BLUE PAPERS

Water & Heritage for Sustainable Development

2023/2

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

Leiden-Delft-Erasmus
Universities

2023 (Vol. 2 No. 2)

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Journal Description

Blue Papers: Highlighting the Critical Role of Water and Heritage in 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 the 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.

This issue of Blue Papers results from a collaboration between the Chair History of Architecture and Urban Planning, TU Delft; UNESCO Chair Water, Ports and Historic Cities; LDE PortCityFutures Center; ICOMOS NL/ISC Water; Waternet; Witteveen+Bos; Stichting OpenAccess Platforms (SOAP).

This issue of *Blue Papers* has been made possible by financial contributions from the Ministry of Infrastructure and Water Management, the Netherlands; the Chair History of Architecture and Urban Planning, TU Delft; LDE PortCityFutures Center and Waternet.

Cover image: The stilt fishermen on the shore near Matara, Sri Lanka. Like many other intangible water heritages, stilt fishing is among one of the dying traditions that urgently need to be revalued and rejuvenated. It needs to be brought back to life with the local communities and live beyond its current limited value as a tourist attraction (Queenie Lin, 2019).

About the publisher: SOAP is the abbreviation for Stichting OpenAccess Platforms. Setting up a foundation in the Netherlands requires that you include the word "Stichting" (Foundation) in the name. SOAP offers affordable and fast solutions for the dissemination of research content in the arts, architecture, built environment and design domain. We host open access e-print, pre-print, conference proceedings, book and journal archives.

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Content

Blue Papers
2023 (Vol. 2 No. 2), pp. 1–3
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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 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 runoff, 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.

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).

Places 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.

Living with Water

Sara Ahmed
Founder-Director, Living Waters Museum

In East Libya in September 2023, two dams burst and flooded low-lying areas in Derna, killing thousands of people. The tragedy has given a painful twist to the idea of living with water and to the preface I was planning to write for this volume. Yes, water is the elixir of life, but water can also bring death and destruction, and the rapid pace of urbanization coupled with the growing uncertainty of climate change means that we must be sensitive to how we live with water. All our actions, whether remodelling riverfronts in the name of modernization, covering ancient water tanks or reclaiming coastal land for malls, flyovers, bridges and housing societies, will have consequences, especially for the poor and marginalized, whose lives are shaped by the intersection of land and water.

All over the world, people have an intimate, if varied, relationship with water. That relationship may be embodied in the river running through their city, in an ancient stepwell, aqueduct, or a rainwater -harvesting system. It might be the ocean or seafront with waves quietly lapping the shores. Whether water is a source of livelihood, as it is for fishing communities and farmers, or is a place for quiet reflection or for recreation, water has many meanings for all of us. Understanding where our water comes from and where it goes, like the ebb and flow of our tides, is critical for planning water-sensitive futures. Some children will unmindfully open a tap to brush their teeth or have a shower, while others may walk with their mothers or siblings to fetch water from distant places, and others may stay at home missing school to look after the young ones – all these actions, whether they involve work or education, are shaped by access to water. How far, how little, how much, what quality.…

When I spoke about the Living Waters Museum at the Watershed Development Center, up in the Catskill Mountains in the state of New York last year, a little girl asked me, “Why do women in India carry water on their heads over so many dusty miles? Who tells them to do that?” I found myself, with some help from the girl’s grandmother, explaining how access to water intersects with gender roles, rights and responsibilities, with class, caste, age, ability, race and many other dimensions of our social identity. Water is not a free resource – it can never be, particularly for those facing discrimination in their everyday lives around water. A poor woman once told me, “Drought lives in our stomachs,” as she tried to fill her jerrycan from a watering hole.

Building a water-secure world means understanding not only the inequality that determines how we live with water, but learning about our fluid past, whether it is the built environment, or the rituals and practices that have been the foundation for our water values. A new civilization ethics concerning water is crucial to a more sustainable and just water future, especially for our children. This is

Blue Papers
2023 (Vol. 2 No. 2), pp. 4–5
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at the core of the work we do through collaborative partnerships at the Living Waters Museum, a digital archive using the power of storytelling and interactive tools to curate visual narratives about India's rich water heritage. *Blue Papers* represents a platform where we can learn about traditional water practices and the results of past developments and we can appreciate the work of those researchers and practitioners who manage to bridge water management and cultural values.

Editorial Issue 2/2023: Living with Water: Bringing Back Human-Water Relationships

Carola Hein, Matteo D'Agostino, Carlien Donkor, Queenie Lin, Zuza Sliwinska and Julia Korpacka

In March 2023, thousands of people from various disciplines came together in New York for the United Nations 2023 Water Conference. The attendees included policymakers, activists, professionals and academics, all with an interest in the water sector. The conference provided a platform to share knowledge and exchange ideas about water-related challenges. Through a combination of in-house and side events, participants were provided with the opportunity to voice their concerns, engage in crucial discussions and exchange novel insights, despite the predominantly scripted nature of the event as a forum tailored for politicians and policymakers. The Water Conference identified risks ensuing from the number of short-term commitments, unclear funding and the lack of quantifiable measurements (President of the General Assembly 2023). The Water Conference also saw the adoption of the Water Action Agenda (United Nations 2023), consisting of voluntary commitments in line with UN Sustainable Development Goals (SDGs) and focusing on water. Crafting these commitments posed a challenge, highlighting the complex nature of the United Nations' efforts in fostering collaboration among people representing diverse backgrounds, interests, cultures and histories.

The editorial team of *Blue Papers* was honored to be part of the Water Conference as part of the work of the UNESCO Chair Water, Ports and Historic Cities. With several partners, we co-organized two series of events that resonate with globally shared concerns. "UN of Rivers, Deltas and Estuaries" focused on the role of these water bodies worldwide in sustaining humankind, and "Water and Heritage: Connecting Past, Present and Future." These events provided a platform for water managers, policymakers, urban planners and heritage experts to share their ideas, concerns and

^ Fig. 2 Visual representation of conversations with activists and artists, drawn live during "UN of Rivers, Deltas and Estuaries" and "Water and Heritage: Connecting Past, Present and Future (Source: Mark van Huystee, PortCityFutures 2023c).

Blue Papers
2023 (Vol. 2 No. 2), pp. 6–9
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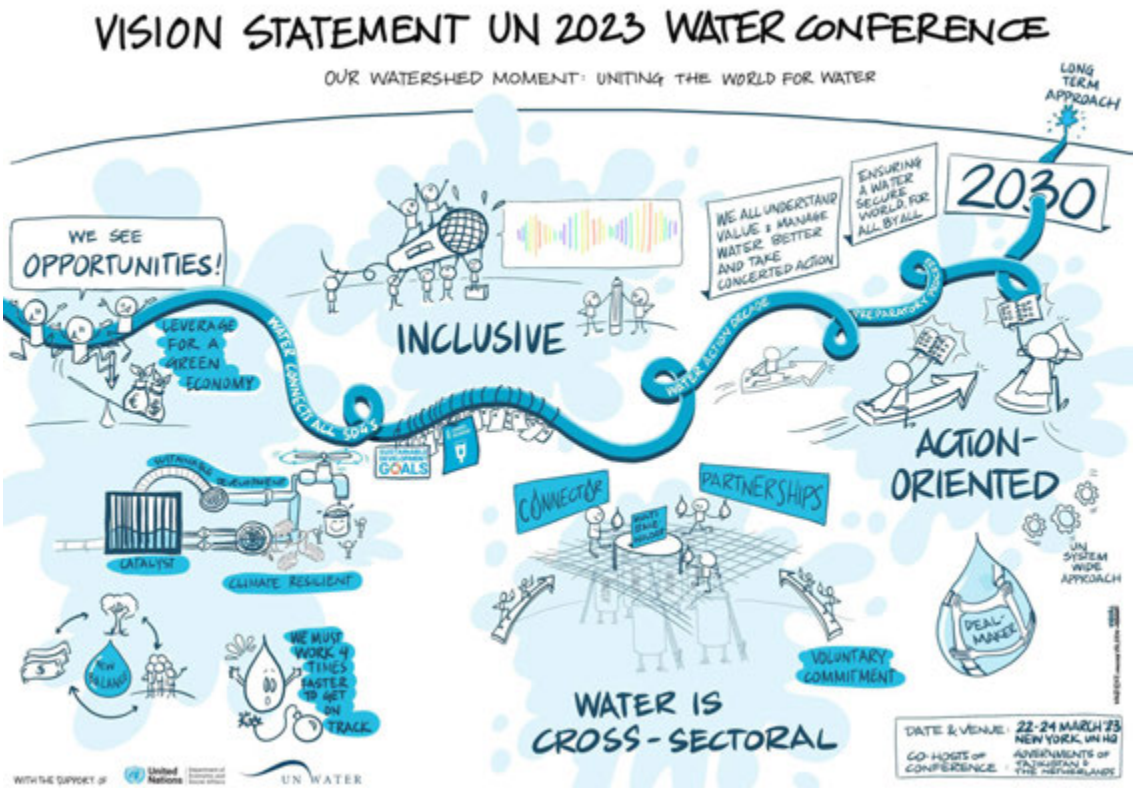
Editorial



^ Fig. 1 Vision Statement of UN 2023 Water Conference (Source: United Nations, 2022, https://www.unwater.org/news/un-2023-water-conference).

proposals. The conversations are summarized in two blog posts and a series of visuals on the PortCityFutures platform (PortCityFutures 2023a, 2023b, 2023c).

Many participants at the UN 2023 Water Conference acknowledged the need for long-term think-

ing. More than 800 commitments were issued as part of the Water Action Agenda. Some 219 commitments include a reference to heritage, and 166 acknowledge the role of the past. Yet, how exactly the past and heritage can help to address water-related challenges requires clarification.

One step to a better connection between water, heritage and the past is understanding which disciplines engage with water and how, and what this means for valuing water, culture and heritage in a shared way. Therefore, capacity building in multiple disciplines – from architecture to dentistry, plumbing to carpentry – can help facilitate more sustainable and inclusive water use. For example, connecting professional water practices to the public and linking the study of maritime heritage to the exploration of water management and its past may help increase water awareness and facilitate the emergence of shared approaches to valuing water and heritage. Studying the past can help us understand the relationship between humans and water and the multiple forms of tangible structures and intangible practices that may derive from living with water. A first lesson to learn from historic practices may be to respect water on a daily basis, pragmatically, emotionally, and perhaps also spiritually.

The Valuing Water Initiative, established in line with the United Nations Valuing Water Principles, has opened debate on a value-based design that goes beyond economic values. As Michela Miletto and Richard Connor write in their preface to the report *Valuing Water*:

> The values of water to human well-being extend well beyond its role in supporting direct physical life-sustaining functions or economies and include mental health, spiritual well-being, emotional balance, and happiness. The often intangible nature of these sociocultural values attributed to water regularly defies any attempt at quantification, but they can nevertheless be regarded amongst the highest values. (UNESCO World Water Assessment Program 2021, 8)

A recent survey conducted by the Valuing Water Initiative emphasized similarly: "Valuing water needs to bring together explicitly the public and private values of water. Bringing these together using a common denominator, typology, or methodology is difficult because they are intrinsically different in value and scale" (Valuing Water Initiative 2020, 7).

The Valuing Water Initiative in its first First *Global Survey of Water Values* proposes a system of multiple values – a values landscape – including what the survey calls fundamental, governance and assigned water values (Valuing Water Initiative 2022). The findings of the survey suggest that there are economic, environmental and cultural values at play. Identifying values is an important step, but how exactly can we implement the values in practice?

We must understand our water system and the values that shape them in space (in the landscape, cities and buildings) and through time (past, present and future) as flows (water is always changing and never fixed) and through the lens of networks in an ecosystemic way. A so-called "value case"

going beyond a financial bottom line can help. To achieve that, we need broad awareness of the role of values, including values that have shaped practices of the past, values that have catalyzed transformations, and values associated with material, economic and cultural flows. Our values also determine how we interact with nature – and how we design and create.

For this reason, it is important to point to the concept of culture, which includes ideas, languages, institutions, laws and rituals in particular social contexts. To get an idea of how diverse water values can be, you only need to think about the different ways you engage with water. We propose that turning to the past, history and heritage can help, at least in three ways:

*1. History can serve as a **mirror** for water-system thinking.*

Analyzing past water systems and the values that guided them can help us understand the importance of water as a complex system, from source to sea. We can get a better sense of how integrated water systems connect spaces, institutions and culture, and how this history can help us imagine sustainable water futures. Values are often anchored in habits, traditions and cultures – even recently created ones. By exploring the heritage of communities, it is possible to unveil these values. For example, the study of traditional water systems shows us how water management, architecture, institutions, laws and rituals have been integrated and have allowed communities to thrive in extreme conditions, including arid or flood-prone environments.

*2. The past has to be recognized as the **foundation** for future development.*

The structures we have erected, the institutions we have formed, the laws, tools and cultures we have developed over centuries are not only a study object; they are the foundation for how we can design the future. Once established, a system of dikes, polders, pumps and institutions shape all future interventions. History provides us with empirical evidence of developments and interventions that failed. It also teaches us ways of living with water that might be reestablished.

*3. Specific spaces and practices can be identified and protected as **heritage**.*

Heritage properties and practices can inspire sustainable development, but if we want to save them for future generations at a time of climate change, they need to be protected, including from destruction by changing water systems. This means developing clear frameworks, terminologies and policies. For example, water management plans for UNESCO World Heritage Sites could help protect these sites. Traditional ways of living with water can also inspire future water management.

The contributions in Volume 2 Number 2 (2023) of *Blue Papers* complement the discussions held in New York during the UN 2023 Water Conference. They stress the benefits of revisiting the good practices of the past with methods and case studies that are neither energy nor capital-intensive, but that are value-based and offer ways of living well despite various water challenges.

Part I, "Challenges, Concepts and New Approaches," explores several value-based perspectives that are linked to indigenous communities, religious practices and living heritage and examines the political dimensions of water heritage. E. Lynn Porta and Aaron T. Wolf focus on the integration of water values in international treaties and organizations, an important perspective for the UN Water Action Agenda. Vera Lessa Catalão and Sergio Augusto Ribeiro explore the role of nature-based solutions and ancient water practices in South American Indigenous communities, by revitalizing ancestral concepts such as *buen vivir* (well-being) conceptualized as a common good. Pascal Bourdeaux touches on the importance of religious history and its potential capacity to develop moral practices for a "global history of religious ecology." Jet Bakels and Chantal Bisschop discuss intangible cultural heritage practices that can support the recreation of a more climate-resilient landscape. Jean-Paul Corten follows up on this discussion with a proposal for systematically connecting water and heritage management through their history, conservation and planning. The complex relationship between the past and the present is further explored by Lena Hommes, with an analysis of the imaginaries of the past and the influence of contemporary values in the example of a Peruvian ancestral water system and the instrumentalization of values for political purposes. Finally, Elena Perez-Alvaro explores the role of intangible and community practices of underwater cultural heritage in achieving the SDGs.

Part II, "Methodologies and Case Studies," begins with three contributions that provide innovative approaches and insights for understanding – and planning according to – the different ways humans relate to water in densely inhabited areas, across multiple geographies and climatic conditions. Rianne Makkink and Barbara Kaczmarczyk describe how the WaterSchool M4H+ project in Rotterdam proposes a new way of thinking about the management of water resources by promoting sustainable, consumption-conscious practices. Theo Kremer, Marco Scheffers and Julia Geven present their approach to harnessing and implementing historical data in sustainable development projects, such as the redevelopment of the Nieuwmarkt area in Amsterdam. Queenie Lin revisits how the Dutch East Asia Company incorporated their own water management knowledge with local knowledge and colonial precedents for living with water in the tropics, identifying challenges for contemporary heritage management. Ana María Arbelaez-Trujillo and Juliana Forigua-Sandoval explore the tensions between natural and cultural heritage preservation using the case of the Serpis River in Spain. The three articles that follow address the potential of traditional ways of living with water to adapt and respond to climate change. Moustaph Ndiaye explores the water heritage of Senegal's St. Louis Island and its climate vulnerability, reflecting on the potential of the area's sustainable development. Laura Cipriani and Alessandro Destro focus on ways in which past coastal landscape and heritage practices can help in addressing climate change challenges through the case of Venetian "fish valleys" in Italy. Szu-Ling Lin and Cheh-Shyh Ting present the Erfeng Irrigation Canal System in Taiwan, which not only facilitates long-term collaboration between Taiwan and Japan but also provides potential solutions to contemporary climate challenges. Joseph Pieterson's article on the Nzulezo stilt village in Ghana explores the challenges of cultural heritage preservation in the context of tourism-oriented site management. Tourism is also one of the topics addressed by Inge Bobbink, Wenting Gao and Isabella Banfi, who present a layered visual analysis as a prima-

ry methodology with which to assess the current situation of the historic water supply system of Sassi di Matera in Italy. Finally, Filipe Condé Alves closes with the Brazilian case of Caxambu City, where the local government, together with citizens, pursued the recognition of heritage status as a way to safeguard traditional ways of living with water and to maintain community water access. In summary, these articles suggest the necessity for humans to rethink the values of living with water. They prioritize sensitivity to cultural and local values over anthropo- and techno-centric approaches. The case studies, methodologies, concepts and new approaches put forward in this issue of *Blue Papers* demonstrate that *living with water* is not synonymous with living around, against, or even despite water. Instead, they establish a unique body of knowledge through which we can reevaluate our relations with water in diverse geographical and functional contexts.

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Matteo D'Agostino is a researcher at Delft University of Technology, a member of the PortCityFutures research group, and is 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 a researcher at Delft University of Technology. She is also affiliated with the LDE PortCityFutures Center 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 including climate change and rapid urbanization pose a risk to the future design and planning of historical water cities like Milan. Other interests include volunteer work.

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Queenie Lin is a PhD candidate in the 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 in Cultural Heritage and Arts Innovation Studies, Taipei National University of the Arts, 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), has equipped her for 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 for 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 architectural designer and researcher with a master's degree (cum laude) from Delft University of Technology in the Netherlands, with previous academic experience at Westminster University in London and the Chinese University of Hong Kong. Her research explores the potential of loss as a method aiding the adaptation of rural communities and their persistence within dynamically evolving contexts in Asian cities, with regard for local cultural heritage and ecology. Her previous professional experience involves large-scale urban projects in the Middle East, focused on regional development.

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Douwe de Jager is a graduate in Architecture at Delft University of Technology. After finishing his bachelor's degree, he continued with a master's degree in Architecture. His master's thesis focused on transformation and the potential of R-strategies in the built environment. As a student-assistant at the Chair of History of Architecture and Urban Planning, he contributes to research projects through (geospatial data) visualization. Besides architecture, his interests include photography and graphic design.

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Julia Korpacka recently graduated from TU Delft with a master's (hons) in Architecture, Urbanism and Built Environment, having received a cum laude distinction. She previously studied in the UK (BSc, University of Bath) and France (ENSAL), and worked in international architecture offices in London and Berlin. Her honors research explored how different perceptions and political interests influence the participatory processes around the redevelopment of the former shipyard area in Gdansk, Poland. Her master's thesis proposed the adaptive reuse of a 1970s courthouse in Antwerp, Belgium, for an archive of contemporary art. Other interests include political critique in spatial and architectural contexts, urban geography, feminist pedagogy, writing and the adaptive reuse of existing buildings.

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PART I Challenges, Concepts and New Approaches


גבול לפניך
BORDER AHEAD
حدود أمامك
граница перед вами

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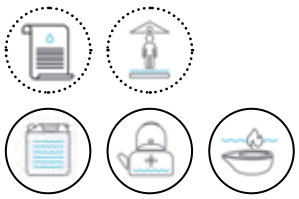
Water, Culture and International Institutions

E. Lynn Porta
Concurrent Technologies Corporation; North American Youth Parliament for Water
Aaron T. Wolf
Oregon State University

This article focuses on the integration of different values of water, ranging from intrinsic to emotional, in international treaties and transboundary organizations. After introducing the "four worlds of water" (Wolf 2017), we discuss the increased recognition of locally based cultural and spiritual values of water in global conventions, international freshwater treaties and regional river basin organizations. Global conventions generally use more technical and broad formulations and international treaties tend to focus on small geographic areas and the need to protect water, and environmental resources associated with water, while the cultural impacts of water management decisions on local communities are most apparent at the governance level of regional organizations.

KEY THEMES



< Fig. 1 Christians taking baptism in the Jordan River (Source: Aaron Wolf, 2019).

The Four Worlds of Water

Compared to other natural resources, water is unusual in the multiple layers of importance it holds for both human and non-human uses.[1] Agriculture, transportation, energy, and basic ecosystem functioning and services all rely on water. These uses are examples of the "physical" values of water. They involve the water we see, touch and move; but also "mental" water – consideration of its efficiency or price. Focusing on these values of water is common in mainstream water management, which is heavily influenced by the industrialized West in global governance institutions, such as the United Nations. These institutions more often than not focus on what can be quantified and located precisely on a map, unlike emotional and spiritual associations, as described below.

In contrast, many local, culturally specific, spiritual and Indigenous traditions also value water for its "emotional" and "spiritual" element. The concept of "emotional" water refers to its connections to history, sovereignty, power and justice. "Spiritual" water stems from the aspects of water that focus on connections and relationships with some form of "other"– other people and their needs, the water resource itself, or, if it is part of one's theology, the Divine (Wolf 2017, 47). In many traditions, springs, wells and rivers are the homes of deities, have divine healing powers and enhance processes of spiritual transformation.

These four "worlds" of water – physical, mental, emotional and spiritual – are often conflated or confused, especially as water management tends to favor those aspects we can measure – physical and mental waters. This rift became more prevalent with what has become known as the "Enlightenment" of the eighteenth–century Western world, when it was argued that public policies should be informed only by "rationality," as exhibited by whether a metric is quantifiable or not. The comparatively recent and geographically specific result has been that, in management and negotiation settings, we are often comfortable talking about the waters that we can measure – physical and mental waters – while the real heart of the issue at hand may relate more to emotional or spiritual waters.

Patterns where the four worlds of water described above appear occur in three layers of water management: global conventions, regional international treaties concerning freshwater resources and local transboundary river basin organizations. These three layers of water management each interact with the four waters (physical, emotional, mental and spiritual) differently, based on the values prioritized at different levels of governance or those overlooked in policymaking. The Transboundary Freshwater Disputes Database at Oregon State University collects information about these three layers of water governance, with documents dating back to 1820. We surveyed the database to note that, over the course of its 200-year record, there are signs of increasing interest in recognizing values for water based on local, cultural and spiritual aspects.

Global Conventions

Documents that guide ethics at the global scale, by their nature, need to be quite general. As such, these documents are often disconnected from local values, resulting in occasional setbacks in the global community's approach to broader and more inclusive values when man-

1. Material in this article draws from: Porta and Wolf (2021).

aging shared water resources. As an example of how these documents can be limited, the 1992 United Nations Economic Commission for Europe (UNECE) Water Convention focuses on water quality but in quite technical terms. It focuses on encouraging signatory countries to work together on the "physical" aspects of water, typically in the form of the creation of joint bodies around water quality and quantity monitoring and research. The only two real exceptions are "effects on the cultural heritage," and "sustainability" is defined as meeting the needs of the present generation, "without compromising the ability of future generations to meet their own needs" (UNECE n.d.).

At the national scale, some "Western" countries have increasingly been reaching out to Indigenous communities for language to describe the emotional and spiritual dimensions of water. The New Zealand National Water Policy (Government of New Zealand 2014) was developed in 2014 with close participation of the Maori community, resulting in explicit language referring to the spirituality of water and a powerful example of how the four worlds of water might be united:

> All things in the natural world have *mauri* (life force) and *wairua* (a spiritual dimension). Respect for the spiritual integrity of the environment and the *atua* (God) that created it will ensure that the *taonga* (treasure) can be protected and passed on to succeeding generations.

International Freshwater Treaties

The layer of water management "below" global conventions, such as the 1992 UNECE Water Convention, is the layer of agreements between states which share international water resources. Moving from the global level to such regional international agreements, we can see that specific patterns of leadership in expressing emotional and spiritual values of water continue to emerge in some regions. Treaties help states organize their interactions over shared water resources. These documents also communicate governments' shared goals, needs and values (Dinar et al. 2019). Over the last two centuries, the "spiritual" and "emotional" dimensions of water slowly found space in international treaties. Values associated with the spiritual and intrinsic dimensions of water first proliferated in international agreements beginning in the 1950s. The 1980s saw a sudden transition to an intensive, long-term concern for water and interconnections between hydrological, social, cultural and economic cycles and systems (Porta and Wolf 2017). These activities are,

^ Fig. 2 Ablution fountain before the Dome of the Rock in Jerusalem (Source: Aaron Wolf, 2022).

^ Fig. 3 A sacred spring in Laos (Source: Aaron Wolf, 2013).

in most cases, associated with specific water resources, and therefore would not apply to all waters of each member country to the agreement. These patterns build on established literature based on work conducted at Oregon State University, which identified the power of water resources to be points of cooperation rather than conflict (Wolf 2008). Key issues from the agreements in place for specific resources include intergenerational water justice, measures to monitor or prevent localized pollution and concern or protection, for local ecosystems or non-human needs for water. This recent trend indicates a building support for values associated with the spiritual and intrinsic dimensions of water, reflected in policies that seek to address these issues.

Different cross-border groups of neighboring countries approach spiritual and emotional elements of water in distinct ways. In the Global North, one or two countries in a region tend to be peer-leaders in their concern for these issues. In Europe, for instance, Finland, Ireland and Georgia are the regional leaders in integrating the "mental" and "emotional" aspects of water in international water agreements (Porta and Wolf 2017). These connections manifest in documents that strongly feature issues of sustainability and equity, and discuss managing ecosystem functions in specific basins in order to protect downstream or related ecosystems and biodiversity for their intrinsic value, in contrast to agreements which manage water for specific industrial or economic purposes. These agreements also tend to focus on small geographic areas such as specific channels, groundwater resources or reservoirs forming borders between countries, or on regulating specific sectors of the local economy.

In the South, there is regional support among neighboring countries for the recognition of emotional and spiritual water values among neighboring countries. Agreements in the Global South/East speak generally about sustainable development and equitable resource access alongside environmental protection and conservation. In Africa, for example, the 1987 Agreement on the Action Plan for the Environmentally Sound Management of the Common Zambezi River System, signed in Harare, addresses both intrinsic values of environmental integrity that need to be protected alongside improving equitable human access to environmental resources in the river system. These protections for the inherent value of the Zambezi system and the communities with social ties and cultural heritage associated with the environment are an example of a more complex recognition of spiritual and physical dimensions of water. The 1991 treaty between the Re-

public of Uruguay and the Federal Republic of Brazil for the use of natural resources and development of the Cuareim River basin thematically focuses on economic development that also conserves resources in the river basin for future generations. These are two documents out of dozens that mention a need to protect water and environmental resources associated with water for the intrinsic value of the resources, the ecosystem and its inhabitants.

River Basin Organizations

The third layer of water management interacting with the four worlds of water are river basin organizations (RBOs). RBOs are institutions with broad mandates in which representatives of countries located in the same international river course or river basin manage shared surface water resources (Schmeier et al. 2016). These organizations are diverse in structure and purpose. Some are knowledge-sharing spaces between countries and economic sectors, such as the Lake Tanganyika Authority (Porta and Wolf 2017). Others can help advise regulators in different countries on sensitive issues, such as the Finnish-Swedish Transboundary River Commission (FSTRC) (Porta and Wolf 2017).

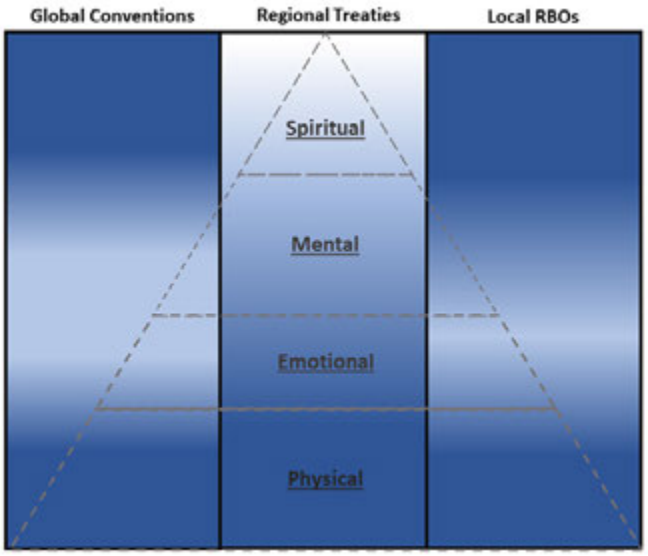
Even at this scale, directly acknowledging the link between culture and water is rare in RBOs. This is a more common practice in African organizations. The Lake Tanganika Authority, the Zambezi Water Commission and the Lake Victoria Basin Commission all acknowledge the cultural heritage of, and intergenerational need for, protection of local water resources in their work. The FSTRC also focuses on protecting the rights of Indigenous groups in Finland and Sweden. The Commission specifically protects the traditional fishing practices of these groups.

Conclusion: Cultural Values and Water Management

In treaties and RBOs in the Global North and South, there is a concern apparent both for the cultural values of water and the physical management of water. However, RBOs address this dual priority more directly than comparable international treaties. The duality in these documents indicates two possible trends to utilize for the future of water. In one arena, countries negotiating treaties are expanding their vocabularies and acceptable priorities to include culturally based protections of water. In the past, concerns about water that were based on connections between physical water and cultural, spiritual water were harder for states to recognize or commit to publicly. The increased presence of these values in treaties then influences the second trend emerging in RBOs. Now and in more local-level management, these connections often become realities for the RBOs established by treaties and the on-the-ground work carried out by these organizations. Thus, treaties may not express values focused on cultural, human-environmental and hydrological connections, but these connections tend to become unavoidable and manifest when managers must implement projects.

Fig. 4 is explained as follows:

Gray text and dashed lines indicate the four worlds of water (physical, emotional, mental and spiritual). The size of respective pyramid layers reflects the order of the four worlds as described in Wolf (2017), and the relative frequency of these worlds being addressed in water management layers. For example, the wider "base" of the physical world represents its dominant representation across all water management arenas, whereas the narrow spiritual "top" shows the rarity that these topics are addressed overall.



^ Fig. 4 Conceptual figure summarizing trends in manifestations of the four worlds of water across the three international water governance layers discussed (Source: Lynn Porta, 2023).

Specific trends of the four worlds manifesting with relative frequency to each other within each water management layer (global conventions, regional treaties and RBOs) are represented in blue-gradient blocks overlayed above the pyramid layers, wherein the darker shading indicates more frequent representation of the values associated with each world as present in a specific water management layer.

Global conventions, which need to be more general in nature, address the broadest concerns of the physical and spiritual/cultural values of water that the global community can consent to addressing. Regional treaties historically focus on the physical and mental worlds of water, with recent trends also supporting a growth in addressing emotional and, to a lesser extent, spiritual values associated with shared water resources. Local RBOs, where practical management meets localized values and culture, have a more even distribution of marrying all worlds of water, albeit with some regional variation.

There are lessons for each layer of governance from looking specifically at how cultural awareness can enhance water management. In treaties, states express generalized values regarding environmental protection and sustainability, and the physical needs of their constituent populations in relation to water supply and quality. RBOs are forums that more frequently recognize the cultural impacts of water management decisions on local communities and their ability to practice long-held fishing, agricultural and social traditions. These are also spaces where local communities can be important influencers, particularly concerning the value of water with cultural or spiritual connotations (Porta and Wolf 2021, 17). Local scales of management and actors can thus be a source of ground-up leadership regarding the voicing and incorporation of these concerns into scaled-up international institutions. At the local level, wisdom from local sources and knowledge can be brought to the fore of water management.

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Water and Heritage: Sustainable Alternatives Based on the Worldviews of South American Communities

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Water has a central position in the cosmovision of Native peoples in Brazilian culture. In the Andes, water is sacred and revered. However, in South America, colonial practices and the advance of agriculture and farming following industrialization has had devastating effects on cultures and ecologies. Only in recent decades has awareness started growing that there might be lessons for a sustainable future to be found in Indigenous peoples' ways of living with water. This article conceptualizes the importance of "nature-based solutions" and illustrates this with examples from Brazil (Minas Gerais) and the Andes. It shows how ancient water practices are still present in local communities and languages, and the authors suggest ways of reinstating and protecting water-related heritage that go beyond the divides between nature and culture, tangible and intangible.

KEY THEMES

< Fig. 1 Aerial photo of the area affected by a dam breaking in Mariana, Minas Gerais (Source: Vinícius Mendonça/IBAMA Brazil, 2017, CC BY 2.0, via Wikimedia Commons).

Introduction

Understanding the world's diverse water cultures is essential to grasping the different rationales, conflicts of interest, and impasses encountered in community-based water management. Such an understanding also suggests possible solutions to common problems. The cosmovision of the Native peoples of South America that is manifested in their ways of seeing, thinking, ordering and feeling the world indicates paths for management based on nature-based solutions, as proposed by a United Nations report (UN 2018). That support recognizes the importance of local traditional knowledge and practices in the functioning of ecosystems and in nature-society interaction. The intersubjective perception of the world of the Amerindian peoples has depended on the interaction between culture and environment.

The ethics of the Indigenous people of South America is rooted in the collective identity of the inhabitants of a common territory. Indigenous communities reassert this ethical sensibility as they try to defend their original place in recurrent clashes with mega-projects of intensive agriculture, dam construction and mining with their destructive and degrading social, cultural and environmental impacts. Cristián Parker (2017), sociologist and researcher, has studied the different worldviews of Indigenous groups, economic groups and environmental movements, as well as the conflicts between different social actors involving water and natural resources in South America. Parker notes that as part of the colonialist development process, extractive policies in Latin America are generally not respectful of the environment (2017).

Parker (2017) also assesses various ethical discourses, such as those proposing utilitarian growth. He defends regulatory ethics as a way to minimize the environmental and social impacts of extractive companies, thus highlighting corporate social responsibility. In addition, Parker proposes sustainable development, with companies regulated by the state, and emphasizes the discourse of ecological ethics.

South American Cosmovisions and the Destruction of Indigenous Territories in the State of Minas Gerais, Brazil

These various discourses are evident in the struggle for survival of the Krenak people in Minas Gerais. The fight for the preservation of their land dates back almost 200 years. When the Portuguese arrived in the territory that today corresponds to the city of Resplendor, they fought against the Krenak to occupy the area to extract minerals and natural resources. It was at this time, around two centuries ago, that the attempt to exterminate the Krenak Indians began.

The Krenak people gained national visibility after the tragedy in Mariana in November 2015. A dam belonging to Mineradora Samarco broke, bringing a flood of toxic mud that covered more than 200 kilometers to the Rio Doce basin (fig. 1). Vegetation and fauna were destroyed, and toxic mud residues covered the river bed like an impermeable plastic mantle. The river was the main source of livelihood for the Krenak community who consider the river their relative and sacred entity. Watu, meaning the old grandfather, the nickname of the river in the Krenak language, is an essential element of the collective identity of his people and his flow is a link between the past, present and future of Krenak riverside communities. Before mining and the dams were built on its course, the Doce River sustained considerable life. In addition to providing water to humans and animals, Watu

made the food that sprouted on the riverbanks; he made fertile lands grow and fishing an important source of food and livelihood.

The Maxacalí, an Indigenous people who inhabit the same territory in the Rio Doce basin as the Krenak, saw their lands and forests devastated by cattle ranching in the early twentieth century. The ranchers cut down the forest and introduced mining. To this day, the Maxacalí continue to farm in traditional ways while surrounded by commercial farms and crushed by the colonial violence, murders and disputes around them. In an interview, Ailton Krenak says that 90 per cent of the Maxacalí people do not speak Portuguese and refuse to learn it – as a way of continuing to live in their world, which they are able to recreate every day (Massuela and Weis 2019). In the view of Paula Júnior (2021), the slow death of the Doce River started when its flow was interrupted by dams.

^ Fig. 2 "Meeting of the Waters" of the Negro and Solimões rivers (Source: Claudio JJ, 2009, CC BY-SA 4.0, via Wikimedia Commons).

Indigenous Worldviews, Traditional Knowledge and Protection of Territories

In Brazil, there are several UNESCO World Heritage Sites, protected by the Instituto do Patrimônio Histórico e Artístico Nacional (IPHAN), in addition to state and municipal bodies. Community initiatives to protect water include secular and recent ones, such as neighborhood communities and environmental movements that work to protect urban lakes and rivers. Religion can also be involved in protecting water resources and changing the way these resources are managed, as in the religious processions by boat that take place in Bom Jesus da Lapa on the São Francisco River, in the state of Bahia. The processions put water back at the center of community spirituality and are intended to prevent boats from running aground in the river. Another example of the protection of waters in Brazil for cultural and heritage reasons is IPHAN's declaration of the Negro and Solimões rivers in the city of Manaus (Amazonas) as heritage, in 2010, at the "Meeting of the Waters" (fig. 2). According to IPHAN (n.d.), "the more than 10 kilometers where you can see the dark and transparent waters of the Rio Negro running along the muddy waters of the Solimões River, in the Amazon, were registered as heritage assets due to the exceptional nature of the phenomenon, considering its high landscape value." This statement at the "Meeting of the Waters" was intended to protect this natural phenomenon from the threat posed by the construction of a port next to the area.

Another contribution of popular cultural heritage in relation to water comes from the Brazilian northeast. This is a dry region, where observing natural cycles, especially related to rainfall, is essential for life. In this context, the Prophets

of Rain have emerged – men and women from the countryside who make meteorological forecasts based on observations of changes in the ecosystem, the signals produced by animals, the atmosphere, and the position and visibility of celestial bodies, among other traditional forecasting methods (Silva et al. 2014). Some prophecies are based on dreams and even on religious rituals that mix Indigenous beliefs and other forms of knowledge. Practices of observing nature and acquiring empirical knowledge related to these predictions are usually transmitted orally from generation to generation.

Worldviews of Indigenous communities have long been ignored, but they can influence decision-making about the protection of community territories. Today, Amazonian Indigenous peoples in Brazil speak 170 languages. There were about six million people when the Portuguese arrived in 1500; today they make up a population of 600,000 self-declared Indigenous peoples. Article 231 of the Brazilian Constitution from 1988 establishes that "the Indians are recognized for their social organization, customs, languages, beliefs and traditions and the original rights over the lands they traditionally occupy, and the Union is responsible for demarcating, protecting and enforcing all their assets." Although even since 1988, there have been many violations of this principle, it represents some kind of awareness and commitment.

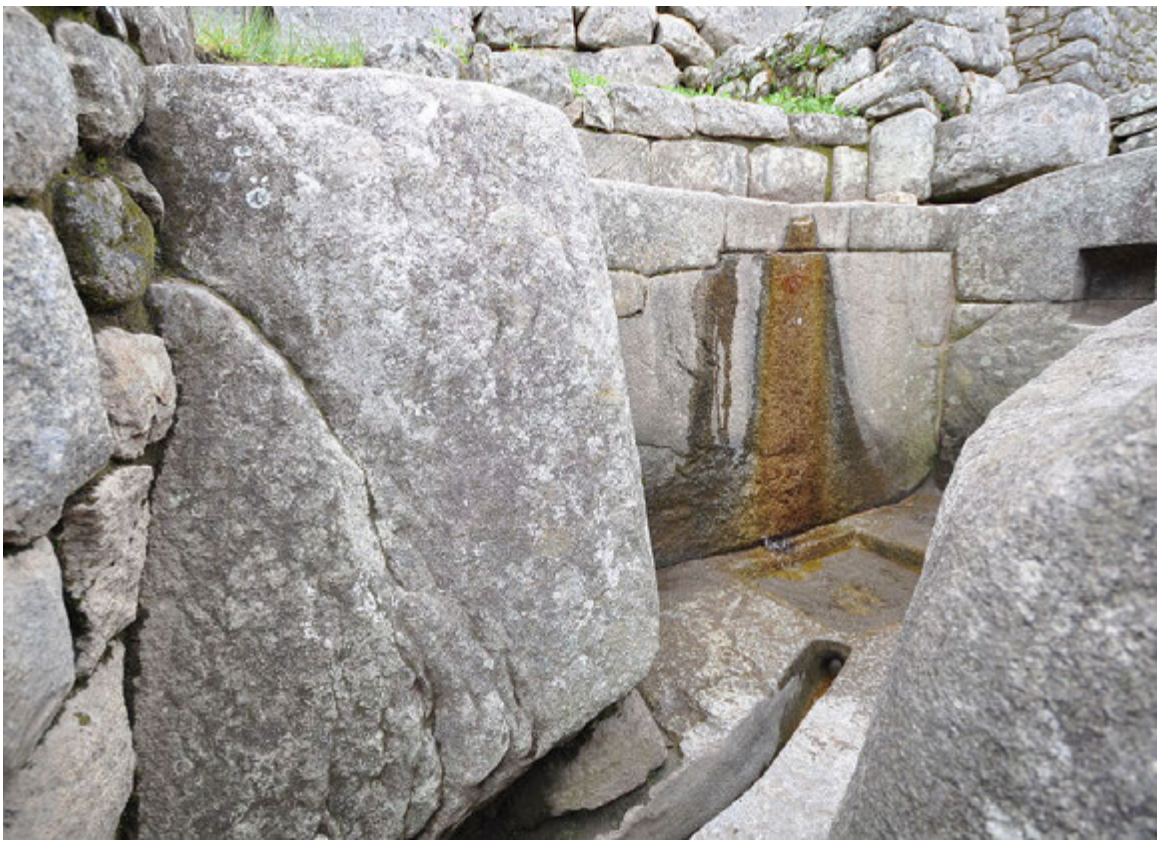
Currently there are territories and areas in Brazil that are protected for ecological and cultural reasons. This protection is established through policy instruments for the protection of cultural and environmental heritage, the delimitation of Indigenous peoples' lands and the recognition of sacred sites in Indigenous religious traditions. There are many religious rituals involving water that are common in Indigenous groups in Brazil. Diegues (Institute for the Environment and Renewable Natural Resources 2006, 169) states that "fishing rituals are performed to obtain permission to enter the river and catch the fish. For the Metutire (Caiapó group) water is considered an element that stimulates physical growth and psychosocial maturation, and women often send their children to take a rain shower so they grow up fast. The Mebengocrê (people from the water hole, also Caiapó) portray the close relationship of their people with water through many myths."

Based on the Indigenous cosmovision, IPHAN protected the Cachoeira de Iauaretê or Cachoeira da Onça, a sacred place of the Indigenous peoples of the Uaupés and Papuri rivers, on the Upper Rio Negro in the Amazon. The Lauaretê waterfall, a sacred site of the Indigenous people who inhabit the region, is bathed by the Uaupés and Papuri rivers in the Brazilian Amazon region. The inscription of the waterfall as intangible heritage favored the protection of the water heritage of fourteen ethnic groups who inhabit the region. Its inscription in the Book of Registration of Places was carried out in 2006, a recognition that the stones, slabs, islands and water courses around the waterfall symbolize wars, persecutions, deaths and alliances described in myths of origin and in the historical narratives of local ethnic groups.

Political conjunctures vary and in certain situations protection becomes possible. In other situations, the opposite occurs, as was the case of Guaíra or "Sete Quedas," sacred to the Guarani people, which was flooded in 1966 to make way for the Itaipu hydroelectric plant.

In the Andes: "Abya Yala" and *Buen Vivir*

As in Brazilian culture, water has a central position in the cosmovision of peoples of the An-



^ Fig. 3 There is a great number of water fountains, interconnected by channels and water-drainages perforated in the rock, designed for the original irrigation system (Source: Jorge Láscar, 2009. CC BY 2.0 via Wikimedia Commons).

des. The original Andean people called America "Abya Yala," which means "mature land of eternal youth." For many centuries, European colonization suffocated Andean culture and made it invisible. However, this vision of the land, rooted in Indigenous cultures, continued to be lived by the Quechua, Aymara, Guarani and others.

Alberto Acosta is one of the authors who recorded the original Andean and Inca cosmovision. According to Acosta (2016), *buen vivir* (well-being) is affirmed in community and cooperative concepts, different from the "good life" for some individuals and the accumulation of goods for common use, such as water, land and forest. The unity of human beings with nature is present in this Andean worldview that emphasizes long cycles of evolution, cooperation and fraternity. The sense of community includes human and biological interaction. Everything is interconnected in our common home. Fernando Huacanuni (2010) is another author who has treated *buen vivir* not only as an intellectual conception but as a philosophical and spiritual vision, the life response of Indigenous peoples, sustained by an ancestral cosmovision. Everything lives: the mountains, the trees, the people. Among the Aymara peoples, it is said that we are children of Father Cosmos and Mother Earth. According to David

Choquehuanca (minister of foreign affairs in the government of Evo Morales from 2006 to 2017), cited by Huacanuni (2015), Indigenous people believe that we are all brothers, humans, and that Mother Earth is fed with water as "milk from the earth," so we must live in harmony with nature and other human beings, caring for and protecting Mother Earth.

The concept of *buen vivir* can support actions to protect water and natural heritage in South American countries (fig. 3). It is a valuable intangible heritage left by Andean communities as a legacy to be continued. Indigenous worldviews have demonstrated resilience and the ability to resist invasions and external pressures, and have strengthened and resurfaced in recent decades. The age-old wisdom contained in the "well-being" cosmovision points out paths to new knowledge and practices that we are invited to follow in building a sustainable future, with socio-environmental justice and respect for life in all its forms. The tangible and intangible heritage that Indigenous cultures have left us is of great value in thinking about the present and the future, and a fundamental approach to implementing the Sustainable Development Goals (SDGs).

For Acosta and Brand (2018, 136), the sustainable economy must be based on solidarity, reciprocity, relationality and complementarity. They consider it essential to socially reinterpret nature from cultural imaginaries such as "*buen vivir*" or "*sumak kawsay*," in the native language of Quechua. The cosmovisions and epistemologies of the cultures of the South are alternatives to the hegemonic concept of economic growth and show that socioeconomic models focused on quality of life, fraternal relationship with nature, socio-environmental justice and sustainability are possible and viable. The history of territorial occupation by Native peoples of South America points in this direction.

Recognition of Nature and Water as Legal Entities

In the clash between the mercantilist economic discourse, the environmental discourse and the Indigenous cosmovision, a strategy adopted by some countries has been to recognize water and nature as "legal persons." In 2010, Bolivia proposed the institution of water to the UN as a human and natural right. In a proposal from Bolivia, April 22 was declared by the UN as the International Day of Mother Earth, Pacha Mama, Mother Earth in Balance. Bolivia and Ecuador are the countries that have made the most progress in applying and institutionalizing this approach based on Indigenous traditions. This South American discourse is in line with initiatives in other parts of the world that have also proposed and approved legislation recognizing rivers as "legal persons" due to the ancestral relationship of their communities with these rivers. In 2017 New Zealand's parliament recognized the Whanganui River (Te Awa Tupua) as an indivisible living whole constituted by the river and its territory. The intrinsic value of Whanganui and its cultural significance has been declared a legal person, recognizing and validating the cosmovision of Indigenous traditions of the river as a being.

Final Considerations

At a time when climate change has intensified, we are witnessing a more acute, imperceptible and sometimes open confrontation between a utilitarian ethic of exploitation and an ecological ethic. In Western colonialist thought, nature is considered an object subject to exploitation (as are vulnerable social groups). This, according to

Parker (2017) is the logic of immediate capitalist accumulation and the ethics of post-industrial, globalized and neoliberal society.

In this context, Indigenous ethics confronts the commodification of territories and emphasizes a kinship of humans and nature that inspires contemporary ecological ethics. The cosmovisions of the Native peoples of South America and the principles of socio-environmental sustainability recognize unity in diversity and *buen vivir* in a peaceful and fraternal relationship with all communities of life. The way forward must be built, necessarily, from an ethics of reciprocity between human beings and nature. The UN notes that 1.8 billion people are affected by land degradation and desertification, extreme weather events and drought, and that economic losses caused by climate change cost an average of $46 billion annually. We are water, outside and inside of us. Life calls for an ethics of care, the only kind of ethics capable of reversing the desolate scenario and the devastating impacts of climate change on planetary ecosystems and, above all, on human communities. According to Catalão (2006), water is the element of listening. It is urgent that we listen with an open mind and heart to the wisdom of traditional and Indigenous peoples in order to achieve the SDGs.

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At the Sources of the Sacred: Evoking Nature and its Cults by Listening to the Rivers

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Zones of fluvial influence, which were the cradles of many human societies both past and present, are key in today's discourse on how to manage water, culture and heritage in ways that are compatible with sustainable development. Water/river customs have served environmental/cultural practices. This article discusses the interdependence or dissociation between "nature/water" and "culture," which has forged a more or less strict dualism depending on specific religious frameworks. This dualism can be critically analyzed by sociology, phenomenology and political ecology. The relationship between the reverence accorded to the "sacred" and "nature" and how humans have maintained this respect is however not enough when addressing environmental crises. Could a new approach involve exploiting religious history to restore practical and moral meaning to contemporary challenges, including water-related environmental issues? Very few research programs or development projects really consider transdisciplinary and transcultural perspectives. A suggestion would be to combine the history of science, the comparative history of religious beliefs, the political sciences and cultural studies to define a "global history of religious ecology." This would aid understanding of the multiplicity of religious conceptions of nature.

KEY THEMES

< Fig. 1 Precarious temple in the Mekong Delta, Vietnam. Living with yearly flooding and under the protection of Buddha and the deity of the soil (Source: Pascal Bourdeaux, 2005).

Introduction

Earth is referred to as the Blue Planet, because two-thirds of the lithosphere is covered by the oceans. Yet it is the continents and not the seas that have long defined the destiny and mobility of humans. Since the acknowledgment of the waters as an element of separation and a multi-faceted danger, people have definitively circumscribed and partially domesticated their natural environments. Traces of ancient human settlements have been found on the most favorable banks of rivers and streams, indicating that the first sedentary people established a specific relationship with rivers - for living, to facilitate movement and to support their agro-pastoral activities. The cycles of nature gave rise to rites and festivities celebrating Earth and the river; communities have been preserved by using material technology and also by devoting spaces to protect themselves from the violence of nature and to venerate the spirits of cereals. Exceptional heritage sites that had disappeared due to rising sea levels and climate change have been uncovered, such as the port of Alexandria in Egypt, and the river port of Arles, where unique remains have been found at junctions between rivers, estuaries and the sea, and also between confluences inland.

Rivers are interfaces constituting natural circulation and communication routes. They are a central element of our biotopes, although we are no longer always aware of them today. And yet, rivers are much more than that. As vectors of civilization, they drive and regulate human activities. As a source and vital power, the river is still today the base of material and immaterial cultures that have continued to diversify and reinvent themselves. But as a source with destructive power, a river can also be uncontrollable and dangerous. It knows how to use violence to overflow the increasingly reduced domain that people have conceded over time. It can become deadly when it dries up or begins to carry materials that are naturally toxic or transformed by humans.

Archaeological Exploration of Heritage Sites: The Mekong Delta

The history of contemporary religions in Southeast Asia or, to be precise, in the societies surrounding the Mekong Delta in the south of Vietnam, serves as a landmark and geographical framework to situate various religious dynamics in space and to recontextualize them in time, taking into account how they are structured around local beliefs or reinterpret scriptural traditions (fig. 2). Modern Buddhist pagodas, temples dedicated to supernatural deities on riversides or hills, and also archaeological relics and on-site museums give materiality to this cultural heritage from Indianized, Sinicized and Indigenized traditions (Tucker and Duncan 1998; Grim 2001). Over time, the Mekong Delta has become as much alive as the populations that stretch along its shores, who move on its tributaries and canals, that live thanks to it. It has revealed itself as an essential, familiar and even central element of what is rightly called the "fluvial civilization of the Mekong Delta," namely the set of lifestyles, popular and scholarly expressions of material and immaterial culture, of original representations of the phenomenal world and imaginary worlds (fig. 3), of pragmatic adaptation to nature.

During the first half of the twentieth century, the digging of canals and aerial photography made it possible to discover a civilization known in texts but never precisely located in space, that is, the case of the Mekong Delta, where the kingdom of Funan once existed. The numerous vestiges (ornaments, statues of deities, founda-

^ Fig. 2 Phước Hậu Pagoda, Trà Ôn, Vietnam. An example of a religious site located at the crossroads of different rivers and canals in the Mekong Delta (Source: Pascal Bourdeaux, 2012).

tions of monuments) prove that people organized their activities according to the rhythm of the river, its layout, its relationship with the maritime coast and the network of hills and places of surrounding elevation. Even today, the ancient establishment and presence of religious communities along the rivers, still marked by archaic places of worship, ancestral and modern places of collective prayers (and meeting places), tell us how people have maintained this relationship with their river, in both rural and urban areas.

Religious Variants

From the cult of nature, which had to be protected by propitiatory rites and seasonal pilgrimages, forms of the divinization of nature and rivers, which formalized this passage from belief in abstract forces to individualized entities, were created by religious leaders. In other words, there was a passage from myths and legends to the ritual practices of agrarian and hydraulic societies. Endowed with a personality and a history, deities act as a reflection of human activities.

Rivers illustrate this alliance between nature and the sacred. It should be noted that the river is distinct from water which, as a generic and sacred element, partially encompasses it. The river is not either the sea or the ocean, a real antinomy of the earth, but rather an in-between. Wanting to "listen" to the rivers means, first, respecting the rivers for what they are, situated in their ecosystem, and not for what people have tried to do with them during the course of history. Wanting to return to the "sources" is then to remember that every river has an origin and an endpoint, that it only represents a segment in the discontinuity of the water cycle. Finally, it is to remember that the river is at the origin of human societies and that it is the respect

^ Fig. 3 The fourth level of Hell (the river of mud) in the Sino-Vietnamese tradition (Source: Riotor Léon and Léofanti, 1895).

and deference expressed toward the river that has forged myths, legends and beliefs. The latter have not completely disappeared, including in industrialized societies where the marks of respect and the rituals of founding industrial works, for example, have taken the secularized forms of “baptisms” and “commemorations.”

We still find today, especially around the Mediterranean or in Asia for example, the memory of these foundations through myths and cults (fertility, mother goddess, agrarian cycles, propitiatory rites, funeral practices) that have distinguished between profane and sacred activities since ancient times; similarly, these myths and cults have distinguished what pertains to nature or culture and even what relates to nature or the supernatural. We also find these distinctions in the sacred texts of revealed religions, the cosmological representations of the religions of Asia, the oral literatures of people without writing in Africa, Oceania and the Americas. There are essential differences between the Western world and the Asian world in terms of defining monism and dualism (are humans part of nature or are they in a position to dominate the latter?), and in distinguishing theological thought from cosmological thought (was the world created or is it uncreated? Does it correspond to a divine plan or does it follow an incessant mutation?). In Indian culture, certain rivers are thus gods or constituent elements of the cosmic entity falling under the category of monism. In Chinese culture, there is a fundamental difference from Indian culture in the “domestication” of the river, in the way of living with the river or protecting oneself from it to form a society. In ancient Buddhism, we also find the realistic or metaphorical evocation of rivers. According to a legend, Siddharta Gautama intervened to settle conflicts over the use of water around the Rohini River; he also crossed the Ganges full of deference. Indian Buddhism evokes eight rivers coming from the same lake, Anavatapta, to better illustrate the notions of the interdependence of all things and of differentiated and gradual progress (eight rivers) toward the same deliverance (original lake).

Many ancestral cultures have transformed the river, for example the Amazon River, into a malevolent genius. The river can be considered an environment inhabited by real or imaginary monsters who, on the one hand, urged respect for the gods of the soil and the rivers, and on the other, who called for humility and vigilance. These beliefs expressed in their own way, in metaphorical forms, what scientific knowledge has since described as physical, chemical and bacteriological phenomena, which made crossings, uses or domestications of rivers perilous , if not inadvisable or impossible; in other words, against nature.

These archaic or refashioned beliefs in the “religions of the world” tend to reappear in the current context of awareness of the environmental emergency. The latter can be alarmist and catastrophist when it points to the irreversibility of the overconsumption of natural resources and climate change. It can also be instructive when it seeks to bring the path of a re-enchanted modernity to scientific debates and political decisions, in other words, when it seeks to rebalance the issues, on the one hand, of the anthropic development of nature and the recognition, on the other, of the spiritualization of nature.

Relations between religion and nature (fig. 4), more broadly between the sacred and nature, have indeed always existed – even if, as we have set an example with rivers, it is primarily a question of the relationship to the supernatural world as if nature has escaped from religious thought to the detriment of science, which fundamentally deals with a desacralized nature.

^ Fig. 4 Dakar, Senegal. Early morning prayer turned toward Mecca and in front of the sea and Gorée island (Source: Pascal Bourdeaux, 2018).

Humans now recognize that if modern science and technology know how to act on natural laws to exploit their potential in the collective interest, the latter very often perceives nature only superficially. In the replacement of the state of nature, which is relegated essentially to mystical contemplation and sensitive life, but also in the replacement of nature religions disqualified as archaisms, it is productivist systems and consumerist lifestyles that have been sacralized. However, these systems also show their limits here in societies that care little about environmental ethics or a holistic acceptance of nature. The loss of religions' influence on modern societies has not only weakened the political, social and cultural functions of religious practice; it has also affected what is often the forgotten relationship of humans to the sacredness of their natural environment.

Contemporary Responses

Can we restrict this nature to a mechanism or does it hide a part of unfathomable mystery connected to water? In recent decades, the spiritualization of ecology has taken various forms, such as bioregionalism and eco-development in the 1960s, and discussions have been revived under the joint effects of secularization, environmental crises and development ethics. Some have engaged in critical re-readings of the Anthropocene and the history of all forms of "living" things, including fauna and flora; others have turned more specifically to an updated analysis of practices and sacred texts, in other words, a ritual and doctrinal reassessment of religions in their relationship to ecology (Gottlieb 2006). A major program developed

in the United States has, for example, enabled the creation of the Religions of the World and Ecology collection. The method and the objectives of the research were to find an answer to the moral challenges caused by environmental crises, to replace the concept of nature at the crossroads of the material world and expressions of the sacred, and, one might add, to promote interreligious dialogue.

It seems that we have been progressing toward an increasingly comparative approach, between human societies and also between systems of thought, to define the policies and logics of development, an ethics of international aid, and even the shared meanings and understanding of "commons" and collaborative economy (Cornu, Orsi and Rochfeld 2017). A survey of all these traditions on other continents and in other societies would undoubtedly illustrate the wealth of cultural expressions that have always linked humans to the river, partially found in all the museums worldwide dedicated to rivers and their infrastructures.

Conclusion

Humans cannot dominate ecosystems by artificializing them, because they are part of the whole living world with which they interact. The natural environment, social space and the phenomena of beliefs which interpenetrate should be considered not only in the same movement but also through their interactions. The history of ideas and techniques can prove useful in bringing back ancestral and local knowledge that is much less archaic or antithetical to scientific progress. In an even more limited context, religious history can also be an essential resource for restoring practical and moral meaning to contemporary challenges, including development and water-related environmental issues in a time of climate change (fig. 1).
Returning to the general theme of rivers and cultural heritage, we therefore realize that it is not only the notion of the "sacred" that must be questioned and compared according to cultural and religious traditions, but perhaps even more that of "nature," as we see that the relationship that humans maintain with their direct environment and with the "values" that they attribute to it have been able to evolve from one society to another, from one era to another. Simultaneously preserving the tangible and intangible heritage can certainly help us promote the use and exchange values of ancient societies, to bring our contemporary societies and cultures into dialogue, to find solutions together to current challenges, or at least a shared definition of what the universal commons are, among which we certainly find the river civilizations.

By considering the current situation, we should rethink environmental history as "global environmental history," taking into consideration the multiplicity of epistemologies from Western countries but also from the "South." We should reread the sacred texts and discuss them together to understand better how each defines relationships between nature and culture, pursuing the study of comparative religions under the lens of ecology and cultural heritage. We talk about the will to "listen" to the rivers: we also have to listen to the riparians at the same time. What can we learn about local and popular knowledge of protecting the environment and preserving heritages? Developing programs on cultural and religious history could be useful.

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Intangible Heritage to Strengthen Local Water Management

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Can intangible cultural heritage (ICH) help to reduce biodiversity loss and and water shortages related to climate change? Can it contribute to managing water shortages and surpluses on a local level? This article argues that some useful forms of intangible, "living" heritage offer valuable knowledge and practices that can serve as adaptive strategies in a changing environment. Binding practitioners to a specific place and to each other and connecting past and future generations, ICH can bring local knowledge and experience into the work field. The examples introduced here include grassland irrigation, water milling and hedge-laying: all used in the past, replaced by new inventions (e.g. fertilizers, new techniques for grinding grains and barbed wire taking the place of hedges respectively), and reintroduced because of their potential role in water management and ability to help create a climate-robust landscape. The valuable insights and practices of "citizen scientists" using these traditional techniques are too often overlooked by policy makers and academics.

KEY THEMES

< Fig. 1 Traditional irrigated grassland at Het Lankheet (Source: KIEN, 2021).

Introduction

The need for sustainable management of our natural environment, including water management, is one of the great challenges of our time. The Dutch Centre for Intangible Cultural Heritage (KIEN) and the Centre for Agrarian History (CAG) in Leuven (Belgium) believe that Intangible Cultural Heritage (ICH) can help us face this challenge. ICH can be a valuable source of knowledge when designing future climate adaptive strategies. This is why the two institutions have joined forces in a three-year project called "Water and Land. Intangible Cultural Heritage and Sustainable Development," which aims to inventory, research and promote ICH as a lever for ecological sustainability. The project aims to make both members of the public and policy makers more aware of ICH's strengths and opportunities.

The notion of intangible heritage has gained ground since the introduction of the UNESCO Convention for the Safeguarding of ICH in 2003. This convention is specifically concerned with traditions and living cultural expressions that are inherited from ancestors and passed on to future generations. It refers to oral traditions, performing arts, social practices, rituals, festive events, knowledge and skills used to produce traditional crafts and knowledge and practices concerning nature and the universe. These practices may offer especially valuable insights that can be applied to climate adaptive solutions.

ICH has several characteristics that make it a potentially powerful instrument in combating the negative effects of climate change. Communities that practice nature-related ICH express their knowledge, which is often embedded in and directly linked to their surroundings, through a wide range of cultural practices that have evolved over time as people have interacted with their environment. ICH, as living heritage, is flexible and adaptive – often it is precisely the ability to adjust to changing circumstances that has ensured its survival over time.

Practitioners of ICH are typically committed to their community and highly involved in their local environment, for their heritage practices not only bind them to one another, but also to their physical surroundings. The stakes can be high since the survival of natural surroundings and the survival of ICH practices are closely entwined. This at least partially explains why ICH often promotes a strong sense of responsibility and may even foster the feeling that one can indeed do something to ameliorate seemingly overwhelming global threats such as floods, (extreme) drought or the loss of biodiversity. In the words of Kathleen Ferrier, chair of the Dutch UNESCO Commission: "When climate adaptation is grounded in local traditions and customs, it empowers communities to take control and initiate change themselves" (Bontebal 2021). This showcases the importance of supporting communities in safeguarding their sustainable intangible heritage.

A Case in Point: Traditional Irrigation

An example of how ICH can make a vital contribution to local water management is the sustainable traditional technique of grassland irrigation. This is an ingenious and almost forgotten farming method that dates back to the Middle Ages and relies on the strategic use of gravitational force and manually created structures to distribute water from naturally occurring water catchment points closer to fields. More specifically, it cleverly utilizes minute differences in elevation, thereby distributing "stunted water" through channels and ditches or "beam weirs"

^ Fig. 2 Traditional irrigation in Lommel, Belgium (Source: Willem Tel, 2023)

(barriers made of stacked planks) and manually operated "inlet gates." This allows practitioners to maintain desired water levels over a wide area and respond to changes in weather and climate. It thus offers them a valuable tool to promote growth and increase (hay) yields. At the same time, traditional grassland irrigation allows lime and minerals to penetrate the soil, thereby creating a rich soil life and grasslands full of plants, insects and birds.

Today, practitioners of traditional grassland irrigation are dispersed around the world. As for the Netherlands, there are two areas where the practice is still in use. One of them is the estate Het Lankheet, below Haaksbergen. Eric Brinckmann, representative of the Water Park and Field Centre Foundation, Het Lankheet, explains: "What we are doing is moving with the landscape. You follow the water. Every week there is a different situation to which you have to respond. So, we take care of the landscape, and the landscape takes care of us. There are 30 volunteers working at the foundation, and together we are committed to restoring biodiversity and creating a climate-resilient landscape that suits nature-inclusive agriculture. People feel responsible and involved. This also strengthens social cohesion. And appreciation for nature. It encourages volunteers to become emotional co-owners of the landscape" (Bakels and Elpers 2021, 39). The Dutch irrigators are part of a European network of traditional irrigation practitioners from Belgium, Luxembourg, Germany, Austria and Switzerland. Learning from this technique is thus not only limited to the Netherlands.

^ Fig. 3 Water miller Ernst at work in Eindhoven (Source: Riet Meijer, 2023).

^ Fig. 4 Hedge-laying in the Netherlands (Source: KIEN, 2008).

Living Heritage: Traditions, Challenges and New Applications

The potential of ICH to contribute to climate-robust landscapes is by no means limited to grassland irrigation. There are many other practices that can play a renewed role in sustainable water and landscape management. Among them, for example, is the ICH practice of water milling. Both the Netherlands and Belgium have a long tradition of water milling. On the one hand, mills historically participated in the work of, for example, artisanal flour milling. But while doing so, their operation also actively influenced local water systems. Therefore, many water millers consider themselves not only millers but also water managers, and that dimension of their work may take on new significance considering changing weather conditions. In an online focus group conducted by the authors in 2022, Riet Meijer, herself a miller and member of the advisory board of Molenstichting Noord Brabant, explains: "I want to use the old techniques to sustainably manage the landscape around the mill. By managing the weirs in the river and streams, we can respond to drought and wetter times and maintain the water landscape well. This gives the mill a new importance. We must ensure that Waterschappen [the Dutch water management boards] and governments accept this new role of the millers." Supporting the renewed role of this old craftsmanship can thus strengthen local water management in a climate-robust landscape.

Hedge-laying is another example. Its practitioners make existing hedges, usually thorny hedges, impenetrable by braiding twines together.

^ Fig. 5 Water milling today means using old techniques to sustainably manage the landscape around the mill. Water milling landscape at Coll (Source: CAG, 2023).

The hedges were historically used to separate plots of land, but their benefits are wider. Braided hedges offer shelter to many different animal species, and function as small yet diverse biotopes. Recently, attention has also been drawn to their water-absorbing capacity – in the shade of hedges, temperatures may be up to five degrees cooler than in the surrounding landscape, resulting in less evaporation. And during heavy rainfall, the roots of hedges act as "flow paths" that transport water to deeper earth layers (Rijsdijk 2022). On the islands of Bonaire, St. Eustatius and Saba – the Dutch Caribbean – people braid cactus hedges. This ICH is receiving renewed attention since there is growing awareness that it may contribute to retaining water and preventing erosion. Curaçao and Bonaire also have natural systems of rooi (gullies) and man-made dams, which guide and catch rainwater. Lately, housebuilding has been allowed in the rooi area, resulting in local and downstream flooding (Loen 2022).

Opportunities for Change: Local Knowledge, Science and Governmental Decision-Making

KIEN has coordinated the implementation of the UNESCO 2003 Convention for the Safeguarding of ICH in the Netherlands since 2012. Its efforts to help practitioners safeguard (develop, promote and pass on) their ICH include the Inventory of Intangible Cultural Heritage of the Netherlands. From 2022 onwards, sustainability will be a spearhead for research (Bakels 2021).

CAG is a knowledge center in Flanders, Belgium, concerned with agrarian history and heritage. CAG studies, preserves, secures and makes accessible the history and heritage of agriculture, food and rural life in Flanders and Brussels as far back as 1750. CAG wants to contribute to the realization of the UN Sustainable Development Goals and a sustainable society.

KIEN and CAG believe that ICH offers valuable alternative knowledge systems for sustainable landscape development and water management. It can be used to inspire and inform environmental and climate change management and politics. Unfortunately, the opportunities offered by ICH are still relatively unknown in wider circles and are not clearly on the minds of policymakers (Fatorić and Egberts 2020; Altenburg and Elpers 2020). In our current society, so focused on official, managerial and scientific knowledge systems, the "intimate" or "local knowledge" of ICH is at best marginalized and most often is ignored altogether. This is unfortunate, as different knowledge systems can reinforce and complement each other – a reassessment of ICH in official policy and academic knowledge systems could lead to a more vital, accurate and widely shared approach to water management.

ICH can enrich landscape and water management. It binds the past, present and future; it can strengthen the appreciation of and emotional attachment to land and nature; and it can inspire responsible and sustainability-oriented attitudes (Ganzevoort 2021; Jagers et al. 2014). In particular, ICH contains concrete insights and knowledge tailored to local conditions. We will desperately need such attitudes in the future – for water management, but also for the well-considered and informed use of our natural resources in general.

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Pondering the Past: Exploring the Synergy between Water Management and Heritage Management

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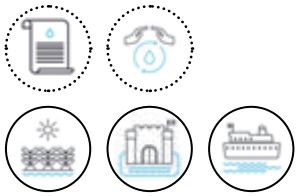
Because of the urgency of the current water challenges, we need to decide on a water-heritage agenda. In order to do so, we should first disentangle the sometimes confusing relationship between water management and heritage management. Where do water and heritage management meet and how can they serve each other? It is argued that fruitful synergy between the two disciplines can be reached in three dimensions: the historic dimension, the conservation dimension and the planning dimension. The subject of interaction between the two disciplines differs per dimension and relates to the changing water system, the heritage we cherish and a changing living environment respectively. The synergy to be reached between the two disciplines differs accordingly.

KEY THEMES



< Fig. 1 New Dutch Water Defense Line at Utrecht, Fort Ruigenhoek (Source: RCE Amersfoort, 2009, nr. 546.217).

Introduction

This publication, *Blue Papers*, addresses many water challenges, including sea-level rise, increasing river flows, changing rainwater patterns, floods and droughts. All these challenges also affect our heritage. Water challenges can be a threat to the heritage we cherish, but sometimes they may offer a new perspective on this heritage. Inversely, heritage can pose an obstacle to urgent water challenges, yet sometimes it can offer solutions to the water issues at stake. Where do the two disciplines of water management and heritage management meet and how can they serve each other? To clarify the water-heritage relationship, we need to distinguish three dimensions: history, conservation and planning. Interaction between water management and heritage management varies in each of these dimensions.

The presentation of the UN's Sustainable Development Goals (SDGs) in 2015 was quite a disappointing experience for the global heritage community. Heritage was again positioned as an innocent victim that had to be protected from a ruthless and careless society, as if we were back in the nineteenth century. The presentation completely neglected the fruitful efforts of an active heritage community over the preceding decades to show and prove the strengths of a living heritage, its resilience and its ability to support sustainable development of a dynamic society. UNESCO acknowledged the omission and, the year after, published its Global Report on Culture for Sustainable Cities, in which it showed the many entry points where the SDGs allow heritage to contribute to their realization (UNESCO 2016). The relationship between water management and heritage management is important to many SDGs, but especially to target 6.5, which aims to "implement integrated water resources management at all levels."[1] It is also important to SDG 11, which aims to "make cities and human settlements inclusive, safe, resilient and sustainable"; and target 11.3 ("enhance capacity for participatory, integrated and sustainable human settlement planning and management") and 11.4 ("strengthen efforts to protect and safeguard the world's cultural and natural heritage"[2]).

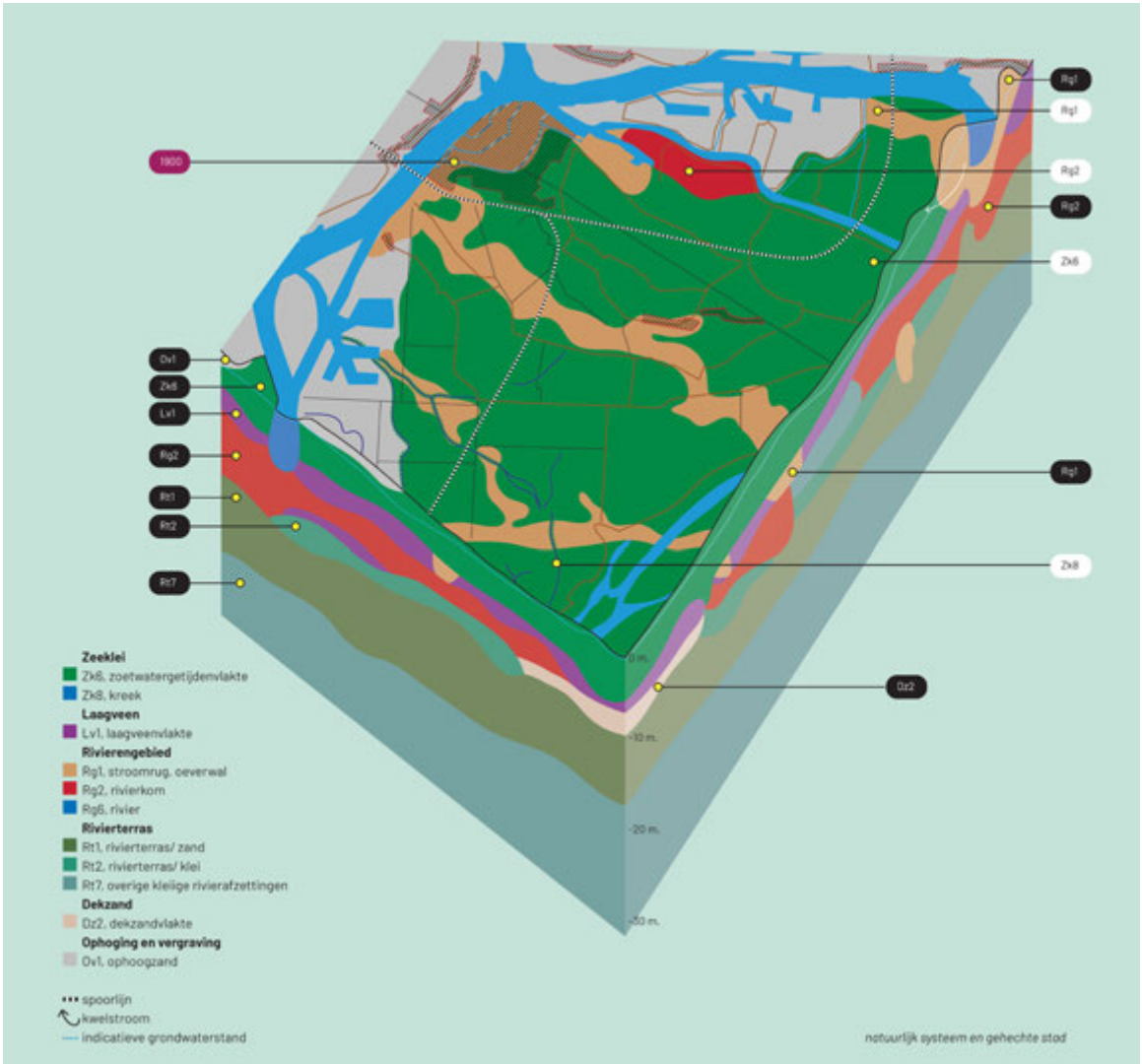
History: To Understand and to Learn

To understand the relationship between the disciplines of water management and heritage management, let us begin with history. In the historic dimension, these disciplines meet each other in the "water system." Here, we understand the water system as the water that flows from a specific source to a certain destination. History is one way to understand the current water system. Why is it the way it is? What developments and changes have occurred? Unless we understand the history of the system, we will not be able to make the right decisions for the future.

The relevance of history is obvious in the Dutch context. Especially in the western parts of the country, the large delta has been restructured many times throughout the ages. To accommodate new agricultural use, to serve transportation needs or to protect residential settlements from flooding, new waterways were constructed, and old waterways redirected, time and again; water flows were blocked on one oc-

1. https://sdgs.un.org/goals/goal6#targets_and_indicators.

2.https://www.google.com/url?q=https://sdgs.un.org/goals/goal11%23targets_and_indicators&sa=D&source=editors&ust=1697459631624341&usg=AOvVaw3Qq0RbTeb8vaduf7dTtTto.



^ Fig. 2 Historic water system in the city of Dordrecht (Source: Grond et al., 2021).

casion, to be reopened at the next. New interventions in this historical multi-layered water system require profound knowledge of past developments. A lack of such knowledge and insight may have disastrous consequences. New developments could easily be put at risk from either flooding or by drought (Broks et al. 2021). Today, historians see history as a way to understand the current situation rather than to learn from the past, since history never fully repeats itself. Still, at certain points we can draw some lessons from water history. Curaçao presents an intriguing example. The Caribbean island has a hot, semi-arid climate which means that it is very dry throughout most of the year. The hurricane season from October until December, in contrast, brings extreme rainfall. Therefore, there was traditionally a need to harvest rainwater on the small island which is surrounded by salt water and has mostly brackish groundwa-

^ Fig. 3 *Waterkuil*, with earthen dams, in the garden of a boarding school in Welgelegen, Curaçao (Source: Soublette et Fils., 1915–1920, courtesy of Koninklijk Instituut voor de Tropen).

ter. One way to capture superfluous rainwater and to store it for the long dry season was by means of a so-called *waterkuil*. This was usually a natural depression in a field that was further dug out and sometimes even walled. The *waterkuil* was fed by rainwater and via brooks that were connected to it. This water catchment system, simple in its performance and maintenance, functioned for many centuries. During the twentieth century however, advancements in engineering techniques provided alternative water supply systems that no longer depended on the seasons and offered water at a constant quantity and quality. There seemed to be no reason to maintain the old *waterkuils*. Over time, they became overgrown and were eventually forgotten. Yet, due to climate change, the modern water system is reaching the limits of its capacity. Now there seems to be a new reason to reactivate an ancient system and to recover forgotten knowledge (Loen 2021).

Conservation: To Protect and to Adapt

The second dimension to address in the relation between water management and heritage management is conservation. In this dimension, the subject of interaction between the two disciplines is no longer limited to the historic water system but consists of "all physical remains" from the past that bear any significance. This heritage is increasingly affected by current water challenges. The question now is how to conserve: should we protect the heritage we cherish from growing threats, or should we adapt this heritage to changing circumstances? Each strategy has advantages and disadvantages. The preferred strategy usually depends on local conditions.

The Netherlands has a long-standing tradition

of protecting the country against water threats. Beginning in the Middle Ages, local stakeholders joined forces to protect earlier reclaimed agricultural lands. They constructed huge dikes, built windmills and established water boards. Over time, water management was further developed and refined to become a highly controlled system, providing shelter and security to people and property. Today's World Heritage Site of Amsterdam largely relies on a meticulously controlled water system. The local water authority regulates the water level in and around the city so that it varies by no more than a few centimeters. Were this system to fail, the canals would become unnavigable, and the timber pile foundations of buildings would rot. The famous canal houses would crumble, and historical attributes would be lost (IWA 2016). Protection, most logically, is a proven and necessary conservation strategy.

However obviously important a protective strategy may be, its feasibility may fade as water challenges intensify. At a certain point in time, the water threat may simply become too big to be kept in abeyance, compelling us to change strategy from protective to adaptive conservation. Adapting to changing circumstances is a widely applied practice in heritage management. People living in river deltas have always accepted water threats to a certain extent and they have learned to continually adapt. The historic city center of Dordrecht, listed as a national conservation area, presents an evocative example. Its main street, Voorstraat, is a prominent public place and is lined with historic patrician mansions, many of which are listed as national monuments. The Voorstraat also serves as a protective dike against flooding. At extreme high tides, the stately mansions are flooded from behind by the river, inundating their ground floors. During such events the residents of these houses are required to block their front doors to stop the water from flooding the street and, consequently, flooding the city. Interestingly, the per-square-meter property value of these houses is among the highest in Dordrecht. This instance shows that water threats can be lived with to a certain extent and can be adapted to. It provides an important perspective now that we must look for alternative ways of conserving our heritage (Groenblauw Dordrecht n.d.).

Planning: To Serve and to Join

The third dimension to address in considering the relation between water management and heritage management is planning. In this dimension, the subject of interaction between the two disciplines shifts again, this time from heritage to the "living environment." Here, cultural interests meet social, economic and environmental interests. Spatial planning is a tool to integrate the different interests. The questions to be answered then are: how and to what extent can heritage serve societal needs, and how can the different interests be combined and strengthen each other? These questions were addressed by the Council of Europe in 1975 when it introduced the concept of Integrated Conservation (ICOMOS Austria 2015). More recently, the approach was updated in the 2011 UNESCO Recommendation on the Historic Urban Landscape (UNESCO 2011).

If we want to include the heritage discipline in spatial planning practice, we should adapt to its language. The better we speak the language, the more impact we will have. Thus, it is helpful to translate "value" into "potential." The concept of "value" may be very useful in the heritage discipline, but in planning discourse it may not resonate. To be applicable in planning practice, we need to identify the development potential of these values that we cherish. This

^ Fig. 4 Canal zone, Amsterdam (Source: RCE Amersfoort, 2012, nr. 10782-9101).

was well understood by the then Rijksplanologische Dienst (RPD) when it published its report titled *Waterlijn* in 1993 (Bolhuis and Vrijlandt 1993). The report explored future perspectives for the so-called "New Dutch Water Defense Line." This military stronghold, constructed in the nineteenth century, is roughly 85 kilometers long and runs through the middle of the Netherlands, where the lower and higher parts of the country meet. It was designed to keep the enemy at bay by means of inundating the countryside. After the Cold War, the defense line lost its importance and in the 1990s the Ministry of Defense almost sold it off. The question arose as to what to do with this highly valued inheritance. The RPD did not set out to determine a detailed historic valuation of the property but instead to examine the way it could serve societal needs. The result was quite appealing. The military landscape was found to have a huge potential to solve urgent water challenges. It could be used not only to retain superfluous riverine water but could also help in reducing dehydration of the higher grounds and may help to desalinate groundwater. Thus, what once was perceived as a vulnerable heritage site may find new vitality by serving urgent societal needs.

Heritage may consequently serve as a vector by using its ability to catalyze spatial development (Janssen et al. 2017). Yet, from Dutch practice we can conclude that heritage conservation seems most effective when positioned jointly with other interests as a factor in spatial planning. Most illustrative in this respect is the highly successful renewal of the historic Dutch inner cities, as accomplished during the last quarter of the twentieth century. Also, the national Room for the River program shows the success of joining seemingly disparate interests. This spatial development program was initiated to address urgent water challenges. Ever-increasing water flows coming from the Alps and running

^ Fig. 5 High tide in the city of Dordrecht (Source: Robin Utrecht, ANP).

^ Fig. 6 Secondary canal in the Waal River at Nijmegen, constructed as part of the Room for the River program (Source: Johan Roerink, via Aeropicture.nl).

through the low-lying river delta to the North Sea required a robust reappraisal of safety measures. Early attempts in 1975 to protect the small rural village of Brakel against rising waters resulted in the paradoxical demolition of its historic center in order to enforce the river dike (Heezik 2007). This traumatic event highlighted the need to include social, cultural and economic interests in future environmental challenges and spatial planning. The current Room for the River program provides water safely by creating an attractive landscape for living, working and leisure (Rijkswaterstaat n.d.). Heritage takes up its position in integral problem-solving, not only serving the attractiveness of the landscape, but meanwhile providing a future base for its own existence.

Conclusion

This brief exploration has attempted to clarify the relationship between water management and heritage management. It should help us direct and strategize our actions effectively. We can conclude that there is reason for the two disciplines to join forces to understand and learn (in the historic dimension), to protect and adapt (in the conservation dimension) and to serve and join (in the planning dimension). It is useful to distinguish the three dimensions, since each covers a different subject of interaction: the changing water system, the heritage we cherish and a developing living environment respectively. This should help establish a water-heritage agenda for future cooperation between the disciplines.

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Whose Past? Reflections on the Recuperation of Ancestral Water Structures in Peru

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Efforts to shape more sustainable and just land and water management practices are increasingly turning to the past for inspiration. However, what the past looked like exactly and what can be learned from it and applied to present-day challenges is not straightforward. Peru is one of those places where reviving ancestral land and water management practices and knowledge has become popular. This article starts with a project that aimed to recuperate ancestral water infiltration structures in the Peruvian highlands. Drawing on interviews conducted shortly after the project's implementation, the author analyses how history and "the past" are imagined differently by various actors, according to their current worldviews, interests and values. The author unpacks the consequences of these diverse pasts for present-day relations and project implementation, calling attention to the importance of making explicit the "politics of the past," including how the past is portrayed and by whom, and which past is to be recuperated or revalorized.

KEY THEMES

< Fig. 1 The intake structure of the Pacchipucro *mamanteo* of Huamantanga (Source: Lena Hommes, 2014).

The Recuperation of Historic Water Infiltration Structures in Peru

Efforts to shape more sustainable and just land and water management practices are increasingly turning to the past for inspiration. The underlying assumption is that the past in general and ancient practices in particular can provide solutions for currently pressing challenges related to climate change, environmental deterioration and socio-environmental injustices. However, what the past looked like exactly and what can be learned from it that can be applied to meeting present-day challenges is not straightforward and can be contested and political.

Peru is one of those places where reviving ancestral land and water management practices and knowledge has become popular. In the region of the capital city of Lima, one of the pioneering projects was implemented in the rural community of Huamantanga, situated at 3400 meters above sea level in the Chillón watershed. In the upper parts of the community's territory, one can find numerous *mamanteos*: canals of various lengths (from a few hundred meters up to 1.5 km) that date back to the pre-Incan era and that divert surface runoff from highland areas during the wet season to improve infiltration on mountain slopes. If maintained well, the *mamanteos* can regulate water flows: water is captured during intensive rainfall events and it infiltrates the soil and resurges after a certain subsurface residence time in downhill springs (Alternativa 2012). Some of the infiltrated water resurfaces within Huamantanga's territory. The rest of the water resurfaces further downstream, which can benefit aquifer recharge and make more water available during the dry season in the coastal area of Lima (Ochoa-Tocachi et al. 2019).

Some of the *mamanteos* in Huamantanga continue to function as described above, but below their capacity because they are partially clogged or damaged; others have been completely abandoned. Because of the potential hydrological benefits for rural and urban water users, in 2012 a Lima-based NGO proposed a pilot project to recover and reconstruct one of those canals – the Pacchipucro *mamanteo* – and investigate its hydrological functioning and effectiveness. The project was implemented and led by Aquafondo, which at the time intended to become the water fund for the city of Lima and planned to carry out a variety of projects in Lima's watersheds (similar to payment-for-ecosystem-services schemes; Grainger et al. 2019 and Hommes 2015). When this project started, it was hoped that it would demonstrate the hydrological benefits for both rural communities and downstream cities of ancestral water infrastructures and management practices, thereby inspiring their large-scale rehabilitation.

Although the project managed to recuperate the Pacchipucro *mamanteo* and generate crucial knowledge about its precise hydrological functioning, it also caused friction among community members and involved NGOs. Various dynamics contributed to this, including a mismatch between the expectations about the benefits from the project (probably partially reinforced by national and international media attention to the project) and the perceived benefits. There were also concerns about the involvement of Lima's water utility, SEDAPAL, as potential future financier and the implications this might have for communal water rights. Further detail is beyond the scope of this article. Nevertheless, what is important is that from the very beginning, the organizations and community members involved had different ideas and expectations concerning the project. Also, people had different understandings of the past and of the historic and future role of the *mamante-*

^ Fig. 2 The Pacchipucro *mamanteo* of Huamantanga visible on the right slope (Source: Lena Hommes, 2014).

os. In analyzing these diverging ideas about the past and about the rehabilitation of historic water management practices, it becomes evident that the past must be understood as political: not neutral, obvious or singular, but diverse and contested.

The reflections presented in this article are not only relevant for the project in question, but are equally relevant to other water management discussions and efforts that aim to restore past practices and environments, including nature and/or river restoration and dam removal projects (Arbelaez-Trujillo and Forigua-Sandoval 2023; Hommes 2022b). Such efforts have tended to focus primarily on the ecological and material dimensions involved, with limited attention to social and political complexities. Underlying assumptions about the past (and the resulting implications for project implementation), have so far been little explored. The aim of this article is to address this gap.

Whose Past? Diverging Ideas about the Past and the Role of the *Mamanteos*

For the original initiators of the project, the recuperation of the Pacchipucro *mamanteo* was not only about its hydrological aspects but also related to the historic-cultural significance attributed to this structure and the associated communal maintenance activities. *Mamanteos* were, in fact, framed as part of the cultural his-

^ Fig. 3 Farmers during a day of communal maintenance of irrigation canals in Huamantanga (Source: Lena Hommes, 2014).

tory of the region and something that deserves admiration, attention and care. There was an underlying appreciation for Incan and pre-Incan societies and their hydrological knowledge and techniques. Such valuation of the past goes along with framing the arrival of the Spanish conquistadores as an important point of rupture that destroyed local culture. As the initiator of the Pacchipucro project explained in an interview in 2014: "The biggest change occurred in the colonial time, it was an aggressive change. Many of the festivals which are celebrated today are actually from colonial times. . . . When the church came, they destroyed and burned everything, very powerfully. And now people deny their past." The strong identification with Catholicism that predominates in Huamantanga today is portrayed as a negation of the past.

However, what should or should not be considered Huamantanga's "real" history and roots remains contentious: during interviews in 2014 with village residents, a distinct interpretation of local history became apparent. A teacher from the local school, for example, explained that "The Incas were savages, they ate roots but the Spanish . . . ate fruits from trees. They are also the ones who brought cows to this area." In a similar manner, a farmer mentioned that "[Pre-Incan and Incan civilizations] believed in the sun and the moon, they didn't have a God. The sun and the moon were their gods. But we have a God, we don't believe in the sun and the moon." Such identification with the colonial era is important, as it shapes the way community members relate to the *mamanteos*. While everybody knows the system and farmers organize yearly maintenance of the canals, the *mamanteos* are also regarded at a distance – as remnants of pre-Colombian civilizations with which the community does not deeply identify. One can observe a much stronger identification and connection with works that were built by the

community in more recent years, such as the parish hall or the village road. Furthermore, the majority of farmers interviewed also did not see the *mamanteos* as a crucial part in solving the problem of water shortages in the dry season. Instead, the construction of reservoirs for water storage and the installation of drip irrigation was often mentioned as preferred solutions. "Modern knowledge," equated with the engineering of dams and drip irrigation systems, was portrayed as better. As one village authority explained, "The ancestors had their ideas . . . . But today science is more advanced, more technologized; there can be a mechanized change."

Importantly, local farmers did not regard the project as "recuperation" or "rehabilitation," but as something new. They made a clear distinction between the Pacchipucro *mamanteo* and other *mamanteos* in the community's territory, mainly because of the use of cement but also because of the involvement of outside organizations in the project. And indeed, when looking at the design features of the Pacchipucro *mamanteo*, it becomes apparent that it is hybrid, because it includes cement and an underflow gate as intake structure – features that were not based on historic, archaeological facts but influenced by today's ideas about hydraulic engineering and particular project objectives. Nonetheless, reports about the project (e.g., by national and international media outlets) sometimes omitted these facts and drew a glossy picture of revalorizing a specific Indigenous past.

The danger of such essentialization or romanticization of the *mamanteos*, and historic or Indigenous water structures and knowledges more generally, was also pointed out in 2014 by one of the hydrologists involved in the Pacchipucro project: "Of course there are also the romanticizers: the ecological romanticizers, and the cultural, archaeological romanticizers. One has to be careful not to drift into the 'everything used to be better in the past' narrative. Because conditions have changed, the conditions today are not the same as 300 years ago."

Reflections: Politicizing the Past

The case of Huamantanga raises calls for caution when considering using historic water systems and practices to construct a sustainable future. The case shows how interpretations of the past may reflect diverging present-day worldviews, interests and positions. As Perreault (2018, 230) puts it: "As a representation of the past, memory is always also a representation of the present, and a reflection of contemporary realities, which in turn informs political demands." This is to say that the present influences ideas about the past. And, vice versa, how the past is imagined shapes present and future decisions – for example, about what place to give historic water structures or management practices (Hommes 2022b; cf. Shah 2012). Precisely because of this entanglement of past, present and future, when striving for a revival of historic structures and past practices it is crucial to critically reflect on questions such as these: Who is defining which past, and with what consequences in the present day and in the future? How do different ideas of the past and the connected future clash?

Such discussions and critical questions are not only relevant to projects such as the one in Huamantanga, but also come back in other water management discussions like those related to river restoration and dam removal – currently hot topics in the realm of river management (Arbelaez-Trujillo and Forigua-Sandoval 2023). Dam removal promoters tend to imagine the past as characterized by pristine nature with limited harmful human interventions (Hommes

2022a). It is a past to which, in the future, humanity should at least partially return. However, this view of the past is often contested by members of the local population, who argue that hydraulic infrastructures have become embedded in the local culture, social relations and environment, and therefore cannot and should not be removed. Thus, the past is not a concluded, fixed time span but a contested temporality with different interpretations.

Another important lesson from the presented case is that it is crucial to stay aware of the potential for romanticizing, essentializing or patronizing of "traditional" culture and heritage, and local people and practices. Who gets to define what "traditional" should mean (e.g., pre- or post-Colombian practices and ideas), and what place tradition should have in the present and future, are contested, political questions. This is not to say that we should not look to the past for inspiration. Indeed, there are many lessons to be learned from historic practices and structures that can help to create a more sustainable and just future. However, it is essential to make politics and contestations of the past explicit and part of the debate.

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Lena Hommes is a lecturer and researcher interested in water governance, political ecology, environmental justice and the politics of hydraulic infrastructure in Europe and Latin America. After finishing her master's degree in international land and water management, she worked for several years in the drinking water and sanitation sector in Peru. In 2019 she returned to Wageningen University, where she is currently a lecturer in the Water Resources Management Group, and a postdoc researcher with the multi-disciplinary research projects Riverhood and River Commons. In 2022 she received the distinction cum laude for her PhD thesis, "Infrastructure Lives: Water, Territories and Transformations in Turkey, Peru and Spain," in which she analyzes how modern hydraulic infrastructures such as dams, hydropower plants and water transfers transform territories in diverse and unforeseen ways. Lena continues to study these issues, but also focuses on understanding upcoming alternative trends in water governance (such as dam removal and the rights of nature) and the discussions, conflicts and outcomes they trigger.

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Underwater Cultural Heritage and the Sustainable Development Goals

Elena Perez-Alvaro
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Underwater cultural heritage is heritage that is surrounded by water. It can be found in rivers, lakes, oceans and reservoirs, and comprises tangible heritage – wrecks, fishing tools, sunken cities and aircraft – as well as the intangible heritage of many civilizations. However, this heritage is not only part of the past; it can also provide answers to the many challenges that international agendas face today. With its connection to cultural aspects of communities around the world, it offers knowledge that can be helpfully applied to the pursuit of the Sustainable Development Goals of the United Nations Agenda 2030.

KEY THEMES

< Fig. 1 Ancient fishing practices as part of the tangible and intangible cultural heritage of the oceans (Source: Pixabay, 2018).

Introduction

In 2001 the UNESCO Convention on the Protection of the Underwater Cultural Heritage defined underwater cultural heritage as "all traces of human existence having a cultural, historical or archaeological character, which have been partially or totally under water, periodically or continuously, for at least 100 years" (UNESCO 2001). According to this definition, underwater cultural heritage may include not only shipwrecks, but also sunken cities, venerated sites, ancient harbors, plane wrecks and prehistoric landscapes.

Underwater cultural heritage is an invaluable source of knowledge about individuals and communities. It can ignite political conflicts, since marine exploration, including underwater archaeology, can have national defense implications if it involves military security information, and it can raise concerns about issues pertaining to safety, culture and food security. Underwater cultural heritage also allows for a critical investigation of historic objects, while providing insights about people's lives in the past. However, underwater cultural heritage consists not only of tangible objects but also the natural environment surrounding them. Often, shipwrecks and sunken airplanes have become artificial reefs for thousands of fish species (fig. 2). The 1972 Convention Concerning the Protection of the World Cultural and Natural Heritage (UNESCO 1972) is an instrument designed to preserve both cultural and natural heritage, although there is an artificial distinction made between these two types of heritage. If underwater cultural heritage is treated as one more element in the ocean, its protection would be guaranteed. This could be of mutual benefit: if underwater cultural heritage is preserved, the natural heritage will also gain protection since there is a close relationship between ecological and archaeological site management. This characteristic of underwater cultural heritage, the fact that it is an integral heritage (cultural, natural, tangible and intangible) that involves many disciplines – archaeology, biology, oceanography, law – and the possibility of applying knowledge of this kind of heritage to present-day issues makes this heritage an important tool for the Sustainable Development Goals of the 2030 United Nations Agenda. This article will consider how underwater cultural heritage can contribute to some of these goals.

Valuing Underwater Cultural Heritage with the UN Sustainable Development Goals (SDGs)

GOAL 1: No Poverty

The Margullar Project (margullar.com) is an underwater cultural heritage project that connects underwater archaeological work and the preservation and conservation of marine heritage with diving tourism in the participating regions and countries. The idea is to create a tourist product that promotes underwater cultural heritage preservation in the Canary Islands, the Azores, Madeira, Cape Verde and Senegal, while engaging local people in preservation activities and raising public awareness of the importance of underwater cultural heritage. Similarly, the project *Rising from the Depths* (risingfromthedepths.com) works with local groups to fill knowledge gaps about how underwater cultural heritage could contribute to culturally and economically sustainable growth in East Africa.

GOAL 2: Zero Hunger

Ancient fishing practices are part of the tangible and intangible cultural heritage of the oceans (fig. 1). As one of the oldest fish-catching methods, stone tidal weirs can help regenerate ma-

^ Fig. 2 Interlink between natural and cultural heritage underwater (Source: Pixabay, 2017).

rine biodiversity sustainably (Iwabuchi 2022). An eco-friendly form of fishing gear, the weirs are completely submerged during high tide, and emerge into full view at low tide, allowing people to collect fish while sustaining many species of marine life. In addition, catches from tidal weirs play a significant role in community health, as freshly caught fish and other seafood are higher in nutrients than imported, processed food. Indigenous coastal communities, based on their accumulated knowledge of local ecosystems, have adapted the weirs to particular coastal topographies and seascapes. In fact, the Intergovernmental Oceanographic Commission of UNESCO has endorsed a project entitled Indigenous People, Traditional Ecological Knowledge, and Climate Change: The Iconic Underwater Cultural Heritage of Stone Tidal Weirs as an action project as part of the United Nations Decade of Ocean Science (United Nations n.d.).

GOAL 8: Decent Work and Economic Growth

Today, the ability to enjoy and access underwater cultural heritage is a powerful driving force in tourism: there are six million active divers around the world and more than twenty million snorkelers, many of whom are interested in protecting the natural and cultural heritage of the seas. By involving them in the protection of underwater cultural heritage, divers will become better educated about this legacy and how to protect it (fig. 3), while providing jobs and otherwise benefiting the local economy. In addition, the creation of underwater parks and reserves of underwater cultural heritage encourages interest in visiting designated sites, with a significant increase in tourism (Aguilar 2013). This

option is not only educational for the tourists but regulates the number of visitors, which makes the exploitation of the heritage site more sustainable, offering controlled economic development. These sites offer experiences unavailable with any other form of heritage. Underwater trails can change mindsets and engage emotions. In the case of historic shipwrecks, visitors can experience the tragedy of maritime disaster while surrounded by the natural environment (Scott-Ireton and McKinnon 2015).

GOAL 13: Climate Action

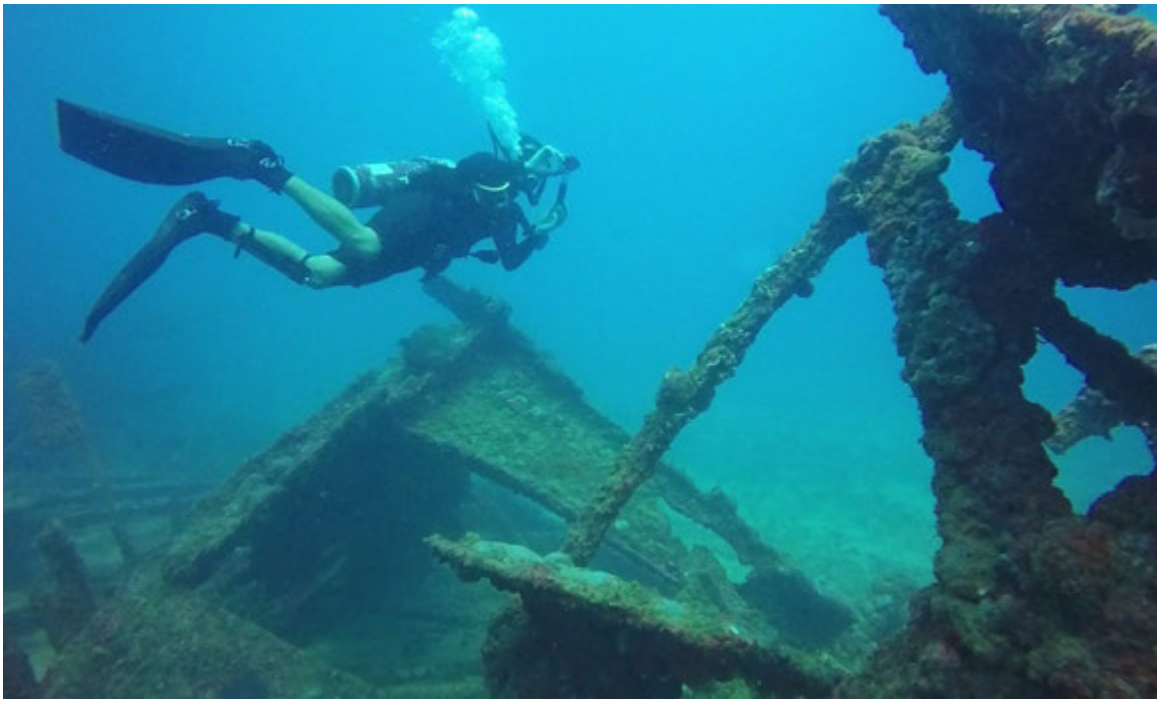
Climate change will not only affect Earth's biodiversity and landscapes, but it will have a large impact on people. It will have economic, political and identity implications and how such changes might affect lifestyles needs to be understood. All heritage is already considered vulnerable to natural disasters and underwater cultural heritage is not an exception. Rising sea levels, warmer waters, ocean acidification and changes in currents will almost certainly affect cultural heritage. Ocean currents may disturb the layer of sediment protecting underwater cultural heritage sites, leading to alteration of the materials and the potential loss of the archaeological record. Although the direct effects of chemical changes (particularly acidification and salinification) are still not well understood, the current rates of metal corrosion and damage to materials may well increase due to climate change-induced fluctuation (Dunkley 2013). Climate change will also increase the depths of oceans and increase the frequency and magnitude of storms, which may further erode or damage heritage. It may also lead to flooding of the cultural heritage that is now on land. In addition to the many other reasons policy makers need to be concerned with climate change, the cultural heritage of many countries that is now above ground may become underwater cultural heritage in the future.

GOAL 14: Life Below Water

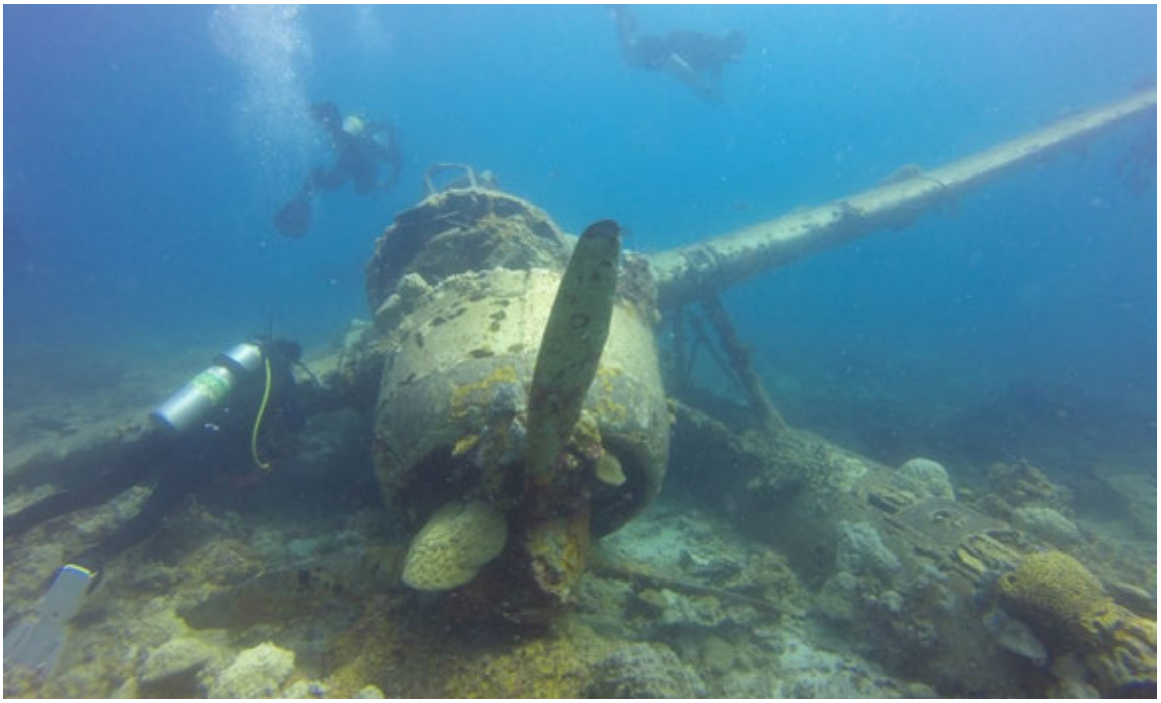
Underwater cultural heritage can potentially contribute to marine pollution. Metal corrosion, toxic materials, or munitions on board wrecked ships and aircraft can damage local areas. The amounts may be relatively small, but the effects are still important (fig. 4). In 2045, sunken wrecks from World War II will become "underwater cultural heritage" according to the 2001 UNESCO Convention for the Protection of the Underwater Cultural Heritage and their situation is complicated: they will be protected, but their structures are aging and their metal plates deteriorating, thus threatening to release their contents into the ocean due to the effects of corrosion (Ireland 2010). On the other hand, some shipwrecks are hosts to incredible biodiversity and most of these are continuously monitored so the data obtained can be important information for understanding how pollution is going to affect the oceans.

Conclusion

Water covers more than three-quarters of the Earth's surface and represents 99 per cent of the living space on the planet by volume (United Nations 2021). Careful management of water heritage is a key feature of a sustainable future. Oceans, lakes and rivers should be seen as similar to library full of books and these books as full of cultural knowledge that can provide answers to the international challenges that communities face today.



^ Fig. 3 Underwater cultural heritage as part of tourism and the diving industry (Source: Pixabay, 2016).



^ Fig. 4 Metal corrosion in underwater cultural heritage (Source: Pixabay, 2016).

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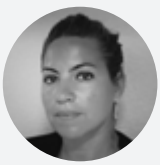

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PART II Methodologies and Case Studies


WATERSCHOOL

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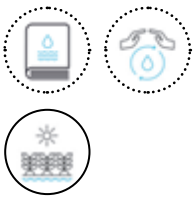
An Experimental Catalyst for the Future Living and Working Environment: The WaterSchool

Rianne Makkink and Barbara Kaczmarczyk
Studio Makkink & Bey

In the times of climate crisis, cities face acute challenges. Over 80 per cent of all climate change emergencies and disasters are water-related: floods and drought, pollution, water conflicts, rapid urbanization, a growing demand for food and energy, and migration. Many of these have historic roots in our lifestyle choices, our preference for specific kinds of technology, and energy usage. The omnipresence of water challenges and the way in which we have addressed them in the past give us the opportunity to treat water as leverage for comprehensive changes.The WaterSchool M4H+ in Rotterdam responds to this opportunity by raising awareness of our enormous water footprint and the ways we can reduce it through possibilities and solutions offered by design.

KEY THEMES



< Fig. 1 WaterSchool M4H+ – Studio Makkink & Bey building (Source: Studio Makkink&Bey).

WaterSchool M4H+

WaterSchool M4H+ is a part of the ongoing, self-initiated project of Rotterdam's Studio Makkink & Bey (fig.1). Utilizing water footprint as an urban design tool and considering water as the "ground" for rethinking the future of urbanism, WaterSchool proposes new approaches for the cultural, economic and infrastructural models of education.

Today, WaterSchool is a growing landscape in which we can place, shape and connect a wide range of related topics. Studio Makkink & Bey brings together private and public companies, designers and artists engaged in themes related to water and education, and asks them to share their expertise and vision. Water use and the way it has been embedded over decades into contemporary lifestyles becomes leverage for the collaborative exploration of a learning production landscape, creating an active archive and network. The studio's aim and dream is to set up the WaterSchool in the heart, and as a heart, of the old port site Merwe-Vierhavens (M4H).

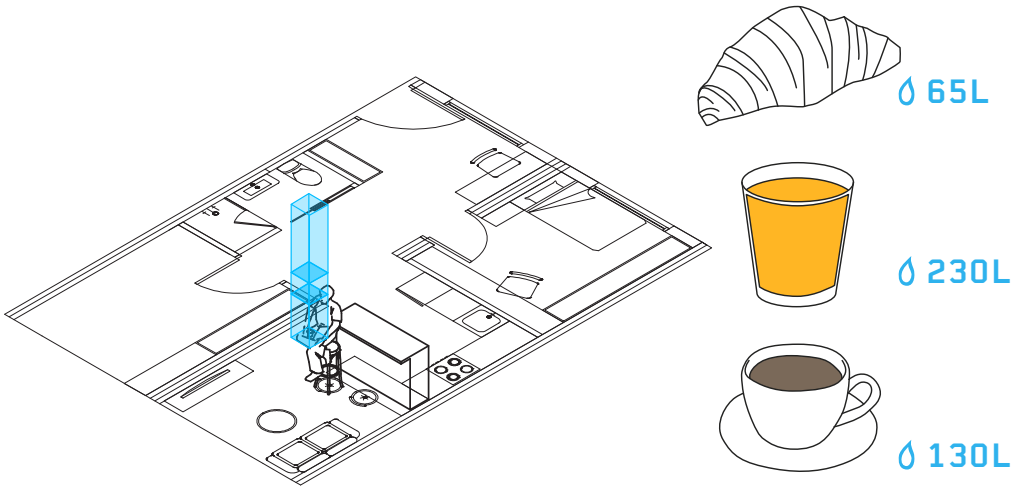
Why WaterSchool? And what is the M4H?

"The people of Rotterdam know a thing or two about living with and on water. About 90 per cent of the second-largest city in the Netherlands lies below sea level, making it vulnerable to rising waters," Elissaveta M. Brandon points out (Brandon 2021). Unfortunately, this dependence on water does not make the city's inhabitants treat it less extractively. An average Dutch person consumes 129 liters of water from the tap per day – around 47,000 liters per year – directly, for everyday use. The same Dutch person consumes another 4,000 liters of water per day – 1.45 million liters per year – indirectly as a consumer of mostly imported goods such as food and clothing (Bakker et al. 2022). Ninety-five per cent of their water footprint is left in foreign countries because of the production of goods abroad, where the water conditions are often much worse than in the Netherlands.

Rotterdam is a low-lying city in a delta, but this is not the only distinctive feature of the city's water landscape. A global hub for international trade and home to some of the world's leading industrial clusters, Rotterdam is Europe's largest seaport, with the Merve-Vierhaven, or simply M4H, being one of its latest expansions (Kimmelman 2017). A port area as large as the center of Rotterdam has been reinventing itself since 1900, when it transformed from a polder landscape to an industrial one, and later, from the biggest fruit port in the world to a future work-residential area. The rapid industrial transformations led to the release of toxic waste into the surrounding waterways, contributing to water and soil pollution (fig. 3) (Schouten 2020). Meanwhile, the focus was primarily on economic growth, with environmental concerns taking a backseat.

To this day, white refrigerated warehouses and business parks dominate Merwe-Vierhavens' landscape. The infrastructure from the harbor's times of "fruitful" splendor has been slowly fading away, giving the area an increasingly eerie appearance. Here, next to the remnants of green areas, by the neglected cargo train rail, with huge trucks often blocking window views, Studio Makkink & Bey has found its temporary home (fig. 4).

The city of Rotterdam and the Port Authority have ambitious plans for the (re)development of the M4H area (Jansen et al. 2021), including innovative manufacturing, 3000 houses for approximately 6,300 new residents, cultural and



^ Fig. 2 Indirect water consumption (Source: Studio Makkink & Bey, 2021).

^ Fig. 3 Aerial photo of old Mathenesse and Merwehaven in 1971, with cranes and gasworks on theright (Source: Group A, 2020).

^ Fig. 4 M4H area (Source: Studio Makkink & Bey, 2021).

educational facilities and mostly small businesses; what makes this an even grander vision is that by 2050, Merve-Vierhaven is supposed to be boasting of a fully circular society with a closed materials cycle. For this to be realized, test projects and coalitions need to be established to figure out how sustainable urban development can be combined with Rotterdam's position as a global port, burdened as it is with a huge amount of waste and countless raw materials and unfinished products crisscrossing the region.

WaterSchool: Making School through Design Thinking in M4H

What do these grand plans mean for the local and global waters in a port environment, threatened by rising sea level, soon to be inhabited by 6,300 new water consumers? Studio Makkink & Bey, commissioned by IABR (International Architecture Biennale Rotterdam), has taken on the task of responding to these challenges and contextualizing the WaterSchool in the M4H area and its hopeful circular future.

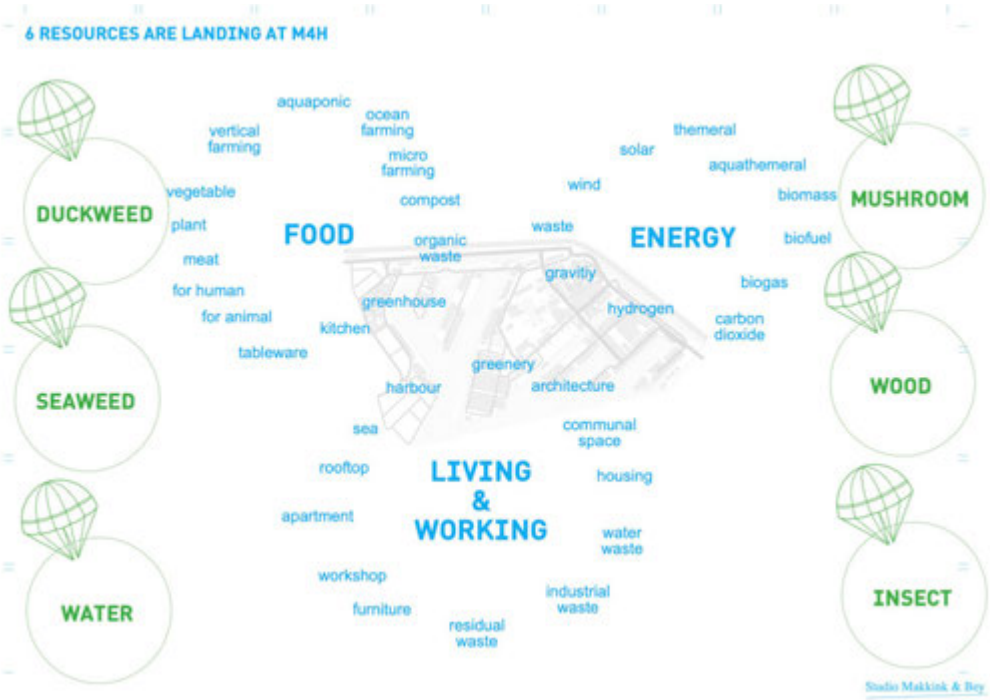
"IABR-Down to Earth: WaterSchool M4H" draws on the previously mentioned water footprint data: 6,300 new residents mean 749,700 liters of water usage per day. The starting point for the WaterSchool M4H+ was to translate these abstract numbers into imaginable and tangible knowledge that would help people realize the spatial enormity and environmental consequences of these numbers (fig. 5).

Insects, duckweed, seaweed, wood and mushrooms are the five resources that the WaterSchool has identified as potential supplies for shaping the future of living in M4H. Starting from the basic needs of an individual's body,

^ Fig. 5 WaterSchool Studio Corvers – Invisible indirect water (Source: Studio Makkink & Bey, 2021).

such as nutrition and water use, these resources contribute to a new diet, suggesting the use of less water-extracting protein sources. When expanded to dwelling, living and working, and to energy and water consumption, they also generate new sustainable building materials and energy supplies, while suggesting new types of architecture and cultures of living (fig. 6).

Within the framework of the exhibition and temporary knowledge center (figs. 7 and 8), WaterSchool M4H+ brings together experts, enthusiasts and small-scale manufacturing companies, connecting driving forces and combining methods and perspectives on water management. Following "research by design" and "learning by doing" principles, the WaterSchool M4H+ superimposes a cultural framework that recognizes the importance of local conditions, history and heritage, in a spatial framework that has been approved by the City and the Port Authority in 2019.



^ Fig. 6 WaterSchool research book - six resources (Source: Chester Chuang, 2021).

^ Fig. 7 IABR-WaterSchool M4H+ Exhibition (Source: Aad Hoogendoorn, 2021).

^ Fig. 8 Fungi scenario visualization (Source: Studio Makkink & Bey, in collaboration with Juhee Ham, 2021).

^ Fig. 9 Workshop Studio Makkink & Bey – Plot 003 Insect Larp (Source: Antoinette Veneman, 2021).

As a result, the WaterSchool M4H+ has been granted a permanent influence on the M4H area as a prime mover of the planned circular economy and as a curator of a public and living archive of multidisciplinary references that can continuously feed M4H with new insights for development.

The curriculum of this water-driven school is diverse and holistic, covering a wide range of related topics. From the basics of water conservation and management to more complex issues like water pollution and climate resilience, the school offers a comprehensive approach to understanding water and changing humans' relationship to it. The program is designed to be accessible to all, with activities and resources for children, adults and professionals alike.

Conclusion

WaterSchool is an example of how design can be a catalyst for social change. It transcends traditional notions of education, blending art, science and community engagement to create a landscape for production and learning. By exploring the intricate relationships between water and society, WaterSchool questions our approach to resource management. In an increasingly water-stressed world, the makers of WaterSchool believe that such initiatives are offering hope and paving the way toward a more sustainable and resilient future.

The impact of WaterSchool extends beyond its physical location. Studio Makkink & Bey actively shares its knowledge and experience with communities around the world. The studio organizes workshops, conferences and exhibitions, spreading awareness, inspiring others to take action and promoting sustainable practices (fig. 9). By fostering a global network of like-minded individuals and organizations, WaterSchool contributes to a collective effort to address water challenges and foster a sense of global citizenship and, consequently, responsibility.

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Rianne Makkink is a Dutch architect and designer who graduated from Delft University of Technology in Architecture. In 2002 she co-founded Studio Makkink & Bey, a practice built on experimental research methods and collaborative approaches in public space projects, exhibition design, architecture, product development and interior and product design. This diversity in implementation reflects the notion that everything is inextricably linked. Her design strategy is to not only think about structure as an engineer would, but also to look at the context.

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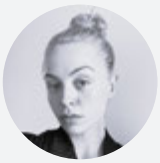

Barbara Kaczmarczyk is a transdisciplinary educator, designer and writer based in Rotterdam. As an educator and designer, Barbara is committed to creating spaces for non-institutional knowledge production that challenge dominant histories. As a writer, she draws from diverse literary genres to propose non-anthropocentric, speculative narratives. In parallel, Barbara works as a movement and yoga therapist. This experience allows her to think through and with the body, and nourishes her interest in choreographic and performative dynamics of various environments. Currently, she has a work placement with Studio Makkink & Bey, where she looks at water through the lens of metaphor and symbolism, developing a program that proposes different attitudes to water.

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The Role of Historical Data Regarding Water Infrastructure in the Spatial Development of the Nieuwmarkt Area, Amsterdam

Theo Kremer and Marco Scheffers
Municipality of Amsterdam, Engineering Office
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Historical information is an important resource for designing and sustainably developing contemporary cities, notably ones such as Amsterdam that have long histories. The historical information is embedded in physical places and structures as well as practices; it is also found in plans and texts that are held in multiple archives. It can be difficult to connect information about the past -- e.g., building materials, construction technologies, plans and proposals -- to contemporary needs and themes. Access to archives is not standardized, the material is not always digitized and it is not compatible with contemporary information systems, such as BIM and GIS. Information that has been organized in the past according to the criteria and values of the past does not always relate to current systems: think of historic handwritten documents, maps or drawings that are geolocalized, historical street names or terminologies. More attention is needed to effectively link historical data to sustainable development, while protecting the heritage of our historic cities. Doing this work is crucial: the information of today is the heritage of the future.

KEY THEMES

< Fig. 1 Nieuwmarkt with the Sint Anthoniespoort and the entrance of the water passage that continues underneath the Nieuwmarkt up to the Kloveniersburgwal (Source: Stadsarchief Amsterdam/Han van Gool, 1990, BMAB00007000124_008).

Introduction

Historic cities like Amsterdam face multiple challenges such as energy transition, liveability, the reconstruction of canal walls and bridges, climate adaptation. Meeting the challenges requires a new approach to future sustainable design. Public space, above ground and underground, especially needs careful attention. In the Netherlands, the City of Amsterdam is currently working on a unique integral approach. In short, this focuses on:

1. Collaboration between all relevant stakeholders on strategic long-term, financial, tactical and operational levels.
2. Innovation to establish a data-driven workflow (analysis, design, management).
3. Integration of spatial, social and cultural processes in adapting historic cities for contemporary challenges.

This proposal is part of a new way of working together in the public space. We see on a daily basis that the current way of working, with a focus on independent domains, is not appropriate. We need new integral approaches that connect stakeholders in the public space. Relevant instruments are co-financing, data-driven approaches, and sharing technical solutions. We believe that historical data will play an essential role in creating durable solutions. This integral approach is currently being used in four areas of Amsterdam, one of which is the infamous red-light district in the Nieuwmarkt district.

Case Study: Nieuwmarkt in Amsterdam

The red-light district on the west side of the Nieuwmarkt is the oldest part of Amsterdam, founded in the Middle Ages (fig.1). Until the construction of Amsterdam Centraal station in 1899, the infrastructure of this part of the city was based on water transport and was reachable from the Zuiderzee, now called IJsselmeer. Over a long period of time, the municipality of Amsterdam has shaped this area through its policies. During the Second World War, the neighborhood became the Jewish Ghetto, and that was followed by a long period of vacancy. In the 1970s the subway was constructed and many buildings were demolished. The 1980s and 1990s marked a period of rebuilding. New reconstruction activities in the Nieuwmarkt area are ongoing today. The historical elements are still distinguishable in the built environment of the area: old buildings and water infrastructure are still recognizable, but not always directly visible.

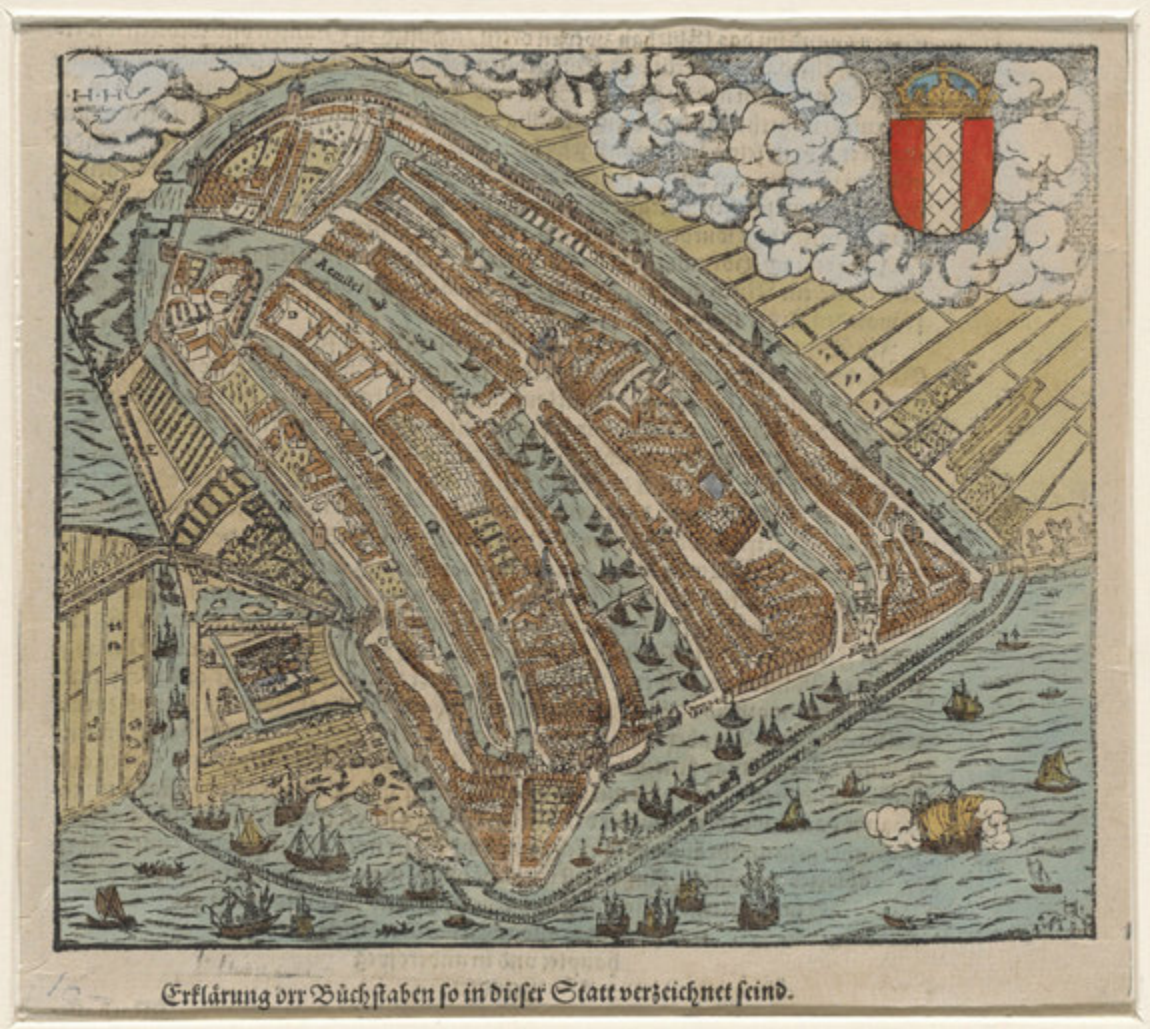
Contemporary Challenges

Current approaches to sustainable development in the Nieuwmarkt area in Amsterdam require attention to diverse factors, including geological and geomorphological factors as well as socio-economic uses. Water management plays an important role in this context.

We see three primary issues:

1. Area-specific possibilities, limitations and obstacles are determined by historical development and human interactions, soil conditions and heritage sites in situ.
2. Redevelopment of an area means the re-use of historic and natural qualities of the area, and if possible, the re-use of water infrastructure.
3. Re-use requires insights regarding the area's potential, limitations and obstacles, above ground and underground.

Understanding and exploring historical data is



^ Fig. 2 Historical drawing of Nieuwmarkt showing a water passage underneath the Sint Anthoniespoort (Source: Stadsarchief Amsterdam/Heinrich Holzmüller, KAVB00003000001).

limited by a variety of factors: access to data to start with. The re-use of data related to a specific site requires access to historical archive material that is organized according to institutions that produced the data. This means that the data is consultable in a way that is not always logical to contemporary minds. To consult archival material, you need to know which institute is responsible for the material. In many ways, this is a challenge. The physical environment develops institutional dependencies and the development phases are not parallel with the institutional developments. As a result, archival material sometimes gets disconnected from the institutional link that it relates to.

One way to consult archival material or historical data is by linked data (this means it has to stay in its original form but also be connected to other data systems). Data platforms for linked

^ Fig. 3 Amsterdam city center with the project area Wallengebied, the "red-light district," an area where multiple challenges coincide, from water management and engineering to social transformation and heritage, and requires an integral approach by all actors in the area (Source: Wallengebied Integrated area plan, Project Information Portal, 2023).

data are ideal for creating more easily readable and editable ways of consulting historical data. Digital archives are being made more accessible. Those of the Dienst Publieke Werken (Public Works of the Municipality of Amsterdam) have been digitized to serve the Bridges and Canals program. A part of the archive has been made accessible through GIS applications via a research grant. Also, drawings of old sewage infrastructure are being compared with data about the current wastewater system to find pipes that are no longer in use.

Linked data can help relate archival material to contemporary systems such as BIM and GIS. That means you can leave the original archival documents in their specific location, but you can extract information that is relevant to contemporary builders and that allows them to understand what lies underground without digging. This is even more important in the case of underground infrastructure that is not tied to contemporary data.

Opportunities for Change (Transformation)

Successful examples of studying historical structures underground mean that city water management can be more efficient. A good example is the old lock Bijleveldschesluis underneath the Waag, in the Nieuwmarkt area. The lock dates from the fifteenth century and has been transformed into a culvert that connects the water of the Kloveniersburgwal and the Geldersekade underneath Nieuwmarkt square. The lock and culvert both prevent the Nieuwmarkt area from flooding in times of heavy rainfall.

Another example can be found in the thirty-three freshwater cellars under Amsterdam's city center. The brick cellars were originally used as fresh drinking water cellars that collected the water of the Vecht. Some of the cellars contained over 200 cubic meters of water. Recently these cellars have been studied with an eye to their performing a new possible function as water reser-

voirs in periods of heavy rainfall and drought.

Other ways of using the underground infrastructure for periodic water storage also offer examples of efficient water management. A large part of the underground is occupied by artifacts that are no longer in use, for example, old sewage pipes which could provide another possible solution to the city's water storage challenge.

Lessons Learned

An integral approach is needed for the coming years to determine the best way to display historical technical data (fig. 3). Information from the past can be essential for future redevelopment on a broad range of themes. Three steps are necessary for success:

1. Organize the project in an interdisciplinary way. Take advantage of knowledge from historians, archaeologists, archivists, data specialists, and technical and water engineers who occupy different functions in science, business and government. Try to find mutual understanding through exposure and patience. In long-term projects, you must deal with different board terms, such as political appointments of limited time that are not aligned with the development periods of a city, and budgets that also expand beyond often limited budget periods.
2. Find ambassadors to convey the added value of the project you are collaborating on.
3. Accept differences and try to understand each other's language and motives and at the same time try to keep an eye on the bigger picture.

Negotiating water heritage is a study in collaboration.

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(Re)visiting and (Re)valuing the Vanishing Water Heritage in VOC Asia: Dutch Malacca and Ceylon

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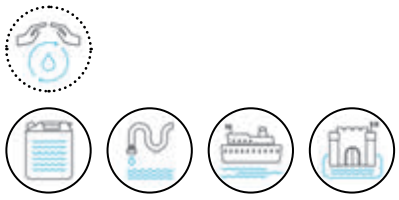
Dutch engineers are well-known for their skillful water management, best exemplified in the meticulously designed canals, irrigation and drainage systems, reservoirs, wells and moats that characterize both the Netherlands and places abroad where they have been active. Many of these structures that exist outside the Netherlands and were created by the Dutch East India Company (Verenigde Oostindische Compagnie, VOC, between 1602-1795) in Asia remain understudied. This article identifies and revisits these forgotten and often vanishing water structures through both archival and field research in Dutch Malacca and Ceylon. It explores the ways in which water management interventions during the VOC period recognized and made use of built-upon local wisdom, systematically adapting environmental knowledge into Dutch technology and governance to improve living in the tropics for both the Dutch and the local hybrid communities. Dutch water structures from the VOC period in Malacca in contemporary Malaysia and present-day Sri Lanka are examples of VOC approaches to tackling challenges in tropical environments. These historic sites – including heritage sites, some of which are recognized as UNESCO World Heritage properties – can be informative about how to adapt to current climate situations, both in terms of spatial structures and in terms of intangible practices, including cultural wisdom derived from strategies developed by the Dutch and from interactions between Dutch and local hybrid communities.

KEY THEMES



< Fig. 1 Traces of the Dutch moat in Malacca (Source: Queenie Lin, 2019).

Dutch Waterways and Water Management in VOC Asia

The Dutch are known as skillful planners in managing their limited lands, seas, coastlines, and other natural resources. Dutch-influenced water management approaches have shaped diverse cultural landscapes around the world and include systems of canals, irrigation, drainage, reservoirs, wells and moats. Unlike their Spanish and Portuguese colonial predecessors in Ceylon and Malacca, who preferred to settle on higher ground in overseas settlements, the Dutch colonists' extensive knowledge of civil engineering and water management facilitated their settlement in estuaries, on coastlines and along rivers (Van Oers 2000). In addition to their own familiarity with water, the Dutch also relied deeply on local knowledge for efficiently shaping their settlements in tropical territories, where they had to tackle unfamiliar heat, humidity and heavy rainfall on a daily basis. During the period of governance by the Dutch East India Company, or VOC (Verenigde Oostindische Compagnie, between 1602–1795), the Dutch carried out extensive environmental investigations to facilitate resource allocation and improve the quality of life for communities of European settlers and local people. What makes VOC water management stand out is how the VOC drew on local wisdom, something which was less often done by other colonial powers in the same territories. Dutch water interventions form a synthesis of European principles and local construction techniques and materials.

This article explores the formation of Dutch overseas settlements in Dutch Malacca (1641–1825, present-day Melaka in Malaysia) and Ceylon (1640–1796, present-day Sri Lanka) and goes beyond the usual suspect of research on Dutch overseas built heritage: fortifications. Instead, it focuses on overlooked water structures such as canal systems in Colombo and Negombo and waterway systems in Galle (Sri Lanka). The coastal settlements in these two colonies include several examples of how the VOC approaches to water governance built upon local knowledge concerning environmental challenges and material availability, and how they achieved the pivotal success of building resilient tropical cities that continually benefited later generations. The lack of attention to these structures has ironically allowed for their preservation and protection from over-development or over-restoration. Rethinking the historical and cultural values of these vanishing structures provides new angles for reflection on how to live with water wisely and more sustainably.

Building and Managing Water Systems in Malacca

In Malacca, in order to create settlements suitable for tropical conditions, the VOC not only built extensive water-related infrastructures like the canals, drainage systems, moats, bridges and wells that are also often seen in other VOC settlements, but they also created comprehensive management approaches that are often addressed in official documents, which provide us great opportunities to learn how the VOC valued and managed water structures and maintained water sources. The strategic location of Malacca drew interest from European hyperpowers such as Portuguese, Dutch and British because of the strategic value of maintaining a sentry post in the Strait of Malacca between East and West. The VOC conquered Malacca in 1641 after 130 years of Portuguese occupation (1511–1641) and initiated Dutch control, which lasted for 145 years (1641–1786). Among the well-documented historical records that can help us understand the close relationship between VOC and water management, the *Report of Governor Balthasar Bort on Malacca,*

1678 (hereafter, "the Bort Report"; Bremner and Blagden 1927) is an outstanding source that makes it possible to reconstruct the vivid port city life of Malacca. This report was written by Bort during his governance in 1665–1677 to help prepare his successor, Jacob Jorisz Pits. It provides a clear view of the principles of Dutch policy and administration in the East, as well as their responses to environmental threats. It provides detailed information that can be used to trace vanishing tangible structures and can help reconstruct the water heritage of Dutch Malacca.

The VOC paid special attention to the defense infrastructure such as the moats and drawbridges. Intensive details are provided in the Bort Report regarding the construction year of the moat (1673–1674) that prove the moat is a Dutch construction unlike other fort features that were inherited from their Portuguese predecessors. Today, Dutch bricks are still visible and indicate traces of the Dutch moat that has been obscured and forgotten with time (fig. 1). Other details like the sizes (183 1/2 rods long, 2-4 rods wide and 12 feet deep in Rhenish measure), as well as special features of *fausse braie* and earthen breastwork that provide stronger defense are also highlighted in the Bort Report. Even the fresh and saltwater fish that came into the moat were considered a profitable resource by the Dutch. The moat also provided a rich ecosystem: crocodiles, perch, gray mullet and lobsters (De Witt 2007), which suggests good water quality. These meticulous details concerning the water structures and water bodies demonstrate that the VOC recognized the importance not only the water resource itself but also the creation and management of water-related infrastructures. Another example is Bort's attention to two drawbridges in Malacca that were made during his governorship, and his reminders that they must be continually kept up so that they do not fall into ruin and perish. It is possible that these drawbridges were repeatedly mentioned in the Bort Report because they are the sole physical linkage between the two completely different entities in Malacca: the cosmopolitan open city, which was a rapidly growing commercial center and high-density hybrid community settlement, and the low-density administrative center of a closed European town on the opposite side of the Malacca River (Widodo 2011).

Wells are often highlighted and evaluated in Bort's report, which shows his concern about how to manage these infrastructures that were so crucial for daily living and an example of sustainable water sources in the tropics (fig. 2). For instance, the water quality is constantly evaluated for certain wells, indicating they are "good fresh water". For the wells valued highly by the VOC, there were frequent efforts to strengthen their protection by adding defensive structures or stationing heavy guards around them. Further efforts were made to protect water providers (drawers of water) and ensure that they had a safe place to obtain water. To further maintain peace and sustainable water sources, the water resources were shared with other ethnic groups. Bort ordered that water be shared with people of all nations who were at peace with the Dutch, including Europeans like the British, French and Danes, and also people of Indian descent who were responsible for drawing water.

In response to the extreme tropical environment, gutters were also valued highly and many management details were included to ensure proper water drainage: "Everyone shall henceforward be bound to make, in front of his doorstep, convenient gutters 1 1/4 feet wide and 1 1/2 feet deep, properly paved with brick in order that the streets may not be damaged and made impassable by the disorderly throwing out of

^ Fig. 2 One of the remaining well structures from the Dutch era in Malacca at the Stadthuys complex shows a mixed use of Portuguese laterite stone for drainage and the Dutch addition of brickworks for defense (Source: Queenie Lin, 2018).

the water" (Bremner and Blagden 1927). This type of detailed legislation concerning water infrastructures is seen throughout VOC archival resources but rarely seen in the archives pertaining to other colonial powers.

Extensive Canal Systems from Dutch Ceylon

Sri Lanka is the country that has the most tangible heritage from the VOC era, including forts, public buildings and dwellings, as well as intensive canal networks. Sri Lanka also has a long history and significance in maritime trade in the Indian Ocean. It flourished between the sixteenth and nineteenth centuries due to the need for supplies for the fleets used in intensive trading networks with Europe. The high quality of cinnamon and other commodities, such as various spices, elephants, peacocks, and gems, attracted the Portuguese and British colonial powers when they expanded their trading network in Asia. During the first decades of the seventeenth century, the VOC developed a hegemony over the coastal areas to monopolize the export trade of Sri Lanka, and it continued to maintain a competitive but also mutually beneficial relationship with the Kandyan Kingdom, which was established by the Sinhalese people to obtain spices and other resources from inland. To facilitate inland coastal spice trading routes throughout the country, the VOC created an extensive canal system, initiated by the Portuguese. Due to the relatively slower pace of urban development in Sri Lanka over the past few centuries, these waterways are still traceable but are not easily recognizable, as they are intertwined with the present-day urban fabric.

The canals in Negombo and Colombo linking the Kelani River and Puttalam lagoon are rare examples of the extensive canal systems VOC built that still exist. They demonstrate the opportunity seized by the Dutch to establish lines of waterways providing both easy and economical transport of goods from outlying territories to their ports. The most well-known and well-preserved canal system in Sri Lanka is Negomo's Hamilton Canal, which links the Kelani River with the Negombo lagoon (fig. 3). It was originally constructed by the Dutch and later improved and strengthened by the British, hence its anglicized name (Brohier 1978). The continuous attention it received throughout the British era might be why this canal system is better preserved. It has become one of the nation's popular tourist attractions.

However, despite being the veins of VOC trade in Sri Lanka, the extensive Dutch canal system in cosmopolitan Colombo is not recognized and preserved for its heritage values. One of the main Dutch canals is the San Sebastian Canal, which was ignored and lost in the modern urban context and is used merely as a ditch that is convenient for wastewater discharge (fig. 4). Although these historic canals are still accessible and visible, they often face serious problems of pollution, urbanization, overpopulation and inappropriate land use, which are especially very challenging in countries with rapid developing needs like Sri Lanka. We are losing these historic water systems and their heritage of centuries of human wisdom regarding how to interact with nature.

The VOC port cities in Asia are often located on shipping routes for economic, strategic and recreational purposes, attracting a great deal of tourism but also involving irreversible impact on the environment and heritage. It is a particularly pressing concern that tangible and intangible heritage is disappearing even faster in coastal areas as a result of excessive reclaimed land development and booming urban regeneration intensified by climate change.

Missing Water Heritage and Water Management at UNESCO Sites

Designated as a UNESCO city (UNESCO 1988) and one of the most well-preserved Dutch overseas settlements, Galle also has rich waterway systems from the Dutch period that are less well-known, which may be due to their sole visibility in currently under-researched archival resources. The irrigation systems, reservoirs and drainages in Galle demonstrate the Dutch urban planning ambition. Canals were also constructed in Galle for the transport of goods, for irrigation and as a flood-control measure. Galle has two canals of around 20 and 30 miles each (Wellmer 2000), and the main water resource comes from a reservoir located in the north outside Galle Fort (fig. 5). These canals and reservoir systems possess rich flora and fauna that are natural treasures, but there have not been enough cultural linkages to the VOC and their Portuguese predecessors. Also, the historic water management approaches that reflect how the VOC responded to water and the environment have been overlooked and are not mentioned in the UNESCO framework. As discussed also by Maria Estefania Gioia, the role of water and water management in the World Heritage framework still needs to be reinforced both in terms of theory and process (Gioia 2022). Similar negligence happens in Malacca. The designation as a UNESCO World Heritage City in 2008 has helped to maintain the tangible and intangible Dutch heritage of Malacca. However, the rich water heritage from the Dutch era, for example, the moat, drainage and irrigation system and water management, are barely mentioned in the UNESCO documents (UNESCO 2008).

^ Fig. 3 The bustling leisure spot and tourist attraction of Hamilton Canal in Negombo (Source: Queenie Lin, 2019).

^ Fig. 4 The neglected Saint Sebastian Canal that is lost in the modern urban context of Colombo (Source: Queenie Lin, 2019).

^ Fig. 5 The rich flora and fauna at the Dutch reservoir outside the old town of Galle (Source: Queenie Lin, 2019).

Conclusion

Dutch Malacca and Ceylon provide a vivid image of how the Dutch survived in a harsh tropic environment with limited clean water resources by building water-related structures and carefully managing them. The VOC also has carefully documented their way of living with water in the tropics, which involved building on local foundations but also making use of the colonial structures of other nations. The well-documented water management approaches and knowledge of Malacca reveal careful thinking about the creation of complex water systems, and an awareness of social justice pertaining to water resources used by hybrid communities.

Historically the locations of VOC ports were often not only chosen for their strategic military value but also for their value to shipping routes. Canals were built, as in Ceylon, to become the veins to support trading and shipping activities. The rich water heritage that survives affords many opportunities for cultural tourism but also brings many irreversible changes to the environment and local culture. However, even when these sites become recognized as heritage, a comprehensive approach that includes consideration of water in heritage management is missing. The VOC water heritage offers unique opportunities to rethink the role of water in heritage, especially in a changing contemporary urban context, to gain a better understanding of how to cope with the dilemma between preservation and development, and to meaningfully reflect on how to attach cultural values to water infrastructures. Understanding the connections can help with heritage preservation and sustainable urban development globally.

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Azudes along the Serpis River: Cultural Heritage, Obstacles and Contested Authority

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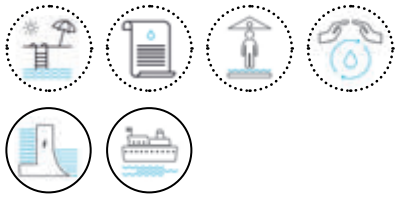
Preserving cultural heritage and achieving the Sustainable Development Goal of protecting life below water do not always go hand in hand. The case of the Serpis River sheds light on the political, cultural and legal tensions that may arise when pursuing these two policy goals. To better understand these tensions, we propose acknowledging that rivers are complex natural-cultural systems imagined and shaped through various actors' values, interests, practices and infrastructures (Boelens et al. 2016). River restoration initiatives generate divisions between actors and institutions with different ways of defining and valuing natural and cultural heritage.

KEY THEMES



< Fig. 1 An *azud* on the Serpis River (Source: Ana María Arbeláez-Trujillo, 2022).

Introduction

In 2007 the Serpis River was declared a "Protected Landscape" due to its landscape and ecological and cultural values. The river runs 74.5 kilometers, and along its course, one can find clues to how the interaction between water, people, riparian fauna and vegetation and water infrastructures has shaped a unique cultural landscape (fig. 2). Which among these elements are the most important and worthy of protection? The answer varies depending on whom you ask. Some people believe that what makes the Serpis unique is its industrial archaeology, namely the *azudes* (small weirs) and small hydroelectric plants that remain following the heyday of the region's industrial era. Other actors, including ecologists and river restoration advocates, believe that the river's richness results from its ecosystems and natural values. For them, the *azudes* should be removed or modified due to their impact on the flow of the river.

What type of heritage deserves more protection: cultural or natural? Who is entitled to decide that? There are no straightforward answers to those queries. Still, reflecting on them could provide valuable insights into how to align the current needs of sustainable development and cultural preservation.

The Serpis: Natural-Cultural Heritage

The Serpis is a Mediterranean river flowing in Spain's Valencia region, from Alcoy (Alcoi) to Gan-

^ Fig. 2 The Serpis River cultural landscape in Alcoy (Source: Ana María Arbelaez-Trujillo, 2022).

^ Fig. 3 A hiker contemplates an *azud* along the Serpis Greenway (Source: Ana María Arbelaez-Trujillo, 2022).

dia. During the Spanish Industrial Revolution, by the end of the nineteenth century, many paper and textile mills and small hydroelectric plants flourished in the area thanks to the river's water. Alcoy became known as an industrial center connected to the sea via the Alcoy-Gandia railway, which ran parallel to the Serpis.

Although the train does not run anymore, the old railway, now called the "Serpis Greenway," reminds visitors of the legacy of this industrial era. Walking along the railway, a visitor can enjoy the Serpis cultural landscape and the coexistence of nature and architectonic elements such as *azudes* and small hydroelectric plants (fig. 3). The river's industrial archaeology reveals a rich ecosystem that has been a key driver of the local culture and economy (Sapena 2021b).

Recognizing the interaction between natural, cultural and social values, on April 13, 2007, the Generalitat Valenciana issued Decree 39/2007, which declared the Serpis a protected landscape. This declaration indicates that governance of the Serpis should protect both natural and cultural heritage in an integrated way. For this purpose, the Serpis Greenway should be accessible to the public and play an important educational role. The decree sought to promote a balanced relationship between nature and culture.

Despite its status as a protected area, currently, the Serpis suffers from water pollution, the presence of invasive species (fig. 4), alteration of the river course, and morphological alteration of the channel (Garófano-Gómez 2019). Aiming to combat such problems, citizens, scholars, activists and ecologists have joined the Plataforma Ciutadana per a la Defensa del Riu Serpis (Citizen Platform for the Defense of the River

^ Fig. 4 This reed (*Arundo donax*) is the most notable invasive species along the Serpis River (Source: Ana María Arbelaez-Trujillo, 2022).

Serpis). The Platform seeks to promote spaces for citizen participation in the decision-making processes affecting the Serpis.

However, collective river restoration efforts have been challenging due to disagreements about issues such as whether the *azudes*, whose water concessions (legal entitlements granted by an official authority to use water for economic activities) have expired, should be removed or modified to allow the free flow of the river, or whether they should be preserved as cultural heritage. In such a context, debates about dam removal and cultural heritage become a contested arena influenced by other ideological debates, such as those concerning what nature is and which of its aspects are worth protecting (Hommes 2022).

Different Positions in the Debate

In the discussion about whether to remove the *azudes*, a central actor is the Jucar Hydrograph-

ic Confederation (CHJ, its acronym in Spanish), the entity in charge of managing the Serpis. Seeking to restore the free flow of the river and the migration paths of fish, the CHJ has requested the councils of Villalonga and L'Orxa to remove three *azudes* located in their municipalities. These water infrastructures belonged to old industries that have ceased operating. Their water concessions have expired and the *azudes* are no longer used, raising the question of whether it is necessary and good for the river's natural flow to maintain them.

The CHJ's petition is underpinned by the Water Framework Directive's goals regarding river restoration and it has received support from local environmental scientists and associations. For example, Virginia Garófano-Gómez (2019) argues that weirs significantly impact the river's connectivity and fluvial processes. For her, restoration efforts should include the removal of all obstacles: transversal, lateral and vertical. Many of these are highly harmful to the riverine ecosystem because they modify the flow of the river, impact sediment transportation, and fragment habitats. Therefore, Garófano-Gómez suggests that a starting point to improving the river's continuity is to consider demolishing obsolete infrastructures, such as abandoned small hydroelectric plants.

However, the focus on the ecological dimension of river restoration has triggered dissent in the region. Counter-arguing the petition of removing the *azudes*, the mayors of Villalonga and L'orxa have brought forward cultural, environmental and social reasons to defend them.

In cultural terms, the mayors claim that the *azudes* are part of the industrial archaeology of the province of Valencia and, as such, form an integral part of the cultural landscape. Moreover, they argue that although the formal water concessions have expired, many local inhabitants use the *azudes* as roads to access rural areas (fig. 5). For them, far from being obsolete, these water infrastructures provide an essential service and are embedded in their daily practices (Sapena 2021a). Finally, they believe that the *azudes* contribute to nature and the river's biodiversity because new life has emerged from their backwater (Sapena 2021b).

After the requests made by the town councils, the CHJ is assessing ways to maintain the *azudes*, and is especially interested in reducing the costs of demolishing them. However, the CHJ and environmental organizations insist on modifying these infrastructures and ensuring their maintenance to allow the Serpis to flow freely. The debate remains open.

The discussion of the *azudes* centers on discrepancies between environmental and cultural values. It also involves considering who has the legitimate right to decide about the river and its water infrastructures: the CHJ, local councils, the users of the infrastructures or the environmental organizations. These clashes reveal the contradictions, facets and dynamics of river restoration policy processes. Therefore, it is necessary to outline the tensions engendered at the local, national and international levels to understand the conflicts that can emerge from the different positions of power.

The Serpis Case, Global and Regional Trends in River Restoration

The request to remove the *azudes* from the Serpis River aligns with global, regional and national policy efforts to foster river restoration strategies to combat climate change. From a global perspective, governments worldwide have adopted the SDGs seeking to halt and re-

^ Fig. 5 A car crosses an *azud* in Potries (Source: Ana María Arbeláez-Trujillo, 2022).

verse the decline of water quality and the destruction of freshwater ecosystems. They have set ambitious goals to protect and restore water-related ecosystems, including wetlands, rivers, aquifers and lakes.

From a regional perspective, the EU Water Framework Directive and the EU Biodiversity Strategy seek to remove barriers from freshwater ecosystems to restore their connectivity and enable the migration of endangered species. At the national level, the Spanish Ministry of the Ecological Transition Environment adopted a set of strategies to "re-naturalize" Spanish rivers, which includes removing or adapting *azudes* along the rivers (fig. 5). These policies and normative repertoires prioritize natural conservation over cultural uses. This prioritization clashes with social norms related to cultural heritage and daily practices, as explained above.

Acknowledging the different layers of norms involved in the discussion enriches our understanding of power dynamics and scale, namely, the interaction between global, national, regional and local processes. Consequently, controversies concerning heritage conservation and the restoration of the Serpis River can help to approach the river as a hydrosocial territory to negotiate and redefine social relations, and as an arena to mobilize global, European, Spanish and local norms. By understanding the Serpis River "as a territory," as proposed by Boelens and colleagues (2022), it is possible to identify and analyze how diverse actors imagine the river and the various norms, policies and legal repertoires they mobilize to materialize their visions and ideas about the river.

Conclusion: Integrating River Restoration and Heritage Conservation

The Serpis River case reveals tensions and conflicts that may arise between the protection of natural and cultural heritage. Moreover, this case challenges the assumption of a direct relationship between heritage protection and achieving SDGs, which sometimes can clash. Developing river restoration strategies beyond managerial notions requires understanding history as dynamic and acknowledging the diverse values, practices and normative repertoires of the actors involved. Along those lines, future restoration efforts could be strengthened by recognizing the different socio-legal systems that coexist in the river. For example, restoration strategies could incorporate a definition of water rights that recognizes the environmental, social, cultural and political orders involved in the efforts to protect biodiversity and infrastructure (Boelens 2011; Boelens and Zwarteveen 2005).

Finally, a central lesson from this case study is that there is no straightforward solution to achieve the SDG of protecting life below water in harmony with other policy goals, such as preserving cultural heritage. It is challenging to anticipate the consequences of prioritizing one over the other: power dynamics and unintended consequences will play a significant role in the outcome.

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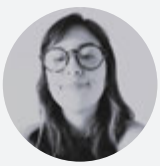

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Water, through Words and Evils: The Case of Saint-Louis

Moustaph Ndiaye
Island of Saint-Louis, Senegal

Certain cultures portray the sacredness of water in rituals performed daily and to mark different stages of life. Water has been revered the home of protective spirits, according to myths and legends, such as those of the Serer people in Senegal. This spiritual connection between water and people, which has favored its preservation, has been undermined with the emergence of industrialization and urbanization. This shift in perception has led to water being viewed primarily as a commodity. The Island of Saint-Louis is faced with a paradox of benefits and challenges due to its colonial cultural heritage and unique deltaic condition. This article discusses the vulnerability of the site and its water heritage along with the opportunities it could bring for sustainable development of the island.

KEY THEMES

CLIMATE

A B C D E

BWh
Dry Arid Desert Climate

< Fig. 1 The person drowning in this Covid-19 exposition is metaphorical in depicting water as a source of death, conflict, war and tension (Source: Abdoulaye Touré, 2021, CC BY-NC-ND 4.0).

Water from the ocean, the sea, the stream, the canal, the lake, the river, the backwater, the oasis, the pond, the retention basin, the source of groundwater, the drilling, the well. Water from the mist, the clouds, the dew, the rain, hail, snow. They envelop us, surround us, overwhelm us. They are underground, on the earth, in the atmosphere.

Beware of the water of the tornado, the storm, the river overflowing its bed, the raging ocean, Katerina, the tsunami and the heavy downpour!

Water from the water tower, from the reservoir, from the cistern, from the tap, from the barrel, from the canary, from the basin, from the can, from the goatskin, from the calabash, from the bottle, from the pot, from the glass, from cups, even inner tubes and the famous 'mbuus' or polluting plastic bags! So many sources, so many receptacles, so many cultures.

- From the author's fieldnotes

Introduction

Concerning the relationship between water and people, as well as the cultural significance of water in our society, it is important to acknowledge the various ways in which water is utilized and valued. These uses and virtues are of great importance at events in all stages of life: birth, baptism, circumcision in certain ethnic groups, marriage and death (fig. 1). The rituals performed in these circumstances attest to the importance and sanctity of potable water as well as water mixed with roots, millet, salt, rice, cotton or other products.

Both spiritually and temporally, water is inseparable from life and has always had the authority to confer power. The establishment of towns and villages have always depended on the existence of water sources. Myths and legends abound on this subject. All the custodians and protectors of their settlements inhabit the waters: Mame Coumba Bang, Mame Coumba Castelle, Mame Coumba Lamba, Mama Ngédj, Mama Ndagne Sangamar (or Sangomar), Mame Mindiss, Leuk Daour Mbaye, among others (Margoles 2007). The priests and priestesses, intercessors between spirits and people, are vested with mystical powers conferred on them by purificatory practices either offerings of milk, wine, blood and other forms of libation. The Serer people from Senegal integrated water into their beliefs, customs and traditions, passed on through generations. *Zamzam* (holy water in Arabic), *saafara* (magic potion to drink or apply to the body), *sangatt* (bath recommended by a marabout or priest) and *tuurs* or *diuur* (totems or evil spirits) are all linked to the sacredness of water according the Serer. A fairly common practice among them, which corroborates this belief, is to pour water at the doors of houses early in the morning as an expression of hope for a peaceful day. Another water-related characteristic of Serer people is found in the town of Joal-Fadiouth, where the maternal line of the Diaxanoor descends from the goddess of the sea, and that of the Fendior descends from the goddess of the rain.

Water Needs and Threats

From time immemorial, the spiritual relationship between water and people has favored water's preservation. Traditional societies ensured that water use was limited to strictly domestic or agricultural needs. It is the same today in rural areas where traditions are still alive, especially where resources have become scarce. Unfortunately, industrialization and urbanization have completely changed this relationship. Water

^ Fig. 2 Aerial view of Saint-Louis Island showing the Langue de Barbarie and its vulnerability to the threat of sea-level rise (Source: Google Earth, 2023).

has ceased to be an element of cosmology in which the elements of nature take on a sacred character because they are essential to life; it has simply become a commodity.

Urban and industrial cultivation require significant amounts of water. Wells and other water sources have given way to large-scale hydraulic installations which facilitate access to water in larger quantities and higher quality. The phenomenon of standpipes, which once stored water and lined the streets of cities, and often initiated disputes between the women who came to collect the resource, has faded with the development of urban hydraulics that allow the installation of taps in most homes. This has to a large extent contributed to the improvement of the well-being of the population but also greatly increased their water consumption. In this context, one cares more about the availability of water than about its preservation. As soon as the bill is paid, we are inclined to believe that water must be available. As long as it continues to flow, most consumers will certainly care very little about its preservation. However, hydraulics specialists continue to sound the alarm about problems of water scarcity. At a time when some people travel for miles on foot, in a cart, on a bicycle or on the back of a donkey to fetch the precious treasure, we in urban agglomerations only have a lever to turn or a button to push to see water flow. If we had more trouble getting it, would we abuse it so much?

The Island of Saint-Louis, a Vulnerable Site

The Island of Saint-Louis, designated as a World Heritage Site in 2000, is an agglomeration of about 300,000 inhabitants. Built on the sandy banks of the mouth of the Senegal River and the Atlantic Ocean, it is made up of a succession of islands and backwaters. Established as a colonial shipping hub, the island became the politi-

^ Fig. 3 Houses destroyed by erosion along the coast of the Island of Saint-Louis (Source: Abdoulaye Toure, 2021).

cal capital of French West Africa because of the affluent activities of European traders traveling up the river in search of slaves, gold, leather and other commodities. It received its World Heritage status for its colonial history in the development and diffusion of cultural syntheses, its urban form as well as the beaches, quays and the Faidherbe Bridge which has become the emblem of the city (UNESCO n.d.). Although there have been attempts to implement a safeguarding and valorization plan for this UNESCO-designated property (Coly 2009, UNESCO n.d), there remains a lack of proper sustainable management of this rich cultural and natural, tangible and intangible heritage (Sine 2020)

One of the main consequences of this omnipresence of water is the amphibious character of the site. More than 20 per cent of the communal area is made up of water. Two-thirds of its living area is liable to flooding during periods of heavy rainfall and yet, ironically, the merging of the river and the ocean has created a magnificent environment (fig. 2). This deltaic condition gives it the status of an exceptional site, being perceived as both a weakness and a strength. It has been nicknamed the “African Venice.”

The situation of the Island of Saint-Louis exposes it to multiple environmental hazards directly linked to water: the river, the delta and the Atlantic Ocean (Delft University of Technology 2021). The site has a very low morphology, separated from the ocean by a sandy strip, the Langue de Barbarie. There is an annual decline in the dune by 1 to 2 meters. If this trend is maintained and nothing is done to stop its progression process, the disappearance of the Langue de Barbarie, which was once a thin sandy peninsula but has recently become an island, would expose the mainland to direct contact with the Atlantic Ocean. Consequently, the disappearance of the Island of Saint-Louis will inevitably follow due

^ Fig. 4 Inland advancement of the sea, threatening everyday human life (Source: Abdoulaye Toure, 2021).

to the inland advancement of the sea.

In addition to maritime hazards, the island is exposed to other climatic phenomena such as outcrop of the water table, floods and capillary rise, with immediate or delayed consequences. All these put Saint-Louis at the confluence of all major climate vulnerabilities, explaining why, from year to year, this city records considerable damage to dwellings, equipment and infrastructures, and sometimes the loss of human lives (figs. 3 and 4).

Conclusion

There have been several interventions to preserve this heritage site, especially in the time of climate change and associated risks, with a focus on institutional capacity building. In 2012 the Tourism Development Program for Saint-Louis and its region (PDT/SL), financed by the State of Senegal and the French Development Agency (AFD), was signed as an emblem of economic, social and environmental impact and as part of a new paradigm of local development of the city, anchored in the national policy of sustainable territorial development. This initiative is structured to enable the municipality of Saint-Louis and its region to be more resilient, not only in the economic sectors of fisheries and tourism, but also with environmental enhancements such as improved air quality as a result of a better transportation system, more sustainable waste management, requalified green public spaces for the entire local population, and the preservation of public and private

cultural and historical heritage for future generations (EnQuete+ 2020).

As part of the celebration of the tenth anniversary of the UNESCO Recommendation on the Historic Urban Landscape, the Island of Saint-Louis was presented as a case of how an extensive conservation and development program can bring together different stakeholders to improve the state of conservation of the historic city (UNESCO 2021). And yet still, particularly in Saint-Louis, there is a significant gap between the investments and expected results. International collaboration can foster an exchange of good practices but also direct water cities to refrain from bad examples (Delft University of Technology 2021).

Today, we are fortunate to have running water and we should make sure we deserve it, recognizing its real value and making a personal investment in what it represents. The UN 2023 Water Conference caught the interest of the international community and was a call to action and for better awareness of our individual and collective responsibilities. Water is not life; it gives life to life. Most of the great civilizations, for instance pharaonic Egypt on the banks of the Nile, were aquatic. To give history the opportunity to run its course, as previous generations have done for us, it is the duty of each and everyone to safeguard water for future generations and to preserve life on our planet. In the words of a popular saying, "We only know the value of water when the well is dry."

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Climate Change and Fish Farming: Venetian "Fish Valleys" as a Design Device for Coastal Adaptation and Mitigation

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Beginning in the fourteenth century, along the northeastern Italian coastline, Venetians began to create a series of hydraulic structures called "fishing valleys," which combined aquaculture production with lagoon and seawater management. According to the current scenarios provided by the Intergovernmental Panel on Climate Change, the coastal areas, where many historic fish farms still stand, will inevitably be affected by the rise in sea level. To be preserved, they will require some sort of water defense or possibly a managed retreat. Can we redesign traditional fish-farm systems as climate, economic and environmental adaptation devices? Through a series of design scenarios, this contribution explores how traditional fish farming can help redefine the territorial scale by addressing climate change and reviving existing production systems.

KEY THEMES

CLIMATE

A B C D E

Cfa
Humid subtropical

< Fig. 1 A fish valley in the northern Venetian Lagoon (Source: Alessandro Destro, 2017).

Introduction: Fish Change Landscape Design

The northeastern Italian coast, which extends from the Po Delta toward the Venice Lagoon and finally the Grado Lagoon, features many historical landscape elements, including traditional aquaculture systems (fig. 2). From the Latin *vallum*, literally "wall," fish farms were created during the Venetian Republic, between the fourteenth and fifteenth centuries, as productive landscapes (Rallo 1997; Benà and Rallo 2011). Initially, the *valli da pesca* were developed for fishing with nets: in spring, the most fished species – sea bream, sea bass, goldfish, mullet and eel – need to leave the sea and look for brackish water to reproduce (Vatova 1962). The fish would then approach the mainland moving toward the large rivers that flow into the lagoon, and there, these species were captured with a system of reed trellises placed in the middle of the waters (D'Alpaos 2010). However, when the technique was refined and the Venetian Republic acquired greater institutional power, this fishing system was gradually replaced with one that involved earth embankments (D'Alpaos 2010). The valleys were transformed into stable dammed and semi-dammed structures (fig. 3), and the aquaculture practice transformed the hydraulic system into an industry that became an emblem of skillful interaction between humans and nature (fig. 4).

In spring, the fry are sown. The gates overlooking the lagoon or the sea are opened in autumn and winter. The fish pass through a channel called a *colauro*. Fishermen then close the grids (fig. 1) and harvest the fish. The mature ones are destined for sale, and the ones still too young to harvest are placed in fishponds to grow until the following spring (Vatova 1962; Fabris 1993).

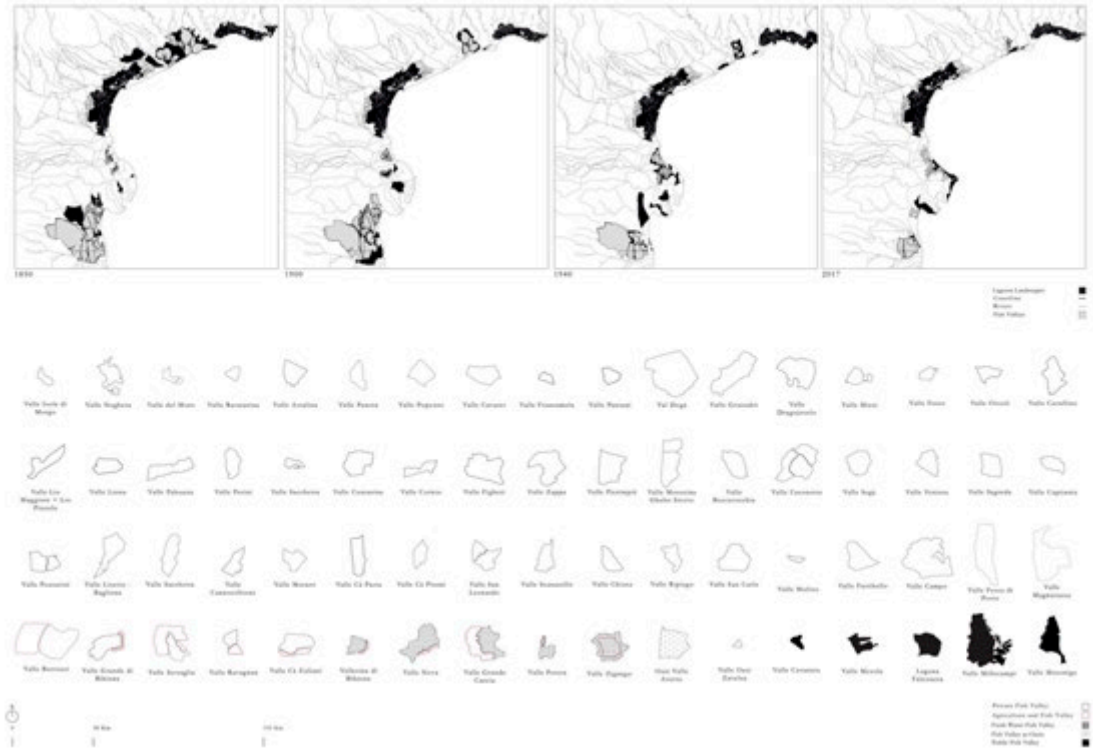
In addition to fishing, many other landscape practices have been taking place within these transitional areas between land and sea: breeding farm animals, cultivating cereals and producing rice fields and salt marshes (Provincia di Venezia 2009).

This historic aquaculture system has remained unchanged up to the present day. However, the economic crisis of fish farming at the end of the 1980s, the development of the global fish market and the growth of intensive farming have severely affected the economy of this traditional form of intensive fish farming (Cosolo et al. 2015; ICRAM 2007).

Methods

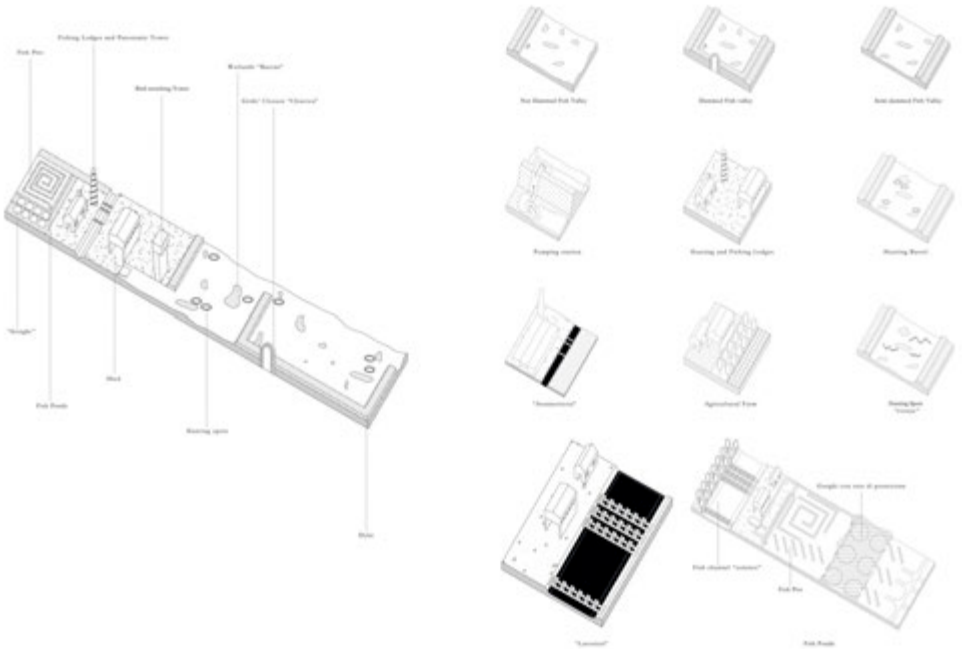
We have conducted research using multiple sources of information and methods. The "research through design" methodology involved mapping the landscape and urban systems. Ancient cartographies of northeast Italy and iconographic materials of former fish-farming systems were collected and carefully compared with the current systems. Geographic data collection and geographic information system analysis helped us investigate the landscape systems at multiple scales.

On-site investigations and fieldwork constituted the cornerstone of our knowledge acquisition and helped us adopt a "place-based approach" to the design process. An in-depth survey was conducted in the 2017–2018 academic year and partly originated from a year-long design process in northeast Italy. We traveled along the coast, observing the places of probable future climate transformation and getting to know the local people and cultures related to aquaculture systems. Our methodology included observing and studying from different scales as starting points for understanding. The survey included photographic investigations and sampling, and



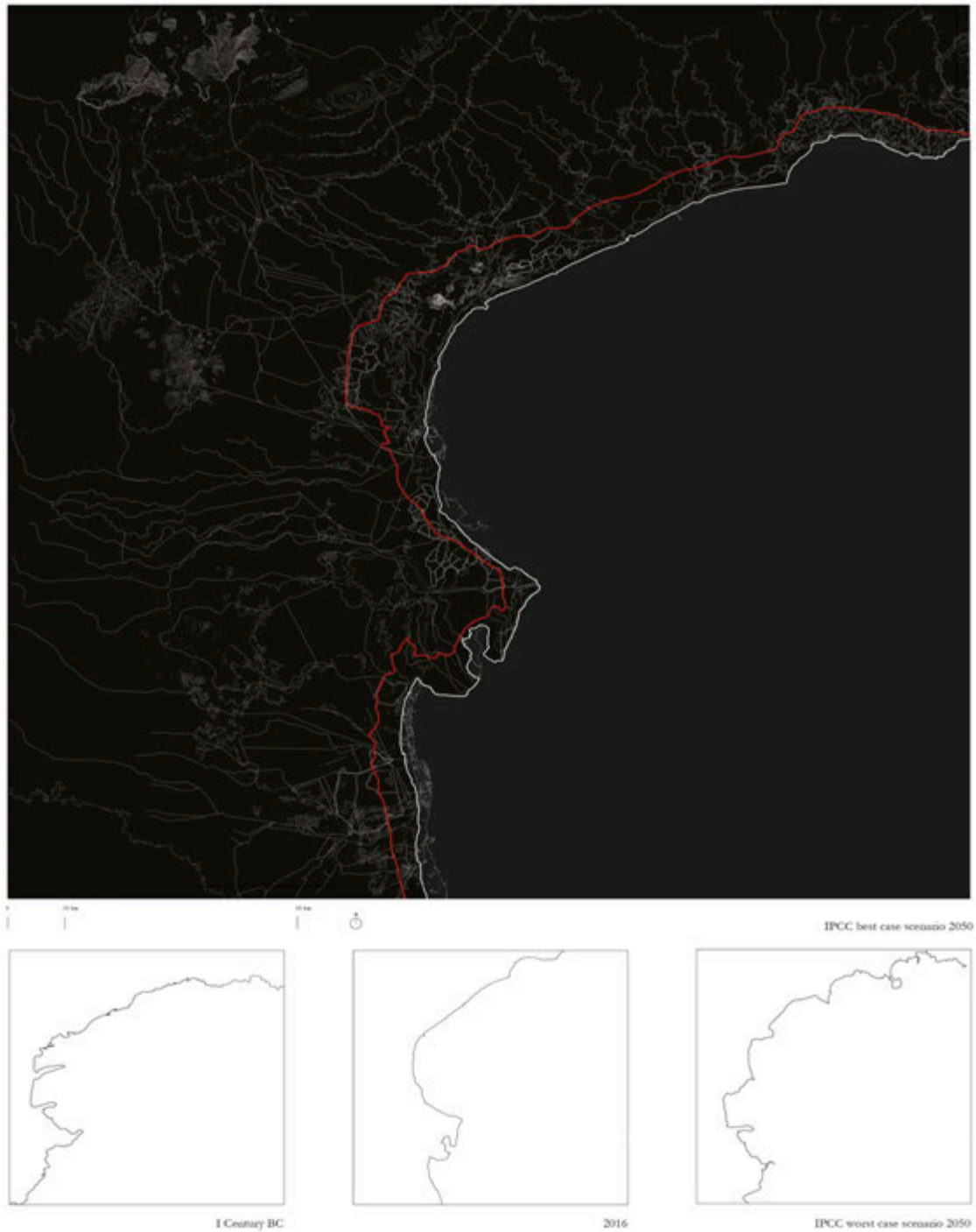
^ Fig. 2 On top, fish valleys' geographical distribution and evolution in the last 150 years (1850-1900-1940-2017) on the northeastern Italian coast. Below is the taxonomy of *valli da pesca* fish farms: today's existing fish valleys according to their different types and peculiarities (private and public fish valleys, fish valleys with agriculture, freshwater fish valleys, and fish valley oasis). (Source: Alessandro Destro, 2018. Supervised by Laura Cipriani, 2018. Edited by Laura Cipriani, 2023).

^ Fig. 3 A fish valley in the northern Venetian Lagoon (Source: Alessandro Destro, 2017).



^ Fig. 4 *Valli da pesca* typologies and elements (Source: Alessandro Destro, 2018. Supervised by Laura Cipriani, 2018. Edited by Laura Cipriani, 2023).

^ Fig. 5 Fishermen at work in a canal of the fish valley (Source: Alessandro Destro, 2017).



^ Fig. 6 On top, in red, is the 2050 coastline assuming a one-meter sea-level rise. Below are the palimpsests of the past and future (Sources: Laura Cipriani, 2018 and Alessandro Destro, 2017).

a study of water quality and plant species to comprehend the phenomena associated with the *vallicoltura* systems – this peculiar type of extensive fish farming practiced in the upper Adriatic Sea in brackish water basins and enclosed by embankments.

Another source of knowledge was interviews with local people involved in the fish farm industry: fishermen (fig. 5), workers, owners, concessionaires, public authorities and local economic players such as restaurateurs and historians of the "Museo del Territorio delle Valli e della Laguna di Venezia" fish farms museum.

Our literature review considered multiple sources of information, including non-academic sources, such as newspapers and documents, which helped us understand the mechanisms underlying the current crisis facing the aquaculture system and the opportunities that may exist for it.

Who Owns the Landscape between Water and Land?

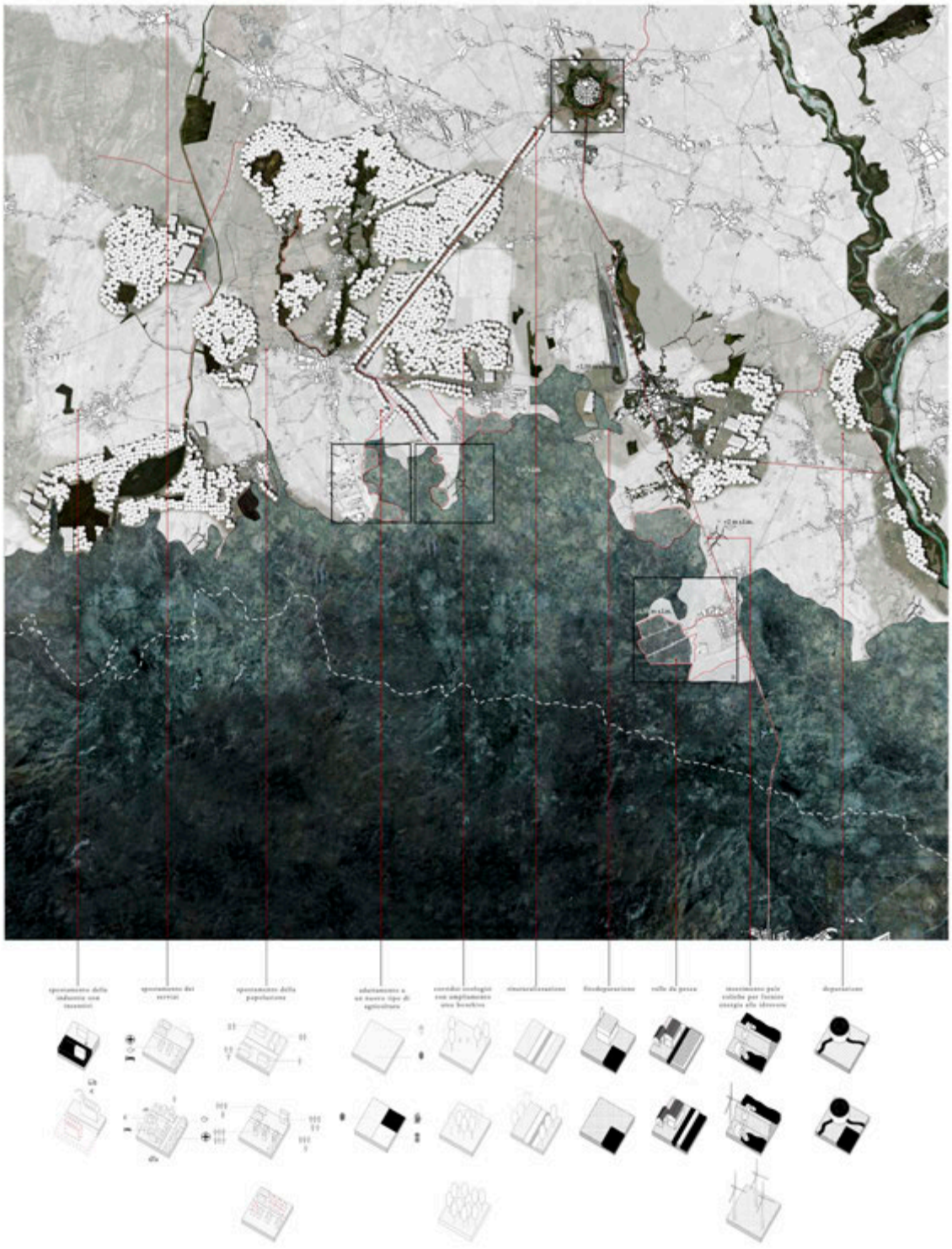
The ownership, hydrology, ecology, conservation and management of fish farms are highly debated. Who owns the landscape between water and land?

Initially, fish farms were lagoon parcels temporarily delimited by reed fences that prevented the expansion of the tide. The hydraulic resistance of the structures reduced sea-lagoon exchanges (D'Alpaos 2010). The Serenissima Republic soon regimented the valley areas, partly as state property and only to a small extent as private property (Rallo 1994, Fortibuoni et al. 2014, Rivoal 2021). Most structures are today private (Alpa et al. 2010), creating conflicts between the public and private sectors that also underlie significant hydraulic problems. The progressive embankment of the fish farms has effectively privatized and modified the hydraulic regimes of the lagoons and transition zones subjected to the action of the tides. The stable embankments of the fish farms limit the expansion of the waters coming from the hinterland upstream as well as of the brackish tidal waters coming from the sea. In addition, ongoing climatic changes necessarily require giving progressively more room to upstream and downstream waters (D'Alpaos 2010).

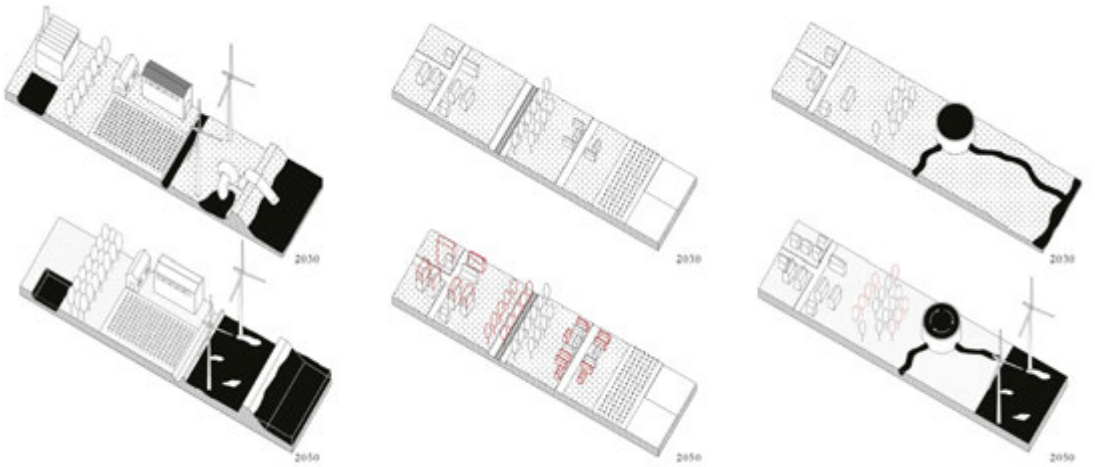
A further conflict is ecological. Today, the economy of the fishing valleys is mainly based on the income deriving from the rental of the valleys for hunting, which because of its frequency and intensity causes many ecological and environmental problems for birds and causes excessive lead pollution of the waters (Arpa 2023). This activity runs counter to European biodiversity conservation regulations since the fish farms in northeast Italy are in Sites of Community Importance and Special Areas of Conservation as part of the Habitat Directive, forming a network of protected sites called Natura 2000 (Regione Veneto 2020; Regione Friuli Venezia Giulia 2018; Regione Emilia-Romagna 1993). Furthermore, some of the fish farms are located near industrial or otherwise polluting areas. The farms near the Porto Marghera industrial area in the Venice Lagoon are examples. Finally, there is a regulatory conflict since the regional and local urban and landscape plans often overlap and differ in their protections for fish farms and their systems.

Fish Farming in Future Scenarios

What other management approach can be considered for the future? Should fishfarms be preserved or transformed? Can we redesign traditional fish-farming systems to make them ways



^ Fig. 7 Retreat scenario in the Marano Lagoon and the fish farms' transformation (Source: Benedetta Bertellini, Roberta Bertoglio, Alessandro Destro, Francesco Fagotto, Francesco Moretton and Matteo Tosoni, 2017. Supervised by Laura Cipriani, 2017).

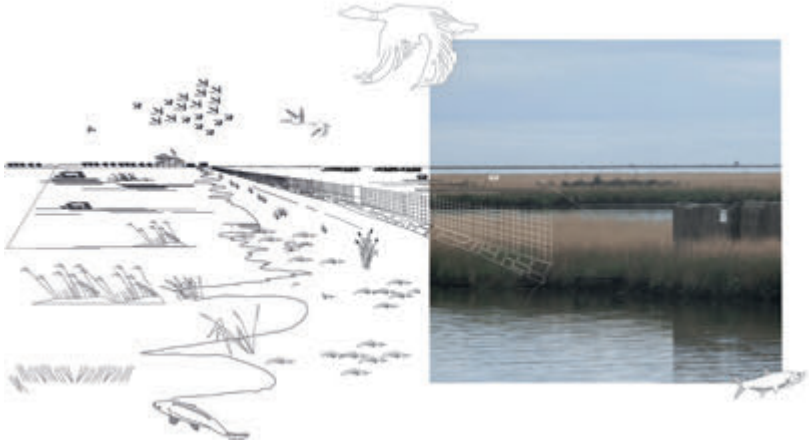


^ Fig. 8 Transformation of a fish valley in the Venetian lagoon (Source: Alessandro Destro, 2018. Supervised by Laura Cipriani, 2018).

of adapting to changes in climate, economy and environment? All cultural landscapes are products of progressive adaptation. Looking at the past teaches us that the Venetian fish farms have never been static systems but rather have evolved to meet the needs and technical-technological refinements that have taken place over time.

Sea-level rise will change the coastline and transform the territories and legislative and administrative systems of the areas concerned. According to the Intergovernmental Panel on Climate Change (IPCC 2014, IPCC 2022), northeast Italy will be one of the places most affected by climate change and sea-level rise. Assuming an increase in temperature of 1.5 °C, the coastline of 2050 will move to a position corresponding to the geo-morphological palimpsest of the first century BC, when the marine waters of the Upper Adriatic were at a much higher altitude than the current mean sea level (fig. 6). Just as in the past the great hydraulic engineers of the Venetian Republic diverted the main rivers that carried sediments into the lagoon to preserve Venice from silting up, so today, some areas of the coast of northeast Italy might reinterpret and adapt the historical tradition.

The project we have presented (Destro 2018; Cipriani 2019) proposes a series of scenarios for the medium to long term for the Venice Lagoon, the Marano Lagoon and the Po Delta to try to take advantage of the new environmental conditions by welcoming or rejecting the water that will come. Many agricultural lands in the water–land transitional areas can be made into fish farms because of the dikes present and the water adaptability and productivity of the area (fig. 7). Farms could be transformed into fishing valleys; this would involve raising their embankments, allowing coastal protection (fig. 8), and activating economies already present in the area (fig. 9). Extending the fish valleys into a territorial system can be a valid climate adaptation tool for coastal protection and a crucial climate mitigation tool for carbon sequestration and storage. Finally, aquaculture's traditional hydraulic, agro-pastoral and economic functions are expected to be transformed with new technological processes such as integrated multi-trophic aquaculture systems (Neori et al.



^ Fig. 9 Fish Valley and its adaptation (Source: Alessandro Destro, 2018. Supervised by Laura Cipriani, 2018. Edited by Laura Cipriani, 2023).

2004; Nesar and Marion 2016) for water purification, biomass (algae) growth and energy production. From their humble origins as small landscape devices, fish farms could ultimately help redraw the coastline on a territorial scale.

Conclusion: Select the "Active Part" of the Past

The projects presented concerning the fishing valleys of northeast Italy induce a series of reflections that transcend the single case study with regard to the themes of water and heritage.

First, all cultural landscapes are the product of progressive adaptation led by social, economic, and technical-technological needs. Preserving does not mean leaving the past unchanged, but rather innovating tradition with an eye to the future. The designer's task is to know how to *select the "active part" of the past*. That means understanding and deciding what are the dynamic parts of the landscape's past and how and if they can be preserved while embracing the transformation according to new uses, forms, and scales of the present. Heritage also extends to all of a landscape's living and non-living systems: plants and fishes can be considered the heritage of an ever-evolving cyclical process. The cultural value lies in adapting site-based landscape devices to meet future challenges in the short, medium and long term.

Second, a close-scale landscape micro-device can change the territorial scale and, in this case, suggest a possible climatic adaptation.

Third, the economic sustainability of a landscape device is an essential element of adapting the past for the future. In plans aimed at mitigating and adapting to the climate crisis, protection from damage must be combined with the production of economic value. Only a plan to generate new economies and innovations can ultimately be effective.

Finally, to respond effectively to climate urgencies, administrators, institutions, planners, associations, communities, individuals and living entities must design and collaborate with the landscape. This implies the need for new governmental and legislative tools for the future.

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Collaborating on Sustainable Interflow Water Collection: The Erfeng Irrigation Canal System from the Period of Japanese Rule in Taiwan

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Cheh-Shyh Ting
National Pingtung University of Science and Technology

While the world struggles with limited water resources, interflow water is a hidden gem of a solution. Interflow is an important water source contributing to river flow. It is the movable water in the unsaturated zone, or vadose zone, which may return to the stream or go into the riverbed. The collection of interflow water was included in the design of the Erfeng Irrigation Canal System (EICS) during the Japanese period in Taiwan (1895–1945), and it is still used in the EICS in Pingtung in southern Taiwan. Today, urbanization and changes in land usage have reduced the EICS's irrigation function. At the same time, intensive habitation has introduced pollution to the canal area. Furthermore, new extensions and rebuilt facilities of the irrigation infrastructure have minimized historic values. We are involved in working to maintain the canal in a way that safeguards cultural heritage values and to expand other functions of EICS, such as by installing micro-hydro facilities over the canal to preserve its importance to local communities.

KEY THEMES

CLIMATE

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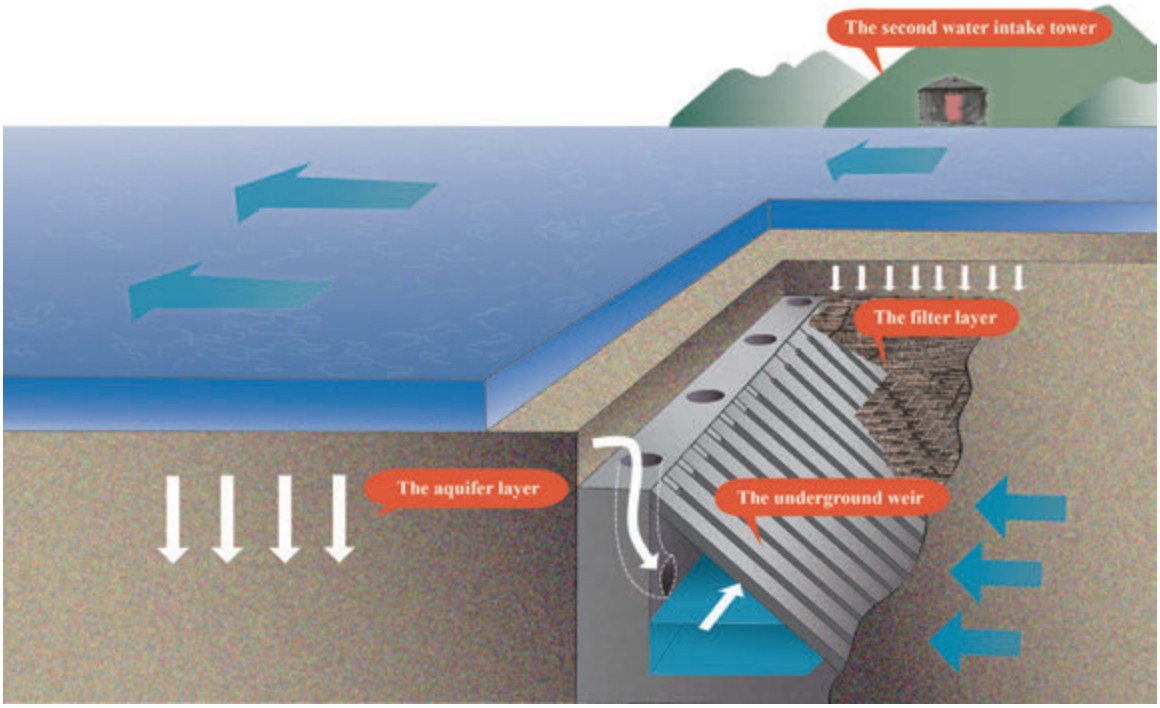
< Fig. 1 The EICS canal in the Pingtung farming area (Source: Szu-Ling Lin and Cheh-Shyh Ting).

Building the Erfeng Irrigation Canal System

The use of underground weirs to collect interflow water as a sustainable method of irrigation is not unique to Taiwan and Japan, but is an important hydraulic technology found worldwide. During the Japanese period in Taiwan, the Japanese wanted to plant sugarcane in a dry plain. Because of the slope of river and stone in the Pingtung area, dry plain conditions are common. The EICS used underground weirs to collect interflow water under the riverbed of the Linbian River to solve the problem of water shortage during the dry season. This kind of technology depends on precise water conservancy surveys to find a suitable water intake location. Then, an underground weir is installed to intake interflow water. With correct measurements of terrain height, it is possible to use gravity to send the captured interflow water to a farm 3436 meters away. In this way the EICS turned waste rubble into fertile fields of sugarcane.

During the Japanese colonial rule of Taiwan, the Japanese-owned Taiwan Sugar Company built two irrigation canals to irrigate sugarcane plantations and rice fields in the Pingtung Plain area in 1923 and 1925: the EICS and the Lili River Irrigation Canal System. EICS is larger and more famous than the Lili River Irrigation Canal System. EICS and its underground weir was designed by engineer Nobuhei Torii, who sought a way to collect interflow water from the riverbed of the Linbian River and solve the problem of water shortage during the long dry seasons in the Pingtung Plain (Torii 1936). After five years of investigation, Nobuhei Torri chose the proper site to bury the underground weir of EICS.

To build this irrigation canal system, the Japanese had to negotiate with local Indigenous people to obtain the territory and hire workers to build the irrigation canal system. Therefore, this irrigation canal system is a water conservancy project made possible by cooperation between the colonists and local Indigenous people. The underground weir of EICS consists of four parts: a trapezoidal weir, an arched tunnel, a catchment culvert and two water intake towers (a translation of the Japanese "*第一與第二取入水塔*") that function as manholes for maintenance access. The foundation of a water intake tower is laid underground, with the rest of its structure extending above ground. The trapezoidal weir, arched tunnel, and catchment culvert are laid to a depth of 2–7 meters beneath the alluvium gravel of the riverbed. The trapezoidal weir is 2.87 meters high, 0.91 meters wide at the top, increasing to 3.94 meters wide at the bottom. Its water intake surface consists of inclined concrete columns arranged to create a 25 per cent slotted seepage surface, forming a right-triangular water channel that is 1.82 meters wide at the bottom with a height of 1.82 meters. The trapezoidal weir, the main structure of the canal system, has a total length of ca. 328 meters, stretching from east to west at a gradient of 1/100 (figs. 2 and 3). The western end of the weir is connected to the eastern end of the arched tunnel, which admits interflow water from the weir into the water intake tower. The tower, which is the endpoint of the structure, is ca. 1.5 meters in width and 8.4 meters in height. The interflow water flows from the arched tunnel through the water intake tower and eventually enters the conveyance waterway. The conveyance waterway is ca. 3.6 kilometers long. A diversion structure (figs. 1 and 4) divides the irrigation water into three routes leading to farms. Using precise topographical measurements, Nobuhei Torii designed a suitable underground weir structure that can successfully collect interflow water without electricity and can use natural gravity to allow water for irrigation to flow to farms 3.6 kilometers away. The area of the irrigated farms were about 3,000 hectares



^ Fig. 2 In the EICS, the underground weir and the second water intake tower (Source: Szu-Ling Lin and Cheh-Shyh Ting).

during the Japanese period. Today, the area of irrigated farms is 2,193 hectares.

Preserving and Managing the Water Heritage of the Erfeng Irrigation Canal System

The canals and sugarcane plantations continue to be maintained by the Taiwan Sugar Company, which was inherited from the Japanese after World War II. The farms stopped growing sugarcane in 1998, and the company is leasing most of its farms, which are being used to grow other crops. Furthermore, some water from EICS contributes to the local Indigenous communities' daily water supply. In 2008 the system was registered as a cultural landscape under the Cultural Heritage Preservation Act because it qualified as industrial heritage with scientific value. This cultural landscape demonstrates one way that human beings can overcome constraints of the natural environment and use its characteristics to create irrigation canals that make it possible to grow crops. In 2017 the underground weir in EICS was part of a large-scale excavation and restoration project after damage occurred as a result of changes in the topography of the riverbed. The construction of the underground weir could then be documented by the EICS (fig. 5).

Today, maintaining and using water as a resource has become a major focus of human activity. Systems of land reclamation, water supply, irrigation, submergence, sewage and micro-hydropower generation help build, define and sustain societies. Water control has long been a strategic social and political consideration for communities.

After World War II, Indigenous people moved

^ Fig. 3 The interior of the underground weir in the EICS (Source: Szu-Ling Lin and Cheh-Shyh Ting).

from their original village to an area along the line of the delivery waterway (conveyance waterway) of EICS. In the early period of the initial relocation in the 1950s, the Indigenous people of this area did not pay close attention to domestic wastewater treatment and facilities. Nor did the government invest adequately in infrastructure. At present, the use of interflow water by the residents along the EICS has significantly increased and pipes are covering the conveyance waterway (fig. 6). Residents have been improperly withdrawing water from the EICS. In recent years, the number of residents has increased, and the Pingtung County Government is making progress improving wastewater treatment facilities. In the future, the EICS's excess interflow water could be diverted to the Taiwan Water Company and used for people's livelihoods, so that the EICS can continue to operate sustainably.

Water heritage conservation has a diplomatic function. The design and construction of the EICS is an example of sustainable and ecological thinking from a century ago. In 2008 when the EICS was listed as cultural heritage in Taiwan, the value of science and technology in the cultural landscape that was shaped by academic and cultural exchanges between Taiwan and Japan was recognized. This recognition is the basis for sustainable management as well. For the people of Taiwan and Japan, the need for management has led to a greater awareness of history. The preservation of the cultural heritage of the EICS has even led to cultural exchanges between Taiwan and Japan. Many Japanese tourists have been drawn by the EICS to visit the Pingtung Plain area. Because of such achievements, Prof. Cheh-Shyh Ting, one of the authors of this article, was honored with an award by the Japanese imperial family in 2023.

To expand the value of the EICS, engineers have been attempting to develop green micro-hydro power energy from the water collected by the EICS irrigation system. The power can be used by the local communities. Pingtung County is an area with abundant water resources, and the county government currently promotes special Green Micro-hydro Power Energy Development Projects in the EICS. In demonstrating and coordinating the micro-water green belts, the equipment has been installed, without interfering with the original water conveyance, to promote the monitoring and development of water conservation and green energy in the community.

Conclusion: Challenges to Developing a More Sustainable Water System

There are three main concerns motivating the current conservation approaches toward the EICS:

1. With intensified urbanization and rap-

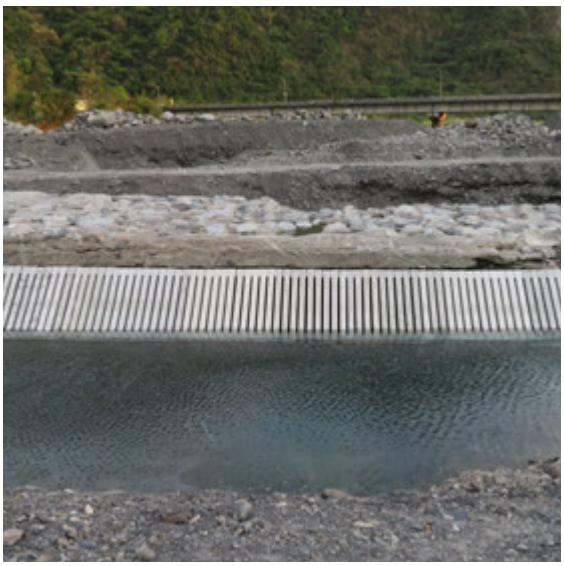
^ Fig. 4 The location and layout of the EICS (Source: Szu-Ling Lin and Cheh-Shyh Ting).

id changes in land use, many irrigation canals in the farming area have been destroyed.

2. The improper use of water by residents living along the delivery waterway pollutes and damages canals.

3. To improve the efficiency of water delivery or to expand the road, some canals in the farming area have been rebuilt, which has resulted in the loss of historical value.

Meanwhile, many EICS canals in the farming area have been partially destroyed. Moreover, some of the EICS canals in the farming area were converted to modern canal technology because of enhanced hydraulic efficiency. For the farming area of 3,000 hectares irrigated



^ Fig. 5 The construction of the underground weir in EICS (Source: Szu-Ling Lin and Cheh-Shyh Ting).

^ Fig. 6 The pipes covering the conveyance waterway of the EICS (Source: Szu-Ling Lin and Cheh-Shyh Ting).

by the EICS, urbanization has brought many changes to the irrigation route. The function of the town has changed and reduced the scope, raising questions about how to preserve the original irrigation function and the original facilities of the ECIS in the future. Preservation of the century-old irrigation project will also preserve important cultural heritage that includes knowledge of people, things, time and place. For this to happen, it will be necessary for the government and the public to strengthen communication.

In 2022 the Pingtung government launched a cultural heritage conservation plan to ensure a conservation area covered all the EICS canals in the farming area. This project is attempting to balance new kinds of land use with the preservation of the original EICS canals in the farming area. Interviews with stakeholders are clarifying the complex issues surrounding land use and preservation. Light detection and ranging (LIDAR) technology is being used along with field investigation and historical document research to reconstruct the original EICS channels in the farming area. The project follows proper preservation methods. According to the LIDAR results, we can observe changes in the canal structures in the farming area of EICS from the Japanese period to the present.

Here we recommend some important principles to follow in the conservation of EICS. When discussing the cultural heritage value of water resource engineering, it is necessary to pay attention to the integrity and authenticity of the operation of a single water resource engineering system, and to fully understand the systematic or serial relationship between different kinds of water resource engineering systems, to avoid a narrow vision that focuses on the value or preservation of a single or partial building or structure. It is important to clearly discuss the value of water as cultural heritage. Therefore, efforts to conserve the cultural heritage of water infrastructure should recognize the importance of

1. The integrity of a single water resource engineering system.
2. The authenticity of single water resource engineering equipment and structure. This will involve the application of engineering technology in different periods, which must be categorized according to the timing of the application of the engineering technology.
3. The systematic and serial correlation of different water resource engineering systems.

Implementing these steps will take time.

Furthermore, in terms of the national development of green energy policy, due to the stable flow of the waterway, it has been evaluated as

suitable for hydropower generation. A set of demonstration micro-hydraulic power generation units was set up as a test, and the results were positive. The development of the power system makes the development of water conservancy resources on the waterway more sustainable. With cultural preservation, the interflow water conservancy wisdom of the past can be passed on to future generations and the new function of green energy can expand the system's value.

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Waterworld: The Use and Reuse of Lake Tadane in Safeguarding Knowledge and Sustaining the Cultural Heritage of the Nzulezo Community

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Nzulezo, a tentative World Heritage Site listed in 2000 by UNESCO, is a community built on Lake Tadane in the Western Region of Ghana. Since its nomination, Nzulezo has become an attraction to both Ghanaians and foreigners alike. Over the years, the population has built dwellings and other structures to form the village over the lake, a way of adapting to an environment made up of about 70 per cent freshwater, about 20 per cent wetland, and 10 per cent land. Nzulezo stands out among heritage sites in Ghana due to its traditional architectural style. The village structures are made of wood and raffia. Located in a water-dominated environment, the community experiences changes in water levels that are predominantly seasonal. The water level is low from December to April during the dry season and high from June to August during the rainy season. In Nzulezo, the entire management of the site has been left to the Ghana Wildlife Society, a non-governmental organization (NGO). The focus of the management is tourism-driven, with less regard for the community members and the environment.

KEY THEMES

CLIMATE

A B C D E

Am
Monsoon climate

< Fig. 1 Picture of life in Nzulezo, a village on stilts in the western part of Ghana. Buildings are made of rafia palm branches. (Source: Kwesi Raul, 2022. CC BY 4.0 via Wikimedia Commons).

Water is colorless and tasteless but you can live on it longer than eating food.

- African proverb

Introduction

The name of the village was derived from the Nzema word *nzulezo* which means "surface of the water," referring to the environment in which the village is located. Nzulezo lies in the hinterland of Beyin in the southwestern part of Ghana. Beyin is located along the coast of the Gulf of Guinea. The Nzulezo community can be accessed by a fifty-minute canoe ride from Beyin, the closest town to the village. The Nzulezo community is also situated within the Amansuri wetlands, the most significant inland swamp forest in Ghana. The Amansuri wetland ecosystem is rich in biodiversity and consists of peat, swamp and mangrove forests, floodplains, sandy shores with streams, a freshwater lake, lagoons and the sea.

Climate change has significant impact on Nzulezo, affecting its ecosystems and well-being. Generally, climate change is already altering the rainfall patterns in Ghana; some regions may experience reduced rainfall while others, like the location of Nzulezo, are faced with more intense rainfall events and flooding. The community heavily depends on agriculture for its livelihood, and changing rainfall patterns, increased temperatures and extreme weather events can impact crop yields and overall food security. Climate change affects Ghana's water resources, including rivers, lakes and groundwater. Increased temperatures and altered rainfall patterns can lead to water scarcity, reduced water quality and conflicts over water usage. This makes Nzulezo highly vulnerable. Before its inscription by UNESCO, the community cohabitated with the environment and water. Today, they are faced with not just cohabiting with the environment for themselves only, but also for the masses who troop there as tourists. Both the community and those who visit the site as tourists are at risk should there be a sudden climate switch.

Current Approaches to Preserving and Managing Water Heritage

Construction knowledge is a vital component in ensuring the continuity of the traditional building style, which is a focal aspect of Nzulezo's cultural heritage. The managers of the community, the Ghana Wildlife Society, pay attention to heritage without realizing the important link between Nzulezo's cultural heritage and water. The lake and how the community leaders have preserved their immediate environment until today deserve more critical attention. Unlike other heritage sites, the Nzulezo community is situated within the boundaries of a heritage site. Often, when heritage sites are located where a group of people live, this location then becomes "living heritage." The concept of "living heritage" emphasizes the links between a community situated within the confines of a heritage site, a place where people participate daily in cultural activities such as language, festivals, crafts and performing arts within the social landscape.

As an attribute of a society (Bicchieri 2005), local norms play a crucial role in communities as they serve as a means through which culture, heritage and the environment are preserved. Neither codified nor written down in books, these embodied norms prove highly effective in local communities. According to Andoh (2019), norms serve consciously or unconsciously to help preserve nature and the environment since most communities, at least historically, depend closely on these natural resources. At Nzulezo,

^ Fig. 2 Nzulezo community on water (Source: YEN News).

^ Fig. 3 High water level (Source: YEN News).

local leaders created demarcations and apportioned areas where community members could relieve themselves. This system was put in place because the lake flows, so the community area would remain clean and unpolluted. Additionally, a demarcated portion of the lake has been reserved for collecting clean drinking water. It is also taboo for any community member or tourist to dump waste into the lake, to ensure cleanliness.

There is no better method to preserve the environment than the ways local people have and protected it for the past 400 years and more. Indigenous knowledge at Nzulezo contains essential values that need to be passed on to younger bearers of local culture. The unique culture and heritage of the community is closely linked to Lake Tadane and is mainly evident through

1. The presence of water and the fact that the community resides on water permanently.
2. The unique architectural and building style of the community. That is, using natural materials such as wood, raffia fronds and palm fronds in building.

Current and Future Challenges of this Water Heritage Site

Residents of Nzulezo have experienced their fair share of threats against the practice, survival and continuity of their heritage. Among these threats is the introduction of new construction technologies, which is evident in a house made of brick that has joined the traditionally constructed buildings on the water. One consideration for recognizing Nzulezo as a World Heritage Site was the community's unique way of building with local traditional materials as part of their adaptation to a wetland environment. Also, Nzulezo is one of the few ancient settlements on stilts and platforms left in the world. The brick house has the potential to heighten the risks that threaten the survival of the ecosystem and local heritage. If the local interest shifts to brick housing, people will start finding ways to fill up sections of the area that can accommodate these structures. Despite the many challenges faced with maintaining their heritage, the elders and other community members of Nzulezo have fought hard against political, policy and sustainability challenges as they have tried to develop and maintain a global reputation, especially since the village was nominated to the tentative list of World Heritage Sites in 2000. The new status provided by UNESCO led to a sudden local heritage boom (Harrison 2013), which ironically has the potential to bring profound changes to the community and its heritage. During the early stages when Nzulezo was being discovered and nominated, heritage institutions and the government were focused on generating revenue at the expense of the community's well-being. Yet so far, the local leaders have stood their ground, hoping to give future generations the opportunity to partake in and continue what they have received and are struggling to pass on. The heritage has been well preserved until now by the locals themselves, who take pride in their culture.

The water system at Nzulezo was stood the test of time in regard to climate change mitigation and environmental protection. There have not been any severe droughts affecting the lake and its environs, but in 2009, an increasing flow of rainwater into the lake caused floods that destroyed part of the community, although fortunately with no casualties. The surrounding ecosystems have also been stable. Some current challenges affecting this water heritage include a massive influx of both national and

international tourists. This has impacted most aspects of community life. Many visitors arriving on weekends and holidays put pressure on the community and its immediate environment. The community is facing sanitation issues due to tourists dumping waste and sewage directly into the water.

Ensuring proper water management is a major challenge throughout Ghana, although the government is trying to achieve SDG 6. People have been fighting against the misuse of the main water bodies that supply fresh drinking water to the population. Of particular concern is the pollution from *galamsey* (illegal mining). Additionally, climate change has been resulting in flooding in Ghana. During flooding, polluted water flows from illegal mining sites all the way to Nzulezo, causing a physical change in the look of the water and for months making it difficult for the community to access clean drinking water. By integrating modern and traditional water management systems, Ghana can work toward sustainable development.

Conclusion

The UN SDGs adopted in 2015 are a universal call to action to end poverty, protect the planet and ensure peace by 2030. In the quest to achieve all 17 goals, it is vital that sustainable management of water resources, including water-related ecosystems in the case of Nzulezo, are met. This can be achieved through water education and awareness initiatives to ensure access to clean water and sanitation. As Nzulezo's cultural identity is closely tied to the lake, the need to properly care for and preserve the environment is crucial for heritage continuity. Acquiring and transferring knowledge to subsequent generations in any social setting is a fundamental process linked to cultural continuity. These processes are not only embedded in belief systems but also closely connected to the qualities of their immediate location. Now, activities relating to heritage management threaten the continuity of the local heritage that defines the Nzulezo people. There is a dire need for collaboration between all obligatory stakeholders (national/international heritage institutions, the local government, NGOs) and the community to achieve a more effective and acceptable course of action.

For an active member of the living community within the heritage space, daily lifestyle forms an integral part of the heritage. This fact can be leveraged to achieve inclusive, sustainable development, social cohesion, equity, community well-being and resilience between the Nzulezo community, the state and NGOs.

It is important to involve the community in better managing their heritage. The management process needs to incorporate traditional ways of learning about and knowing the world. Traditionally, sanctions, norms and taboos have been important social tools for managing heritage assets. This method of heritage management is linked to a belief system. With a community such as Nzulezo, where people have great respect for tradition, incorporating and implementing these local methods as part of managing the community should improve the current situation.

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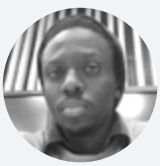

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A Hidden Water-Harvesting System: The Sassi di Matera

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The water-harvesting system of the ancient Sassi di Matera, in the Basilicata region of southern Italy, represents a clever way of living with water in an arid climate. The terrain, with its soft rocks (Calcarenite di Gravina), provided the foundation for the water-harvesting system that shaped the cave dwellings of Sassi physically, socially and culturally. People caught, guided and stored water in private and public spaces, mostly underground, ensuring its availability for all. In 1993 UNESCO declared the cave village a World Heritage Site. Unfortunately, the water-harvesting system of Sassi di Matera is no longer functioning. Its historic ingenuity is not as visible as the system deserves and its cultural and social values are almost forgotten. Using layered visual analysis – the illustrative method – knowledge can be collected and communicated in drawings to get insight regarding more resilient, circular, and people-related approaches (Bobbink, Chourairi and Di Nicola 2022). This article and the included drawings focus on the water system's value, from which we can learn today.

KEY THEMES

CLIMATE

A B C D E

Bsk
Dry Semi-Arid (Cold)

< Fig. 1 View of the Sassi di Matera from Belvedere Murgia Timone; in the foreground is the canyon of the stream Torrente Gravina (Source: Isabella Banfi, 2022).

A Smart Urban Water System

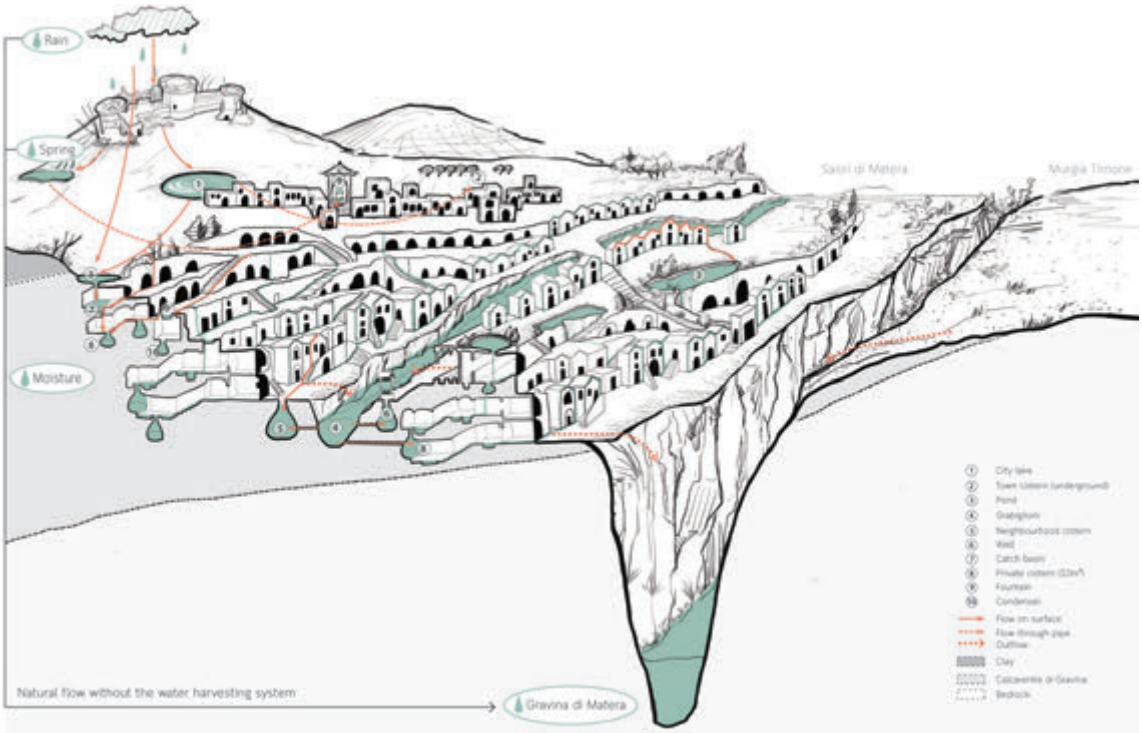
Due to low precipitation throughout the year, water is scarce in the Basilicata region, once known as Lucania. Since the Bronze Age, people have used soft rocks (*Calcarenite di Gravina*) to create cave dwellings and cisterns to store rainwater for domestic use and irrigation. The water-harvesting system includes wells, catchment basins, ponds, cisterns, condensers, fountains and *neviere* – large spaces carved in the rocks where snow is stored to cool food in summer – all horizontally and vertically connected by channels. About 2,210 cisterns were identified using a statistical approach, including 2,039 small bell-shaped cisterns, 170 neighborhood cisterns and two large cisterns of 1,300 and 5,000 m³ each (Manfreda 2016). The water harvesting in the Sassi demarcated private and public spaces. Private cisterns could store 10 m³ and consisted of basins and water channels on different levels, helping water to flow smoothly and become progressively cleaner. The *vicinato* – a shared courtyard where children played, and people met – was always accompanied by a cistern serving four – six families. Over the centuries, water shaped the town's physical state and influenced how people lived and worked. The system provided water for the development of an agropastoral society in which most people were engaged in agriculture and animal husbandry.

In 1920 the Sele Aqueduct began to deliver water through pipes to the houses, which resulted in neglect of the historic water-harvesting system. The *grabiglioni* (drainage canals) were covered in 1936 and turned into streets. In 1952 52 per cent of the inhabitants were still peasants (Pontrandolfi 2018). At that time, due to the increasing population, cisterns were transformed into living spaces. In 1952 when the town was labeled a "national shame" because of its poor living conditions, which included sanitation problems, crowding and a lack of electricity, the government evicted people from their homes. Between then and 1960, about 15,000 inhabitants left the ancient center of the community and moved to newly built houses uphill. As a result, the cave city became a ghost town.

In 1993 Matera became a UNESCO World Heritage Site because of its unique combination of site-contextual living and water-harvesting system. Funds were then raised to bring people back to the city. Today, the city's recovery is a success, with more than 700,000 visitors annually. The caves have been transformed into hotels, restaurants, lovely courtyards and alleys. Yet, reactivating the water system for use was deemed unfeasible due to modern demands regarding water quality, hygiene and quantity. Luckily, even though the water-harvesting system is no longer used, most of its elements are still in place.

Current Challenges to Preserving and Managing Matera's Water Heritage

Locals who own hotels and restaurants and those who have taken on other commercial initiatives are pursuing possibilities of preserving elements of the traditional water system so that, even without the water, the importance of the system is recognized as a part of the town's story. Antonella Passione, a member of La Scaletta – a cultural association committed since 1959 to the conservation and enhancement of the historical, artistic and environmental heritage of Matera and the Lucanian territory – renovated a series of *hypogea* spaces, a subterranean part of an ancient building, with three levels and seven cisterns. She converted the space into a restaurant, La Lopa, while maintaining its original shape, materials and appearance and

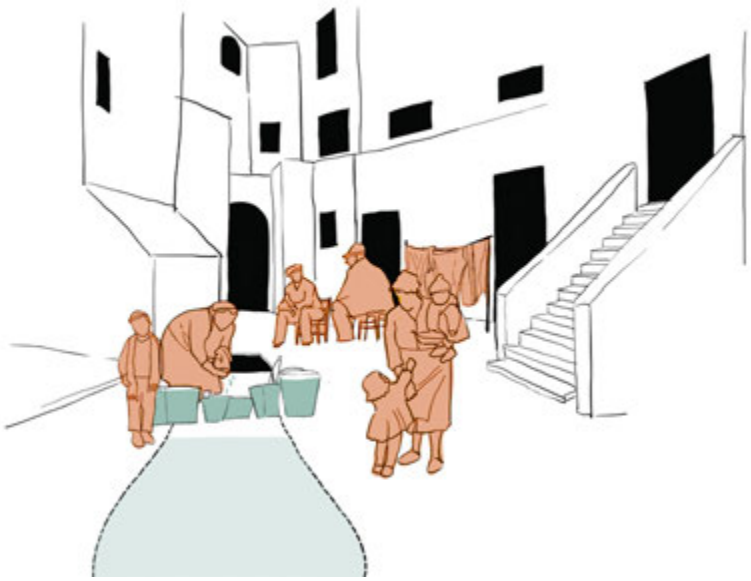


^ Fig. 2 Sectional perspective of the water-harvesting system of the Sassi di Matera depicting the circularity of the system and its sustainability (Source: Wenting Gao, 2022, based on literature review).

without altering the original waterproof layer. La Lopa is an example of preservation through transformation by focusing on the cultural and social values of heritage. Its name originates from the tool, a type of bucket, used to retrieve water from a well. Passione shows her guests the prints of these buckets, which are still visible on the wall. At the lowest level in the cellar, at a depth of 18 meters, she hosts cultural activities, displays films of the old Matera and explains to visitors the traditional water system. For Passione, retelling the stories is a way to remember the times in which, in Matera, resources like water were shared and re-used.

Art also offers ways of restoring appreciation for the traditional water system. Fernando Ponte, the director of Hotel Corte San Pietro, included eight cisterns in his hotel. When Matera was abandoned, the cisterns became garbage containers. When Ponte arrived, he cleaned them and tried to restore their original function to catch rainwater. However, less frequent and abundant rains made this idea unrealistic. Instead, he participates in the Matera Alberga, Arte Accogliente, a public art project integrating site-specific installations in six Sassi hotels. The art on display makes the visitors more aware of the water system and aims to demonstrate a new reality – a Matera that is welcoming, convivial and participatory. Inside one of the tanks, the artist Alfredo Pirri developed IDRA, an art piece that links the external open space with the interior of the restored cisterns in the courtyard of the hotel. In this way, visitors can still see the underground structures and the water-harvesting system, which was made of tuff, water and tradition.

Another attempt to display the water system



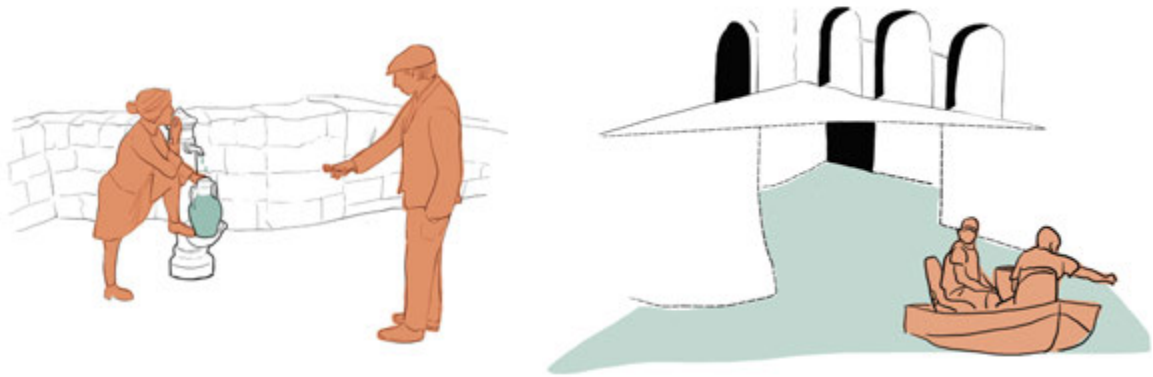
^ Fig. 3 Sassi di Matera: water-centered public life (Source: Wenting Gao, 2022, based on a literature review).

is the recovery of *cisterna del comune in trasano-conca d'aglio*. This project, initiated by Murgia Materana Park Authority and designed by the architect Vincenzo Stella, has revived an old state-owned cistern built at the end of 1700, when people drew water from it for their herds and flocks. Today, the water reserve is used for firefighting to protect the peculiar wood formations in the park (SassiLive 2021).

With the success of Matera, more and more investors are buying properties in Sassi for commercial activities. There are examples of cisterns that have been completely transformed, converted into "fancy" places with concrete floors and stone walls. Residents have been pushed out of the old town. If private stakeholders alter the spaces inside the caves, soon the underground system, and with it, the elements of the water system, will disappear. In this way, tourism contributes to the loss of heritage. Therefore, the value and development of Sassi di Matera as world heritage will largely depend on including the fascinating story of its water-harvesting system. That story is not only about a practical system, but about cultural and social values.

Lessons Learned

Due to Sassi's unique location and scale, tourism has generated new income for the region. This has not brought back the original function of the site. Instead, when night falls, the town lights up like a giant Nativity scene – an exhibition during the Christmas season of objects representing the birth of Jesus, who lived at a time when people lived in cave houses – a tourist-like image. But from the point of view of a landscape architect, there is so much more to discover and value in the Sassi. The town is an excellent example of how humans could live in harmony with nature by living in caves with fresh water running through them, using the local stone to live in and build with, and producing food by irrigation. Traditionally, people interacted with water daily, understanding its value



^ Fig. 4 Left: Sassi di Matera: public fountain and local rocks (Calcarenite di Gravina). Right: Illustration of the largest town cistern, Palombaro lungo, showing the size of the cistern and the plaza above. (Source: Wenting Gao, 2022, based on a literature review).

because of the effort they made to harvest it. Moreover, the water in public spaces encouraged people to gather. This way of living had a low environmental footprint due to its circular water system.

Today, environmental change makes rainfall unpredictable in Matera. There are periods of severe drought. Floods are also a problem, like in 2019, when rainfall flowing down from the hilltop brought mud and debris, posing a new risk to the cultural heritage. By opening the *Grabiglioni*, the drainage canals that channeled both rainwater and wastewater, this disaster might have been prevented. Using the illustrative method, several values can be defined related to the Sustainable Development Goals (SDGs) defined by the UN.

SDG 6

> *Ensure availability and sustainable management of water and sanitation for all."*

The close relationship between the settlement and its water harvesting is almost invisible. The water was hidden and treasured in the stone city as a resource accessible to all. The complex system not only ensured the sustainable management of water, but also helped to achieve equality in water usage. The spaces once used for water are today transformed into fancy rooms for tourism. Therefore, the outer form and internal mechanics of the Sassi di Matera should be valued equally.

SDG 8

> *Promote sustained, inclusive and sustainable economic growth, full and productive employment, and decent work for all.*

Rainwater, spring water, moisture and ice were used sustainably for production, domestic use and drinking purposes. There was also a sustainable use of the building materials (local rocks) because houses built into the caves, and cisterns were made from the same rocks.

SDG 12

> *Ensure sustainable consumption and production patterns.*

The water-harvesting system in the caves de-

pends on the local material, Calcarenite di Gravina. Although most are no longer used, the cisterns are part of the tangible cultural heritage. Restoring the public features of the system by opening the streets, like the *Grabiglioni*, to prevent floods and installing more public fountains using local materials could enhance a sustainable future bound to water, local rocks and people.

SDG 15

> *Protect, restore and promote sustainable use of terrestrial ecosystems.*

The Sassi di Matera demonstrates how a human-made water system can be fully integrated into the living (building) and agricultural landscape. A water design on a regional scale could make not only the old town but the whole city and the region more connected and resilient.

What's missing in the Sassi di Matera is a broader strategy to make the water-harvesting system part of what is valued as heritage. With today's climate crises and the increasing regional droughts, the system can be an inspiration for addressing today's challenges. The recovery of the Cisterna del Comune is a good start. Moreover, water is part of a system that needs to be addressed through scales, from the source until it flows back into the river. The Sassi di Matera and its surrounding area have lost their sustainable knowledge of water harvesting and depend on water supply from afar. With water supplies under such pressure today, we need to learn from the past, especially since harvesting water also contributes to social interaction and helps raise awareness about the value of water.

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Caxambu Water and Heritage: Cultural and Environmental Strategies for Mineral Water Preservation

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This article examines civic commitments and legal frameworks that have defended public access to water by recognizing its cultural value. In Caxambu, Brazil, the local population has collected mineral water from natural springs for centuries. The water's use is embedded in local social and cultural practices. However, over the last thirty years the water sources have become increasingly threatened by commercial and industrial interests. The local government and civic society have responded to the threat by creating protected areas and their efforts have culminated in the legal recognition of cultural intangible heritage as the basis for preserving water quality and ensuring access for future generations.[1]

KEY THEMES

CLIMATE

A B **C** D E

Cwa
Humid Subtropical

1. The information presented in this article comes from the experience and civic work of Filipe Condé Alves, who served as secretary of tourism and culture of the City of Caxambu, vice president of the state council of tourism of the state of Minas Gerais, vice president of Federação dos Circuitos Turísticos of the State of Minas Gerais and president of the Regional Governance Instance of Circuito Turístico das Águas.

< Fig. 1 Parque das Águas in Caxambu (Source: Paulo JC Nogueira, 2016. CC BY-SA 3.0, via Wikimedia Commons).

The City of Caxambu and its Water Resources

The city of Caxambu, an Atlantic Forest hotspot in the Mantiqueira Mountains, is located in the southeast of Brazil and is one of the most populous areas of the state of Minas Gerais, where 50 per cent of the national GDP is concentrated. The city is located in the micro region of Circuito das Águas where thirty-seven carbonated natural mineral water sources flow.

The occupation of the region started in the seventeenth century, although it became famous in the second half of the nineteenth century when the Portuguese royal family moved to Caxambu. The presence of the monarchy brought prestige and notoriety to the mineral springs.

Today, the city of Caxambu is listed as historical heritage of the state of Minas Gerais. In particular, the landscape and architecture of the Parque das Águas complex is protected by the Decree of the Executive of State of Minas Gerais no. 40.288/1999. Besides the state listing, the site also obtained a municipal listing with the Protection Council of Cultural Heritage of Caxambu in 2017 and an ongoing listing analysis is being conducted by the Artistic and Historical National Heritage Institute (Instituto de Patrimônio Histórico e Artístico Nacional; IPHAN).

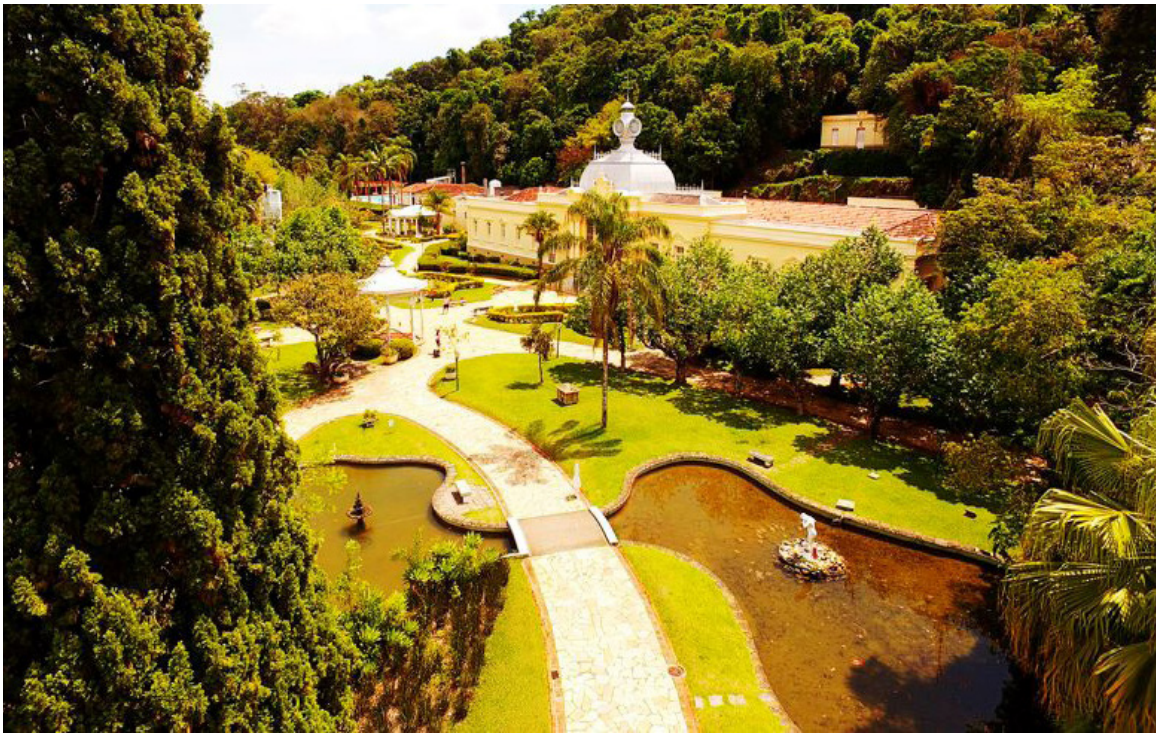
The Value of Parque das Águas

Parque das Águas is a historical site of artistic, environmental and cultural beauty, which features the presence of carbonated mineral water. The geological phenomenon of the site is yet to be completely studied, however there are twelve water sources with distintinctive physical and chemical properties in an area of just over 210,000 square meters. The value of the park and its mineral water goes beyond its geological wonder. The presence of these springs led to a city surrounded by the park and tourism. The local population has a cultural and spiritual relationship with the water. Practices include water collection habits and mineral water-based medical treatments. The carbonated mineral waters of Caxambu have elements of lithium, magnesium and iron. Widely used for mineral replacement in health treatments, the water is part of the local cuisine and ultimately of the territorial identity. The water is no ordinary drinking water, but a rare medicinal water resource with many uses. The presence of Caxambu water sources in poems, books, photographs and art exhibitions testifies to their close connection to the local population.

Yet, the mineral water and its sustainable use is endangered. In the contemporary context of profit-driven exploitation and climate change, there is the risk of water source degradation, pollution and extinguishment. The historical, environmental and cultural value of the mineral water is also in danger. Governments and society are challenged to develop laws, agreements and studies able to meet the threats and work for sustainable development and creative economic models that place people's culture and environmental action at the center of effective planning.

Threats to Mineral Water Sources and Public Responses

In the Brazilian legal context, mineral water is considered an ore rather than a water resource and that status threatens both mineral waters and people's access to them. According to Brazilian legislation, mineral waters are considered minerals and can be exploited up to total exhaustion, a threat that likely will become reality as water companies lobby the federal congress



^ Fig. 2 Overview of Parque das Águas de Caxambu, in the state of Minas Gerais, Brazil (Source: Mangia Samuel, 2018. CC BY 4.0 via Wikimedia Commons).

to prevent legal changes.

Since 1990 the explosion of the bottled water market resulted in overexploitation of the waters from Parque das Águas and the pollution of the mineral water sources. During the 2000s, the region became the subject of European multinational disputes, as international corporations had almost exhausted some of the region's water sources. Although some multinationals decided to leave the region to avoid reputation loss, the national companies that purchased the water sources continue to threaten the natural resource. As a result, the once-natural water flow has required the installation of faucets and pumps, a huge cultural shock for the local population, who have had to turn on taps from fountains that had always spouted from the earth. Also, the taste of the waters was altered, and people forgot the original taste. The need for pump installations represented a red flag that the total exhaustion of the mineral waters loomed. That would mean that future generations would no longer have access to this valuable resource.

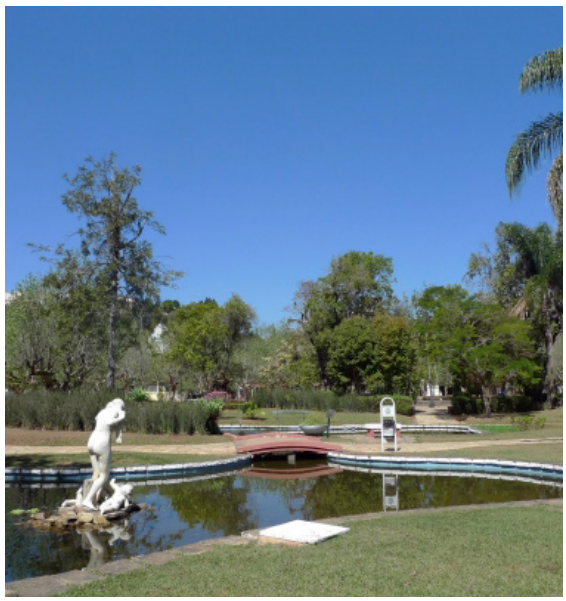
Organized environmental and social movements have managed to restrain commercial water exploitation in some Brazilian cities. The city of Caxambu was one that managed to curtail industrial expansion. The position against commercial exploitation of the mineral water found legal basis in Mine Manifesto no. 1046, an authorization mechanism for mineral resources exploration made by the state of Minas Gerais in 1942 for several nationalized resources.

In 2018 a great public and municipal effort began to protect the mineral water sources of the city. This process focused on the interconnec-

^ Fig. 3 Dom Pedro Mineral Water Fountain, Caxambu Mineral Water Park (Source: Bruno Souza Jeremias, 2022. CC BY 4.0 via Wikimedia Commons).

tion between the social, environmental and economic aspects of water access and management and aimed at strengthening tourism as an economic force. The efforts of preservation needed to be broadened, and the national federative agreement, which extended legal power to federal states and counties, provided the legal framework to continue this campaign. In the same year, an interdisciplinary study of the environmental and geological resources of the region took place, focusing on the Circuito das Águas of Minas Gerais.

Public efforts and scientific studies converged in demanding the creation of environmental preservation areas. The Municipal Environmental Area of Preservation (Área de Proteção Ambiental Municipal; APA) plan was proposed to boost educational and economic opportunities while guaranteeing low carbon emissions by



^ Fig. 4 Caxambu Mineral Water Park (Source: IEPHA - MG - GOV, 1999. CC BY 4.0 via Wikimedia Commons).

safekeeping the superficial water, mineral water and historical heritage of the area, strategically protecting cultural and touristic practices. This plan was the starting point for the expansion of legal initiatives concerned with environmental protection and cultural safeguards, with the support of the local population and local and regional environmental movements.

^ Fig. 5 Mineral Waters Environmental Protection Area (Source: Caxambu City, 2018. CC BY 4.0 via Wikimedia Commons).

The Municipal Plan for the Cultural and Ecological Preservation Area

The APA was presented on World Water Day in 2018. It involves a total area of 677 hectares surrounding the Parque das Águas and protecting the entire upper part of the stream micro basin, which goes through part of the city. The date of the presentation was chosen to stir up social support and the project was widely promoted, resulting in municipal decree nº 2300/2018 creating the Municipal Preservation Area. Later the same year, the town hall of Caxambu approved the county law nº 2514/2018, proposed by the Municipal Executive, that included the project in the Cultural System of Caxambu, the legal, financial and budgetary plan of the municipality concerning matters of culture and preservation. By approving such a proposition, the town hall recognized the cultural aspects of water for Caxambu citizens along with its practical aspects. This represented an important turning point in the field of local water and culture management.

The decision of the Municipal Executive was strategic. On the one hand, APA areas do not guarantee access to water or cultural rights. On the other hand, without effective public involvement, the creation of protected areas would be dominated by political motivations threatening the effectiveness of the resolutions. Therefore, in late 2018 as the municipal secretary of tourism and culture, and also as president of the Municipal Council of Cultural Heritage (Conselho Municipal do Patrimônio Cultural; COMPAC), I proposed the listing of water usage and the collection practices carried out in the Parque das Águas as intangible cultural assets of the city.. This new framework aimed to provide a legal and political basis for the protection of mineral water access and recognition of its intangible value, while using cultural arguments to increase the local population's awareness of environmental preservation policies and the importance of safekeeping the waters, park and architectural heritage of Caxambu.

Beginning in 2020, the mineral waters and their cultural and therapeutic aspects have been recognized by the Municipal Plan of Culture, the planning instrument used by government and civil society organizations to define goals, actions and cultural objectives for the city. The civic effort intensified during the intense phase of the COVID-19 pandemic, when another area of environmental preservation was created, the Natural Municipal Monument of Morro do Caxambu, protecting fifty-seven additional hectares of territory. Also in December 2020, COMPAC started the research process for the "Dossier and Inventory of Cultural Practices," documenting the cultural practices related to the collecting of mineral water.

In 2021 a new municipal decree ratified the registration that recognized the centenary practice of collecting water from the hydric amenities in the region as intangible cultural heritage, guaranteeing the population access to the sources of mineral water, an unprecedented step in Brazil.

Legal Battles for the Recognition and Protection of Intangible Cultural Assets

Currently, the Municipal Plan of Culture is being challenged in court. The state of Minas Gerais filed a lawsuit against the city of Caxambu, claiming that the preservation of intangible cultural assets related to the use and collection of mineral waters amounts to "private property interference." The public space of Parque das Águas and its resources are managed by the Economic Development Company of the State of Minas Gerais (CODEMIG). CODEMIG is a publicly traded company, whose shares are owned by both the state and private investors. By protecting the mineral water sources through the recognition of their intangible heritage, the municipality of Caxambu threatens to undermine the revenues of CODEMIG private shareholders, which led the state of Minas Gerais to file the lawsuit as the majority shareholder.

However, the Historic and Artistic Heritage Institute of the State of Minas Gerais recognized the registration of the mineral water sources as intangible heritage and approved it with a caveat: the immaterial assets of the mineral waters sources are therefore officially recognized pending the completion of studies and the gathering of further information. Furthermore, the prosecutor's office of the Minas Gerais Public Ministry has unanimously supported people's right to access water and has supported the registration of intangible assets heritage proposed by the municipality of Caxambu, ratifying its legal validity.

With the approval of the Historic and Artistic Heritage Institute and the support of the public prosecutor of the state of Minas Gerais, the practices surrounding the collection of mineral water and its use will be recognized as state heritage. The work of the municipality of Caxambu provided the legal basis to protect mineral water sources throughout the region as well as to safeguard their cultural dimensions and to guarantee free water access for the population. Now, the city of Caxambu seeks funding, partnerships and researchers to help list all twelve mineral water sources of the Parque das Águas as UNESCO World Heritage, based on the local cultural practices of water collection and the need to ensure access to clean and healing mineral water for future generations.

Conclusions

Sometimes the establishment of protected areas is not enough. To achieve long-term socio-ecological justice, environmental actions need to be in tune with cultural practices. In the city of Caxambu, the local government and the public worked together to achieve a legal basis for the preservation of environmental, cultural, and social aspects of water sources.

After years of struggle, the collaboration between local government and citizens achieved the recognition of social practices surrounding the mineral waters of the Parque das Águas as intangible heritage on a state level, thus protecting both the water sources of Minas Gerais and the public access to them.

The case of Caxambu exemplifies how the legal recognition of cultural heritage aspects of water makes it possible to manage water as something more than just a resource, safekeeping the local population's water rights acquired

^ Fig. 6 Historical photo of the Parque das Águas de Caxambu (Source: turismocaxambu.com.br, 1920. CC BY 4.0 via Wikimedia Commons).

through generations and maintaining them for the ones yet to come. The recognition of heritage from government bodies can foster appreciation for water sources, the related practices and the surrounding territory, becoming the starting point for the preservation of water quality and people's relationship with the essential source of life.

The collaboration that happened in Caxambu between local government and civic society to recognize the multiple values that water holds for the local population can be replicated in other contexts. The author hope this case study can be an inspiration to others who fight to preserve water for humanity.

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