sisters (Source: https://www.youtube.com/watch?v=jPDu1byc258*).*

S2:

[original in Polish]

Odro, rzeko, rybo, ptaku, małżo, ziemio… Przyszłyśmy i przyszliśmy tu dziś dla Ciebie, dla Was, a także dla nas samych.

Chcemy Cię opłakiwać – wspólnie, publicznie, w widoczny sposób, oficjalny – bo na to zasługujesz.

Rzeko, która doznałaś krzywdy. Pragniemy zatrzymać się na tej krzywdzie, bo nami wstrząsnęła.

(…)
To także akt polityczny. Nie jesteśmy tu po to, by Cię pogrzebać czy zapomnieć. Nie jesteśmy tu, bo chcemy się poddać. Przyszłyśmy i przyszliśmy dlatego, że chcemy o TOBIE PAMIĘTAĆ, MÓWIĆ, UPOMINAĆ SIĘ w sposób, który oddaje to, że jesteś złożonym, pięknym, fascynującym bytem. Domem dla milionów czujących istot. Potężną wodą.

(…)
Myślę, że tym marszem budujemy nową jakość tożsamości – oficjalne, kolektywne opłakiwanie tego, co nam bardzo bliskie, a co przez lata było lekceważone. Tożsamość ludzi związanych z rzekami. A łzy są to tego nieuniknioną drogą.

[translated by Deja DeMoss]

Oh you Oder, Oh you River, Oh you Fish, Oh you Bird, Oh you Clam, Oh you Earth… We came…We came here for you. We came here for you all. We came here for us all.

We want to cry… We want to cry for you. We want to cry together, We want to cry publicly, We want to cry visibly, We want to cry officially, We want to cry… because you deserve it.

Oh you river… You, who has been hurt. We wish to pause for your pain because it has shaken us.

(…)
This is also a political act. We are not here to bury you and forget. We are not here because we have given up. We came… We came because we want to REMEMBER YOU, We want to SPEAK ABOUT YOU, We came to DEMAND in a way that reflects your complex, beautiful, and fascinating being. You are home to millions of feeling creatures. You are powerful water.

(…)
I think that with this march we are building a new identity, we are officially and collectively crying for what is very close to us, but that which was neglected for years. We are building the identity of people who are connected to rivers and tears are the necessary way.

Letter to the Oder River and her inhabitants, by Karolina Kuszlewicz (Source: magazynpismo.pl/idee/felietony/list-do-odry-i-jej-mieszkancow/).

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Marianna Strzelecka's work draws from the fields of political science, sociology, psychology, and political ecology to shed light on sociocultural aspects of the relationships between communities of place and local 'natures', and how tourism makes it possible to renegotiate these relationships. Marianna works with concepts of justice, empowerment, and nature stewardship. While she holds an associate professor position at Linnaeus University in Sweden, she is also affiliated with the Environmental Social Science Research Team at **the Institute of Environmental Sciences** at Jagiellonian University in Krakow, Poland, where she is looking into the role of tourism and outdoors recreation in shaping human-nature relationships.

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On the Frontline of Climate Change: The Underwater Cultural Heritage of Stone Tidal Weirs

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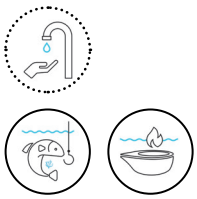
Stone tidal weirs are not just relics of the past; they also serve as a guide to future sustainable marine ecological conservation. They symbolize the ability of humans to adapt, use, and live in balance and harmony with the ocean environment. Situated along intertidal or coastal zones, these stone tidal weirs are on the frontline of climate impact and are often abandoned as the local community cannot afford the costs of repair. This has led to loss of this valuable traditional resource management system that contributes to tangible and intangible heritage of coastal communities, as well as to culture and biodiversity.

KEY THEMES



< *Fig.1 Stone tidal weirs in Japan (Source: Akifumi Iwabuchi).*

^ *Fig. 2 Stone tidal weirs in Timor-Leste (Source: Akifumi Iwabuchi).*

Introduction

Stone tidal weirs, a form of underwater cultural heritage, are a type of fish trap or barrier, operated only by tidal amplitude. These structures are made of large rocks or coral limestone, extending along the shoreline on a colossal scale in a semicircular, circular, arrow-like, or almost linear shape (fig.1). Stone tidal weirs are completely submerged during high tide, but emerge into full view at low tide, allowing people to collect fish, which cannot escape their stone walls (Iwabuchi 2014). Many examples still exist and provide a tangible link to a sustainable or eco-friendly fishing practice that has incorporated traditional ecological knowledge and is connected to the spirit world, providing balance and harmony for indigenous people for thousands of years. In other words, this tangible heritage also has intangible or living heritage features, and combining the two it forms a local traditional resource management system. In many local coastal communities, almost all the weirs are still used for fishing. They are located within seascapes created and maintained by harmonious interactions between humans and marine ecosystems (Montgomery et al. 2015). For instance, the indigenous ecological knowledge tells local people that the quantity and quality of fish has been improved after they build stone tidal weirs along the coastal zones. However, this traditional knowledge is usually shared only among local networks and not at the national level.

Current Approaches to Preserving and Managing Water Heritage

Today these weirs are not just relics of the past, but they also serve as a guide to future sustainable marine ecological conservation. Stone tidal weirs symbolize the ability of humans to adapt, use and live in balance and harmony with the ocean environment. Stone tidal weirs contribute to marine biodiversity. Compared to intertidal zones without stone tidal weirs, those with stone tidal weirs host a greater diversity of marine species (Pattrick et al. 2022; Zayas 2019).

The stone tidal weirs also contribute to rich intangible heritage values that often inspire creativity and continuity of traditional knowledge for local communities (Jeffrey 2013). For example, in Hainan Island, China, the traditional ecological knowledge of local songs and other oral traditions, which mention the lunar calendar and days and times of the flood and neap tides. Local fishermen have passed down songs from generation to generation as a reminder of the fishing season at stone tidal weirs. In commemoration of a good haul at a stone tidal weir, the Mullet Memorial Service Pagoda was built in western Japan by its owner. Mullet, and fish in general, are anthropomorphic beings with spirits, which are respected profoundly by local people in Japan. In celebration of large catches with stone tidal weirs, therefore, the local community conducts ceremonial rituals and erects religious memorial service pagodas, which are actuated by the community spirit of local coastal communities. The rich local traditional ecological knowledge around stone tidal weirs is maintained by members of local coastal communities, which perform fishery-related ritual activities such as beach-opening ceremonies and frequent community-led repair work. On the island of Hawai'i, some stone tidal weirs have been diverted into fishponds to be used by locals to produce fry (young fish). Traditionally, local communities use stone tidal weirs twice a month during the spring tide; a custom that has been preventing overfishing. In Timor-Leste, only fish spears are allowed to be used inside stone tidal weirs, because the stone tidal weirs

^ *Fig. 3 Stone tidal weirs in the People's Republic of China (Source: Akifumi Iwabuchi).*

function not only as fishing gears but also as fish spawning grounds. Local fishermen only manage to catch large fish with the spears, while small fish continue to grow (fig. 2). As a communal activity, Timorese throw raw chicken meat into stone tidal weirs at the beginning of the fishing season, praying for good fishing, and then they all undress together to repair stone tidal weirs.

Current and Future Challenges to this System

The stone tidal weirs are extremely vulnerable to global climate change, specifically to the ocean climate crisis. Recent field surveys and participant observation reveals that many stone tidal weirs have been abandoned or simply not repaired, largely because of ocean environmental change. If sea levels rise more than a meter, stone tidal weirs no longer function as fishing gear. These days, many fishermen in coastal communities agree that the tide is not ebbing as much as previously. Climate change is fueling destructive storms and high waves, and then subsequently, coastal erosion; after stone tidal weirs have been destroyed, many coastal communities cannot afford to repair them and leave them abandoned. Once stone tidal weirs are abandoned, fewer fish are caught. As the attention of local people shifts to destructive modern fishery, all aspects connected to cultural diversity have also disappeared. In order to maintain sustainable coastal communities, biocultural diversity must be retained; stone tidal weirs can serve as a symbol of such diversity.

All over the world, indeed, the underwater cultural heritage of stone tidal weirs is in danger of being lost, as cultural heritage and as traditional fishing gear. Especially in East Asia, typhoons are the greatest threat to stone tidal weirs. As a result, it is now difficult to carry out community activities and take care of spirits properly. In Southeast Asia, stone tidal weirs near larger towns have been catching not fish, but only ocean plastic debris. Just outside them, modern fishery fleets and fishing nets are catching almost all the available young fish, which could manage to escape the stone walls of stone tidal weirs as well as from fishermen's spears. In addition, ocean acidification is depriving stone tidal weirs of their important function as an artificial womb for marine species.

Conclusion and Future Approaches

Stone tidal weirs have improved community health, since higher-nutrient fish contributes to people's well-being, and is associated with lower child mortality, improved cognitive performance, and strengthened immune function. Heritage items situated along the intertidal or coastal zones, including the underwater cultural heritage of stone tidal weirs, would be the first cultural property to disappear as a result of climate change. On the other hand, some coastal communities have started to use the stone tidal weirs as a tourist attraction and the site of environmental education for younger generations (Zayas 2019). According to the UNESCO 2001 Convention on the Protection of the Underwater Cultural Heritage, the stone tidal weir is one of the most typical underwater cultural heritage items to be safeguarded, but its future is uncertain. A few countries, such as the Federated States of Micronesia or Taiwan, have already started to safeguard the underwater cultural heritage of stone tidal weirs, within the framework of national governmental cultural policy. However, many countries, such as China (fig. 3), Japan, or Timor-Leste, do almost nothing to safeguard them, mainly because stone tidal

weirs are not the underwater cultural heritage of shipwrecks.

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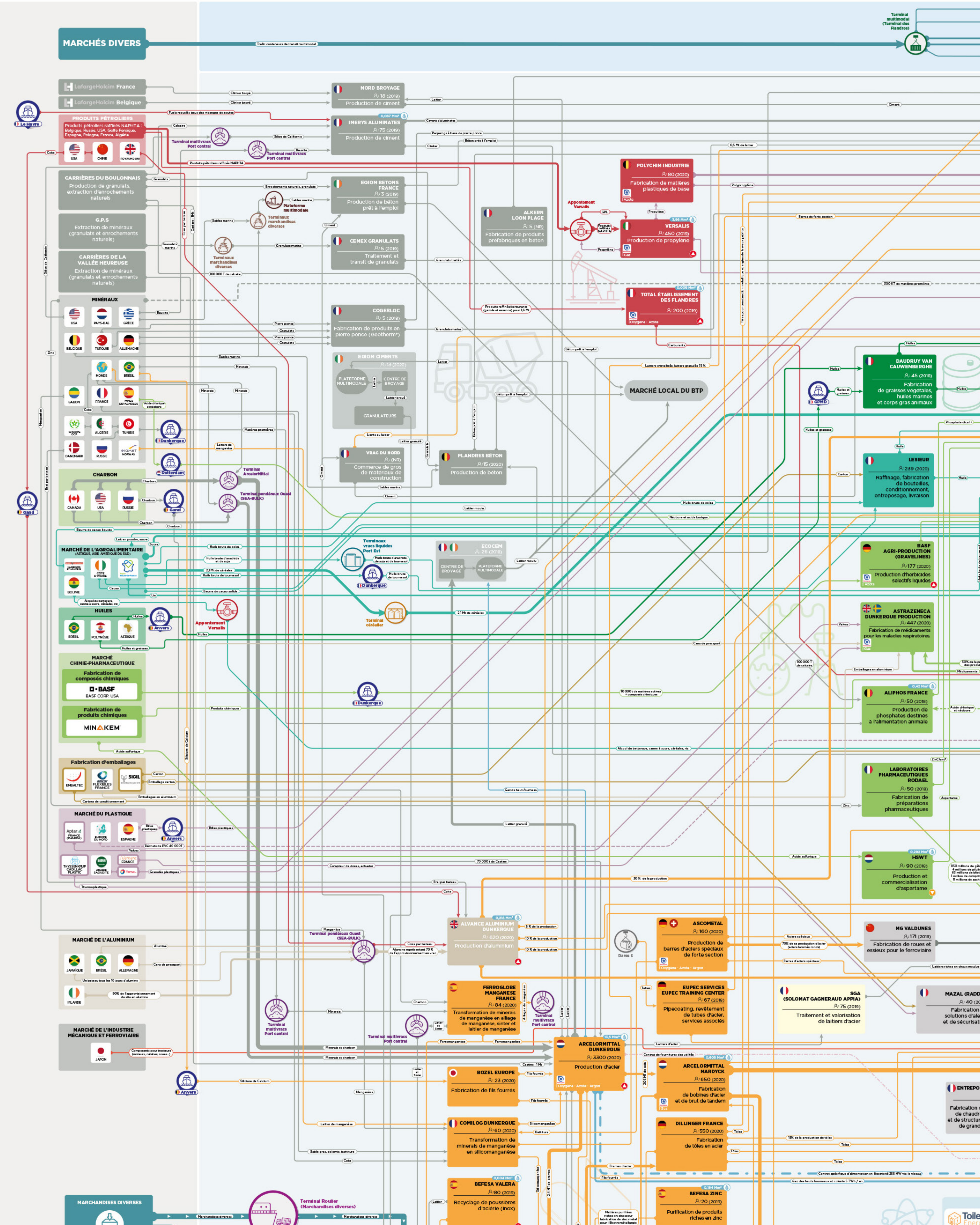
PART II Methodologies and Case Studies



MARCHÉS DIVERS
Trafic conteneurs de transit multimodal
Terminal multimodal (Terminal des Flandres)
LafargeHolcim France
LafargeHolcim Belgique
Clinker broyé
NORD BROYAGE
18 (2019)
Production de ciment
Le Havre
PRODUITS PÉTROLIERS
Produits pétroliers raffinés NAPHTA : Belgique, Russie, USA, Golfe Persique, Espagne, Pologne, France, Algérie
USA
CHINE
ROYAUME-UNI
Terminal multivracs Port central
IMERYS ALUMINATES
75 (2019)
Production de ciment
Produits pétroliers raffinés NAPHTA
CARRIÈRES DU BOULONNAIS
Production de granulats, extraction d'enrochements naturels
EQIOM BETONS FRANCE
3 (2019)
Production de béton prêt à l'emploi
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G.P.S
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5 (2019)
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80 (2020)
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Azote
ALKERN LOON PLAGE
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Appontement Versalis
VERSALIS
450 (2019)
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Gaz
TOTAL ÉTABLISSEMENT DES FLANDRES
200 (2019)
Oxygène - Azote
MINÉRAUX
USA
PAYS-BAS
GRÈCE
BELGIQUE
TURQUIE
ALLEMAGNE
MONDE
BRÉSIL
GABON
FRANCE
MINES ESPAGNOLES
GROUPE OCP
ALGÉRIE
TUNISIE
DANEMARK
RUSSIE
NORWAY
COGEBLOC
5 (2018)
Fabrication de produits en pierre ponce (Géotherm®)
EQIOM CIMENTS
13 (2020)
PLATEFORME MULTIMODALE
CENTRE DE BROYAGE
GRANULATEURS
MARCHÉ LOCAL DU BTP
DAUDRUY VAN CAUWENBERGHE
45 (2018)
Fabrication de graisses végétales, huiles marines et corps gras animaux
GPMD
Dunkerque
Rotterdam
VRAC DU NORD
(NR)
Commerce de gros de matériaux de construction
FLANDRES BÉTON
15 (2020)
Production de béton
LESIEUR
239 (2020)
Raffinage, fabrication de bouteilles, conditionnement, entreposage, livraison
CHARBON
CANADA
USA
RUSSIE
Gand
Terminal ArcelorMittal
Terminal pondéreux Ouest (SEA-BULK)
MARCHÉ DE L'AGROALIMENTAIRE (AFRIQUE, ASIE, AMÉRIQUE DU SUD)
CÔTE D'IVOIRE
BOLIVIE
Terminaux vracs liquides Port Est
ECOCEM
26 (2018)
CENTRE DE BROYAGE
PLATEFORME MULTIMODALE
BASF AGRI-PRODUCTION (GRAVELINES)
177 (2020)
Fabrication d'herbicides sélectifs liquides
HUILES
BRÉSIL
POLYNÉSIE
AFRIQUE
Anvers
Appontement Versalis
Terminal céréalier
2,3 Mt de céréales
ASTRAZENECA DUNKERQUE PRODUCTION
447 (2020)
Fabrication de médicaments pour les maladies respiratoires
MARCHÉ CHIMIE-PHARMACEUTIQUE
Fabrication de composés chimiques
BASF
BASF CORP. USA
Fabrication de produits chimiques
MINAKEM
ALIPHOS FRANCE
50 (2018)
Production de phosphates destinés à l'alimentation animale
Fabrication d'emballages
EMBALTEC
FLEXIBLES FRANCE
SIGIL
LABORATOIRES PHARMACEUTIQUES RODAEL
50 (2018)
Fabrication de préparations pharmaceutiques
MARCHÉ DU PLASTIQUE
Aptar
FRANCE (PHARMA)
EUROPE DU NORD
ESPAGNE
ARABIE SAOUDITE
TOTAL
HSWT
90 (2018)
Production et commercialisation d'aspartame
MARCHÉ DE L'ALUMINIUM
JAMAÏQUE
BRÉSIL
ALLEMAGNE
IRLANDE
ALVANCE ALUMINIUM DUNKERQUE
620 (2020)
Production d'aluminium
Terminal pondéreux Ouest (SEA-BULK)
ASCOMETAL
160 (2020)
Production de barres d'aciers spéciaux de forte section
Oxygène - Azote - Argon
MG VALDUNES
171 (2018)
Fabrication de roues et essieux pour le ferroviaire
FERROGLOBE MANGANESE FRANCE
84 (2020)
Transformation de minerais de manganèse en alliage de manganèse, sinter et laitier de manganèse
EUPEC SERVICES EUPEC TRAINING CENTER
67 (2018)
Pipecoating, revêtement de tubes d'acier, services associés
SGA (SOLOMAT GAGNERAUD APPIA)
75 (2019)
Traitement et valorisation de laitiers d'acier
MAZAL (RADD
Fabrication
MARCHÉ DE L'INDUSTRIE MÉCANIQUE ET FERROVIAIRE
JAPON
Terminal multivracs Port central
ARCELORMITTAL DUNKERQUE
3300 (2020)
Production d'acier
Oxygène - Azote - Argon
ARCELORMITTAL MARDYCK
650 (2020)
Fabrication de bobines d'acier et de brut de tandem
ENTREPO
BOZEL EUROPE
23 (2020)
Fabrication de fils fourrés
COMILOG DUNKERQUE
60 (2020)
Transformation de minerais de manganèse en silicomanganèse
DILLINGER FRANCE
550 (2020)
Fabrication de tôles en acier
MARCHANDISES DIVERSES
Terminal Roulier (Marchandises diverses)
BEFESA VALERA
80 (2019)
Recyclage de poussières d'aciérie (inox)
BEFESA ZINC
20 (2019)
Purification de produits riches en zinc

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The "(Water) Canvas" as a Tool For the Analysis, Interpretation and Planning of Water Territories and Heritage

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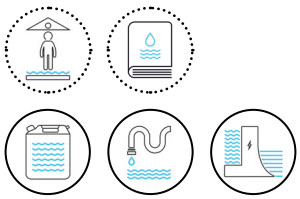
Today, urban territories are under pressure to accommodate all the needs of growing cities. New designs and approaches are needed that build on historical developments and respond to the shifting and overlapping needs of water, cities and their territories (Capoccia and Kelemen 2007). Due to these inexhaustible demands, it is often common to overlook sustainable development and heritage. However, diagrammatic analysis such as the canvas approach can help us understand how people have changed cities and institutions over time and allows us to consider complex economic, political, social and cultural interactions. This ecosystem approach opens a new path for territories and structures aimed at promoting dialogue between citizens and those who are key players in the sustainable development of cities. Together with mapping, the canvas helps build systemic and evolutionary resilience of water systems and resources, incorporating cultural and ecological values.

KEY THEMES



< *Fig.1 Fragment from The Industrial Canvas, a representation of the industrial ecosystem of the Flanders-Dunkirk region (Source: AGUR 2020).*

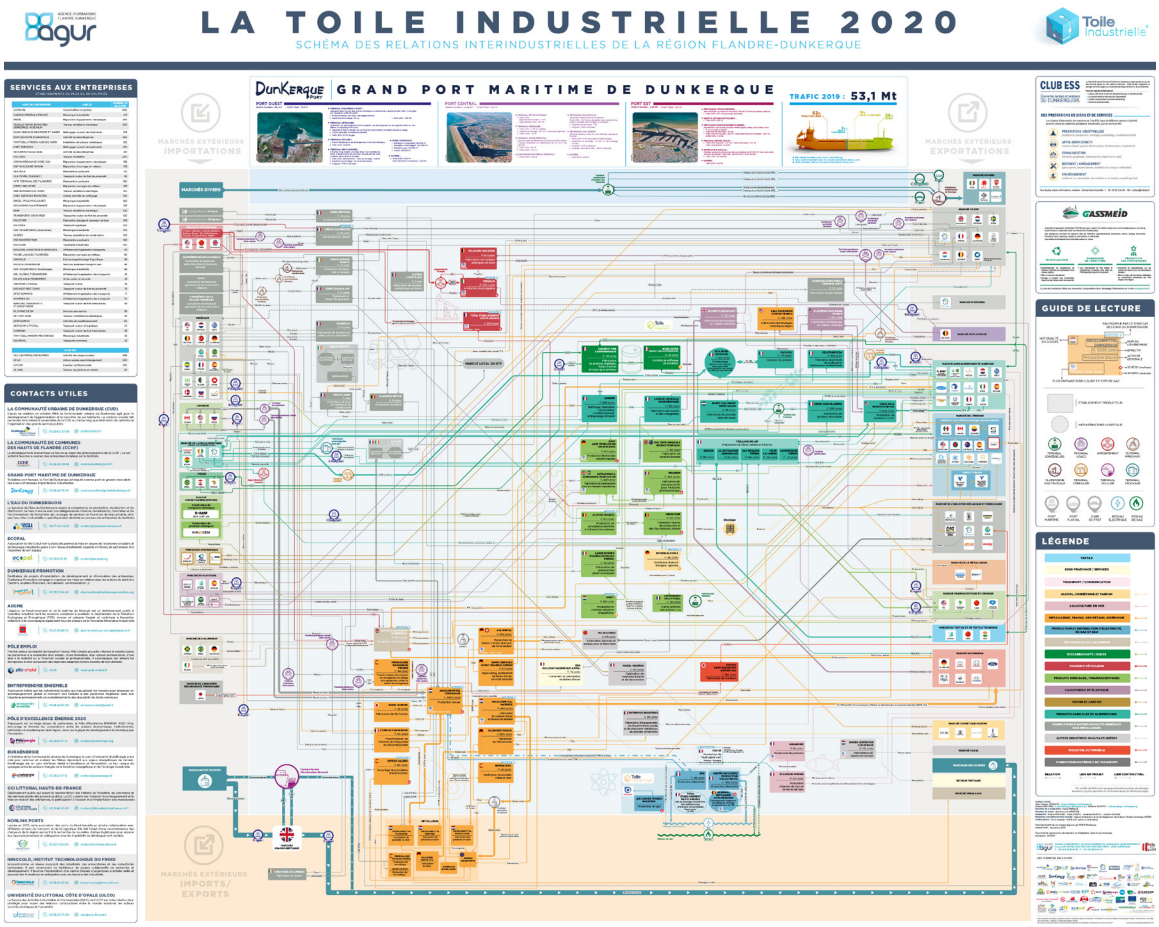
"Because water does not stop at borders."

Introduction

At a time of climate change and transition, it is important to understand geographical territories as places of natural and man-made ecosystems. We need to understand and plan these systems and develop strong, independent territorial actors, new tools and collaborative practices (Hein 2012). The concept of the canvas was spearheaded by the Urban Planning and Development Agency of the Flanders-Dunkirk Region (AGUR). Especially in AGUR's canvases of water, the canvas can be seen as a tool that can engage diverse territorial actors, including water managers, port authorities and heritage specialists, in responding to multiple, sometimes contradictory, challenges. In Dunkirk, for example, water managers need to provide water for agricultural and industrial uses while also removing millions of cubic meters of water per year from the countryside to lower the risk of flooding.

The Canvas and Water Canvases: Changing Cultures, Values and Heritage Thinking

To address the complexity of water systems in



^ *Fig. 2 The Industrial Canvas, a representation of the industrial ecosystem of the Flanders-Dunkirk region (Source: AGUR 2020).*

a multilayered landscape and to meaningfully connect the global flows that intersect in local space, AGUR inaugurated a new approach in 2001 by creating what is called in French *toiles*, which translates in English as "webs" or "canvases." The canvas is a system-centered representation of a given territory, highlighting the main flows and links between the components of the system according to a single theme. The canvas is a useful tool for serving the re-imagination and re-organization of complex spaces. The challenge of this method is to represent sufficiently clearly "what makes up the system," that is, the most structuring relationships. The approach is therefore carried out in an open system, making it possible to better understand the interrelationships between the territory and the systems linked to it. This method was made public in 2009 when the first Industrial Canvas® was introduced as a response to the systemic consequences of the subprime crisis (fig. 2) (La Voix du Nord 2016).

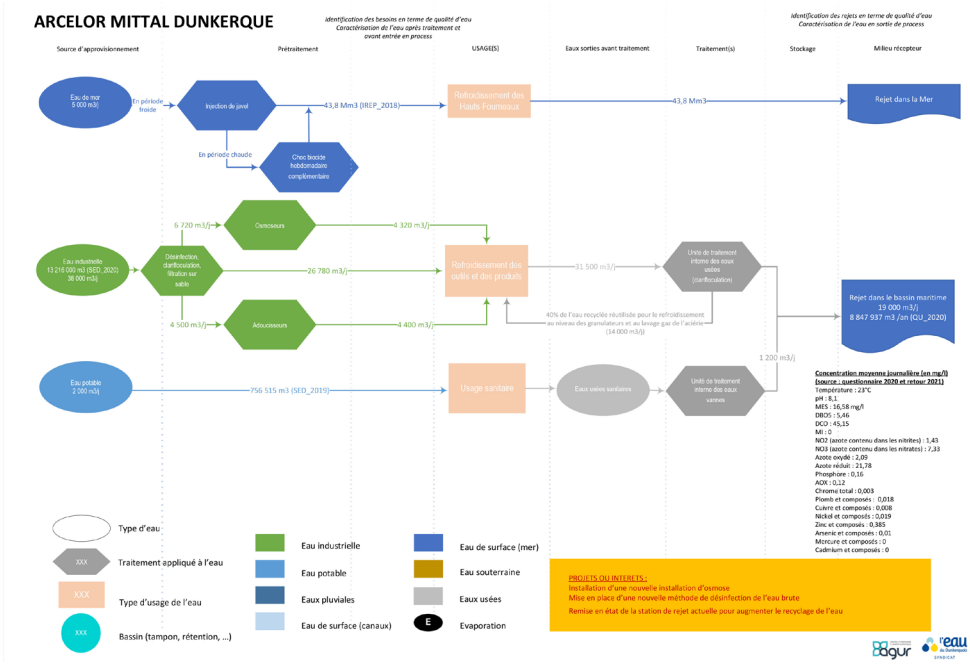
Understanding territory–systems relationships can also be approached on a smaller scale or with a lighter, more general touch, hence micro canvases. Micro canvases can help explore a single industry, a specific sector or a particular aspect of a water system (fig. 3) or help sketch the concept of the canvas for educational purposes and general understanding. Over time, the framework has evolved, and the decision support tool is no longer a representation of economic flows, but rather of the crossing of all the ecosystems studied in the territory. Concretely, this unprecedented approach to territorial intelligence has led AGUR to design a workspace, the macroscope dedicated to these exercises, equipped with mobile supports for the different ecosystems, in the same place and within the same time frame.

Indeed, the global visualization of a system on a single plan makes it possible to identify not only existing synergies but also the deficiencies, what we regularly refer to as the 'holes in the racket.' The illustrated links allow users to be introduced to a field of possibilities; they may even arouse an effect of mimicry in response to the question "they collaborate, why not me?" As for the missing links, they implicitly suggest the potential for improving the system, by identifying "win-win" strategies. The simple representation of a system generates a feedback loop aimed at its revision in response to an improvement objective (Vereecke 2020).

The canvas tool is thus particularly suited to the needs of complex systems, which Benjamin Rey defined as being composed of "critical infrastructures." Rey's approach is fundamentally similar to the canvas approach: it evokes the aggregation of interacting subsystems and components in the geographical space of a territory and their evolution over time (Rey et al. 2013). Based on his concept, Rey analyzes systemic resilience via scenarios. Although less quantitative, the canvas method follows the same process. It can, however, replace the approach from the engineering sciences with the expertise of the actors of the territory through a shared qualitative representation of the territorial ecosystem.

In the case of an actual or potential shock or disturbance, the canvas makes it possible to trace the sequences of chain impacts and to identify entities that would potentially be affected in the short or medium term. It is then possible to collectively define ways to break these chains of consequences, find alternative scenarios, or even anticipate consequences by implementing sometimes very innovative solutions.

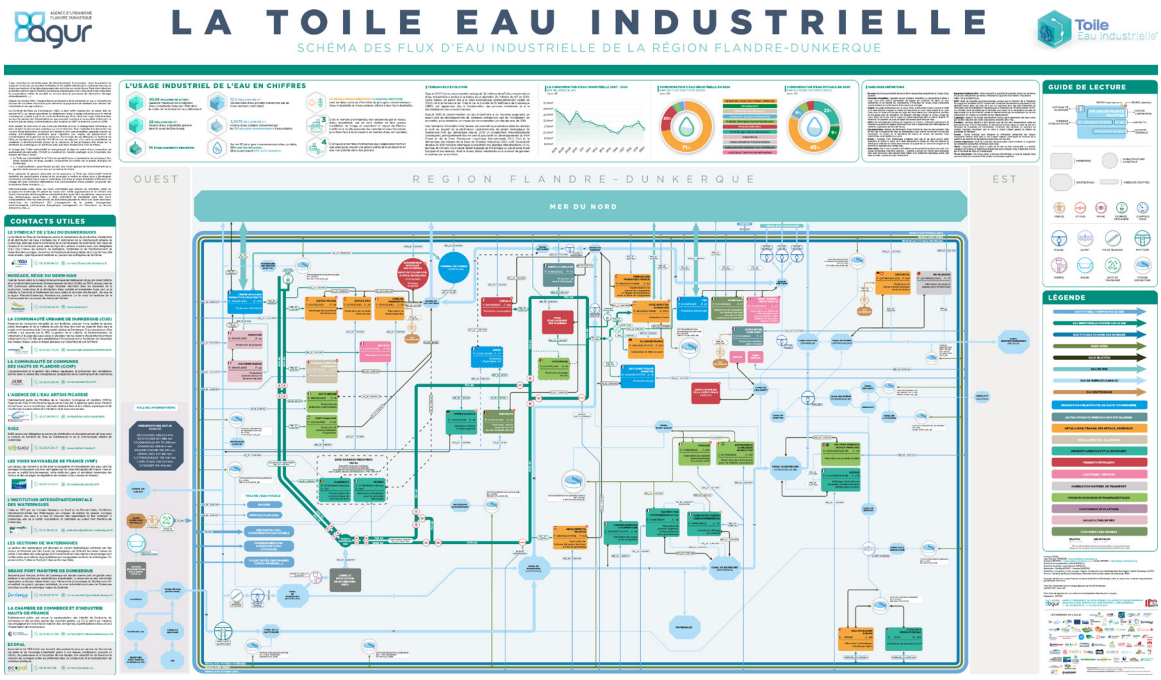
This is precisely what was implemented in Dunkirk in regard to water. In a context of in-



^ *Fig. 3 A micro canvas captures (economic) flows and relationships for targeted topics. Here, we can focus, for example, on a specific part to observe with more detail the use and allocation of water from within the process of an industry (Source: AGUR 2021).*

creasing scarcity and pressure on the local water resource, it has become essential for the Syndicat de l'Eau du Dunkerquois and the Agence de l'Eau Artois Picardie to continue the effort initiated several years ago to develop more sustainable methods of water resource management. In its road map, the syndicate has identified the construction of three water canvases (industrial water, potable water and the hydrosystem). The Industrial Water Canvas (fig. 4) has been used to encourage a circular economy by revealing synergy opportunities and the best possible exchanges between industrial sites. Circular water-saving solutions have been devised, using the thermal waste and wastewater of industrial establishments. Combined with other avenues identified at different levels of the industrial water canvas, these responses have paved the way for a global system for regenerating water resources according to a logic of symbiotic economy.

The ecosystem approach of the water canvas offers an extremely promising perspective for the management of water networks and resources within all types of territories. It also presents a more complete approach to territorial ecosystems by creating a collaborative workspace, thus it is useful for strengthening partnerships (Sorensen and Robinson 2011). Stakeholders who contributed to the construction of this innovative tool can use it for predicting prospects.The other objective of this in(ter) vention is to provide new tools for mediation and citizen participation in reflections on the development of territories and the elements composing them. It is necessary to provide very didactic elements of understanding, allowing people to understand the local impact of global decisions and vice versa.



^ *Fig. 4 The (Industrial) Water Canvas connects flows and spaces to better understand the hydrological interrelationships within territorial regions. (Source: AGUR 2021).*

Conclusion

AGUR's ambition is to create an Interpretation Center of the Territory in Transitions (CITT) which would provide the public with the best adapted support to understand the Flanders-Dunkirk territory, its major transitions and its ecosystems. Visitors would not only be led to discover its realities and challenges, but also to get involved as actors of change and authors of proposals. The CITT will also be available as an "off-site" solution, a "mobile agency," which will be able to get as close as possible to users.

In order to facilitate easy reading of the canvases and to enhance interaction with the public, a partnership has been set up with the Territories, Cities, Environment & Society Laboratory (TVES), an accredited research unit under the supervision of the University of Lille, to integrate the canvases into interactive 3D models, completing the systemic approach with a spatialized vision of the territory.

Acknowledgment

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Jean-François Vereecke is doctor of economics, urban planner and visual artist and deputy director of the Urban Planning and Development Agency of the Flanders-Dunkirk Region (Agur). He is also the director of Observation and Foresight. In this context, he has piloted and co-edited numerous multidisciplinary publications on the development of the Flanders-Dunkirk region. During the 2000s, he created the Industrial Canvas® and designed an operational solution using systems for decision support in various fields of local development. He thus works directly with industrialists, elected officials, technicians, teachers, researchers, etc. to build bridges between all these worlds and benefit from the effects of symbiosis. In addition, as an artist and administrator of the Hauts-de-France Regional Contemporary Art Fund, he mobilizes these experiences in a sensitive way to offer an artistic translation and exhibit them in galleries and fairs in different countries.

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Sandrine Deveycx is research officer at the Urban Planning and Development Agency of the Flanders-Dunkirk Region (AGUR), under the supervision of Jean-François Vereecke. More specifically, she brings all her expertise to the design of the canvases in order to represent and allow a clear reading of the local socio-economic ecosystem of the Flanders-Dunkirk territory. She also works on the deployment of these innovative tools on various themes (energy, water, agriculture, waste, etc.) and on the promotion of this method to students, policy makers, technicians and future investors. Coming from a geography background, she daily strives to articulate different scales and always works on both spatial and systemic approaches.

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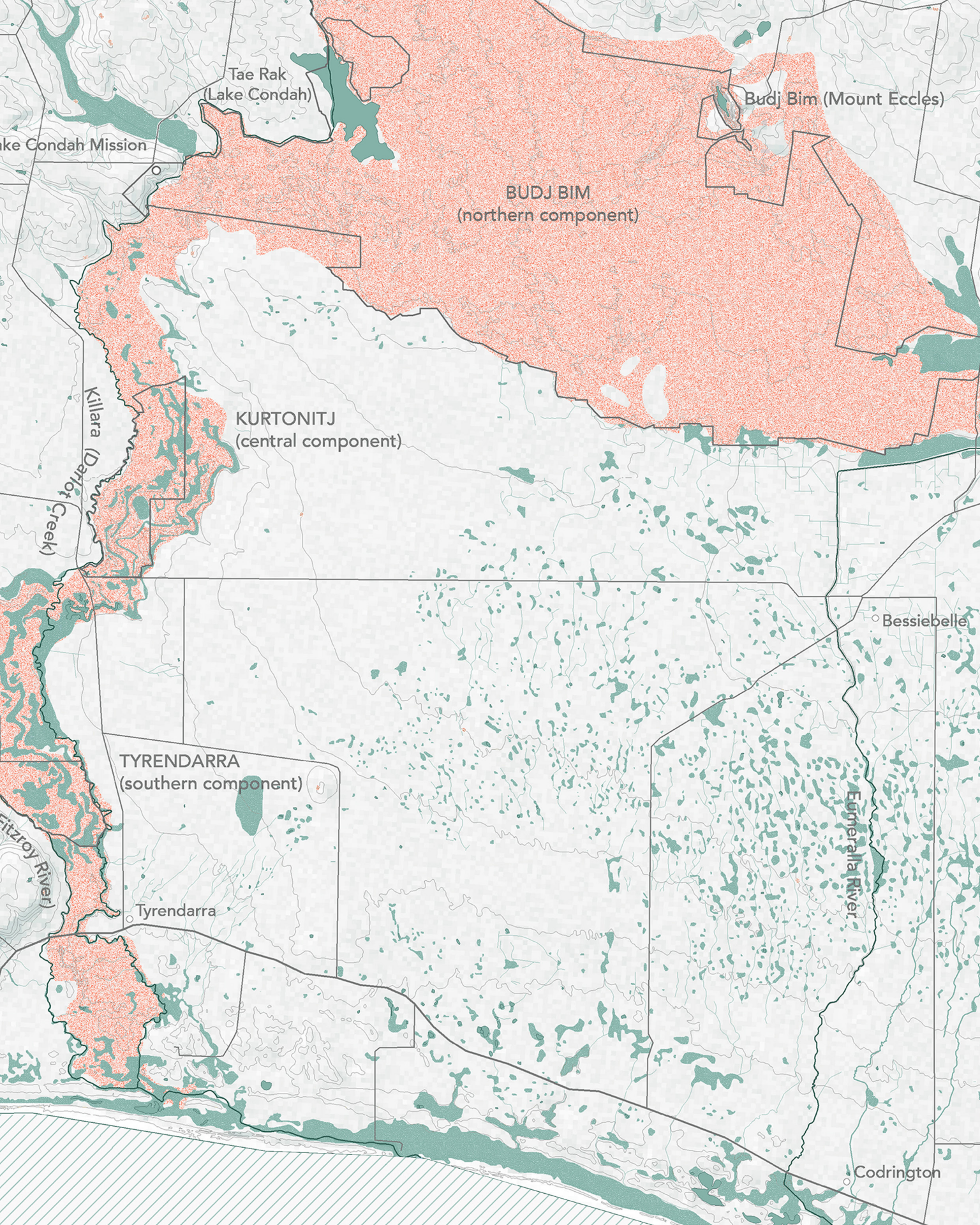
Tae Rak
(Lake Condah)
ake Condah Mission
Budj Bim (Mount Eccles)
BUDJ BIM
(northern component)
KURTONITJ
(central component)
Killara (Darlot Creek)
Bessiebelle
TYRENDARRA
(southern component)
Fitzroy River)
Tyrendarra
Eumeralla River
Codrington

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Visualizing Water: Using the Illustrative Method to Learn from Long-Lasting Water Systems

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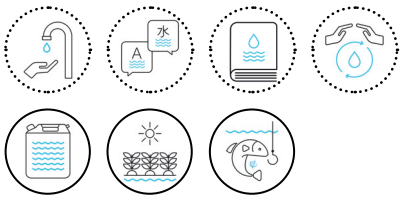
Camilla Di Nicola
De Urbanisten

To analyze traditional water systems and their development over time, researchers I. Bobbink and M. Ryu developed the so-called Illustrative Method in 2017 based on former water systems studies (Bobbink and Loen 2010; Ryu 2012). The method visualizes connections between spatial, social and cultural aspects of water systems in a standardized way. It provides insight into unique local patterns, forms the foundation for comparative analysis and can ultimately inform the creation of new water systems for future sustainable development.

KEY THEMES



< *Fig.1 Fragment from Catchment area (Source: M. José Zúñiga).*

Introduction

The Illustrative Method is a tool to analyze Traditional Water Systems (TWS) (Bobbink 2019). The term "traditional" emphasizes the focus on water systems that functioned for hundreds of years.

The method has been designed as an educational tool for landscape architecture graduates at TU Delft. It has been used since 2018 to visualize the site specificity of human-made water systems, in students' final year projects and in projects conducted by students who are already practicing. Five generations of graduates have developed Circular Water Stories (CWS) in laboratories (2018/2019 – 2022/2023) and have used their knowledge to tackle today's spatial challenges.

The Illustrative Method focuses on spatial and visual aspects of water systems. It represents these in a standardized form to allow viewers to better understand the geomorphological and sociocultural context of water systems. The visualization must follow the representation guidelines while leaving considerable freedom to personal graphic expression. Students are given a limited color palette: black, grays of different opacities, white, light blue, green for the water, and orange for highlighting relevant parts of the drawing.

The Illustrative Method requires students to focus on elements worth displaying and it simplifies information. Students learn to interpret and decode water systems in the context of their unique physical geography and the natural elements of the surrounding environment. By reading the anthropic formations, architectonic settlements, and landscape interventions, students can grasp the essential aspects of these systems and integrate the practices of traditional water systems within well-performing new designs. The analytical drawings also focus on specific social aspects of water systems, including a comprehensive assessment of water heritage. A comparative evaluation of the analyzed water systems will follow in the coming years.

To display the complexity of a TWS, multiple types of visuals are combined – pictures, maps, diagrams, and architectural drawings (plans, sections and 3D). Sometimes, various maps are needed to show transformations through time or to find connections between water systems, soil information and height differences. Ideally, the main illustration per case is a map on the scale of the whole water system (e.g. catchment area, including the waterworks built structures like sluices, weirs and pumping stations), revealing the system's complexity. Students have used pictures at different scales to show the relation to the surrounding landscape, the water, waterworks, and other elements such as plants, buildings, and people. "Drawings may be done by hand or computer. The images are organized from large to small scale: from territorial landscapes through water systems to waterworks, from general overviews to specific details. Finally, after consulting the whole set of images and drawings, the reader should be able to grasp the water system, its waterworks, and the system's specifics regarding usage and landscape.

The Illustrative Method consists of ten components as represented below – context, climate diagram (fig. 2), climate zones and a world map (fig. 3, 4), catchment area (fig. 5), transformation over time (fig. 6), human interaction (fig. 7), the functionality of the water system (fig. 8), circularity including water elements, waterworks, and water stories (fig. 9.1, 9.2), detailing (fig. 10) – and a conclusion describing values and lessons. Each component is illustrated by one

or more illustrations to demonstrate the drawing technique and to show the freedom in the handwriting. The method provides insight into many kinds of cases and possibilities for representing them. More illustrations can be found on the Circular Water Stories site (*https://circularwaterstories.org*).

Context

An overview image, preferably a bird's eye view photo of the water system, provides a visual introduction to the water landscape. This image is followed by geographical maps that locate the water system on a continental, national, and regional scale, integrated with a concise text description (year or period of development, primary function[s], surface, principal components, waterworks, status, etc.).

Climate

Climate is an essential precondition for water systems. A diagram introduces the climate zone of the water system, combined with precipitation distribution over the course of a year and additional relevant information (highest, mean, and lowest temperatures; annual millimeters of precipitation; humidity; average wind speed; pressure; hottest, coldest, wettest and windiest months; yearly rainfall). To determine climate zones, the Köppen-Geiger classification is used. Since many of these systems originated from ancient times, students have not always been able to collect the corresponding climate information. In many cases, this research has brought to light the fact that climatic conditions were once different than they are today. As we are aware, today, the climate is changing even more rapidly due to human actions and will increasingly play a decisive role in the design of water systems.

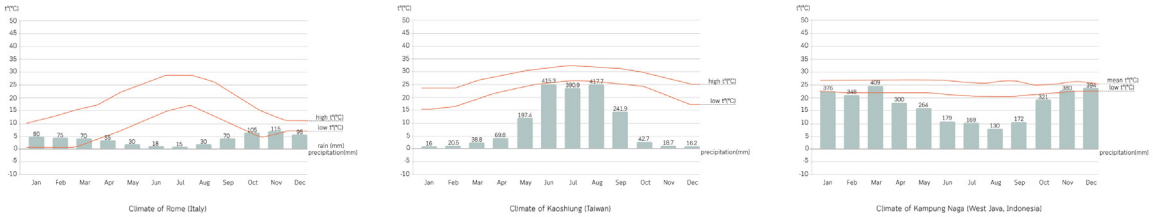
Catchment Area

Water systems change as significant conditions change, such as those in their catchment area. Defining the catchment area of a water system is a complex task. The outcome is often a map of the water system (plan) on a regional scale, from inlet to outlet (lake, river or ocean), with waterworks, a topographical map, and aspects of geomorphology, if relevant. Information about disappeared elements can also be represented.

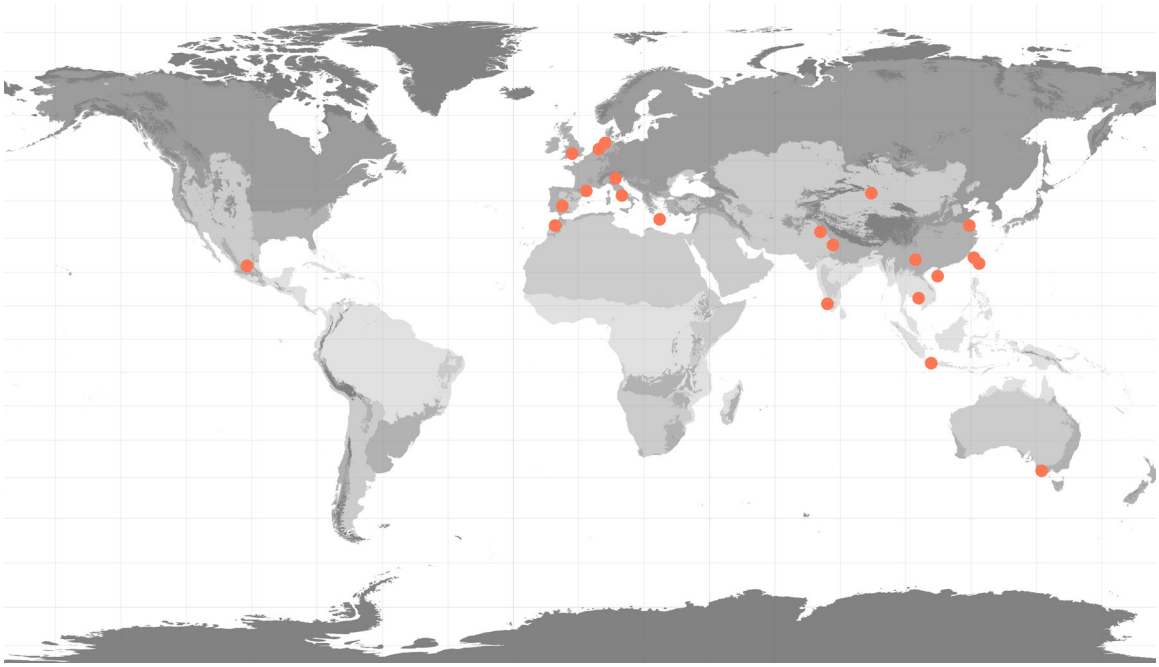
Transformation over Time

The development of a water system over time is synthetically drawn in a sequence of diagrams

^ *Fig. 2 Context. Continental, national and regional scale, fishing valleys, Italy (Source: A. Chouairi).*



^ *Fig. 3 Climate. Average precipitation and highest and lowest temperatures of three cases (Sources [from left to right]: Rome, Italy – C. Di Nicola; Kaohsiung, Taiwan – M. Lin; Kampung Naga, Indonesia – A. Prestasia and B. Kim; Images processed by: A. Chouairi).*



^ *Fig. 4 Climate. Köppen-Geiger climate classification maps at 1 km resolution. The orange dots indicate the 22 locations of TWS analyzed in the CWS laboratories (2018–2021). From light to dark grey: tropical, dry, temperate, continental and polar (Source: M. Pouderoijen).*

^ *Fig. 5 Catchment area. The watershed defines the borders of the water system (Sources [from left to right]: fishing valleys in the Venetian Lagoon, Italy – A. Chouairi; The delta, Xinghua Duotian agrosystem, China – P. Surajaras; A seasonal river, Aboriginal eel aquaculture, Australia – M. José Zúñiga; Images processed by: A. Chouairi).*

based on historical maps and charts. The diagrams represent an extended period and the water system's different functions and seasonal usages. Historical illustrations help reveal the strong connection between the water system and the evolution or decline of a civilization. The period worth studying is selected from a range of historical moments. Since many of these systems are declining, today's situation is not always the most interesting one to explore. Therefore, the students can choose a period and proceed with the analysis.

Human Interactions

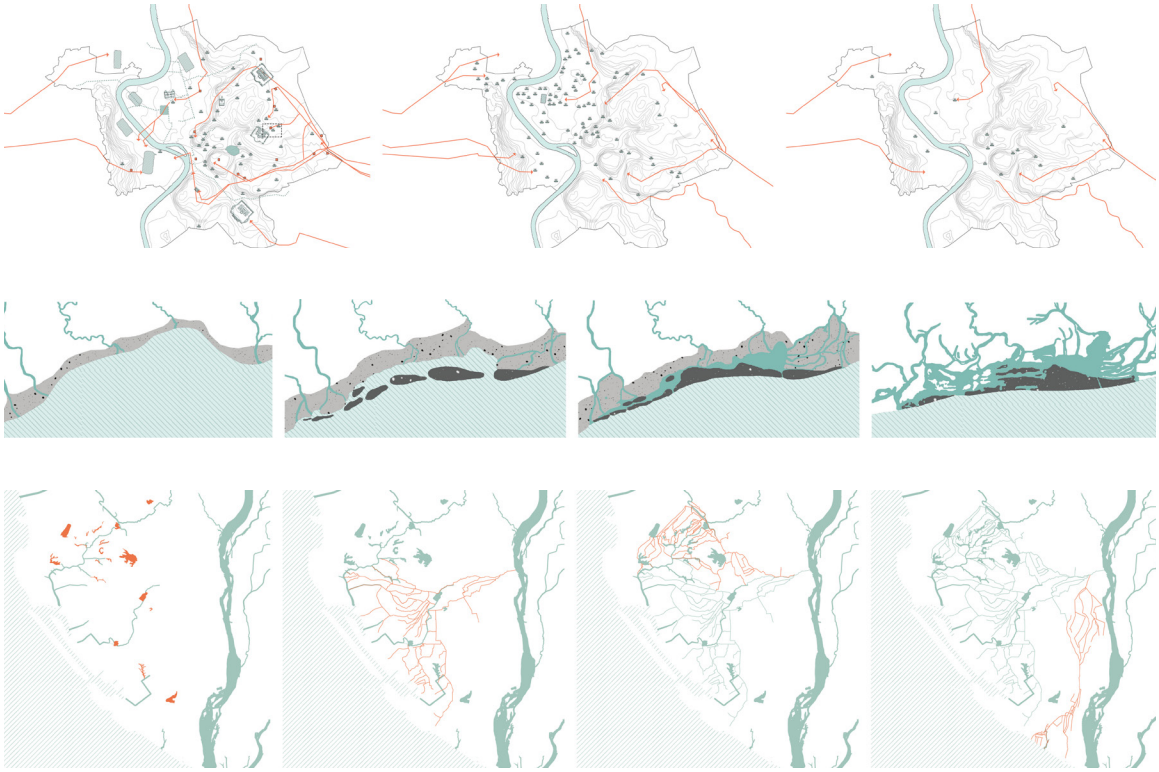
To capture human engagement with water systems, students include pictures or paintings as a base on which the interaction between humans, the landscape, the water system, and, if possible, flora and fauna are highlighted. Water and people are marked in blue-green and orange; depending on the use of the color; the essence of their relationship is indicated. The pictures may represent workers and visitors, water landscape elements, waterworks, working tools, site-specific housing, transportation, and so on. The images are collected consulting historical sources, often studies conducted by anthropologists or historians. Recent photographs are employed to show, where possible, the structure of the remaining elements and their relationship with the modern context.

The Functionality of the Water System

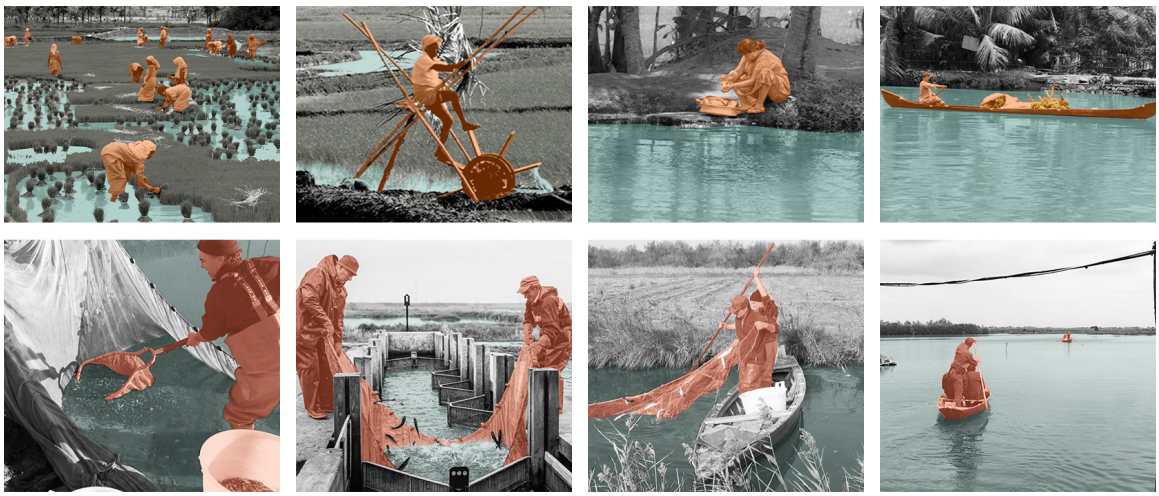
The functionality of the water systems is portrayed through maps representing the management of water (plan), using the height map on a local level as the base map. The plan presents the water system's extension, type of water (salt, brackish or fresh), water landscape elements, flooded areas, underground water, dry soil and marshes, fields and crops growing on land or water, relevant vegetation, buildings, waterworks and other features. The drawing, representing functional landscape elements, determines the available and spatial dimensions of the system. In making the drawing, students figure out how the water system works; arrows show its flow direction.

Circularity

The circularity of the water system is shown through an axonometric section. This is considered one of the essential drawings since it explains the interaction between water flows, system functioning, activities, human action and ecology related to seasonality. The diagram represents significant aspects such as sustainability or the spiritual or symbolic importance of the water system. Scaleless drawings connect the regional and local scales and incorporate relevant elements from the research. The students use water landscape elements, waterworks, and water stories to create the drawing. Water landscape elements indicate those components of a large-scale water system made with materials like soil or stones, etc., reshaping the water flow. These are systems that have been created by people using mainly natural materials that differ according to the territory. Waterworks are built structures, like sluices, weirs and pumping stations, involving a certain amount of craftsmanship: they are created by people using mainly artificial materials. Most of these innovations developed simultaneously in different places, and many were installed on different continents as knowledge spread. Water stories illustrate actions (spiritual, cultivation or other) of people or animals related to the water. A person or animal in action is added to the drawing to highlight the relationship between the element and culture (Bobbink and Loen 2020).



^ *Fig. 6 Transformation over time (Sources [from top to bottom]: Roman aqueducts and their decline [from 312 B.C. to 226 A.D., 5th to 15th century and 16th to 17th century], Italy – C. Di Nicola; Kuttanad Kayalnilam agrosystem evolved because of sedimentation and fixation of the coastal area [Pre-Holocene, Middle-Holocene, Late-Holocene and early nineteenth century], India – N. Ali; Ksôkong Tsùn irrigation system [before 1837, 1837–1838, 1842 and 193], Taiwan – M. Lin; Images processed by A. Chouairi).*



^ *Fig. 7 Human interactions. First row – Kuttanad Kayalnilam agrosystem, India: planting rice, ploughing, washing and sailing (Source: N. Ali). Second row – Fishing valleys, Italy: sowing juvenile larvae in the valley, standing on the lavorièro (fish trap) with nets, capturing fish, inspecting the valley lakes (Source: A. Chouairi).*

^ *Fig. 8 Water systems. From left to right – Aboriginal aquaculture, Australia: system plan of the Muldoons Trap Complex, where the Indigenous population, taking advantage of the natural elements and the composition of the land, built canals and dikes, regulating the course of the river. They were thus able to fish for eels, according to the seasons (Source: M. José Zúñiga). Xinghua Duotian agrosystem, China: the polder landscape system was developed to cultivate crops; dike and roads form the border of the polder in which the water system is controlled by water gates (Source: P. Surajaras).*

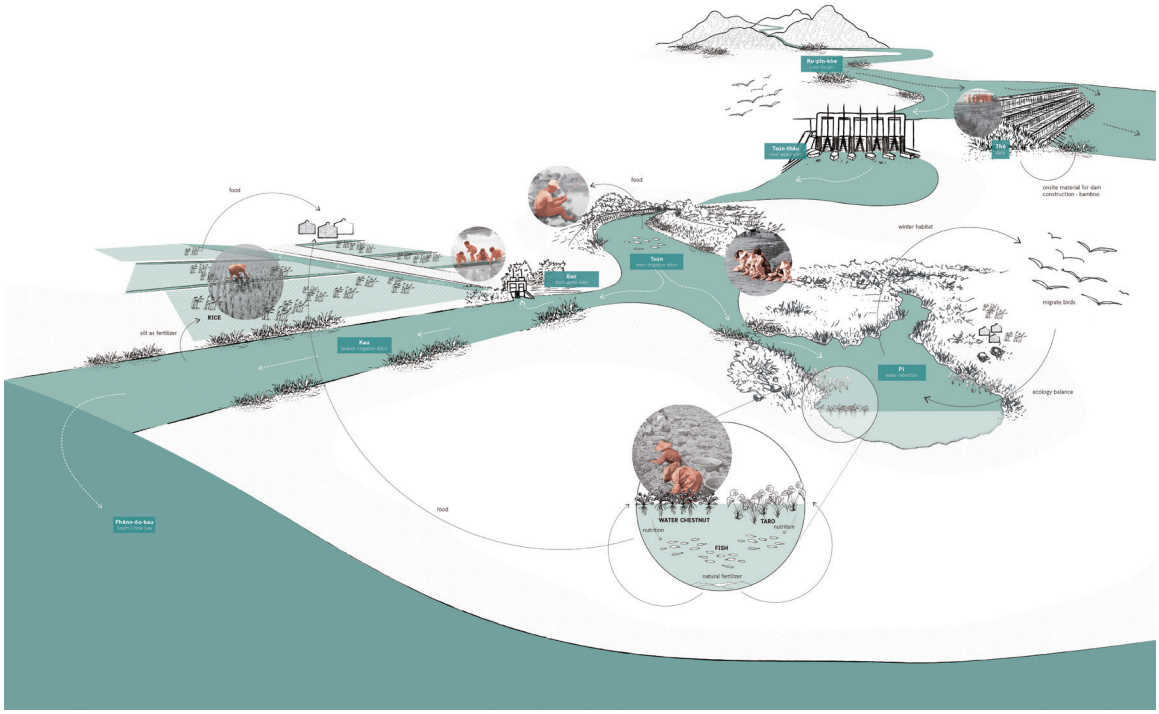
Details

Technical drawings (schemes and diagrams) and pictures of waterworks complement the other visuals. They show the spatial composition of the water flow and provide more insight into the process in which a water system is made (design). Drawing details reveal the craftsmanship and the materials used in construction, which often come from the site or region where the water system is located, providing another layer of local integration.

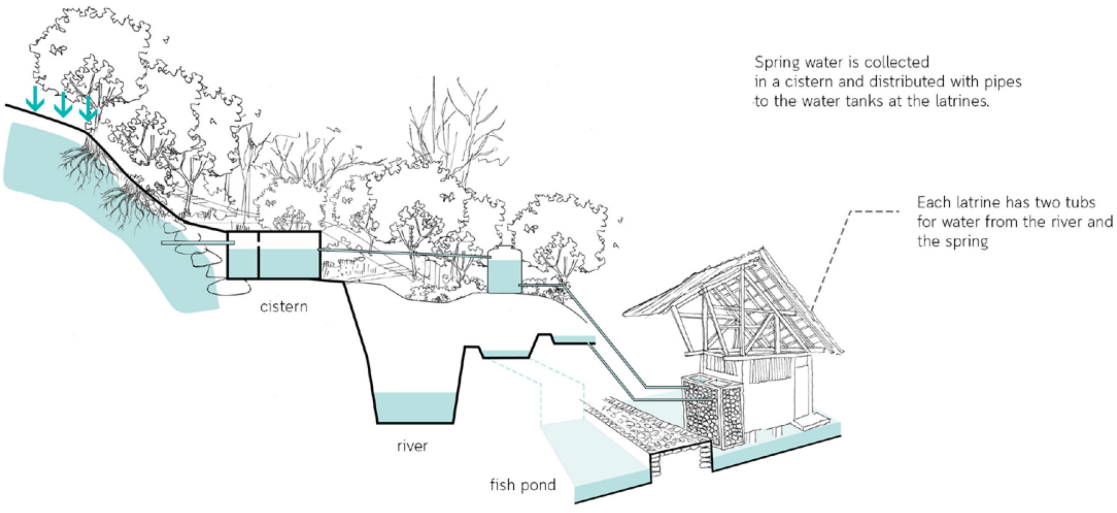
Values and Lessons to Learn

To understand TWS, values that conclude the analysis are named. By drawing and describing, students determine strategic, functional, material, tangible and ethnographic values, and values relating to landscape, identity and sustainability. These values are defined explicitly for traditional water systems based on the dissertation "The Architecture of a Productive Territory: The Water Mills of the Sierra de Cádiz" (G. Rivero-Lamela 2020).

By identifying such values, we gain insight and awareness of water heritage, its connection to the specific site, and similarities we can identify similarities between sites. Here, the interest lies not only in the objects per se but also in the tradition, the coexistence of tangible and intangible heritage. Consequently, the primary purpose of the "lessons to learn" is to inform contemporary landscape design proposals, whether for a heritage site or simply by assimilating the ingenuity of the water system.



^ *Fig. 9 Circularity. Ksôkong Tsùn irrigation system, Taiwan: A dam in the Ko-pin-khe river redirects water with the help of irrigation ditches and inlets to the plain to make farming possible. In addition to the rice fields, water plants, such as taros and water chestnuts, are part of the circular production systems. The Ksôkong irrigation system accommodated a variety of human activities (Source: M.C. Lin).*



^ *Fig. 10 Details. Schematic drawing of the collection and distribution of spring waters, Kampung Naga, Indonesia (Source: A. T. Prestasia and B. Kim).*

A large body of research has been accumulating since 2018, making it possible to dive deeper into knowledge of climate-, site-specific and adaptable water management related to beautiful cultural landscapes. So far, by developing the Illustrative Method and expanding it with knowledge gained from the landscape biography, this work has supported a rediscovery of human belonging to the landscape. What is achieved through the application of the Illustrative Method for TWS is a site-social analysis with room for further development. In the future, interviews and site surveys will contribute to the method's accuracy and complexity. Ideally, soil conditions, flora and fauna determination, and reflections on water quality should become an integral part of Traditional Water System research. Because of the Illustrative Method, the analyzed water systems are comparable. At this stage, there are enough analyzed projects for comparison to begin, which will make it possible to be more explicit about lessons for the future.

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Two Towns in Indonesia, One on the Coast, the Other "A City of One Thousand Rivers"

Historic Urban Landscape (HUL) Quick Scan Method Workshops and Publication of Handbook for Indonesian University Lecturers

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The Historic Urban Landscape (HUL) Quick Scan Method is a methodology that can be used in workshops to foster multi-stakeholder collaboration and a holistic understanding of a context and its challenges. The HUL Quick Scan Method was conducted in three phases in Muntok and Banjarmasin, Indonesia, and demonstrated its efficacy in promoting heritage and socio-cultural practices as catalysts for sustainable development. The features of the workshops run in the two cities stimulated discussion among the local communities and including private and public sectors, establishing a basis for applying the UNESCO Historic Urban Landscape approach.

KEY THEMES

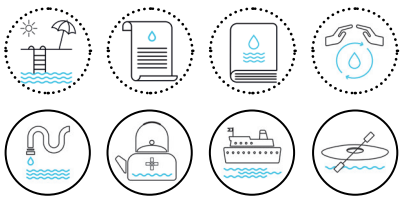


Fig. 1 Riverine settlement along the Kuin River Banjarmasin. In the river city of Banjarmasin people to some extend still rely on the river today (Source: Peter Timmer).

Introduction

Cities in Indonesia grow and develop in part based on their natural potential. The history of the city can be presented as a narrative of how the city creates and maintains relationships between humans and nature. But local knowledge and wisdom, nurtured over the years, is often forgotten. An important natural feature of the city is water, which appears in various forms, such as the sea, rivers and lakes. In general, each city must have a water element and it constitutes a distinctive marker. The shape and design of water-based cities like those in Indonesia are often seen as monuments that must be protected, but the designation as heritage often means that the logic of the relationship between cities and nature is broken. An example is the historic canals, developed for shipping and swamp drainage, that are designated as cultural heritage and no longer function the way they were intended.

Efforts to manage water are driven by the frequency of hydrological disasters, such as floods. Awareness of sustainable urban development practices has encouraged a responsive approach to water governance. This article describes an attempt to identify and influence nature-based responsive urban design, including that involving water, by applying the HUL Quick Scan Method. Workshops held in the cities of Muntok and Banjarmasin revealed water to be central to each city's identity, indicating that heritage conservation and water management are complementary and can be implemented together.

HUL Quick Scan Method

The Recommendation on the HUL was adopted by UNESCO's General Conference in 2011. It promotes a holistic approach that "focuses on the entire human environment with all of its tangible and intangible qualities. It seeks to increase the sustainability of planning and design interventions by taking into account the existing built environment, intangible heritage, and cultural diversity, socio-economic and environmental factors along with local community values" (UNESCO 2013). The HUL Recommendation is in line with UN's Sustainable Development Goals (SDGs) and its approach can be an impetus to achieving the latter.

In 2018, a quick scan method was developed by Indonesian and Dutch parties to implement the HUL Recommendation as a tool to study and develop ideas regarding the conservation of historic cities in Indonesia. It is called the HUL Quick Scan Method. The HUL Quick Scan Method is applicable through workshops that should involve all stakeholders in a conservation effort (government institutions, non-government organizations, universities, private sector, and community groups). The method considers all integrated elements of conservation, including built environment, intangible heritage and cultural diversity, as well as socio-economic and environmental factors and local community values. The HUL Quick Scan Method emphasizes:

1. Exploration — understanding the place, challenges and opportunities, and the wishes and needs of the local community.
2. Translation — creating a vision in which heritage is a starting point and asset for sustainable development.
3. Inspiration — presenting ideas in an attractive way, and creating awareness, local enthusiasm and commitment.

The HUL Quick Scan Method is generating ideas regarding the conservation and sustainable

development of historic urban areas, and it inspires people to become engaged with it. The method does not replace UNESCO's HUL approach. The HUL Quick Scan Method aims to create proposals for an attractive "horizon" for historic urban sites, and by doing so, it can pave the way for implementing the HUL approach. It is a workshop model and practical tool based on HUL recommendations (tangible and intangible) and the idea that cities change and will always change as living landscapes.

The coastal town of Muntok, also known as Mentok, and the river city of Banjarmasin feature an urban landscape that is closely intertwined with water. Both cities face many challenges when it comes to environmental and socio-economic issues, and they are seeking ways to integrate water and heritage management and sustainable development. Proposals were developed by applying the HUL Quick Scan Method. This article provides an overview of the method, the outcomes for each city and the recently developed Handbook HUL Quick Scan, for which both cities served as an experimental garden.

In 2018, an HUL Quick Scan Method workshop was organized in Muntok, and Banjarmasin was the topic of a second workshop involving the method in 2019.

The Old Tin Mining City of Muntok

Exploration
Muntok is the capital city of the West Bangka Regency, which is part of the Bangka Belitung Province. The area of sub-district Muntok is approximately 505.94 km^2, with 53,306 inhabitants in 2021. It consists of tropical sandy beaches, tropical forests, the 400-meter-high Menumbing Hill, tin mining pits and smelter facilities, white pepper plantations, palm oil plantations, multicultural traditions, a built environment and a rich cultural heritage. Water is an important feature of Muntok because the city is located on the west coast of Bangka Island and is traversed by several rivers (Kurniawan et al. 2020).

Since the city's tin mining activities have slowed down, the condition of the town and the livelihood of the inhabitants are not what they used to be (Dipowijoyo et al. 2019). How can Muntok face its challenges and find a way to improve the overall environment and bring "new life" to the town? Is it possible to use heritage as an asset for future development?

Translation
Including everything learned in the workshop, the final proposal for the town of Muntok embraces heritage as a catalyst of development. As such, it is necessary to develop a "new map of Muntok" that can be used to start discussions with owners and the local community. The main objective of this initiative is to find new functions for historical buildings through public-private cooperation or partnerships. The new functions should be in line with or closely connected to existing vital economic functions or preferably narratives of the specific district involved, for example harbor-related use in the harbor area.

Inspiration
Conservation and development of Muntok's urban character can be achieved by integrating tangible and related intangible heritage and cultural features in urban planning regulations. For example, design principles could be established for new developments that follow these distinctive features and urban and landscape planning could focus on restoration and enhancing historical character. Among the proposed ideas,

some are concerned with water:

1. Developing the seafront – An integrated approach to achieve a more developed seafront will make the seafront an asset to the city again and help the town cope with climate change. This means reviving historical-functional relations, kampong (urban village) improvement, adding recreation facilities and creating an attractive and sustainable living environment.
2. Giving the river back to the city – To do so, stakeholders and members of the local community need to work on an integrated plan that includes water management, a clean water program, functional use along the river and landscaping of public and private spaces, and that reduces concrete and adds suitable vegetation to reduce the urban heat islands effect.

The River City of Banjarmasin

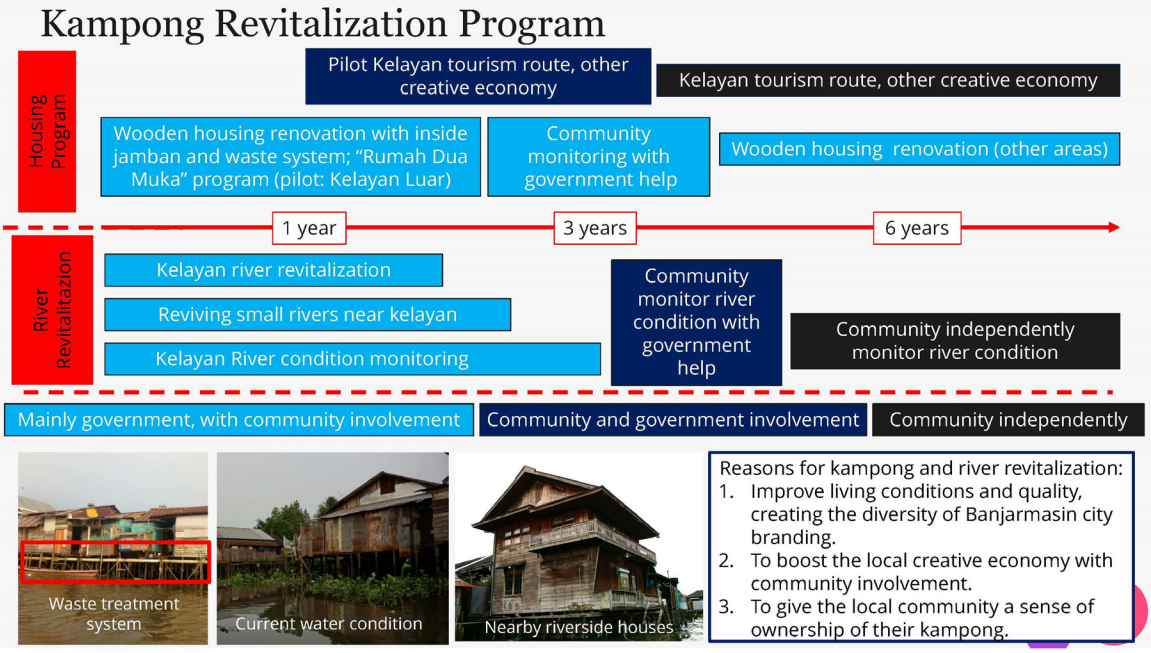
Banjarmasin was established in 1526 and is located in South Kalimantan Province. The area of the city is 98 km^2 with 662,320 inhabitants in 2021. The landscape character of Banjarmasin is influenced by the fluvial environment and swampy terrain (Damayanti 2019). Rivers and canals of all sizes crisscross the city; thus, Banjarmasin is known as "a city of thousand rivers." This port city is a significant economic center of the South Kalimantan region. In the old days, Banjarmasin's population was highly dependent on the river that led to the growth of settlements along the rivers and canals (fig. 1).

The workshop focused on four riverside kampongs which have been designated as urban heritage sites by the municipality: Seberang Masjid, Muara Kampung Kelayan, Sungai Jingah and Pasar Lama-Kampung Arab (Damayanti et al. 2020). The workshop pivoted on two questions:

1. River-based urban development. How could the city's river-related cultural heritage and identity be a source of inspiration for integrated urban development in Banjarmasin?
2. Riverside urban revitalization. How could the city deal with the challenges for these areas, and how could they become assets for the future development of Banjarmasin?

The future development proposals produced by the participants in general were concerned with the preservation of the kampongs as heritage and tackled the environmental issues related to the river as follows:

1. Kampong of Seberang Masjid – the intangible heritage of *sasirangan* (traditional cloth) and traditional culinary culture became the source of inspiration in the design which focused on the development of existing tourism activities and community empowerment. The environmental issue of river pollution was resolved by using an aqua biofilter – a floating vegetated wetland/island system that removes pollutants in water- to manage the sasirangan's industrial waste, and the domestic waste management system.
2. Muara Kampung Kelayan — the participants proposed riverside kampong revitalization as their strategy by integrating the reinforcement of Kampong Kelayan's identity related to traditional ways of building and living, the local history of the riverside rice market and preserving the river transport system,



^ *Fig. 2 The revitalization and future development plan for the Kelayan riverside kampong puts the river at the center of the program (Source: Imara, Indriyani, Karina, Luthfiana, Maulana and Saraswati in Damayanti et al. 2019).*

in addition to developing river cruises for tourists centered on the kampong's potentially attractive features (fig. 2).

3. Kampong Sungai Jingah – the participants identified "river identity and riverside kampong as a key point for development" in their vision, which would be achieved through a heritage tourism program using the kampong narrative of *kampung saudagar* (the kampong of wealthy merchants) as the main source of inspiration, along with the religious sites, and sasirangan industrial heritage. Furthermore, the toponym of the kampong (Jingah, the tree species *Gluta Renghas*) was used to enhance the kampong's identity while improving the riverside greenery space and reduce riverbank abrasion.
4. Pasar Lama – as one of important historical economic hubs in Banjarmasin this market was accessible by river and land, but now it has lost its river connection. The market's condition has degraded, mainly because of river pollution and the community's lack of environmental awareness. The proposal emphasized the market's existence as a riverside economic center in the context of conservation and identity formation, and incorporated a program to reduce pollution by involving the community and visitors.

Epilogue

The HUL Quick Scan Method is not focused on water-related urban heritage specifically. Nevertheless, it features a holistic and integrated

approach that fully includes water-related narratives if applicable. The outcomes of the workshops in Muntok and Banjarmasin underline this conclusion and offer many leads for water- and heritage-inclusive sustainable development. The method also offers possibilities in the field of participatory revitalization of water-related urban sites. Community participation led to a better understanding of tangible and intangible heritage related to water, and above all residents' socio-cultural and socio-economic needs. The workshops encouraged the local government and the local community in both cities to undertake follow-up actions in line with UNESCO's HUL approach.

To ensure that the HUL Quick Scan Method could be disseminated in Indonesia, a handbook was published in November 2021 for university lecturers. With guidance from the handbook, the lecturers can organize their own workshops with students and other stakeholders. Hopefully, this will help to raise awareness about the HUL approach of UNESCO as quickly and widely as possible at a time of vast development of urban and rural areas in Indonesia. The handbook is available in English and Indonesian, with free access through the website of Universitas Indonesia.[1]

Acknowledgment

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1. For more information refer to the link https://architecture.ui.ac.id/home/publications

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Place Loss and Re-Negotiating Local Water Heritage: The Case of Sztoła River, Bukowno, Poland

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The history of the Sztoła River in Poland provides important insight into how the industrial use of a river can ultimately lead to the disappearance of the water source, the river itself, affecting culture and everyday practices in local communities. It is an example of negative heritage, where the preservation of surface water is neglected as it does not match official narratives of the local mining traditions and social values. Because the river is not considered an important component of local culture, decision makers expected that the local community would accept the "liquidation of a river." However, the anthropogenic drying up of the Sztoła received much attention on social media as people lost the opportunity for nature-based leisure activities. The local community's vivid responses on social media and activist interventions are examples of engagement with heritage "in the making" – standing up for the values that have not so far been recognized.

KEY THEMES

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< *Fig.1 Sztoła, December (Source: Daniel Sztork, 2021).*

The valley of the Sztoła River is located in the Małopolska region of Poland. The river's name comes from the Germanic "Stolla" which stands for an adit – a tunnel or a canal for discharging water from a mining area (Pucek 2014). Until the end of 2021, the Sztoła used to meander in the forest, between the sandy slopes, for 13.4 km, passing residential areas of the small town of Bukowno. Mining traditions in the region date back to medieval times, that is, from the eleventh to thirteenth century (Ciszewski 2019; Rozmus 2019). The development of mining and metallurgical industries of zinc and steel ores, which began in the nineteenth century, propelled the growth of the settlement. Currently, the municipality has about 10,000 residents and approximately 65 square kilometers of land area with 75 per cent covered by forest (Dziechdziarz and Sypień 2017).

Local industrial activities and proximity to the large industrial region of Silesia resulted in high levels of pollutants in the air, soil and water (Kicińska et al. 2019) including rivers (Ciszewski 2019; Krodkiewska et al. 2022). However, this did not restrict the use of nature by the surrounding communities, where residents cherished fishing, berry and mushroom picking and bathing in nature. Wildlife also flourished in the local forests.

The fate of the Sztoła was long connected to rapid urbanization because of its leisure value. In the first half of the twentieth century, it was a popular recreation area for citizens of nearby industrial metropolises. Even though the Bukowno municipality lost its status as a health resort due to increasing air, soil and water pollution, residents' leisure was still strongly dependent on the river, and daily visits from towns and cities located nearby Bukowno continued. Sztoła was a spot for taking recreational hikes, bathing, trout fishing (introduced to the river by local fishing associations), and eventually kayaking. Its sandy slopes became an icon of local nature, and in 2020, the river was selected as the Małopolska region's best tourist attraction in a contest organized by a popular national radio station (fig. 1).

The boom of the mining industry in the 1970s severely impacted the local water system and accelerated groundwater decline. The extraction of zinc and lead ores in the "Olkusz" and "Pomorzany" mines near Bukowno struggled with an exceptionally high volume of groundwater. Pumping water out of mines was considered a significant challenge for the industry, which redefined the venture as "a fight against water" – both contemporarily as well as historically (Niewdana and Świć 2011).

Bukowno is surrounded by many historical mining sites. One example is the Ponikowska Adit – the 10 km long infrastructure for water discharge dating back to the sixteenth century (Godzik 2015). Parts of the construction that can be found in the area are considered important sites of medieval mining. Miners and their struggles with the four elements: soil, air, fire and water, are well documented and displayed in the museum "Mind of Knowledge about Zinc," in Bukowno. However, as this museum was founded by the mining company, primarily exhibiting their findings (fig. 2), the narratives presented at the museum portray water as the "enemy" of the industry.

Mining activities severely altered the conditions of underground and surface water in the Sztoła valley in the second half of the twentieth century. The spring of the Sztoła almost dried up completely in the early 2000s; the local water table dropped to more than 10 meters below the river bed, but the river was supplied with water discharged from the mine to the old river-

^ *Fig. 2 Zinc and lead ore, Museum of Zink, Bukowno (Source: Daniel Sztork, 2022).*

^ *Fig. 3 The mining waters (on the left) enter Sztoła's riverbed in December (Source: Daniel Sztork, 2021).*

^ *Fig.4 Sztoła, August (Source: Daniel Sztork, 2022).*

bed (fig. 3) (Ciszewski 2019; Morman and Czop 2012). The transition of the Sztoła from the natural river to an anthropogenic watercourse that carried water discharged from the mine was hardly noticeable according to residents. Yet, it defined the river's future. In early 2022, all mining operations in this location ceased, water discharge into the river stopped and the river disappeared (fig. 4).

Although the drying up of the river is a tremendous landscape change, in this case, it does not present any "practical" difficulties. The Sztoła River was the source of drinking water until the late 1990s when pollution levels rose. Industrial processes account for 90 per cent of Bukowno's water consumption, however this water does not come from the river. Currently, drinking water is sourced from outside the depression created by the zinc and lead mine, and this infrastructure was co-financed by the mining company (obliged by the court, as compensation for damaging the local water source). However, environmental activists claim that negative effects of the end of mining operations such as the disappearance of a river may occur in other regions. For instance, the pollution of underground and surface waters after the mine closes is expected to occur up to several decades after the depression is filled with underground waters. Water will rinse metal elements from the mining area. While it will not affect the water supply to the towns of Bukowno and nearby Olkusz, which now receive water from elsewhere, pollution may affect water sources for towns in the neighboring region, where nature protection bodies did not participate in the environmental assessments of the closure of the mine. The area of Bukowno and Sztoła valley is located on the border of two regions in Poland, therefore institutionally, water and nature are managed by public administration from Małopolska and Silesia, including Polish Waters, two forestry units,

Małopolska's landscape conservation body, and a Silesian mining regulation administration. Its location at the border of two regions makes it more difficult for public management to recognize relevant environmental threats if the impacts occur in another administrative region than the source of the pollution and are consequently managed by different management bodies. In that sense, it is somewhat of a peripheral area for public institutions, which may result in underestimation of environmental risks and threats. Climate change already affects freshwater resources in Poland, for both domestic and industrial purposes (Kubiak-Wojnicka and Machula 2022; OECD 2013), challenging long term achievement of the UN SDG 6: clean water and sanitation. Current contamination levels of soil and water already preclude use of land for agriculture purposes (Miśkowiec et al. 2015); their potential increase may further affect populations' health and well-being (SDG 3), which is already severely affected by air pollution.

Today, the Sztoła River is an empty riverbed filled with garbage, which is partially removed by local people in a few organized events. While the management body responsible for the area – Polish Waters – confirmed the cleaning up of the riverbed, no action was taken in the first nine months. The issue of refuse disposal into the riverbed is regularly brought up on social media and has stained the community's memory of the Sztoła as a lovely meandering river. An ecosystem change that is as drastic as it has been in the case of the Stoła River can affect existing ways of life, and lead to the loss of personal identity formed in relation to places of local heritage (Tschakert et al. 2019). Such loss, Lertzman (2015) argues, must be properly grieved. Grief is a long-term emotional consequence of place loss (Marshall et al. 2019; Bonanno 2001, 494–95) that can generate new activist practices.

Several months before the closing of the mine, local activists began their fight to keep the river flowing, demanding that the mining company ensure minimal water flow to sustain biological life in the river. These activists' social media activity attracted the attention of several local and regional newspapers. The "liquidation of a river" received much attention on social media, and Sztoła's altered landscape attracted many nature photographers. The memories of the living river are captured in the local painter's work. Several local tourism and leisure organizations held events dedicated to the Sztoła, which they named "farewell," "goodbye" to Sztoła, and even "funerals." Although attended mostly by people outside the community, the most spectacular event was organized by a Krakow artistic collective, River Sisters. They created a symbolic performance of pouring water into the dry riverbed with a dedicated song and music. In contrast, a few residents actively joined local authorities in supporting the mining company's decision to irreversibly stop water discharge to the Sztola River. These locals may have felt that they never really "owned" the river and that they lack the agency to fight for this cause.

Almost one year after the events, some activists argue that there is still a chance to restart pumps to revive the Sztoła riverbed. However, others note that the groundwater is already polluted and such an action would only further accelerate ecological degradation. According to predictions, it could take at least 40 years for Sztoła to come back naturally (Ciszewski 2019; Morman and Czop 2012) or it may never regain enough flow to refill its riverbed. In any case, it will not be suggestive of the peaceful, relaxing landscape it used to be for local people.

Overall, however, the ongoing discussions and decision making processes have overlooked any socio-cultural impacts of drying up the river.

They mainly focused on environmental and ecological consequences, neglecting the needs and values of local communities related to the river. No law asks for consideration of recreation or tourism in the relevant decision-making process or other influences on local values or practices. There is an absence of a narrative that acknowledges the loss of the local community spirit and the relevance of the river for wellbeing – in its intangible, cultural and psychological aspects.

Many residents of Bukowno considered this river a charming, meandering, emerald river. For them, the river connected the community's past, present and future, as the changes in the river water system and ecology reflected local social transformation. For others, the Sztoła was a waste stream carrying the water discharged from the mine during weekdays yet enabling communal recreation or fishing mainly over the weekend.

The case of the Sztola River provides insights into the interplay between the mining industry, miners' culture, local community and water. While groundwater is a part of the official narrative on local mining traditions, surface water remains a vital aspect of the private life of miners' families and weekend leisure. Although surface waters – the Sztoła river – were central to local leisure activities and became a symbol of the beauty of nature, they are overlooked in the official heritage narratives. We argue that including Sztoła in the heritage narratives of the region will enable local communities to reinvent themselves under the new circumstances through the extended story of the historical relationship between people and water in the region. This contributes to the questions of how to conserve the "dry river" and how nature can still contribute to sustainable futures.

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Collaboration Between Nature and Humans in the Desert: The Qanat System in Iran

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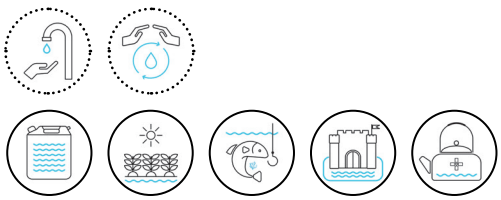
The qanat system exploits groundwater aquifers in arid and semi-arid regions with the help of local water facilities and infrastructure. The system originated in Iran's central plateau and then spread widely around the world, from the Middle East and Eastern Asia to Europe, North Africa and even South America. This historic water system, which reduces costs and energy consumption, offers a model of how humans can connect to their environment in a completely sustainable way. This system not only satisfies human water needs but does so without depleting natural resources. The relationship between humans and nature is very fragile in desert regions and the qanat system is capable of sustaining settlements even in Iran's hot and dry climate. This historic system enables settlements and agriculture to survive while inspiring a unique desert-specific approach in line with the UNESCO Historic Urban Landscape (HUL) approach. This ecosystem-like approach involves not only the qanat's canals but also associated natural structures and historical components like water reservoirs (Ab-Anbar), water mills (Asiab), water coolers (Yakhchāl), gardens (Bagh) and farms (Mazrae) and floodways (Masil).

KEY THEMES



CLIMATE

Bsk
Tropical and Subtropical Steppe

Introduction

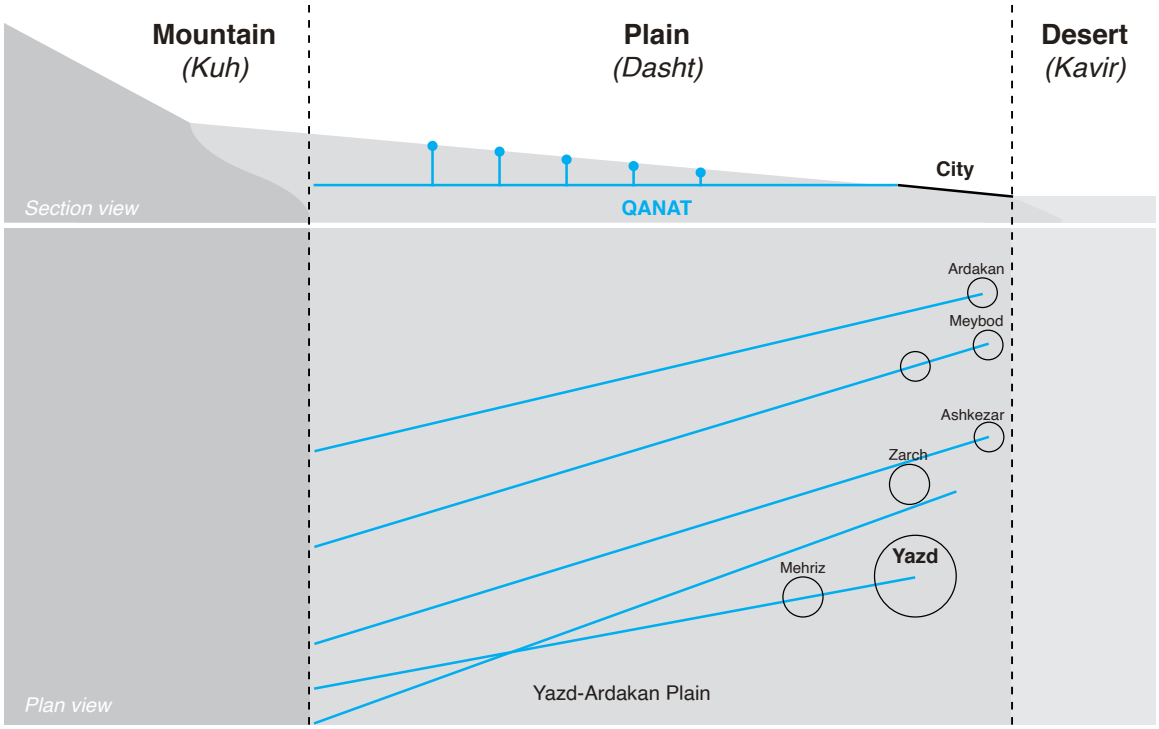
A significant part of central Iran is covered by dry deserts; obtaining adequate water has always been a challenge. Throughout the arid regions located in the margins of the central desert, the agricultural and permanent settlements are supported by the qanat ancient irrigation system (*kariz* in Persian). This system conducts water through underground tunnels to the earth's surface with the aid of gravity from the main well. It allows water to be transported over long distances without losing water to evaporation, and it provides water for drinking, agriculture and other uses at considerable distance from the main well (about two to eighty kilometers; Semsar Yazdi 2019).

The qanat system consists of a series of vertical shafts in sloping ground that are interconnected at the bottom by a tunnel with a flatter gradient than the ground level. The first shaft (mother well) usually sinks into an alluvial fan, to a level below the groundwater table. The shafts are sunk at intervals of 20 to 200 meters in a line between the groundwater recharge zone and the irrigated land. From a bird's eye view, a qanat system looks like a line of anthills leading from the foothills across the desert to the greenery of an irrigated settlement. Qanats are generally used on the edge of the central desert of Iran. The most important qanats in Iran are located in arid regions in the provinces of Yazd, Khorasan, Kerman, Markazi and Fars. Specific characteristics of qanats vary depending on the region, the type of urban and public space and building scale (Semsar Yazdi and Khaneiki 2016).

From an ecological point of view, qanat structures are part of integrated natural and human networks. With the aid of nature, the nearest snow-capped mountains provide permanent water reserves, flood paths move seasonal rainfall and serve as a temporary source of water, and water streams under the shade of trees, helping to prevent evaporation. The water reaches its final destination in urban areas, where it is used for agricultural and horticultural irrigation. Along with human intelligence and technology for water transportation, distribution, storage and management, qanats are linked to tributaries, channels, water outlets, gates and temporary ponds. This interlocking water system is an outstanding example of sustainable collaboration between humans and natural ecology.

The social and cultural significance of qanats cannot be underemphasized. The qanat is considered a communal technology for water extraction in arid and semi-arid parts of Iran. It requires collaboration and sharing, and it is impossible to build a qanat individually: an or-

^ *Fig. 2 Qanat system in Iran (Source: International Center of UNESCO on Qanat and Historic Hydraulic Structures).*



^ *Fig. 3 Ideogram of qanat system in Yazd-Ardakan plain (Source: Massoud Ghaderian).*

ganized group must gather its forces for construction. After construction, regulations are necessary to clarify the manner of using and sharing. All the techniques related to the qanats, from transfer to operation and maintenance, have become social and cultural traditions over time. Also due to the high value of water for desert dwellers, the qanat as a water supply has a high cultural and social position. Rituals and religious meetings are carried out next to the qanat demonstrating the socio-cultural importance of this water infrastructure. One of the best examples of the social and cultural dimensions of this water system is the marriage with the qanat. During the drought, when the qanat's water decreased, the Iranian villagers believed that if a woman (as a symbol of fertility) was married to the qanat, its water discharge would increase. Marriage with the qanat was performed in a special ceremony next to the mother of the well with joy and the giving of food.

As the vital water infrastructure of arid and semi-arid regions, qanats have played an important role in these regions' economies: water is an essential prerequisite for development. The qanat brings groundwater to the surface by gravity, which is economical and does not require the use of energy. Qanats have not only supplied water at minimal cost, but their components have also provided various water services such as transferring, storing, and cooling water in a sustainable manner. For example, an *ab-anbar* is the type of reservoir that has been the most common way to keep water cool in arid regions. A *yakchal* has been used as a refrigerator to store frozen water in winter to con-

sume in summer. In addition to water-related services, the qanat's water has been the driving force for many daily supplementary services, such as applying the waterpower from water mills to grind wheat. The qanat system has not only been effective in reducing costs, but has also played an effective role in creating direct or indirect added value.

Current Approaches to Preserving and Managing Water Heritage

In the list of national heritage in Iran, initially, the qanats and their associated structures were registered separately. With the recognition of the qanat as a historical water supply system and traditional technology, in 2016, eleven Iranian qanats were listed as World Heritage sites. Those qanats are still active water carriers and have retained not only their architectural and technological structures but also their function. They continue to provide the essential resource of water, sustaining Iranian settlements and gardens, and they continue to be maintained and managed through traditional communal management systems. These management systems have remained intact and have been transferred from the distant past thanks to the collaboration of many, including users of the qanats. The government of the Islamic Republic of Iran established the International Center on Qanats and Historic Hydraulic Structures in Yazd, Iran, under the auspices of UNESCO. Since the world's recognition of the qanat, UNESCO has developed rules and regulations to ensure the continued functionality of the qanats and the water catchment areas included in the buffer zone, and they have been committed to protecting their essential function in the provision of water resources. Likewise, the agricultural areas affected by the distribution and use of qanat water resources have been protected through buffer zones to allow the full long-term protection of the qanat system.

In the past, committees consisting of local people were responsible for managing the water obtained by the qanats. This management included the construction and maintenance of the qanat and the distribution of water. The traditional communal management system, which is still in place, allows equitable and sustainable water sharing and distribution. Nowadays, urbanization, government agencies, including the Water Management Organization, are responsible for maintaining the qanats. In recent years, with the introduction of the qanats as cultural heritage, the National Cultural Heritage Organization has carried out activities in matters of protection and tourism related to the qanat. Some qanat researchers have suggested that highlighting qanats as tourist attractions could help justify the conservation of qanats. They believe that tourism and its revenues could help protect the qanat as well as stimulate regional development.

The approaches to preserving qanats vary depending on the organizations associated with their management. Three categories of institutions in Iran are in charge of qanats: water management organizations, cultural heritage organizations, and groups of public and communal owners of qanats. The Water Management Organization of Iran and its provincial branches generally ignore the role of the qanats as a water resource due to the low volume of water discharged by qanats. The Cultural Heritage Organization of Iran pays more attention to the qanat as a tourist attraction. Groups of co-owners focus on the amount of water produced and on managing property related to the qanats. Unfortunately, qanats have no particular role in spatial development planning and little research has been carried out related to Historic Urban Landscape (HUL) approaches.

^ *Fig. 4 Activities of daily living in the desert in tandem with the qanat system. Due to its activities and applications, the qanat system has played a significant role in the social, economic and cultural life of desert city residents. (Source: ICQHS, International Center of UNESCO on Qanat and Historic Hydraulic Structures).*

^ *Fig. 5 Water pumping by digging water wells, Yazd, Iran,1959. In the 1950s, the digging of wells to extract water directly from underground sources by pumps accelerated. At that time, people and officials were pleasure to gain direct access to water, while less than 50 years later, the water levels underground were greatly reduced, which resulted in the lack of water again, the destruction of the qanat system and its components (Source: Vaziri).*

Current and Future Challenges to this Water System

The historical and sustainable water system of qanat has been gradually replaced by the digging deep wells and expanding water pipes over the last fifty years in Iran. The construction of deep wells for pumping groundwater has caused most of the qanats to dry up. Furthermore, it is very difficult to rehabilitate them because the new deep wells have already lowered the natural water level significantly. In addition, with the expansion of the modern water distribution network along with urbanization, qanats have not been considered due to high maintenance costs and low levels of irrigation. A few qanats are being used only for agricultural purposes, while other abandoned qanats are often blocked or drained.

Along with the destruction of the qanat as an ecosystem, the natural and man-made components are also being destroyed. Gardens, agricultural lands and farms are examples of these natural components that had been used to protect against desert and seasonal floods as a green belt. The destruction of the city against recent floods and droughts is an example of the result of the destruction of the qanat and its green components. In the past, seasonal floods have been part of the water system in historical cities for watering gardens and farms which were green belts of cities. Nowadays, with the drying out of historical gardens and farms, seasonal floods are damaging the historic core of cities.

Conclusion and Future Approaches

Qanats are an environmentally friendly method of using groundwater aquifers. They can aid sustainable development in arid and semi-arid areas by utilizing local facilities and infrastructure, lowering costs and reducing energy consumption. They offer a way forward for a country facing environmental and economic crises. If economic, social, cultural and environmental values are aligned, the government, and society in general, will conclude that instead of focusing entirely on transferring water from the seas to cities, qanats can contribute to the water supply and also provide benefits as an ecosystem. The HUL approach will be extremely beneficial to integrating qanats in existing opportunities and future challenges. The UNESCO Recommendation on the HUL proposes a six-step action plan. In line with that plan we can think of the qanat in terms of:

1) Mapping cultural and natural resources

According to the Ministry of Energy and Water of Iran, there are more than 36,000 qanats in Iran. Only in fewer than 20 qanats has their main route has been accurately identified. Although it is difficult to map qanats due to their numbers, depth and complexity, it is impossible to protect them without knowing their location. New technologies can help to map qanats.

2) Consulting stakeholders, including communities, about which values and attributes to protect

All stakeholders, including local people and officials in the sectors related to water management and cultural heritage, should be familiar with the value of qanats and the historical water infrastructure as an ecosystem.

3) Assessing vulnerability

Due to the sensitivity of historical water infrastructures and qanats, annual monitoring is necessary to identify damage. It is also necessary to document maintenance operations along with protective action.

^ *Fig. 6 Destruction of historical fabric due to flooding, Yazd, Iran, 2022 (Source: Majid Jahrahi).*

4) Integrating heritage elements in spatial planning

After identifying the historical water infrastructure and qanats, an active role in urban development plans should be considered for them. This goal requires spatial analysis and spatial statistics at the urban network level.

5) Prioritizing policies and actions for preservation

Although protection policies for qanats have been on the rise in recent years, coordination between them at the national to local levels is still weak. A hierarchy of policies based on regional characteristics of qanats and stakeholders can help prioritize protection policies.

6) Developing partnerships to implement projects

Improving the performance of historic infrastructure and qanats is possible with knowledgeable intervention. Planning and design interventions are possible in the form of projects. To implement projects, it is necessary to develop a network of participants.

With the HUL approach, we could focus on the preservation of historical water infrastructure as water heritage by integrating development with environmental and socio-economic changes. This approach aims to provide sustainable planning and design interventions of water infrastructure within historical environments. In this way, qanats can become an inseparable part of the current urban infrastructure networks.

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Reconciling the Bryggen World Heritage Property with Bergen's Strategy for Sustainable Urban Development through Heritage Impact Assessment

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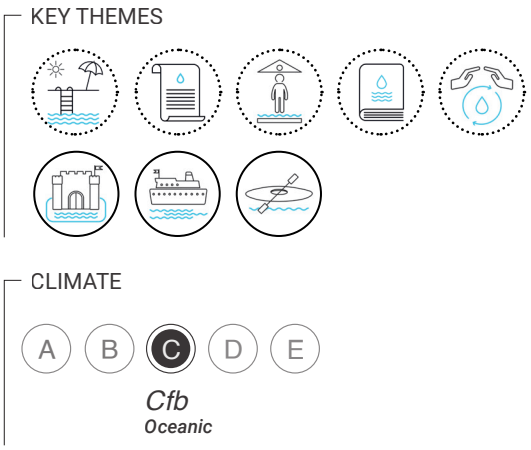
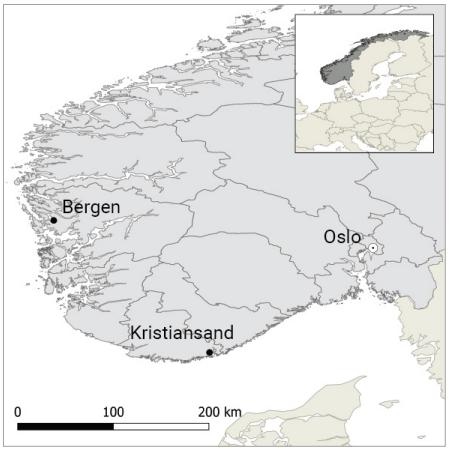
This case study sheds light on potential ways of embedding water-related heritage in an integrated strategy of sustainable urban development in Bergen, Norway. Particular attention is paid to the ongoing Heritage Impact Assessment (HIA) process in Bergen, which was started in 2019 to assess potential impacts of Bergen's new transport strategy on the World Heritage site. Various HIA reports have been compiled and discussed with Bergen's planning authorities, other experts and in a public hearing process. The municipality of Bergen has used the HIA to reconcile the preservation of the Bryggen World Heritage site and its historic harbor setting with its strategy for sustainable urban development. Hence, the HIA is serving as an essential tool to implement the UN Agenda 2030 for sustainable development.





< *Fig. 1 Fragment: The World Heritage Site of Bryggen and its setting, seen from Strandkaien (Source: Philipp Tebart).*

Introduction

The World Heritage site of Bryggen, located in Bergen, Norway, was inscribed in the World Heritage List in 1979. Today, Bryggen is the only place worldwide where the building structure of a Hanseatic "office" (*kontor*, trading post) is fully conserved. Bergen's population is proud of its Hanseatic roots, but the preservation and sustainable development of Bryggen as a water-related heritage site is not a smooth process. Key issues relate to Bergen's future sustainable development strategy, which may include the development of a new light rail line in the immediate vicinity of Bryggen. In addition, Bergen's harbor is strongly dependent on cruise ship tourism, which is directly tied to Bryggen, thus causing both mass tourism and unsustainable tourist traffic. Also, water-related climate change will require new interventions in the historic harbor area.

Vågen Harbor and Bryggen Hanseatic Office

Bergen, located in southwest Norway and known as "the city between the mountains," is the second-largest city in Norway with nearly 300,000 inhabitants. Bergen's favorable harbor conditions are considered a main reason why, by the Middle Ages, the city had become an important Northern European trading and shipping port. In 1350, the Hanseatic League established an office in Bryggen and proceeded to dominate international trade for 400 years. In 1754, the Hanseatic office was closed and replaced by a Norwegian office, which most of the German merchants joined.

During the period of the Hanseatic office, Hanseatic merchants gradually acquired ownership of Bryggen and controlled the trade in stockfish from northern Norway through privileges granted by the Norwegian king. The Hanseatic office at Bryggen was one of four; the others were London, Bruges and Novgorod. Bryggen, named after its quay, which was called "bryggene" during the Middle Ages, is the only one of the four where the entire building structure of a Hanseatic office can still be experienced. Each trading house had its own part of the quay with private stalls and rocker booms for loading. Important elements of the context of the Hanseatic League related to the Norwegian king, the church and the city are still visible in the relation between landmarks of Bergenhus fortress, one of the oldest preserved fortresses in Norway, the churches and the ruins of the townhall. Mariakirken (St. Mary's Church) is one of the oldest churches in Norway and served as the Hansa League's church (Bergen Kommune 2020).

At present, the wooden buildings of Bryggen have become iconic of the Vågen harbor, which is still a fully active shipping port. Consequently, Bryggen was inscribed in the UNESCO World

^ *Fig. 2 The World Heritage Site of Bryggen and its setting, seen from Strandkaien (Source: Philipp Tebart).*

Heritage List as a northern version of a "fondaco" (the most famous of which is Venice's Fondaco dei Tedeschi), unequaled in the world, where the structures have remained within the cityscape and perpetuate the memory of one of the oldest large trading ports of Northern Europe.

Due to its outstanding location, due to a relatively mild climate, access to the North Sea and fjord, shelter from the sea enhanced by the offshore islands, the city of Bergen had a central position as a military, administrative, political and religious center in Norway for several hundred years. The oldest Vågen harbor settlements were established along the east side of Vågen and the main features of medieval Bergen were centered on the harbor area. Building plots, streets and public spaces were oriented toward the harbor to facilitate easy access to each merchant's quay. The quay in front of Bryggen was not publicly accessible until the late 1800s, when the private quays were purchased by the Port Authority. However, access to the harbor was important earlier than that. Consequently, in 1276, the city council designated spaces for public use (*allmenninger*) securing everyone's right to access the sea and common areas. They are still visible in present-day Bergen. In short, Bryggen, Vågen bay, and the entire setting of this historic harbor area has been widely preserved until today.

Challenges for Bryggen and Vågen Harbor due to Norway's Zero Growth Strategy for Carbon Emissions

In the present day, Bergen's unique location between the mountains and by the sea is both an asset and a problem. For hundreds of years, the sea was the most important transport route to and from the city. But this changed rapidly when Bergen was connected to the east of the country by train and later, during the twentieth century, when car traffic arrived. Bergen, which at first had developed as a compact city around the harbor area, quickly developed into a suburbanized region connected mainly by motorized traffic.

To support more sustainable development patterns, Norway currently follows a zero-growth policy with regard to carbon emissions for large cities. Growth of passenger traffic should be covered by public transport, cycling and walking, while carbon emissions caused by vehicle traffic should be reduced to the lowest point possible. Consequently, Bergen, as the capital of Vestland County and a commuter hub for the surrounding municipalities, developed a Green Strategy with the overall goal to support sustainable urban development and to become a fossil-free municipality. This strategy promotes zero growth in vehicle traffic and its decrease by at least 20 per cent from 2013 to 2030 respectively.
The Bybanen (city tram) light rail network opened in 2010. Connecting the different parts of the city, it functions as the backbone of Bergen's future sustainable public transport system. One Bybanen line is currently in operation and a second was opened in November 2022. To extend this network, the municipality of Bergen is planning a third light rail line, which is meant to link Åsane, on the north side of Bergen, with the city center. Growing numbers of users of Bergen's new Bybanen network show that this overall strategy is generally successful. However, one of the most discussed points of the planned Bybanen extension to the northern city districts is Vågen harbor and especially Bryggen. Part of the new Bybanen tram track is planned to be located directly on Bryggen Quay. These planned transformations in the immediate vicinity of the UNESCO World Heritage site have led to heated discussions among Bergen's

^ *Fig. 3 Vågen harbor and Hanseatic League quarters around 1870 (Source: Marcus.uib, Knut Knudsse , ubb-kk-2127-0158).*

^ *Fig. 4 Bergen today, Vågen harbor and Bryggen are visible in the foreground (Source: Philipp Tebart).*

population for several years. The construction of the tram could have negative structural impacts on both the archaeological heritage and the groundwater levels that are crucial for the property's wooden foundations. It is also feared that the tram extension could have a negative visual impact on the iconic view of Bryggen in historic Vågen harbor. To assess potential impacts of the tram extension on Bryggen, city governance commissioned an Heritage Impact Assessment (HIA), which is currently being conducted with the participation of relevant stakeholders. The HIA process was planned in several phases and with visualizations designed to inform the public, experts, planning authorities and politicians. Due to the various assessment phases, the planned light rail track near Bryggen has been modified successively to mitigate negative impacts (Kloos 2022).

Bergen's Green Strategy will also affect Vågen harbor, which is at present Norway's largest cruise ship port. Because most of the tourists arriving by cruise ships are visiting Bryggen, the World Heritage property receives an extremely large number of visitors, especially in summer months. During the pandemic, the Port of Bergen, the tourist agency VisitBergen and several partners developed a plan for more sustainable cruise tourism in Bergen (Armland 2021). In May 2022, Bergen City Council decided that a maximum of 8,000 cruise ship passengers daily will be accepted in the future, and that the number of cruise ships per day will be reduced to three. Four ships will only be accepted if electrical power can be provided from the shore. According to Bergen City Council, all cruise ships mooring at Bergen should be able to connect to shore power and this should be a mandatory requirement by 2026 at the latest. To support this, Bergen harbor built the world's largest onshore power supply system, which can supply three cruise vessels with shore power simultaneously (Port of Bergen n.d.). Additionally, Bergen plans to introduce requirements for zero emissions on air and sea traffic including cruise ships. The Norwegian Maritime Directorate is preparing regulations and setting an introduction date for the Western Fjords, another of Norway's World Heritage Sites.

Climate Change and Seafront Strategy for Vågen harbor

Both Vågen harbor and Bryggen might also be affected by climate change. Severe threats for Vågen harbor from sea level rise are handled in Bergen's master plan for wastewater and water environment, 2019–2028. In the long term, adverse effects as a result of sea level rise are to be limited by establishing barriers at the entrance to Vågen and Store Lungegårdsvann, possibly in Damsgårdssundet at Puddefjordsbroen. The speed of climate changes will determine when it is necessary to build the barriers but planning of the barriers should start in this master plan period (2019–2028).

Bergen has also developed a seafront strategy which sets out frameworks and guidelines for the development of marine areas. Good links between the existing urban structure and the seafront must be clarified, and a continuous promenade with associated urban spaces has been proposed to connect diverse areas. The seafront strategy also aims to manage the upkeep of cultural heritage and to ensure that Bergen is further developed as a green, compact walking city. To this end, Bergen intends to upgrade its entire waterfront, which at the moment is not yet fully accessible (Bergen Kommune 2022).

^ *Fig. 5 Planned Bybanen light rail on Bryggen Quay and modifications carried out throughout the Heritage Impact Assessment process (Source: Philipp Tebart /mkphc).*

Conclusion

From medieval times to the present, Bergen's urban development has been closely related with its harbor. Vågen harbor and the World Heritage Site of Bryggen are unique cultural assets which still truly represent the "heart of the city." However, the problems that must be solved indicate that an integrated strategy is needed that sets out directives for reconciling the preservation of this valuable area with Bergen's sustainable urban development strategy.

The HIA initiated by the city assessed the consequences of Bergen's plan to extend its light rail network on the Outstanding Universal Value of Bryggen. This was an important starting point from which to devise an integrated strategy for urban planning. The HIA shed light on a variety of interrelated challenges, including Bergen's future traffic development, cruise tourism, a need for a visitor strategy, climate change and the future protection of Bryggen and the harbor. In doing so, it was also an important basis for a public hearing process carried out to inform a broad range of stakeholders in Bergen. Visualizations of the planned new Bybanen line led to successive improvements of the plan, but also helped all stakeholders understand the complexities of the situation and alternatives to cope with potential risks to groundwater levels as well as potential negative impacts on the historic setting of Vågen harbor, which can be considered fully intact at present.

The municipality of Bergen meanwhile recognized that the HIA process can help it achieve its ambitious sustainable development goals, as well as a strategy for integrated urban planning which includes the preservation of the World Heritage property and its unique setting. When Bryggen was inscribed in the World Heritage List in 1979, the unique setting of Vågen harbor and medieval Bergen was not included as part of the site. However, it has become obvious that it will be crucial to consider the setting in efforts to preserve the Historic Urban Landscape of Bergen as a unique water-related city and to pursue Bergen's sustainable development. To further support this, one of the recommendations of the HIA focused on the creation of a buffer zone around the World Heritage property to support both the protection of the unique historic setting as well as the sustainable development of Vågen harbor. Although a number of issues have yet to be resolved, the HIA has been a tool of support for the implementation of Agenda 2030, as well the related Sustainable Development Goals.

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Fairmount Water Works and its Water Stories

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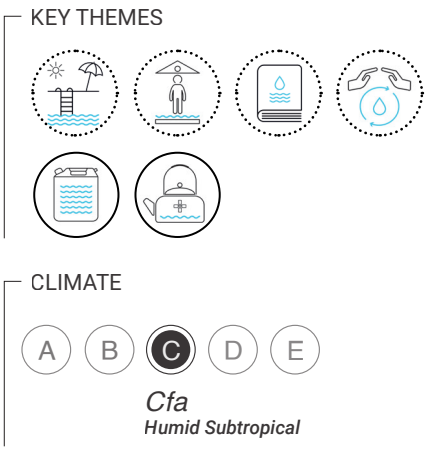
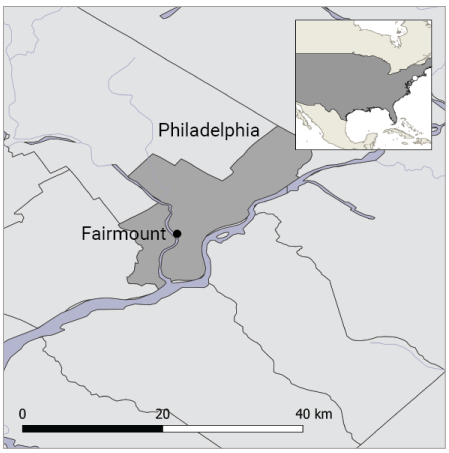
The Fairmount Water Works of Philadelphia has many stories to tell that span its rich 200-year history. It speaks to the history of technology in America, urban water systems, public health and civic architecture. Although struggling with the increasing impact of climate change, it still has a significant role to play today as a heritage site and as an iconic expression of architectural beauty, civic pride, environmental education and protection and the stewardship of water for all.





< *Fig. 1 Contemporary view of the Fairmount Water Works looking southeast with the Philadelphia Museum of Art and Philadelphia skyline as backdrop (Source: Fairmount Water Works Interpretive Center photographer).*

History of Fairmount Water Works: Philadelphia's Public Water Supply System

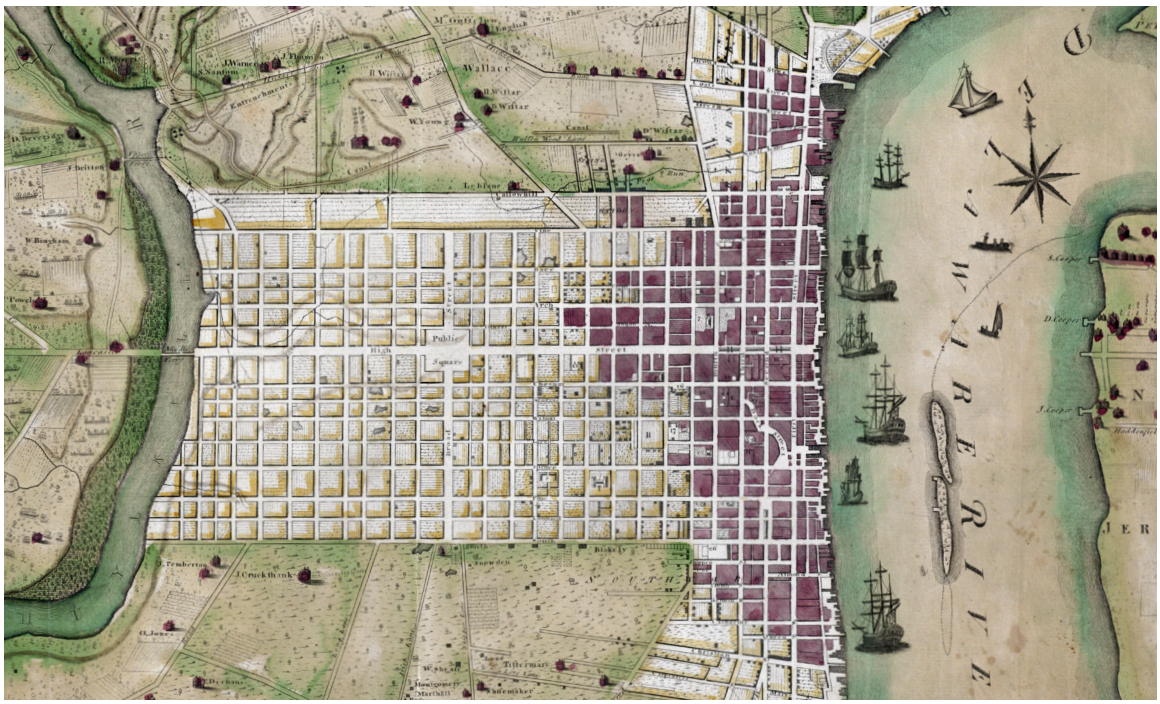
The Fairmount Water Works is a "landmark" in many ways (fig. 1). It was named a National Historic Civil Engineering Landmark in 1975, a National Historic Landmark in 1976, and a National Historic Mechanical Engineering Landmark in 1977. It also serves as a significant landmark for a kind of environmental education that connects the natural world with the built environment. As a cultural landscape, it asserts the principle that access to clean, safe water is a human right and therefore, a civic responsibility.

Water Works: The Arc of History

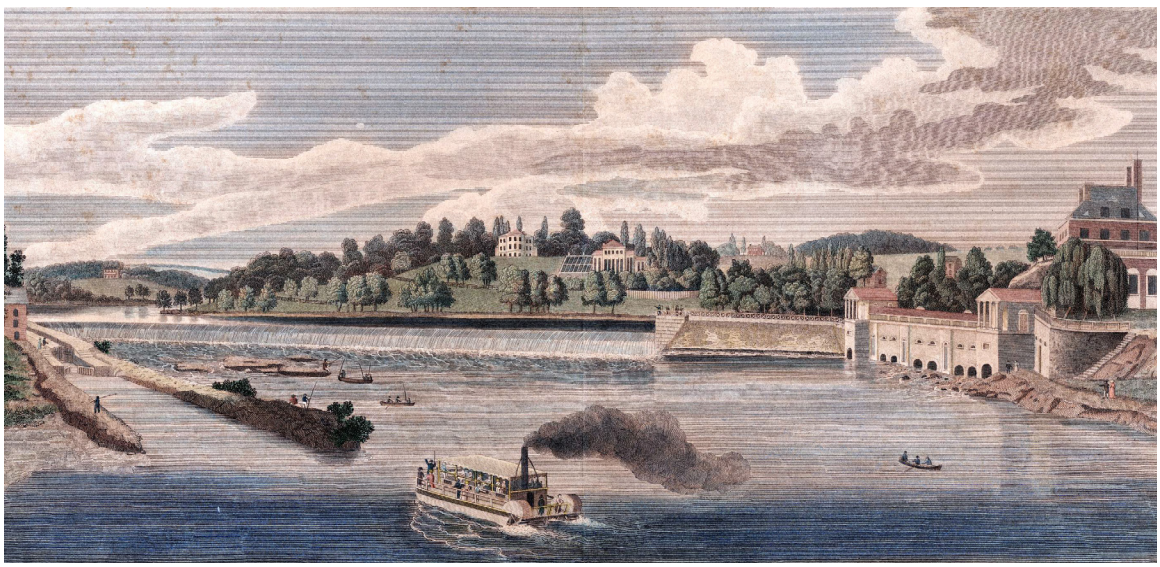
In 1683, William Penn's vision for Philadelphia was to create a grid pattern of streets laid out from river to river - a city of 2 square miles between the Delaware and the Schuylkill (fig. 2). The Delaware River, wider and navigable, became home to the city's active port, and development emanated from its docks and piers. The Schuylkill River was a pristine, more sublime waterway with rapids and elevation changes and it was late to develop along its shores. With the growing plague of yellow fever epidemics of the late 18th century (blamed erroneously on fouled water), increasing waste in the streets and contamination of groundwater, the city became desperate for a clean, reliable source of water. The relatively undeveloped and bucolic Schuylkill River, far away from the active port, appeared the best option (Smith 2013). As early as 1801, with its first pump house at Centre Square, Philadelphia made a commitment to engineering a water system that would be public, reliable and healthy. Soon the larger and more reliable Fairmount Water Works (1815–1909) was designed (fig. 3). It came to be admired as a successful experiment for the city and the nation, creating a public water distribution system renowned for what was called its water of uncommon purity (Smith 2013).

The Fairmount Water Works stands as a remarkable collection of white temple-like structures that rise from the eastern embankment of the Schuylkill River and yet it functioned as a public utility. These iconic buildings are now part of Philadelphia's public park system and once housed pioneering technology that supplied drinking water to Philadelphia. Pumped from the Schuylkill River to a high spot, water was then conveyed by gravity through an underground infrastructure system. This engineered system of engines, water wheels, pumps and pipes was originally steam powered (1815) , but the steam system was quickly replaced with water power created by a spillway just upstream that raised the level of the river and redirected the flow behind and through the buildings to drive water wheels inside. Pumps forced the water nearly 90 feet above to fill reservoirs on the adjacent hill called the Faire Mount. Gravity conveyed the water downhill in an underground system of hollowed out logs, which were soon replaced by cast iron pipes, to reach homes, businesses, public pumps and fountains (Gibson 1998).

In its heyday (1820–1840s), the Water Works was one of the most visited sites in the United States, second only to Niagara Falls. People came from around the world to witness its unrivaled scene of artistic expression for the public good, with its open-air pathways and gardens, and evidence of technological innovation (Gibson 1998). Prominent figures such as Mark Twain, Charles Dickens and Frances Trollope were among the numerous tourists. It was the prototype for water-supply systems around the globe (Gibson 1998).



^ *Fig. 2 The 1683 plan for Philadelphia was designed in a grid pattern from river to river. This c. 1796 map shows that the city grew instead from east to west along the Delaware River and expanded north to south along the riverfront. The large brown-ringed, rounded rectangle in the upper left corner is a high flat landform called the Faire Mount, the future sight of the reservoir and Water Works. Natural streams are delineated by winding black lines; many streams were eventually covered over and used as sewers and the infilled land became the foundation for building development, particularly of row home (Source: P. C. Varle, artist, and Scott, engraver).*



^ *Fig. 3 View of the dam and waterworks at Fairmount, Philadelphia, with pleasure boats in foreground (Source: Published by Edward Parker, 1824. Thomas Birch, artist, and R. Campbell, engraver [after painting by Birch]).*

In the early years of the republic, Philadelphia was at the center of design for high style civic institutions related to health, education, commerce and even prison reform as seen in other landmark buildings such as Pennsylvania Hospital, Girard College, the Second Bank of Pennsylvania and Eastern State Penitentiary (Bass Warner 1987).

Above all, it could be argued that a reliable, safe and accessible water system was at the very heart of the thriving city and what enabled Philadelphia to become a manufacturing powerhouse during the industrial age of the nineteenth century. The city was seen as such a forerunner in health, economy and commerce that it earned the name "Workshop of the World". (Bass Warner 1987)

Starting in the early nineteenth century, in an effort to protect the quality of the city's water, the city purchased large tracts of land bordering the Schuylkill River upstream of the Water Works to prevent unwanted development. As more and more land was purchased, the Fairmount Park Commission was created to oversee the property. Today Fairmount Park is 8,700 acres and one of the largest city parks in the world – and it all started in an attempt to protect the city's drinking water. However, despite these efforts, pollution from industry and coal mining upstream as well as outside the city began tainting the water supply. Growing industrial cities upstream, such as Norristown, Pottstown and Manayunk, used the river as a convenient sewer in an era when the economic benefits of industry outweighed any environmental concerns.

During this time, the growing drinking water system, with additional reservoirs to meet the exponential increase in population, did not supply filtered water, but rather relied on impurities settling out in large reservoirs. As the population grew and water pollution from both human and industrial unsanitary waste increased, thousands of people died from diseases such as typhoid and cholera, which were caused by contaminated drinking water. In 1890, Philadelphia suffered one of the worst typhoid epidemics in the nation. By 1909, the Water Works was decommissioned, replaced by several slow-sand-filtration plants constructed upstream on the Schuylkill as well as on the Delaware River. Filtration, along with the introduction of chlorine treatment in 1913, all but eradicated typhoid cases (Gibson 1998).

Saving the Fairmount Water Works: Adapt or Collapse

Between 1911 and 1972, no longer a functioning part of the drinking water system, the structures were transformed for new uses, first as a public aquarium (1911–1962) and then as a recreational pool facility, the Kelly Natatorium, (from 1962–1972). In 1972, flood damage from Hurricane Agnes caused the facility to shut down for good and the site was all but abandoned (fig. 4). After 180 years of constant use, and now threatened with complete deterioration, saving the Water Works buildings became imperative.
As Philadelphia prepared to celebrate the Bicentennial of the Declaration of Independence in 1976, the movement to showcase the "founding" city's significant landmarks and institutions gained interest. This included an effort to save the deteriorating Water Works. Recording and acknowledging the site's history was the first step. Around the time of the Bicentennial, research and a full set of drawings were recorded in the Historic American Engineering Record and the site was successfully nominated as a National Historic Engineering Landmark (Gibson 1998).

^ *Fig. 4 Interior view of aquarium looking south, showing display tanks aquarium located below north and south wings and pavilion, Fairmount Waterworks, east bank of Schuylkill river, Aquarium drive, Philadelphia, Philadelphia county, Pennsylvania, US (Source: HAER PA,51-PHILA,328--64).*

Documenting and designating the site was just a starting point to making it once again a vital part of the city's life. Without a plan for the buildings, the site languished and by 1984 it was listed as endangered by the National Parks Service and had become a vacant eyesore. Fortunately beginning in the 1980s, public/private partnerships between the park, the Junior League and other civic partners began the 40 years of strategic planning, adaptive reuse plans, and preservation fundraising that would save the Fairmount Water Works. The effort became a model for public-private partnership with its engagement of park leadership, through the Fairmount Park Commission (now called Philadelphia Parks and Recreation), public institutions as the Philadelphia Water Department, and numerous nonprofit partners including the Fairmount Park Conservancy, Women for the Water Works, and the Fund for the Water Works. These partnerships helped fundraise to match park capital dollars and promote long-term stewardship and use of the buildings. Moreover, committed leadership was key. A renowned philanthropist and park commissioner Ernesta Ballard, took on the project leadership in the late 1990s, and the entire site was transformed and over $30 million was invested. The buildings and terraces, historically significant sculptures, the Cliff Path Trail, South Garden and gazebos were restored in phases, followed by the 1926 Italian Fountain and subsequently the Boardwalk Trail and pedestrian bridge which led to improved wetlands along the bank of the river. Together these places formed an integrated environmental, recreational and historic landmark site, forming a kind of grand "gateway" of sorts.

The Fairmount Park Commission (now called Philadelphia Parks and Recreation) and the Philadelphia Water Department with the Fund for the Water Works, a nonprofit entity, worked to advance the long-term stewardship and use of the buildings.

Water Management: Commitment to Public Education

Civic commitment to public health beginning in 1801 and continuing to this day is both a legacy and constant pledge of the Philadelphia Water Department (PWD). In the early nineteenth century, the focus was on the provision of safe drinking water to its citizens and a reliable supply of water to the mills and factories that contributed to the prosperity of Philadelphia. Over the last 200 years, PWD has evolved from a single, iconic pumping station to a utility that protects Philadelphia's rivers, which are its drinking water sources, ensuring that stewardship activities are watershed wide. This legacy has evolved into a 3,000-mile system of pipes, pumping stations and treatment plants.

Today, the portfolio of water resource services that PWD provides, along with the regulatory requirements and aspired best practices for all facets of water resource management, is staggering. It provides safe and reliable drinking water, cleans wastewater and manages stormwater using a model program called Green City, Clean Waters, celebrated by the nation, which blends traditional infrastructure with nature inspired green stormwater infrastructure that seeks to engineer nature-inspired systems that better balance our natural ecological systems while collecting ever more challenging stormwater flows.

PWD recognizes that customers and residents need to be informed about and engaged in the stewardship of water resources to have confidence in the quality of services it receives and to affirm the value of their investment in their public utility. For PWD, education and engagement are an essential ethic. This is the reason PWD in the early 1980s, under the leadership of Ed Grusheski, made the commitment to transform the Fairmount Water Works into an Interpretive Center as part of the department. After two decades of effort, the Fairmount Water Works Interpretive Center (FWWIC) opened in fall 2003. Since then, passionate educators, interpretive exhibits, and a groundbreaking school curriculum use the power of place to increase understanding and transform visitors of all ages into ambassadors for our water environment.

Achievements and Challenges

Since its opening in 2003, the FWWIC has been operating as the educational center of the PWD. It has also become a regional and national destination for innovative water and watershed education programming, such as integrated STEAM (Science, Technology, Engineering, Arts and Math) education that fuses environmental education, scientific research and community engagement (fig. 5). People of all ages and backgrounds learn about the region's urban watershed ecosystem and sustainable technologies that improve water quality. Visitors are urged to take action to protect land and water resources. FWWIC is uniquely positioned to serve teachers and schools equitably throughout Philadelphia's urban watershed, connecting each school with locally relevant watershed projects in and around their neighborhoods.
More than 25,000 adults, 20,000 families and more than 7,000 school-aged children are served by the FWWIC's programs and exhibits each year. There is no admission fee and the site is partially

^ *Fig. 5 Adaptively reusing the landmark site for groundbreaking freshwater mussel research and public education (Source: GreenTreks, Courtesy of Habithèque Inc.).*

^ *Fig. 6 Aquatic scientist in the lab (Source: Fairmount Water Works Interpretive Center).*

^ *Fig. 7 Performance in the Kelly Pool space of Tributaries, a choral piece commissioned for the Fairmount Water Works Interpretive Center (Source: Kate Devlin; Courtesy of Habithèque Inc.).*

compliant with the American Disabilities Act.

The FWWIC 's commitment to place-based education has grown and flourished. As a field trip experience, education programming has been innovative and creative from the start. This National Engineering Landmark site has offered a unique and powerful setting for students to experience first-hand the dynamic ecosystem of the river, the evidence-based exploration of the technological innovations responsible for creating a successful drinking water system and discovery of cutting-edge architectural design in the context of the early republic (fig. 6). The FWWIC has received several awards for its innovative education accomplishments such as the Dr. Ruth Patrick Excellence in Education Award (2015), the Meaningful Watershed Education Experience Partner of Excellence Award (2020) and the Pennsylvania Environmental Council Special Places Award (2021). In 2021, Hurricane Ida brought record-breaking flooding to Philadelphia, and near catastrophic damage to the FWWIC. But the persistent challenge following severe storms is the repeated expense and burden associated with removing river debris and industrial cleaning. Despite this, FWWIC remains committed to cleaning, redesigning, restoring, and replacing needed elements – with a focus on making operations more flood resistant. The next major campaign is focusing on adapting to the increasing demands of climate change while continuing to interpret water history.

Innovative Exhibitions at the Fairmount Water Works Interpretive Center

In 2016, with a combination of private funding from the Pew Center for Arts and Heritage and the Mclean Contributionship and operational support from the PWD, the FWWIC installed a demonstration Freshwater Mussel Hatchery (Prizzia 2016). The working research laboratory and interpretive exhibits like this one offer education about the ecological benefits of freshwater mussel restoration within the Delaware River watershed. This site-specific living enclave was the first of its kind in the region, in addition to breaking new ground within the field of interpretation for its genuinely interdisciplinary approach to environmental education – integrating history, science and the arts (Prizzia 2016).

In 2019, the exhibition POOL: A Social History of Segregation was awarded an exhibition grant from The Pew Center for Arts and Heritage matched by on-going support from the PWD. A 4,700 square-foot, multidisciplinary seasonal exhibition, set in the Fairmount Water Works' former Kelly Pool (known as the "Aquarium Pool" by those who swam there), the exhibition explores the role of public pools in our communities, with the goal of deepening understanding of the connection between water, social justice and public health (Dawson 2018).

Through an inspiring collective of artists, swimming champions, aquatic activists, researchers and scholars, POOL weaves together history, site-specific artwork, storytelling, scholarship, and place-based learning (fig. 7) (Dawson 2018). The exhibit installations throughout the historic structure build on one another to illuminate a history of segregated swimming in the US and its connection to present-day drowning risks affecting Black communities. At this moment in time, the persistence of institutional racism has fueled a movement that has touched every major city and small town in the US. POOL's messages and experiential goals connect the Fairmount Water Works to this landmark time in American history and validate how important shared social and public spaces are to fostering social change.

The multidisciplinary stories told in the Mussel Hatchery and within POOL are framed by the site's unparalleled power of place – a thread that links the future with the past and connects visitors to the urban landscape and watershed of today. The FWWIC traces connections between individuals and our water sources, linking global water issues of the present to one of Philadelphia's greatest civic contributions: the engineering innovations of the historic Water Works site. Both projects advance the commitment to water for all – whether for drinking, swimming or agriculture.

What is the Future?

Today the parks department tries to make the site more resilient at a time of increasing natural disasters, while providing a welcoming environment for all Philadelphians. The Fairmount Water Works stands as an example of a civic commitment to safe, clean and reliable water access; it embodies engineering innovation and an aesthetic expression of the public good and the persistence and perseverance of water suppliers, public park managers and the people of Philadelphia who celebrate its legacy and power of place by not allowing it to deteriorate beyond repair. Will it survive the new threats brought on by climate change? The answer lies within the civic commitment to do what needs to be done to ensure the preservation of this legacy for generations to come.

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