International Council on Monuments and Sites
Conseil International des Monuments et des Sites
Deutsches Nationalkomitee e.V.

WATER HERITAGE – A SOURCE OF KNOWLEDGE FOR SUSTAINABLE DEVELOPMENT

Contribution to the Global Climate Goals and to the *Conference on the Future of Europe*

ICOMOS DEUTSCHES NATIONALKOMITEE
ICOMOS GERMAN NATIONAL COMMITTEE
ICOMOS COMITÉ NATIONAL ALLEMAND

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International Conference
11–12 November 2021, Berlin and online
Organised by ICOMOS Germany and
the European Academy Berlin
Partners:
University of Groningen, Delft University of Technology,
ISC Water and Heritage

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Welcome

Ladies and Gentlemen,
Distinguished participants in the digital space and
here at the European Academy Berlin,

I would like to give you a warm welcome on behalf of the European Academy Berlin Association.
Do you prefer tea or coffee, swimming in the sea or skiing in the mountains? Or, what is your answer to the well-known question: Do you see the glass of water half full or half empty?
Whatever comes to mind: Just as the bits and bytes of the digital age increasingly evolve and enable our lives like an invisible cloud, it is above all water that makes our lives possible. There is no life without water! For as long as humankind has existed, the struggle for water has always been a question of survival.
Today, with climate change, we face the most serious man-made crisis ever for our globe, and water is literally up to our heads. At this critical point in history, what can we do better than going back to find out what lessons we can draw from centuries of an evolving water sector. How did people manage to master the basic element of water? What role did water play in politics, economics and social development? Which essentials do we have to take care of?
This international conference of ICOMOS Germany on water-related cultural heritage, here at the European Academy in Berlin (EAB) today and tomorrow, provides a unique opportunity to find answers to these old and new questions by engaging in dialogue, hearing about different perspectives, and generating new impulses and ideas. Thank you to ICOMOS Germany and the EAB Team for making this possible.

For almost 60 years now, the EAB has been striving to build bridges – between people, nations, and worlds. Our constant effort is to ensure fruitful exchange between science, politics, civil society and the public, and that the European discourse – which is by no means without controversies – can transition from stormy waters to the calm harbour of understanding.
In this year of the Conference on the Future of Europe, this transnational and interdisciplinary dialogue is more important than ever. Only together we can find out where the shoe pinches and how by close cooperation, broad exchange and intensive networking we all can look into the future more optimistically.
May your assembled expertise, from across national borders and from the most diverse perspectives ensure the success of our conference. And remember: We should always carry with us: our cultural heritage and a glass of water (or wine depending on the time of day, as wine is basically water)!

A warm welcome to you all!

Dieter Ernst
European Academy Berlin
Chairman

Welcome

Dear guests, speakers and organisers –
here at the European Academy Berlin and
in the digital distance,

It is my pleasure, on behalf of ICOMOS Germany, to welcome you to this special event about an increasingly important aspect of our cultural heritage that has received far too little attention to date.

Water is literally the link between culture and nature, it connects our human cultural creation with our dependence on a global ecosystem and is an inevitable cornerstone of all our activities. Over the next two days we will focus on water-related heritage, yet in fact, there is no cultural heritage that is not related to water, really. All settlements and civilisations were only made possible by a balanced approach to water – be it protection against floods, land reclamation, the provision of drinking water and water for agriculture, or the availability of water for transport, to name just a few examples. Over the millennia, humans have created a wealth of techniques, approaches and rules that regulate the use of water in such a way that it enables culture to thrive. And more than once, water problems have been the trigger for the fall of civilisations.

This wealth of historic water management elements that I have just mentioned is at the heart of this conference. To be clear, these two days are less about protecting heritage sites from water impacts but more about heritage sites that are part of historical water management systems in the broadest sense. These water distribution systems, locks and canals, water landscapes, water mills, irrigation techniques, access rights to water, wells or spiritual rites hold great potential. They can show us how certain water-related systems evolved and proved their worth over centuries, before many of them were rigorously replaced by modern solutions that were often short-sighted and have led to problems. Therefore, a key objective of this conference and related attempts to bring the heritage of water into policy and water management is to reveal parts of the wisdom that these historical sites hold and to make this wisdom available for current engineering, planning and policy. This can also change our understanding of water-related heritage: not only as something historically valuable, fragile and worthy of protection, but also as a resource of knowledge and experience that can help address water issues and climate change challenges. Heritage conservation is sustainable not only because it protects sites and extends their lifespan, but also – and most importantly – because it provides access to the knowledge and experience embedded in these objects and structures.

ICOMOS plays a leading role in national and global efforts to conserve heritage sites, and its Scientific Committees are crucial to the study of specific types of these sites. This year, after several years of preparation, ICOMOS appointed a new International Scientific Committee on Water and Heritage. It provides an excellent opportunity for international cooperation in the study of water-related sites and for communication between heritage experts and other relevant fields. And we are happy to hear from interested professionals who would like to contribute to the work of the committee. Don't hesitate to talk to us – there is no time to lose! I am pleased that this conference contributes to this important task and I hope that it will be an opportunity for stakeholders to join forces to communicate and reveal heritage's potential as a key to sustainable development. It was in this spirit that ICOMOS Germany and the European Academy Berlin sought and forged their cooperation. At this point, let me express my thanks for all the efforts made and actions taken in connection with this conference.

It is a pity that the rising Covid-infections have forced many of the participants to retreat into the digital space. When we started planning, we had the vision of a vivid live event – but unfortunately, we cannot change this. Nonetheless, I wish us all a stimulating exchange, new insights and a great time. Thank you all very much for your participation and contributions.

Tino Mager
President of ICOMOS Germany

Welcome

Dear participants,
Dear initiators of this ICOMOS Conference,
Dear readers of this volume,

Thank you very much for the opportunity to welcome you at the beginning of this conference.
I am Hildegard Bentele and a member of the European Parliament for the European People's Party. In Parliament, I work in the Committees on the Environment (ENVI), Development (DEVE) and Industry (ITRI) and am therefore closely involved with the issues concerning the *European Green Deal*. As you may know, the current focus is set on the comprehensive legislative package to reduce CO_2 emissions by 55 percent by 2030 in the EU.
At the time of my video greeting at the ICOMOS Germany conference *Water Heritage – a Source of Knowledge for Sustainable Development*, I had just returned from the UN Climate Change Conference in Glasgow (COP26) as a member of the European Parliament delegation. This conference has once again drawn all our attention to the urgent need to act now to keep our planet in balance and to preserve it for future generations. And what the UN Climate Change Conference can do to move things on a large scale, you as ICOMOS are doing on the ground in your day-to-day work to preserve cultural heritage and monuments that are just as affected by climate change as we are.
Your conference and its proceedings therefore come at the right time. Because more than ever, we need your knowledge about cultural monuments in general, and in the context of this meeting, about water as cultural heritage. Right now, your expert knowledge of well-established solutions, as well as of new and innovative approaches, is crucial.
I am therefore pleased that you are addressing the topic of water heritage in this publication and discuss how water-related heritage can contribute to sustainable development and the climate goals of the 2030 Agenda, as well as to other Sustainable Development Goals.
In this context, I would like to point out a recent and important development at the European level: *The Conference on the Future of Europe* has been running since May 9, 2021. Launched by Commission President Ursula von der Leyen, it is the largest experiment in shaping the future and citizen participation at the European level to date and offers you all the opportunity to participate directly in the deliberations and discussions on how the future European Union should be shaped. This public and transparent dialogue will focus on the future direction of our European Union, as well as on key priorities and challenges of European policy. These key topics on the future of Europe are highlighted and discussed in European citizens' forums. The topic of environment, climate and energy is, of course, one of these core issues. As one of the 433 official members, I am involved in the Climate and Energy Working Group, in which we process the ideas and proposals from the European and national citizens' forums for the plenary session of the conference.

However, the digital platform of the Future Conference plays a key role in the entire process. There you will have the opportunity to contribute your ideas and insights from your daily work or from this conference directly to this unique European debate. These contributions will be collected and bundled and made available to the participants in the working groups and the European citizens' forums, and be fed directly into the conference.
I would therefore like to cordially invite you to visit the website of the *Conference on the Future of Europe* at https://futureu.europa.eu and to take advantage of this perhaps unique opportunity to share your innovative ideas, your insights as well as your expert knowledge with a broad European audience and to beneficially enrich the Europe-wide discussion for your topic!
In this spirit, I wish you much pleasure in reading this publication and continued successful work on your topic of our water-related cultural heritage.

Hildegard Bentele
Member of the European Parliament

Welcome

Dear Ladies and Gentlemen,

Welcome to the European Academy Berlin. It is great to have ICOMOS – Professor Haspel and his team – with us again here. We are still in the middle of the pandemic, and are meeting, once more, in a hybrid form. Yet, we hold the idea up high that our topics have to be shared, discussed and argued about in a setting like this one where we can exchange ideas.

Two days ago, on 9 November 2021, I was in a workshop with Professor Rabbi Andreas Nachama, a valued German historian and journalist, right here, where you are sitting now. Together with partners from Poland, France, Lithuania, and Germany, the European Academy Berlin has initiated an international project group that is empowering memorials and historic sites all over Europe to digitize their work and thus to collaborate more often and in new ways with younger generations. In this workshop, we met for the second time to plan our collaboration. We were all inspired and high spirited when we asked Rabbi Nachama what, in his view, the central commonalities were for the people in Europe. What do we have in common? Where can we meet? What topics should we rally around? With big eyes we were awaiting his surely inspiring and profound answer. And the Rabbi simply replied: borders. And indeed, he is right. When you look at the past, the present and – let's be honest – the future – we always talk about borders and we will continue erecting them.

My history teacher always taught me that there were no natural borders (with the probable exception of the oceans). To talk about natural borders is misleading when you look at how people have been settling and living for thousands of years. In fact, one may say that the borders we humans erect and always try to overcome, are among the central themes of our work here as civic educators. And that is one reason why we as the European Academy Berlin are so proud of having you with us. We are curious in which ways you will be looking at water in its many different shapes and forms and at how it may have shaped our thinking and civilizations. We want to learn more about how to talk about water in order to better understand each other and in order to find more common grounds between us as people. Indeed, we want to discuss topics that unite rather than divide us.

Why do we want to do this? Our non-profit organization was founded in 1963. In the middle of the Cold War, our house was meant to be a beacon for those sailing through stormy and cold waters in the West and those in the East. We wanted to signal that we did not want to be forgotten, that we would not forget. We kept this promise and our partners from all over Europe kept theirs. So today, 30 years after the fall of one of the most prominent symbols of the Cold War, we are still working together with partners from all over the world to overcome borders and walls and to shape a common and united future. We are a bottom-up, civic society European House that connects Berlin to Europe and brings Europe to the people in Berlin. Although I am here to talk to you about the Conference on the Future of Europe it behooves everyone who looks at the future of the European Union, at the future of Europe and at the future of mankind to first have a look at our past. The Greek philosopher Heraclitus was born 2500 years ago. He coined the phrase *panta rhei* which translates into *everything flows*. Everything we see is in constant change. The phrase has been in regular use since then. One interpretation of *panta rhei* reads "You cannot step twice into the same stream". It still fits to our experiences today, especially at our non-profit conference centre, after 20 months of pandemic and in the middle of its fourth wave. How do I get from ancient Greece to modern Berlin (some still call it *Spree-Athen* or *Athens on the Spree*) and to the future of the European Union?

Only yesterday, I spoke to the Greek president of the European Committee of the Regions, Apostolos Tzitzikostas. He shares our analysis of the current state of the *Conference on the Future of Europe* that is now half-time through. As a form of citizen participation, the *Conference on the Future of Europe* consists of citizen panels and an online platform where everyone can share and discuss his or her wishes and ideas for our future. The model for that online platform was a similar website that the region around Barcelona set up some years ago – a classic bottom-up example, one might say.

The *Conference on the Future of Europe* had a tough start. It was hard for the Council, the Commission, and the Parliament to agree upon a structure for the conference. It was and still is hard to agree on the aims for the conference. It is hard to agree on the final date of the conference. It is hard to motivate the 445 million citizens of Europe to share their ideas and wishes for the future. Because, in the end that's what this conference is about.

Europe wants to find out what its citizens think about the future of Europe. It is a deeply idealistic approach in a world shaken by a pandemic, by the enemies of democracy, by constant and ever faster changes in our technology and our environments.

We here in Berlin came together to support the *Conference on the Future of Europe*. Not because it is popular or because we know what will become of the conference after next spring, but because our job as civic educators here in Berlin is to bring people together and to talk not only about Europe but about our common future and shared aims. And although the conference was initiated by politicians, it is a call to action to every one of us to participate in shaping our future, to discuss it, to argue about it, and to better understand where we come from and where we are going.

Therefore, I am very happy that you are sharing your unique perspective on the world with us. I can assure you that we will transport your ideas and arguments down the river with us. There, we will see what the future will hold for us.

Thank you for being with us and best of luck with your endeavours.

Christian Johann
European Academy Berlin

Contributions

Paulo Oliveira Ramos

On Water and the City: A Heritage for Lisbon

Introduction

This article provides a general overview of the historical importance of water in my home town of Lisbon, Portugal, in the form of a survey that begins four and a half centuries ago and gradually works its way through to the future, which still lies ahead.

16th–17th centuries

When the Portuguese illuminator and architect Francisco de Holanda (c. 1517–1584) wrote *Da Fábrica que falece à cidade de Lisboa* in 1571, which roughly translates as The Works that the City of Lisbon Needs, he decided to represent the city of Lisbon in the form of a queen that emerges from the depths of the river Tagus holding a ship in her arms. This drawing epitomizes Lisbon's rich historical relationship with the water (Fig. 1).

The traces of pre-Roman communities are scattered all over the Tagus estuary. However, this port town once called *Felicitas Iulia Olisipo* is simply awash with leftovers from the Roman occupation. Consider, for instance, the remains of fish-salting industries which date back to the first centuries AD and could be found in multiple sites throughout central Lisbon with increased concentration near the river, from *Rua Augusta* to the *Campo das Cebolas* borough, as well as in the western part of the city, in the *Belém* area, where a complex comprising thirty-four *cetariae* has recently been excavated, or even in the left bank of the Tagus river, the *aurifer Tagus*, according to Latin poet Catullus.

Centuries later, Lisbon grew into prominence as a world entrepôt (Fig. 2).

In 1554, the prominent Portuguese humanist Damião de Góis (1502–1574), a friend of Erasmus and his inner circle, declared in his *Urbis Olisiponis Descriptio*, that "There are two cities which, in this era of ours, one could rightfully call the ladies and even Queens of the Sea [...]. One of them is Lisbon".[1]

From the second half of the 16th century up until the first half of the 17th century, there is a considerable number of drawings, prints and paintings that showcase the changes which the discoveries and maritime trade had

1 Góis, Lisbon in the Renaissance, 1996, p. 3. The first editions of this book outside Portugal were in Cologne (1602) and Frankfurt (1603).

Fig. 1 Figure of Lisbon (1572) in Francisco de Holanda's A Fábrica que Falece à Cidade de Lisboa, public domain

Fig. 2 View of Lisbon by the end of the 16th century, engraving in Georg Braun and Franz Hogenberg - Civitates orbis terrarum, c. 1598, public domain

Fig. 3 Chafariz d'el Rei (King's Fountain), c. 1560–1580, anonymous Flemish painting, oil on wood, 93×163 cm, The Berardo Collection, Lisbon, public domain

produced in Lisbon and its port, including "important embankments, new quays, the expansion of shipyards and building of new warehouses".[2] While the port and the city had always been intimately connected for centuries, these new "facilities, due to their number, volume and location by the waterfront, shifted the urban centre of Lisbon nearer to the river Tagus, thereby conferring a definitive new image to the city".[3]

In those pre-industrial times, the inhabitants of Lisbon sourced clean water from the local wells and public fountains. Just a few steps away from the river Tagus, one fountain in particular, tellingly known as the King's Fountain (*Chafariz d'el Rei*), was the epicenter of everyday life in this riverside area of Lisbon known as *Alfama*, not only for the benefit of its inhabitants, but also to fulfill the need for water supply to all those engaging in maritime activities, foreigners or Portuguese. According to de Góis, "the King's Fountain [was] a remarkable structure with columns and marble archwork. So much water gushes from its six spouts that it alone could provide for the drinking needs of everyone" (Fig. 3).[4]

In an oil on panel that, in the 1870s, used to hang in Kelmscott Manor, West Oxfordshire, southern England – William Morris's "Heaven on Earth" – and is currently stored in a private collection in Portugal (the Berardo Collection), an anonymous late 16th century painter depicted an immense range of over a hundred and fifty human beings, animals of all sorts, as well as five boats sailing across the Tagus River. Among the multitude, one can easily spot a number of water-carriers (*aguadeiros*), such as the man that be seen in the lower left corner of the painting, carrying a water barrel on his back.

18th century

The early 18th century *Great Panorama of Lisbon* is one of the top masterpieces of Portuguese tilework, providing a spectacular view of the city. It measures around 23 metres in length, and it represents about 14 kilometres of Lisbon waterfront, showing palaces, churches, convents and

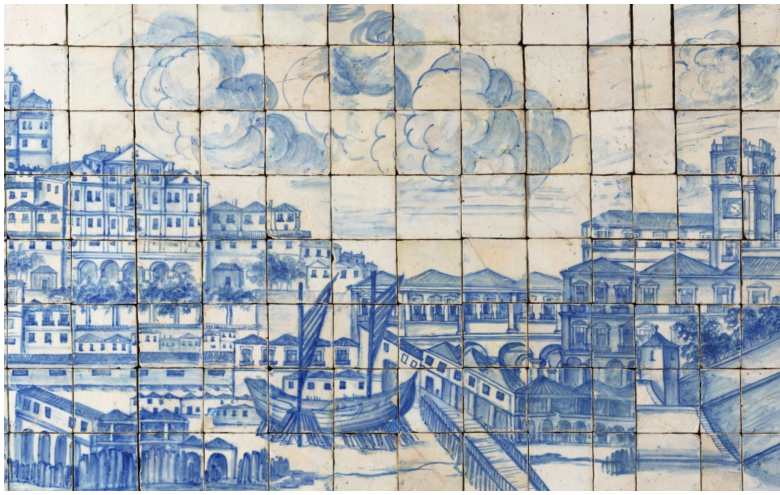

Fig. 4 Section of the Great Panorama of Lisbon, c. 1700, attributed to Gabriel del Barco (1649–1703), 115×2247 cm, Museu Nacional do Azulejo (MNAZ, nº inv. 1), Lisbon

2 Moita, A Imagem e a Vida da Cidade, 1983, p. 10.
3 Moita, A Imagem e a Vida da Cidade, 1983, p. 10.
4 Góis, Lisbon in the Renaissance, 1996, p. 23.

Fig. 5 Urban setting of the Junqueira National Ropery (here Cordoaria Nacional), Arquivo Municipal de Lisboa (Inv. KPI 000 232)

common houses. The foreground of the panel is perhaps the most interesting part, as it displays quays, warehouses, the mint, the royal palace, furnaces, shipyards, and the boats navigating up the Tagus River.

This panel is currently housed in the National Tile Museum (*Museu Nacional do Azulejo*), Lisbon (Fig. 4).

It should come as no surprise that the first general projects devised for improving the Port of Lisbon trace all the way back to the 18th century. Special mention must be made to the Hungarian architect Carlos Mardel's plan for Lisbon, which probably dates back to the 1730s, surviving in a striking, three-metre-wide watercolour painting in the Historical Archive of the Ministry of Economics, in Lisbon. Mardel envisaged to build, right at the heart of the capital city, a naval yard which, had it been constructed, would have been the largest one in the whole world at the time (Fig. 5).

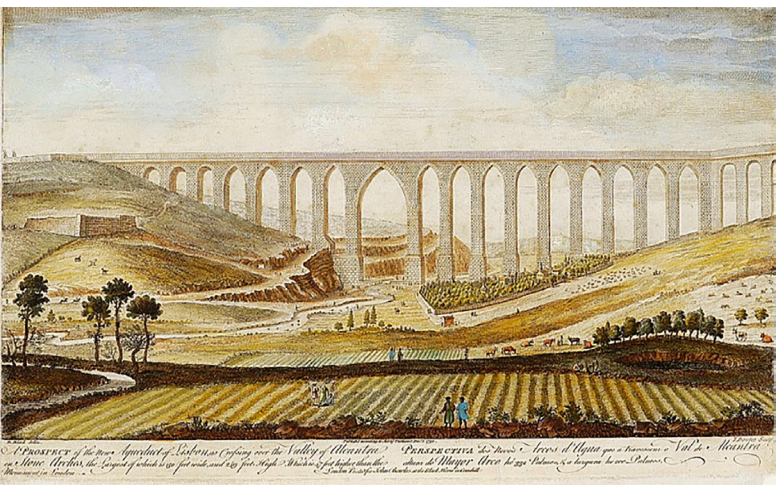

Fig. 6 "Aqueduct of Lisbon, as crossing the Valley of Alcantra", engraving by T. Bowles after R. Black (18th century)

One of the major buildings of particular note in Lisbon's waterfront – in the last quarter of the 18th century but even to our day – is without a doubt the historic *Junqueira* National Ropery (*Fábrica Nacional de Cordoaria*), with its 396 metres (1,299 feet) long extension. Built around 1775, it was then washed by the Tagus on its southern side, with quays for loading and unloading raw materials and related products like ropes, sails and flags. Before the disfigurement caused by the continuation of a road that follows the original shoreline, as well as the construction of a railway from Lisbon to Cascais, the lateral buildings of the Ropery measured 125 metres. The heart of the building complex consists of the two 353.5 m (1.159 feet) long spinning and laying houses, among the largest ever built. It was listed as a national monument in 1996 (Fig. 6).

As to new attempts to bring water to the inhabitants of Lisbon, one ought to mention, first and foremost, the notable *Águas Livres* (Free Waters) Aqueduct. This edification began in 1732, following a project by Manuel da Maia (1677–1766) and was thus described by the British writer Thomas Pitt upon visiting the Iberian Peninsula in 1760: "The city is supplied with water by a noble aqueduct of stone, conveying it 9 miles from near a town called Belles (*sic*), west of Lisbon, sometimes on arches, sometimes underground. The highest arches are to be seen in the valley of Alcantra (*sic*), where you stand under one 112 feet diameter, and 226 feet high".[5] In concrete

5 Pitt, Observações de uma visita, 2006, p. 111.

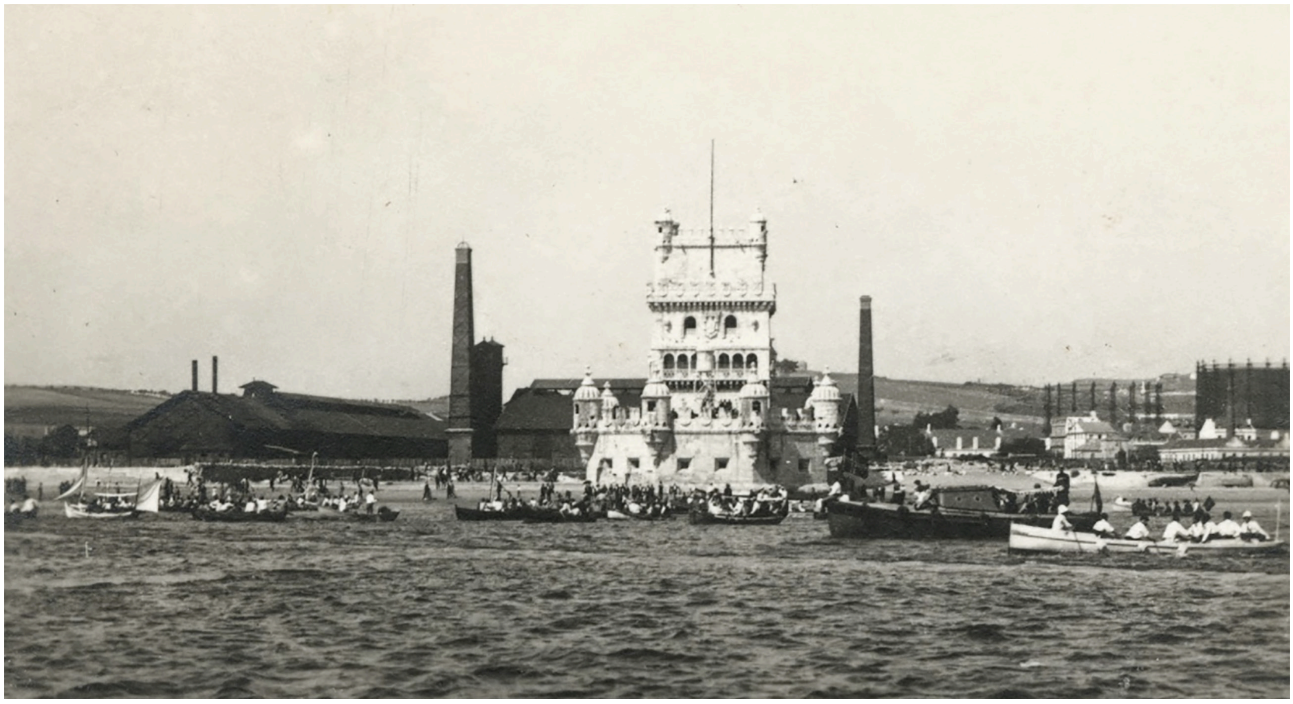

Fig. 7 The Tower of Belém and the Gasworks of Belém, photograph c. 1900, anonymous, Arquivo Municipal de Lisboa (Inv. POR 050 585)

terms, the total length of the aqueduct, including all secondary channels, spans 58 kilometres. The 35 arches across the Alcântara Valley measure 941 metres in length and 65 metres in height and were designed by Custódio Vieira. The aqueduct began supplying water to the City of Lisbon in 1748. It was listed as a national monument in 1910.

Another noteworthy mention is the stone building of the *Amoreiras Mãe d'Água Reservoir*, created by Carlos Mardel, which was begun to be built in 1746 and was concluded in 1834, with a capacity of 5,500 cubic metres, so as to collect and distribute the water being carried over by the aqueduct. Inside this space, the water surges from a dolphin's mouth and drops into a waterfall, a typically Baroque scenic effect.

Close to the reservoir stands the Register House (*Casa do Registo*), where water was discharged into five 18th-century galleries (*Campo Santan*a, *Necessidades*, *Loreto*, *Esperança* and *Rato*)[6], which supplied around thirty fountains, factories, convents and noble houses"[7]. Among those fountains lies the Janelas Verdes fountain, built around 1775 in white and pink marble with statues of Venus and Cupid carved by António Machado, looking over the National Museum of Ancient Art (*Museu Nacional de Arte Antiga*).

19th century

Throughout the 19th century, during the Industrial Revolution, new projects emerged in Lisbon, both in the port itself as well as in expanding the domestic distribution of water. The very symbol of the industrial times, chimneys, but also gasholders, would become part of Lisbon's waterfront landscape, well-illustrated by photographs taken at the time (Fig. 7).

In the accompanying picture, one can take a clear look at what happened to the *Tower of Belém* which, built from 1514 to 1519, was to become a metonym for Lisbon, even Portugal at large. Notwithstanding its landmark status, in 1888 it was to be surrounded by a large complex of buildings and chimneys that were part of the Belém Gasworks. According to the architect Raul Lino, at a certain point, the iconic tower "was even offered to the powerful [gasworks] company for office space".[8]

It should be noted here that this act of vandalism would originate an impressive and long-lasting national protest movement for over sixty years, a campaign which I had the chance to study as the focus of my doctoral thesis.[9]

As to the water supply in Lisbon, one must not overlook the important role that was still played at the time by the water-carriers. In 1856, the second edition of Murray's *A Handbook for Travellers in Portugal* took note: "These water-carriers are almost all *Gallegos* (inhabitants of Galicia). 3,000 of these men find employment in

6 Some of these galleries can currently be visited.
7 Douet, The Water Industry, 2018, p. 48.
8 Quoted in Ramos, A Princesinha Branca e Esbelta, 2018.
9 Ramos, A Princesinha Branca e Esbelta, 2018.

Fig. 8 Barbadinhos Pumping Station, photograph by Francesco Rocchini, 1880, EPAL, Museu da Água, CDHT - Centro de Documentação Histórica e Técnica, Lisbon

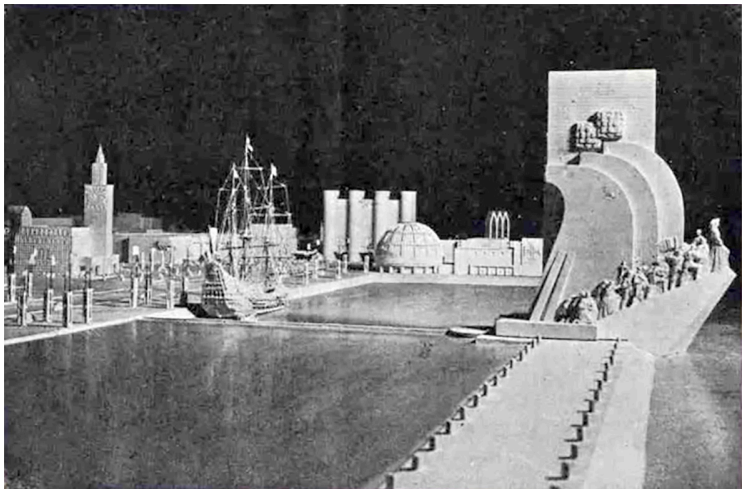

Fig. 9 Scale model (1939) of Portuguese World Exhibition, illustration taken from Revista dos Centenários no. 6, p. 16

distributing water. They are to be distinguished from the Portuguese in carrying their burden on their shoulders instead of on their heads. It is scarcely possible to walk ten steps in Lisbon without meeting one of them".[10]

The need for larger and improved water supply systems meant that a number of new water installations was built to serve Lisbon. Among these, I would highlight the so-called Patriarchal Reservoir, located underground beneath the *Príncipe Real Garden* (then *Praça Dom Pedro V*). The octagonal reservoir, built between 1860 and 64, was originally designed to supply the downtown area of Lisbon. It was designed in 1856 by the French engineer Louis-Charles Mary (1791–1870), then an inspector of *ponts et chaussées* of the Seine, taken to be the "engineer of the most achieved merit in the expertise of distributing water", and the author of a fascinating volume, *Mémoire à l'appui du projet de la nouvelle distribution des eaux de la ville de Lisbonne* (Fig. 8).[11]

Another important installation was the *Barbadinhos* Steam Pumping Station inaugurated in 1880. This marked the beginning of a new era in urban drinking water supply in the city of Lisbon. The Barbadinhos Steam Pumping Station operated from 1880 to 1928, and still stands today, although activated for demonstration purposes only.

By the late 19th century, after an international call for projects, a modern port for Lisbon was planned by the French engi-neer Pierre Hildernet Hersent in 1887. A new stage then kicked off in the historical development of the Port of Lisbon. Today, it is still possible to find a number of the early warehouses of a traditional construction in wood and bricks, along with others representing the transition to a larger scale of port building.

But the many other maritime works, shipyards, riverside installations and sheds, as well as tramway lines, intense road traffic, and an urban double-track railway along the northern side of the Tagus would, in aggregate, create what could be defined as a "wall effect", keeping the people of Lisbon from enjoying the river waters for decades on end.

20th century

The Lisbon archives and the landscape of the city are not silent about improvements made to the water distribution and port facilities in the 21st century, akin to what had happened from the sixteenth to nineteenth centuries.

Among the main water supply works in Lisbon during the first half of the 20th century, a particular emphasis should be given to the elevated reservoir of *Penha de França* (1929–32) built to serve the eastern area of the city; and later on, the new underground reservoirs of *Monsanto*, *Amadora* and *Olivais*, among others. In addition to these, it is also worth mentioning the *Sacavém Syphon* Bridge (1940s), the Pumping Stations of *Olivais* and *Campo de Ourique*, as well as the very iconic "Monumental Fountain" (1940) to mark the arrival of the Tagus Canal water to Lisbon. The construction of new water or landslide structures was a key to the survival of the port of Lisbon. Concerning the shore infrastructure to serve the port: two maritime passenger stations were built, *Alcântara* and *Rocha do Conde de Óbidos*, as well the ferry stations of *Belém* and *Terreiro do Paço*, not to mention the cold storage warehouses that belonged to the Codfish Trade Board (transformed in 2008 into the swanky Museum of the Orient).

But throughout the long 20th century, the Lisbon waterfront was above all shaped by two exhibitions that were held half a century apart from one another, and in two diametrically opposed political regimes.

10 Murray, A Handbook for Travellers in Portugal, 1856, p. 29

11 See Ramos, O Projecto de Louis-Charles Mary, 2011.

The first one was titled the Portuguese World Exhibition (*Exposição do Mundo Português*) and took place between June and December of 1940 in the *Belém* quarter, "in the shadow of Jerónimos [monastery], next to the Tagus – the great road of our civilization".[12] This became a major stage for the historical-ideological propaganda of the so-called "national spirit" and turned into the most important cultural-political event of the *Estado Novo* (New State) dictatorship, 1926-74.

Besides multiple pavilions – like the Foundation of Portugal Pavilion, the Independence Pavilion, Colonization Pavilion, Portuguese People Abroad Pavilion, Lisbon Pavilion, etc. –, an enormous "Water Mirror" was built on site, effectively a pond destined to host nautical activities (Fig. 9).

The high point of the exhibition was the construction of the so-called *Nau Portugal*, a reproduction of the former galleons from the Portuguese *India Armadas* (from the 17th–18th centuries), weighing 1100 tonnes, and built using a variety of Portuguese and Brazilian woods. This ship was anchored right on the dock of the exhibition, and was accessible to the public.

Not far from this site stands the iconic Monument of the Discoveries, in the stylized shape of a caravel created by architect Cottinelli Telmo and sculptor Leopoldo de Almeida, originally erected with ephemeral materials. "Both sides [of the ship] feature representational figures of prominent people of the Portuguese discoveries, including monarchs, explorers, cartographers, scientists and missionaries. Infante Henrique, "Henry the Navigator," is at the prow of the symbolic caravel".[13]

The second noteworthy event was the 1998 Lisbon World Exhibition, also known as *Expo 98*, entirely dedicated to the theme "The oceans: a heritage of the future", and in commemoration of the 500th anniversary of Vasco da Gama's arrival in India. This event was also responsible for prompting the urban and environmental regeneration of an extensive sector of the Lisbon waterfront, occupied until then by unhealthy and dangerous industrial facilities.

A number of particular aspects about what was then done should be stressed. The first of these was the pressing need to provide access to the waterfront where the derelict industrial areas remained, encouraging the exploration and fruition of the area by the local communities, the visitors from Lisbon and further afield, and overseas tourists. This was achieved by building new cultural and leisure facilities such as the Pavilions of the Oceans and Knowledge of the Seas, as well as a large aquarium and a marina, from which it is possible to set sail up the river aboard a traditional boat, the so-called *varino*, a historical vessel that can only be found at the Tagus River.

Between these two major historical exhibitions in the capital city, one could claim that the functional divide between shipping activities and water-related activities for the pop-ulation of Lisbon was aggravated, especially ever since the phenomenon of "containerization" became widespread.

I will turn now to the last example of water-related heritage, this one unrelated to the port or the water supply. This example is located right in the centre of Lisbon and is said to be the "heart of the garden" of the Calouste Gulbenkian Foundation: the pond. "Built in the sixties, a project by landscape architects António Viana Barreto and Gonçalo Ribeiro Telles, the Calouste Gulbenkian Foundation's Garden is one of the most iconic modern gardens in Portugal and a prime example of Portuguese landscape architecture." [14]

Conclusion

I believe that the previous examples suffice to demonstrate the nature of the intimate relationship between the city of Lisbon and the water.

Over the centuries, important water-related landmarks have been lost, such as the medieval tide mills, one of which can be found in the Tagus estuary as a remain of the 14th centu-ry (1313) and which can still be identified in the *Great Panorama of Lisbon* tilework. Another example is the long stone quay, entitled *Cais da Pedra*, pictured in the Braun & Hogenberg map of Lisbon of 1598, included in volume V of the famous first atlas of world cities, *Civitates orbis terrarum*.

Today, the city of Lisbon, or more specifically, the local authorities, the industrial and commercial world as well as the cultural associations, heritage societies, and the private individuals, have already preserved a substantial part of the heritage assets that we have referred to above. They comprise an impressive roster of buildings, large fixed technical structures, and small equipment including

12 De Castro, Guia da Exposição..., 1940.

13 The definitive construction dates from 1960, on the occasion of the celebration of the fifth centennial of Prince Henry the Navigator's death.

14 https://gulbenkian.pt/jardim/en/garden/historia-do-jardim/

machines, objects, and archives related to water heritage. A badge of honour should be awarded to the Water Museum (*Museu da Água*) which belongs to *EPAL*, successor to the Lisbon Water Company (*Companhia das Águas de Lisboa*) established in 1868. This museum presents a collection of structures (buildings and equipment that were built in the 18th and 19th centuries, as seen before) which are preserved on site but shown here in the context of its network.

The headquarters of the museum is housed in the historical building of the *Barbadinhos* Steam Pumping Station mentioned above. The museum not only had the great merit of saving the building but it also boasts the original and stunning four steam pumping engines made by E. Windsor & Fils of Rouen, Normandy, acquired in 1876. They have been kept inside and remain much admired by industrial archaeologists (Fig. 10).

The Water Museum's permanent exhibit invites visitors to discover the role that water has long played in the city's history, as it pertains to issues of science, technology and sustainability. In short, we could state that water heritage is seen as an educational tool.

As to the Port of Lisbon, it is still possible to find, scattered here and there, the ancient remains that embody some of the values that were once famously ascribed to monuments by Aloïs Riegl at the University of Vienna in 1903, integrating, at once, historical, cultural, technical, and artistic values. And yet, it should nevertheless be emphasized that their preservation has been particularly volatile over the last decades.

Throughout the 20th century, several areas would gradually be stripped off their original port functions. Consequently, all along the riverfront, many of the port warehouses that were built during the last decades of the 19th century, ultimately lost their purpose and have been converted into trendy restaurants, clubs, and shops.

Unfortunately, in spite of the multiple ideas that have been proposed and the numerous projects that have been suggested over the years to no avail, it appears that there is a strange lack of space for a museum or any other means that would allow interpreting the cultural and symbolic dimension of the port of Lisbon. Such a continual succession of lost opportunities has been more than unfortunate, to say the least.

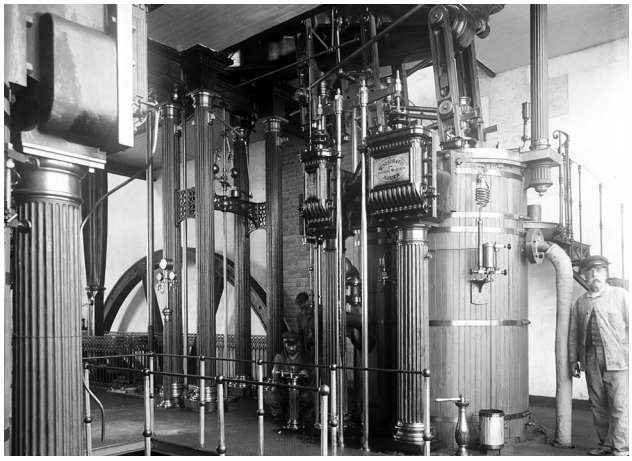

Fig. 10 Barbadinhos Pumping Engines, c. 1880, Arquivo Municipal de Lisboa (Inv. LIM 001 539)

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Rolf Höhmann
Water World Heritage

Water as the main source of human life is already well represented in the Cultural and Natural World Heritage, either as main object or sometimes „hidden" behind prominent sites, buildings and structures. Water can be the central piece and/or an important attribute in the justification of the OUV. Water use is an extremely wide field and it seems impossible to research and develop an exhaustive and complete global Thematic Study. Several attempts were undertaken to develop Thematic Studies for specific fields of water use to form a basis for comparisons and future applications. The following overview presents two quite recent Thematic Studies as well as the approach used for the International Comparative Analysis for the nomination file of the Augsburg Water Management System, including a survey of water-related World Heritage already listed or proposed as Tentative List properties. Not presented is the early specialized International Canal Monuments List, published by the International Committee for the Conservation of the Industrial Heritage (TICCIH) in 1996, although some of the objects listed and nominated therein are also considered in this survey.

Thematic Studies

The most recent study „The Water Industry as World Heritage"[1] was published by TICCIH in collaboration with ICOMOS in 2018. The author, James Douet, focusses his selection of possible World Heritage sites on objects related to large industrial-type water systems and technical installations for the supply and provision of drinking water, drainage and the treatment of waste water. Consequently, these objects are concentrated in more recent periods – 18th to 20th centuries – and in early industrialized regions like Europe, North America, Australia and Argentina. Two of these sites have become World Heritage – Tarnowskie Gory (Poland) was listed in 2017 and Augsburg (Germany) in 2019. Both sites are unusual in so far as the origins of their respective water management systems lie before the Industrial Revolution. In Tarnowskie Gory, the drainage of large water volumes was essential for the extraction of the lead-silver-zinc mines. First mentions of Augsburg's water management date from 1276, and thence underwent a continuous development of the water supply over centuries. Indeed, in the 19th and early 20th centuries, the distribution of clean drinking water and water resources for water power reached the highest standard in Augsburg.

The list of proposals in the Thematic Study reads as follows:

1. Augsburg water management system, Germany
2. Sete Fontes aqueduct, Portugal
3. Tarnowskie Góry mine and its underground water-management system, Poland
4. Águas Livres aqueduct and water-supply system, Portugal
5. Old Croton aqueduct, USA
6. Kew Bridge and Kempton Park pumping stations, UK
7. Berlin Radialsystem sewage treatment network, Germany
8. Boston Metropolitan Waterworks Museum, USA
9. Vyrnwy and Elan Valley distant supply schemes, UK
10. Melbourne sewage system and Spotswood pumping station, Australia
11. Palacio de las Aguas Corrientes service reservoirs, Argentina
12. Old wastewater treatment plant Prague-Bubeneč, Czech Republic
13. Prague-Podolí water treatment plant, Czech Republic
14. R. C. Harris filtration plant, Canada

In 2015, following a conference on the topic, ICOMOS published a Thematic Study entitled „Cultural Heritages of Water – The Cultural Heritages of Water in the Middle East and Maghreb"[2], edited by Michel Cotte. According to the subtitle, the conference and publication dealt exclusively with the described regions, where early water use and management date back to Antiquity. Some of the examples were listed as World Heritage (Aflej in Oman, Quanats and Shushtar in Iran), or included in the Tentative List (Carthage in Tunisia). The study provides very useful categories for a systematic approach, which are not directly connected to the region, but can be seen as a more general and universal approach:

1 https://www.academia.edu/39018279/The_Water_Industry_as_World_Heritage (consulted last on 27.3.23)

2 https://www.icomos.org/images/DOCUMENTS/World_Heritage/CH%20of%20water_201507_opt.pdf http://openarchive.icomos.org/id/eprint/1846/ (consulted last on 27.3.23)

1. The various types of water use;
2. The development, management and control of water to make it available for purposes of human use;
3. The management of constraints and control of natural water;
4. Water and health, water quality and associated representations;
5. Water, and water-related knowledge, know-how, myths and symbols;
6. Cultural landscapes of water.

Adapting the existing approaches and systematics, a typology was derived relating to a chronological and regional analysis of water systems in the World Heritage List and national Tentative Lists. This scheme was thus used in the International Comparative Analysis for the nomination dossier of the Augsburg Water Management System. It may not be complete, as the keyword „water" cannot be tracked very well in the UNESCO data base of the World Heritage List, which thus calls for a more detailed individual research for each country.

The study includes the following types of water systems and water use:

1. Early water systems in the Middle East and Asia;
2. Water systems from the Roman period;
3. Early water systems in China;
4. Water systems in the mining industry;
5. Providing water for the supply of cities and landscapes and for irrigation purposes;
6. Inland navigation canals;
7. Water management / control;
8. Abundant water resources: parks and decorative fountains;
9. Water for hydropower.

1. Early water systems in the Middle East and Asia

- *Iran, Shushtar Historical Hydraulic System*
- *Jordan, Petra*
- *Qanat:*
  - *China, Karez Wells (TL)*[3]
  - *Iran, The Persian Qanat*
  - *Oman, Aflaj Irrigation System*
  - *Pakistan, Karez System Cultural Landscape (TL)*

The selection of these properties is based on the ICOMOS Thematic Study "The Water Industry as World Heritage". An important and widespread development for the collection and transport of fresh water was the Qanat system, represented with listings in Iran and Oman (called here „Aflej") and with Tentative List nominations from China and Pakistan (in both countries named „Karez").

2. Water systems from the Roman period

- *Spain, Old Town of Segovia and its Aqueduct*
- *Spain, Archaeological Ensemble of Merida*
- *Spain, Archaeological Ensemble of Tarraco (Fig. 1)*
- *France, Pont du Gard (Roman Aqueduct)*
- *Italy, Cascate della Marmore and Valnerina (TL)*
- *Lebanon, Baalbek*
- *Greece, Delos*
- *Tunisia, Le complexe hydraulique romain de Zaghouan-Carthage (TL)*
- *Turkey, The Theatre and Aqueducts of the Ancient City of Aspendos (TL)*

Stone aqueducts are a hallmark of Roman water engineering and many surviving examples are spread all over the former Roman Empire around the Mediterranean Sea. Some are elements in larger archaeological complexes which also have other water-related structures.

3 TL = Tentative List.

Fig. 1
Roman aqueduct in Tarraco, Tarragona, Spain

Fig. 2 Mining water wheel in the Upper Harz, Germany

Fig. 3 Water gallery in the Ore Mountains in Saxony, Germany

Fig. 4 Steam pumping engine, mines in Cornwall, United Kingdom

3. Early water systems in China

- *China, Mount Quingcheng and the Dujiangyan Irrigation System*
- *China, Old Town of Lijiang*

The Dujiangyan system was built for flood control, irrigation, water transport and general water consumption. It was begun more than 2250 years ago and still irrigates 668,700 hectares of farmland. It is possibly the oldest system still in operation.
The town of Lijiang, founded in the 13th century, is supplied by a water system with canals.

4. Water systems in the mining industry

- *Bolivia, City of Potosi*
- *Germany, Mines of Rammelsberg, Historic Town of Goslar and Upper Harz Water Management System (Fig. 2)*
- *Germany and Czechia, Mining Cultural Landscape Erzgebirge/Krušnohoří Mining Region (Fig. 3)*
- *Poland, Tarnowskie Góry Lead-Silver-Zinc Mine and its Underground Water Management System*
- *Slovakia, Historic Town of Banská Štiavnica and the Technical Monuments in its Vicinity*
- *United Kingdom, Cornwall and West Devon Mining Landscape (Fig. 4)*

The drainage of deep mines was an important task and led to many inventions and the development of pumping technologies and their power supplies, like the steam engine. Technical solutions and craftsmanship were spread with the miners who migrated to many countries.

5. Providing water for the supply of cities and landscapes and for irrigation purposes

a. Irrigation

- *Brasil, Cedro Dam in the Quixada Monoliths (TL)*
- *Columbia, Pre-Hispanic Hydraulic System of the San Jorge River (TL)*
- *Philippines, Rice Terraces of the Philippine Cordilleras*

b. Rural water systems built by monks

- *Germany, Maulbronn Monastery Complex*
- *Mexico, Aqueduct of Padre Tembleque Hydraulic System*

c. Urban water systems

- *Cambodia, Angkor*
- *Kuweit, Abraj-Al-Kuweit (TL)*
- *Syria, Noreas de Hama (TL)*
- *South Korea, Oeam Village (TL)*
- *Germany, Augsburg Water Management System*

With the knowledge derived from Antiquity, in the Middle Ages many more densely populated areas could be provided with water supply and irrigation systems. In Europe, monks were often builders of water infrastructures; many monasteries owned mining grounds and were able to use early mining water system technologies for civil purposes.

Fig. 5 Pontcysyllte Aqueduct of the Llangollen Canal in Wales, United Kingdom

6. Inland navigation canals

- *Belgium, The Four Lifts on the Canal du Centre and their Environs*
- *France, Canal du Midi*
- *Canada, Rideau Canal*
- *China, The Grand Canal*
- *United Kingdom, Pontcysyllte Aqueduct and Canal (Fig. 5)*
- *Belarus and Poland, Augustow Canal (TL)*
- *Columbia, Canal del Dique (TL)*

In Europe, larger canal networks started with the pioneer Canal du Midi, which initiated the complex canal system in the United Kingdom and then all over Europe, but they cannot be compared with the long history and the dimensions of Chinas Grand Canal.

7. Water management / control

- *Netherlands, Mill Network at Kinderdijk-Elshout*
- *Netherlands, Ir.D.F. Woudegemaal (D.F. Woudegemaal Steam Pumping Station)*
- *Netherlands, Droogmakerij de Beemster (Beemster Polder)*
- *Netherlands, Seventeenth-Century Canal Ring Area of Amsterdam inside the Singelgracht*
- *Netherlands, Defence Line of Amsterdam*

The special situation of the Netherlands with many parts of the country lying below sea level led to special technical solutions for drainage, pumping, water power and even defence measures using the water resources.

8. Abundant water resources: parks and decorative fountains

- *France, Palace and Park of Versailles*
- *Germany, Bergpark Wilhelmshöhe*
- *Italy, 18th-Century Royal Palace at Caserta with the Park, the Aqueduct of Vanvitelli, and the San Leucio Complex*

Using the already developed technologies, water was used as an integral part of feudalistic representation complexes of castles and palaces with their designed gardens and parks. Versailles is the best known and largest that influenced other examples like Kassel and Caserta.

9. Water for hydropower

- *United Kingdom, Derwent Valley Mills*
- *Norway, Rjukan-Notodden Industrial Heritage Site (Fig. 6)*

The waterwheel, invented in Greek times, was the power source for decades, also in early mining and at the start of the industrialization. More efficient water turbines paved the way for large-scale power generation in mountainous regions and areas with large water volumes.

Fig. 6
Saeheim water power station in Rjukan, Norway

Credits: All photos by Rolf Höhmann

Conclusion

Although water is represented in numerous ways on the World Heritage List, its importance for human life could justify a greater number of proposals and more differentiated examples, especially from modern times and the industrial era. Sustainability as one of UNESCO's main objectives can be reflected in outstanding examples of protection and long-term use of water-related sites.

Andrea Oldani

Waters and Landscapes of Invention: for a New Interpretation of Water Heritage

Heritage as teaching deposit

This paper focuses on specific aspects of a more comprehensive research study on one of the most relevant hydraulic monuments in the Milanese context, the Naviglio Grande Canal. It proposes a description and reinterpretation as to understand the object from the past in regards to its values concerning the present.[1] Achieving this result involves investigating the meaning of tools, methods, and theories to understand and interpret the complexity of the landscape and deepening the knowledge of how the past can communicate valuable content for the present and future.

The observation starts from the specific disciplinary point of view of landscape design and assumes, as an ultimate horizon, the modification of the environment as a response to understanding the landscape and guaranteeing its permanence through its evolution.

Looking at heritage in a way that is capable of illuminating the present and providing answers applicable to completely different physical, social and cultural contexts involves a considerable effort that implies a critical operation that makes comparisons and transliterations, starting from a strongly directed synthesis. To this end, the research starts from a transect crossed by the Canal and proposes a reinterpretation that focuses on water as a material of space essential to the future of the landscape.

This cultural approach attempts to reinterpret and reapply the principle of „continuity" developed in Milanese architectural culture. According to this theory, the reference to the past becomes „historical consciousness" and leads to a „dynamic continuation", not to „dogma" but to "free research".[2] History thus becomes operable material, like the territory[3], and with its dense deposit lends itself to a wide range of autonomous re-elaborations in which the echo of history is present and can be perceived despite not being dominant or oppressive.

This concept, substantiated by numerous cross-cultural references, all Milanese, represents an emblematic example of understanding the relationship with history in architectural design, applied to the search for a specific language for contemporary architecture in relation to the problem of environmental pre-existences. Nevertheless, the concept did not find immediate application to the landscape phenomenon, unless one recalls specific aesthetic values (volumetric aspects, sculptural determinations, rhythmic sequences, chromatic vibrations) and refers to a form-oriented sensitivity, in which case it is crucial to focus on what continuity means for the contemporary landscape. For this reason, a theoretical realignment is indispensable, explaining why this research associated with continuity should be located in a different problematic and cultural context, directly related to the difficulties of the Anthropocene.

First, it is evident how this attention to formal values and language makes sense in an argument about architecture and the landscape of infrastructures, because it operates concerning the study and rethinking of forms constructed in space. Furthermore, the comparison is even more meaningful if examined in relation to the degree of invention that historical infrastructures such as the Naviglio Grande can express. This capacity of invention is necessary to answer the challenges imposed by environmental imbalances and ecosystem degradation and corresponds to functional, aesthetic, and spatial wisdom and creativity.

Consequently, continuity becomes not only understanding and treasuring a way of using architecture and its materials to construct space and compose skilful forms, but also recovering the creative and unconventional abilities to imagine places, address problems and find solutions that can also be understood in the study of history.

This process is an actual operation of invention that has stood the test of time, has survived, and has been handed down and can thus inspire the present. The interest lies in understanding the degree of complexity, invention, capacity for relationships and plurality present in the emblematic works of the past in order to then replicate their spirit according to the needs of the present, not by emulating but by reinterpreting. The process envisages a series of actions that analyse the complexity, dissect its characteristics, and re-propose them through a renewed formula.

1 The research is presented in Oldani, Acque, 2020.

2 Ernesto Nathan Rogers focused on the concept of "continuity" and critically discussed within the pages of the magazine Casabella Continuità. For an overall examination of Rogers' theoretical approach, see Rogers, Esperienza, 1997, p. 93; and Rogers, Elementi, 2006, p. 59.

3 The extension of Rogers' thought to the territory and its interpretation in relation to history is carried out by his alumnus Vittorio Gregotti. In his theory, the entire anthropo-geographical universe becomes operable material through architecture tools. See Gregotti, Territorio, 1966.

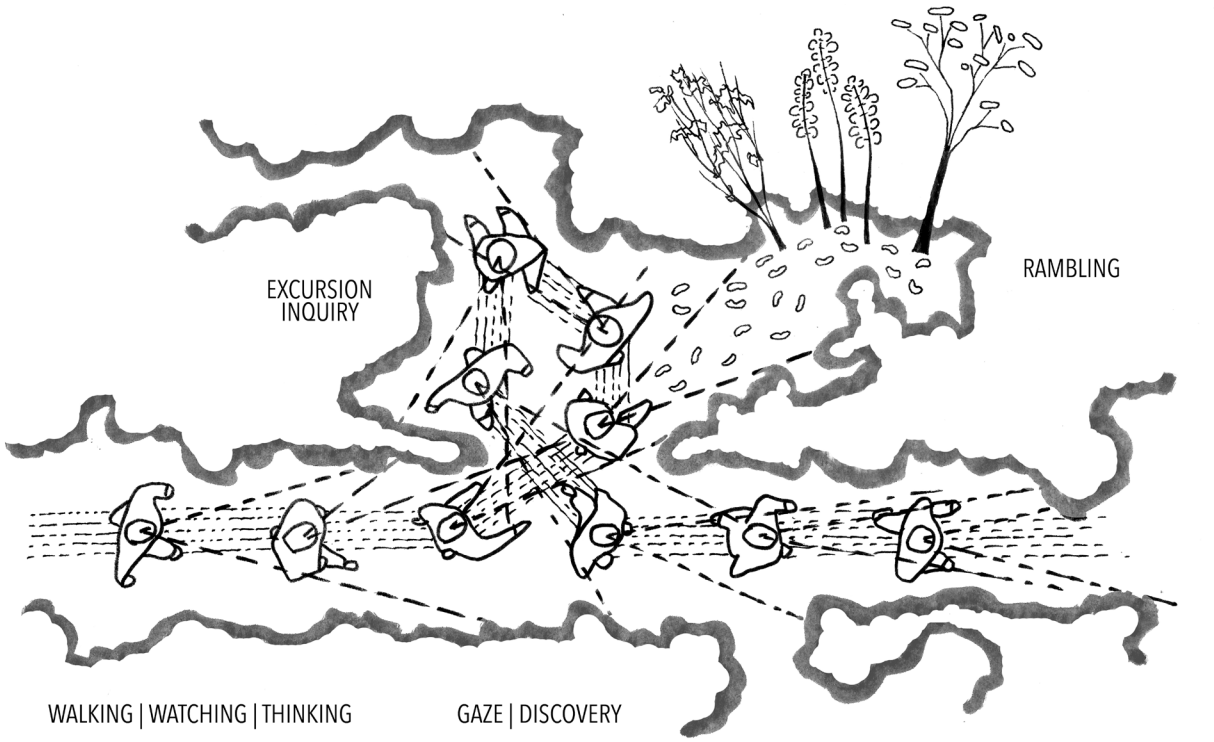

Fig. 1 Walking rituals, landscape discovery

As a first step: immersion

The hypothesis of discovering and acquiring various forms of knowledge and inspiration by studying infrastructural works from the past requires first understanding methods and tools for their comprehension. Therefore, immersing oneself in the landscape becomes an essential priority and necessity. It is evident how the value of the direct relationship with places and the meaning of seeing with one's own senses are vital. This is true since the landscape is a phenomenon that depends on complex factors where the act of living is essential,[4] but also because it is necessary to contrast the contemporary excess of images affecting our way of perceiving the landscape.[5] In fact, several studies have shown how excessive visual consumption leads to superficiality, a lack of deep observational stimuli and a reduction in attention to reality. [6]

For this reason, recovering a one-to-one personal experience with the site allows reflecting on the reality before its representation and training to improve how to look carefully and see. Moving through the landscape means walking according to a ritual that considers each step a gesture. This act corresponds to the initial stage of discovery and understanding and, reiterated and improved, provides the necessary awareness to describe and interpret the landscape (Fig. 1).

The on-field research work conducted on Naviglio Grande started from the elementary experience of walking. This activity was carried out in different sessions, slowly, through repeated gestures, proceeding regularly and continuously, with the mind ready to evasions and excursions in search of the elements of exceptionality. Those components are fundamental to understand the landscape and to open to the design value inherent in any descriptive operation carried out by the architect.

Transects and cross-sections: unveiling inventive complexity

The value of direct knowledge of a landscape does not end with mere exploration but requires precise transcriptions. This operation is essential for at least three reasons. The first is to transmit the knowledge and make the landscape intelligible, thus increasing its value. The second is to focus on resources and criticalities, allowing the terms for improvement necessary in the design phase. Finally, the third reason, as in the case of the Naviglio Grande, is to assess landscape value as a source of knowledge for the present. The research that this paper attempts to illustrate from a methodological point of view has used multiple tools, including drawings, maps, and photographs.

4 Jullien, Living, 2018.

5 The list of literature dealing with these issues is extensive, a rather broad but not generic review is offered by: Mirzoeff, How to See, 2015.

6 The effects are mainly studied concerning taste preferences expressed in social media, see: Thömmes, Hübner, Why People Press, 2020.

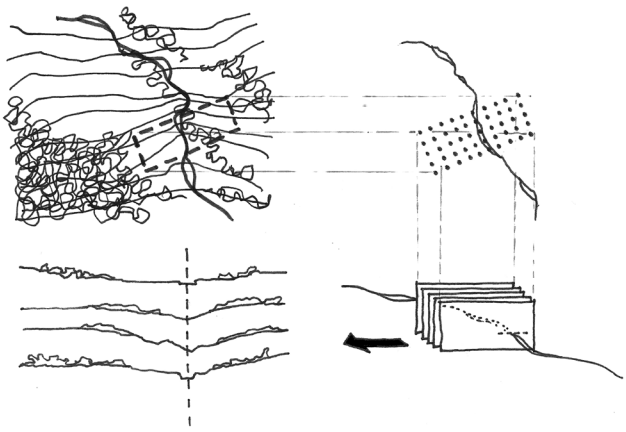

Fig. 2 Transects, cross-sections, tomography

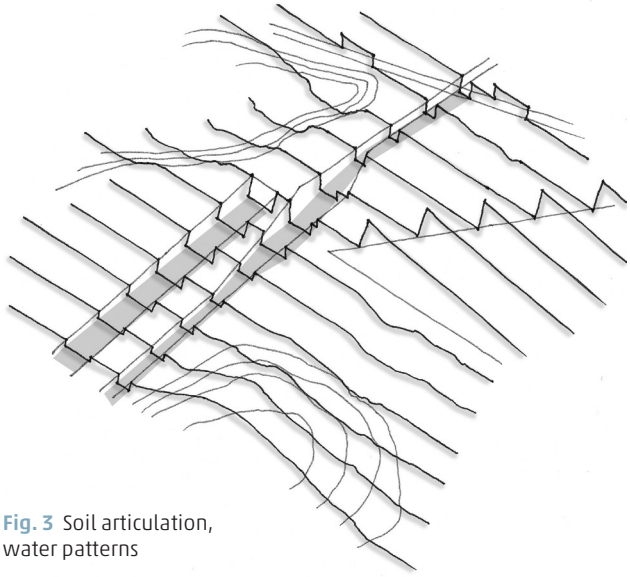

Fig. 3 Soil articulation, water patterns

However, since the contribution is limited, it is more relevant to focus on transects and cross-sections, which are considered the primary method for representing landscape complexity.

The transect concept has a relevant history in landscape studies, from Alexander von Humboldt to Patrick Geddes and Ian McHarg, as a tool directly related to ecology, used to describe transitions, successions of diversities up to becoming a design tool.[7] In addition to this, archaeology also uses transects in a slightly different way. This discipline considers the transect a theoretical and operative device that directly links survey experience and field-walking through research sites. Here it is usually assumed that a limited exploration field chosen in a random area constitutes a sample capable of representing the peculiarities of the entire population and allowing a first, simplified and measurable, exploratory insight.[8]

For this reason, the concept of the transect can be easily transferred to the study of territorial infrastructure. The choice of one or more sample areas, defined according to the character of the territory, makes it possible to highlight, within a measured area, the specificities and differences that can first be assessed and then extended and generalised.

Furthermore, the transect consisting of a measurable area with a fixed geometric character, can be understood horizontally as a field of singular points and vertically as a series or sequence of parallel planes. This interpretation establishes a clear relationship between transects and cross-sections, offering a direct correspondence and relationship between two views. Consequently, the transect appears as an ideal theoretical tool capable of penetrating the constituent essence of things, establishing a clear relationship with tomography (Fig. 2).

Transects, cross-sections and tomography thus become means to delimit, understand and describe the complexity of the landscape and its formal consistency. These topics or rather tools have been assumed, speculated about, and practised by researchers and finally applied to the knowledge of the landscape crossed and determined by the Naviglio Grande Milanese. Drawing, reading, and interpreting a sequence of sections reveal the complexity determined by the soil movements and the succession of cavities designed to receive and distribute the water and construct landscapes (Fig. 3).

Shapes of water

At this point, it is necessary to go back to the initial assumptions and clarify which inventive aspects found in the past can become resources for using water as a material to build the future landscapes.

The study highlights how constructing an artificial canal such as the Naviglio Grande has favoured the indispensable conditions for the settlement. Moreover, it has shown how its presence influenced the entire environment and is connected to every form of production and living. The water did not just flow and defined a line, but multiplied, reaching other destinations and providing support for an advanced form of multifunctionality that corresponds to a precise determination of space.

The ground has been excavated, adapted, and levelled. Differences in the plans have been skilfully exploited. Construction works guaranteed the perfect efficiency and plurality of the system by making the water flow, accessible and collectable, guaranteeing overpasses, boating facilities, accesses, controls, measurements, and

7 Braae, Steiner, Research Companion, 2018.
8 Banning, Archaeological Survey, 2002.

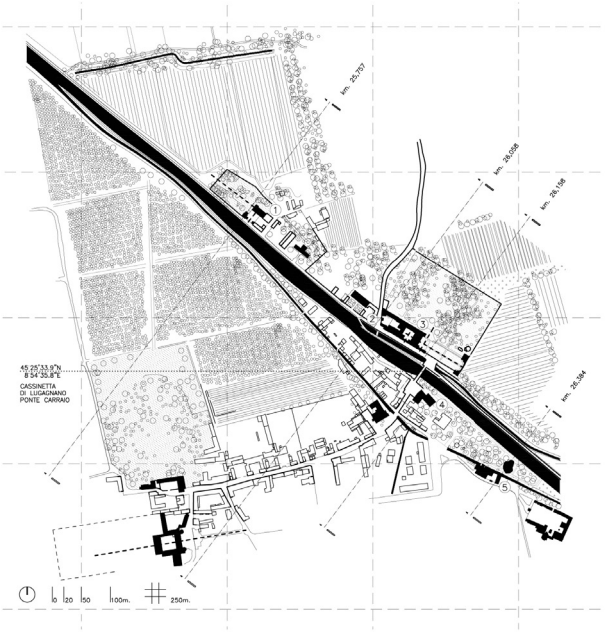

Fig. 4 Naviglio Grande, Cassinetta di Lugagnano, mapping, cross-section contextualisation

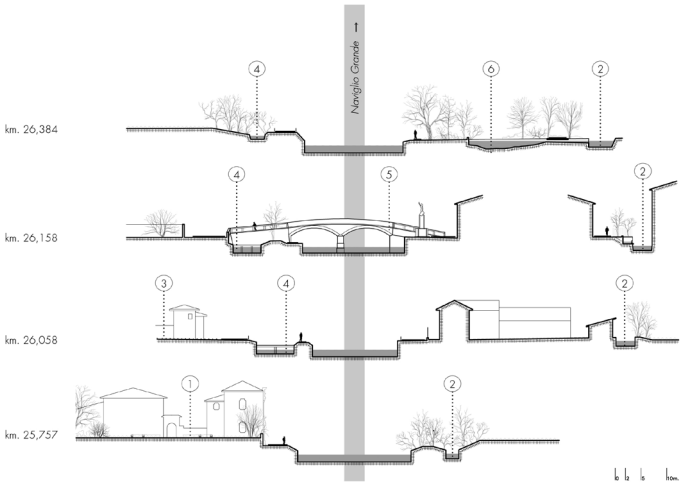

Fig. 5 Naviglio Grande, Cassinetta di Lugagnano, cross sections, tomography

ensuring quality. The liquid matter has been subjected to the most varied desires over time, in which its recycling has played a fundamental role and has made it a plural resource (Figs. 4 and 5).

A fundamental example is a secondary canal named Roggia Soncina, whose waters taken from the Naviglio Grande generate an alternative, varied landscape, responding to primary functional and secondary needs (Fig. 6). It is a romantic garden where the water passes through a tiny ditch, creating an extended variety of ponds designed for the pleasure of the middle class (Fig. 7). This richness created by water makes the Milanese Navigli extraordinary for their plurality of invention, producing a well connotated and resilient landscape that has evolved since the 13th century.

Water has no form; rather, it takes the form of its container. This is why we can speak of the forms of water, that is, how this material has been skilfully used to construct singularities, successions, spatial concatenations. This richness, plurality and diversity become the cue to understand the lesson of the Naviglio Grande. They allow us to reflect on how heritage becomes an opportunity for reflection that helps to redirect the efforts needed to emerge from the condition of crisis that characterises the present.

Fig. 6 Robecco Sul Naviglio, Roggia Soncina, washhouse

Fig. 7 Robecco Sul Naviglio, Sironi Marelli Garden, ponds and ground movements

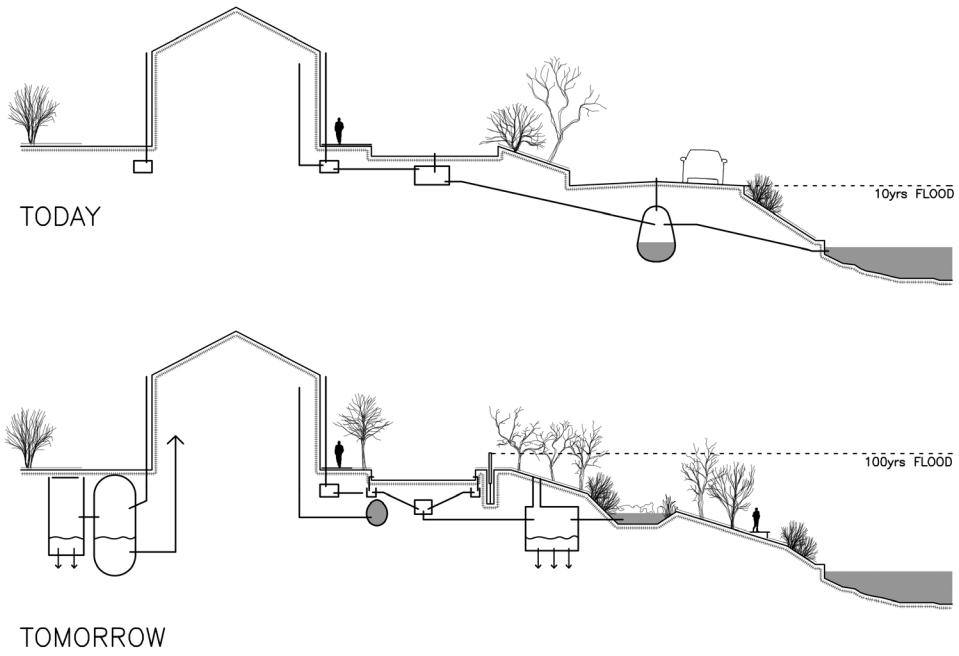

Fig. 8 Water-sensitive city concept

Water as a matter of space and form in times of climate change

Today, water plays a central role in addressing the critical conditions imposed by climate change. European and global policies have responded to changing and evolving criticalities for some years now. Mitigation and adaptation, together with resilience, have become indispensable concepts when dealing with excess, scarcity, or anomalies in our daily or extraordinary relationship with this element.[9]

The novelty of this paper and the research presented do not lie in enunciating a series of strategies to improve urban metabolism or the characteristics of the natural landscape to make our territory more resilient. In this respect, numerous contributions provide a very clear panorama of appropriate technical solutions.[10] Instead, from another point of view, the intention is to shift the attention towards the value of water as a material capable of shaping a new identity of open and urban space. This stage represents a step forward as it focuses not only on technical terms but also on issues of spatial design, which are necessary for the creation of high-quality landscapes. Thus, some issues closely linked to architectural design, which can be grouped under the problem of form, are given a new priority and crucial role in the conception of the resilient city of the future.

Consequently, the need to give more space to water, collect it in a differentiated way and reuse and recycle it becomes a theme of urban and landscape design. The reason lies in the potential visibility and perceptibility of water, and the operability of the liquid material constitutes the basis for a renewed grammar of spaces. This possibility is not new. The same thing happened in the past, when the construction of modern water infrastructures, like aqueducts and sewers, led to the birth of a specific and innovative landscape,[11] progressively deleting the pre-existing one.[12] It is possible to imagine the same for the future, with a transitional phase that will gradually lead to a new identity and grammar of spaces. In order to do this, it is necessary to focus on water and its preciousness; it can no longer be reduced to an impediment or waste product, and it is the task of architects to find new spaces to give a recognisable form to the flow of water.

It is difficult to describe this change, which shifts attention from the implementation of technical solutions, frequently invisible, to insert water into the space as a tangible material capable of influencing the degree of appreciation of places. A scenario can be imagined where a succession of complex figures replaces the invisible water linearity of the present. This new condition breaks up our predictable vision of water, starting from the tap in our sinks. Today we are used to always having water available and seeing it disappear, often denying the reality of when it reappears polluted in watercourses that we only care about when they cause disasters and floods.

9 For a comprehensive insight on Europe see Keskitalo, Developing Adaptation, 2014.

10 A vast series of technical solutions is offered by Strosser, Water Retention, 2014.

11 The contributions of Gandy, The Fabric, 2014 and Smith, City Water, 2013, contribute significantly to highlighting the role of water in producing a new urban imaginary.

12 A demonstration of how the availability of tap water through the aqueduct changed the landscape of a city like New York is offered by Greenberg, Springs and Wells, 2021.

All this flowing must manifest itself in new urban and landscape figures. The speed of water must be reduced, allowing it to find a new rhythm, to stop and purify itself, to originate places and give room to plants and species. The water flows will again become visible as continuities, creating landscapes that change with the seasons and the weather. The asphalt will disappear and the soil will breathe again, revitalised by water and reconstituting essential environmental infrastructure. Sometimes wet and sometimes dry, new spaces will emerge in cities and landscapes (Fig. 8). Water will be stored and redistributed, creating a succession of milieus where water will be present to reduce heat islands and improve the comfort of increasingly hot places.

This variety can only be imagined if it is conceived as an extensive infrastructure that is superimposed on or inserted between the voids and folds of the existing city, restoring, replacing, and occupying the obsolete space we experience in the present.

The example of the Naviglio Grande thus returns as a testimony that can narrate the coexistence of forms, invented spaces, and places that all revolve around a blue line. It is a question of capturing this inspiration for the present to demonstrate the capacity for accumulation and stratification. The landscape of the Naviglio Grande returns the result of progressive transformations that have produced more complexity, starting from an extreme awareness of the use of resources. This condition occurred through the multiplication of flows and the complex articulation of infrastructures designed for water use, movement, and control. The same operation should be carried out today, starting from a completely different concept of water infrastructure and profoundly alternative needs. Continuity means applying the inventive imagination of the past to the present project.

Some highly anticipatory projects constitute the germinal elements of this future. One can mention the Watersquare in Rotterdam, designed by De Urbanisten.[13] It is a pioneering example of dry/wet integration and a new figure for public space in times of climate change. Another relevant case is offered by Tredje Natur's design for Enghavepark in Copenhagen. The scope is similar but more in line with the needs of cities with a relevant corpus of obsolete parks and public spaces which need to be progressively updated. The park, renewed in 2019, is an emblematic example of a resilient and flexible environment readily responsive to climatic conditions characterised by extreme rainfall. The result is a perfect example apt to describe the resilience that will characterise our work in the future. Later, Asplan Viak's project for Deichmans and Wilses Gate in Oslo, Norway can be mentioned. The realisation offers a particularly illustrative scenario of rethinking the water cycle for historic cities. The water flowing off the roofs during the rainfalls becomes urban material, shaping a new architecture of flows (Fig. 9). The disappearance

13 Peijpe, De Urbanisten, 2010.

Fig. 9 Architecture of flows, Deichmans and Wilses Gate in Oslo, Norway

Fig. 10 Deichmans Gate, Oslo, Norway

of asphalt thanks to a reduction of car traffic and the elimination of parking spaces guarantees the possibility of a renewed landscape that will restore the quality of the urban environment and offer a life improvement to residents (Fig. 10).

These are a few examples of an attitude that is in the process of redefinition, episodes of invention that demonstrate water's capacity to once again become a material with which to construct spaces and to recover the sense of an ancient heritage whose legacy is necessary.

For now, these are singular or small implementations. Hope is that the future will bring a broad integration of these solutions in the city. This step requires an overall reform project that will necessarily start with the revision of the waterworks that support the present's complex urban metabolism. In this sense, rethinking maintenance processes and procedures as an opportunity to revise models and improve infrastructure's plural meaning is a step of great scope and interest.

Credits:
Figs. 1–5, 8: drawings by Andrea Oldani
Figs. 6–7, 9–10: photos by Andrea Oldani

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Till F. Sonnemann

"Not a drop of water" – The Functioning of the Angkorian Baray, and Their Role Today

Introduction

The construction and maintenance of the water management system is regarded as a major factor in the development and potentially the decline of Angkor,[1] the medieval Khmer capital.[2] Particularly the role of the four large baray as part of the network of embankments and channels has been the subject of discussion. The baray consist of raised linear earthworks, each creating a giant rectangle with a temple, the mebon, in or near its geometric centre. Making use of the gentle slope, their embankments reach up to 16 metres in height at the lowest point of the basin in the southwest. Their design is a physical representation of the Hindu cosmological worldview: Mount Meru as the centre of the universe, surrounded by an ocean of milk.

Archaeologist Bernard-Philippe Groslier of the École française d'Extrême-Orient (EFEO) proposed irrigation purposes in his hydraulic city hypothesis from his research in the 1950s to 1960s.[3] Regulated water flow from the baray would give the giant temple ponds the role of reservoirs. Water engineer W. J. van Liere counter-argued that without outlets, irrigation was not possible.[4] This set the stage for the discussion on the purpose of the baray in the following decades.[5] Missing evidence of exit channels at its lowest point, as to be expected from a reservoir, favours the concept of a purely ceremonial function, with the only purpose to surround the mebon by a constant water level. However, during their long time of use, the baray underwent modifications and potential evidence may now be covered by earth. Remote sensing images, visual and radar remote sensing techniques and archaeological surveys by the Greater Angkor Project (GAP)[6] had shown that Angkorian rice fields in an area south of the largest West Baray were oriented perpendicular to the canals and the local topography, supporting the irrigation hypothesis.[7] However, where did the water leave the baray? Were these outlets temporary breaches, or did solid structures designed for water control exist?

Modern engineering pre-empted scientific analysis. As early as in the mid-20th century, a weir gate in the southern embankment made the West Baray into a water storage reservoir for irrigation purposes, partly filling it for most months of the year. Flooding events between 2009 and 2011 threatened the modern town of Siem Reap south of the temple complex. The Cambodian authority for the protection and management of Angkor and the Region of Siem Reap (APSARA) decided to refill the Jayatataka, smallest of the four baray. By referring to its intentional use, the Jayatataka received a modern weir gate in the northern embankment and an overspill in the south.[8] An additional intent was to stabilize the groundwater table and safeguard Angkor's masonry temples from potential sinking groundwater table due to heavy water extraction in the hotel areas.[9] However, how did the baray actually function historically? A large-scale Ground-penetrating Radar (GPR) survey detected several structures, allowing assumptions on the role of the baray as part of the water management system.

Historic Overview

In prehistoric times, small rivers from the Kulen hills in Angkor's Northeast had run through the Siem Reap basin southwest towards Lake Tonle Sap.[10] With the subsequent establishment of Angkor's *low density urban complex*[11] in the plains between the hills and the great lake from the 8th-9th centuries onwards, the rivers were redirected to channel the water south through a network of canals. Earthworks directed the flow through the centre of Angkor, into the large reservoirs, or in the case of flooding, directly into the lake (Fig. 1). The water management system expanded over centuries; its instalment is mentioned in inscriptions. While there are large rectangular ponds at Isanapura (Sambor Prei Kuk)[12] and other pre-Angkorian capitals, the Indratataka is commonly regarded as the

1 Lustig et al., Angkorian Hydraulics, 2018.
2 Fletcher et al., Water Management, 2008; Shimoda et al., Angkor Thom, 2018, p. 33.
3 Groslier, Cité Hydraulique, 1979.
4 While van Liere "examined all of the major ponds from aerial photographs and many of them on the ground" he did not find "a single case where a temple pond was equipped with a distribution system to water the fields"; van Liere, 1982, p. 11.
5 See among others: Acker, Geographic Tests, 1998; Pottier, Rice Fields, 2000; Kummu, Human Impacts, 2009; Klassen and Evans, Diachronic Model, 2020.
6 Fletcher et al., Massive Structures, 2008, p. 235.
7 Pottier, Rice Fields, 2000, p. 119.
8 Hang, Sacred Water, 2015, p. 22.
9 Chen et al., SAR, 2017: SAR interferometry showed no change in subsidence between 2011 and 2013.
10 Groslier, Cité Hydraulique, 1979.
11 Fletcher, Limits, 1995, p. 93.
12 Shimoda and Shimamoto, Sambor Prei Kuk, 2012.

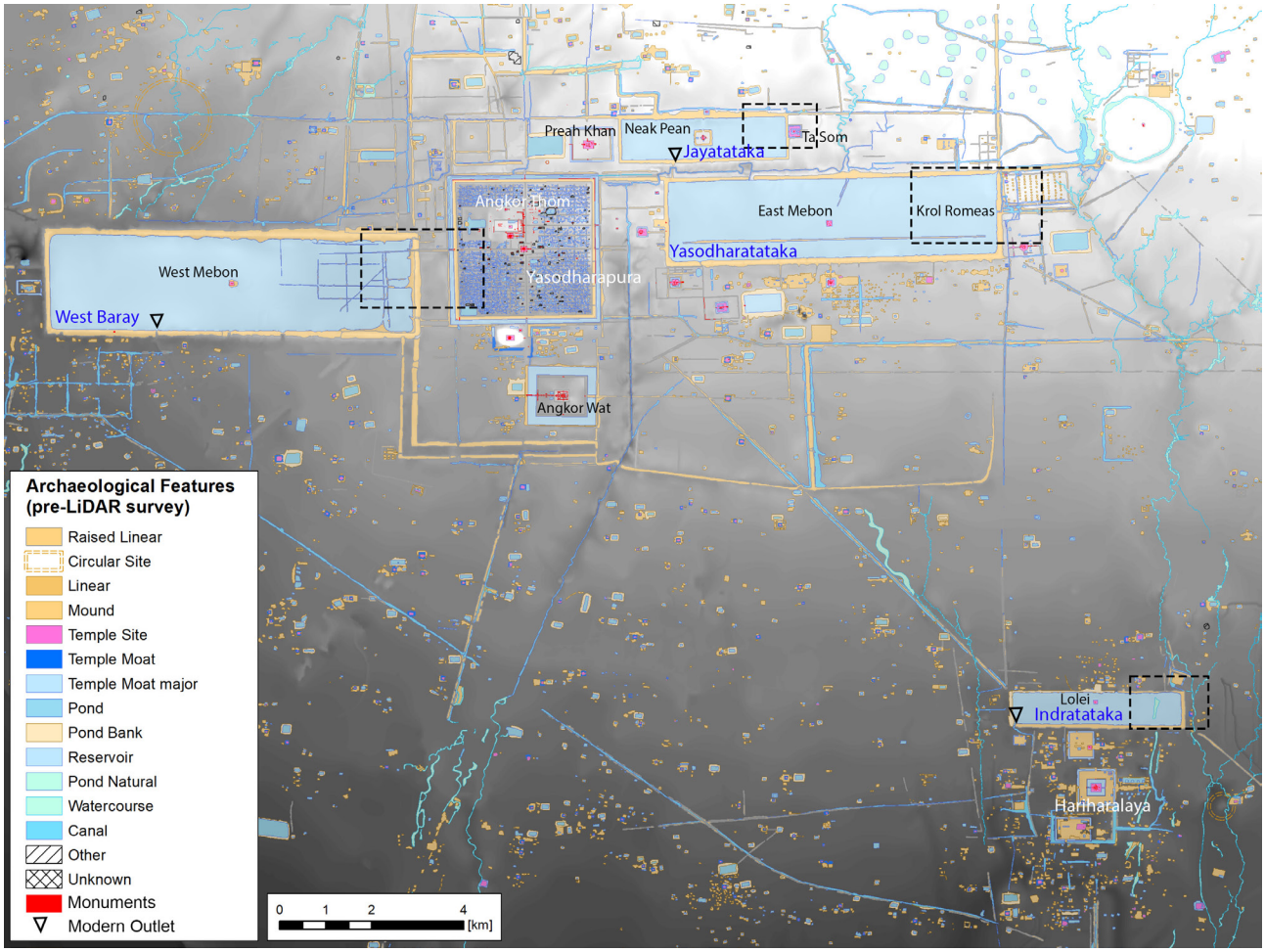

Fig. 1 The four baray and topography of the central part of Angkor

first baray of the Angkor period. Situated north of the enclosure of the early capital Hariharalaya,[13] it was attributed to the reign of King Indravarman I (877–889 AD).[14] The initial outline of the reservoir may have consisted of three embankments that were open upslope, working as water catchment devices.[15] This first design has been linked to the configuration of dams near the capital of Indravarman's predecessor Jayavarman II in the Kulen.[16] When Yasovarman I (889–about 910 AD)[17] placed the Lolei temple into the baray north of its geometric centre,[18] the catchment was transformed into a place with spiritual meaning, modelling the Hindu universe: the mebon representing Mount Meru, the sacred Hindu mountain surrounded by the world ocean represented by the baray.[19] The displaced central east-west axis of the mebon may indicate that in a later stage the existing embankments were raised, while the construction of an additional embankment further north closed off the reservoir.[20]

The palimpsest of the Angkor complex is evidence of baray associated with the placement of a new royal temple. Evidence of remodelling is detectable in several baray. The system in place must have influenced the design of the following constructions. The Yasodharatataka, commonly known as East Baray, is associated with the reign of Yasovarman (915–923). Rajendravarman (944–968) consecrated the East Mebon in its centre in 953 AD. The West Baray was the largest reservoir constructed by the Khmer. It may have started as an extension of a causeway that potentially reached from Phnom Bakheng, first capital of Yasodharapura, to the now buried pre-Angkorian temple of Ak Yum, but its date of construction is not mentioned in inscriptions. Stela K752 found in Ak Yum[21] dates to the year 1001 AD,[22] indicating that the

13 Pottier, Carte Archéologique, 1999, p. 149.
14 Dagens, Les Khmers, 2003, p. 38.
15 Dumarçay and Royère, Cambodian Architecture, 2001, p. 49.
16 Dumarçay, Architecture Models, 2003, p. 42; Chevance et al., Mahendraparvata, 2019, p. 1310.
17 Dagens, Les Khmers, 2003, p. 38.
18 Jacques and Freeman, 1997, p. 76.
19 Jacques and Freeman, 1997, p. 40.
20 Dumarçay, Architecture Models, 2003, p. 42.
21 Jacques and Freeman, Cities and Temples, 1997, p. 75.
22 Cœdès, Inscriptions, 1953, p. 59.

Assoc. Temple	Name	Assoc. Centre	Construction period	Reign
Ak Yum	?	?	7th cent.	?
Bakong	Indratataka	Hariharalaya	late 9th cent.	Indravarman I
Bakheng	Yasodharatataka	Yasodharapura	late 9th cent.	Yasovarman I
Prasat Thom	Rahal	Koh Ker	early – mid 10th cent.	Jayavarman IV
Banteay Kdei?	Sra Srang	Yasodharapura	10th cent. / 13th cent.	Rajendravarman II
Baphuon?	West Baray	Yasodharapura	early – mid-11th cent.	Udayadityavarman II
Beng Mealea	?	Beng Mealea	mid-12th cent.	Suryavarman II
Banteay Chhmar	?	Banteay Chhmar	late 12th – 13th cent.	Jayavarman VII
Preah Khan KS	?	Preah Khan KS	?	?
Preah Khan	Jayatataka	Yasodharapura	12–13th cent.	Jayavarman VII

Remodelled	Oriented	Length [m]	Width [m]	Ratio	Area [ha]	Mebon	Inlet	Outlet	Framed
overbuilt	E-W	~3870	?	?	?	?	?	?	no
Possibly	E-W	3760	760	4.9	286	Lolei	yes	yes	no
yes	E-W	7250	1844	3.9	1337	East Mebon	yes	yes	no
?	SW-NE	1310	550	2.4	72	no	?	?	no
yes	E-W	790	410	1.9	32	yes	?	?	yes
?	E-W	7950	2080	3.8	1654	West Mebon	yes	yes	no
?	E-W	1580	780	2.0	123	Yes	?	yes	no
?	E-W	1690	790	2.1	134	Yes	yes	yes	yes
?	NW-SE	1870	750	2.5	140	Prasat Tkol	yes	?	no
possibly	E-W	3640	960	3.8	349	yes	yes	yes	no

Table 1 Overview of the Angkorian baray.

upper part of the temple was still in use at that time. The raising of the south embankment, which buried most of the temple,[23] is associated with Suryavarman I (1002–1050).[24] Either he[25] or his successor Udayadityavarman (1055–1066)[26] was responsible for placing the West Mebon directly in its centre. Jayavarman VII (1181–~1218) inaugurated the last and smallest baray, the Jayatataka, constructed just north of the Yasodharatataka. [27]The mebon Neak Pean in its centre, the large monastery to its west, Preah Khan, consecrated in 1191,[28] and the temple of Ta Som have all been linked to this ruler.[29] The latter lies attached to the eastern embankment slightly north of the central axis; its outline somewhat inclined to the baray embankment. Other baray were also built in secondary centres of the empire, in similar configurations, but adopted to the local environmental circumstances, mainly considering water source and slope direction. This was the case at Preah Khan of Kompong Svay, Beng Mealea and Banteay Chhmar, and the Rahal at the short-time capital Koh Ker. The latter, however, also hosts a different type of water storage, a system of embankments that uses the natural terrain, similar to the retention devices on the Kulen.[30]

23 Jacques and Freeman, Cities and Temples, 1997, p. 307.
24 Jacques and Freeman, Cities and Temples, 1997, p. 134; Cœdès, Indianized State, 1968, calculated ~1040 AD, while Groslier, Cité Hydraulique, 1979, estimated 1000–1050 AD.
25 Dagens, Les Khmers, 2003, p. 39.
26 Jacques and Freeman, Cities and Temples, 1997: p. 144.
27 Jacques, Historical Development, 2007, p. 40. Jayavarman VII was responsible for major construction works at Angkor, such as the Angkor Thom enclosure and several large monastery complexes, and throughout the Khmer Empire.
28 Dagens, Les Khmer, 2003, p. 41.
29 Uchida et al., 2003, p. 30.
30 Evans, Koh Ker, 2010, p. 146; Lustig et al., Angkorian Hydraulics, 2018.

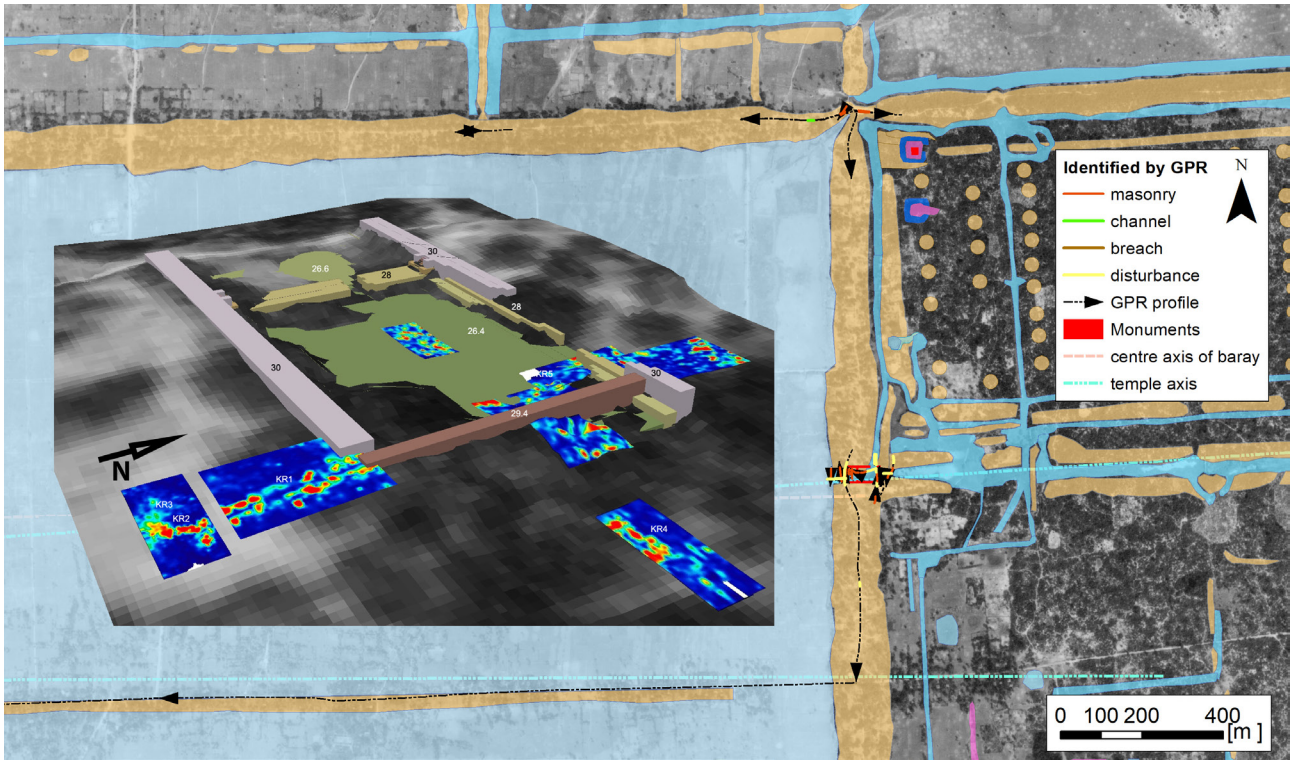

Fig. 2 Yasodharatataka, with model of Krol Romeas, model and DTM created from GAP survey data

Discussion – evidence of inlets and outlets

Van Liere did not question the existence of inlets, as there are clear indications in the embankments of the East Baray, the West Baray, the Jayatataka, and a channel pointing towards the Indratataka. Visible evidence for outlets exists at the Yasodharatataka, where George Trouvé came up with first ideas of an exit channel. He defined a breach in the western embankment of the Yasodharatataka in alignment with the axis of Angkor Thom's Eastern Gate of the Dead, *"the old outlet"*.[31] The GPR survey, however, did not show any evidence of a masonry structure or a channel connected to water management, while laterite blocks on top of the embankment appeared as remains of a platform. As part of a large landscape archaeology survey searching for sub-surface features by ground-penetrating radar (GPR), profiles covered the embankments of all four baray. The result was compared with existing plans and available remote sensing data sets, and archaeological excavations followed promising finds. The immense area and local conditions made an adaption of research methodology necessary.[32] The topsoil in the Siem Reap basin mainly consists of clayey sand that is several meters deep.[33] When excavated and dry, as in the case of most earthen baray embankments it can become hard as concrete and impenetrable to water,[34] reducing the signal penetration depth significantly. Nevertheless, in most areas a 250 MHz antenna provided good conditions to about five metres depth.[35] The survey results, clay, laterite and sandstone structures of different size, give evidence of inlets and outlets at particular locations of the embankments of the reservoirs.[36]

More promising is the huge masonry structure in the east embankment near the centre of the axis of the baray (see Fig. 2). Catalogued as early as in the early 19th century as Krol Romeas, the "den of the rhinoceros",[37] and later mapped as a gap in the embankment by Georges Trouvé (EFEO) in 1939, it was only in the 1990s that it was measured and interpreted as a water management device.[38] The archaeological campaign of the GAP revealed a huge exit structure, concluding that Krol Romeas was initially an outlet, which was remodelled to change its purpose.[39] Possibly the original inlet in the northeast corner of the baray had not provided enough water. Consequently, water was directed south alongside the east embankment to enter the baray at a topographically lower point. Part of the northern wall of Krol Romeas

31 Trouvé, 1933, p. 1125.; Sonnemann, Angkor Underground, 2011, p. 183.
32 Sonnemann, Classification, 2013.
33 Tsukawaki et al., East Baray, 1998, p. 276.
34 Courbin, Sra Srang, 1988, p. 22.
35 Sonnemann, Angkor Underground, 2011, p. 76.
36 Sonnemann, Angkor Underground, 2011, p. 176; Sonnemann, Hariharalaya, 2015.
37 Lunet de Lajonquière, Inventaire, 1902–1911, p. 227f.
38 Pottier, Carte archéologique, 1999, p. 109.
39 Fletcher et al., Massive Structures, 2008, p. 235; Greater Angkor Project, Krol Romeas, 2011.

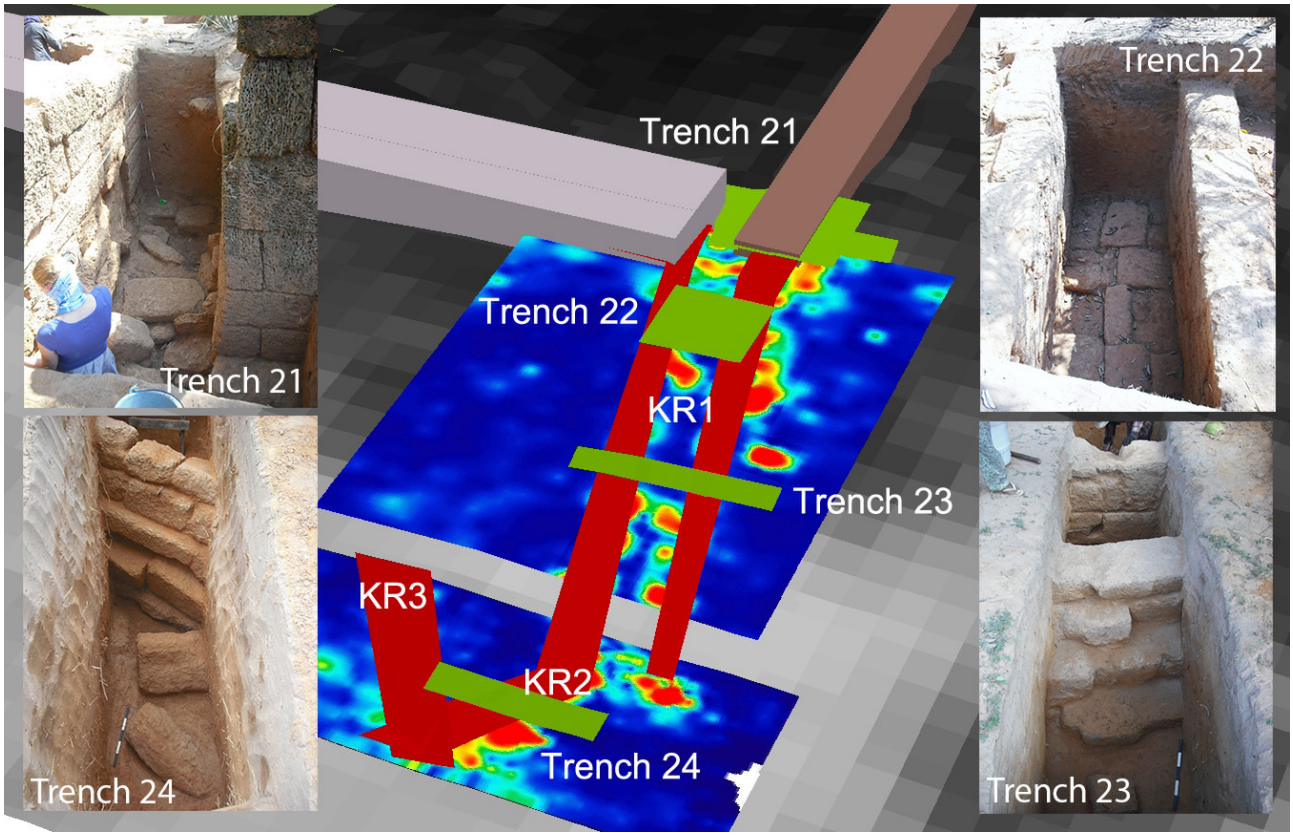

Fig. 3 Survey results and excavations: Trench 21 shows the gap in the Krol Romeas south wall, Trench 22 is a view along the channel, Trench 23 shows the structural support, and Trench 24 the angled wall

was knocked down to send water through the gap into the reservoir. A masonry wall closed off the east side and Krol Romeas became an inlet. With the outlet blocked, however, this raised the problem where water could flow out. Possibly, the GPR survey found the answer (Fig. 3). In the southeast corner of Krol Romeas there is an earthen filled gap. Surveying this location revealed two linear walls of 20 metres length running parallel, which begin at the small gap and continue southwards. Excavations revealed that the upper part of the walls is about 50 cm wide, with straight smooth surfaces facing the inside of one metre width. Smoothly paved laterite also covers the floor at 170 cm depth. To the outside, the walls' thickness increased with depth, like an irregular staircase. The construction material differs from that of the south wall; the masonry consists of smaller, irregular blocks, similar to the material used for the eastern wall. Several of the laterite blocks have an L-shape, possibly blocks that once secured the uppermost layer on the north wall. An additional masonry wall of four layers of laterite blocks, significantly deeper and oriented perpendicular to the channel, had no apparent structural connection.

Dirt roads made it possible to surround most of the Indratataka. The northern embankment revealed strong reflections from masonry inlet structures and channels.[40]

At the northeast corner, a large channel reaches the baray. To its north, a system of earthen embankments may have served to slow down the water before reaching the reservoir. Very slow water intake may have reduced sedimentation.[41] Profiles on each side of the dirt road running parallel to the eastern embankment of the Indratataka revealed a 20-metre-wide massive flat structure one metre below the surface. The location aligns with the baray's central axis and shows a dip in the embankment. The GAP excavation revealed a smooth lateritic masonry surface with clearly defined border stones at its western and eastern ends (Fig. 4). A cluster of laterite blocks within the alignment of the pavement led to the assumption that the floor had originally continued east of the Roluos riverbed, but was destroyed by uncontrolled floods.

Early French maps show that the West Baray's massive walls retained water in their western part even before modern in- and outlets.[42] Inside the West Baray, aerial images display shallow parallel embankments that may have directed water (see Fig. 1). GPR profiles which covered the top of the embankments revealed that signal penetration did not reach the base of the massive

40 Sonnemann, Hariharalaya, 2015.

41 Penny et al., West Baray, 2005 measured only 30 cm of fluvial sediments in the West Baray.

42 N.N., Chronique 1931, p. 242f.: in the map by Buat and Ducret from 1909, the western part is filled with water.

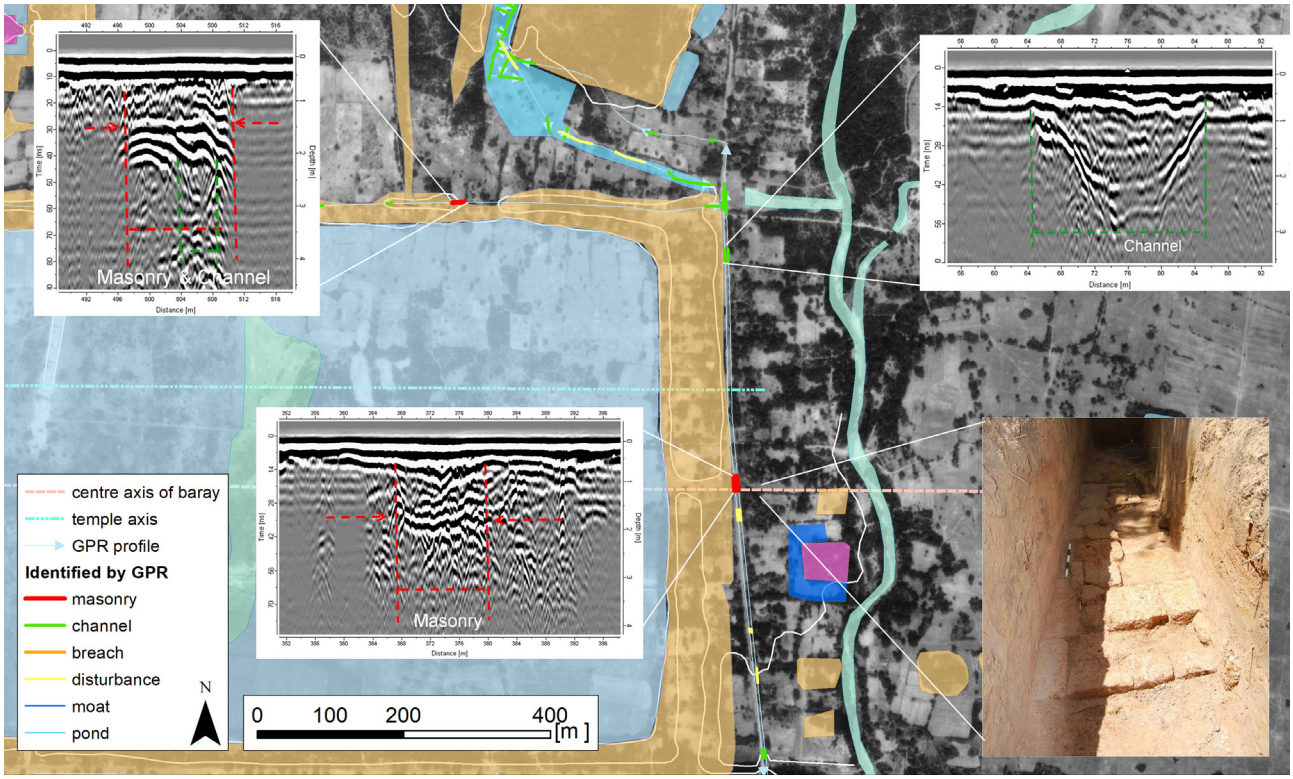

Fig. 4 The GPR survey at the eastern embankment of the Indratataka, potential inlets and outlets

earthen structure. However, breaches, most likely fixed in modern times, were identified. Particularly large breaches are located in the central area of the eastern embankment (Fig. 5). They correspond to a dipping, about 40-metre-wide and rather shallow channel feature measured east of the embankment.[43] The following GAP excavation showed soil change: sand deposits inside a channel dipping in the centre, clearly different from the clayey sand of the embankment. The only similar feature mapped in the long north-south profile through the forest of Angkor Thom may indicate a channel running parallel to the baray axis. Any supporting evidence, however, was destroyed by the installation of Angkor Thom.

A masonry inlet in the northern embankment of the Jayatataka was excavated in the 1930s.[44] Trouvé mentions laterite remains near the southern embankment's western end as a potential outlet.[45] The area was not accessible by GPR, but later freed from brush by APSARA, revealing remains of parallel laterite walls that cut through the embankment. A depression south along the east-west-axis to fill the moat of Angkor Thom was proposed as a later instalment.[46] Due to the findings at the other reservoirs the search for outlets focused on the east side (Fig. 6). In- and outside the southern part of the west wall of Ta Som the GPR profiles revealed a 60-metre-wide dipping structure, becoming a steeper channel towards the centre, 300 centimetres deep covered by an eight-metre-broad masonry structure. Coring to the feature hit a compact surface at exactly the calculated depth of the linear feature. An outlet blocked by the temple walls associated with the same ruler as responsible for the Jayatataka appears odd, but the answer could lie in the chronological order of construction. The orientation of enclosure and temple being off the central axis of the Jayatataka indicate a later addition compared to the temples of Preah Khan and Neak Pean, which align exactly with the baray. The outer walls of Jayavarman VII's large monasteries Ta Prom and Preah Khan have been associated with his successor Indravarman II who died in 1243.[47] According to architectural style comparison and magnetic susceptibility readings of the sandstone, Preah Khan (described as periods VIa and VIb) and Neak Pean (VIc), the two temples associated with the construction of the Jayatataka, are placed in earlier construction periods than Ta Som (VIII).[48] Finally, the southern part of the outer enclosure of Ta Som is lower than the rest of the temple. All this indicates that Ta Som's outer walls were constructed after the baray.[49] There is no topographic or underground

43 Greater Angkor Project, West Baray, 2011, p. 3.
44 N.N., Chronique, 1931, p. 216.
45 Trouvé, Chronique, 1933, p. 1121.
46 Pottier, Carte Archéologique, 1999, p. 100–102; Dumarçay, Architecture Models, 2003, p. 56.
47 Jacques, Derniers Siècles, 1999, p. 373.
48 Uchida et al., Magnetic Susceptibility, 2003, p. 221.
49 Cunin, Analyse Comparative, 2004, p. 325.

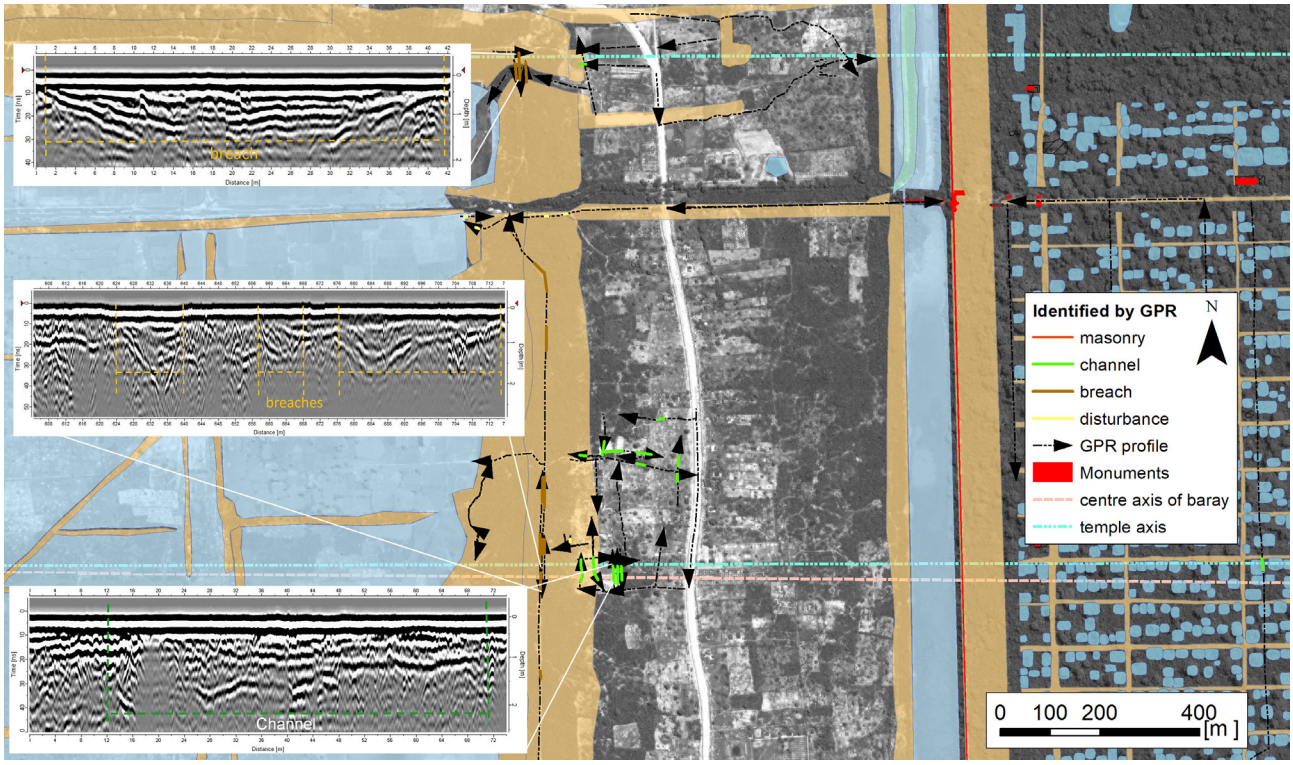

Fig. 5 The West Baray survey area

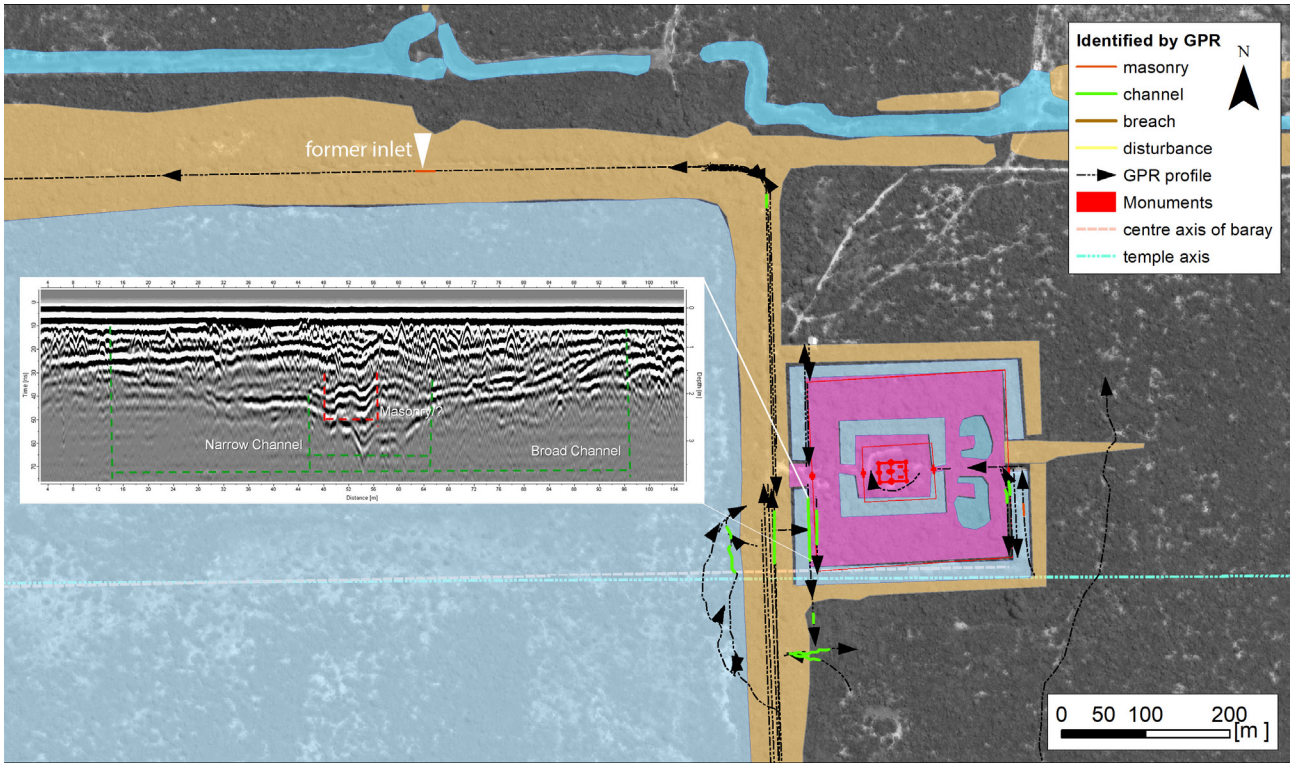

Fig. 6 Jayatataka and associated features

evidence that the canal continued eastwards, but the water may have been directed south. The structure could have been the outlet until it was closed by the outer wall of Ta Som, with the new outlet potentially breaching the south embankment.

Inlet or outlets also exist at other baray. Small laterite blocks frame the complete baray at Banteay Chhmar. The three-metre-wide masonry opening in the southern embankment make 90 degree turns twice, possibly to slow the water flow into the baray. The masonry base of the channel is destroyed and, laterite blocks spread out into the reservoir, indicates an uncontrolled water surge into the baray. A drawing of Trapeang Noem, the reservoir of Beng Mealea,[50] indicates an inlet connected to the temple moat in its southeast corner. GPR surveys conducted at Preah Khan of Kompong Svay and the Rahal of Koh Ker did not reveal evidence of artificial outlets.[51] The retention dam system at Koh Ker, however, includes a massive outlet north towards the river, and a large spillway. [52]

Conclusion

Angkor's water engineers made good use of the gentle slope of the Siem Reap basin, so that east-west running earthworks could block the flow of water and retained it across the Angkor plain.[53] The purpose of straight canals running south were to quickly discard excess water towards Tonle Sap. The GPR survey revealed masonry infrastructure, including dam-bridges, baray inlets and potential outlets, showing evidently that the baray were integrated in this hydraulic network and cannot be seen as singular devices. Water entered the baray at their highest point, at Angkor meaning at or near the northeastern corner. All inlets are topographically lower than the footstones of the mebon near the centre of the baray. This means opening or closing the inlet already regulated the water level. The massive embankments are nearly impermeable and natural evaporation compared to the original water volume is negligible. There is no evidence of temporary breaching the embankments, or reinforcement of the walls that supported this strategy. Outlets, however, exist in the central area of the eastern embankments in all four baray. There is a variety in design as they differ in size, style and regarding the material used: a flat masonry floor with earthen walls at the Indratataka, massive masonry structures at Krol Romeas, possibly a simple broad earthen breach at the West Baray. Only the last addition, the Jayatataka has a potential weir in the southern embankments that could have served as a regulating device, possibly after the Ta Som enclosure walls barred the initial outlet. The outlets in the east provided a runoff for excess water to either use it for irrigation or shunt it south. Outlets at this location question the western understanding of irrigation, of using the baray as storage device to distribute water in the dry season to produce higher yields. The newly discovered masonry outtake at Krol Romeas, as narrow as it is, however, due to its structural strength could rapidly discard large quantities of water if necessary, and regulate the water level of the entire baray for its full channel depth of 170 centimetres. Several construction stages, multiple inlets and outlets in a single baray show that their main function may have changed between temple pond and reservoir; precise dating would help clarify the working order. Regardless, the baray demonstrate the ability of the medieval Khmer to direct and manage large quantities of water across the landscape, and with the developing system, new practices were implemented.

50 Dumarçay, Architecture Models, 2003, p. 54.
51 Sonnemann, Angkor Underground, 2011, p. 204.
52 Evans, Koh Ker, 2010; Sonnemann, Angkor Underground, 2011, p. 124 and Lustig et al., Angkorian Hydraulics, 2018.
53 Kummu, Human Impacts, 2009, p. 1416.

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Credits

Fig. 1: DTM derived from JICA data. The archaeological map features GIS data by C. Pottier, J. Gaucher, D. Evans and the JICA monument database, combined and remodelled by the author for GAP in 2012.

Fig. 2: Aerial image by Finnmap

Fig. 3: All photos by author

Fig. 4: Background: Finnmap; photo by S. Player

Fig. 5: Satellite image by IKONOS (Space Imaging)

Fig. 6: Background: GAP map 2012; DTM from JICA topography

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Henk van Schaik

Bridging Water-related Cultural Heritage and Water Management Challenges

Introduction

This article is based on a presentation given at the Conference *Water Heritage – a Source of Knowledge for Sustainable Development*, organized by ICOMOS Germany in Berlin 11 to 12 November 2021. It has been updated since to include insights acquired after the conference, in particular at the UN Water Conference held in March 2023 in New York.

1. The Water and Heritage Initiative

A bridge spans two sides of a river that elsewise have no connection. Sir Diederik Six, restoration architect and at the time President of ICOMOS Netherlands, observed in 2011 a wide gap between water management and water-related heritage. On the one hand, nine out of eleven World Heritage sites in the Netherlands were water-related. On the other hand, the water management policies hardly considered water-related heritage to be meaningful for present and future water management challenges. Indeed, water professionals typically think of water-related cultural heritage as something merely pertaining to the past. This observation triggered Diederik and he started to look for a partner from the other side of the bridge, a water management professional, to team up.

When asked, I was intrigued by the idea. I had worked for 40 years in water supply, water allocations, water diplomacy and water and climate matters all over the world. Since 2001, I had led the Dialogue on Water and Climate, an international programme promoting the exchange between water professionals and climate experts from different professional and institutional backgrounds to overcome professional and disciplinary divides and enhance responses to climate change. Diederik's Water and Heritage Initiative sounded to me very similar, familiar in its endeavour to bridge the divides, just like our dialogue sought to connect the ends between water management experts and climate scientists.

This is how the Water and Heritage Initiative started (Fig. 1). Now, ten years on, our initiative is getting increasing international attention, both from the areas of heritage as well as of water management. Clearly, we have achieved major steps: in 2021, ICOMOS approved the creation of ISC Water, and, most recently, in March 2023, the UN Water Conference proposed to start an international platform for water, culture and heritage to further enhance the network and strengthen water heritage's potential to contribute to sustainable development.

Fig. 1 Sir Diederik Six and Henk van Schaik at the World Water Forum 7, Daegu, Korea, 2015. Photo from the private archive of the author.

Since 2012 the most important markers are:

Publications:
- Water & Heritage: Material, Conceptual and Spiritual Connections (2015)[1]
- Adaptive Strategies for Water Heritage (2019)[2]
- Water Heritage – Global Perspectives for Sustainable Development (2020)[3]

Recommendations of the symposium Water and Culture (Tokyo, February 2020):
Organised in collaboration with the Japanese National Graduate Institute for Policy Studies (GRIPS) the symposium was chaired by Dr. Han Seung-soo, Chair of the High-Level Experts and Leaders Panel on Water and Disasters (HELP), President of the 56th session of the UN General Assembly, and former Prime Minister of the Republic of Korea. The Chair's statement at the closure of the event recommended that ICOMOS established an international scientific committee which then became the ISC Water, and that the initiative continued organising dialogues among politicians, scientists, practitioners, spiritual leaders and young professionals about the significance of water-related heritage to better tackle present and future water management challenges. The statement further supported the development of informative narratives and of a portfolio of meaningful examples and universal methodologies. It also encouraged the promotion of professional capacity building to improve the assessment of water-related heritage values in the context of water management challenges.

Outreach:
Following the Chair's statement, a number of dialogues and webinars for water managers and heritage experts were organised. They can be watched at the following links:
- The Water Channel: https://thewaterchannel.tv/videos/water-and-heritage-telling-examples-assessment-methodologies/ (consulted last on 17.4.23)
- Global Adaptation Centre: https://gca.org/four-ways-that-spirituality-can-revolutionize-climate-adaptation/ (consulted last on 17.4.23)
- PortCityFutures: https://www.portcityfutures.nl/news/blue-paper-3-valuing-water-related-cultural-heritage (consulted last on 17.4.23)

Activities at the Mid-term Review of the UN Water Action Decade (New York, March 2023):
in collaboration with US/ICOMOS, the UNESCO Chair on Water, Ports and Historic Cities, the Amstel, Gooi en Vecht Water Board, and Witteveen+Bos, the ISC Water organized cultural and spiritual activities as well as a conference to discuss the values and significance of water-related heritage in regards to conceptual and operational aspects.[4]

2. Origins and development of (cultural and natural) heritage concerns

After World War II and in response to the concerns over the massive destructions of humanity's cultural heritage, the idea emerged to create an international movement to protect heritage for future generations. In 1948, the International Union for the Conservation of Nature (IUCN) was established with the aim to bring governments and civil society organisations together, to encourage international cooperation and provide scientific knowledge and tools to guide conservation action.[5] In 1964, the creation of the International Council on Monuments and Sites (ICOMOS) followed. Some years later, in 1972, the UNESCO General Conference adopted the Convention Concerning the Protection of the World Cultural and Natural Heritage, better known as the World Heritage Convention.[6] The Convention foresaw that a representative of both ICOMOS and IUCN attend the World Heritage Committee's meetings in an advisory capacity. Thus, a global institutional structure for heritage preservation was established within the United Nations.
Realising the importance of linking up with global sustainable development policies and frameworks, the World Heritage Committee adopted the World Heritage Sustainable Development Policy in 2015. This policy integrates a sustainable development perspective into the

1 Willems, van Schaik (eds.), Water and Heritage, 2015.
2 Hein et al. (ed.), Adaptive Strategies, 2020.
3 Ministry of Culture, Water Heritage - Global Perspectives, 2020.
4 https://www.icomos.org/en/focus/un-sustainable-development-goals/122372-icomos-at-un-water-conference-2023 (consulted last on 17.4.23)
5 https://www.iucn.org/about/iucn-a-brief-history (consulted last on 17.4.23)
6 https://whc.unesco.org/en/conventiontext/ (consulted last on 24.4.23)

processes of the World Heritage Convention. It also provides guidance on how to harness the potential of heritage for sustainable development and to mainstream heritage conservation into national and local processes and policies to further support sustainable development at these levels.

2.1. IUCN

In the early 2000s, IUCN developed a strategy to engage business by prioritising sectors with a significant impact on nature and livelihoods such as mining, oil, gas and water to ensure that their use of natural resources is equitable and ecologically sustainable.
Later in the 2000s, IUCN pioneered the Global Standard of Nature-Based Solutions, a framework referring to nature conservation actions that also address global societal challenges, such as food and water security, climate change and poverty reduction. By providing tools, training and support to stakeholders, IUCN broadened its scope of a mere conservation agency and became a service agency providing services for sustainable development.

IUCN and water

In 2000, IUCN published the Vision for Water and Nature: a World Strategy for Conservation and Sustainable Management of Water Resources in the 21st Century.[7] This document has set a new tone on nature and environment. Rather than considering it as a separate theme to be protected it brings nature and environment into the mainstream of sectoral (water) policies. The Vision for Water and Nature even became the environment and ecosystems component of the World Water Vision exercise of the World Water Council of 2000. It represents the first meaningful attempt to fully integrate environment issues into the development of a comprehensive strategy for water resource management at the global level. IUCN's consultations led to emphasise the crucial role of ecosystems as the basis of our life support systems, without which security cannot be achieved and sustained.[8]
With its objective to incorporate the significance of water-related natural heritage into water management planning and policy development processes, IUCN's water programme mission statement[9] claims that it is a trusted partner for evidence-based and adaptive change in water resource management to benefit nature, heritage and people. The programme focuses on promoting good water governance, implementing nature-heritage solutions for climate change adaptation, and supporting increased investment in nature-heritage systems as water infrastructure.
Since 2000, the IUCN Water Programme has grown into a mature and recognised, well-funded global programme that, in close collaboration with other nature-based and water-resources organisations, has developed the concept of the Economics of Ecosystems and Biodiversity (TEEB) applied in decision-making processes at all levels. It has also promoted the relevance of ecosystems in several of the Sustainable Development Goals (SDGs) and ensured that the ecosystem and environmental values of water are reflected in several chapters of the 2021 United Nations World Water Development Report.[10]
Although the concept of ecosystem services has become an important model to link the functioning of ecosystems to human welfare, including in water management planning processes and policy development, an agreed meaningful and consistent definition of the term ecosystem services is yet missing. Work continues to develop classification schemes for ecosystems and ecosystem services in support of the wide range of decision-making levels.[11]
All in all, the IUCN Water Programme certainly represents an inspiration for ICOMOS' ISC Water.

2.2. ICOMOS

Over the years, ICOMOS has set up 29 International Scientific Committees, the last one being the International Scientific Committee on Water and Heritage or ISC Water, formally established in 2022.
In addition, ICOMOS initiated two working groups studying and addressing policies impacting on heritage and, vice versa, heritage impacting on global challenges: the Climate Action Working Group[12] and the Sustainable

7 https://www.iucn.org/content/vision-water-and-nature (consulted last on 17.4.23)
8 https://www.worldwatercouncil.org/en/world-water-vision (consulted last on 17.4.23)
9 https://www.iucn.org/theme/water/about (consulted last on 17.4.23)
10 https://www.unwater.org/publications/un-world-water-development-report-2021 (consulted last on 17.4.23)
11 https://www.sciencedirect.com/science/article/abs/pii/S0921800908004424 (consulted last on 17.4.23)
12 https://www.icomos.org/en/focus/climate-change (consulted last on 17.4.23)

Development Goals Working Group.[13] Another focus sets on the connections between culture and nature.[14] These Working Groups broadened ICOMOS' scope from mere scientific research to a two-pronged approach, namely:

- connecting heritage protection to the global challenges of climate change and development by referring to the wholeness of culture and nature as set out in the World Heritage Convention of 1972,[15] and
- championing tangible and intangible heritage as a source of inspiration and an asset to better face the global challenges.

ICOMOS ISC Water and Heritage

The ISC Water's mission statement echoes the Working Groups' two-pronged approach.[16] Indeed, the two objectives are set out to explore the diverse aspects of water heritage in more detail to:

1. identify possibilities of water heritage protection;
2. make it known as a source of knowledge highlighting the potential of water heritage to support water management challenges in the future.

In connection with objective 2, the ICOMOS ISC Water developed a statement of significance, based on the one developed under the Burra Charter of 2013; it enables the development of cultural heritage services.[17]

Since its inception, the ISC Water has been organising dialogues and events to bring water professionals and heritage experts together, just like during the most recent one at the UN Water Conference in New York in March 2023.

ICOMOS National Committees

The National Committee of ICOMOS of The Netherlands initiated the creation of a National Compendium on Water, Culture and Heritage. With financial support from the Dutch Ministry of Water it invited water professionals and heritage experts to present their views on the significance of water-related heritage for today's and tomorrow's water management challenges at operational level and set a particular focus on policies. The process triggered substantial support as shown by the similar processes which have started since then in the USA and in Taiwan. Others are being considered to start in Japan, Brazil and India.

ICOMOS ISC Water and Heritage Awareness Shield

The ISC Water created the ISC Water and Heritage Awareness Shield, an award given to professionals or organizations in recognition of their outstanding achievements promoting water-related cultural heritage and raising the knowledge and awareness about water heritage. Any project or initiative meeting the aims and objectives of ISC Water can apply; the application form can be requested directly at the ISC Water bureau (ISCWater@icomos.org).

3. Water management and cultural heritage

3.1. Increasing complexity

For millennia, water-management, -services and -safety were local issues. From the industrial revolution onwards, water management challenges gradually transcended local and even national borders: the length of irrigation systems increased, water-related diseases became a global concern, transboundary water conflicts deepened. Between the two World Wars, these developments led to the creation of international water-oriented scientific and professional bodies notably the International Association of Hydrological Sciences (1922) and the International Association of Hydraulic Engineering and Research (1935). They were formed by professionals of various disciplines and nationalities to provide common intellectual forums to share expertise and stimulate and promote research.
These programmes became part of the United Nations. Since its inception in 1945, the United Nations advocated broad multilateralism and acknowledged that the roots of military conflict can be addressed by improving human living conditions. The UN agencies were to tackle the range of global issues: health, nutrition, education and science, economics, human rights, and so on. Through the advent of its specialized agencies, the United Nations system yielded a new tier of professional bodies such as UNESCO, FAO, UNICEF, WMO and others, all with interests

13 https://www.icomos.org/en/focus/un-sustainable-development-goals (consulted last on 27.4.23)
14 https://www.icomos.org/en/focus/culture-nature (consulted last on 17.4.23)
15 https://whc.unesco.org/en/convention/ (consulted last on 27.4.23)
16 https://water.icomos.org/ (consulted last on 24.4.23)
17 https://water.icomos.org/wp-content/uploads/2021/11/Statement-of-Significance-for-Water-as-Cultural-Heritage.pdf (consulted last on 24.4.23)

in water. In these agencies, government representatives, often administrators rather than scientists and engineers, became prominent mostly for their pursuing the advancement of sound practices and social progress.

In the developed countries, the post-war period was also a time of boundless confidence in the ability of science and technology to transform society and adapt the landscape to human needs. Nowhere was this new impulse more manifest than in the realm of water. The era was marked by ambitious large-scale water works such as dams, tidal barrages, irrigation schemes, hydroelectric plants, river diversions, inter-basin transfers, and projects to drain wetlands and reclaim land. Proclaimed as totems of twentieth-century progress, these enterprises underlined the centrality of water to society. During the 1950s and 1960s, UN agencies spearheaded the earliest global resources initiatives spanning decades. The first of these to address water issues was the influential International Hydrological Decade (IHD, 1965–1974), which drew together scientists and water managers from across the world, spanning the ideological divide created by the Cold War. IHD consolidated the understanding of the hydrological cycle and served the green revolution of the early 1970s to resolve the world food crisis.
The IHD was followed by the United Nations International Drinking Water Decade, 1981–1990, agreed upon at the first UN Water Conference held at Mar del Plata in 1977. Its aim was to provide access to clean drinking water and sanitation across the world to reduce water-related morbidity and mortality, which was considered the biggest threat to health worldwide at the time.
Although the first water decade brought safe water to over 1.2 billion and sanitation to almost 770 million people, growth and rapid urbanization together with the low level of public awareness about health drastically reduced many countries' ability to keep up with the needs. Today, a quarter of the global population – two billion people – use unsafe drinking water sources. Half of humanity – 3.6 billion people – live without safely managed sanitation. And one in three persons – 2.3 billion people worldwide – lack basic handwashing facilities at home.[18]
In the 1990s, the international community realised that in addition to addressing the challenge of serving the unserved with safe water supply and sanitation, managing and allocating the limited water resources in an equitable manner to the many stakeholders at local and also international level was required to mitigate and avoid conflicts. This insight led to the concept of *Integrated Water Resources Management* (IWRM).
Due to urbanisation, agricultural expansion and industrial growth both surface and groundwater resources became heavily exploited. Therefore, many of the rivers nowadays are overtaxed by pollution and the effects of damming and diversion – especially in arid and semiarid regions. This threatens water security at local and international levels and leads to water conflicts. Moreover, due to changes in land use and the water cycle, the livelihoods of millions of people are endangered by the perils of flooding, storms and droughts. Further threats are caused by urbanisation, climate change and increasing pollution as well as the ecosystem's degradation and corruption. Political leaders talk about the water crisis. As a matter of fact, all these water-related challenges are laid down in the Sustainable Development Goal 6 for water and reflected in its six targets on: 1. water supply and sanitation, 2. the reduction of water pollution, 3. the increase of water efficiency, 4. the promotion of integrated water resources management, and the promotion of transboundary cooperation, 5. the protection and restauration of ecosystems, and 6. the support and strengthening of capacity building in developing countries and local communities.

3.2. Water management initiatives

The increasing local and global complexity of the water management challenges have led to a large number of water management initiatives and institutions at local and global level. Global water initiatives, in short GWIs, encompass institutional frameworks, organizations, special events, knowledge or professional platforms, as well as awareness-raising campaigns that focus purposefully on water-resources management. GWIs examples include:

- **International knowledge programmes:** Intergovernmental Hydrological Programme, the World Water Assessment Programme of UNESCO/UNWATER;
- **International water dialogues and conferences:** the World Water Forums; annual international water conferences in Amsterdam, Stockholm, Korea, Singapore, Dubai;

18 https://www.unwater.org/publications/who-unicef-joint-monitoring-program-for-water-supply-sanitation-and-hygiene-jmp-progress-on-household-drinking-water-sanitation-and-hygiene-2000-2020/ (consulted last on 27.4.23)

- **Water partnerships and networks:** Global Water Partnership, national water partnerships; Water Integrity Network;
- **Water frameworks and paradigms:** Integrated Water Resources Management and the Valuing Water Initiative;
- **International organisations of water professionals:** International Water Association, the International Commission on Irrigation and Drainage, the International Hydropower Association, Inland Waterways International, International Water History Association;
- **Knowledge and capacity development centres and institutions:** Delft Institute for Water Education (IHE), International Center for Quanats and Historic Hydraulic Structures (ICQHS), Centro Internacional de Água e Transdisciplinaridade (CIRAT).

These GWIs are typically oriented towards resolving present and future water management challenges through innovation. None of them, however, considers learning from the past. Nor do the universal Sustainable Development Goals, including the SDG 6 for Water, mention water-related culture and heritage.

This innovation-oriented bias of the development agenda may explain why water managers don't recognize the value of water-related heritage for present water management challenges. When asked this question they would typically respond: "I don't know this narrative". And if asked further, they would explain that their mandate laid out in the SDG 6 was to "provide water security and water safety for the people today and tomorrow, for the economy, for society and for the environment". No one seems to think about the significance water-related heritage could have for today and tomorrow. On the contrary, for many water management professionals water-related cultural heritage is rather considered a handicap, an extra cost or an obligation to conserve and maintain relics of the past, or something worse, and not an asset. In fact, already back in the 1950s Karl A. Wittfogel[19] described how water management was often connected with negative associations, e.g. political repression and despotism.

19 Wittfogel, Sociologus, 1953, pp. 96-108

4. Bridging

Such bad image hides the fact that today, although precise estimates do not exist, the livelihoods of millions of people depend on traditional water management systems. These systems include the falaj/qanat systems in arid areas e.g. from China to Spain, the spate irrigation systems also found in the same arid regions, the ancient canals and water ways worldwide, the water boards and water courts, and the values of water in faith traditions. Indeed, at this point the second objective of the ISC Water comes into play, which pursues to inform water managers about the significance of water-related heritage for water management challenges of today and in the future.

4.1. Thematic studies

ICOMOS published two thematic studies on water and heritage:[20]

- ***The Cultural Heritages of Water in the Middle-East and the Maghreb***. This publication provides assistance to recognise, study and preserve traditional cultural heritages linked to water in arid or semi-arid regions and to establish benchmark examples.
- ***The Cultural Heritages of Water in Tropical and Subtropical Eastern and South-Eastern Asia.*** This volume is devoted to the tropical and subtropical countries of East and Southeast Asia, the scope of the heritage considered has been limited to freshwater and inland waters. This publication should be primarily seen as a methodological aid to achieve recognition and protection of such heritages.

Similar studies could be done for other water management systems in the same or other climatic and hydrological conditions, for example for terraced agriculture in mountainous areas and for small hydropower generation plants in Europe in relation to clean energy.

4.2. Conceptually

The thematic studies of ICOMOS only describe water management structures. Equally important in water management, however, are intangible domains of governance and spirituality or water-related visions as conveyed in the title of our first publication *Water & Heritage: Material,*

20 https://www.icomos.org/en/component/tags/tag/thematic-studies, https://openarchive.icomos.org/id/eprint/2571/ (consulted last on 22.5.23)

Conceptual and Spiritual Connections (see footnote 1). The challenge for the ISC Water is to substantiate conceptually and methodologically the significance of the material, to promote the conceptual and spiritual qualities for present and future water management challenges to ensure water security and water safety.

4.3. Methodologically

Yet, how can one assess the significance of water-related heritage for today and tomorrow? Little or no research has been done on this challenge. Methodologically it seems that the approaches of the Historic Urban Landscape (HUL)[21] and of the Valuing Water: Conceptual Framework for Making Better Decisions Impacting Water[22] could be adapted to assess the values of water-related heritage for today and tomorrow. In a first step, both documents set out a mapping of the civil, social, environmental and other values that may contribute to development and/or climate change mitigation and adaptation. In the second stage, i.e. planning and policy development, both approaches inform a multi-stakeholder process about the values of the concerned heritage. And the third stage consists in institutionalising the significance of water-related heritage, ex ante, in policy, planning and implementation processes.

5. Conclusions and recommendations

5.1. ISC Water

In conclusion, and considering the above-mentioned aspects, the ISC Water should pursue the following points to further strengthen the potential of water-related heritage as a contributor to sustainable development:

- continue organising dialogues between water managers and heritage experts at national and international level;
- continue identifying and collecting meaningful cases in publications;
- continue promoting the development of methodologies to assess the significance of water-related heritage considering IWRM, HUL and Valuing Water;
- encourage the development of national working groups on water heritage and related platform to exchange experiences;
- encourage the development of an international platform on water, culture and heritage.

5.2. ICOMOS Germany Working Group on water and heritage

Based on the above and on the experience in the Netherlands and elsewhere, I recommend that ICOMOS Germany creates a Working Group on water and heritage considering the following steps:

- Identify operational and scientific professionals within ICOMOS Germany and in water management institutions (policy makers, water institutions, research institutions, NGOs and civil society) interested in initiating a joint multidisciplinary working group between water management professionals and heritage experts.
- Initiate the development of a compendium including practical examples and viewpoints as well as visions to promote the significance of water-related culture and heritage for present day water management challenges.
- Identify and describe telling examples of living water-related heritage that has significance for today's water management challenges in Germany. Examples could include cultural water sites or landscapes for climate change adaptation, small hydropower stations for clean energy vis-a-vis the European Water Framework Directive and others.
- Identify a theme on water and heritage that is significant for Germany.
- Develop a methodology for water management and heritage experts to value water-related heritage for present and future water management challenges.
- Advise local and national government policy makers in Germany about the significance of water-related heritage in policies and planning procedures.

21 https://whc.unesco.org/en/news/1026 (consulted last on 24.4.23)

22 https://www.government.nl/documents/reports/2020/01/31/valuing-water-a-conceptual-framework-for-making-better-decisions-impacting-water (consulted last on 9.5.23)

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Carola Hein

Water Works: Heritage and the Pursuit of Sustainable Practices

Water is essential to human life. It has sustained human societies for thousands of years and has shaped the way we live, the spaces we occupy and how we travel. People have developed practices and structures for water spaces over centuries and sometimes millennia to both facilitate human life and to defend themselves against threats posed by water. They have created buildings and settlements around water, which historically have been intimately intertwined with formal and informal institutions such as government structures, laws and regulations and informal traditions and values. Water systems are thus interconnected and dynamic with multiple physical and cultural dimensions: still and flowing, drinkable and dirty, for agriculture or for shipping, for humans and non-humans. Water systems have changed over time, along with the place of water in everyday culture. Understanding water practices and systems and their changes in the past has the potential to aid sustainable development and to help solve water problems of the present and future.[1]

As humans, we have built a lot of culture around water. We celebrate water in songs and poems, in films and literature. Water is part of many religious rites and spiritual practices. Think of the Ganges River, where believers bathe to wash away their sins, of water basins in front of Japanese shrines for purification, basins with holy water at the entrance of Catholic churches, or celebrations for opening a revitalized river bed today. Paintings of waves, rivers, oceans or rain clouds provide yet another glimpse into the multi-facetted presence of water in our environment and the multitude of artistic expressions it has generated. There are also many idioms with water references, for example, "water under the bridge" referring to a past conflict no longer worth arguing about, or "muddy the waters" when something is made too complicated or confusing, or, we say "don't wash your dirty laundry in public" which referenced traditional practices of washing, "blood is thicker than water", or "Don't throw the baby out with the bath water." Many songs also connect life stories to water, rivers, and seas.

Water can also be a great source of conflict, which sometimes requires international diplomacy to resolve. National borders rarely reflect water needs. The source of a river can be located in a different country than the river's

Fig. 1 Europa Regina, map of Europe as a queen in Sebastian Munster's *Cosmographia* (1570)

delta. This depiction of 1570 shows Europe as a queen with its rivers playing a major role in her robe (Fig. 1). Some rivers cross multiple countries, potentially creating conflicts between neighboring nations. The Grand Ethiopian Renaissance Dam on the Blue Nile, which is designed to produce energy for Ethiopia and neighboring countries, heavily impacts the water ecosystem in Egypt. Water conflicts also exist around public and private interests, as shown through the financial importance of large privately owned water companies. Solving these conflicts requires novel approaches. A student at Delft University of Technology, for example, proposed a modern water temple as a way to ameliorate the conflict between Israel and Palestine.[2] Water is an inherent part

1 Hein, Adaptive Strategies, 2020.

2 Jong, Water as Source of Conflict, 2019.

of our history and of tangible and intangible heritage around the world. It is part of everyday practices and of global conflicts.

Numerous artefacts such as aqueducts and cisterns still exist as reminders of how water systems grew over the centuries. But heritage is not just about an artefact, a building, or an object that has been preserved, like a watermill or a cistern. Instead, we should think of water and heritage as a comprehensive system that can provide new insights for future water and heritage practices. At a time of climate change, sea level rise, extreme flooding and changing rainwater patterns, we need to return to historic water sites to get a better understanding of their function and to see if and how they might inspire future practices (or what we should not do). Studying these sites will help us develop new approaches, learn from historic water-related practices, preserve heritage sites and promote sustainable development.

Over centuries, people have selected materials and technologies to live with water and to protect themselves against flooding, humidity, rain and snow. The qanat system in Iran and other countries in the Middle East is an excellent example of the intricate ways in which people have captured and redistributed water for drinking and agriculture. This underground system has been built to transport water from springs, rain or infiltration through underground channels to settlements and fields. Using the underground channels of cool water from the quanat system, people were even able to store ice through the heat of the summer.[3] These buildings and structures corresponded to local water needs and technical capacities, including for cooling buildings as shown here, and they facilitated people's lives in this hot climate.

Landscape-scale water structures existed also in the Roman Empire, where aqueducts sustained major cities, including the capital, Rome. Decision-makers in Rome provided sewage infrastructure to allow for healthy urban living. People developed intricate systems to capture rainwater, to access underground water, and even to store it. The Naples underground has long held water basins, even some for keeping fish. Specific professions developed around these spaces: The practitioner of a particular profession, the aquarius, kept these places clean. Water systems that take advantage of natural ecosystems, connecting physical infrastructures and communities, exist around the world. Wells, such as the castle well in Cardiff, Wales, provided individuals and settlements with drinking water, including in times of warfare. They speak of a time when water supplies were used by an individual or a specific community.

Local communities have been stewards of water systems, creating a spatial network, institutions, and cultural imaginations. The Dutch water boards, set up to guarantee the functioning and upkeep of the water system, are an excellent example. As early as the 12th century, people in what is today the Netherlands created institutions to manage water. Building a dam on the Old Rhine to control water led to problems upstream and the request to install a sluice to facilitate drainage. By 1255, the so-called heemraden started to oversee the dykes in the Netherlands. An official, the Dijkgraaf, the chair of the water board, was in charge of maintenance. In 1255, Count Willem II granted permission to the dyke wardens to levy a toll on ships that passed through the sluice, as depicted in the painting by Caesar van Everdingen (fig. 2).

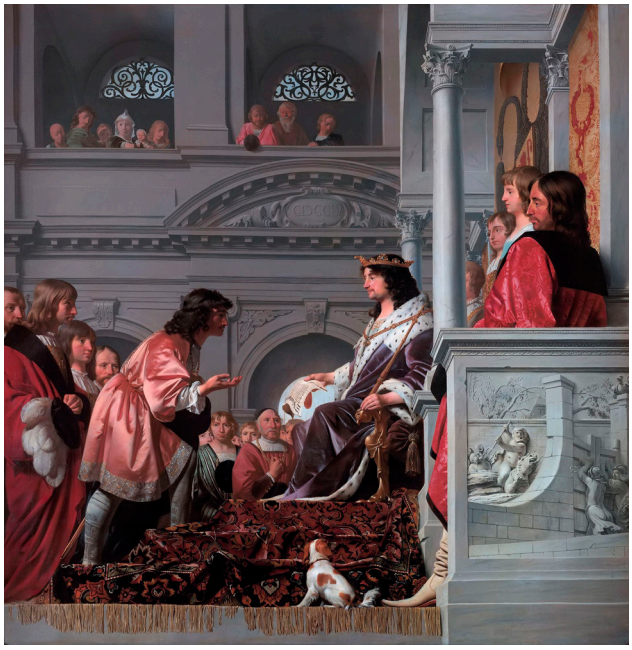

Fig. 2 Count William II of Holland and Zeeland granting privileges to the waterboards and their representatives in 1255, painting by Cesar van Everdingen and Pieter Post, 1654, oil on canvas, 218× 212 cm, Gemeenlandshuis Leiden

3 Bensi, The Qanat System, 2020, pp. 40– 7.

Fig. 3 Detail of tatami flooring in a pavilion, the Shokin-tei, at Katsura Rikyu Imperial Villa in Kyoto, Japan.

Decisions about where and how dykes and dams were built and where water could be let out into the rivers and seas were important to keeping the Netherlands dry and to creating the great polders on which much of the country was built. Charters granted to the water boards were key to developing sluices and dams.

Intricate systems existed also for water distribution in agriculture, such as water meadows in Europe and rice terraces in Asia. They depended on water infrastructure and on collaboration among communities and across cultures. Around the world, people erected vernacular buildings based on in-depth knowledge of local water patterns. They selected materials and technologies to protect inhabitants against flooding, humidity, rain and snow. A look at traditional Japanese buildings illustrates the complexity of building for and with water. The entrance gate at the Imperial Palace complex has a thatched roof that guides rain away from the center, where people pass. The palace buildings have external corridors and large eaves to guide the rainwater away from the interior. Under the eaves, patterns of pebbles and stone guide rain water. Buildings and materials were carefully adapted to the climate. Tatami mats, for example, serve as flooring. The floor structure of the building is lifted from the ground to allow air circulation through the tatami mats to take care of the extreme humidity in the air typical of Japanese summers (fig. 3).[4]

Diverse technologies, like the water wheel, helped generate power. Windmills aided land reclamation, leading to the creation of new lands, such as the Dutch Polders, low-lying areas that have been reclaimed from the sea and are protected by dykes. The historical Dutch windmill system called Kinderdijk served to drain reclaimed land. In the case of the Netherlands an entire defense system was built – the Dutch Defense Line – to flood the countryside so that invaders could not reach the Western provinces with their rich cities. People also developed water systems for defense purposes. Dykes channeled rivers and prevented flooding, as the case of the fortified city of Naarden in the Netherlands exemplifies.[5] People have adapted to water sometimes in surprising ways: In Amsterdam, for example, people built floating cellars. To keep basements from flooding, the floor was disconnected from the walls. Nature-based solutions and human labor have shaped water spaces for centuries.

Industrialization, advancing technologies, new materials, and new economic and political systems have changed relationships between people and water systems. New technologies have replaced earlier, more labor-intensive ones. The steam engine transformed cities and landscapes around the world, in multiple ways. Large shipping canals, including the Suez and Panama canals were built with industrial dredging machines. They also helped transport global commodities, like the petroleum carried by steam ships. These new waterways effectively reshaped geo-

4 Hein, Tatami Life, 2022, pp. 61–70.

5 Verschuure-Stuip, Hold the Line, 2020, pp. 250–269.

political systems and led to the construction of new cities, such as Suez City. Local, individual water distribution systems gave way to large public systems. In some cities water towers have come to shape urban skylines filled with water towers that use gravity to distribute water or to store it for firefighting or for regulating water pressure, as in the case of Chicago's famous Water Tower. With changes in water systems, professions and decision-makers emerged, each with their own, often very specific, goals related to water management.

Coal- or oil-fueled industrial pump stations, such as the Wouda pumping station put an end to windmills for draining the Dutch low-lying areas. In general, energy and water infrastructures became more centralized. Giant dams, such as the Hoover in the USA were erected to provide energy for some 1.3 million people in Nevada, Arizona and California. The dam exemplifies the shift from local to centralized energy infrastructures. As a result, traditional local patterns have often been abandoned. New technologies and larger machines have made it possible also to build bigger defense structures against water. Let us think of the concrete blocks on many coasts, concrete river beds, or large dams designed to keep water out.

Like our water systems, the spaces, governance systems and other institutions connected to them have changed. Historic sites have become heritage often devoid of context as historical practices have been forgotten or become impossible. Since 1942, the island of Schokland located in the Zuiderzee in the Netherlands, for example, ceased to be an island when it became surrounded by dry land: the Noordoostpolder. The beautiful palace of Chenonceau in the Loire Valley of France, built on the foundations of a water mill, no longer hosts ladies of the court, but, instead, serves as a museum. Yet, many historic sites have much to offer sustainable development. The water-retaining barays of Angkor, sometimes called a hydraulic city, can help us think about what we need to do to create circular water systems and what kind of temporal interventions or community structures are needed to make them work. The Jayatataka baray, for example, is a man-made basin that stores excess water at the end of the rainy season, taking into account changing water patterns.

With the advent of the car came new plans for historic cities. The American traffic engineer David A. Jokinen designed a plan to build highways and demolish large parts of historic Amsterdam under the title: "Give the City a Chance". The plan blatantly disregarded the historic relation between urban areas and water. In Amsterdam, like in many other cities, such car-focused plans or other large-scale plans led to citizen protests. Municipal police and military police used water cannons during the 1975 riots on the Nieuwmarkt, which started in opposition to the demolition of houses for the construction of a metro. By the 1970s and 80s, citizens were demanding the preservation of Amsterdam's historic sites, including vernacular ones. Former port areas, such as Java-Eiland, were redeveloped as small-scale housing near the water. As lifestyles evolved and communities changed, historic buildings and landscapes were adapted, destroyed or became heritage. Amsterdam is a good example: The historic canal district with its concentric arcs and radial waterways and streets was largely preserved and turned into a tourist destination. Cities like Amsterdam have emerged as a model of restoration and preservation efforts. Recognized as UNESCO World Heritage in 2010, the city attracts tourists from around the world. With the preservation of historic sites as heritage, new actors and stakeholders have emerged. Tourists provide income to the historic cities, which they also change through their presence. New accommodation enterprises like Airbnb, which originally promised to make historical cities more accessible, have met with opposition in many cities and have been limited in Amsterdam.

Water actors have changed extensively over the centuries, with individuals and communities in many cases being replaced by national and international organizations. Nowadays, a multitude of stakeholders act upon water and historical buildings and landscapes in different ways, according to a plurality of perspectives and often following different agendas. Some have opposing interests: Water managers may focus on technological and economic interests and want to replace historical structures that no longer serve contemporary needs. Meanwhile, heritage professionals aim to protect and preserve those same structures. Their different approaches have various benefits and challenges.

Many of the contemporary catastrophes that we are experiencing are the result of our own making and stem from the absence of a holistic approach to living with water. Our decision to settle in low-lying areas and to rely

on defensive infrastructures, such as dykes (rather than living on higher ground), can lead to extensive flooding and the loss of lives, buildings and income.

Many cities have experienced floods over time. Low-lying areas in Tokyo like Shitamachi have always been at risk of flooding, compared to the higher grounds of Yamanote, where the wealthier people, such as the samurai, traditionally lived. Working-class people pay the highest costs. In the great flood of Hamburg in 1962, areas in Wilhelmsburg and other areas that were traditionally home to lower income groups, were flooded.

Absence of long-term planning to protect all parts of the population has led to loss of life, as with the flooding of low-lying areas in New Orleans in 2005 after Hurricane Katrina. The flooding after Hurricane Harvey further demonstrates the problems of land use planning that allows the dirty water of refineries and other sites to flow into residential areas. Most recently, in 2021, flooding in New York brought to the foreground the danger of living in basements. The last decade has provided many examples of water-related disasters induced by climate change. The flooding of subway stations, landslides in Peru and in Japan, rivers that left their river beds in Germany and Belgium – all demonstrate the vulnerability of the structures that we have created in recent decades. Flooding, which used to be beneficial for nearby territories by providing soil nutrients, has become primarily a threat. From being beneficial and necessary to life, water has become a danger. Access to shipping water has allowed the growth of many cities, such as New York, but rising sea water levels threatens their future.

After centuries of living in harmony and in close connection with water, our water values have changed. People have come to rely on public systems and often very large infrastructures for energy generation, such as the Three Gorges Dam in China. They have defended themselves against water with large dykes and dams, such as the Afsluitdijk in the Netherlands. These large infrastructures have had benefits for people's lives, but they have also had many negative side effects for humans and non-humans. The giant structures of the recent past have an impact on our current thinking and the future, an effect that we call *path dependence*, in line with discussions in the political sciences, where the concept of *path dependence* captures the notion that structures and decisions of the past effectively impact the future, because of the structures that exist, the ways we have shaped our environment, the places we live in, the laws we created, and the institutions we rely on. We need to overcome path dependencies. The strategy of resisting water has effectively become part of our culture. Many contemporary projects perpetuate this idea that water must be resisted, on an ever-increasing scale: think about the proposals for new islands as flood protection or for a dyke across the North Sea.

Developing new water values focused on resilience first of all means rethinking the values that we have used to shape our environment over the last decades. Shifting our approach to water management, from resistance to resilience, requires new governance systems, new technologies and new narratives. The Dutch project Room for the River is one example of how we can respect the flow of water and live with it in a resilient way.[6] In line with this way of thinking, we argue that we need to study and understand the past to design the future. This can happen through a better, more thorough understanding of historical structures and the preservation of historic buildings that serve as reminders of the past and that help us understand the institutions and cultures associated with them. Throughout history, many communities have developed around diverse water practices and they have changed over time. To name just one more fascinating example: Water tribunals such as the Tribunal de les Aigües de València have long served to settle disputes concerning irrigation water among farmers. In 2009, the Water Tribunal was selected as intangible UNESCO heritage. It may be time to reassess the role of water in the lives of everyday citizens. And to do that we can revisit and learn from historical water practices.

The United Nations has identified Sustainable Development Goals (SDGs) in 2015 to combat climate change and its impact. Water is a key aspect of the SDGs. To design the water practices of the future, we need to bring back nature-based ecosystem thinking. We need to explore nature-based solutions that are connected to social and cultural developments. The Leiden Delft Erasmus University consortium's PortCityFutures Center and the UNESCO Chair Water, Ports and Historic Cities have

6 Rijkswaterstaat, Room for the River, https://www.rijkswaterstaat.nl/en/about-us/gems-of-rijkswaterstaat/room-for-the-river (consulted last on 18.10.2022).

Figs. 4 a-c: Dualities of Water Works

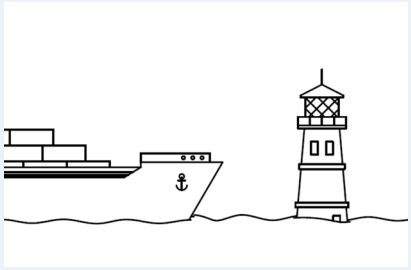

Fig. 4a Changing Water Patterns versus Preservation: How does sea level rise affect maritime exchange through recently freed up waterways, while also threatening historic space and communities next to water bodies? it, while rehabilitating, renovating, or reconstructing a city's historic urban legacies for economic benefits and city development?

Fig. 4b Historic Preservation versus Economic Development: How to preserve the values of the historic urban landscape, and the intangible lifestyle related to it, while rehabilitating, renovating, or reconstructing a city's historic urban legacies for economic benefits and city development?

Fig. 4c Spiritual Values versus Consumption: How can local stakeholders include the spiritual values of water in their identity as a public good rather than only a product for consumption?

identified a number of dualities that capture the ways in which water values can collide and which require a solution (Figs. 4 a-c). For example, whereas the maritime sector may appreciate climate change for opening up the Northern Sea Route without using ice breakers, the heritage sector fears the sea level rise challenging historic cities, including those on the UNESCO World Heritage List such as Venice.

Modern, water-intensive farming may be able to feed large populations, but small-scale farming such as on terraced landscapes, has taken advantage of natural ecosystems. Large infrastructures, like dams, serve the energy demand of many people, but they destroy local practices and can even lead to water conflicts. For some time, we have sealed off cities and channeled water away from them; it is time to reconnect to historic practices of storing water in the ground, to facilitate flooding, and to create seasonal basins with new constructions. Local practices can perhaps be preserved or sustained on a limited scale, but how can they be integrated in modern industrialized cities? Modern technology has allowed us to build large dykes and to reclaim land. This has been to the detriment of biodiversity on sea and land. Many of the current challenges are the result of value conflicts, pitching economic values against others, such as cultural ones.

To facilitate more sustainable and socially just approaches, the zen quote on the ritual wash basin in the Ryoanji Temple in Japan may be inspirational: "What one has is all one needs". Following the lead of ICOMOS Netherlands, the ICOMOS International Scientific Committee Water and Heritage and other academics and professionals, on behalf of the UNESCO Chair Water, Ports and Historic Cities, we argue that we need to reconnect with historical knowledge, as well as local and community practices, to tackle water challenges of the present and the future. Implementing the UN SDGs requires paying particular attention to people and culture, as demonstrated here. Culture is explicitly mentioned in SDG no. 11. It is also clearly recognized in other international frameworks, such as the New Urban Agenda.[7] The UNESCO Thematic Indicators for Culture in the 2030 Agenda spell out the multiple dimensions of culture in sustainable development.

Integrated approaches, such as the UNESCO Historic Urban Landscape Approach (HUL), specifically acknowledge the role of heritage in facilitating the preservation and sustainable development of cities and landscapes around the world.[8] Adopted by UNESCO's General Conference in 2011, HUL aims at moving beyond the preservation of historic cities to promote sustainable development by connecting the existing built environment to socio-economic and environmental factors and local practices. The UNESCO HUL approach also includes a specific method of carefully analyzing geospatial systems and their heritage. In line with the UNESCO HUL approach, many other initiatives aim to rethink the role of nature and specifically of water in society. There is for example the Initiatives for the Future of Great Rivers,[9] a project

7 New Urban Agenda, https://commission.europa.eu/eu-regional-and-urban-development/topics/cities-and-urban-development/urban-agenda-eu_en (consulted last on 13.3.2023).

8 Unesco, New Life for Historic Cities, 2013; Unesco, Recommendation on the Historic Urban Landscape, 2011.

9 https://www.initiativesrivers.org/

focusing on balanced river management as part of a holistic ecosystem approach. Such initiatives also include providing rivers such as the Whanganui River in New Zealand or the Ganges River in India with the status of a legal person to achieve better protection. We need comprehensive initiatives to reach sustainable development. Infusing culture into the Valuing Water Initiative[10] initiated by the Government of the Netherlands may be one step –

Credits
Fig. 3: Carola Hein
Fig. 4: PortCityFutures Center

10 https://valuingwaterinitiative.org/

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Annex

Berlin Paper On Water Heritage

Over millennia, humans have developed, managed and controlled water to make it available for human use. A wealth of techniques and approaches regulate the use of water to let culture thrive, which today has left us an immense number of water-regulating devices ranging from canals and irrigation systems to water distribution in urban environments and palatial gardens with their decorative fountains.
Managing water has been an inevitable corner stone for human activities. Settlements only thrived with constant access to water, the control of it powered the rise of civilizations, creating water engineering wonders in their path giving water heritage a unique socio-cultural value. In addition to their historic value, these waterscapes have also inspired artists, poets, writers and travellers for their magnificent aesthetic values.

However, today, this very important aspect of cultural heritage has received far too little attention. This is why the conference *Water Heritage – a Source of Knowledge for Sustainable Development. Contribution to the Global Climate Goals and to the Conference on the Future of Europe*, proposes to enhance the transmission of the cultural values of water heritage, to better address the many challenges it faces and, above all, to highlight its crucial contribution to the global climate goals.

Many questions and concerns were raised and discussed during the two-day conference, the essence of which we would like to share with the public through this paper.

Observations

Several observations have been made by the heritage and water experts:

- Water heritage is a unique source of collective memories resulting from the constant interaction between human activities and natural conditions.
- There is no cultural heritage without the element of water.
- Water heritage is not only historically valuable, but also a source of knowledge that can contribute to solving current water problems.
- Still functioning historic water distribution systems can show how water-related systems have evolved and stood the test of time. The aim is to reveal some of the wisdom of these sites to make it useful for today's technology.
- UNESCO's global network of water museums has the goal to foster an emotional bond with water. Engaging audiences by disseminating knowledge about water heritage is crucial to better face the global water crisis.
- In the recent past, water has often been merely seen as a means for industry, transport, etc., or as a threat, wherefore the control of water was considered the priority aim without alternative.
- Water links with growing employment opportunities (renewable energies, transport, tourism...).

Challenges

As mentioned above, water heritage has been overlooked and receives too little attention from authorities, planners and even heritage experts. For that reason, today, it is facing several challenges, which have been discussed in depth during the conference:

- A lot of water heritage is mismanaged, either disregarded completely and abandoned or poorly maintained and over-exploited.
- Migration, soil erosion, climate change, droughts, rural depopulation, deep wells, modern technology, heavy rainfalls and loss of traditional knowledge are some of the threats of rural water heritage.
- Further, urban water heritage is threatened by constant uncontrolled urban development worldwide, leading to the loss of these historic elements making way for modern structures.
- Outdated local policies are another main reason that pose a problem to the preservation of water heritage restricting in parts or fully the access to and use of waterways in cities.
- There is a plethora of interests from different sectors, which sometimes collide with each other (boat, fishing, transport, heritage).
- The loss of water heritage sites and their values, will eventually lead to the vanishing of traditional knowledge and techniques.

Recommendations

In a response to these complex challenges, the experts and participants of the conference present the following list of recommendations:

- **Dialogue between all stakeholders:**
  Reach out and initiate dialogues between heritage experts, organizations, policy makers and citizens/ communities to work out practical cases and show how water related heritage can make a significant impact. Involving local stakeholders through a participatory and multistakeholder partnership approach is crucial. Inclusive participation of all stakeholders, including communities, in the management of heritage sites, is key to sustainable preservation.

- **Water heritage as a source of knowledge in reaching Climate Goals:**
  In face of the most serious man-made crisis, climate change, we need to learn from the past and draw lessons from centuries of an evolving water sector: How did past generations manage to master the basic element of water? What role did water play in politics, economics and social development? What do we have to be aware of? Bearing this in mind, water heritage is also a key knowledge resource that cross-links various perspectives set up in the SDGs.

- **Water heritage as an essential element for local economy:**
  Understand water heritage as an economic asset harnessed through adaptive reuse. Turn water heritage into a sustainable attraction and focus on responsible tourism (slow tourism) including ways of sustainable mobility by bicycle or canoe supporting the local economy.

- **Water heritage as a rich source of tangible and intangible cultural heritage:**
  Water heritage celebrates the natural and cultural diversity in both tangible and intangible ways. Both are important inspirational sources for arts, technology, innovation, education, sustainable tourism and creative industries etc. Preserving intangible assets of water heritage can be reached through the transmission of water stories in (guided) tours. This should also feed the interpretation of these sites to counter the disappearance of water way culture. Preserving oral history and memories of boatmen, sailors and fishermen, as well as the literary landscape including novels and poetry, and other cultural representations like paintings, photography, postcards and traditional knowledge of craftsmen and ferrymen.

- **Digitalization as a tool to preserve water heritage:**
  Digital technologies play an increasing role in interpreting and disseminating elements and values of heritage. They can be used as a tool to facilitate access to water heritage and to promote sustainable tourism (to access hidden heritage and to engage the youth audience) for example through interactive maps rendering space and place Moreover, digitalization encourages and fosters communication. It enables easy access to and dissemination of knowledge, in particular among young generations and with the support of education transformation.

- **Inventory of water heritage:**
  A first step to preserve water heritage is its mapping and setting up of a (global) inventory. This can help to show the rich and diverse water heritage sites and build a repository of visual knowledge to commemorate the past, explore the legacy of water assets with digital trails for responsible tourism and inspire future generations by learning from previous sustainable uses of water.

- **Community engagement and outreach:**
  Heritage protection needs citizen engagement and dialogue with politics. This is particularly important when it comes to water heritage, as it is a multi-layered concept with local communities playing a central role in this human society-nature interaction. Furthermore, citizen engagement from different backgrounds is needed to efficiently protect water heritage – this includes spiritual relationships between water and communities.

- **Policies and politics have a direct impact on water heritage:**
  The study of water management policies and the appreciation of water related heritage in the policies of government and water institutions is helpful to better understand and control this impact. Moreover, it is crucial to foster education disseminating water related knowledge in order to secure long-term conservation and to identify national interests in order to get national water communities on board with international working groups.

Conference Programme

Thursday, 11 November 2021

Water Heritage and Water History as Knowledge Resource

09:30: Registration
10:00 Opening, Welcome and Introduction

Greetings
- Dieter Ernst, Chairperson European Academy Berlin
- Tino Mager, ICOMOS Germany

Keynote
- Hildegard Bentele, MEP, Conference on the Future of Europe
- Christian Johann, Managing Director European Academy Berlin

Session 1
11:00 Water-related Heritage – Historical Resource and Future Potential
Moderation: Weronika Priesmeyer-Tkocz

- *Domestication of Water. Management of Water Resources in the Dry Zone of Sri Lanka as Living Cultural Heritage*
  Wiebke Bebermeier, FU Berlin
- *On Water and the City: A Heritage for LisbonThe Water Heritage and Water Museum of Lisbon. Learning from the Past for the Future?*
  Paolo Oliveira Ramos, Universidade Aberta
- *Unveiling Venice's Waterways Heritage. From the Extended Water Museum of Venice to UNESCO-IHP's Global Network of Water Museums*
  Eriberto Eulisse, Global Network of Water Museums / University of Venice Ca' Foscari

Session 2
14:00 Water Heritage and Inclusive Development
Moderation: Tino Mager

- *Waters and Landscapes of Invention: for a New Interpretation of Water Heritage*
  Andrea Oldani, Politecnico di Milano
- *Bridging Divides – Between Water Heritage and Water Management*
  Henk van Schaik, ICOMOS ISC Water and Heritage
- *Communicating Water Heritage and Mobilizing Citizen Science and Civic Engagement*
  Carola Hein, TU Delft

Session 3
17:00 Inspired by Water Heritage
Moderation: Jörg Haspel

Inspiration talk:
Artistic Approaches to Water Heritage in the Netherlands
Anna-Rosja Havemann, University of Groningen

Panel Discussion:
- Anna-Rosja Havemann, University of Groningen
- Henk van Schaik, ICOMOS ISC Water and Heritage
- Rainer Nagel, Bundessstiftung Baukultur
- Steffen Skudelny, Deutsche Stiftung Denkmalschutz
- Dieter Ernst, IWC – Innovation and Water

18:30 End of first conference day

Friday, 12 November 2021

Implementing Water Heritage for Sustainable Development

Session 4
09:00 Future Workshop Water Heritage (Live Stream)

Inspiration talk:
E-learning Curriculum on Water: Friend and Foe of Miners in Mining Region Erzgebirge/Krušnohoří
Ping Kong, Heritage & Education gGmbH
Friederike Hansell, Saxon State Office for the Conservation of Monuments

3 Workshops:
Development of a Berlin Paper on Water Heritage
- Education & Culture
- Citizen Engagement
- Policy Making

12:00 Presentation of the Results of the 3 Panels
Presenters and rapporteurs with references for Berlin Paper on Water Heritage

12:30 Summary of the Conference, Conclusion
Tino Mager, Christian Johann

13:00 End of the conference

Curricula Vitae

Carola Hein

chairs the Department of the History of Architecture and Urban Planning at Delft University of Technology as well as the UNESCO Chair Water, Ports and Historic Cities. She has published widely in the field of architectural, urban and planning history and tied historical analysis to contemporary developments. Among other grants, she received a Guggenheim Fellowship to pursue research on The Global Architecture of Oil as well as an Alexander von Humboldt fellowship. Her recent (co)edited books and monographs include *Oil Spaces* (2021), *Urbanisation of the Sea* (2020), *Adaptive Strategies for Water Heritage* (2020), and the *Routledge Planning History Handbook* (2018).

Rolf Höhmann

has a diploma in architecture and town planning from the Technical University of Darmstadt in Germany, where he also worked as a researcher in the project „Early Industrial Buildings". In 1989, he founded his own independent Bureau for Industrial Archaeology for the documentation, evaluation and restoration of industrial monuments in Germany and Europe. He worked in different stages on several World Heritage projects, like the Völklingen Ironworks and the Erzgebirge/Krušnohoří Mining Region and prepared Tentative List proposals as well as the nomination dossier for the Water Management System of Augsburg, included in the World Heritage List in 2019.
Rolf Höhmann is speaker of the Working Group on Industrial and Technical Heritage of ICOMOS Germany, a long-time member of ICOMOS and TICCIH, and ICOMOS monitor for the Zollverein Coal Mine Industrial Complex and the Völklingen Ironworks World Heritage Sites.

Andrea Oldani

(MArch, PhD) is an assistant professor of landscape architecture at the Department of Architecture and Urban Studies at the Politecnico di Milano. A faculty member of the School of Architecture, Planning and Construction Engineering, he teaches Landscape Architecture and Design. Since 2008 he has developed theoretical, didactic, and design contributions on the landscape of contemporary infrastructures, focusing on riverscapes and waterscapes architecture.

Paulo Oliveira Ramos

was assistant professor of Heritage Studies at the Universidade Aberta (Portuguese Open University) and researcher at the Art History Institute NOVA-FCSH. He has more than 30 years of research experience in the fields of history, heritage studies, industrial archaeology, and museum studies and has published widely on cultural heritage. Among his publications are Iconografia Histórica da EPAL, 2 volumes, EPAL, 2007 and 2008, O Projecto de Louis-Charles Mary para distribuição de água na cidade de Lisboa, 1856, EPAL, 2011 and „Ports: An (ancient) History, a (new) Heritage" in: Knowledge of the Seas Pavilion: 1998 Lisbon World Exposition, 1998, pp. 225-240.

Henk van Schaik

is the Honorary Vice President of the ICOMOS International Scientific Committee for Water and Heritage and Ambassador for Water and Heritage of ICOMOS Netherlands. Since 2019 he directs the International Centre for Water and Transdisciplinarity (CIRAT) in Brazil. In the past, he chaired the Advisory Committee of the Sustainable Water Subsidy Fund of the Netherlands Government, represented the Lead Water of the University for Peace in The Hague, and was also a member of the Alliance of the Water Integrity Network. From 2001 to 2012 he directed the International Cooperative Programme on Water and Climate. He previously worked as a Water Advisor of and for the Dutch Ministry of Development Cooperation. Upon completion of his MSc in Water Management at Wageningen University, NL, he worked for several years in rural water supply provision in Malawi and Zambia. He co-edited the book Water and Heritage: Material, Conceptual and Spiritual Connections, published in 2015.

Till F. Sonnemann

works at the Bonn Center for Digital Humanities at the University of Bonn. A trained geophysicist, he completed his PhD at the University of Sydney on the archaeological landscape of Angkor in Cambodia, giving him the opportunity to do extensive fieldwork from 2007 until 2012. From 2013 until 2016, he conducted postdoctoral research at Leiden University, from 2016 until 2022 he was junior professor for digital archaeology at the University of Bamberg. He is interested in the use of non-destructive techniques to investigate archaeological and heritage sites, with particular focus on water management.

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