Water Heritage

Global Perspectives for Sustainable Development

Bureau of Cultural Heritage, Ministry of Culture, Taiwan, R.O.C.

Foreword

Exploring and inheriting the wisdom of water heritage

Some of the large world organizations such as the UNESCO have taken the initiatives on the fight against climate change due to the severe impact it has caused to all lives on Earth. A possible solution is to look for answers in human history and to learn from ancient wisdom of water culture and heritage. This is also globally recognized as an important strategy in response to climate change while preserving world heritage.

Taiwan is a vertically long and horizontally narrowed island. It is divided into east and west by the Central Mountain Range that runs from the north of the island to the south with altitudes of more than 3,000 meters. Although the island has many lakes and rivers, its geography has made water storage uneasy as water flows rapidly in many areas. In addition to the characteristics of the Tropic of Cancer that passes through the southern part of the island and the amount of rain that accumulates during typhoon seasons, Taiwan inherits diverse water culture and heritage due to these natural challenges. Taiwan is experienced in flood control, water management, water conservation and utilization as a result of its geographic location, landscape and climate.

In 2019, Taiwan International Institute for Water Education (TIIWE) in corporation with International Council on Monuments and Sites (ICOMOS) Netherlands held the “2019 International Conference – Water as Heritage”. More than 300 experts and scholars from 27 national and/or international organizations joined and participated in the conference. The event broadens the horizon on water management and conservation, irrigation and drainage, hydroelectricity, and port management. It also opens up more room for exploration and discussion on these issues. The Earth is now encountering serious climate challenges that require the cooperation and coordination of everyone who lives here for better management of water resources, in which Taiwan would be honored to play a role in.

The publication of the articles presented in the "2019 International Conference – Water as Heritage" is part of Taiwan's effort on contributing to the fight against climate change. This book, "Water Heritage – Global Perspectives for Sustainable Development", is published in both English and Chinese to meet the needs of more readers with the hope to raise more awareness on the importance of water heritage for people today and for the future. It is time to call for the world's attention to cherish and preserve the surrounding water heritage, and make water a durable resource for the sustainable development of mankind.

Gwo-Long Shy
Director-general
Bureau of Cultural Heritage, Ministry of Culture

Heritage and water for a sustainable future

Even on quiet nights, you could hear its panting, 'the unsettling grumble of a restless beast'. But on particularly tumultuous nights, when the wind would slam the window shutters shut and sandbags needed to be piled up high against the houses, you could actually hear its howl, the sound of sharpening claws while he was licking the foam off of the roaring waves. It was ready, waiting to attack, willing and capable to drag along everyone and everything it would encounter on its raid. This monster, the 'Water Wolf', had made many victims—especially from the villages of Vijfhuizen, Nieuwerkerk, and Rietwerk, all swallowed by its waves. 'Enough!' said the Dutch, and armed with shovels and determination, we started reclaiming this land from the sea. Pulling our lands straight out of the sharp claws and teeth of the Water Wolf threatening our existence.

The Dutch were not unfamiliar with the art of turning water into land. Poldering our waters to safeguard it from floods, to create place and space for agriculture, cities, and recreation is an all-time Dutch way of life. Safety and quality were best met with this collaborative approach, where farmers, politicians, tradespeople, and others joined forces with the engineers and designers to defend, plan and develop 'new land'. In the Haarlemmermeer, our plans outsmarted our engineering, our windmills proved not to be fast enough to implement our designs and fight off the hungry Water Wolf: we imported steam engines from the UK to speed up the pumping of the water. The steam engines of Cruquius, Lynden, and Leeghwater in the municipality of Haarlemmermeer are true examples of the need for innovation, coupled with partnership and (international) collaboration to safeguard and develop our land and livelihood. Until this day, the battle against the Water Wolf continues to be an inspiration for how to live with water, how working together brings out the best in us, and how we always have to adapt to overcome our water-related challenges. We always need to stand ready and be prepared: the future continues to hold challenges across the 2030 Agenda for Sustainable Development that can only be met in a holistic, future-oriented and inclusive way.

Innovation alone is not enough: cooperation, inclusiveness, keeping everyone's interest at heart, are critically important too. That is what the

Dutch word ‘polderen’ means. A polder is the word for low-lying land reclaimed from the sea; the verb ‘to polder’, or in Dutch ‘polderen’ now stands for the way the Netherlands operates politically and as a society—by collaboration, participation, inclusion, and deliberation. Water has that critical capacity to unite, to bring together all values of society, to bring us together as a society, to inspire us to learn from the past, and to prepare for a common future.

These lessons are more important now than ever. The future is rapidly changing, with the complexity of water and climate challenges increasing every day. The current COVID-19 crisis exposes all our weak spots and vulnerabilities in a way unprecedented in our lifetime. Countries and marginalized groups that have always been more vulnerable to climate change now face the biggest challenge of all: How to invest in fighting this crisis, in fast responses and in resilient recovery while at the same time continuing to mitigate against climate change and invest in water security, in resilience and preparedness? This is not easy, but then again it is our only way—an inclusive and fully comprehensive approach integrating everything and everyone in order to build a just, sustainable, and resilient society. Now more important than ever, we have to act and reach out to all concerned. Reinventing the past helps us shape this better future, realize the sustainable development goals, and fulfil the ambitions of the Paris Agreement. But this cannot be done in siloed responses or by only reacting to past disasters—we must be proactive, innovative, using an integrated approach, and radically include everyone. If anything, the battle against the Water Wolf has taught us the following: together we are stronger, and in partnership and by deliberation and innovation we can re-shape the future. Now!

Henk Ovink
Special Envoy for International Water Affairs, Kingdom of The Netherlands Sherpa to the UN/WB High Level Panel on Water

The significance of water heritage and the role of Taiwan

Since its reclamation, Taiwan has undergone many major changes in a relatively short period of time. “Water” had to be the first thing to consider for early immigrants who came to this island. The trajectory of human’s social development is to be found along water. Taiwan’s water system still reveals the footprint of some of our ancestors. The way patterns of water change demonstrate Taiwan’s landscape biography. How water has been used and managed shows the wisdom and spirit of our ancestors for their survival. Some of these values do not fade over time. The understanding of Taiwan’s water heritage is one great way of understanding Taiwan and ourselves. And this is what makes the local cultural heritage unique.

In recent years, the international water community and/or agency show increasing attention on water heritage, and the United Nations has put forward global initiatives for international organizations to act upon. Taiwan has an active role in this, as the first international conference, the “2019 International Conference ‘Water as Heritage’” was held in Taiwan, where experts and opinion leaders from various countries prepared for the establishment of the International Science Committee (ISC) on “Water and Heritage”. Professionals and experts around the world share the same vision: to actively promote water heritage. Taiwan keeps pace with the world and will continue to work towards this goal with all.

This book is a collective of the spirit and wisdom of human beings on water in history. It is an integration of the opinions of international leaders on water and heritage, and the outcome of Taiwan’s participation in this global action. Water heritage is a universal experience and a common language shared by everyone in this world. How Taiwan is able to share some of its solutions proves the commonality of water heritage for all.

Please enjoy this book. I believe it offers some insight into water heritage. Our continued participation in this topic connects us with our ancestors, our homes and ourselves.

Hong-Yuan Lee
Professor
Department of Civil Engineering, National Taiwan University

Preface

This book brings together key contributions from the *Water as Heritage International Conference* held in May 2019 in Chiayi, Taiwan. The conference reflects the intensive cooperation between the Taiwan International Institute for Water Education (TIIWE), the International Council for Monuments and Sites Netherlands (ICOMOS NL), and the Leiden-Delft-Erasmus Centre for Global Heritage and Development (CGHD). Its aim was to emphasise the importance of water heritage and to make the associated experience and knowledge available for sustainable development. It still pursues that aim. To this end, it built bridges from heritage organisations to water professionals, planners, and policymakers, as well as to organisations that are essential for these areas. Representatives from all regions of the world came together to discuss how best to communicate and exploit the significant contribution that water heritage can make in meeting upcoming water challenges. In this sense, the publication is a documentation of some of the diverse and global perspectives on the water heritage presented in Chiayi. It combines scientific contributions with field reports, historical analyses, and indigenous views. Its aim is to provide case studies and application areas; it also aims to raise awareness that historical technologies and practices combined with current knowledge and technology can contribute to sustainable development. Thus, the publication is a further component of the Water and Heritage initiative—it was initiated by ICOMOS NL and supported by other organisations; its next milestone to establish the ICOMOS International Scientific Committee for Water Heritage.

Both the conference and the present publication are the products of intensive, multidisciplinary, and international cooperation. In this sense, the decisive contributions and the indispensable commitment of Henk van Schaik (ICOMOS NL) and Sinite Yu (TIIWE) should be mentioned first and foremost. It is thanks to their vision and drive that both the conferences came about and the ongoing cooperation in the field of water heritage could take place. Special gratitude goes to Gwo-Long Shy and the Bureau of Cultural Heritage, the Ministry of Culture of Taiwan, and Martien Beek for the financial support from the Dutch Ministry of Infrastructure and Water Management. Particularly noteworthy is the valuable sponsorship provided by Water Resources Agency, Ministry of Economic Affairs; Construction and Planning Agency, Ministry of the Interior; Soil and Water Conservation Bureau, Council of Agriculture, Executive Yuan; Tinghsin Hode Culture & Education Foundation;

Ministry of Foreign Affairs, Republic of China (Taiwan); Taiwan Water Corporation; Taiwan Power Company; CPC Corporation, Taiwan; Chiayi City Government; Water Resources Bureau of Taichung City Government; and the Water Resources Bureau of Kaohsiung City Government.

The jointly organised conference was strongly supported by the Ministry of Culture of Taiwan; the Dutch special envoy for International Water Affairs, Henk Ovink; National Taiwan University Prof. Hong-Yuan Lee; Netherlands Trade & Investment Office; National Museum of Taiwan History; Chinese Taipei Committee / ICID; Northern Region Water Resources Office, Water Resources Agency, Ministry of Economic Affairs; Water Resources Planning Institute, Water Resources Agency, Ministry of Economic Affairs; and the Chinese Ocean & Underwater Technology Association.

Furthermore, special thanks go to the cooperation partners: Willy Event Consultants Co., Ltd, PCO; Nice Prince Hotel; Maison de Chine Hotel Chiayi; Hotel Day Plus Teascape; CPC Human Resources Department Training Institute; Mr Ronald Li; Prof. Rémi Wang / National Taipei University of Technology; Prof. Hsiao-wei Lin / Chung Yuan Christian University; Prof. Li Beng Chun / Huafan University; and the Nanhua University Goodwill Ambassador.

The conference programme was developed through cooperation between Henk van Schaik, Sinite Yu, Tino Mager, John Peterson (ICOMOS USA / International Scientific Committee on Archaeological Heritage), Steve Brown (ICOMOS Australia / International Scientific Committee on Cultural Landscapes, International Federation of Landscape Architects), Sahdev Singh (International Commission on Irrigation and Drainage), Hsiao-Wei Lin (The International Committee for the Conservation of the Industrial Heritage), Sergio Ribeiro (International Centre on Water and Transdisciplinarity) and Rohit Jigyasu (ICOMOS / International Scientific Committee on Risk Preparedness). The implementation of the interdisciplinary panels was further supported by Ioannis Kalavrouziotis (International Water Association), Giuseppina Irine Curulli (The International Committee for the Conservation of the Industrial Heritage), Nupur Prothi Khanna (ICOMOS India), and Hee Sook Lee-Niinioja (ICOMOS International Committee on Intangible Cultural Heritage).

In addition, a large number of people have made significant contributions to the Water and Heritage Initiative, the organisation of the conference and the publication of books. Among them are Diederik Six (ICOMOS NL), Dave Pritchard (Culture Network of the Ramsar Convention), Eriberto Eulisse (Global Network of Water Museums), Carola Hein (TU Delft). For the work on the creation of the ICOMOS ISC Water and Cultural Heritage, special support was provided by Sheridan Burke (ICOMOS Australia / Twentieth Century Heritage International Scientific Committee), Ian Travers (ICOMSO Australia), Meisha Hunter (Li/Saltzman Architects), Nils Ahlberg (ICOMOS Sweden), Piotr Lorens (Gdansk University of Technology), Taha Ansari (National Agency of Hydraulics Resources, Algeria). Finally, I would like to thank the Bureau of Cultural Heritage for the possibility of publication and especially Amanda Lu (TIIWE) for their excellent cooperation in the production of this book.

Delft, June 2020

Tino Mager
Delft University of Technology / University of Groningen
ICOMOS Germany

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Introduction

Introduction: Unlocking the wisdom of heritage for water challenges

Tino Mager, Henk van Schaik and Sinite Yu

There would have been no world without water. Every part of our planet depends on water one way or the other: it could be the formative power of water through erosion and sedimentation or simply the manifold effects of the presence and absence of water. Water is the basis of all life. Therefore, its existence is also a prerequisite for any spatial cultivation that serves the permanent residence of humans and living beings. On the one hand, agriculture and ranching are inconceivable without sufficient water supply; on the other hand, the development of larger permanent settlements like villages, towns, and cities also depend on the availability of water. But there is another side of the coin—water can also pose a threat as it can destroy areas and make them unusable. Over the years, people have developed creative systems for water supply and also taken measures for protection against water. In a nutshell, people have devised and are still devising strategies for living with water.

Over long periods of time, people developed different approaches to dealing with too much or too little water to ensure agriculture, settlements, transport, land reclamation, and energy production. These approaches had to stand the test of time; they could only be successful in the long term if they considered local conditions and did not bring about unacceptable or irreversible damage to water resources sooner or later. Practices that, for example, led to soil salinity as a result of bad irrigation and drainage or depletion of groundwater reserves due to over-extraction were doomed to fail. Conversely, successful practices are characterized by sustainability in the management of water resources such as qanats. These systems are characterized by a complex technical water supply system combined with a management system and ethical principles, such as equity and water rights, which maintain the balance between the natural water availability and supply in keeping with the demand of all stakeholders including nature. While access to and protection from water is an issue in most highly developed areas, a great many people around the world are threatened by water-related hazards and water shortages. In view of the rapidly changing climatic situation, our planet is facing challenges associated with achieving a globally balanced water management in populated areas. These challenges are likely to become more daunting in the near future.

Water management has changed rapidly since the 19th century. The introduction of steam-, fuel-, and electricity-powered systems has enabled the vast growth of urban conglomerations. This technological aspect relating to water management has also inspired the Green Revolution in agriculture. The use of antibiotics to diagnose and cure water-borne and water-related infections has greatly diminished; in fact, water-related diseases have been virtually eradicated over time. These and other technical abilities have led to an almost unshakeable belief in the ability of technology to overcome any challenge, including water management challenges, related to water supply, water transportation, water purification, and water protection measures. The resulting paradigm of technical and organisational efficiency in supply and demand, along with the control over and protection against extremes and disasters in order to dish out economic development, has often replaced traditional water management systems, local organisational setups, and local ethical as well as legal practices.

These largely technocratic approaches mostly do not consider water resources management as embedded in existing (local) cultural frameworks including material and immaterial aspects. This book investigates the history of water resources management. Through this investigation we aim to find out, by means of water-related heritage, what actually characterizes sustainable and resilient water management systems. The study of water-related heritage makes it possible to trace the strategies used for dealing with water in a sustainable manner in certain regions over centuries. Solutions have been developed over the years to enable people to adapt the local water situation to their needs in the best possible way using technical and organisational tools. The wealth of knowledge and experience inherent in the structures built, the strategies, and the related cultural practices is an essential element of water heritage and constitutes its primary value. Water heritage is, therefore, an educational tool which, when explored in its entirety, can make a significant contribution to meeting today's challenges. The creative and intelligent combination of the centuries-old experience with cutting-edge engineering knowledge can enrich innovative and future-oriented solutions that have the potential to offer long-term perspectives for dealing and living with water.

This fascinating chemical compound also plays a major cultural role. Water has a fundamental importance in religions and cosmologies all over the world. From time immemorial, water acted as a medium of transport over long distances and thus facilitated the exchange of people, goods, and ideas. In this way, it served as a link across wide areas and accelerated global cultural and technological development. The tangible and intangible aspects of water heritage are manifold as the relationship between people and water are not only physical and practical, but also emotional, philosophical, and spiritual. This relationship has been influencing and shaping people's lives from the beginning of the appearance of the human race. By having an effect on the feelings, way of thinking, and beliefs of human beings, this relationship has played a catalytic role in the emergence of philosophies and religions, thereby influencing the cultural aspects of human civilisation on a full scale. These aspects are part of specific local relationships with water all over the world and are expressed in simple structures, old rights of use, and ritual customs—these could be seen in iconic world heritage sites. The latter are characterised by water relations of all kinds, ranging from drinking water supply, port facilities and waterways, irrigation and drainage systems, watermills and lines of defence, to land reclamation.[1] Other water-related heritage includes water rituals, such as baptisms, songs, and global visions in religions and traditional societies, water courts, and water diplomacy practices. Aaron Wolf researched the latter and showed that hundreds of water conflicts were mitigated or resolved. He also asserted that 'there has never been a single war fought over water' since 2500 BCE (Wolf, 1998, p. 262). This fact led Kofi Annan, former secretary-general of the United Nations, to state in 2002 that 'the water problems of our world need not be only a cause of tension; they can also be a catalyst for cooperation'(Annan, 2002).

Water and heritage for the future

The lack of communication between heritage and water experts means that the significance of water-related heritage is seldom applied or used for tackling challenges in water services and water resources management. Disciplinary backgrounds and diverse institutional and regulatory frameworks are often the reason for the separation

[1] Some of these World Heritage sites are: Angkor (Cambodia); Rice Terraces of the Philippine Cordilleras; BudjBim Cultural Landscape, Australia, The Four Lifts on the Canal du Centre and their Environs, La Louvière and Le Roeulx (Hainaut) in Belgium, Seventeenth-Century Canal Ring Area of Amsterdam inside the Singelgracht (The Netherlands); Alhambra, Generalife and Albayzín, Granada(Spain); Water Management System of Augsburg (Germany) or former port areas such as the Speicherstadt Hamburg (Germany). The Persian Qanat, Iran The Grand Canal, China.

between heritage managers, water resource managers, and other stakeholders. Water engineers are concerned with supplying and treating water, while governments are focusing on regulating water supply and use. Local communities may use water for recreation as well as in rituals and ceremonies. Consequently, water-related cultural heritage is not considered in addressing present and future water management challenges and is rarely on the agenda of global water conferences or water policies.

The goal of *Water and Heritage for the Future* is to unlock the knowledge that can be gained from water-related heritage in order to showcase its significance, to incorporate it in the present, to combine it with current technologies and management strategies for an improved water future, and to bring together heritage experts, water engineers, and policymakers. The initiative was launched in 2012 by the Dutch section of the International Council of Monuments and Sites (ICOMOS NL) and has since gained international momentum by supporting the dialogue between water and heritage organisations. The motivation for this was fed by an increasing interest in The Netherlands for the incorporation of water-related cultural heritage in water management projects.[2] They demonstrate that water-related cultural heritage should be considered as significant and adaptable to all current and upcoming water management challenges.

Water and Heritage for the Future has been organising events and conferences to bring together water professionals and heritage experts to present examples and cases of water-related heritage as well as to discuss their relevance at present. The first major event was the International conference called *Protecting deltas, heritage helps* (Amsterdam, 23-28 September 2013) that resulted in the *Statement of Amsterdam* (ICOMOS NL) and whose presentations were published in *Water & Heritage: Material, Conceptual, and Spiritual Connections* (Willems & van Schaik, 2015). As the title says, the scope for the water and heritage initiative is to consider the multiple dimensions of water heritage. Moreover, it discusses the impact of water in relation to climate change, the impact of storms and extreme water-related events on cultural heritage, the adaptability of water-related heritage to climate-related changes, and the policies and assessments of water-related heritage. The book was launched at the 7th *World Water Forum* in South Korea (Gyeongju, 13 April 2015) and presented to the UNESCO director of the Division of Water Sciences and secretary to the International Hydrological Programme, Blanca Jiménez Cisneros,

[2] E.g. *Room for the River* (https://www.ruimtevoorderivier.nl/english).

and the Dutch minister for infrastructure and the environment, Melanie Schultz van Haagen. For the first time, the theme ‘Water and Cultural Heritage’ was so prominently presented and discussed at a *World Water Forum* and attracted considerable interest.

In 2016 the international conference *Water and Heritage* (Delft and Fort Vechten, 25–26 November) took place—it was the start of a strategic partnership between ICOMOS NL as the lobbyist and the networker, and the Leiden-Delft-Erasmus Centre for Global Heritage and Development as the scientific partner. The conference attracted heritage and water scientists from around the world and resulted in the publication of *Adaptive Strategies for Water Heritage –Past, Present, Future* (Hein, 2019). An important outcome of this conference is the recognition of the need for a universal assessment methodology to establish and describe the significance of water-related heritage for contemporary and future water-related planning and policy development, as well as the need for a carefully moderated multi-stakeholder process to incorporate the significance of water-related cultural heritage in the planning and policy development process. Moreover, it emphasised the need that water-related heritage in some cases may have to be adapted to contemporary and future water issues to stay functional. However, this adaptation may compromise the heritage value, and the challenge here is to reach a balance for water heritage between meaningfully enhancing present and future water management and the conservation as well as protection of this heritage.

At the 19th ICOMOS General Assembly in Delhi, India (11–15 December 2017), *Water and Heritage for the Future* held a workshop on water and heritage and proposed an International Scientific Committee (ISC), ‘Water and Heritage’, to the Scientific Board of ICOMOS. This submission was positively received: ICOMOS NL was invited to prepare for the creation of the ISC, while the Bureau of Cultural Heritage of Taiwan offered to host an international conference as a preparation for the ISC Water and Heritage. The mentioned workshop included representatives from the International Union for Conservation of Nature (IUCN) and the International Commission on Irrigation and Drainage (ICID) to present their activities regarding water related cultural heritage; it aimed to establish linkages with both organisations. The Water Programme of IUCN considers natural heritage as an asset for water-related development and shares interests with the intended ISC. The ICID Programme on World Water Systems Heritage, a registrar of intangible water-related cultural heritage icons, did the same. This was also recognised by ICID by inviting ICOMOS NL to become a member of the International Technical Advisory Committee.

These efforts to bring together cultural heritage experts, water professionals, and decision-makers have increased awareness, understanding, and insights into the potential importance of cultural heritage for water challenges, including its relationship to climate change and the opportunities for mitigation and adaptation to these challenges. This was further improved at the water and heritage panel at the UNESCO International Conference on Water (Paris, 13–14 May), which stated the following:

> *Mindful of the plethora of examples of cultural and natural, tangible, and intangible heritage related to water, its spiritual and cultural significance,*
>
> *Acknowledging the role of custodians and communities of water-related living heritage for whom heritage represents identity and a sense of belonging,*
>
> *The panellists of the 'water and heritage' panel session note obstacles and challenges arising from disciplinary and institutional divides as well as from tourism and other development pressures, and accordingly, call for enhancing the cooperation between water planners and water-related heritage practitioners and professionals by strengthening an inter-sectoral approach so as to*
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> *- overlay tangible and intangible cultural heritage with natural heritage and water management systems and to demonstrate their significance for planners and policymakers;*
>
> *- support the transmission and safeguarding of heritage by accompanying civil society and community-based organizations in order to ensure that their values and aspirations and their identity are captured in water management;*
>
> *- continue the dialogue between water planners and water-related heritage practitioners and professionals, as commenced during UNESCO's International Water Conference 2019, to strengthen water-related heritage in planning and to include all relevant communities.*[3]

2019 International Conference Water as Heritage

At the invitation of the Government of Taiwan, with the support of the Bureau of Cultural Heritage and the Taiwan International Institute on Water Education (TIIWE), and financial support from the Ministry of Infrastructure and Water

[3] Contribution to the call for action of the UNESCO International Water Conference 2019 by the panellists of the session 'water and heritage' (Ana Aleksova, Susan Keitumetse, Clemens Küpper, Caroline Munier, Rasul Samadov, Henk van Schaik, Wayan Windia).

Management of the Netherlands, ICOMOS NL and the Leiden-Delft-Erasmus Centre for Global Heritage and Development organised the *2019 International Conference Water as Heritage* that took place 27–31 May 2019 in Chiayi, Taiwan. Chiayi (Latitude: 23° 20' 0.24" N; Longitude: 120° 27' 0.00" E) lies on the Tropic of Cancer. Due to the trade winds, this type of geographical location is not the most suitable area for people to live in. But Chiayi is an exception: Because of its proximity to the ocean and the heavy and intense rainfall, as the city is surrounded by hundreds of mountains. These geographical and climatic characteristics gave the international conference on water and heritage a special context. The objectives of the conference were: 1) to draft a thematic framework for water and cultural heritage, thereby responding to the call of the UNESCO Paris Conference, which appealed to define the scope of the Water and Cultural Heritage Agenda; 2) to promote preparations for the International Scientific Committee to be established by ICOMOS at its next General Assembly in Sydney that was scheduled for October 2020; 3) inviting representatives of relevant international cultural heritage and water organisations to the Conference to explore possibilities for co-operation; 4) inviting cultural heritage experts and water professionals to present cases and examples of activities that demonstrate the significance of water-related cultural heritage for current and future water management challenges.

A preparatory workshop was held in Taipei on 21–22 May 2018, attended by representatives from five continents of both international cultural heritage institutions and international water organisations.[4] In this context, the topics relevant for the conference were discussed, and the conference programme, including the excursions, was outlined. The preparatory committee drafted a concept note and developed a thematic framework for the conference. This framework builds on the five thematic areas identified as a result of the 2016 Water and Heritage Conference: ‘Infrastructure designed for drinking water; agricultural sites designed for irrigation and drainage; land reclaimed by poldering and other land reclamation in agriculture, settlement, and defence systems; river and coastal planning; and urban and engineering structures in ports and on waterfronts’ (Hein et al., 2019b, p. 8). In order to specifically address the desiderata identified during the 2016 conference and for the publication of the results (namely waterways, sewage systems, hydropower,

[4] The members of the preparatory committee were: Henk van Schaik, ICOMOS NL, chair; Sinite Yu, TIIWE, vice chair; Tino Mager, Centre for Global Heritage and Development, ICOMOS D, vice chair; John Peterson, ICOMOS US, ISCICAHM; Steve Brown, ICOMOS AUS, IFLAS and ISCCL; Sahdev Singh, ICID; Hsiao Wei Lin, TICCIH; Sergio Ribeiro, CIRAT; Rohit Jigyasu, ICOMOS, ICORP.

world views, and legal positions), the thematic areas for the conference were supplemented and restructured:

1. Water for services (including drinking water, waste water, and irrigation)
2. Waterscapes (including polders, wetlands, water defence systems, urban areas)
3. Waterways (including rivers, canals, and ports)
4. Waterpower (including hydro power as well as floods and inundations)
5. Worldviews on Water (including spirituality, philosophy, ethics, and legal systems)

The rationale for this framework assumes that this scope and themes are explicit for water professionals and water institutions; it also assumes that the World Heritage List contains outstanding examples of all these categories. In order to allow for a comprehensive dialogue, it was decided that each theme would be led, whenever possible, by a heritage expert and a water expert representing international organisations.[5] The outlines of the five themes are as follows:[6]

Water for Services deals with the essential life services that water provides for human communities. These services link water with human needs and settlements, both for sustenance as drinking water and irrigation and for providing vectors for the removal of wastes. Irrigation systems led to the world's first major landscape transformations by channelling water from source locations and distributing it throughout agricultural networks. Throughout human history water management or mismanagement has been critical to human survival, and those systems that fared the best serve as models for sustainability today. These sustainable systems are models for future low-energy, sustainable technologies that would promote reuse, recycling, and renewable energies and act as the cutting edge for future human settlements. With increasing population and urbanization, along with climate change, we face new challenges to manage, maintain, and sustain water services in a changing world.

Waterscapes include natural and/or human-made, maritime, coastal, rural, or urban areas with—agricultural, industrial, or leisure purposes, for example—in which an expanse of water has been a dominant feature. Waterscapes can include, but are not limited, to protected areas and the

[5] The following theme leads were appointed: Theme 1: John Peterson (ICOMOS US, ICAHM) and Ioannis Kalavrouziotis (IWA), Theme 2: Steve Brown (ICOMOS AUS, IFLAS and ISCCL) and Sahdev Singh (ICID), Theme 3: Giuseppina Irine Curulli (TICCIH) and Hsiaowei Lin both (TICCIH), Theme 4: Tino Mager (CGHD, ICOMOS D) and Nupur Prothi Khanna (ICOMOS IND), Theme 5: Sergio Ribeiro (CIRAT) and Hee Sook Lee-Niinioja (ICOMOS ICICH).

[6] The description of the themes is based on the texts provided by the theme leads.

water systems that support the local fauna and flora; defensive systems; mining landscapes; fisheries systems; specialised agro-ecologies including indigenous water management systems; agricultural and pastoral systems and the spectrum from irrigated to dry land farming; settlements and urban areas and the water systems developed to support them; and recreation facilities including surfing, water skiing, and winter sports. To understand in a better way the connections between important heritage values and contemporary uses of water and water infrastructure, it is important to understand the engagement of traditional ecological knowledge, cultural, and natural heritage practitioners, hydrologists, water engineers, chemists, government, and private-sector water regulatory authorities and policymakers, and landscape planners.

Waterways have not only served as an infrastructure to collect, distribute, and treat water for human consumption, but they have also been used for the transportation of goods and travel between cities. Hence, they are important to urban landscapes everywhere. Early modern patchworks of local water supply gradually become interlinked and refashioned urban areas, got extended to other technologies, and led to the development of the modern networked city. Thus, waterways are typically associated with transport, trade, and the physical movement of materials, people, and cultural knowledge. This theme focuses on rivers, canals, and other routes for travel by water; this also focuses on ports and harbours, particularly exploring their technological, economic, social, and cultural impacts on people's life and the transformation of the landscape and use of the waterway. As industrialization drives more and more people to live in cities and work in concentrated industrial area, the changing function of waterways exposes urbanites of all social levels and lifestyles.

Waterpower refers to the ability of water to support human existence—through power generation, for example—as well as the destructive power of water as evidenced in disasters arising from floods, tidal waves, and sea-level rise. Hydropower is one of the oldest sources of mechanical energy used by mankind; it belongs to the group of renewable energies and will therefore continue to play an important role. But dams and power plants can also pose environmental risks and cause damage, while the power of water also contains destructive forces against which humans have tried to protect themselves since time immemorial. A variety of approaches were developed to protect settlements, agriculture, and infrastructure from the elemental forces of life. Living with water has proven to be more sustainable than living against water. Modern approaches have often ignored this experience, much to the dismay of man and the environment.

Climate change requires learning from solutions that have stood the test of time. Protection from and living with water is becoming an increasingly vital issue, not only in coastal and delta regions.

Worldviews on Water looks at the different water cultures of the world and takes a complex view of the relationships between different cultures and water, and the related ways of life and survival of different peoples. Practice has shown how dominant groups have tried to make people identify with the formalised water culture—as colonial subjects, nation-state citizens, efficient water users, or customers of the water market. History is full of so-called reciprocal pacts, governmental ideologies, and cultural categories constructed to fit the dominant command structures. In many ways, laws and legal frameworks confirm and protect this structure, which is also reproduced in the field of water. In the meantime, however, promising initiatives have emerged in several countries in the field of law based on world views of traditional cultures. It is, therefore, a very topical and necessary subject with practical applications in a wide range of fields concerning the relationship with water and all life on the planet. This theme aims to deepen knowledge and reflection on the role of the worldviews of the different traditions in people's relationship with water.

A call for abstracts was sent out internationally together with the concept note, and representatives of relevant international organisations were invited to participate, including the Ramsar Culture Network and the Global Network of Water Museums. Finally, in May 2019 delegates and presenters from 24 countries on all continents joined the conference in Chiayi. In addition to the thematic sessions, posters, and presentations on national policies, the international heritage and water organisations also introduced themselves and representatives of the ICOMOS National Committees reported on their activities on water and cultural heritage. In two task force meetings, a committee discussed the rationale, scope, mandate, membership, and objectives for the establishment of an ICOMOS International Scientific Committee (below).

At the end of the conference, the results of the five thematic sessions and the internal meetings, as well as the starting points for future actions, were presented. The guests had the opportunity to express their opinions, to critically review the programme, and to make suggestions. The global case studies and the broad spectrum of interdisciplinary thinking on the subject inspired and motivated many participants, and the concluding discussions focused on how to effectively demonstrate the importance of water-related cultural heritage to planners and policymakers. Key issues include strategic communication on the current and future potential of cultural heritage between cultural heritage experts and water experts, a better level of involvement of communities and stakeholders, adaptation of knowledge of water and cultural heritage, and revitalisation of the partly abandoned water heritage. In addition, adjustments to the legal framework are essential to create more equitable social conditions in many places. An important aspect of these tasks is the involvement of emerging professionals and high-quality training in the field of water heritage. Subsequent excursions, on 30 and 31 May, were dedicated to the conference topics related to Taiwan and its different population groups. Several museums (Baileng Tachichai Hydropower Museum, Kaohsiung Museum of History, National Museum of Taiwan History), water facilities (Tachichai Hydro Power Plant, Huludun Waterfront, Xinle Interception Pumping Station, Babao Canal), and cultural sites (Cheng Mei Culture Park, Niumatou Site Cultural Park) were visited. This provided the opportunity to visit unique water heritage sites to learn about regional peculiarities and to get into dialogue with local authorities.

The ICOMOS ISC Water and Heritage

A major outcome of the conference was the agreement to continue working on the issue of water and heritage in future. During two meetings with invited experts, concrete measures for further effective work in this area were discussed.[7] It was decided to work towards the creation of an international platform for networking, education, and dialogue on the importance of water heritage in the form of an international scientific committee of ICOMOS. As mentioned above, the proposal was first presented at a meeting of the ICOMOS Scientific Council in December 2017 in Delhi, India, and has since received broad support. The overall aim of the ISC is to improve the future of water by integrating water heritage in community engagement, technology, and policymaking. In addition to the necessary formal steps, a contextual specific focus is placed on the following aspects:

- The development of specific methodologies that serve as a basis for the development of policies and design processes considering the importance of cultural heritage in the water world.
- The presentation and promotion of best practice examples for the management of water heritage.

[7] The meetings were joined by: Nils Ahlberg, Steve Brown, Sheridan Burke, Irene Curulli, Eriberto Eulisse, Meisha Hunter, Ioannis Kalavrouziotis, Hsiao-Wei Lin, Henk van Schaik, Diederik Six, Sahdev Singh, Hee Sook Lee-Niinioja, Piotr Lorens, Tino Mager, John Peterson, Nupur Prothi Khanna, Sérgio Ribeiro, Ansari Taha, Ian Travers, Sinite Yu.

- To discuss and develop communication and links between the ICOMOS ISC with water managers, designers, planners, and relevant organisations.

The proposed ISC is to fill the disciplinary and institutional gap as there is still no international cultural heritage organisation explicitly dedicated to water-related heritage. Nor is there any major water organisation that considers heritage to be a major asset for water management. The ICOMOS ISC should set up working linkages with several international water organisations, such as the International Water History Association that is dedicated to historical aspects. And within ICOMOS it cooperates with several other ISCs like Archaeological Heritage Management (ICAHM), Cultural Landscapes (ISCCL), International Scientific Committee on Risk Preparedness (ICORP), Intangible Cultural Heritage (ICICH), and Places of Religion and Ritual (PRERICO), among others. They do not explicitly deal with the water aspects, but, just like other ISCs, include them in their specific work. Further, cooperation will be sought with the International Committee for the Conservation of the Industrial Heritage (TICCIH), a designated consultant to ICOMOS, touching on water industry heritage (Douet, 2018). Outstanding bridging initiatives with specific interests are the above- mentioned Ramsar Culture Network and the Global Water Museums Network (see the articles by Dave Pritchard and Eriberto Eulisse in this book). Heritage approaches such as Historical City Landscapes also naturally touch on water issues, but they are not explicitly focused on this topic. On the other hand, assessment tools, such as hydrobiographies that are being developed modelled on the landscape biography, have not yet reached universal recognition (see the article by Hans Bleumink and Jan Neefjes in this book and Beek & Kooiman, 2014; Bosch & Soré, 2016).

Two international water organisations show increased interest in cultural heritage, the International Water Association (IWA)—especially through the Specialist Group on Water in Ancient Civilizations—and the International Commission on Irrigation and Drainage (ICID) through the World Water System Heritage Programme and the Working Group on History of Irrigation, Drainage, and Flood Control. While the World Water Council has only once (Kyoto 2003) addressed cultural heritage at the World Water Forum, there are clear tendencies towards recognition of the importance of the issue—e.g. the World Water Week 2019, organised by the Stockholm International Water Institute, hosted a session on water and heritage. Also on 3 February 2020, the United Nations Centre for Regional Development

(UNCRD), the National Graduate Institute for Policy Studies (GRIPS), the High-Level Experts' and Leaders' Panel on Water and Disasters (HELP), and the International Council on Monuments and Sites (ICOMOS), Netherlands, held an international symposium titled 'Water and Culture: Learning from Water Heritage to Innovate Regional Development' in Tokyo.

The proposed International Scientific Committee on Water and Heritage will be dedicated to the research, protection, and promotion of water-related cultural heritage and its material, conceptual, political, and spiritual aspects. The aim is to improve comprehension and dissemination of the knowledge and experience contained in the world's water heritage and harness it to sustainably address the water-related concerns of the present and future. Specifically, the objectives are to create an international platform for interaction between ICOMOS, its ISCs, and other heritage organisations and the water sector; to forge a connection between governments, agencies, associated communities, and NGOs for networking, education and dialogue about the significance and management of water heritage; and moreover, to develop methodologies, training, policies, good design processes, responding to traditional wisdom; to inform climate change mitigation and adaptation; to improve current and future water management and planning; and generally, to strengthen the role of water heritage in social engagement and policymaking.[8]

This book

This book presents the outcomes of the *2019 International Conference Water as Heritage*, held from 27–31 May 2019 in Chiayi, Taiwan. It combines academic perspectives with case studies, field reports, and contributions from activists, thereby giving it a heterogeneous structure in terms of content and form. While the conference and its five themes were conceived primarily from a water management perspective on cultural heritage, the structure of this publication aims to look at water from a cultural heritage perspective. Thus, a major aim is to support the setup of the proposed ISC Water and Heritage. As the ISC targets the promotion of water heritage by emphasising its significance for contemporary water challenges and the identification of best practice examples for utilising water heritage, the three parts of the book focus on conceptual approaches and cultural dimensions of water heritage, the sustainable technologies of living water heritage, and re-activation strategies that support the significance of water heritage respectively. Hence, the different parts

[8] Paragraph based on the ISC Water and Heritage draft Mission Statement, compiled by the ISC Task Force. See also: water.icomos.org

deal with the general relevance of water heritage; they showcase useful examples of water heritage and exemplify ways to integrate manifold aspects of water heritage in today's water management. International authors provide a global and interdisciplinary perspective on water heritage.

The **first part**, Water Heritage: Conceptual Approaches and Cultural Dimensions, contains articles on the framework of and perspectives on cultural heritage. Dave Pritchard presents a view on water in the context of ecological and socio-cultural systems. He outlines possibilities in cultural heritage policy, practice, and research by taking the Ramsar Convention as a starting point and extending the spectrum to the involvement of contemporary artists in the socio-cultural system of water. Eriberto Eulisse provides an insight into the institutionalised cultural perspectives on water based on an introduction of the Water Museum of Venice and reaching out to UNESCO's Global Network of Water Museums. Nupur Prothi Khanna and Prachi Sharma emphasize the importance of integrating cultural aspects into the process of tackling water challenges regarding sustainable urbanization in Asia. By taking a look at centuries-old stepwells in India, Saranya Dharshini reveals their importance for local communities and highlights the patronage of women in the construction of these vital and fascinating examples of water facilities. Da-Wei Kuan explains the strong relationships between a water-dominated landscape and an indigenous community in Taiwan while giving a profound insight into the close ties that exist between nature and culture. The first part is rounded off with two contributions featuring Middle-Eastern and South American perspectives. That a place with old water relations can become an important element for political change is shown by Sarah Yassine in her article on Beirut's Dalieh el Raouche. Sérgio Ribeiro and Maurício Andrés Ribeiro bring in a global perspective on water-related heritage in Brazil, including indigenous knowledge and attitudes.

The **second part**, Living Water Heritage: Sustainable Technologies, examines the continuous relevance of historical water management technologies and practices. The articles also deal with ancient but very effective and sustainable agricultural irrigation systems. Sinite Yu, Po-Kang Shih, Pei Hua Lu, Yu-Chuan Chang, Wen-Yao Hsu, and Chia-Ying Wu examine the effective technology of water distribution in Taiwan's Hakka Tongharm Heritage, while Karim Nawaz and Frank Steenbergen analyse an irrigation strategy in arid regions with regular flooding by investigating spate irrigation. The long-term usability and sustainability of old water supply systems is a reality, which has also been shown by Mikiko Ishikawa's description of a more than two millennia-old water distribution system in China. Taha Ansari explains the preservation of the structure and management of Foggara, a water distribution system in the arid regions of Algeria. Looking at the water supply systems in ancient Greece, Ioannis K. Kalavrouziotis gives an impression of the origins of today's water services. Hans Suijs concludes the second part with the history of the waterways of Gouda, once the busiest port in the Netherlands and now a picturesque city with a rich water heritage. And finally, Edmond Staal presents the heritage of the watermills of the Netherlands by providing an overview and identifying current challenges as well as potentials.

The **third part**, Significance of Water Heritage: Re-activation Strategies, contains contributions to the reactivation and preservation of water heritage sites, including their social and cultural functions. A useful methodology for assessing landscapes defined by water is presented in the opening article by Hans Bleumink and Jan Neefjes. Their introduction on waterscape biographies provides a comprehensive tool for integrating aspects of heritage in the management of cultural landscapes. Carola Hein exemplifies that it is worth giving special attention to water and waterfronts when it comes to the renewal of historic ports and industrial areas in cities. Jan Neefjes and Hans Bleumink outline their work on a guideline for the restoration of running waters—they deal with water-rich landscapes in the Netherlands and offer inspiration and guidance for a wide range of possible cases. The different elements of a water landscape are sketched by Mariano Castellanos Arenas for the case of a Mexican river valley, while Harry den Hartog analyses Shanghai's new relationship to its situation in a water-rich area by taking a close look at the character of its new water towns. The fact that even modern achievements become historical and will eventually become part of our heritage is underlined by the contribution of Yu-Pang Cheng and Chin-Hsing Chien on the cultural history of hydropower in Taiwan. Finally, Queenie Lin and Yin-Chun Wei examine the history and restoration of the Cheng Mei Ancestral Hall in Yongjing and shed light on the role of water heritage associated with it.

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Part 1

Water Heritage: Conceptual Approaches and Cultural Dimensions

Water in its context of ecological and socio-cultural systems – opportunities in heritage policy, practice and research, from the Ramsar Convention to contemporary artists (and beyond)

Dave Pritchard

Introduction and background to the Ramsar Convention

This contribution highlights some ways in which different heritages of water - cultural and natural, historic and contemporary - all come together in an international policy context. This is illustrated here primarily in relation to the Ramsar Convention on Wetlands (Ramsar Convention).[1] The Ramsar Convention was adopted in 1971: it was the first of the modern environmental treaties agreed by governments at a global level, and is the only one to focus on a particular type of ecosystem.[2] That focus naturally concerns the flora and fauna of wetlands, as well as the landscape settings and human uses that combine with these, in socio-ecological complexes. Wetlands are defined in the Convention as "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres" (Convention on Wetlands, 1971, Article 1.1). The scope is therefore broader than might sometimes be thought, and it encompasses areas underground, areas in the sea, forested areas, peat-blanketed hillsides and human-made wetlands, as well as the more obvious lakes, rivers and marshes. It is also valid to think of the Ramsar Convention as an agreement about water. There are only two other global treaties on this subject, namely the Convention on the Protection and Use of Transboundary Watercourses and International Lakes (UNECE, 1992), and the Convention on the Law of the Non-Navigational Uses of International Watercourses (UNGA, 1997); but those deal only with transboundary waters. For other aspects of the water environment,

[1] https://www.ramsar.org/

[2] Ramsar is an intergovernmental treaty. It is adopted by all the governments that met at the final negotiation conference and is open to accession by others thereafter.

therefore, it is often the Ramsar Convention that can fill the gap. The Convention's focus on wetlands is, in effect, a focus on water in its ecological context, and a context of water catchments at a landscape scale.

For many years, initially, the Ramsar Convention was seen in the main as a biodiversity-related regime, and it did not give major attention to the water industry, nor to the water sector as such. Subsequently, however, that gap has been progressively narrowed, with greater involvement in the sector, and the adoption under the Convention of a range of relevant policies and technical advice frameworks for governments, water management agencies and others. These cover subjects such as water storage infrastructure, groundwater modelling, water stress and climate change, regulation by wetlands of water regimes, environmental flow standards, water allocations for maintaining hydrological functions of ecosystems, River Basin Management, Integrated Water Resources Management, and links to the Sustainable Development Goals. (See for example Adams, 2012; Barchiesi et al., 2018; Ramsar Convention, 1996, 2005a, 2008; and Ramsar STRP, 2012). The 171 countries (at the time of writing) that are Parties to the Convention accept three primary obligations, referred to as the three pillars of the Convention. These are: the conservation of wetlands included in the Convention's List of Wetlands of international importance (the Ramsar Sites, currently totalling almost 2,400 worldwide); the wise use (or sustainable use) of all wetlands; and cooperation between countries on these objectives internationally. The sustainable use provision was pioneering for its time (Pritchard, 2016), and the combination of all three pillars seeks to support the maintenance of the ecological character of wetlands in the face of a range of growing pressures and threats.

Ramsar, wetlands and culture

The aims mentioned above are not a matter only of flora, fauna, hydrology and limnology; because the Convention's definition of ecological character includes the benefits that a wetland provides for people, or in other words its ecosystem services - which in turn include a category identified as cultural ecosystem services (Ramsar Convention, 2005b; Papayannis and Pritchard, 2016). This central relevance to Ramsar's objectives of the human dimension, and human culture as a part of this, has not always been as visible or as fully appreciated as it could be, especially perhaps in earlier years when there was some emphasis on waterbird conservation in particular.

At the very outset, however, the text of the Convention itself made reference to the importance of wetlands for human culture. Supported by that fact, and by the progressive development of the wise use and ecological character concepts over subsequent years, Ramsar has increasingly provided an interesting model of integrated approaches to the conservation and management of both the natural and cultural heritage. In this, it shares some common interests with the World Heritage Convention (UNESCO, 1972), and there is good collaboration between Ramsar and UNESCO in that context. This is not least because both Conventions have regimes for identifying and protecting networks of important areas. Moreover, some individual sites can have both designations, hence needing a coordinated approach (see for example Schaaf and Clamote Rodrigues, 2016). Institutionally, however, the World Heritage system, and UNESCO more generally, often treats natural and cultural heritage in different ways. There is also an imbalance in the global list of World Heritage sites, with around four times as many sites listed for their cultural values as those listed for their natural values. Partnership working with Ramsar therefore is important, as the latter may offer some leadership on ways of taking an integrated approach across the two types of heritage.

The Parties to the Ramsar Convention have adopted three formal conference Resolutions on culture and wetlands (Ramsar Convention 2002, 2005c, 2018), and another on Indigenous peoples and local communities (Ramsar Convention 1999). Included in these are principles and guidelines on ways of giving proper attention to social and cultural values in the context of wetland conservation and management. Interested organisations and individuals have joined together in the Ramsar Culture Network, a voluntary community of interest and practice that serves as a platform for knowledge-exchange, policy development, collaborative research and awareness-raising activities. As an expanded supplement to the guidance in the Resolutions mentioned above, one of the Network's first initiatives (at a time when it was known as the Ramsar Culture Working Group) was the publication of a more extensive guidance document in 2008 (Papayannis and Pritchard, 2008).

There is a recognition at the heart of this that wetlands shape human societies, and at the same time human societies shape wetlands. The World Heritage concept of cultural landscapes (UNESCO, 2019) only partly reflects this, in that it addresses the second aspect but not the first. Ramsar's acknowledgement of a more bi-directional relationship in this respect finds greater similarity with the philosophy of another Convention, the European Landscape Convention (Council of Europe, 2000). The breadth of elements encompassed by the concept of wetland ecosystem services should be borne in mind here. As well as tangible benefits such as provision of food or building materials, and natural infrastructure protections against flooding or land degradation, it also includes important intangible values such as spiritual development, sense of identity, knowledge and aesthetic experience (Millennium Ecosystem Assessment, 2005). These can all, at different times and in different circumstances, be equally critical to a society's ability to survive, and to its resilience in the face of unwanted change. When a wetland has great cultural significance (and it may for example have both Ramsar and World Heritage designations, as mentioned above), this might in some cases be simply a matter of locational coincidence. A site could be sacred because a saint was born there, or a temple was built there, and by coincidence it happens also to be a wetland. The concept of cultural ecosystem services, however, involves something more; namely a necessary and intimate link with the functioning of the ecosystem itself (Pritchard, 2018). This could involve, for example, myths or deities associated with the seasonality of the water regime, traditional uses of the wetland products, the reflection of a wetland system's special aesthetic qualities in art, or other factors. The cohesive structure and resilience capabilities of a given society could be substantially built upon knowledge, traditions, practices and the assigning of roles and responsibilities to particular social groups in relation to these aspects.

Conversely, a range of cultural values of this same kind can play a key role in maintaining the ecological character of wetlands. Examples include places where religious taboos protect wildlife from over-exploitation; others where customary regimes for apportioning water rights or traditional knowledge about sustainable irrigation methods help to maintain the ecosystem; and others where the significance of an area as an icon of local identity is the basis for people being motivated to protect it. It is important to stress here that not every indigenous tradition or culturally significant use of a wetland is necessarily benign for the ecosystem. In some cases there may be conflicts that need careful managing. Mass participation ritual events, religious souvenir-hunting and over-harvesting of medicinal plants are all examples that can cause damage.

Policymaking on environmental sustainability partly concerns questions about the self-renewing capacity of natural systems. It also, however, involves issues of the choice of societal attitudes, to questions such as the extent to which humanity owes a moral obligation to future generations, and the spatial scale(s) at which we perceive our place in the world. These issues are informed by the language of cultural value. Practical wetland management strategies therefore depend as much on a good understanding of this kind of cultural context as they do on knowledge about aspects such as water chemistry or animal population dynamics. The limiting factors that prevent the adoption of effective strategies for environmental sustainability often stem from societal issues such as mis-matched world-views, linguistic framings and ideas about values. Fundamentally these are matters that are culturally determined. What is at stake here, therefore, is much more than simply documenting the breadth of benefits attaching to particular wetlands. In this sense it could even be possible to say that the entire agenda of the Ramsar Convention is rooted in matters of human culture.

The "global leadership" project

After many years of relying on voluntary support, work on culture in the Ramsar context received a major boost from March 2015 to March 2018, through a three year agreement with the MAVA Foundation, brokered by the Ramsar Culture Network and signed by the Convention Secretariat. The project supported was entitled "Conservation of the natural and cultural heritage of wetlands: global leadership for an integrated approach"; and its five programme strands, part-funded by the Foundation, covered policy, knowledge, appreciation, partnership and engagement (the latter aimed at enhancing the operation of the Ramsar Culture Network). Within this framework a series of events was organised, and a number of knowledge-exchange projects produced various useful case studies, tools and reports, several of which can be found on the Ramsar website.

One example was the development of a methodological guide to undertaking low-cost rapid "cultural inventories" for wetlands (Pritchard, 2016), which then supported some individual inventory initiatives in different parts of the world, including one that covered parts of North Africa and the Middle East, conducted jointly with the Arab Regional Centre for World Heritage (Abulhawa and Cummings, 2017). A major review of wetlands and Indigenous peoples and local communities was also produced (Oviedo and Ali, 2018), as well as a compilation of case studies with lessons learned from sites that have both Ramsar and World Heritage designations, which was funded by the UN Environment Programme and was carried out jointly with UNESCO (McInnes, Ali and Pritchard, 2017). Other sub-projects addressed subjects including Mediterranean gastronomy (Dodouras, Lyratzaki and Papayannis, 2018), women's management of shellfisheries in West Africa (Sanó, 2018), and examples of wetland culture in the Pacific Islands (Denyer et al., 2018), Colombia (Páez-Vásquez et al., 2018) and Central Europe (Kadlečík, Kubicová and Thompson, 2018).

Networking and communications were supported by a periodic newsletter, with articles and special editions on topics such as water, art, gender, language, agriculture and others; while technical and policy inputs were made to advances concerning multiple values of wetlands, the Ramsar Sites database and Resolutions of the Conference of Parties.

Water heritage and contemporary art

It is worth just briefly here singling out the issue of art, as mentioned above, because this has advanced in some interesting but under-appreciated ways in recent years. More than simply an ornamental or interpretive human response to the water environment, art of all kinds (literature, performance, visual art, land art, political activist art, conceptual art, etc.) is a significant aspect of contemporary tangible and intangible values of the living heritage of water. This is reflected in the categories of ecosystem services that relate to aesthetic inspiration and cultural expression, in the making of meaning and the making of place, in a historical context and in a phenomenological context of lived experiences today.

Contemporary art often has an obvious role in the interpretation of all kinds of heritage; finding attractive ways of engaging attention, and imaginative ways of putting across a story or creating an experience. What is generally less obvious, however, is the role that certain arts practices can also play in mediating public policy conflicts, challenging and expanding the philosophy of heritage values, providing a language for cultural identity, and leading transformative change. Some art also has a special value in being a vehicle for breaking beyond the undue sectoralism and boxed-in thinking which, as suggested earlier, is often a key obstacle to the adoption of sustainable holistic strategies for environmental management (see Fremantle, Douglas and Pritchard, in press). This therefore goes far beyond art being merely used as a medium with which to communicate about non-art issues. It is instead a matter of what the art represents in its own right, as part of a repertoire of human capabilities. Nor is this to reduce its function to one of utilitarianism, but rather for it to be more fundamentally a component of more artful approaches overall; in value systems, shifting paradigms of what heritage means and how it is managed, and the fostering of creativity in a broader sense that will produce fresh ways of thinking, acting and being in the world (CIWEM-AEN, 2012; Weintraub, 2012; Brady, 2016).

Artists who work with the heritage of water are therefore not necessarily making objects or producing representations. Their work is just as likely to involve interventions and collaborations with communities, river engineers, water supply companies, religious leaders or heritage agencies, on a wide variety of topics as illustrated by the examples below:

- habitat restoration;
- rebuilding communities after flood and drought disasters;
- modelling climate change;
- mapping lost rivers and rediscovering water sources;
- recovering lost folklore;
- demonstrating water flow dynamics;
- researching water chemistry and molecular water memory;
- modelling the hydrological cycle by running a farm;
- designing major infrastructure solutions for drainage, flood control and water quality treatment;
- environmental justice, ethics and conflict mediation over rights to water;
- new rituals for respecting water;
- accounting for virtual water in trade;
- museums of water;
- documenting sacred water sites in China.

This illustrates the breadth of the present-day field of ecological arts. Working in this way in multi-disciplinary contexts, where problems can be tackled with the skilled insights of re-framing the questions at issue, exploring creative challenge and expanded engagement, is increasingly being seen by mainstream water and heritage institutions as a real source of fertile hope for the future. One of the sub-groups of the Ramsar Culture Network, the RCN Arts Thematic Group, is focused on art, and it is giving attention to just this kind of approach.

Conclusion: Integrated multi-disciplinary approaches, and collaboration

As this short account has shown, art, traditional knowledge and the social sciences are an important part of the technical work undertaken in the framework of Ramsar Convention implementation, alongside the other disciplines of ecology, limnology and hydrology. Ramsar may in this way be considered the pre-eminent global governance framework for dealing with the heritage of water in its landscape and socio-ecological context. Powerful drivers for action on this exist in the Convention's requirements and its policy commitments, good practice standards and data systems adopted and operated by Contracting Party governments.

Properly integrated implementation, however, remains generally weak. Lead authorities for the Convention in most countries tend to be Environment Ministries or conservation agencies, staffed by biologists or environmental scientists rather than culture specialists. More needs to be done through cross-sectoral working methods and partnership with organisations such as UNESCO and ICOMOS. The development of a new Scientific Committee on Water and Heritage within ICOMOS offers good prospects for strengthened moves in this direction. The issues at stake here are fundamental ones – the part that culture plays in wetland conservation, and the part that wetlands play in water security, cultural heritage and people's livelihoods and well-being. It is to be hoped that good leadership on this will continue to be given in future by the Ramsar Convention, with the support and collaboration of all other interests in the fields of water and heritage.

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Unveiling Venice's hidden waterways heritage: From the digital and extended Water Museum of Venice to UNESCO's Global Network of Water Museums

Eriberto Eulisse

Water, as with all things considered only for their usage, has become alienated from its own history, and made 'invisible' (Renzo Franzin, 2005).

Introduction

The emergence of Europe as a world power cannot be understood without recognizing the critical role played by its dense plot of navigable rivers and artificial canals in establishing the industry, carrying out trade activities, and building the nation. Characterized by intrinsic complexities, the history of European waterways begins in the middle ages, develops further during the Renaissance, and reaches its highest point during the industrial era when rivers are modified substantially and new canals built to optimize water transport. In this process, waterways have become a symbol of the establishment of the modern nation-state (Hassan, 2010). For a long time, waterways served as structural assets to develop intense trade-off and as linear paths for economic growth and intense cultural exchange. Indeed, cultural expressions should be acknowledged together with economic drivers. Fertile interactions among natural elements and human ingenuity produced distinctive and unique architecture as well as heritage along the waterways. So, manifold representations of waterscapes in European paintings and literature can be considered as the most iconic landscape elements in the continent's history (Cosgrove and Petts, 1990; Schama, 1995; Vallerani, 2017).

The city of Venice is renowned worldwide for its centuries-old dominant position in Mediterranean maritime trade and its business, which was oriented mainly towards the East (Lane, 1973; Norwich, 1981). However, the huge investments aimed at controlling and modifying rivers in the hinterland, towards West, and the titanic hydraulic works made by the Republic of Venice to develop an efficient system of waterways for inland navigation are still largely overlooked in the literature. With the only exception of a few cultural landscape studies, the complex waterways system built westward by Venice in its inland counties has not been enough studied well enough (Dorigo, 1983; Cosgrove, 1993; Vallerani, 2017). The hydraulic heritage created in Venice's country estates further inland is an interesting example to reflect upon a curiously neglected water asset. Indeed, considerable changes in water management, perceptions, and attitudes towards Venetian inland waterways can be noticed over the last few centuries.

This paper discusses a project planning approach aimed at re-valuating the heritage of Venetian waterways—both cultural and natural as well as tangible and intangible. Following a research perspective outlined already (Eulisse and Visentin, 2018), it focuses on the geo-historical context of Venice's inland waterways. Next, it discusses how new applications of ICTs to cultural heritage and the involvement of local communities can provide useful models to redeem derelict waterscapes. In this frame, it is being highlighted how it is possible to build a strategy for sustainable tourism linked with waterways' heritage in districts where there is no significant tourist flow today. The paper also presents some concrete outcomes of the research and project-oriented approach developed by the University of Venice Ca' Foscari and *Civiltà dell'Acqua* in order to sensitize regional authorities about the potential development of a responsible tourism business along inland waterways[1]. The desire to re-discover and promote this inherited water asset has led to the creation of a number of digital itineraries that have been awarded at the international level.

Digital routes are powerful tools to promote the value of waterways for human well-being. Indeed, psychological and medical investigations have provided consistent insights into the importance of blue spaces for their salutogenic effects on human health (Herzog, 1985; Gesler, 2003; Williams, 2007). In this perspective, it will be highlighted how waterways can be considered as a strategic asset to enhance the quality of life for residents and develop new forms of sustainable eco-tourism in Venice, a city where mass tourism's impact is becoming increasingly heavy and harmful nowadays.

An additional outcome of this planning approach is the *Water Museum of Venice,* a digital online platform created to provide more visibility to major and minor local water heritage. This digital museum

[1] The *Civiltà dell'Acqua* ('Water Civilization') International Centre is a non-profit NGO based in Venice, Italy. The Centre was founded in 1996 to promote trans-disciplinary and holistic approaches to change unsustainable behaviours and practices in water perception, use and management. See www.watermuseumofvenice.com/engl and www.civiltacqua.org [accessed 5 Dec. 2019].

promotes not only methods aimed at digitizing and classifying the hydraulic assets, but also at improving heritage physical access and fostering public participation. As a result, local museums, organizations, and institutions engaged to re-valuate the inherited liquid heritage and promote more sustainable water management models have been integrated into an active network—the *Water Museum of Venice*.

As it will be discussed in the final part, activities developed with local institutions served eventually to build a worldwide network of water museums and heritage sites. The *Global Network of Water Museums*, which in 2018 was formally endorsed as a 'flagship initiative' of UNESCO-IHP, is committed to promoting any form of inherited water asset to foster more farsighted water management and facilitate the implementation of several SDGs[2].

A human-made waterscape: Venice's heritage of inland waterways

A summary of the history of Venice's inland waterways and their pivotal role in the flourishing of the *Serenissima* Republic of Venice[3] is essential to understand why and how local water heritage can be considered as well as promoted as an 'extended water museum'. Over the centuries, Venice's endeavours to manage and control different watercourses transformed radically large portions of the original natural landscape characterized by marshes and ever-changing lagoons. Similar transformations required specialized hydraulic knowledge and technology—this know-how resulted from a specific cultural and socio-economic context. The care for local hydro-morphology and all water flows has always been a field of utmost importance for the *Serenissima*. Thus, functional and well-managed waterways generated unique inland waterscapes, which were admired by writers and travellers like Goethe, Montesquieu, and Shelley, to name a few. Yet, despite the high level of sophistication of hydraulic models and works which have been developed at least over 700 years—from the 12th century to the 18th century—the rich and unique heritage of Venetian inland waterways is still an under-investigated subject (Dorigo, 1983; Cosgrove, 1993; Vallerani, 2017).

As testified by archaeological investigations, the present-day hydrography of Venetian hinterland is the result of a long history of human operations. Since the medieval ages, navigable rivers were considered as part of a complex hydrography where

[2] See: https://sustainabledevelopment.un.org/?menu=1300 [accessed 15 Nov. 2019].

[3] In historical chronicles, the Republic of Venice is often referred to with the epithet of the Serenissima (i.e. the 'most serene' or unperturbed city).

natural watercourses could be connected by means of artificial canals. However, owing to irregular flow patterns and differences in water levels, not all local rivers were naturally suitable for navigation. For this reason, from the 12th century onwards, several artificial canals were constructed to strengthen fluvial trade connections. During the Renaissance, new hydraulic knowledge contributed to a more sophisticated control of all water flows. A well-managed network of navigable waterways was built further to facilitate both trade and the transportation of military troops for strategic control of inland counties. The increased number of liquid roads was functional to connect Venice to other inland cities like Milan, Bologna, Ferrara, and Mantua.

In 1476, after the fall of Constantinople, the interests of the Venetian aristocracy gradually shifted towards the country estates located in the mainland westward. Huge capital was invested to develop modern agriculture near farms and villas always built along the well-managed and navigable waterways. Thanks to new hydraulic knowledge and know-how, this period was characterized by massive waterworks which included not only drainage management and further development of an artificial canal system, but also the diversion of major river flowing away from coastal lagoons. From the 16th century onwards, hydraulic engineers increasingly focused their efforts on controlling all watercourses and diverting them away from the Venice lagoon. New findings made it clear that continuous transportation of fluvial sediments would have provoked soon the transformation of the city and its satellite islands into a wretched mainland—an environment without natural defence for the Serenissima. For this reason, some renowned *Savi alle Acque* (water masters), such as Cristoforo Sabbadino (1489–1560), embarked between 1601 and 1684 on a series of gigantic public works to divert systematically all rivers flowing into the Venice lagoon, including the Brenta, the Sile, the Piave, and even the mighty Po river (Ciriacono, 2006; Eulisse, 2014; Vallerani, 2017).

Beyond security needs and trade opportunities, waterways also became a popular leisure spot for the Venetian aristocracy. From the Renaissance, the nobility started to commission the construction of country farms, magnificent villas, and pleasure gardens as symbols of the power of Duke families. Side canal locations were listed among the most attractive sites in Andrea Palladio's treatise on architecture (1570), thereby matching productive interests with leisure aims. Today, most of this heritage still survives along inland waterways, creating attractive and unique waterscapes. The *Riviera del*

Image 1. The river port of Portello, in Padua, was depicted in many paintings of Canaletto. Photo courtesy: Water Museum of Venice.

Image 2. Villa Contarini, located in Piazzola sul Brenta (Padua), is a typical example of attractive Palladian architecture built along the side canals. Photo courtesy: Water Museum of Venice.

Brenta is a good example of this. This canalized stretch of a former river connects the Portello, the fluvial port of Padua (Image 1), to Venice and its lagoons. This waterway is also known as the 'elongated Grand Canal' of Venice, since the 40-km liquid road is lined with amazing buildings such as Villa Pisani and Villa Malcontenta (Image 2).

Fascinating hydraulic artefacts and waterworks—many of these are still functioning today—shape this human-made inland waterscape. This is a landscape built both by nature and human tenacity in striving to control and modify natural watercourses over the centuries. Its peculiar characters can be found in the vast, although today quite fragmented, hinterland of Venice (Dorigo, 1983; Cosgrove and Petts, 1990; Cosgrove, 1993; Eulisse, 2014; Vallerani, 2017).

Thanks to well-tested hydraulic management models, historical waterways have been used as a secure mobility system also after the fall of the Republic (1797) and until the First World War. Nonetheless, in the 1950s and 1960s fluvial trade declined dramatically, and neglect and indifference towards this water heritage started to prevail. All state investments previously directed to maintain the historical system of 'liquid roads' were diverted to support railways and motorways' networks. The decay of the infrastructure of waterways produced large negative impacts on riverine towns and communities. The fluvial trade economy and related activities by craftsmen declined relentlessly. What is more, their abandonment simultaneously marked the progressive loss of memorial values and the sense of place linked with Venetian inland waterscapes (Image 3 and 4).

Image 3. The so-called cemetery of burci ('barges', traditional wooden boats) on the Sile river, near Treviso, is a symbol of the derelict state of river sailing traditions along Venice's waterways. Photo courtesy: Water Museum of Venice.

Image 4. The last existing examples of traditional wooden boats are kept and used by local rowing clubs, such as the 'Remiera El Bisato' of Battaglia Terme: a town located at the Medieval waterways' crossroad. Photo courtesy: Water Museum of Venice.

Inherited water heritage among memories, identity, and a new sense of place

The progressive abandonment of Venice's inland waterways and related water heritage can be compared with the western sections of the Po Valley and the county of Milan, where river navigation started as early as in the middle ages. Today, the regional governments of Veneto and Lombardy have failed to develop a strategy to regenerate inland navigation for tourists and waterways-related assets, despite their considerable potential as tourist destinations. In northern Italy, the waterway network is managed today with highly fragmented regional policies and regulations compared to other European countries like France, Germany, or England. With the only exceptions of the *Riviera del Brenta* (the well-known 'elongated Grand Canal' of Venice) and the *Navigli* (Milan's artificial canals of medieval origins), all the remaining waterways are today in a state of general abandonment and disrepair. It is worth noticing that the waterways system built historically by the Serenissima has suffered not only from a functional decay, but also from the decline of a fluvial sense of place—the loss of identity and perceptions that for centuries inspired so many people's lives and behaviours. Local water worlds were abruptly truncated in the 1960s with a sudden stop of traditional river trade. This cleavage is testified in many books of local history and in the ethnographic literature, where both tangible and intangible cultures linked with the tradition of Venice's inland navigation have been investigated[4].

After half a century of decay, a spontaneous (though fragmented) revaluation of waterways-related amphibious identities is now occurring due to a rising awareness of their multifunctional values. Based on longstanding lifestyles shaped by material relations with water, including traditional fishing, activities of craftsmen, and religious beliefs, local communities are now striving to create new links with inherited blue spaces. Practical examples of these waterways' re-valuation range from leisure activities of a growing number of residents to rowing clubs' traditional practices devoted to the *voga alla veneta* and other popular events like the *Vogalonga Euganea* and the *Remada a seconda*.[5] Moreover, a few municipal museums have been created to keep and exhibit ethnographic artefacts related to sailing traditions. Among them, one can find in Battaglia Terme (Padua) the River Navigation Museum, the only museum dedicated to river navigation in Italy[6]. These initiatives have been crucial in keeping alive the traditional sense of place of small river towns historically linked with Venetian waterways. In this context, partnerships among local institutions, museums, and associations can play an important role to regenerate a sense of place linked with historical waterscapes. In addition, there is today an increasing interest in the ecological conditions of riparian environments as far as these contexts provide an ideal setting for sports and recreational opportunities, thus satisfying the growing demands of citizens for attractive places to relax and regenerate physically and psychologically in daily life (Vallerani, 2017).

In revaluating any form of water asset, there are several advantages to consider including its direct correlation to human well-being. The literature consistently demonstrates that health benefits are strongly associated with blue spaces. The concept of 'therapeutic landscape' incorporates a physical, social, and spiritual environment—and it is very often associated with water. In both urban and natural contexts, recreational and restorative experiences along blue spaces have stress-reducing and mood-enhancing powers, thereby intensifying the mental attention and mood (Herzog, 1985; Kaplan and Kaplan, 1989; Gesler, 2003; Williams,

[4] See Pergolis, R. and Pizzarello, U. (1981). *The boats of Venice*. Venice: L'Altra Riva. Pavan, C. (1989). *Sile, alla scoperta del fiume [Discovering the Sile river]*. Treviso: Cooperativa Servizi Culturali. Zanetti, P.G., ed. (1998). *I mestieri del fiume. Uomini e mezzi della navigazione [The river's crafts. Men and trades of navigation]*. Verona: Cierre Edizioni.

[5] The *voga alla veneta* is a typical rowing technique used with wooden river boats, where the rower paddles standing up from the bow. The *Remada a seconda* is a funny boat race on waterways, recalling the *Regata storica* (historical regatta) of Venice.

[6] See https://museonavigazione.eu/en/ [accessed 5 Dec. 2019].

2007; Abraham et al., 2010; Völker and Kistemann, 2011).

How to redeem forgotten water heritage sites?

After World War II, the progressive abandonment of Venice's inland liquid roads has been paralleled by unprecedented tourism growth in Venice, the well-known city listed as UNESCO's World Heritage (WH).[7] This growth, however, has been characterized recently by cumulative negative impacts. In 1987 the site designated as *Venice and its Lagoon* was registered as a WH for its uniqueness comprising 'historical, archaeological, urban, architectonic, artistic heritage and exceptional cultural traditions, *integrated* into an extraordinary and outstanding environment, natural and landscape context'. Indeed, Venice lagoons are one of the most noticeable examples of longstanding connections among hydrological natural dynamics and human activities, where a unique concentration of artistic expressions and natural environments can be found. It is for exactly this reason that UNESCO's designation of Venice includes simultaneously both cultural and natural heritage. However, like any site listed in the WH, UNESCO recommends that a management plan be implemented to examine constantly the forces of change underway and to define strategies and continuous interventions for the protection of the WH site's compatibly with sustainable development.

In addition to alarming high tides, there are other threats that jeopardize the survival of Venice. Today, over-tourism represents one of the major challenges for a city built in a unique although a very fragile water environment. Despite mass tourism—or maybe because of it—lagoon islands are suffering from heavy, rapid, and uncontrollable population decline. In this context, over-tourism is changing radically the life of its inhabitants—and this will lead to serious socio-cultural threats unless the whole process is planned and managed properly (Visentin and Bertocchi, 2019). The impact of over-tourism has often been condemned by the international press[8]. In 2015 a monitoring survey conducted by UNESCO announced the possibility to downgrade Venice in the list of valuable cultural assets 'at risk' because of unsustainable growing pressures due to mass tourism and the impact caused by big ships (UNESCO, 2015). After much controversy and discussions for the presence of big cruises in the lagoon, it was by mere chance that in 2019 a titanic

[7] See https://whc.unesco.org/en/list/ [accessed 5 Dec. 2019].
[8] See e.g. the article published in *The New York Times* titled 'Venice invaded by tourists, risks becoming *Disneyland on the Sea*' (Horowitz, 2017).

275-metre-long tourist ship crashing into a wharf did not damage the city's heart—St. Mark's square.

In this context, Venice's inland waterways represent considerable potential for alternative and more sustainable tourist itineraries if compared to mass tourism, which nowadays is damaging the socio-cultural fabric of Venice. Indeed, the fascinating natural and cultural water heritage of hidden waterways can play a crucial role in revaluating a forgotten Venice and foster unconventional as well as less stereotyped tourist experiences. But how is it possible to compete with the potent tourism industry? Experiential tourism provides the opportunity to offer 'authentic experiences' related to genuine local produce, craft, and fish tourism. Possible destinations for sustainable eco-tourism linked with waterways include a coastline of approximately 250 km, from Trieste to the Po delta river, with related lagoons and the inland countryside.

The final part describes how a cultural geography and anthropological approach, in combination with the use of digital media, was put into practice with the purpose of redeeming the derelict heritage of Venice's waterways and stimulating more sustainable tourism. The project objective was to co-design with locals a number of digital routes and stimulate new spatial relationships among residents and waterways. In this frame, project planning tried to promote the waterways' multifunctional values and alternative tourist routes through ICTs, thereby inspiring more farsighted tourism policies.

Revaluating neglected waterways by means of ICTs and digital tourism

The application of information and communication technologies (ICTs) to cultural heritage and tourism has been driven by a growing interest in how it offers new and meaningful experiences in the tourism sector. In the field of digital tourism, ICTs influence increasingly the way we travel and our approach to destinations. Interactive maps, digital information, and databases are transforming our habits of perceiving space and place. The use of applications for smartphones and tablets is revolutionizing the experience of tourists in the travel domain. Geo-spatial technologies are powerful tools to engage audiences and can stimulate access to cultural heritage (Pease et al., 2007; Dickinson et al., 2014; Xiang and Tussyadiah, 2014; Haus, 2016). The inland waterways of Venice offer a unique setting to use interactive maps and digital information to revaluate the neglected water heritage. By creating several digital audio guides, the interplay between water heritage and geospatial technologies provided the possibility to stimulate civic engagement towards minor waterways' assets. Indeed, digital itineraries can easily improve heritage accessibility and promote alternative routes compared to the stereotyped destinations of mass tourism.

Private sponsors and European funds provided the opportunity to digitize water assets and historical waterscapes located between the Euganean Hills (near Padua) and the Po delta river and create different digital itineraries co-designed by locals. A selection of the most relevant existing water heritage was digitized for this purpose, including rural farms, watermills, wooden boats, river ports, locks, bridges, elegant villas, castles, fountains, historical gardens, and even festivals related to river sailing traditions.[9] Examples of this peculiar mix, which considers both natural and cultural water assets, include the lagoon fishing basins of the Po Delta (a traditional fishing practice dating back to the Roman period) and the baroque monumental garden of Villa Barbarigo in Valsanzibio (Padua), to name a few (Image 5 and 6).

Image 5. The monumental water-door of the baroque garden of Villa Barbarigo (Valsanzibio) once was connected directly to Venice through the Medieval waterways system of the Euganean Hills. Photo courtesy: Water Museum of Venice.

Image 6. Digital routes invite visitors to explore the lagoon fishing basins of the Po delta by bike or kayak. An example of natural and human-made waterscape included in the *Water Museum of Venice*. Photo courtesy: Water Museum of Venice.

The main results of this project-oriented approach include four smartphone apps with more than 80 digital routes and the *Water Museum of Venice*: a new online platform designed to enhance public access to the water heritage of Venice's historical waterways. Digital routes are designed for tourists on kayaks, boats, bicycles, horses, and on foot. All of them are freely available to rural tourism networks, hikers, and cycling associations (Eulisse and Visentin, 2018). The digital platform of the *Water Museum of Venice* incorporates a consistent cultural and natural heritage with more than

[9] For the complete list of sites, see www.watermuseumofvenice.com/engl [accessed 5 Dec. 2019].

a hundred relevant water assets. This tool is functional not only to improve the visibility and access to inherited hydraulic assets, but also to create a framework for sustainable mobility and 'slow tourism' as well as to foster the implementation of SDGs (Eulisse, 2019).[10] The ideal context to promote Venice's forgotten water heritage and launch this platform for sustainable tourism along historical liquid roads was provided by a universal exhibition, which was co-hosted by the city of Venice in 2015.

Image 7. One of the outstanding Medieval wells of Venice displayed in the interactive space "Exploring the Venice Lagoon". This hydraulic system for collecting rain water was used until the end of the XIX century. Photo courtesy: Water Museum of Venice.

The extended museum of Venice's waterways

Inspired by the ethical framework of the 2030 Agenda, the project of the 'digital and extended' *Water Museum of Venice* was launched by *Civiltà dell'Acqua* in the framework of EXPO Venice to redeem the derelict waterscapes of the *Serenissima* and develop new opportunities for eco-tourism.[11] The project consisted of a combination of 'immersive installations' and new digital routes, combined with augmented reality, to re-discover the fascinating, although neglected, water heritage assets along inland waterways.

The multi-sensorial space *Exploring the Venice Lagoon* was made in cooperation with the Venice Municipality on the premises of UNESCO's Venice office in order to display the different forms of water civilization that tourists can discover both at the historical city centre and the many islands and lagoons nearby (Image 7). Another interactive installation, titled *Memories of the Po Delta*, was created to evoke the water worlds related to river navigation in the Italian largest delta river.[12] A third interactive installation, *Visualizing Water Worlds*, was made at the main entrance

[10] Digital routes of the Water Museum of Venice are downloadable for free from the open-source platform izi.TRAVEL. See also www.watermuseumofvenice.com/engl/routes [accessed 5 Dec. 2019].
[11] EXPO Venice is the title of the universal exposition hosted by the city from May to October 2015, in parallel to the main venue of EXPO located in Milan.
[12] Interactive installation made with the support of the Foundation Cassa di Risparmio di Padova e Rovigo.

Image 8. The interactive installation *Aquaboll*, made by the video artist Paolo Scoppola, was inaugurated to launch the *Water Museum of Venice* at EXPO Venice in 2015. Photo courtesy: Water Museum of Venice.

Image 9. The "Innovation Award" 1st prize was granted at the 29th World Canals Conference (2016) to *Civiltà dell'Acqua* for the project on digital routes related to Venice's waterways heritage. Photo courtesy: *Civiltà dell'Acqua* image archive.

of EXPO Venice to sensitize visitors on raising threats to the water heritage at both local and the global scales, right from the growing water pollution and islands of garbage patch on the oceans to local freshwater ecosystems at risk.[13] Interactive video games were made to attract visitors and reflect on the global water crises by playing with the liquid shapes of their bodies (Image 8). In this context, the digital platform of the *Water Museum of Venice* was framed not only as a digital repository of temporary installations designed for EXPO in different sites and locations, but also as an online tool to display the most representative heritage of the whole area crossed by Venice's historic waterways—from the Po to the Tagliamento river, thereby including the county estate that for centuries was subject to economic and cultural influences of the *Serenissima*.

Image 10. Video interviews included in the digital audio guides "Exploring forgotten Venice" (free download from izi.TRAVEL) portray the last Venetian craftsmen as carriers of ancient water knowledge. Photo courtesy: Water Museum of Venice.

Almost 300 points of interest linked to tangible and intangible water assets related to the historical network of Venice's waterways, including more than 70 digital routes, were digitized in four apps.[14]

[13] Interactive installation made in cooperation with Eulabor Institute and VSY.
[14] The following applications were developed between 2013 and 2016: 'Tagliamento river', 'Bacchiglione river', 'Euganean Hills and Medieval canals', and 'Po Delta'.

Thereby, in 2016 *Civiltà dell'Acqua* was awarded the 'Innovation Award' at the 29th World Canals Conference for its pioneering work—and this confirmed the growing interest at an international level to revaluate the neglected and 'minor' forms of water assets (Image 9). The methodology developed to create digital routes along Venice's inland waterways was then used to frame the project 'European Waterways Heritage', a pilot project aimed at creating a transnational platform, 'Waterways Explorer', co-designed with locals.[15] Following this, the traditional sailing heritage of Venice was the focus of another European Union-funded project titled 'Exploring forgotten Venice'. Five digital audio guides were co-designed with young students to explore and promote the derelict sailing heritage of Venetian wooden boats and related craftsmanship in some minor districts (*sestieri*) and islands of Venice (Image 10)[16]. Eventually, these digital itineraries were recognized in 2019 with the award on sustainable cultural tourism in Europe, conferred by Europa Nostra and ECTN.[17]

In summary, the *Water Museum of Venice* is not only a digital platform aimed at facilitating access to the inland waterways. By adopting methods of eco-museums, it is an 'extended museum' that includes both material assets and communities.[18] So, with its four-year project planning, the *Water Museum of Venice* can be considered as an extended and digital museum that embeds methods for heritage revival, public participation, and networking of local institutions committed to promoting sustainable water management.

The Global Network of Water Museums and UNESCO-IHP in support of water awareness education

Projects developed to create the digital platform and audio guides described above provided the background to generate an outcome that was not planned originally. Methods used to classify water assets, foster public participation, and networking local communities and institutions provided

[15] The project, led by the Venice University Ca' Foscari, was aimed at developing a common methodology for the census of the minor waterways heritage in four different European regions. EUWATHER produced eventually eight digital itineraries in four countries focusing on historical waterscapes through the open-source platform izi.TRAVEL. Project funded by the European JPI-CH programme. See: www.waterwaysexplorer.org [accessed 5 Nov. 2019].

[16] Pilot action funded by the Interreg project YouInHerit (Central Europe). All digital routes are downloadable for free from the open-source platform izi.TRAVEL (search for "Explore forgotten Venice").

[17] Prize "Innovation and digitization" conferred to *Civiltà dell'Acqua* for fostering the development of new "Sustainable Cultural Tourism Destinations" in Europe. See http://www.culturaltourism-network.eu/ [accessed 5 Nov. 2019].

[18] For the definition of 'extended museum', see: Folga-Januszewska, D., ed. (2017). *Extended museum in its milieu*. Krakow: Wydawnictwo University.

a conceptual frame to create a network of water museums and heritage sites on a global scale: the *Global Network of Water Museums* (WAMU-NET). Indeed, water museums display all over the world a unique repository of different forms of humankind's connections with water and its heritage, both on material and non-material planes. These museums exhibit artefacts, know-how, and techniques aimed at preserving and promoting an outstanding variety of traditional knowledge and water values that have been passed down through generations. By considering the inherited water management and know-how shaped by environmental limits, many of these museums are developing new approaches and interpretation tools to support the implementation of SDGs. Nevertheless, there is an overarching need to improve cooperation and share educational approaches among these museums.

During a seminal workshop co-organized in May 2017 by the UNESCO Venice Office that engaged some 30 museums from all over the world (Image 11), a manifesto was drafted with the goal of creating a network of institutions committed to promoting more sustainable water management on a global scale—the Global Network of Water Museums (WAMU-NET). At last, WAMU-NET was endorsed by the

Image 11. The director of the Musée de l'Eau of Burkina Faso reads the *Manifesto* of the Global Network of Water Museums to the Tribunal of Waters of Valencia, dressed in their traditional black togue. Photo courtesy: Water Museum of Venice.

Intergovernmental Council of UNESCO-IHP (Intergovernmental Hydrological Programme) as a 'flagship initiative' in June 2018.[19] As stressed by the Resolution n. XXIII-5 titled 'Global Network of Water Museums and UNESCO-IHP in Support of Water Sustainability Education and Water Awareness Efforts', educational activities focusing on SDGs are the core business of WAMU-NET. This resolution also highlights the need to strengthen cooperation with UNESCO on water awareness education to foster more far-sighted water management. Indeed, the Global Network aims to call upon people and institutions to implement urgent actions to repair our deteriorated relationship with the most precious liquid element on earth by promoting the values of ancient water wisdom in the frame of a

[19] See Report of the 23rd Session of the Intergovernmental Council of UNESCO-IHP (Intergovernmental Hydrological Programme), pp. 66–67 https://unesdoc.unesco.org/search/N-EXPLORE-deeb7503-c326-46d4-a196-b1b07ca08615 [accessed 15 Jan. 2020].

Image 12. Water awareness education activities at Yaku Parque Museo de l'Agua (Quito, Ecuador): a partnering museum of the Global Network. Photo courtesy: Yaku Parque Museo de l'Agua & Global Network of Water Museums.

new paradigm of sustainable water uses. In this sense, WAMU-NET is active to protect and promote any form of inherited water heritage—whether natural, cultural, tangible or intangible—in order to compensate the continuous losses of biological and cultural diversity related to water, thereby balancing the future needs of humans and the biosphere as a whole.

In recent decades, pure technocratic approaches conceived water, as stated in the charter of the Global Network, mainly 'as a means to support economic development at all costs'. In this perspective, the presence of water presence in human environments has been made increasingly invisible and far from public awareness. This condition has made the multiple values inherent to our precious liquid element more vulnerable than ever. For this reason, 'new multidisciplinary and holistic approaches are today crucial to overcome unduly narrow technical perspectives that have proved to be an inadequate response to present-day challenges'. There is a need to re-interpret our inherited liquid heritage to foster an ethically oriented vision that must inspire more farsighted water management (Global Network of Water Museums, 2019).[20]

Today, WAMU-NET groups almost 60 water museums and institutions from all over the world, which count together an average number of 20 million visitors per year. The network is growing constantly, thus confirming the need for improving coordination on water awareness education among museums and other institutions (Image 12). Shared educational approaches towards young generations focus on ground-breaking activities, combining water sciences with the urgent imperative to create new emotional bonds between people and water.

Conclusions

The historical waterways of Venice testify how the interaction among natural elements, architecture, waterworks, and craftsmanship has developed intensively over the centuries. This interaction proved

[20] Charter downloadable under the menu 'contact us' of: www.watermuseums.net [accessed 5 Nov. 2019].

to be non-invasive and in keeping with the nature. The case study of Venice's forgotten waterways investigated here highlights how nature and culture can and must be reconnected again in any project planning perspective on water heritage regeneration. The planning approach outlined in this paper confirms that cultural water assets cannot be artificially separated from aquatic ecosystems.

The gradual rediscovery of recreational opportunities offered by the whole network of Venice's waterways and their recognition as a crucial public asset can possibly lead to better protection and recovery of local hydraulic assets as well as of related freshwater ecosystems. Indeed, the re-generation of these waterways can play a crucial role in the complex dynamics of territorial competitiveness, inasmuch only a safe and pleasant environment—considering also the ecological functions and cycles—can provide residential and existential gratification, producing the serenity and confidence of citizens towards the future (Vallerani and Visentin, 2018).

Today, freshwater biodiversity is dramatically shrinking throughout the Anthropocene, and it must be stressed that different forms of water heritage and related biodiversity are, first and foremost, threatened by increasing globalized indifference. Historical practices and attitudes of respect towards water seem to have been lost in contemporary consumer societies, where the liquid element has too often been reduced to a mere chemical formula and its complex history and related values erased. In this sense, the root of the present-day global water crisis seems to be essentially cultural so that a new water culture—a new ethically oriented approach dealing with water—can be found to reverse all negative and harmful development trends (Illich, 1992; Teti, 2003; Franzin, 2005; Eulisse, 2010; Holst-Warhaft and Steenhuis, 2010).

In the encyclical letter *Laudato Si*, the perverse relations among capitalism, technocratic humanity, and an increasingly aggressive nature have been stressed with courage and farsightedness by Pope Francis within the greater context of a theology of nature. A blind faith towards the unlimited power of technology is misleading and, as such, will continue to produce even more harmful consequences to our common home (Francis, 2015). The challenges of growing water scarcity, depletion of resources, pollution, and disrupted patterns of floods and droughts because of climate change, together with a dramatic decline in both biological and cultural diversity, cannot be resolved through purely technocratic approaches. Now more than ever, interdisciplinary and holistic visions are necessary to ferry humankind towards a new water paradigm (Global Network of Water Museums, 2019). By considering ecosystem services together with bio-cultural values as the primary unit of any form of water heritage, it is possible to strengthen eco-social approaches and mitigate the biological and cultural diversity crisis of water (Strang, 2004; Lianyong and Eagles, 2009; Wantzen et al., 2016).

In this paper, it has been outlined that while redeeming inherited cultural assets there is an opportunity to regenerate local ecosystems and produce tangible effects on human health and well-being. From this perspective, the project planning approach, which was built to unveil the hidden heritage of Venetian waterways as a 'digital and extended' museum, by connecting the local to the global can be taken as a reference to stimulate new processes of water heritage revival and rejuvenation all around the globe. Traditional water knowledge and know-how—which has been passed down through generations over a long history of human fight and coexistence with the liquid element (as it is exhibited by many museums worldwide)—can still inform and influence our everyday life by inspiring more far-sighted water management models. Indeed, museums today play a pivotal role in educating youngsters and inspiring innovative solutions to the global water crisis. Water museums are to be listed listed among the key players in fostering new holistic visions rooted in ancient water wisdom.

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Water wisdom for sustainable urbanization in Asia

Nupur Prothi Khanna and Prachi Sharma

Introduction

Water has been an enabler of societal development as human civilizations flourished near river embankments or valleys harnessing the abundant water supply for domestic consumption and food production. Many of these known ancient civilizations were located in Asia and Africa, named after these river embankments/valleys such as the Indus River system (Indus Valley Civilization), the Nile River (Ancient Egyptian Civilization), the Yellow River (Huang-He River Civilization), and Tigris–Euphrates (Mesopotamia Civilization). In course of civilization growth, the water bodies or waterscapes became integral parts of human communities and their economic, social, cultural, political, religious and spiritual aspects. 'Water is life' became a common phrase in many languages (Image 1).

Image 1. Historic landscape in Kyoto, Japan (Nupur Prothi Khanna).

Image 2. The future of the past, Mengzi town, China (Nupur Prothi Khanna).

Historically, it was not assumed that water could be a limiting factor for human development; however, as populations grew from millions to billions, they started to see the finite dimension of water, which is now termed 'water scarcity'. Once a life-critical natural resource becomes limiting, attention is diverted to its value, its use or misuse, its criticality to survival, and its conservation. Humankind started feeling constrained and questioning the early assumptions of the infiniteness of water, and more importantly, exploring ways to overcome this scarcity as climate change, coupled with an over-stretched carrying capacity of the ecosystem, came in the way of the development of civilizations (Image 2).

Globally, more than 2 billion people are already living with high water stress (UN, 2018). Nearly 73% of the people affected by water scarcity are in Asia. This figure is projected to be 69% by 2050 (Burek et al., 2016). South Asia alone accounts for 25% of the world's population and has access to mere 4.5% of the global freshwater resources (Kumar et al., 2015).

Image 3. Water channel within royal complex, Seoul (Nupur Prothi Khanna).

Fortunately, water is now being discussed in many domains which have a diverse worldview on the subject. Understanding its universal nature, its value to human existence, and its multi-dimensionality needs to chart the way forward for water conservation. Applying an integrated approach, a holistic perspective in Asia is facilitated by dialogue among diverse stakeholders with asymmetric knowledge contexts, capacities, beliefs, socio-economic backgrounds, within an overarching cultural and spiritual vision. This article highlights the Asian perspective on the urban challenges of population growth, environmental degradation, and an increased demand for freshwater in a reality of fast-depleting resources. It explores how water heritage, or wisdom learned and earned over millennia, can be a guiding light for future innovation, sustainability, and eventually, our survival (Image 3).

The Asian urban dilemma

'A first of many firsts in city building, this millennium witnessed a majority of the 7 billion global population becoming urban for the first time in world history' (UNCHS, 1996b). A singular figure of global statistics does not convey the reality of unequal population distribution across geographies. Disparity in population growth distribution is evident as it is merely three countries—India, China, and Nigeria—that account for 37% of the projected growth of the world's urban population between 2014 and 2050, with the two Asian nations adding the bulk. The figures for India are forecast to reach 404 million urban dwellers, China, 292 million, and Nigerians accounting for 212 million. What is the future for Asian cultures that have survived out of a deep respect for context, especially water, at the core of global urban expansion? What is the future relevance of traditional cultural practices to the physical environment in the urban realm?

As witnessed across Asia, an unprecedented rate of urbanization has severely eroded the cultural fabric of cities, towns, and urban villages, directly impacting their water systems. As evident in urban stretches, the current use of waterways and water bodies as dumping grounds carrying sewage, sullage, and solid waste has completely obliterated their connection with the community. This has irreversibly eroded the relationship that was vital to their protection in the past. Many examples found across Asia reiterate this indifference. For example, the Xinmalu heritage district in the city of Ningbo, China, served as the historical transition for the historical silk route from sea to land. A tour through the expanse of the city and a visit to the Grand Canal in the region shows the face of a modern city which has forgotten its physical and intangible connection with the network of water systems. As is visible in many town centres, this city has lost its original water network in the urban landscape. Perceived as a city of canals, Ningbo has turned its back on natural drains and water that retain some relevance only through family folklore and memories of an outgoing generation. This water narrative is not reflected in the planning and policy for the city. This reality is a normal for other Asian cities (Image 4).

Image 4. Ningbo: new response to the historic water system (Nupur Prothi Khanna).

Indian cities such as Chennai, Delhi, and Bengaluru are visibly suffering the consequences of such neglect. The river Yamuna, which flows through the Indian capital Delhi, has played a crucial role in the selection of this strategic site for ancient civilizations. The historic imperial city of Shahjahanabad, founded in 1639 A.D., was modelled on natural barriers created by the Yamuna and the ridge (forested hilly area). Subsequent descriptions from the colonial era mention canals criss-crossing this terrain, most of which have vanished, dried up, or been encroached or misused over the years. With the community caring for these 18 tributaries, and about 800 large and small ponds and tanks, the settlement would have faced fewer issues of water shortage (Mishra, 2012). Increasing population and rapid urbanization have taken over these tributaries and ponds, drastically reducing the width of the river and its floodplains, incoherently populating the landscape which once nurtured the city. Traditional knowledge respected and worked with its water systems, but the postcolonial planning and aspiration to modernize and subsequent infrastructure development have impacted the water-safe futures of many of these cities.

In the Southern Indian city of Bangalore (Bengaluru), many lakes, also referred to as ‘tanks’, have disappeared along with their catchment areas due to the rapid and unbridled urbanization and associated development ending in frequent flooding even with a normal range of rainfall. Field surveys since 2007 show that many of these tanks (54%) have been illegally encroached for construction; nearly 66% are sewage-fed, 14% surrounded by slums, and 72% showed a whopping loss of catchment. A similar analysis for the neighbouring city of Chennai indicates a 13-fold increase in surface concretization and one-fourth reduction of the flood plains and open areas (Rao, n.d.). The Centre for Ecological Sciences at the Indian Institute of Bangalore used satellite imagery, topographical maps of the Survey of India and the Chennai Municipality to demonstrate that the severe flooding in 2015 was a disaster in the making. In 2019, just four years after the flooding episode, the city again hit the headlines for is extreme drought-like scenario of the magnitude similar to the Cape Town water crisis, severely impacting its 10-million population.

This is the urban reality where Asians have inevitably come to live within urbanized conglomerations, with densification of villages, sprouting of peri-urban centres around large towns, and also the migration of people into towns, and the quality of their lives and livelihoods being severely affected by the paucity of life-giving water systems. Indian and South Asian cities critically rely on their floodplains, marshes, and wetlands for draining excess water and maintaining the quality of their water systems, many of which are lost in the quest to provide urban infrastructure. This has set off a vicious cycle of extreme weather events, such as flooding and droughts, thereby exacerbating the impacts of climate change.

A Glimpse of Written Rules of Operation/Management from Sheikh-Bahaie Water Allocation Scroll (originally in Persian)

Image 5. Glimpse of written rules of Operation/ Management from Sheikh Bahaie Water Allocation Scroll (ICID News, 2018).

Traditional water wisdom: The case of Sheikh-Bahaei Scroll in Iran

There are abundant examples of water wisdom across Asia that reiterate the centrality of water to civilization. The Sheikh-Bahaei Water Allocation Scroll in West Asia, for example, is reminiscent of a special water distribution pattern or system attributed to the famous scientist and scholar Sheikh-Bahaei (Image 5). It was set during the Safavid Dynasty after the reign of Shah Abbas I (1571–1629). Today, while changes in the catchment and general socio-economic conditions have led to changes in the system of water distribution in Isfahan, what was written in the Sheikh-Bahaei Scroll continues to be the most acceptable way to allocate water of the Zayandehroud among traditional water users, in particular local farmers. The system laid out in the scroll has been adopted by law in 1954 as the main pattern of water distribution in the Isfahan region of Iran. This distribution was also referred to by the Law of Equitable Water Allocation adopted in 1982. At present, the volume of water is distributed based on time, location, and particularly the percentage of water available in the river. This means that, based on water availability in the river, the water is allocated among the 33 water shares.

Image 6. Historic Wood cut system for water sharing at Honghe Hani Rice terraces in China (Nupur Prothi Khanna).

In times of water shortage, water availability and distribution become critical in the region. The Sheikh-Bahaei Scroll, conceived nearly four centuries ago, remains relevant in this scenario as it addresses the inadvertent transformation of the landscape, such as the extension of cultivated lands, leading to the development of new irrigation networks. Based on the Scroll, the adaptive water management in Zayandehroud mitigates the impact of climate change and increasing water requirements (ICID News, 2018).

A similar ethos of water sharing can be found in many agricultural societies that

Image 7. Honghe Hani World Heritage Cultural Landscape, China (Nupur Prothi Khanna).

live by traditional farming techniques. The rice terraces of the Ifugao people in the Philippine Cordilleras was the first site to be nominated to the Cultural Landscape category of World Heritage List in 1995. The Honghe Hani rice terraces of South Western China, a World Heritage Cultural landscape and a GIAHS site (Globally Important Agricultural Heritage Systems), follows a woodcut system (Image 6) for water distribution under the supervision of a village elder, a system that has continued for over a millennium. Similar to related rice growing systems in the region, traditional wisdom around water availability, water distribution, and water stewardship continue to be relevant in these societies (Image 7).

Aesthetics of inclusion

The notion of water-based development has been prevalent across geographies and timelines, serving as perhaps the earliest example of design for sustainability (DfS) and design for environment (DfE). The correlation between architecture and water in terms of urban design and material vocabulary is visible till today in historic towns across Asia. For example, the architecture of the ghats (stepped interface of water edges) invariably responded to the changing water levels of the river, respecting the maximum (monsoon) and minimum (lean period) seasonal variations of water flow (Dept. of Landscape Architecture, University of Illinois, 2014).

Studies related to the Indo-Gangetic plains illustrate some meaningful responses to water, for example, at Bithur, a lesser-known historic town in the north Indian heartland (linked to the valour of Rani Laxmi Bai, a renowned female freedom-fighter). The town was conceived for its religious associations with the holy river that auspiciously flowed from north to south and was considered extremely auspicious in the landscape. The river edge was designed as a poetic composition of spaces and details, showcasing an architectural vocabulary rhythmically imbued with lines and punctuations, most of which lie wasted today (Ray, 2008). The Ghats of Varanasi, at a grander scale, convey the coherence of architecture and water (Dept. of Landscape Architecture, University of Illinois, 2014) in much the

Image 8. Water tank strategically located to collect run off in Rajasthan, India (Nupur Prothi Khanna).

same way. This visual consistency evident across the South Asian landscape created a design symbiosis. River Ganga played a centric role in Hindu culture and cities along its route, establishing an unparalleled aesthetic and identity.

Contemporary Asian planning has largely ignored the natural context in managing historic water systems. Water bodies are isolated within urban sprawl, which is evident in most historic cities. For the city of Bhubaneswar, the water bodies are disappearing within dense development, and those that continue to exist are highly polluted. The natural drainage system that regulated quality and quantity remains disrupted as municipalities are unable to visualize the whole picture. Despite this deep physical disconnect in the landscape, the intangible practices of ritual bathing and other traditions related to water continue on the steps of these tanks (Image 9). This is a discouraging trend within a culture that is deeply embedded in traditional ecological knowledge, where nature and culture are inseparable (Larsen and Wijesuriya, 2017). 'Why has environmental decline been so pronounced in Asia if, as had become widely believed, Asian religions promote environmental responsibility?' (Taylor, 2005) This statement highlights the contradiction in most cities in urban Asia. Cultural practices that have inherently respected nature continue alongside the exploitation of water systems. Remedial action towards environmental pollution in historic areas has to begin with an understanding of continuity, connectivity, and collaboration of the natural and cultural contexts.

Heritage informing sustainability

Innumerable studies and projects continue to highlight and address the crisis of water availability and pollution. Humanity can make development sustainable; it has to ensure that it meets the necessities of the present without compromising the ability of future generations to meet their own needs (World Commission, 1987). This vision of a balanced world was spelt out in the Brundtland report, in October 1987. The traditional notion of sustainability as implicit in the field of forestry was applied to the world economy, leading

Image 9. View of Bindusagar tank in Bhubaneshwar, India (7th/8th century) (Nupur Prothi Khanna).

to the United Nations Conference on Environment and Development in Rio de Janeiro and the Agenda 21 (1992), both important milestones in reconsidering the dominant role of economic policies and assessments as indicators of national prosperity.

With regard to water, the Dublin Principles on Integrated Water Resources Management (IWRM), 1992, especially Principles 2 and 3 refer to the significance of culture. This significant connection is somewhat ignored in the UN Sustainable Development Goals (SDG). Goal 6—Clean Water and Sanitation—addresses water from the perspective of WASH (water, sanitation, hygiene). Target 6.6 focuses on natural water heritage and its significance, and Target 6 B lays emphasis on the local community. But most of the conversations overlook the significance of culture leading the way for Asia in achieving all the targets of WASH. Goal 11—Sustainable Cities and Communities—and Target 11.4—to strengthen efforts to protect and safeguard the world's cultural and natural heritage—circumvent the direct relevance in Asia of cultural heritage and traditional wisdom to the future of water conservation and innovation. However, Goal 11 focuses on making cities and human settlements inclusive, safe, resilient, and sustainable. The UNDP has worked with the United Nations Development Group (UNDG) in developing a strategy for supporting the effective and coherent implementation of the new Sustainable Development Agenda under the acronym 'MAPS' (Mainstreaming, Acceleration, and Policy Support). The seven targets and 14 indicators of Goal 11 imbibe social, cultural, and economic well-being, and address disaster risk reduction, architecture, natural and cultural heritage, regional development planning, safe, inclusive and accessible public space, besides other concerns. These conversations are outcomes of discussions within the domain of science and technology and fail to include the possibility of reversing this situation with culture at the helm.

The SDGs and the aim for 'Transforming our world' spell out a grand vision, but the follow-up and progress towards this end is a voluntary, country-led effort reviewed at national and global levels. National ownership is a basic prerequisite as global reviews will rely on official national data (Aglietta and Bai, n.d.). Grand statements such as ‘we are setting out a supremely ambitious and transformational vision’ (para. 7b) lays out that the partnering nations will be responsible for the ‘means of implementation and global partnership’, e.g. providing development finance and debt relief, facilitating technology cooperation, access, and trade reform. To make a difference, the nations will essentially need to align their domestic development policies and priorities with the global vision set out within the SDGs. The emphasis on culture within SDG 11 needs to be connected to SDG 6 to achieve the desired results on water conservation in Asia. It is only then that cities will achieve the desired results.

Way forward

Monocle’s Quality of Life Survey initiated in 2006 and Mercer’s Quality of Living Survey have ranked cities based on criteria such as political and social environment, medical and healthcare, public services, recreation, access to nature, culture, quality of architecture, and urban design amongst others (Khanna, 2015). Water is the thread that ties culture, nature, communities, and this vision will help achieve future sustainability if understood in its entirety. For preservation of natural and cultural water heritage, it becomes vital to highlight the significance of embedded knowledge in traditional water systems for current and future generations. Learning how these structures and their community-based governance and management regimes have been tested through time and over centuries would help to harness the age-old indigenous knowledge today for future sustainability of human societies. This may subsequently help us to deal with climate change effectively to address sustainability in our natural resource use. Moving forward, culture will help leverage between a water-sensitive, contextual approach and the futuristic technologies.

Identification and recognition of urban heritage along waters and their role in the planning of cities is one possibility for reviving their significance. A few examples from the Asian scenario portray how historic urban landscape can serve as a potential economic driver, thereby also improving urban liveability through the creation of healthy open spaces. An important criterion to be kept in mind while taking up water projects is the mandate of adopting a culturally relevant, contextual approach rooted in the rich architectural heritage to define a contemporary future of Asian cities (Image 10).

The design and function of culturally contextual solutions have, time and again, proved to be appropriate for water system restoration. Learning from city planning

Image 10. A privately owned step well or baori in Rajasthan, India (Nupur Prothi Khanna).

initiatives from the past and applying contemporary innovation in design and material will hopefully contribute to improving the condition of our rivers and give them the status they deserve. It is, therefore, imperative that we realize the value of contextual approaches where materials and aesthetics with innovative strategies provide sustainable solutions for integrated development. However, more often than not, one overlooks the issue of equity of public spaces, especially at an urban scale where the underprivileged are left with no space for existence, let alone recreation. Visionaries such as Bernard Kohn[1] can be seen as an inspiration for contemporary riverfront development initiatives, where a holistic approach would mean balancing the social with the economic to provide an ecological solution to the growing issue of urban riverfront revitalization.

The future of Asian cities lies in devising techniques that favour equitable urban open spaces. Revival of urban precincts requires sensitive approaches that may uplift the city on the social, economic, ecological, and cultural fronts. Restoration, revitalization, and conceiving our urban water systems with cultural moorings offer a possible way forward. The need of the hour is an equitable solution to restore the vibrancy of community water interaction that formed the main reason for these riverside historic settlements. Though a number of agencies have begun to realize the importance of rivers and are holistically viewing both ecological and economic impact of their proposals for riverfront development, the adoption of a contextual approach centred around the traditional Asian reality may provide an apt solution for the revival of our waterscapes.

[1] Bernard Kohn is a French American architect who is credited for envisioning revival of the Sabarmati Riverfront as an Ecological Valley for the first time in 1960s (Shah, 2013 and Jha, 2013).

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The role of women in subterranean waterscapes of India

Saranya Dharshini

Introduction

Only in India, subterranean structures, known as stepwells, were built from the 8th to the 19th centuries to collect water. Stepwells are basically multi-storeyed structures beneath the surface with a set of stairs for access. These acted as an essential bond between past Indian cultures and traditional water-harvesting practices. Such wells are part of the rich architectural history of India. However, little is known about the role of women in the development of this unique architectural marvel. Women's patronage played an important part in the evolution of stepwells, especially in the western Indian region that has a hot and semi-arid climate with rainfall variability. Apart from supporting the construction and development of stepwells, women also served as an inspiration for their designs derived from the stories of their courage, valour, and love, thereby creating a space where water and women met. To an extent, the design language and ornamentation within these multi-storeyed structures connected femininity and the influence of women patrons who were either the wives of kings, or merchants, or village maids, among others. This article focuses on the study of stepwells from Gujarat in India—these include the 15th century Adalaj stepwell, also known as Rudabai ni vav, which is named after its patron—a Hindu queen—and its contemporary Dada Harir ni vav built by a harem lady. The stepwells also represent women in a godly form derived from Hindu mythology, as in the 11th century stepwell of Rani ni vav (Queen's Stepwell). Studying the architectural and artistic aspects of these stepwells, this article focuses on the importance of women's patronage and the role of gender in keeping water heritage. In the past, stepwells functioned as a platform to bring the community together for drinking, bathing, or to celebrate festivals in antithesis to their function today as memories of a past age gone by.

Waterscapes of India

Water has always been an essential part of human culture. Water gave birth to civilizations wherever it flowed through.

Image 1. Subterranean Waterscapes of India, from left to right – Stepwell at Dada Harir ni vav, Gujarat; Nahargarh fort kund, Amber; Panna Meena ki kund, Amber, Rajasthan, Pariyon ki bagh, Amber; Rani ni vav, Patan; and Nahargarh fort kund, Amber, Rajasthan.

Whenever the flow ceased, humans endeavoured to reach other water sources. India has a long practice of human efforts in water management because of the country's diverse ecology and vast expanse where the monsoon can be sometimes followed by long dry months. Although India is known for its numerous rivers, its habitation is not limited to riverbanks but has expanded far beyond them with the help of water structures. Such structures have played an important role in the development and progress of human life, giving rise to a distinctive form of subterranean water architecture found in the hot and semi-arid regions of western India, particularly in the states of Gujarat and Rajasthan (Image 1). However, the role of women in the development of water architecture is little known. Women's place in the history of water, especially in India, has attracted scholarly attention. The works of Jutta Jain-Neubauer and Purnima Mehta-Bhatt, as well as an exhibition organized by Anthill Design (*Stepwells of Ahmedabad*) held in the Kanoria Centre for Arts in Ahmedabad in 2016, focused on stepwells in Ahmedabad and their patronage by women.

Subterranean water architecture in India

Unique to India, stepwells were built predominantly from the 8th to 19th centuries

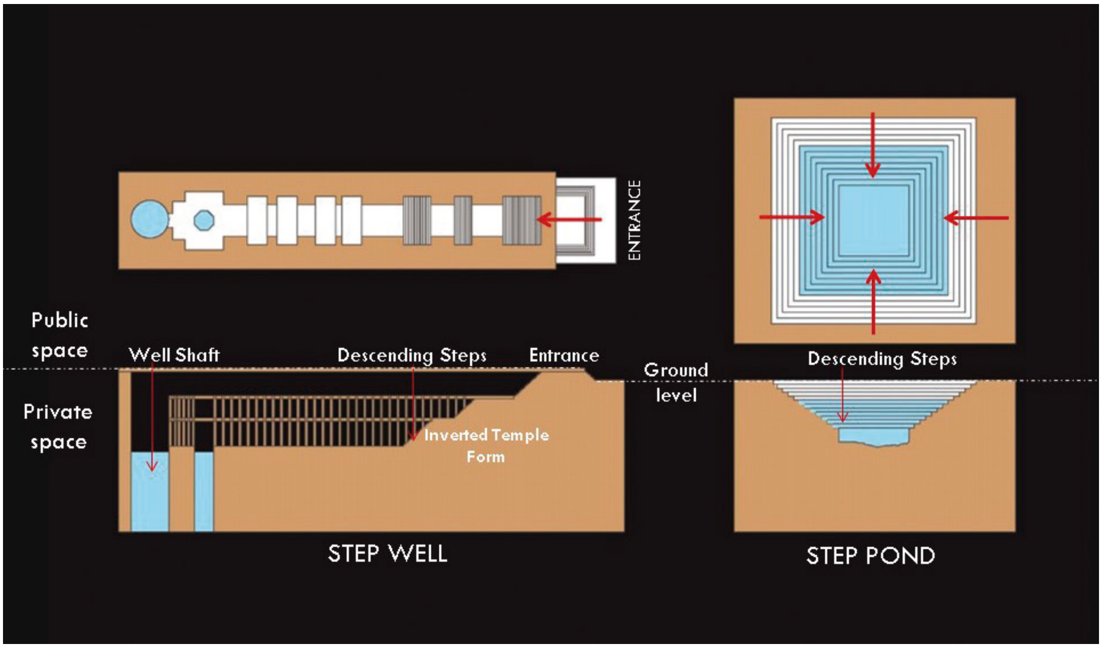

Image 2. Two types of subterranean water structures commonly found throughout India: step wells (L) and step ponds (R), illustration shows the typical difference between them, by Saranya Dharshini.

to collect water, but the earliest known structure can be dated farther back to the Bronze Age (Livingston and Beach, 2002). The *Arthashastra*—an ancient tenet written by Kautilya, minister and closest advisor to the first emperor of the Maurya Empire in the 3rd century BCE—provides a clear account of the management of water during the Mauryan reign. The tenet states that local communities were conscious and familiar with the monsoon cycle, soil type, and irrigation methods of specific regions. In addition, it mentions that the empire promoted and supported water-harvesting techniques and structures (Agarwal and Narain, 1997).

Stepwells and stepped ponds are typical examples of these water structures. A stepwell, as the nomenclature itself mentions, is a cylindrical well shaft that is accessed through a series of steps below the earth's surface to collect rainwater and store it for dry months (Livingston and Beach, 2002). Stepwell is known as vav in Gujarati and *baudi/ baori/ baoli* in Hindi. Stepped ponds (*kunds*) are often mistakenly considered as stepwells, but they differ considerably in terms of construction, function, and appearance (Image 2). Stepped ponds were generally used by men and associated with community temples, while stepwells were usually patronized by women from royal families and used by community women to fetch water for domestic use. In Gujarat, women are responsible for fetching water (Bhatt, 2014). Symbolically, stepped ponds and stepwells represented the patriarchal and matriarchal system, respectively, which is revealed through their aesthetics and usage (ASI, 2014).

Stepwells in Gujarat

Located in the western part of India, stepwells are a unique feature of Gujarat's cultural landscape due to the hot and semi-arid climate of the region. Moreover, stepwells act as an important link between the socio-cultural realm and traditional water-harvesting practices. The functioning of stepwells not only differed from ordinary wells because they had steps descending right to the edge of water (Image 2), but also due to their cultural association with women as their inspiration and patrons. Many stepwells in Gujarat are linked with women. It has been mentioned that nearly 25% of stepwells were commissioned by women of several hundred excavated stepwells (Bhatt, 2014). Some of the well-known stepwells, such as Rani ni vav (Queen's Stepwell) built by Queen Udayamati and Adalaj ni vav credited to Queen Rudabai, were built under women's patronage (Image 3).

Image 3. The descending access to the well is flanked by intricately sculpted columns supporting intermediate pavilions in the Rani ni vav. Photo by Dimple Mehta.

Stepwells and women

Many stepwells in Gujarat, such as Rani ni vav, Adalaj ni vav, Dada Harir ni vav (Image 4), Nadiad vav, Minal ni vav in Balej, and Virpur and Roho ni vav, among others, have been commissioned by women who were either royalty or associated with royalty (Jain-Neubauer, 1981). These stepwells predominantly date from the 11th century CE to the 18th century CE. Among these, the seven-storied Rani ni vav (Queen's Stepwell), also known as Patan ni vav, is considered the most elaborate

Image 4. Intricate detailing and sequence of ascension into the stepwell looking towards the entryway from the multi-storeyed well shaft, *Dada Harir ni vav*, Gujarat. Photo by Saranya Dharshini.

and got included in the UNESCO world heritage list in 2014 (Image 3). However, not all stepwells were commissioned by women who were wives or mothers of the ruler of the region. But sometimes the beloved mistresses of rulers supported the construction of stepwells as patrons and benefactors, as seen in the case of Dada Harir ni vav (Image 4). Even the stepwells commissioned by men were sometimes influenced by women in various forms of inspiration, either in the honour of a female relative (wife, mother) or a goddess (Bhatt, 2014).

The typology of stepwells can be categorized by their style of access and their construction dates to ascertain architectural influences from ruling empires and their multipurpose functionalities like drawing water for domestic use, bathing, religious ceremonies, social gathering, and resting place, among others. According to the S*hilpa Sastras,* an Indian traditional canon on arts and crafts (Acharya, 1927), stepwells can be summarized based on the access style: *Nanda*, a stepwell with a straight-stepped corridor and a single entrance; *Bhadras*, a stepwell with a straight-stepped corridor and two entrances; *Jaya*, a stepwell with a straight-stepped corridor and three entrances; *Vijaya*, a stepwell with a cross-shaped ground plan; an L–shaped stepwell; and a stepwell with a circumambulatory passage around them (Image 5). The construction style and type of iconography on the stepwells usually are indicative of the period when the stepwells

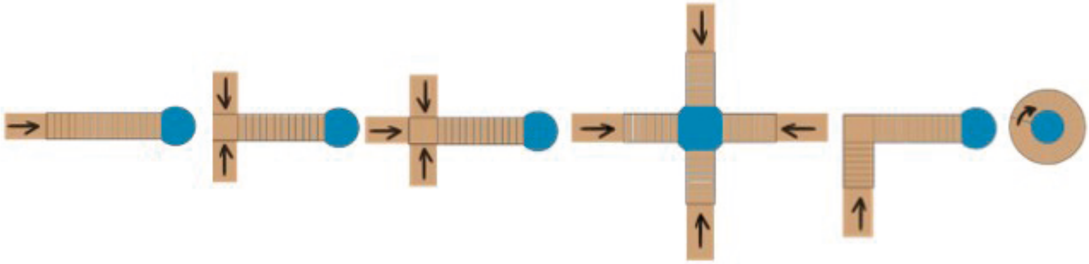

Image 5. Illustration on the stepwell typology, from left to right ─ Nanda; Bhadras; Jaya; Vijaya; L–shaped, and circular, by Saranya Dharshini.

were built—for instance, under the Sultanate period (14th century onwards), the aesthetics and construction of stepwells had more Islamic influence, as seen in Dada Harir ni vav (Image 4), featuring more geometric and floral patterns versus human figures and religious figures seen in Rani ni vav (Image 6). The construction and design elements of stepwells, such as the use of arch, human figures, and floral motifs, among others, indicate if it was built in the pre-Solanki period from the 8th century to the 11th century, the Solanki period for the 11th century to the 12th century, the Vaghela period for the mid-13th to the 14th century, or the Sultanate period from the 14th century onwards (Lakshmi, 2010).

Image 6. Sculptures of women are depicted in various forms in the walls of the *Rani ni vav*. Photo by Dimple Mehta.

Patronage

The reasons for building stepwells—beyond their practical functions—varied from religious intentions, building memorials for the deceased, or as an act of philanthropy. As mentioned in the *Agni Purana*, an ancient encyclopaedic Sanskrit text attributed to Vyasa and written in the medieval era (Rocher, 1986), the charitable act of providing water is considered thousands of times above any other form of sacrifice, even above *Ashvamedha Yagna* (horse sacrifice), and the benefactor will be granted access to heaven and shall never go to hell. So, the role of stepwells in the lives of community members went beyond the realm of religious worth and its utilitarian function (Bhatt, 2014).

Water plays an integral role in Indian legends, mythology, and folklore (NIH, 2018). In some Indian traditions, water is considered as the *tirtha*—a border line between heaven and earth, while stepwells are considered as human-made *tirtha*. Since ancient times, temples or religious deities have been installed near water sources—it might be in the form of a lake, river, or pond—as a protector or guardian angel and a detractor of human misbehaviour and vandalism (Pathak and Kulkarni, 2007). Water deities, especially goddesses, were mounted inside stepwells so that they always kept clean to maintain the sacredness and purity of the water-storage buildings. To some extent, this concept has indirectly helped in the preservation of stepwells even in times of water scarcity (Image 6).

Even though the practical function of the stepwell was to store water and keep it available for drought months, such wells could be used for drinking water, bathing, or farming. Most of the stepwells in Gujarat were located along important trade routes and settlements, thereby providing merchants or traders a place of sanctuary to rest. Devotees on pilgrimage (some even praying at the stepwell shrine) or travellers took refuge under the pavilions of stepwells at daytime or night (Image 2) (Pandey, 2016). Considering that almost each village in Gujarat used to have a functioning stepwell, travellers, pilgrims, or merchants used them as a caravanserai.

Considering the time period, in the patriarchal society of Gujarat, it can be postulated that there was an informal timetable set for being used on the gender basis. Since the stepwells were open to all genders, women fetched water from them for domestic use during dusk and dawn, while the rest of the hours were available for men. In other ways, it can also be assumed that there were times when men and women did interact as folklores do mention tales of tryst and clandestine affairs such as those between Mithdi of Deha village and her lover Nathio or about the lovelorn girl under the spell of Dagara who forgot to fill her water pot (Bhatt, 2014). Royal hunting parties and troops on march also made use of the stepwells as a resting place even during the colonial period.

During the time period, when the stepwells were being built, women after marriage became part of her husband's household, leaving behind her family and friends. The stepwell provided a domestic realm for the women, just like their birthplaces, to share their joys and sorrows with other women (Jain-Neubauer, 2016). It became a feminine space of companionship where water and women met and emotions transcended—a private space in the public realm. Globally, water has been linked with the curative powers of fertility, and this earthy connection is symbolized in the architecture of the stepwell where water is stored in the depths inside the womb of the water structure (ASI, 2014) (Image 7).

The main source of water for stepwells were monsoon rains and nearby rivers or lakes. The steps allowed people to reach groundwater as well as to maintain and manage the well. In Gujarat, even though patronage varied from village to village, craftsmen or masons from the same community were known as the Somparas. Following the canonical texts of the Shilpa Shastras, ancient Indian texts on arts and crafts, especially for the vav (stepwell) construction, every generation of the Somparas had skills to work on stepwells (Jain-Neubauer, 2016). Since the traditional knowledge of stepwell construction was passed from generation to generation among the Somparas, irrespective of the gender of patronage, the structural system of stepwells was almost the same, except for the type of access that depended upon

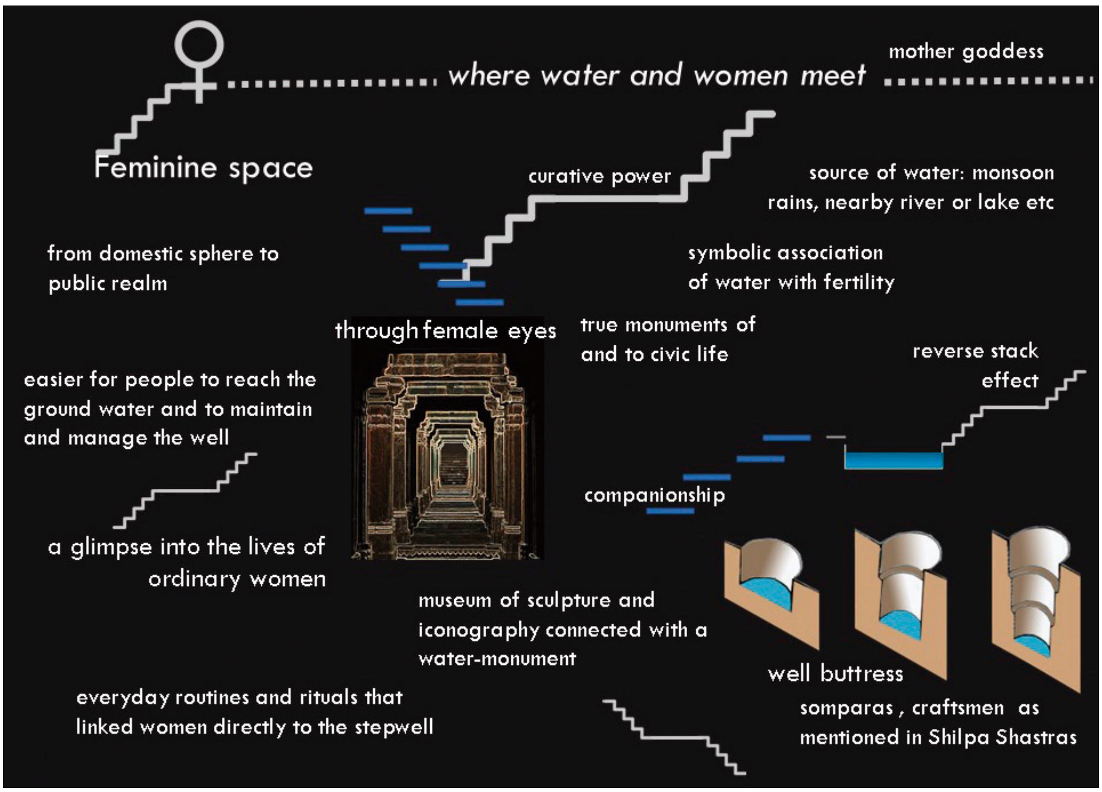

Image 7. Illustration on water, women and stepwells, by Saranya Dharshini.

Image 8. View of the pavilions while descending to the well shaft at *Rani ni vav*. Photo by Dimple Mehta.

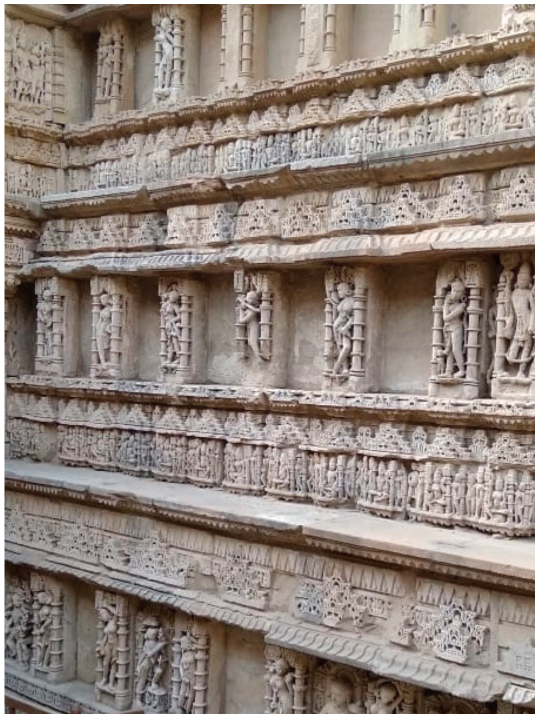

Image 9. The stepwell adorned with nearly more than 500 Sculptures at the *Rani ni vav*, Patan, Photo by Dimple Mehta.

the typography of the construction site and groundwater level. Stepwells provided a clean canvas for patrons to paint their influence by using decorative architectural elements and art sculptures. Women patrons took advantage of this, as seen in Rani ni vav.

Architectural and aesthetic aspects of stepwells

Aesthetically, the stepwell can be considered as a true monument of and to civic life. Stepwell iconography allows a glimpse into the lives of ordinary women and their everyday routines as well as rituals that linked women directly to the stepwell. This concept is evident in Rani ni vav, which could also be considered as a museum of sculpture and iconography connected with a water-monument. Built in 1065–1070 CE, Rani ni vav was commissioned by Queen Udayamati as a memorial for her deceased husband, King Bhimdev Solanki of the Chalukya Dynasty (Image 8) (Mankodi, 2012). Located near the Saraswati river, the stepwell, adorned with some 500 sculptures, was under silt after a flooding until its rediscovery in the 1940s. After its restoration, this unique stepwell got included in the world heritage list in 2014 (Image 9).

Rani ni vav, a *Nanda* type (Image 5) stepwell, has the four necessary elements which commonly distinguish between developed stepwells: 1) a staircase leading from the ground level to the well, 2) pauses at regular intervals with multi-storeyed pavilion, 3) a well at the end, and 4) a large tank to store the excess water from the well (Image 2). This type of architecture for water storage works on the principle of reverse stack effect; the design is effective in protecting water against evaporation as the exposed surface at the lower end is cooler; and when the hot air meets the cooler air, it sinks due to its moisture and forms a protective sheen for the stored water. The micro-climate created, therefore, increases the humidity inside the well volume and helps to significantly lower the temperature, which would be favourable for the community gathering in a semi-arid region.

Stepwells functioned practically as inverted subterranean temples—a canvas of carved images of the Hindu religious deities. In Rani ni vav, Vishnu can be seen in the forms of Dashavatar and the female goddess Mahishasurmardini can be seen in all her glory (Image 12). In effect, a stepwell could function as a temple for various reasons like 1) its proximity to water, 2) stepping into the sanctum sanctorum through the transition of spaces (public to private), 3) the womb-like well is

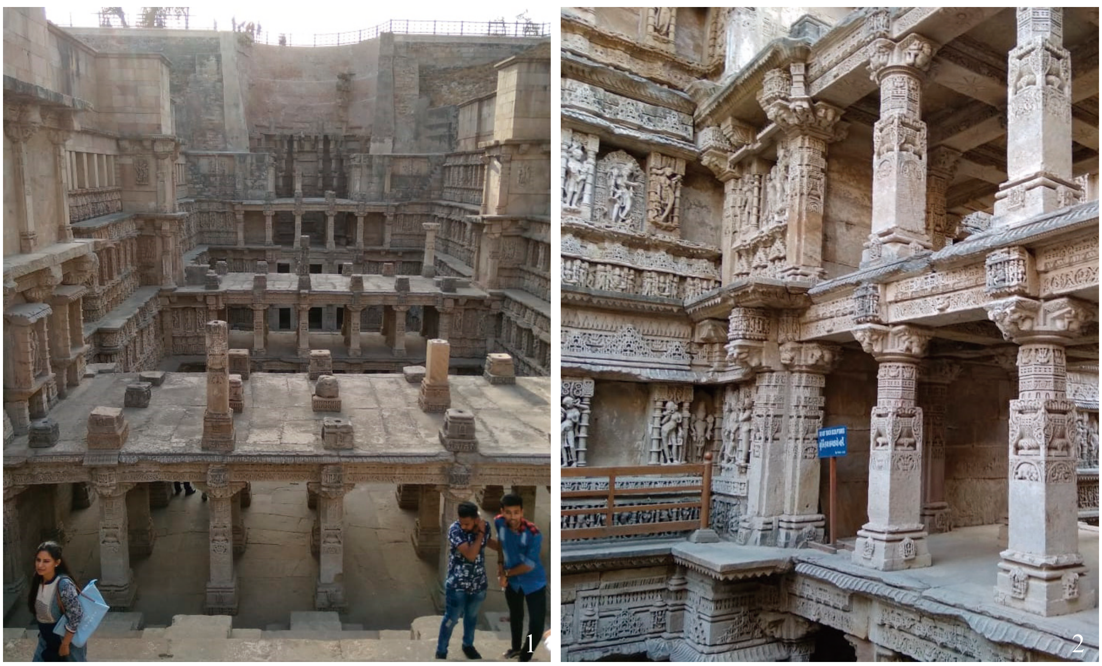

Image 10. Overview showing the *Rani ni vav* built in series of pavilions and the walls and columns embellished with architectural elements venerating women. Photo by Dimple Mehta.

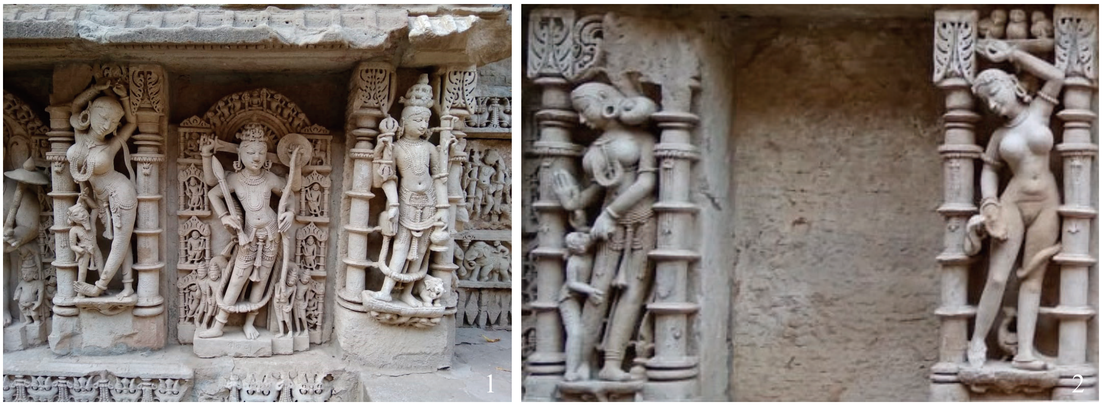

Image 11. Rani ni vav embellished with stories of women in different forms. The representation of women and their depictions are vividly sculpted on the walls of the stepwell in their various forms as celestial beings, goddesses, royal and common women among others. Photo by Dimple Mehta.

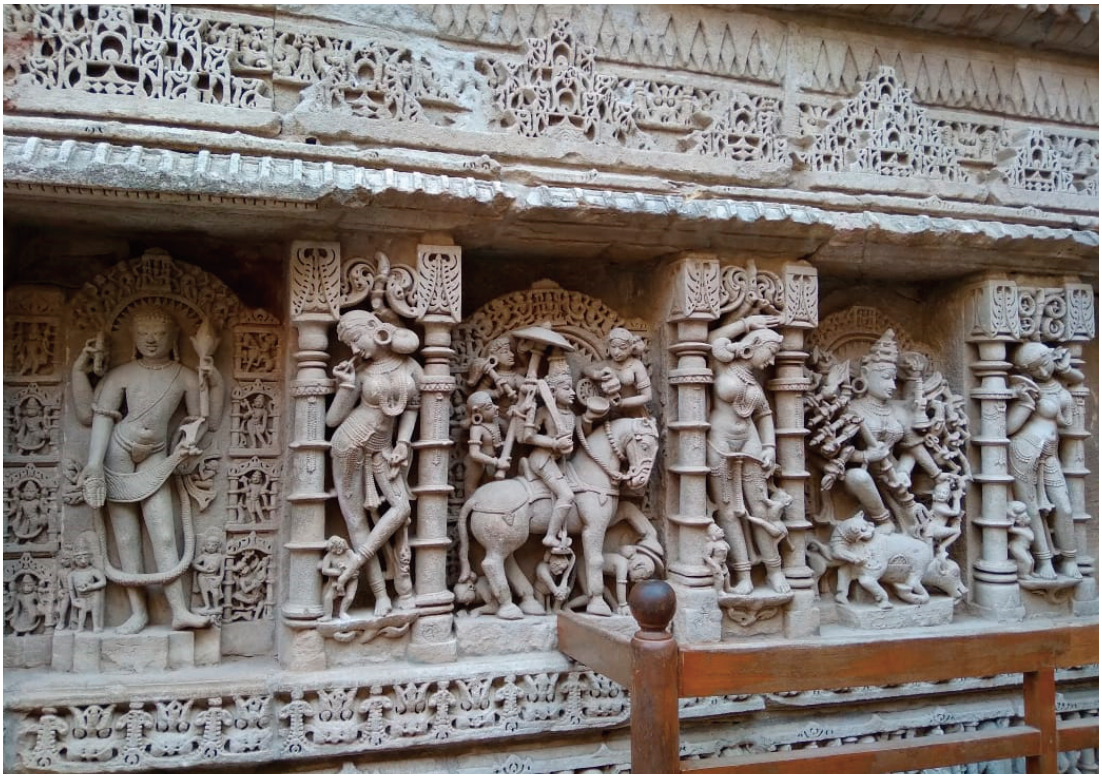

Image 12. Left to right: Sculptural art depicts playful maidens and serpent maidens in different activities with specific hand gestures called mudras. The ensemble panel shows the avatars of *Vishnu* and *Mahishasuramardini* (Goddess Durga killing demonic buffalo) in the larger three spaces and the narrow spaces are filled with semi-divine beings in the act of *Solah Singaar* practicing *Mudra vijnana*. Photo by Dimple Mehta.

akin to the garbha-griha of a Hindu temple, and 4) religious motifs and iconography on the walls (Images 2, 9, & 10).

Artistic expression and representation of women

The representation of women and their depictions are vividly sculpted on the walls of the stepwell in their various forms as celestial beings, goddesses, and royal and common women. The sculptural themes represent the fertilizing feature of water through the presence of the heavenly *apsarās*, mothers or young wives, and serpent maidens (*nāgakanyās*). Several cantos of the Vedas praise waterbodies, most importantly the rivers Sarasvati, Ganga, and Yamuna, as *apsarās* (Pathak and Kulkarni, 2007). The presence of serpent maidens is not surprising in a stepwell—anthropomorphism is highly prevalent in general Indian regional art (Jain-Neubauer, 2016) (Image 11).

The female sculptures are shown in various poses, adorning themselves with earrings and looking in mirrors, perhaps applying lip stains and playing with monkeys or snakes (Images 11, 12). An entire series of sculptural art is dedicated to *Solah Singaar,* 16 traditional decorations with which women adorn themselves—this clearly shows the design sensibility and aesthetic interest of the female patrons for only they could depict such intimate art with clarity and nuance (Bhatt, 2014).

The sculptures and iconography that adorn the stepwells reflect the religious and artistic outlook of the women patrons, but a closer look would tell us that they could possibly be speaking about something deeper like the female health. As mentioned by Rekha Rao in the *Therapeutics in Indian Sculptures: Ranki Vav-Patan*, the female figures could be semi-divine beings exhibiting cure for ailments of the female body which can be diagnosed and healed through *Mudra vijnana*—the healing science of hand gestures which is intrinsic to yoga, a therapeutic science (Rao, 2006) (Images 11, 12). In a way, the stepwell was a place for dissemination and transfer of this knowledge.

In addition to the depiction of the various goddesses, the stepwell at Patan contains a large number of carvings of women engaged in activities relating to dance and music as well as daily chores. Like a lifestyle magazine from that era, the walls of stepwells depict intricate geometrical designs which bear a close resemblance to the ancient textile tradition of Patan called Patola, which forms a huge part in the intangible heritage of Gujarat (Image 13).

Extent of influence

The influence of patronage by women is clearly evident in the surface aesthetics of stepwells, but their impact on the construction design changes with the

Image 13. Patterns on the walls of the stepwell depicts the textile heritage of the region. Photo by Dimple Mehta.

political scenario. Until the 12th century CE, the construction method under the regime of Hindu rulers generally used the post and lintel style, as seen in Rani ni vav. But right from the 14th century, heavy Islamic influence is visible under the Sultanate period through the introduction of arches and domes—this could be seen in the case of Adalaj and Dada Harir stepwells (Images 14, 15). Built in 1499 CE, Adalaj ni vav was commissioned by Queen Rudabai for her husband, Rana Veer Singh of the Vaghela Dynasty, during the reign of Mahmud Begada. During the same period, Dada Harir ni vav or Bai Harir ni vav was also built—a harem lady of Mahmud Begada commissioned it (Images 14, 15) (Jain-Neubauer, 1981). Both stepwells similar architectural styles. Even though the Adalaj stepwell begun under the Hindu reign, the absence of deity-like sculptures showcase the later Islamic influence which only depicted motifs of flowers and geometric patterns, as seen in case of the Dada Harir stepwell. It becomes evident from these stepwells that women patrons had more control over the art subject than the construction of stepwells.

Image 14. Interior of the Dada Harir ni vav stepwell shows the absence of human figures, while religious deities indicating the time period of the stepwell. Photo by Saranya Dharshini.

Future of the stepwells

The different uses of stepwells were a boon to the parched land of Gujarat. They laid under the surface as a tangible identity of the feminine association with water and were specifically patronized by women. Built for water and its services, stepwells reached out and offered a public realm for the daily function of women who were relegated to fetching water for centuries. Stepwells were a dedicated space for women and their creation went beyond the act of philanthropy by providing a communal space where women segued from the domestic domain to the public sphere while doing a mundane daily chore. Women depicted in and around stepwells came from all walks of life; they showcase desirable qualities—strong and powerful goddesses, playful maidens, virtuous queens, and the mystical water nymphs/apsaras, providing space for recreation and knowledge dissemination.

Stepwells have been an integral part of India's cultural landscape. But with the advent of the 19th century and particularly under the colonial rule, stepwells began to spiral into despair and neglect (Tadgell, 1990). Stepwells were considered unhygienic. With the advent of piped water supply and storage tanks, stepwells were completely replaced and became obsolete. By the beginning of the 20th century, most of the stepwells disappeared under the weight of garbage and silt deposits (Lautmann, 2017). However, the stepwells that survived continue to serve as social and religious sites, but most of these stepwells have gone dry today due to poor maintenance and low water tables.

Way forward

Like any other heritage sites, awareness is an aspect for the preservation and protection of stepwells. Major tourist turnouts can be seen mainly at Rani ni vav and Adalaj ni vav—they are the two most elaborately built stepwells—even though there are

Image 15. Sculptural art seen in Rani ni vav, Patan (L) Photo by Dimple Mehta; absence of human figures, religious deities in Adalaj ni vav indicates the later Islamic rule, assigns a time period to the construction of the stepwell (R) Photo by Saranya Dharshini.

many other similar ones like the Dada Harir stepwell. Being a world heritage site, Rani ni vav has received its due protection and preservation, but many other stepwells still need to be protected as well as preserved. Apart from Gujarat, Rajasthan has many stepwells dotted on its cultural landscape commissioned by women. Further research on the typology of stepwells would identify a greater number of monuments and generate interest in the unique contribution of women to the community in the past. It would be beneficial for communities to revive the socio-cultural quotient of stepwells by creating a heritage travel circuit for exploration of the stepwells patronized by women and give them their due recognition and protection.

Based on old trade routes scattered with stepwells patronized by women, a heritage travel circuit would revive the living heritage aspect of the stepwell as the traveller's resting stop as in the past. Such a travel circuit also create a community-driven gathering space to reinstate the lost glory of stepwells. A travel circuit would play a vital part in creating awareness and distributing knowledge, as some of the stepwells are in very remote places of Gujarat where accessibility is not easy and travelling would need greater motivation.

The carved walls of the stepwells in Gujarat are important pages from the book of art and architecture unique to the subterranean waterscapes of India. Distinct in their way of storing water, these stepwells should be restored for recharging the water table and spreading water literacy for its eventual revival. Stepwells from the past could be a model for a community-oriented water system and democracy in times of water wars and conflicts in keeping with modern space and time.

Even after the negligence shown to stepwells in the 19th century, women adapted some stepwells as a feminine space with the seat for worship of goddesses. This could be seen in Mata Bhavani's stepwell. Adaptive reuse in the form of water knowledge centres showcasing the workings of a stepwell would help conserve the architectural and cultural heritage. Such reuse would also encourage spreading of knowledge with a closer understanding of techniques and lifestyles of the past, especially the role of women and stepwells. Such conservation works should be encouraged with the support of local communities as, after all, stepwells belong to the community. This would provide employment opportunities to local craftsmen and revive a craft long forgotten, thereby allowing the craftsmen to become proud custodians of their heritage. Of course, not all water structures may come back to serve as they did, but it is possible to still use them as learning institutes of water knowledge and pave the way forward by learning from the past to safeguard the future of water.

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Rethinking the cultural ecology of river, reconciling the state-indigenous relations: A study in the Tayal communities, Taiwan

Da-Wei Kuan

Introduction

Austronesian language-speaking indigenous peoples in Taiwan lived within their specific social organizations and were autonomously involved in economic production and political operations before the colonial contact. Like many other indigenous peoples around the world, they generated their ecological knowledge through continued and intimate interaction with their environment. Such knowledge was, however, disparaged and marginalized by modern science and state bureaucracy. For example, in the colonial era, the officers in the forestry bureaucracy of the colonial government asserted that the 'barbarians' living upstream of the major rivers in Taiwan were unlimitedly cultivating and hunting on the slopes in a primitive and destructive way that harmed the mountain and forest (Ma, 2005). Therefore, the Japanese colonial government implemented a series of policies to nationalize most of the forest, reallocate indigenous peoples, confine them in limited parcels (namely reserved land), and to promote fixed-location wet-rice farming. After WW II, the succeeding KMT[1] government from China continued the nationalization policy. At the same time, under the state-led development spree, the KMT government exacerbated the logging business in the national forest which was initiated in Japanese colonial era. Further, the Indigenous Reserved Lands were privatized in the 1960s and cash-crop growing was promoted in the indigenous mountain area.

For controlling the forestry resources, the government banned indigenous peoples from accessing the national forest as the previous colonizer did. In addition to the forestry, the government's exploitation of water resources also scared indigenous peoples. The Tayal community deployed in the drainage basin of the Shih-Men Reservoir (see Image 1) is one of the significant cases. When the government

[1] Kuo-Min-Tang, the Chinese Nationalist Party.

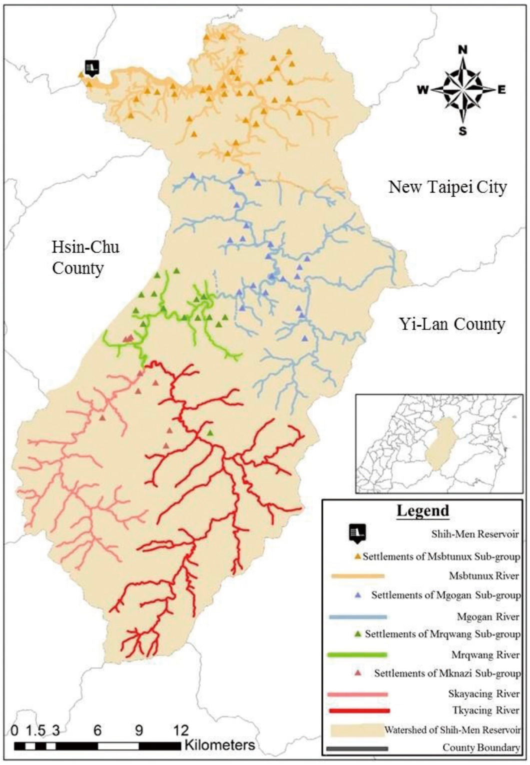

Image 1. Settlements of Tayal subgroups in the drainage basin of the Shih-Men Reservoir (Revised from Kuan, 2015, p. 104).

built the reservoir in the 1960s, some settlements were forced to reallocate. For those who denied any rehabilitation, the living space became the drainage basin of and for the reservoir. After 1990, the policy on the mountain area turned into more conservation-oriented. The mountain which once was considered rich in resources is now considered ecologically sensitive. In recent years, the government is facing increasing pressure of slope-land conservation for disaster mitigation rather than the need to generate economic profit from agriculture. Many farming activities previously introduced and encouraged by the government's policy have been prohibited in the mountain area. Indigenous peoples once again are scared by the government's policy. Their cultivation of slope-lands was often blamed as one of the major factors causing disasters such as erosion, landslides, debris flows, and floods without clarifying the comprehensive local conditions (Chen et al., 2009, p. 288). The government re-enforced the land-use regulations and issued penalties strictly to those who would violated the regulation. In 2013 some indigenous farmers, supported by human rights lawyers, filed a petition for the constitutional interpretation, arguing that the restrictions have violated the indigenous rights recognized by the Indigenous Basic Law passed in 2005 (Lin, 2013).

From the government's perspectives, classifying the slope and fixing penalties for overuse is a means for drainage basin management to avoid environmental degradation. However, from indigenous perspectives, these regulations are seriously violating indigenous land rights and affecting indigenous livelihoods. A new approach is urgently needed to interpret the indigenous knowledge of land, to put it into dialogue with modern drainage basin management, and to reconcile the conflicts.

Ethno–physiography as an approach

The term ‘landscape’ refers to the visible features of a portion of the earth’s surface. The visualization of landscapes can be traced back to landscape painting, which emerged in the Renaissance Europe with the discovery of optics principles (Creswell, 2004, p. 10). Prior to the 1960s, the study of landscapes was mainly the study of geomorphology under the framework of regional geography and physical geography. However, the Berkeley School, led by Carl Sauer, in the 1960s argued that all landscapes are the result of the interaction between nature and human cultures (Sauer, 1962). The study of landscapes eventually turned into the analysis of social processes that form it. Later, in the book Topophilia, the humanistic geographer Tuan (1974) reveals the relations between the cosmologies of certain peoples and the landscapes in their living environments. Meinig (1979) further addresses landscape as ‘the unity we see, the impressions of our senses rather than the logic of the science’. It is defined by our vision but also gets interpreted (Meinig, 1979, pp. 1–10).

Landscape ecology emerged during the 1980s. It is the study emphasizing the relations between landscape and ecosystem—for example, it explores how the structuring of landscape components (patch, corridor, matrix) form diverse patterns, how these patterns provide habitats for different species, and how the change of landscape pattern causes the transition of ecological system (or vice versa). Landscape ecology, therefore, provides a new model of ecological conservation based on the management of habitats but not the number/species of animals (Forman, 1995; Forman and Hersperger, 1996; Forman and Collinge, 1997). In the 1990s the discussion on landscapes went beyond the visual experience. For example, Feld (1996) pointed out that senses such as sound, flavour, and touch are also important for the human perception of landscapes. Macnaughten and Urry (1998, p. 110) further proposed the concept of ‘inner eyes’—it implies that people’s ways of perceiving landscapes are actually shaped by their socio–cultural experiences. These discussions formed the basis of ethno–physiography.

Ethno–physiography studies how people conceptualize the landscape and how the conceptualization is informed by their culture. Inter-disciplinary methods, including the methods relating to geography, ethnography, and linguistics, are applied to approach the emic views. The naming of the landscape is a main concern of the ethno–physiographical study, as it represents the way in which a culture understands and constructs the world. A

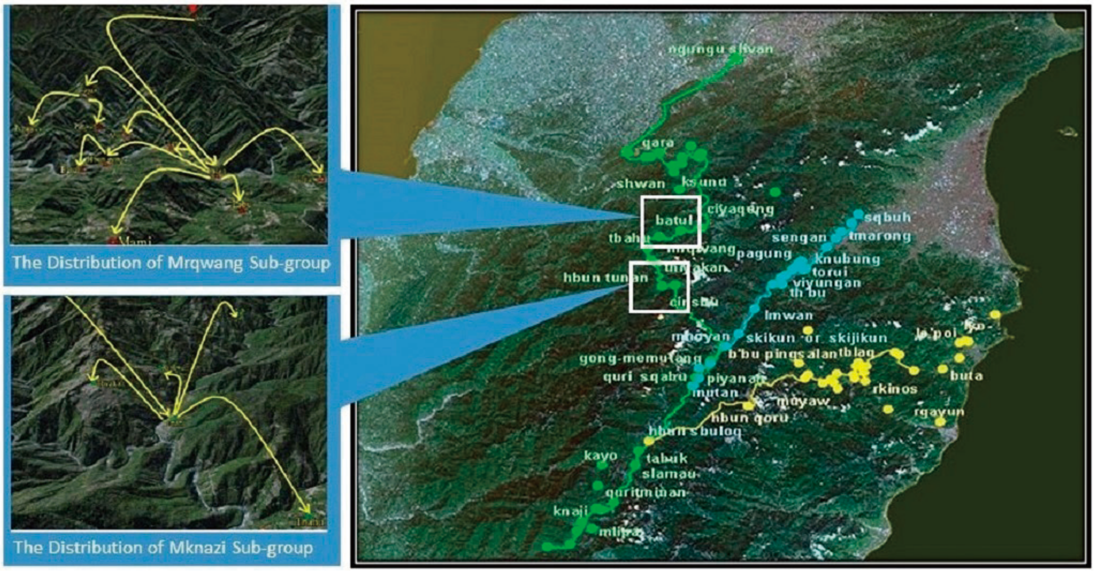

Image 2. The major migration route and the distribution of Mrqwang and Mknazi subgroup (Revised from Lin, 2019; Kuan, 2009, p.148).

proper understanding of the landscape vocabulary and its cultural context provides foundations for the understanding of other important dimensions of ethno–physiography that include the study of knowledge systems, the beliefs and customs of a people concerning landforms, and landscapes (Mark, 2011, pp. 4–5).

Adopting the ethno–physiographical approach, this article explores Tayal chanting, oral history, toponyms, and their meanings through ethnographical methods. They include a series of in-depth interviews and community mapping in the Tayal settlements. Based on this research, this article reveals the human–river relations from the Tayal perspective and how the dialogue between indigenous knowledge and state resource management can be facilitated.

Tayal people and river

Tayal is the most widely distributed Austronesian language-speaking people in the Taiwan mountain area. According to anthropological, archaeological, and linguistic studies, Tayal people have been living in Taiwan for a thousand years (Blust, 1988; Tryon, 1995; Bellwood, 1995; Bellwood, 1997). In Tayal people's oral history, the ancestors of Tayal people departed from the original settlement in central Taiwan, moving north along mountain ridges and river valleys, to build a series of settlements in one drainage basin after another. A drainage basin is the spatial basis of the identity of the community that shared it. Very often, the names of subgroups comprising settlements are also the names of the valleys these settlements live in and the names of the rivers that run through them—for example, the region called Mrqwang was named after the Mrqwang river that runs through it. People in the region also identify themselves as the Mrqwang subgroup (Kuan and Lin, 2008).

The map on the right of Image 2 shows the main migration route of Tayal people. Maps on the left illustrate the subtle migration routes of Mrqwang and Mknazi subgroups where most of the fieldwork for this research was conducted. As showed in Image 1, Mrqwang, Mknazi, and other two subgroups have been deployed in the drainage basin of the Shih-Men Reservoir long before the reservoir was built.

Language, identity, and the river

Rivers are important in the Tayal expression of identity and history. Lmuhuw, a form of chanting in the Tayal tradition, records the routes of migration and important place names in these routes. By marking the confluence of rivers along which the ancestors moved, lmuhuw also mark the branching of subgroups. The texts usually combine memorized phrases that trace the Tayal genealogy and extemporization on the occasion of chanting competitions and rituals like marriage ceremonies and peace negotiations (Kuan, 2009). Being a form of story-telling linked with ritual and symbolic occasions, lmuhuw are a vital carrier of history and identity. The following two quotations are examples of the lmuhuw chanted by the elders.[2]

> *From now on, we spread out from this rock. I am giving you a tongue of weaving*[3] *and the leg joints of wood*[4]*. No matter which riverside you choose to go to, do not live an ignorant life there. Do not live your life like a fallen leaf that has lost its root. Keep this in mind then you will proliferate like stars*[5]*. Your neighbors will be proud of you and respect you.*
>
> *A lmuhuw recorded in the Knazi group by Payan (1998),*
>
> Translated in Kuan 2009, p. 140.
>
> *When they (the ancestors) were about to divide into groups and separate from each other, Buta*[6] *stood up and exhorted: "Wherever you are going, you should*

[2] Nowadays, lmuhuw is still practised by some elders in the Tayal community. But it is also facing increasing difficulty to be handed down to the younger generation due to the cultural assimilation policy and social transition after the colonial contact. Recently, more and more efforts have been done by academic researchers and community practitioners to revitalize the practice of lmuhuw as an art as well a way of historical narrative (Cheng 2018).
[3] A metaphor for interlacing, shared language.
[4] A metaphor for strength.
[5] A metaphor for prolificacy
[6] Name of the common ancestors of the subgroups showed in the map of Image 2.

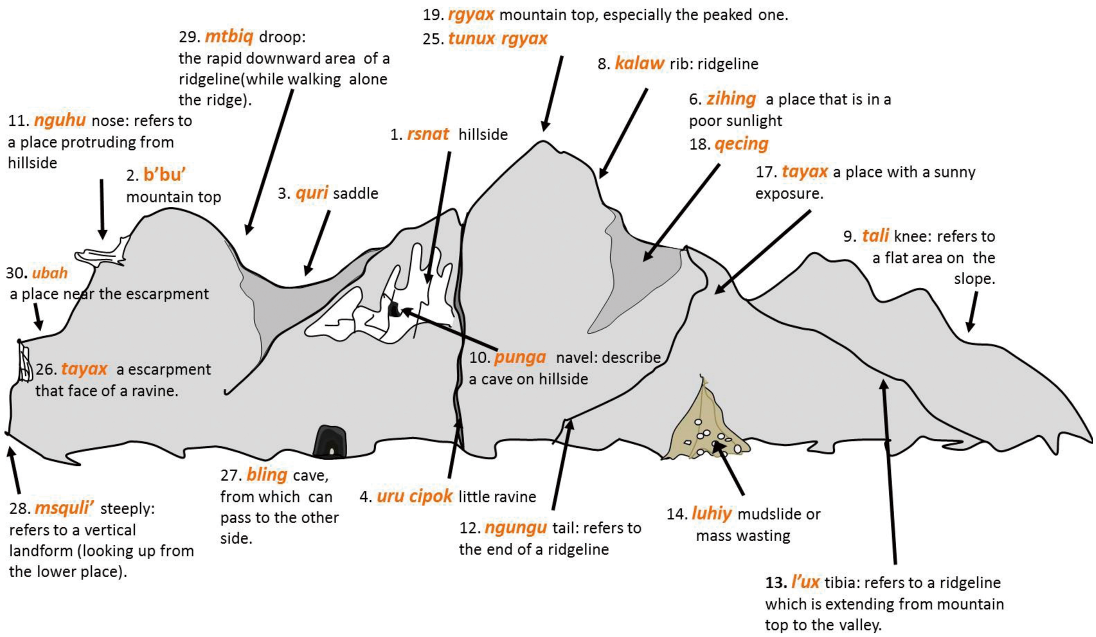

Image 3. Abundant vocabularies describing the ridge landscape show Tayal people's knowledge of the mountain ridge (Revised from Kuan, 2017, p. 294).

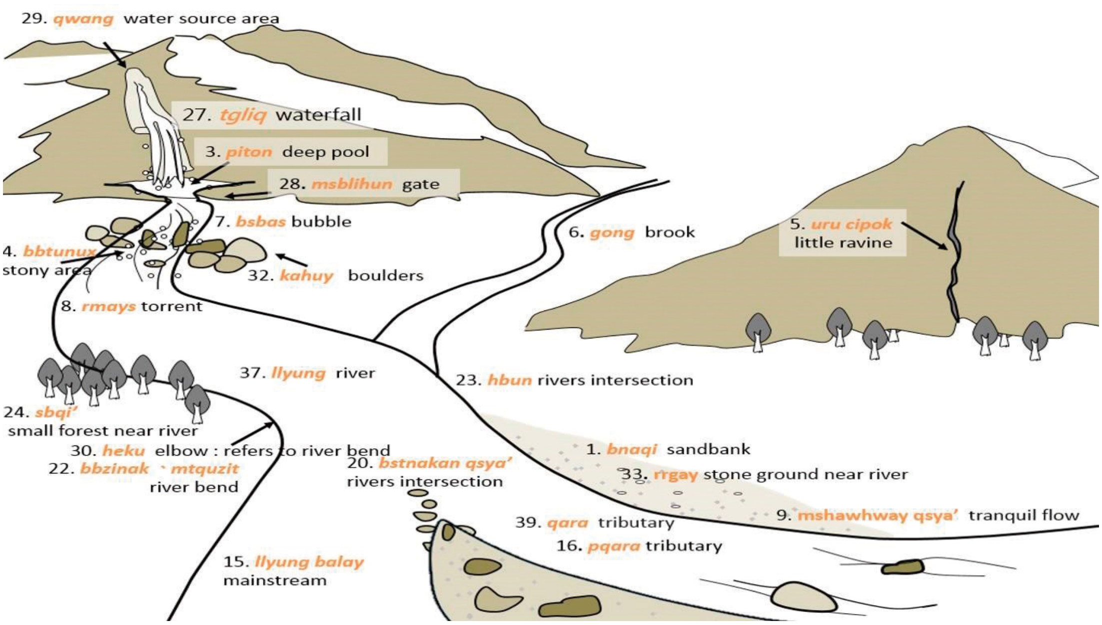

Image 4. Abundant vocabularies describing the river landscape show Tayal people's knowledge of the river (Revised from Kuan 2017, p. 295).

Table 1. Examples of Tayal vocabularies referring body parts to topographical features (Kuan, 2013, p. 20).

Tayal Vocabulary	Body Part it Refers to	Landform it Refers to
kalaw	Rib cage	Ridgeline
tali	Knee	The flat area of the hillside
punga	Navel	The cave of the cliff
hqu	Elbow	Where the river bend
hbun	The pit of the stomach	The confluence in the river valley
nguhu	Nose	The outstanding area of the hillside
ngungu	Tail	Smooth end of the ridgeline
tuka	Caudal	Steep end of the ridgeline
l'ux	Calf shank	The end of the ridgeline extending from peak to valley
qolu	Throat	Where roads intersect

take the knots[7] with you. Each of you should lmuhuw (means 'go through' in this context) the sources of rivers and springs. Do not turn you backs to each other. Do not hide yourself from each other by the door plank[8].

A lmuhuw recorded in the Sbtunux group by Jieng (2005),

Translated in Kuan 2009, p. 142.

The term 'lmuhuw' literally means 'flowing' and 'going through' in the Tayal language. When it is used to refer to the chanting, it reflects multiple meanings of fluidity. Tayal history flows through people and flows in the language when lmuhuw are chanted. It flows from one place to another as well as from one generation to another. As many metaphors are embedded in the text, it also flows through the words and their metaphoric meanings.

The abundant vocabularies in Tayal language related to the landscape show the relation between language and living environment. For Tayal people, the mountain ridge and the river are just like the coordinates along which the world extends. Image 3 and Image 4 demonstrate the vocabularies referring to diverse landforms of the ridge and riverscape collected by the author's ethnographical works. They are the evidence of Tayal people's intimate relation with the mountain ridge and the river.

[7] A metaphor for promise to each other.
[8] A metaphor for being unconcerned.

The embodiment of landscape

Regarding the river, it is not just about history and identity, but also about a material and physical body. For example, a river is a playground for villagers to swim as well as a source to catch fish. People practise, feel, learn, and pass on their knowledge of the river and in the river. Swimming and catching fish in the river are the ways to practically experience the fluidity of the river and the literal meaning of Lmuhw (going through) chanting with the body. Further, to embody the environment by naming it after body parts is also a way to understand the world through the body. As pointed out earlier, the mountain ridge and the river are just like the coordinates along which the Tayal world extends. The confluence where rivers meet in the valley is called hbun in the Tayal language. It is often mentioned in the lmuhuw chanting as an identifier of the migration route. As the same time, the term 'hbun' also refers to the pit of the stomach of the human body. Table1 demonstrates the examples of referring body parts to topographical features in the Tayal language.

The toponymy is not just an analogical contrast of shapes, but also intertwined in the symbolic systems of Tayal culture. For example, the term l'ux means the calf shank of the human body which looks similar to a mountain ridge in shape. Qolu (throat) looks like the intersection of roads and reminds its importance for communication and defence. Hbun (the pit of the stomach), as the centre on the axial of human body, reflects the key role of the confluence in the river valley in Tayal people's migration and expansion. All these examples imply the symbolic connection between the human body, landscape, and society.

Livelihood, ecology, and society

The main livelihood activities in pre-colonial Tayal society include fishing, hunting, and swidden agriculture. The knowledge surrounding these activities is multi-layered and involves the knowledge of landscape, species, and their habitats, the methods of production, as well as the knowledge of social negotiation (See Table 2). For example, the fishing activities involve the knowledge of the river landscape. As different species of fish have different behaviours and their own favourite habitats in the river, it is important to know where to find them. In Tayal fishing activities, there are diverse practices of fishing, such as spearing, setting the cage, and poisoning the fish with the juice of narcotic plants. The first two practices are usually conducted by individual persons respectively. The third one is a collective community action. In addition to that, there is a collective action

Table 2. Examples of multiple-layered knowledge surrounding livelihood activities.

	Fishing	Hunting	Farming
Knowledge of Landscape	*Lyung* (main stream), gong (tributary), uru (creek), *pkwagan ksyax* (water source that has been utilized), *Silung* (pool)	*babaw ubah* (above the cliff), *syaw na ubah* (aside the cliff), *snat* (cliff wall), *syaw na snat* (the side of the valley), *quri* (concave), *rahaw* (river terrace), *qhoyaw* (steep slope)	*Nagaw* (the land that the vegetation has just been burned), *slaq* (wet land), *uraw karux* (black soil), *hmshaway* (slow slope, good for cultivation)
Knowledge of Species and Their Habitats	*Quleh tayal* (Taiwan shovel jaw carp, lives in the river section with rapid current), *qlohong* (Guapote tiger, lives in clean water), *tlaqi* (eel, lives in the deep pool)	*Qbuh* (masked palm civet, likes to eat fruits from the trees, often appears aside the cliffs or rocky places), *yapit talah* (flying squirrel with red chest, likes to eat leaves and tree fruits, and climbs the horizontal branches of trees)	*Trakis* (millet, can be further divided into different categories: *msinu, pnahai*, heqin, marai), *saqu* (yam), *sehui* (taro), *takun* (yellow bean), *kabilay* (pea), *tungi* (cucumber)
Knowledge of Methods of Production	*Mu quleh* (spearing fish), *qru sbuyu* (fishing with a cage), *tuba quleh* (poisoning fish with the root of derris), *muya quleh* (growing fish fry in the stream)	*Qmalup* (group hunting), *mrahaw* (setting trap on the tree), *boli* (trap with the bouncy tree branch), *rusa* (trap with rock), *ttu* (trap with clip), *pyulang* (trap with the rope)	*Manzyan* (use fire to open new land for cultivation), *sm'atu* (seeding to grow crops in proper locations and seasons), setting *haga* (retaining wall made of rocks or tree trunks)
Knowledge of Social Negotiation	Rules to decide the river section and time for collective fishing (with the root of derris)	Rules to use the personal hunting cottage, family hunting route, and communal hunting field	Rules to exchange labour, exchange land

called muya quleh (means growing fish). In this practice, people take the fish fry from the main stream to the tributaries where fishing is prohibited. These practices form another aspect of knowledge of fishing—the methods of production. Further, the knowledge of negotiation is also important. The main stream is divided into minor sections and maintained by the nearby settlements. People need to negotiate for the proper time and river section for collective fishing in such a way that the fishery will not be ruined. The multi-layered knowledge shows that the functioning of these livelihood activities is not just sustained by personal abilities, but also by social rules and organizations.

The social system of Tayal is, in fact, embedded in the ecological system of the drainage basin that extends by rivers

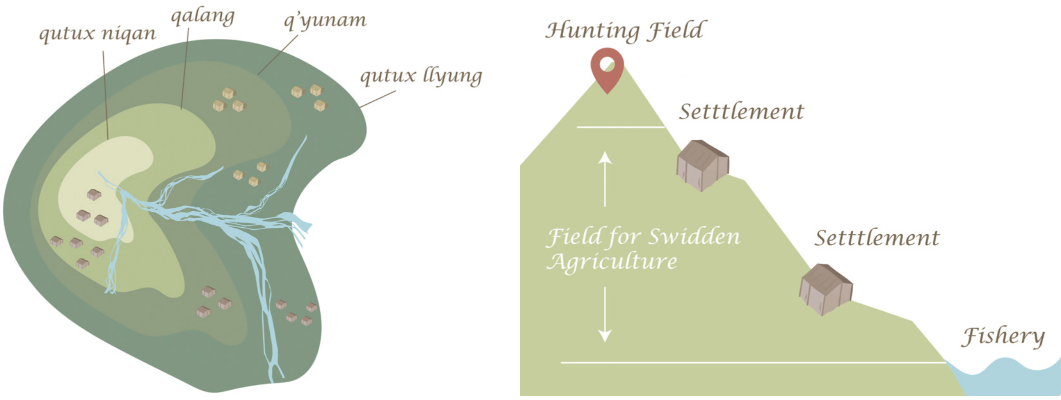

Image 5. Plan-section and cross-section showing the social ecological complex in the drainage basin (Revised from Kuan, 2017, p. 296).

and mountains. Gaga—the term refers to shared norms in the Tayal language—plays an important role in maintaining social consistency and integrity. Even though the settlements are usually scattered and distant from each other, a series of gaga is applied to various social categories going through various geographical scales. For example, there are gaga for qutux niqan (those who eat together in a settlement), gaga for qalang (settlement), gaga for q'yunam (the hunting field shared by settlements of one subgroup), and gaga for qutux lllyung (the subgroups who are sharing one river). The relations between the settlements of one subgroup are often reciprocal. Moreover, such relations are horizontally as well as vertically extended in the drainage basin.

For example, according to gaga, the settlements deployed in higher areas and closer to hunting fields should share the fields with those settlements of the same subgroup in the lower valley. Further, when hunters from higher areas meet hunters from the lower valley, it is common to share a part of prey with them because it is more difficult for them to reach the hunting field and get prey from there. Likewise, people from the lower valleys will not just share the fishing field to those from the higher hill, but also share the fish they caught with them (Kuan, 2013). Image 5 demonstrates the socio–ecological complex formed by the resource conditions in the drainage basin and the cultural creation of *gaga*.

Land-use on the basis of drainage basin

The mutual embeddedness of the social–ecological system is the result of cultural creation and environmental adaptation. Further study of Tayal people's knowledge

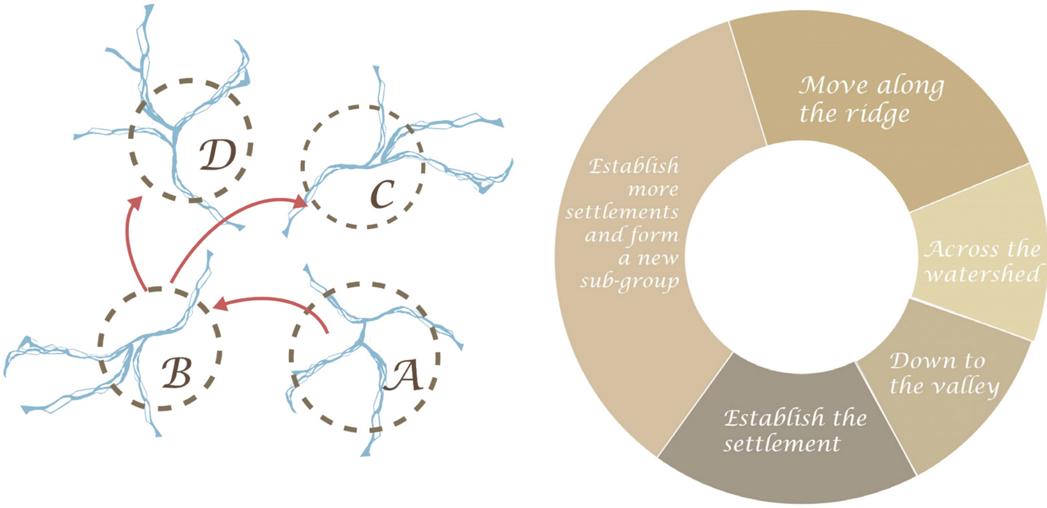

Image 6. The spatial/temporal patterns of Tayal migration across drainage basins (Revised from Kuan, 2017, p. 297).

of land-use shows a sophisticated, dynamic, and ecologically meaningful landscape management system that constitutes of practices in the following three scales:

Land-use across drainage basins

The first scale of landscape management appears in the practice of inter-drainage basin migration. As mentioned, Tayal ancestors migrated along the mountain ridges and rivers. Overpopulation was usually the reason for migration. The locations of Tayal settlements are distributed from 500–1500 metres above sea level. In comparison with indigenous groups in lower altitudes, there are two major features of the distribution of Tayal settlements: 1) the number of households in each settlement is very limited[9]; and 2) the settlements are distant from each other [10](Kuan, 2013).

According to the migration routes recorded in lmuhuw chanting, every time Tayal ancestors crossed mountain ridges and came to a new drainage basin, they built the first settlement on hbun (refers not only to the confluence in the valley, but also to the pit of the stomach on the axial of the human body). Gradually, people scattered to build other settlements along the river and tributaries in the drainage basin. The regions for hunting, farming, and fishing were guarded, and a subgroup with a

[9] Taking the Mrqwang and Mknazi subgroups as example, along with the main research site of this study, there are totally 645 households within 15 settlements. Each settlement has 43 households on average (Council of Indigenous Peoples 2019).

[10] According to the author's calculation with GIS, In Mrqwang and Mknazi subgroups, the average travel distance between two nearby settlements is 5.45 km.

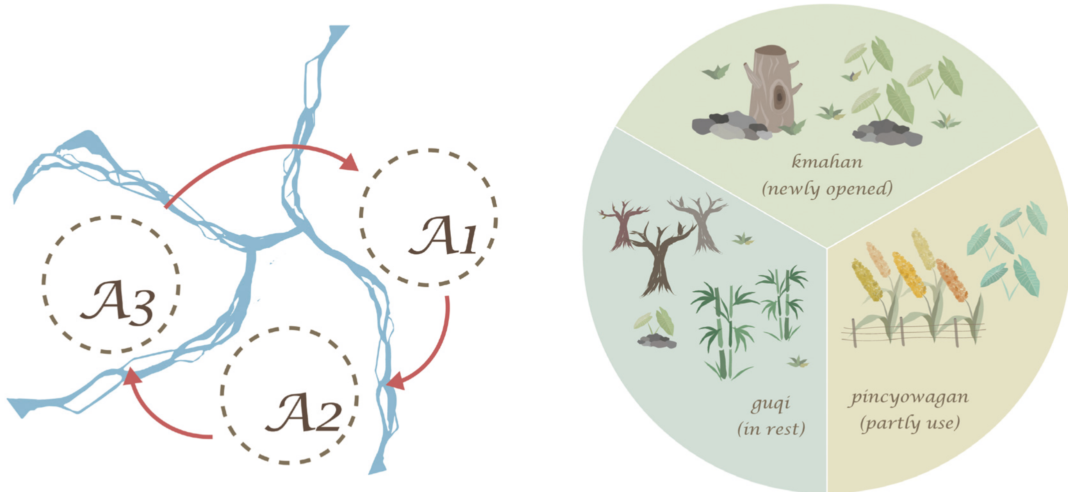

Image 7. The spatial/temporal patterns of Tayal swidden agriculture in one drainage basin (Revised from Kuan, 2017, p. 298).

unique identity emerged over time (Hetay, 2002; Lin, 2015). The spatial and temporal patterns of Tayal people's cross-drainage basin migration, as represented in Image 6, show the way such people have developed these methods to alleviate the pressure of population growth and distribute it across the country.

Land-use within drainage basin

In the Tayal language, there are different terms to refer to a land under different situations of cultivation. The land that is newly opened is called kmahan; the land that is partly used is called pincyowagan; and guqi refers to the land that is taking rest. These terms reflect the life cycle of land under swidden agriculture. After burning a patch of forest into a farmland, the phase of kmahan last for one to two years—the land has the most fertile soil During this period. When the fertility decreases, the land turns to the phase of pincyowagan that last for another one to two years. Usually, three to four years after the farmland is opened, it turns to the phase of guqi, which means you should let it take rest—all land users will leave this land and search for another patch of forest that is proper for cultivation. Before they leave, they will plant alder trees over the guqi as the land is now at rest. The period of rest last for about 10 years during which people will not disturb the land. Sometimes, when people shift their cultivation to a newly opened land, they move the entire household to live closer to it. Shifting agriculture practised in the drainage basin shared by the same subgroup manages to balance the need of farming and maintaining the soil.

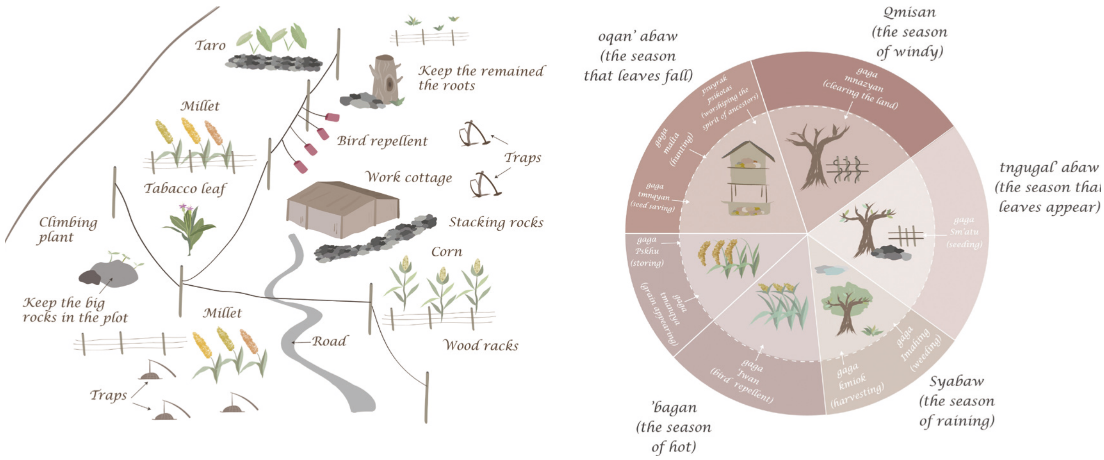

Image 8. The spatial/temporal patterns of Tayal cultivation over individual land parcels (Revised from Kuan, 2017, p.299).

Land-use via individual plots in the drainage basin

Third, in the scale of individual land plots, the cultivation practised by Tayal also shows a kind of ecological significance. These practices include: 1) keeping the big rocks or the roots of big trees after burning a patch of forest into farmland; 2) stacking rocks or wood racks to stabilize the slope; 3) planting different crops according to subtle changes of the landforms (e.g. vine for the scree and millet for the gentle slope); 4) setting bird-disturbance devices and hunting traps to catch small animals to protect the crops and also create alternative food sources; 5) planting with tiny hoes to avoid massive and in-depth destruction of the land. The picture on the left of Image 8 shows the landscape that grows diverse foods, while the picture on the right of Image 8 shows a Tayal calendar that follows the schedule of the millet plantation and the seasonal transition of the environment (for example, when the mountain cherry starts to bloom, it is the time for seeding the millet). These practices reflect a delicate and adapted strategy on land management.

The three land-use scales

To sum up, the traditional Tayal land-use aspects are: 1) reducing pressure on the land by migration or household separation; 2) periodically recovering nutriments in the soil via shifting agriculture; 3) implementing active adjustment of the agricultural strategy with subtle observation and adaptation to the topography.

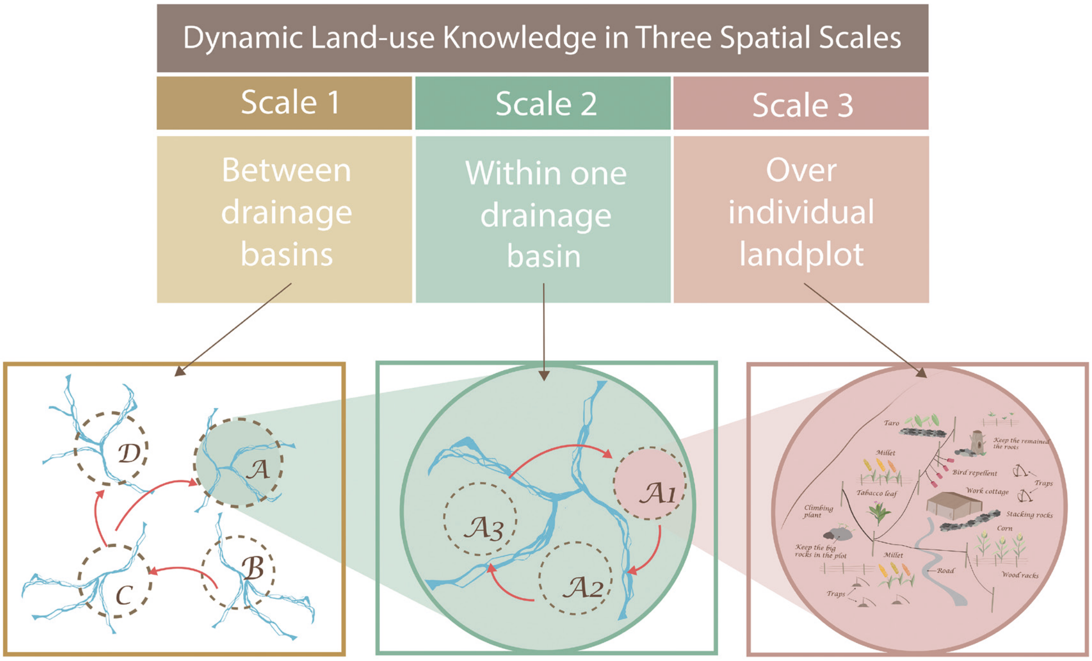

Image 9. The spatial articulation of Tayal land use in three scales (Revised from Kuan, 2017, p. 300).

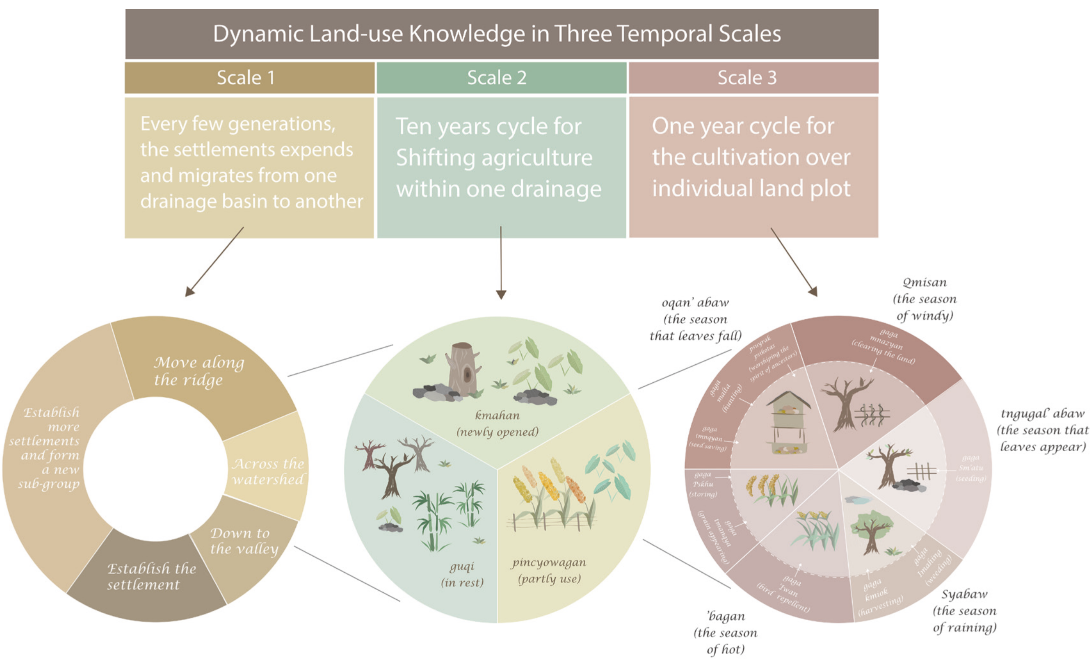

Image 10. The temporal articulation of Tayal land use in three scales (Revised from Kuan, 2017, p. 300).

Image 9 shows the spatial articulation of Tayal land use in three different scales (between drainage basins, within one drainage basin, and over individual land plots). Image 10 further shows their temporal articulation. From the perspectives of landscape management, the practices in three scales have formed a sophisticated, articulated, well-organized, and dynamic system. It disproves the already mentioned colonial claims of destructive and primitive cultivation.

The effects of and changes after colonial contact

The rich human–land relations and the dynamic landscape management maintained in the Tayal social–ecological complex were impacted in many aspects by the colonialization of Taiwan. The effects are explained in following section.

Resource use

Even though the Qing dynasty ceded Taiwan to Japan in 1895, Qing had never been able to effectively administrate highland Taiwan. The Japanese governor-general launched a series of pacification wars towards the high and indigenous area since 1910. The control of the commending height after fierce battles in 1912 declared the beginning of a new era. Now, the state has become the dominating power regarding resource utilization in this region.

The promotion of fixed-location wet-rice agriculture was a significant transition of traditional land use. The report from colonial scientists accusing indigenous peoples' 'backward' and 'foolish' slash-and-burn agriculture that allegedly degraded the environment has become outdated and has been disproved. But the idea legitimized the colonial policy of that time. According to recent historical studies, considering the maintenance of the terraces and ditches that were regularly ruined in typhoon seasons, wet-rice agriculture in highland Taiwan during the colonial period was not cost-effective at all (Chen, 1998). However, elders in the indigenous community recalled that every summer the Japanese police would organize all villagers to repair the ditches after a typhoon attack. Relocation, setting up villages, redistribution of land, educating the farmers, and mobilizing them to repair the irrigation system provided perfect access for the state to extend its control over the daily life of locals (Kuan, 2009, pp. 171–172). It is one explanation as to why the colonizers were so devoted to promote wet-rice agriculture in the mountainous indigenous area.

The role of the river in the hydro-engineering project

Along with the change in resource utilization, the function of rivers, defined by the dominating state power, overrode

Table 3. Examples of conservation laws influencing indigenous land-use activities.

Law (Year of Enactment)	Influences to Indigenous Land-use Activities
Running Water Act (1966)	Logging and farming are prohibited in the protected area set for conserving the quality of running water according to this act.
Regional Planning Act (1974)	Zoning system is applied to rural areas. Most of the indigenous areas are categorized as forest zone or slope land conservation zone. Land plots in the zones are further categorized. Most of the land plots are categorized as forestry land, which is not allowed to be utilized for the purpose of housing and farming.
Slope Land Conservation Act (1976)	This act defines the land located 100 metres above sea level as slope land and sets up further criteria to categorize slope lands into six grades. Grade 5 and Grade 6 allow activities for forestry and conservation only.
Soil Water Conservation Act (1994)	This act defines the term 'over-utilization' of slope land based on the criteria setup in the Slope Land Conservation Act and further sets up the penalty for over-utilization.

local needs. The building of the Shih-Men Reservoir after WWII further simplified the multiple roles of a river into an object of hydro-engineering. The reservoir divided the up-stream catchment and the down-stream water supply area; it also disturbed the relation that the catchment should serve the need of the water supply area. To fulfil the function of water supply, other functions were just marginalized. For example, to avoid sediment in the reservoir, more than 100 check dams were built in the drainage basin of the Shi-Men Reservoir (Chu et al., 2005). These check dams entirely changed the landscape and ecology of the river. From the current state policy perspectives of hydro-engineering, even though these check dams will be filled with sediment in five to six decades (or even sooner) after they are built and then turn into malfunctioned entities, they still successfully accomplish their duty. However, from the perspectives of the indigenous community, they permanently damage the landscape that carries deep historical memories. While the streams were covered with cement and turned into drainages, the places for families and friends to gather and live within are also disappearing.

The logic of land management

More and more land-use restrictions were established upon this area after WWII, as shown in Table 3. Indigenous people were more quickly put in a position to easily violate the state law. They are very often deemed as troublemakers regarding the state's forest and slope land conservation. However, behind the phenomena of violating the laws are fundamental conflicts between modern scientific knowledge and indigenous knowledge.

The characteristics of land management in the modern state include a bureaucratic hierarchy and instrumental rationality. By categorizing and modelling the world, the state translates the world into readable information through bureaucracy. Moreover, bureaucracy results in planning in accordance with rationality as well as projects a rational order to the world by implementing laws and policies (Scott, 1998). In these laws and policies, the landscape is essentially managed through visualized and fixed boundaries.

The study of Tayal people's ecological knowledge revealed a dynamic, situational relation between human and land (Kuan , 2013). Instead of fixing certain land uses in fixed geographical regions, indigenous ways of deciding on proper land use come out of daily negotiation, observation, and adaptation. Further study even points out that in Tayal ontology, the possession of land is neither fixed in certain locations nor does it contain a timeless permanency. Rather, it shifts from one place to another and there are changes in a periodic sequence (Chen et al., 2018). Such a paradigm was, however, deemed as out of order according to the state's rationality in the top-down process of decision-making.

Recent efforts to reconcile indigenous knowledge and state management

In the absence of any opportunity to defend indigenous knowledge, indigenous people kept carrying the stigma of lawbreakers, regulation violators, and soil–water degraders in Taiwan's mainstream environment discourse. Even though an indigenous land movement in Taiwan began in the 1980s, the dialogue on relating indigenous knowledge with state management has just emerged recently.

From Indigenous Peoples' Basic Law (2005) to National Spatial Planning Act (2015)

Taiwan went through a democratization movement in the 1980s, the time when the indigenous movement also gained momentum. In the indigenous movement, land is always a main issue as well as the source of a fundamental conflict between indigenous peoples and the state. The goal of the indigenous land movement required the state to 'return' the land to indigenous peoples. The government then responded with providing additional (but very limited[11]) reserved lands to those peoples. In the 1990s the movement started to claim indigenous sovereignty

[11] The total area of reserved lands assigned to indigenous people in the Japanese colonial era was 24,000 acres. The additional reserved lands assigned to indigenous people in response to indigenous land movement from 1990 to 1995 was around 16,500 acres (Council of Indigenous Peoples 2016, pp. 3–4).

and required an overall review of state–indigenous relations on the land issue, rather than just returning individual land parcels. Later, in 2005 the Congress passed the *Indigenous Peoples Basic Law*, which is a landmark when it comes to the recognition of indigenous rights in Taiwan. The law recognizes indigenous peoples' rights over both reserved lands and traditional territories. It also requires the government to respect indigenous peoples' choice for the living style, social economic organization, resource utilization, and the way of land management. As resource utilization and land use are regulated in diverse legal constructions in the state, the recognition cannot be realized by the *Indigenous Peoples Basic Law* itself. In 2015, ten years after the enactment of *Indigenous Peoples Basic Law*, the Congress passed the *National Spatial Planning Act*, in which indigenous peoples' rights in the state's spatial planning system are addressed. The land-use zoning and regulations derived from the land-use zoning over indigenous land need to meet the requirement of *Indigenous Basic Law*[12]. Further, these regulations need to be jointly designed by the Ministry of Interior and the Council of Indigenous Peoples (Article 23, *National Spatial Planning Act*) so that indigenous peoples' interests can be represented in the process. Similarly, when a special chartered regional land-use plan covers indigenous lands, it also needs to meet the requirement of *Indigenous Basic Law* and be jointly designed by these two government agencies (Article 11, *National Spatial Planning Act*).

Comparing the types of logic for soil–water conservation

A growing number of research papers now concentrate on legitimizing the indigenous ways of resources management, as the concerns of indigenous rights over traditional territories are gradually increasing. For example, after revealing Rukai people's knowledge of maintaining their hunting fields (Pei and Ro, 2000), Pei (2010) further advocates the incorporation of Rukai knowledge in the state's wild animal management. Lin (2002) addresses the importance of the Tayal perspective on forestation in conceptualizing ecological conservation. Lu et al. (2006) and Sasala et al. (2011) made suggestions to the establishment on community-based protected areas for natural resources management. Within these papers, Kuan and Lin (2013) examine the correlation between landslides and 'over-utilization' in accordance with the definition of the *Soil–Water Conservation Act*. This research points out that in the 10-year term covered

[12] According to Article 21 of *Indigenous Basic Law*, any government action, law, or decree that constrains indigenous land use will need to consult indigenous people and get prior consent.

Table 4. Comparison of logic for judging the land-use suitability between state management and indigenous knowledge.

	Land Grading System of the State	Land-use Knowledge of Tayal People
Minimum Area of the Land Parcel as a Unit for Certain Land-use Activity	0.25 Ha	Changing according to the landform
Criteria for Deciding the Suitable Land-use Activity	Depth of soil, degree of slope, condition of erosion	Changing according to the crop you cultivate and the way you cultivate it
Decision-maker	Trained government officer	Experience of indigenous knowledge practitioners

by the research data, about 1/3 of the 'over-utilized' (in the legal definition) lands are practically maintained well without causing any landslide. Therefore, it can be argued that some of the 'over-utilized' lands should be further used for farming activities and to maintain proper soil–water conditions at the same time.

If there is an adapted way of judging the suitability, indigenous farmers will not receive penalties for practically suitable land-use activities. Table 4 compares the logic for judging the land-use suitability between state management and indigenous knowledge. It shows that Tayal people have subtler and more situational ways in judging the suitability. Further, the key element for implementing this logic is based on places and the experience of indigenous knowledge practitioners.

The Special Chartered Land-Use Plan of the Cinsbu Community

Urged by the *Indigenous Peoples Basic Law* and also encouraged by academic studies, the Construction and Planning Agency in the Ministry of the Interior launched an experimental project in 2014. A team of planners was sponsored to work with the villagers of Cinsbu, which is one of the Tayal settlements, for a field study of this research. Based on the understanding of Tayal people's ecological knowledge and land culture underlined by previous research, this team of planners facilitated the villagers to address the spatial issues that concerned them. Moreover, these planners also facilitated the villagers to find possible solutions in the traditions that are deemed as important (Chen, 2015). Two years after the initiation of this project, the first draft of a local land-use plan was accomplished. The outcome of this participatory planning reveals important information (National Taiwan University Building and Planning Research Foundation, 2015): The villagers expressed higher demand of local water source conservation than the government did. They efficiently detailed the locations that are relatively sensitive to heavy rainfall and therefore need further protection. The land uses they addressed are more diverse than the government expected. Their land-use plan considers future transitions. At the same time, in certain areas, it allows the co-existence of agricultural, forestry, and even hunting activities.

After three more years of negotiations with the government, the final *Special Chartered Land-use Plan* in the Cinsbu community was approved and announced by the Ministry of the Interior in 2019. The announcement not just released the spatial plan, but also required the relevant government bureaus to revise their administrative regulations to meet the needs of the plan. Even though there are more challenges to be tackled, it signals a new achievement in the dialogue between indigenous knowledge and state management.

Conclusion

Indigenous knowledge has long been ignored by modern environmental discourse. The claim of 'backward' and 'foolish' indigenous agriculture in colonial Taiwan is one example. Such a claim underpins the colonial policy to relocate indigenous people as well as to change indigenous social economic orders. Following the same logic that ignores indigenous peoples' knowledge of the environment, succeeding governments after WWII exploited the resources from the mountain area and set up further regulations to prevent indigenous people from degrading the state of soil–water conservation. However, the ethno–physiographical study of Tayal people in this research proves that indigenous people have very ecologically adaptive ways of land use that come from long-term experiences of continuous and intimate human–land interaction. The migration history, the art of chanting, and the form of social–ecological complex all point to the fact that rivers are definitely the core of these experiences. River are not just bodies of resources, but also symbols of connection in Tayal people's way of knowing the world.

In this sense, the cultural ecology of rivers is not only about rivers themselves. It is about how things are dynamically and fluidly articulated. Therefore, it provides inspires us to rethink the current drainage basin management. The recent efforts presented in this paper reveal a positive chance for a fruitful dialogue between state management and indigenous knowledge. Participation plays an important role in this process. It brings all knowledge-holders together. The ethno–physiographical approach adapted in the research plays an important role too. As a mediator of dialogue, it broadens the spectrum for mutual understanding. As the very first case in Taiwan, the Special Chartered Land-use Plan in the Cinsbu community is an opportunity for Tayal people to realize the environmental philosophy and its dynamics and fluidity. The opportunity was actually fostered by continued efforts put in by indigenous movements, institutional adjustment, and academic involvement in the past. It also needs continued concern, observation, and contribution in the future.

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Dalieh el Raouche – The wilderness of Beirut: Framing cultural landscapes as waterscapes by an expert-led community campaign in Lebanon

Sarah Lily Yassine

Introduction

Lebanon is situated on the eastern shores of the Mediterranean Sea. It is a landscape that captures the sea and the mountain displaying a diverse geomorphology. Natural springs bisected by valleys flow into the sea-forming estuaries, bestowing upon its coastal plain fertile soils and topographic signatures that allowed human settlements on its shore since prehistory. Moreover, waterscapes like rivers, aquifers, springs, and the coast are undeniable attributes of Lebanon's sociocultural identity, its economic liveability, and its resilience.

This paper offers a reading into Dalieh el Raouche, an urban coastal cultural landscape in Beirut, illegally privatized for real estate development. Dalieh el Raouche (in short, Dalieh) is a 140,000 m^2 unique natural site that slopes towards the sea (Image 1) near Beirut's emblematic Raouche (Pigeon Rocks)—the 60-m offshore rock formation that dominates Beirut's view from the sea and features on many postcards (Dalieh Campaign, 2015). The paper is organized into two parts. In the first, I narrate how the Dalieh Campaign protected the site by establishing its significance as a waterscape. In the second part, I delve into the history of the campaign, its formation, its mode of operation and achievements, and its seminal role in creating an urban social movement in Lebanon (Harb, 2016). This paper will demonstrate how the Dalieh Campaign (in short, Campaign) ushered in a socio-cultural shift and political movement that witnessed fruition on the October Revolution (on 17 October 2019), a "massive wave of unprecedented nationwide protests, which are deemed to mark a new era in Lebanon's history" (Social Watch, 2019).

Dalieh el Raouche: Wilderness of Beirut

Seafaring people, the Canaanites followed by the Phoenicians, "established kingdoms from Sidon to Tripoli along the shores of

Image 1. The ensemble of '*Dalieh el Raouche*' composed the promontory the offshore arch and stack breakaway rocks. Image courtesy of the Dalieh Campaign.

today's Lebanon" (ICOMOS Lebanon, 2019). The Assyrians, the Persians, the Greeks, the Romans, and later, the Byzantines and the Arabs "modified those layered and long-standing coastal cities where a flourishing economy and rich cultural life thrived across periods" (ICOMOS, 2019, p. 7). Today, the Lebanese coastline extends over a 230-km linear corridor between the Al-Kabeer river at the Syrian border in the north and Naqoura at the southern border with Israel/Palestine. It is one of the country's richest and yet most sensitive waterscapes. The coast is characterized by its archaeological and built heritage, underwater ruins, geologic formations, offshore islands, historic salt marshes, natural fishing ports, agricultural plains and estuaries, as well as sandy, pebbly, and rocky beaches.

Top-down urban planning policies, the civil war (1975–1990), and "corruption, inefficiency and incapacity" have resulted in poor environmental and heritage management policies and a planning framework that lacks implementation mechanisms at both regional and local levels (Harb, 2016, p. 4). According to economists, more than 80% of the Lebanese coastline have become privatized, and the country is witnessing significant ecological degradation, its rivers have become waste streams, and its agricultural valleys are being threatened by infrastructure projects like dams or rampant urbanization (ICOMOS, 2019). What remains has become unique and hence in need of urgent protection.

Image 2. '*Minet el Dalieh*' the historic natural fishing cove, displaying natural inlets and caves all of which form the karstic outcrop of 'Dalieh' belonging to the Cretaceous geological period. Image courtesy of the Dalieh Campaign.

Image 3. People experiencing the tidal pools on Dalieh's western marine terraces or paleoshores formed by the interaction of weathering factors and the presence of fresh water sources. Dark flint can be observed within the karst beds. Image courtesy of the Dalieh Campaign.

Dalieh el Raouche: Between city, land, and sea

With two hills, a promontory, the coast, and a river, the landscape of Beirut shapes its topographic, socio-political, and geopolitical borders (Chabarek and Yassine, 2018, p. 115). On the southern tip of the promontory lies Dalieh el Raouche, the unscripted urban wilderness of Beirut, the locus of its relationship with the sea and a site of multi-layered significance, spatially, ecologically, socially. The word 'Dalieh' refers to vine plants, while 'Raouche' means rock and originates from the French Rocher or Arameic Rosh (head). So, Dalieh el Raouche literally means the vine of the rock. Minet el Dalieh (Image 2), the historic natural fishing cove, was studied by the Jesuit Priest Raoul Describes. He hypothesized that the area must have been a Solutrean industry (advanced flint tool-making process) site—it probably got abandoned during the Iron Age—because of the resemblance of the black flint tools with those developed by Homo sapiens in occidental Europe. He called the tools Stylets of Minet Dalieh (Makarem, 2014). Today, these tools are found at the Musée des Confluences in Lyon and several museum collections in Lebanon, including the Prehistory Museum and the National Museum.

Interviewed by the French Lebanese Daily *L'Orient-Le Jour* in 2014, the historian Corinne Yazbeck asserted that Dalieh el Raouche is a unique site to be protected in the Eastern Mediterranean region. She argued that it is the only in situ where the lithic flint industry was identified on the northern coast of the Levant, adding that Dalieh displays a succession of paleoshores (fossil shores; Image 3) formed during the Quaternary (Makarem, 2014). The last remaining coastal karstic outcrop belongs to the Cretaceous geological period—it was formed around 95 million years ago—and geologists confirm it was "a rocky cliff island, covered with sand dune, transformed during the middle Paleolithic Age, when it became joined to the mainland" (Dalieh Campaign, 2015, p. 16). For them, Dalieh is a living testimony to the geological history of Lebanon, exhibiting a diversity of features and habitat typologies such as vermetid reefs that are biogenic platforms situated exclusively on the Levant coast, tidal ponds, and underwater caves where a large community of fruit bats have taken refuge alongside the Mediterranean monk seal. Seasonally, migratory birds are observed here as Lebanon is situated on the African Eurasian bird flyway, and bottlenose dolphins can also be seen from Dalieh (Barriche, 2010). In addition, Dalieh encompasses a promontory, breakaway cliffs, protruding stone terraces, sandy beach sediments, shallow bays, and natural inlets arches (Image 4).

The geomorphology of the site explains its ecological importance for marine and terrestrial fauna and flora, which were the subject of numerous national and international studies (Chmaitelly, 2007). The National Physical Master Plan of the Lebanese Territories (2009) identifies the site as a distinguished natural area to be protected; Greenpeace's study in 2012 proposed Dalieh for the Network of Marine Reserve in the Lebanese Coastal

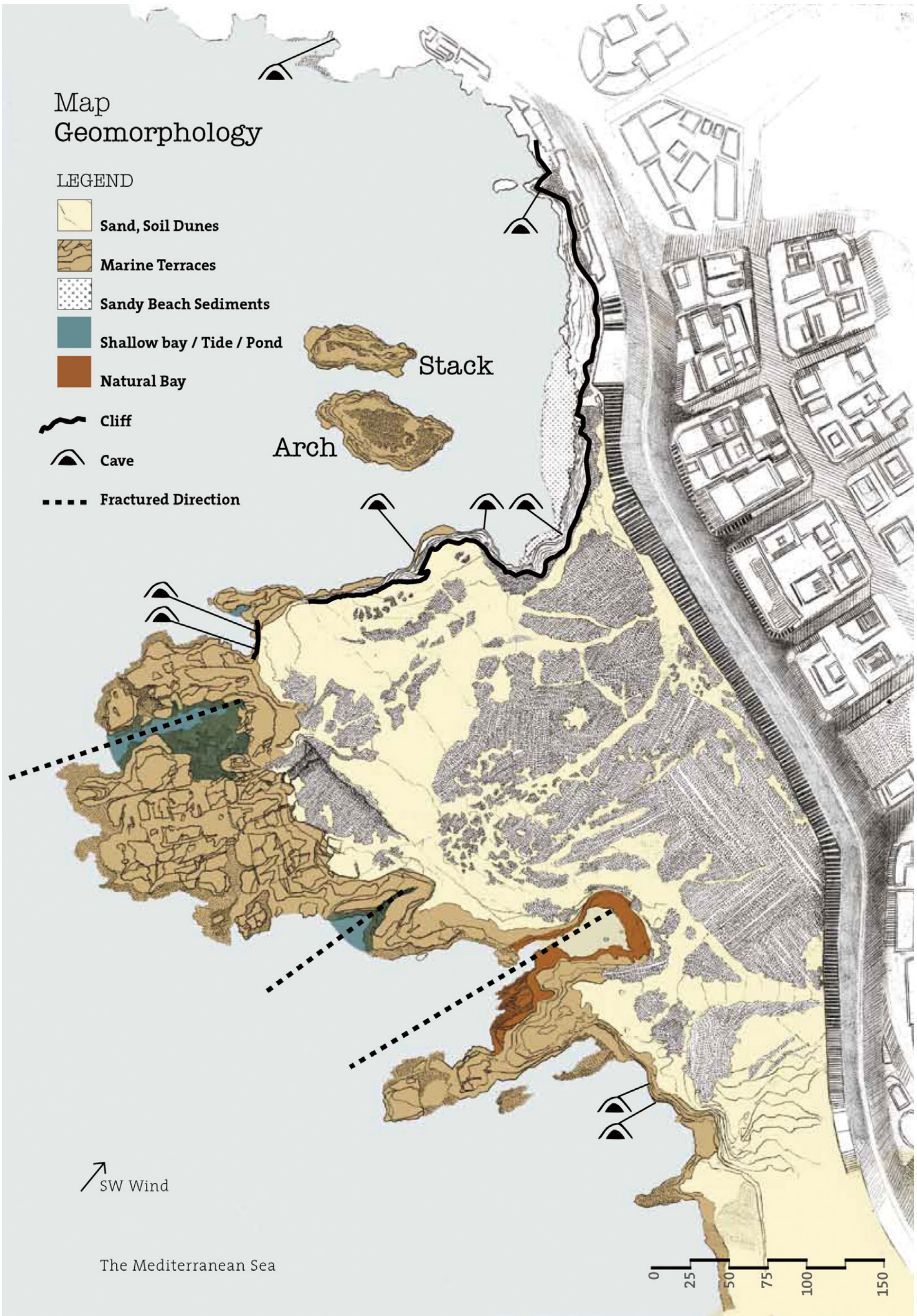

Image 4. A series of 4 maps produced and designed by the '*Dalieh Campaign*' illustrating landscape features including archeology, social practices and biodiversity. This one situates the site's geomorphological features. Map courtesy of the Dalieh Campaign.

Image 5. Site visits organized for the ideas design competition '*Revisiting Dalieh*'. In this image designers participating in the competition descent to discover 'Dalieh' in spring blooming with endemic flora only found in a few remaining coastal sites. Image courtesy of the Dalieh Campaign.

Waters; and the International Union for Conservation of Nature classified Dalieh as an Important Plan Area (IPA) and one of the last remaining patches of semi-natural vegetation significant to the Lebanese marine ecosystem.

Mapping urban social practices and cultural heritage

Considered the backbone of the city's visual landscape, Dalieh el Raouche is a natural monument of Beirut—it's where tourists take photos. Googling Beirut, it is the first image one appears on the screen. It is where the power of topography, wind, and the sea are felt (Image 5). Oral historians have recounted numerous stories about the social significance of Dalieh, which is known as one of Manateq at Tanazuh (places of promenade). Until the 1960s Dalieh occupied a central space in social imagination both as the "destination of regular strolling" and "the location of repeated rituals", involving instrument playing, food preparation, and family picnicking (Dalieh Campaign, 2015, p. 28). A yearly celebration took place at Dalieh on the last Wednesday of April, commemorating Job's Wednesday, the miracle of Prophet Job who swam seven times patiently in the caves of Dalieh to get relief from his pains. On that day, Beirutis marched to Dalieh, prepared the traditional dish mfatqa, and children flew their kites and picked seven types of flowers. Dalieh also remains the destination for the celebration of the grand Nowroz festivities, the vernal equinox, marking the beginning of spring, celebrated by the Kurdish community in Beirut.

Prior to 2013, an informal fishing economy marked the tempo of life in Dalieh as they arranged tours in fishing boats. They took visitors to experience the stories of the caves of Dalieh and offered fresh sea dishes in small shacks. Traditionally, diving competitions took place every summer where dozens of swimmers gathered (Image 6). Today, however, only a small group known as the Dalieh Swimmer perpetuates this activity, while another group practises yoga every morning.

Image 6. Photograph of a diving competition at '*Dalieh*' in the summer. Archive courtesy of the Dalieh Campaign.

From a campaign to an urban social movement

One day in the fall of 2013, residents of Beirut woke up to find Dalieh el Raouche cut off by barbed wire. As citizens and site-users, we felt professional and personal responsibility to protect Dalieh. We discovered, contrary to our belief, that it was privately owned by a very powerful Lebanese political figure and that Rem Koolhaas, founder of the Office of Metropolitan Architecture (OMA), had been commissioned to design a high-end sea resort on the site. So, we had to react and gathered as the Civil Campaign to Protection Dalieh el Raouche—in short, the Dalieh Campaign. The campaign's logo features the contours of the site. We called our first meeting in a community space, and many concerned people— landscape architects, urbanists and planners, designers and artists, academics and journalists, lawyers and policymakers, as well as Dalieh lovers, swimmers, and fishermen—attended in it.

A campaign of many acts

The first phase of the campaign was reactive as it aimed at onsite contestation. The members organized a press conference, an event titled *An Encounter to Reclaim Public Spaces*, with concerts and talks—interventions that included installing a permanent banner and art works that remained on the fence until it was taken down in 2015 (Image 7). Dalieh fishermen took to the streets to protest when urgent court cases were field against them by real estate companies that claimed ownership over Dalieh. These real estate companies wanted to evict the fishermen from their shacks, which were demolished after negotiations were reached and compensations settled. In November 2014, the campaign launched an online petition titled *Dalieh: All What Remains of Beirut's Shores*. The petition went viral and succeeded in raising awareness about the importance of Dalieh and the controversy over its ownership. While the campaign began operating organically, with people joining open meetings, slowly a nucleus of core active members coalesced and carried the momentum forward.

The second phase aimed at producing extensive research on the site's significance

Image 7. In situ interventions organized by the '*Campaign*' at an event in 2014 aiming to reclaiming public access to '*Dalieh*' after it had been fenced by owners in 2013 thus gating the site and preventing access to it. The black human like figure on the left of the image remained on the fence until it was removed by protestors in 2015. Image courtesy of the Dalieh Campaign.

as a waterscape (discussed in Section 1) as well as delving into the legal framework of the property's history. Throughout the Ottoman Empire (1517–1918) and the French Mandate (1920–1943) periods, land on the western coastline of Beirut, where Dalieh lies, was verbally entrusted to notable families, symbolically granting them guardianship over the city's commons, considered wild, barren, and remote from the historical core (Dalieh Campaign, 2015). The campaign reviewed official cadastral property records for the period between 1920 and 1995 and discovered that "they had been converted from the shared property 'masha' to private property" (Harb, 2016, p. 13). Nevertheless, these property titles did not contradict the status of Dalieh as "the place of the city's collective commons" or wilderness, which was further reflected in the vision of policymakers (Dalieh Campaign, 2015, p. 34).

As a matter of fact, Order 144, issued in 1925 and still in effect, formulates the rights of access to natural resources, stipulating that the furthest highest water point on the beach constitutes an inalienable maritime public domain that can neither be sold nor owned (Dalieh Campaign, 2015). The importance of preserving Beirut's seafront wild, unbuilt, and open to all was also reflected in the 1954 Beirut Master Plan, which still defines zoning regulations today, prohibiting construction of any kind in Zone 10 where Dalieh is situated.

Owning the sea

Economic and political fluxes in the Middle East throughout the 1960s were echoed by real estate developers and property owners who put pressure on the authorities to reverse legislations against building on the coast, especially in Zone 10, and intensifying building coefficients, allowing for privatization of areas on the coastline that were being used publicly as gathering spaces. Despite these pressures and the gradual transformation of Beirut's coastline, Dalieh was not affected. However, going through official property records in July 2014 revealed that in "1995 three private companies belonging to the same influential political figure purchased property shares and consolidated them into a single private ownership" (Dalieh Campaign, 2015, p. 34).

In addition, further examination of historical cadastral maps shows that current private land boundaries have been modified to encroach over the maritime public domain, illegally privatizing a large section of the natural site, in contravention of urban and building regulations that had protected Beirut's seafront for decades. Violation of the regulatory framework is not a recent happening. In the post-war period, policymakers and politicians manipulated regulations to serve their private interests. This acquisition marks an important shift because it meant that historical practices taking place for decades on communal land were now happening on private land, thus rendering them illegal or informal in the eyes of their new owners. However, in social imagination, Dalieh is still being viewed as an urban wilderness, free and open to all.

To add to the controversy, further research demonstrates that the legal jurisdiction over the protection of Dalieh as a natural heritage site and gathering space is a responsibility shared by several institutional bodies including the Ministry of Environment, the key agency that can undertake the preservation of the site, and the High Council for Urban Planning that has the sole power to refuse granting exceptional decrees and the mandate to propose any new legislation for the protection of the site (Dalieh Campaign, 2015). In short, Dalieh el Raouche is a waterscape of national importance, which is protected by legislation but still paradoxically privately owned.

Image 8. Boat tours organized by the '*Dalieh Campaign*' taking visitors in fishing boats along the natural inlets, tidal pools and the 7 caves of 'Dalieh'. Image courtesy of the Dalieh Campaign.

Watch Dalieh

The year 2015 was important for the Dalieh Campaign. Institutional momentum to protect the site was building, with the press and public figures endorsing the work of the campaign and a growing interest in Dalieh as a cultural landscape within the heritage field. All campaign members were invited to speak at several universities including the Lebanese University and the American University of Beirut (AUB). The members also participated in symposiums along with stakeholders at the Order of Architects and Engineers of Beirut at art institutions and community organizations where talks revolved "around three themes — the social and property history of Dalieh, the legal and land tenure framework, and the landscape heritage features of the site" (Chabarek and Yassine, 2018, p. 125).

To widen the scope of public engagement, a bilingual Arabic/English publication was authored, designed, and self-funded by the campaign. It was disseminated at public libraries, schools, cafes, universities, art spaces, and design studios. The Dalieh Campaign Booklet converted research into infographics and provided a thorough history of the regulatory framework governing the site's ownership, thus shedding light on the ownership dilemma and summarizing a list of demands. This provided the foundation to design a website to consolidate an archive (https://dalieh.org). Various design studios and artists had produced material for the campaign, but the city witnessed another creative momentum when designers not associated with the campaign began creating slogans, visuals, and videos endorsing the plea which went viral on several online platforms and appeared as stencils and graffiti on the city's walls. In response to massive demand, the campaign members organized guided land and sea tours (Image 8) and partnered with local Dalieh fishermen to "purchase safety jackets for children tours" (Chabarek and Yassine, 2018, p. 125).

In addition, an open letter was addressed to Rem Koolhaas on the online platform *Jaddaliyah*, an independent ezine produced by the Arab Studies Institute, after learning that OMA was commissioned to conceive a proposal for a private beach resort on Dalieh. Koolhaas responded "assuring the Campaign that it's concern will be taken into account" (Sowa, 2015). Indeed, many journalists were aligned with the campaign, and several articles appeared in national and international press such as *The Guardian*, e.g. Habib Battah's article 'A city without a shore: Rem Koolhaas, Dalieh and the paving of Beirut' (Battah, 2015). This, of course, did not assuage the campaign. In fact, it filed a lawsuit at the High Administrative Court against Decree 169 of 1989, which removed state protection from Zone 10 of Beirut's masterplan. The campaign argued that "developers held close ties to the politicians who passed it" and that "development laws had been passed during the chaos of the civil war and had not been made public or ratified by other government bodies, many of which were not even in session during the war" (Battah, 2015). At that moment, the Campaign had reached unprecedented public support—it was time to influence national policy and institutionalize those efforts to permanently halt the real estate project and protect Dalieh el Raouche for generations to follow.

Revisiting Dalieh: A call for alterative visions for Beirut's coast

The campaign did not stop at opposing current development plans (Sowa, 2015). It launched *Revisiting Dalieh: A Call for Alternative Visions for Beirut's Coast* (Image 9), soliciting proposals in which "participants were invited to articulate creative, sensitive, and environmentally sustainable design proposals for the conservation and future of Dalieh" (Jadaliyya, 2015). The competition was organized under the patronage of the Lebanese Environment Ministry, the AUB's Asfari Institute for Civil Society, and its Nature Conservation Centre (Chabarek and Yassine, 2018, p. 125). Following an online crowdfunding campaign to raise funds to cover the competition's expenses, an international interdisciplinary jury was invited comprising the president of the International Federation of Landscape Architects (IFLA) and several prominent national as well as international practitioners.

Reputable designer firms participated in the campaign, and winners were shortlisted according to the following criteria: "sensitivity to urban context; reaffirming historical identity of Dalieh as a space for the public; functionality, flexibility, and economic feasibility; ecological and environmental sustainability; institutional framework addressing property and managerial/administrative concerns; innovation and creativity; clarity and completeness of the submission" (Jadaliyya, 2015). The competition jury deliberated in May 2015 at the Issam Fares Institute for Public Policy at the AUB, selecting three winning schemes that were published by *Jadaliyya* to "disseminate to a wide public the range of alternative possibilities to develop Dalieh el Raouche in environmentally sustainable ways that respect the site's urban history, socio-spatial practices and ecology" (Jadaliyaa, 2015). Finally, an exhibition of all entries was organized as part of Beirut Design Week. Simultaneously, the campaign collaborated with the Ministry of Environment to provide research and documentation to categorize Dalieh el Raouche as a Natural Protected Area, which means that construction on the site would be strictly regulated by the ministry which has the sole right to decline any project. For the campaign, this marked a tangible achievement towards protecting the site. However, until this day (five years later), the decree remains at the Council of Ministers awaiting implementation.

In the summer of 2015 Beirut witnessed an unprecedented municipal waste crisis—the municipal landfill used beyond its capacity triggered months of massive protests coalescing into the You Stink movement. In October 2015 protestors from within the movement and connected with the Dalieh Campaign took to Dalieh, cut its fence, and reclaimed it as a public space. In the ensuing month, OMA abandoned the project. In October 2015 Dalieh el Raouche nominated by the Dalieh Campaign was one of 50 sites chosen by the World Monuments Fund (WMF) for its Watch list cycle for 2016–2018 where it was described as a "7,000-ywar-old public space on the coast of Beirut" (WMF, 2016). This provided the campaign with "symbolic international weight that comes in very handy in negotiating for its preservation" (Harb, 2016, p. 14).

In 2017 the Dalieh Campaign partnered with Save Beirut Heritage, another urban collective that had also successfully nominated Honeine Palace, a 19th century

Image 9. Poster designed by the '*Dalieh Campaign*' to promote participation in the design competition '*Revisiting Dalieh*' organized in 2015 in partnership with the Lebanese Ministry of Environment. Posters were disseminated nationally. Visual courtesy of the Dalieh Campaign.

Image 10. Poster for Beirut Watch Days organized by the ‘*Dalieh Campaign*’ and ‘*Save Beirut*’ heritage to promote the program of the heritage week highlining the importance of natural and built heritage facing the same threat from real estate development.

endangered mansion in Beirut, on the same cycle of the Watch. The WMF argued that both sites, one natural and the other man-made, faced the same threat resulting from economic corruption, poor heritage management, and a regulatory framework only serving the benefit of the real estate sector. To elaborate on this point, both collectives organized the Beirut Heritage Watch Week, a weeklong event, in collaboration with Lebanese Ministries of Culture and Environment in May 2017. The programme included readings, exhibitions, discussions, and guided tours connecting the two sites and a collaboration with Temporary Art Platform that worked with the Dalieh Campaign to commission in situ art and design intervention on Dalieh (Frieze, 2017). The international press covered the programme, which took place as part of the Beirut Design Week (see Image 10). Moreover, in 2017 the Dalieh Campaign led to the establishment of the Lebanese Coast Alliance, a national coalition, to develop a strategy to protect the Lebanese coast.

Conclusion

This article discussed how a group of active professionals in Lebanon, the Dalieh Campaign, established the significance of a contested privatized coastal site, namely Dalieh el Raouche, as a waterscape of national as well as regional importance and successfully preserved it from private real-estate development. The success resulting from the multiple strategies and actions deployed by the Campaign "contributed to shedding light on the important value of Dalieh for the city, and dissuaded its owners from their construction plans" (Harb, 2016, p. 14). Moreover, the achievements of the campaign permeated the heritage field, urban studies, and socio-politics. The cultural heritage discourse in Lebanon is still maturing but lacks an interdisciplinary perspective. So, the Dalieh case sets a precedent—for the first time a natural coastal site was at the forefront of heritage discussions—sowing seeds of collaborations between the Ministries of Environment and Culture. According to the World Monuments Fund, "Beirut's Dalieh, a prominent landmark […] a landscape of beauty, rich social history, and cultural memory, has been a feature of city life for more than 7,000 years" (WMF, 2016). This endorsement has propelled the interest of the Ministry of Culture to investigate the potential of Dalieh el Raouche to be featured in a tentative list of National World Heritage and the formation of a working group within the Lebanese committee of the International Council for Monuments and Sites (ICOMOS). The latter working group was formed to reflect on establishing two national scientific committees—one on "waterscapes as heritage" and the other for the "protection of the cultural landscape of the Lebanese Coast". At the urban policy level, the Dalieh Campaign "had successful impacts on urban policy", with its members developing "new modes of action and intervention that have led to tangible results" (Harb, 2016, p. 14). Indeed, the campaign pioneered a new discourse on the coast—it analysed and depicted the coast as a complex landscape system with multi-layered significance and not merely as public space or public marine domain.

Beirut appeared peripheral to the upheaval of the Arab Spring, which convulsed the Arab region in 2011 (Sharp and Panetta, 2016). However, the *You Stink* movement triggered an uprising in the fall of 2015. Led by a coalition of urban planners, landscape architects, archaeologists, heritage experts, ecologists and environmentalists, designers and artists, who are politically and socially active towards more inclusive modes of spatial production, Dalieh Campaign members belong to a generation that is "well aware of urban social movements that are multiplying across the world, led by the same urge to reclaim cities and urban spaces, and to participate in their processes of spatial production" (Harb, 2016, p. 11). Indeed, the campaign is part of an extended network of professionals and citizens who led several other initiatives, coalitions, and campaigns, many of which coalesced into several political pressure groups since 2015. These groups include Beirut Madinati (translates into Beirut My City), a campaign that ran for municipal elections in 2016; the 2017 Nakabati (My Syndicate), an initiative for the Order of Architects and Engineers; and finally, the 2018 National Coalition that ran for parliamentary elections (Chabarek and Yassine, 2018). All the above-mentioned refer to the Dalieh Campaign and have employed its discourse to argue for alternative visions for the Lebanese coastline at the forefront of all their political electoral campaigns. In the book *Beyond the Square*, Sharp and Panetta (2016) argue for the centrality of space and spatial concerns with regard to the ongoing political transformations in the region.

On 17 October 2019, at about 8 pm, protestors took to the streets of Lebanon. Motivated "by the direct repercussion of the economic and monetary crisis on the Lebanese population", the still ongoing October Revolution is "indeed rooted in a structurally flawed economic system and wicked political practices and corruption embraced by the successive governments for decades" (Social Watch, 2019). Once more, socio-spatial phenomena, including the access to and preservation of the Lebanese coastline, was a key issue that the protestors reclaimed. A new wave of visuals, events, sit-ins, and discussions exploded, and Dalieh el Raouche and the Dalieh Campaign were referred to as successful cases. Reporting on a panel discussion that took place in

Paris in January 2020, the journal *Al Modon* quotes the closing remarks of the urbanist Eric Verdeil, who said that activists behind the Dalieh Campaign are taking part in the revolution and continuing to build a new phase of Lebanon's history according to an alternative vision (Murad, 2020). A water heritage site and its traditional use have become not only a local starting point for multidisciplinary engagement with heritage, but also a catalyst for political renewal and social cohesion.

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Protecting water and heritage based on the worldviews of South American communities

Sérgio Ribeiro and Maurício Andrés Ribeiro

Understanding the world's diversity of water cultures – historically and today – is essential to understand the context-based water management rationalities, conflicts, and solutions. In local water territories, water norms, principles and authorities of different origins co-exist and interact. Everyday water control forms a dynamic mixture of local, national and global rules deriving from indigenous and colonial norms. Seemingly irrational, disorder often appears to be organized complexity. (Boelens, 2017, p. 28)

Introduction

In sociology, philosophy, law, politics, and other fields, communities are defined as people who organize themselves according to the same norms, the same place (be it at a local, regional or global scale), under the same government, or share the same cultural legacy. A variety of motivations lead individuals to cluster—there are biological and affective motivations in families and clans; or in ethnic groups within tribes who resist external pressure; or in neighbourhoods, clubs, and associations that defend common interests. There are also professional and economic motivations to cluster when individuals are grouped into companies, corporations, trade associations, workers' unions, or orders. Sometimes, individuals are even grouped into shareholders and investors who come together in meetings. There are communities with similarities of beliefs and religions that congregate in churches and share ideas, worldviews, or interests, and communities can be formed by persons sharing the same political views—they can be grouped into governments as well as social organizations. The various scales of communities range from one family group, a neighbourhood, a city, a country, to the scale of the planet (Image 1).

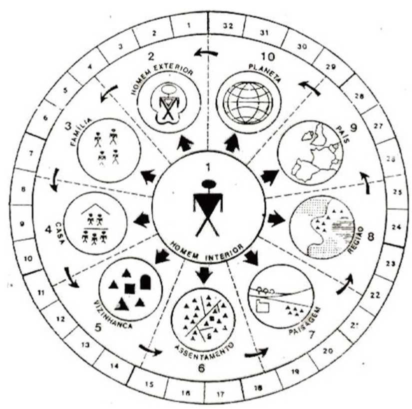

Image 1. Scales of a community: from the family (3) to the planet (10) (Pierre Dansereau).

Some communities are dense and local, while others are scattered and global. There are supranational economic and political communities, such as groups of countries that join to achieve common goals like the European Economic Community. There are virtual communities such groups on social networks that contribute to building Wikipedia. The various stakeholders in a community involved in an economic activity have different interests in terms of employment, income, quality of life, safety, environmental protection, and heritage protection. The interests of top-down and inward-looking economic development often prevail over the interests of protecting and caring for the local environment. These are defended, for example, by tribes and local communities in the face of large infrastructure and mining projects.

In this text, we will treat the situation in Brazil and the Andean countries. Some case studies have been chosen to exemplify the different worldviews that are present in each of them. Next, we compare the conflicts between these different worldviews. We analyse cases of water and heritage protection from the indigenous worldviews and cases of non-protection when a distinct utilitarian approach has prevailed.

South American worldviews and heritage protection

Cristián Parker, sociologist and researcher at the University of Chile, studied the different worldviews of different indigenous groups, economic entrepreneurs, and environmental movements. He also studied the conflicts between various social actors involving water and natural resources in South America. Parker lists the various ethical discourses, such as the one proposing utilitarian growth and another that advocates regulatory ethics to minimize the environmental and social impacts of extractive enterprises while highlighting corporate social responsibility. Besides these, there is the discourse that proposes sustainable development, with companies being regulated by the state. And then there is also the ecological ethics discourse 'that favors a complete change in production mode and large investments in mining and energy. It puts the issue of water, ecosystems and local populations as the overriding priority for economic growth. Local people become the main actors, compared to the priority which investors receive in conventional projects'. Finally, there is the indigenous ethic of Indian/ aboriginal peoples who 'formulate a discourse based on the defense of their territories and oppose electrical and mining megaprojects and their social, cultural and environmental impacts. Their arguments are related to their own character and identity. Ancestral traditions have an important place' (Parker, 2017, p.177).

Some of these different worldviews emphasize commercial and economic values in the market, while others stress value-in-use and symbolic value. For one type of speech, 'what matters is the exchange value of the mineral business in the global metals and minerals market (the resources to be used)' (Parker, 2017, p.178). For another discourse, 'the symbolic value of the territory is paramount because it is associated with identity, ancestors, community life, shared environment and also spiritual life (the heritage to be protected)' (Parker, 2017, p.178). Parker even contrasts elements containing two of these ethics and discourses (Table 1).

Parker (2017) notes that 'as part of the development process, extractive policies in Latin America generally do not respect the environment. The actors confronting each other on the ground brandish economic, ideological or ethical discourses. It has been well analyzed that indigenous lifestyles oppose the forces of extractive industries, global companies that regard indigenous lands strictly as resources' (Parker, 2017, p.174). Extractive megaprojects that cause environmental impacts and social conflicts, led by large corporations, have intensified under governments of any ideological hue.

He notes: 'In recent times, ecological discourses of indigenous peoples, local and regional identities have multiplied; they are demands and mobilizations for social and environmental justice and for employment. This shift toward territory and ecology converges on a common language that illustrates the innovative intersection between the indigenous community discourse and environmental discourse' (Parker, 2017, p.175).

Furthermore, he proposes 'to emphasize the importance of the indigenous worldview, which has an ethics of participation with nature that opposes the commodification of land and territory. Ethics based on the symbolic value of the common good and not its market value or value-in-use' (Parker, 2017, p.174). And

Table 1. Ethics and discourses confronted (Parker, 2017).

Category	Autochthonous Vision	Market Vision
Totality	Holism	Cartesian Dualism
Rationality	Comprehensive/ Reciprocity principle	Rationalism / Positivism
Subject/Object	Cohabited Cosmos	Dualism Subject–Object
Matter	Living Beings: Energies and Spirits	Dead Nature: Inert Site /Rocks
Moral	Moral Ambivalence	Moral Dualism: Good and Evil
Higher beings	Multiplicity of Spirits	Monotheism

yet: ‘Autochthonous discourse is an ethical discourse that promotes respect for life and nature. The cosmological thinking of indigenous peoples shows an ethical attitude towards life, based on respect for it and in harmony with the sacredness of nature, as a specific peculiarity of their planetary consciousness’ (Parker, 2017, p.182). Parker concludes: ‘At a time when the visible symptoms of climate change have intensified, we see a sharper, sometimes subterranean and imperceptible, sometimes open conflict, confrontation of two poles of fundamental planetary ethics: an utilitarian ethic of exploitation and an ecological ethic among which there is actually a range of positions. Indeed, in Western rationalist and colonialist thinking, nature is considered an object subject to exploitation (including those humans considered inferior). This is the logic of immediate capitalist accumulation, accentuated by the ethics of postindustrial society in the context of the neoliberal model of recent globalization. On the other hand, social injustices and the protection of the environment and ecologism bring to light issues of ecological inequalities and, therefore, of intergenerational, social and geographical justice and equity. At the heart of this global confrontation, the indigenous ethic that resists the commodification of territories, as we present, accentuates a dimension of the human-nature relationship that is close to certain ecological ethics, such as Pierre Dansereau's proposal, among others’ (Parker, 2017, p.182). The emergence of the current climate crisis calls for ecological ethics and somehow leads to revaluation of indigenous ethics and their worldviews.

Protection in Brazil

In Brazil, there are several UNESCO World Heritage sites, protected by the National Institute of Historical and Artistic Heritage (IPHAN), as well as state and local agencies (see Forest, 2011). Community initiatives that lead to water protection can be secular, such as neighbourhood communities and environmental movements that protect urban lakes. Religious demonstrations can lead to protection of water resources and change in the way these resources are managed, such as religious boat processions (e.g. the boat procession in Bom Jesus da Lapa on the São Francisco river, which induces changes in reservoir operation during religious manifestations so that the boats will not run aground on the river). Another emblematic example of the protection of waters in Brazil for cultural and heritage reasons is the case of IPHAN’s declaration as permanently protected heritage in 2010 at the Meeting of Waters of the Negro and Solimões rivers in the city of Manaus: ‘The more than 10 kilometers where you can see the dark and transparent waters of the Rio Negro running alongside the muddy waters of the Solimões River in the Amazon were declared as protected due to the exceptional nature of the phenomenon, considering its high landscape value' (IPHAN, 2010).

A more recent case of recognition and appreciation of the nexus between water, culture, and heritage occurred in the federal district, where by an initiative of the Federal District Government and with the support of the International Centre on Water and Transdisciplinarity (CIRAT), the Ecological Amended Waters Station (ESECAE) has been recognized by the Water and Heritage Shield of the International Council of Monuments and Sites (ICOMOS Netherlands). At its 50 years of creation, ESECAE in 2018 achieved the sixth place in the world and the first in Latin America to receive the ICOMOS Netherlands Water and Heritage Shield. More than strategic water resources for the capital of the country, the station is home to a unique hydrological phenomenon (the same path spills water into two different major Brazilian river basins). Moreover, this phenomenon also has historical and heritage importance, for it appeared in the region's first record that was made in the commission's report' Explorer of the Central Plateau', coordinated by Luis Cruls, in 1892.

Another contribution of popular wisdom in relation to water comes from the Brazilian Northeast, which is a region of low rainfall and where it is a fundamental part of life to observe natural cycles, especially rain. In this context, the Rain Prophets have arisen—these are rural men and women who make weather predictions from observing changes in the ecosystem, signs produced by animals, the atmosphere, the position and visibility of celestial bodies, among other traditional methods of forecasting. Some prophecies are based on dreams and even religious rituals that mix indigenous beliefs and other forms of knowledge. The observational practices

Image 2. The inauguration of the Water and Heritage Shield and a view of the water path at the Ecological Amended Waters Station—ESECAE (Agência Brasília, 2018).

of nature and the empirical knowledge of these predictions are generally transmitted orally from generation to generation. Rain forecasting is an activity rooted in the culture of Ceará and other states of the northeast. In the city of Quixadá, the Annual Meeting of the Popular Prophets of the Central Sertão is held since 1997.

Indigenous worldviews

Indigenous community worldviews can influence decision-making on the protection of Indian territories. There are currently territories and areas protected in Brazil for ecological or cultural reasons. This is made by means of policy instruments for the protection of cultural and environmental heritage, the delimitation of indigenous lands and the recognition of consecration of sacred sites for indigenous religious traditions.

The current Amazonian indigenous peoples in Brazil speak around 170 languages. There were about eight million people in the country when the Portuguese arrived in 1500. Today, they make up a population of ca. 400,000 (Dixon and Aikhenvald, 1999). Article 231 of the Brazilian Constitution states that 'Indians are recognized for their social organization, customs, languages, beliefs and traditions and the original rights over the lands they traditionally occupy, and it is for the Union to demarcate, protect and enforce all their property'. The 2005 National Water Resources Plan of Brazil (PNRH) found that '[waters] from rivers, streams and lakes is vitally important to indigenous peoples and in the mythology of many societies, water is directly related to its origins, in many cases considered a living being that must be respected. These peoples have developed myths that relate the emergence of their tribes, their ancestors, and the relationships between water beings and humans. These beings can cause harmony or disharmony' (PNRH, 2005).

Religious rituals with water are common in indigenous groups: Diegues (PNRH, 2005) states that '[f]ishing rituals are performed to get permission to enter the river and catch the fish. For the Metutire (Caiapó group) water is considered an element that stimulates physical growth and psychosocial maturity, and women often send children to bathe in the rain to grow quickly'. He also says that '[t]he Mebengocrê (people from the water hole, also Caiapó) portray the close relationship between their people and the water through many myths. The Aúwe Xavante distinguish two types of water: rivers, identified as living water, and lakes and ponds, considered still or dead water, each having their owners' (2005). Attesting to the importance of water in the lives of indigenous peoples, indigenous languages possess many words to designate aspects of water. They were based on the indigenous worldview that the National Institute of Historical and Artistic Heritage (IPHAN) protected the Iauaretê Waterfall in the Amazon. The Waterfall of Iauaretê corresponds to a fundamental reference point for the indigenous peoples who inhabit the region bathed by the rivers Uaupés and Papuri in the Brazilian Amazon. It is considered a sacred place of the indigenous peoples of the region. The Waterfall of Iauaretê was registered as intangible heritage by the Brazilian government (IPHAN) in 2006.

Burg (2014) highlights the difference between the idea of progress of 'whites' and the idea of progress for Guarani Indians in Brazil. But the indigenous view is barely visible. There is a deafness and unwillingness to understand it from those imbued with bringing economic progress through enterprise and who perceive themselves as possessing a higher truth. The Indian Statute of 1973 has as its objective the 'assimilation of the Indian into Brazilian society in a harmonious and progressive manner'. It, therefore, expresses the superiority of Western culture over indigenous culture. Political conjunctures vary, and protection is feasible in certain situations. In other situations, however, there is no protection, as was the case of the Guaíra or Seven Falls, sacred to the Guarani Indians, which got flooded in 1966 to give way to the Itaipu hydroelectric dam.

Traditional system of Corongo's water judges—Peru

UNESCO (2015) states: 'The Traditional System of Corongo's Water Judges is an organizational method developed by the people of the district of Corongo in Northern Peru, embracing water management and historical memory. This practice is the pillar of Corongo's memory and cultural identity and complies with the fundamental principles of solidarity, equity and respect for nature. As a token of devotion and authority, the water judges bear all year long a wooden rod with the image of their patron, St. Peter. Children learn about devotion to the patron saint either by participating in religious celebrations or through the oral tradition.' The system dates back to a time before the Incas and is aimed at supplying water sustainably. It was recognized as 'Cultural Heritage of the Nation' in 2013 and inscribed in 2017 on the Representative List of the Intangible Cultural Heritage of Humanity.

In the Andes: Abya Yala and Buen Vivir

America is the name given to this continent by European colonizers in honour of the Florentine navigator Americo Vespucci. Original Andean peoples called their land 'Abya Yala', which means 'mature land of eternal youth'. For many centuries, the spread of Andean culture was stifled and almost invisible in the face of the force of European colonization. Since there was no strong written tradition, a large part of the worldview, mythology, and orally transmitted stories was lost. However, this ancient view, drowned out by the Spanish colonization, continued to be experienced by the Quechua, Aymara, and others discreetly and underground. Only about 30 years ago, it became more widely disseminated, and several scholars began to study, record, and write about it in the last few decades.

Image 3. A water channel in Machu Picchu-Peru (Ribeiro, 2017).

Alberto Acosta (2017) is one of the authors who recorded the original Andean and Incan worldview. 'Good Living' (Buen Vivir) emphasizes sufficiency, coexisting, and coevolving. This refers to community and cooperative concepts prevalent in Quechua and Aymara cultures as well as in the cosmology of Ecuador and Bolivia. These are distinct concepts of good life, dolce vita, and of living better. The unity of the human being with nature is present in this Andean worldview that emphasizes long cycles of evolution, cooperation, fraternity, and the community. A community is all about a social structure and life structure; it is a human as well as biological organism. According to a conception, original Andean peoples were integrated with nature and the cosmos—they had a perception of the long cycles of life. 'Buen Vivir' is called 'Sumak Kawsay' in the Quechua language. It describes a way of doing things that is community-centric, ecologically balanced, and culturally sensitive. With 'Buen Vivir', the subject of well-being is not individual, as it puts the individual right in the middle of the social context of the community and in a unique environmental situation.

Fernando Huanacuni Mamani (2010) is an author who dealt with 'Good Living' not only as an intellectual conception, but as a philosophical and spiritual vision, which is the response to lives of indigenous peoples, supported by their ancestral worldview. Everything lives—the mountains, trees, people. In Aymara, it is said that we are children of cosmos father and mother earth. Buen Vivir concepts can underlie actions to protect water and natural heritage in South American countries. It is a valuable intangible heritage left by the Andean communities as a legacy to be continued. Indigenous worldviews have demonstrated the resilience and ability to withstand invasions and external pressures; they have been strengthened and have resurfaced in recent decades. The ancient wisdom contained in the Buen Vivir worldview points the way to new knowledge and elaborates that we should build a tomorrow with equality, justice, and reverence for life. This ancient wisdom recognizes the enormous contribution of the cosmovision represented by the tangible and intangible heritage that different cultures have left us so that future generations can think about the present and the future—this paves the way to a fundamental approach to the implementation of the Sustainable Development Goals (SDGs). The right to cultural diversity is expressed in the laws, but in practical life there is discrimination when it comes to diversity. This discrimination becomes the most intense when indigenous people are treated as inferior in real life and their worldviews are neglected. Burg (2014) says that ‘it is necessary to deconstruct assumptions that one group - indigenous - has to enter the symbolic and organizational universe of the other group - surrounding society’.

Recognition of nature and water as legal entities

In the clash between economic and utilitarian discourse and indigenous and environmental discourse, the former has been taking advantage of the world everywhere. To counter this, some countries have adopted a strategy—to recognize the value of water and nature as legal entities. In 2010 the UN recognized water as a right of humans and of nature (UNHRC, 2010) At Bolivia’s proposal, 22 April has been declared by the UN as International Mother Earth Day, Pacha Mama, mother earth in balance. Bolivia and Ecuador are the countries that have made the most progress in applying and institutionalizing this approach from their indigenous traditions. These traditions have been incorporated into the constitution and defended by other nations at the UN General Assembly. In addition to other initiatives in other parts of the world, this South American discourse has also proposed and passed legislation recognizing rivers as legal entities due to the community’s ancestral relationship with these rivers.

Emphasize macro community identities

The issue of community identity can be addressed in various scales—from micro to macro perspectives. Micro identities emphasize diversity and can induce disunity. Nano or micro-scale identification can lead to disagreements, disputes, conflicts, and violence. In many fields of human activity and many ideological constructions, what separates us or what we diverge from is emphasized. Macro identities, on a larger scale, are determinant. Examples of macro identities: being a citizen of the world, being a member of the human species, being an earthling. Using macro identities can be a way to avoid schisms and disruptions—it can help us to build the unity needed to jointly address the mega risks and dangers before all of us. Macro identities lead us to discover unity and convergence by focusing on what brings us together or unites and brings affinities. To build peace, it can be valuable to find common denominators and points of unity beyond our differences.

In crisis and emergency contexts, such as in climatic, environmental, and other situations, divergent forces tend to separate people and groups and pit them against each other. 'In a house where there is no bread everyone screams and no one is right,' says a popular proverb. In these contexts, it is good to remember that my identity is Terran and my place of speech is that of an inhabitant of the third planet, Earth, which revolves around a fifth-magnitude star, Sun, on the outskirts of the Milky Way, one of the billions of galaxies in this universe. In the context of human history as part of natural history, it is important to expand the time-horizon of history from the developmental approach to the evolutionary approach by considering the role that our species plays in this current crisis of evolution. The world is diverse, but it is, after all, one. The astronaut in the distance perceives this unity beyond all internal diversities. To establish peace, it can be valuable to focus on macro identities.

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Part 2

Living Water Heritage: Sustainable Technologies

Hidden gem in Hakka Tongharm for Taiwan water management

Sinite Yu, Po-Kang Shih, Pei Hua Lu, Yu-Chuan Chang, Wen-Yao Hsu and Chia-Ying Wu

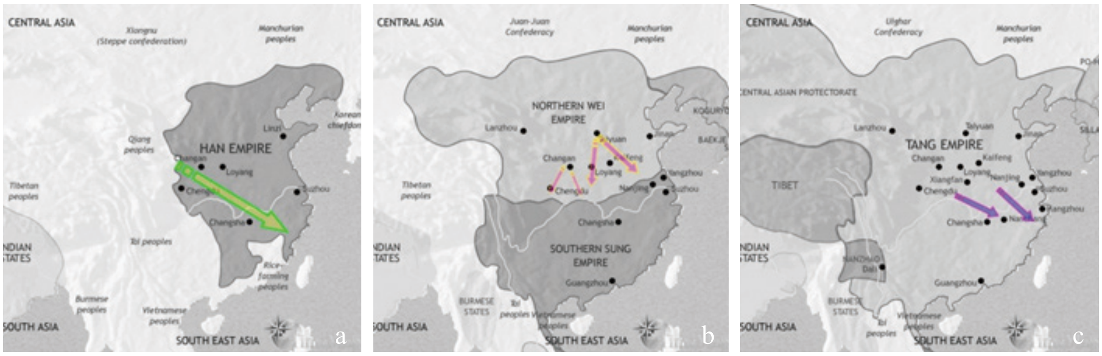
Introduction

Taiwan, an island with a total area of about 36,000 sq km, is strongly influenced by immigrants in terms of culture. Its components of population have changed over time with a large number of people coming from China as well as from southeast Asia—migration and immigration shape the history of Taiwan. Agriculture was one of the key factors to survival for those who immigrated to this island where different regions can experience notable differences in climate change due to its geography and landscape. Here the hills and mountain ranges make hydro-technology essential for irrigation and drainage purposes. The application of water resource management depends not only on environmental factors, but also on the culture. The outcome of the development of the relationship between locals and their use of water is a history of abundant water culture and heritage.

Both tangible and intangible heritage has sustainable inheriting potential, particularly offering insights into scientific thinking and sharing of cultural meanings and values for a community or specific group of people. This paper introduces Tongharm—a simple, efficient, and energy-saving water resource management technique used by the Hakka, an ethnic Chinese group, when they immigrated to Taiwan. Re-exploring the technique that has been largely forgotten is akin to rediscovering the lost treasure of ancient wisdom (the 'hidden gem'). In this exploratory paper, Tongharm is used as an example for demonstrating the tradition and systems of knowledge and skills that the ancestors of the Hakka have accumulated throughout history.

Hakka and their migration to Taiwan

The Hakka are a branch of the Chinese Han people. They have considerably influenced the course of modern Chinese and overseas Chinese people throughout history. Unlike some other Chinese groups, the Hakka are not named particularly after a geographical region. The Chinese characters for Hakka can be translated as 'guest families' because they consider themselves as guests whose ancestors had migrated across the mainland. The Hakka



a.Migration in 210's BCE b.Migration in the 5th century c.Migration in the 9th century

Image 1. Patterns of migration for Hakka people in ancient China.

a.Migration in the 15th century b.Migration in the 18th century c.Migration in the 19th century

Image 2. Patterns of migration for the Hakka people in the last five centuries.

are thought to have lived on the Loess Plateau through which passes the Yellow river. The migration history of the Hakka in China could be traced back from 219 BCE to 210 BCE, since Emperor Qin Shi Huang garrisoned on the Baiyue Mountain, followed by the turmoil of Yongjia of the Western Jin dynasty to the Uprising of the Five Barbarians (Huang, 2008). The An Lu Shan Rebellion during the Tang dynasty and the late Tang peasant uprising were reasons for the Han people to migrate from north to south (Image 1) (TimeMaps Premium, 2020; 2020a; 2020b). During the reign of Emperor Kangxi in the Qing dynasty (1677–1776 CE), the coastal regions were evacuated by an imperial edict called 'Move from Huguang to fill Sichuan'.

Evidence shows that the Hakka have already migrated to Taiwan around 1600 CE, as some of them were interpreters for the Dutch and indigenous people in Taiwan, according to the German historian Ludwig Riess (Lung, 2005). As ancient China remained unsettled after the defeat in the Taiping Rebellion (1851–1911CE),

Image 3. Distribution of the ethnic Hokkien (including Hakka) and Cantonese population in 1920.

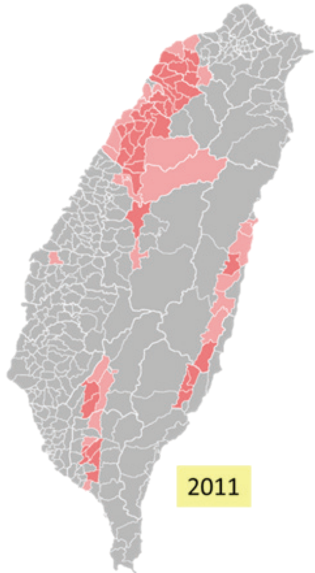


Image 4. Distribution of the ethnic Hokkein (including Hakka) in 2011.

many Hakka people migrated to parts of southeast Asia and other countries throughout the world (Image 2) (TimeMaps Premium 2020c; 2020d; 2020e),. Those who moved to Taiwan mainly settled in northwestern and southern parts of Taiwan, such as Taoyuan, Hsinchu, Miaoli, Kaohsiung, and Pingtung (Wikipedia, 2019b). Image 3 and Image 4 compare the distribution of the Hakka population in Taiwan between 1920 and 2011 (Map, 1920; TIIWE, 2011). The data indicates an overlapping settlement pattern of the Hakka people in Taiwan.

The technology of Hakka Bei construction

The main migration period of the Hakka was about a few decades later than that of the Heluos from the Fujian region in China. The largest part of the Hakka settled on the outskirts, which are mainly on the slopes and hills. One explanation of why the Hakka survived well on those types of upland could be their traditional technique of water resource management. The Hakka people brought their traditional technique in Bei (water pond) construction when they migrated to Taiwan. In Taoyuan, Hsinchu, and Miaoli, the topography is mostly terraced and hilly, as can be seen in Image 5 that shows an old topographic map of the Taoyuan Tableland (Map,

Image 5. Ponds on the topographic map of the Taoyuan Tableland in 1920.

1920b; Yu, 2017). Here irrigation and drainage are challenging due to gravity. The Hakka, therefore, built numerous ponds for the purpose of water storage and resource management (Image 6) (TIIWE, 2016); they also built berms and swales along the contour line (Chang, 2016). The method used on slope land was to fill the lowland with rock and soil removed from the upland, which follows an idea quite similar idea to terracing—to work with gravity along the slopes. The height of the bank could be about 2–3 m and the depth about 4–6 m. Similar methods might also be applied on flatland (Image 7) (TIIWE, 2019; Hsu, 2019). All the ponds are connected by ditches so that water can flow from above to below when an excessive amount of water accumulates at the higher point. The Hakka, moreover, planted bamboo along the windy side of the ponds and grass on the less windy parts to avoid erosion of soil. Prior to the completion of modern reservoirs and urban streams, these ponds were crucial to those who lived on the Taoyuan Tableland for supporting their daily needs that were found all over the tableland. A record shows that there were about 8,000–10,000 ponds built for irrigation and drainage purposes on the Taoyuan Tableland (Chen, 2003). But the number has been decreasing due to urbanization and industrialization.

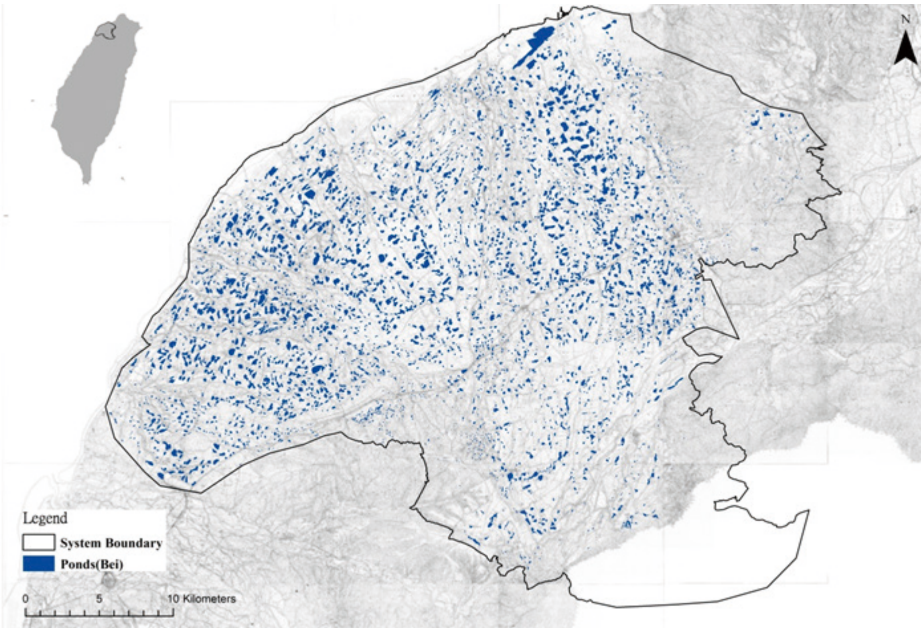


Image 6. Distribution of Beis on the Taoyuan Tableland.

The hidden wisdom in Hakka Tongharm (塘涵)

During the Japanese colonialization period (1895–1945), a number of Japanese engineers came to Taiwan to support the work on hydraulic engineering projects. Evidence shows that they sometimes had to rely on the Hakka people's technique while encountering issues relating to water supply. For example, the elevation of the Taoyuan Tableland created challenges for irrigation and drainage, but the ponds made by the Hakka were found to have sustained a farmland for about three times its size (Chen, 1979). These ponds are built with earth and soil—their bottoms are made of layers of clay to avoid infiltration. Without the availability of much stronger material (e.g. steel) at that time, the Hakka applied a unique technique called 'Tongharm' to regulate water supply. It is an airtight facility made of bricks and other similar materials on the edge or in the middle of the pond that connects to a pipeline to be easily controlled by a plug (Image 8) (TIIWE, 2016c). The Hakka built these ponds with Tongharm in most places they migrated—this made them hydraulic experts in Chinese history.

Professor Takayasu Maki worked on water resource engineering projects (e.g. the Dongshan river and the Wushantou dam) in Taiwan, lectured on agricultural engineering at the Taipei Imperial University (later renamed as the National Taiwan University) between 1938 and 1944, and

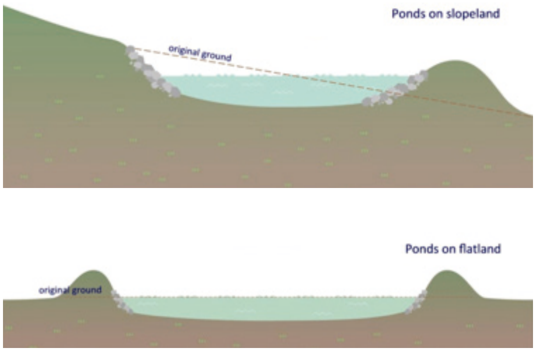


Image 7. Diagram of Hakka Bei construction.

Image 8. An example of Tongharm with a removable plug.

studied and depicted the structure and design of Tongharm (Image 9) (Chang, 2019; Kuwano, 1979; Anon, n.d.). His schematic diagram of Tongharm shows that the air trapped in the opening (on top of the facility made of bricks) creates a pressure balance between the water inside and outside of the Tongharm—a simple plug can effectively control the water outflow as necessary.

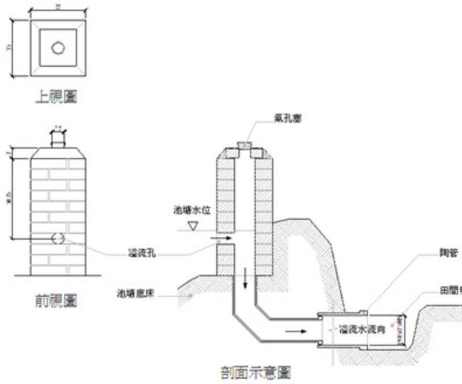


Image 9. Schematic diagram of Tongharm.

This technique coincides with Bernoulli's principle and Daniel Bernoulli’s theories in his book *Hydrodynamica* from 1738 (Wikipedia, 2019). According to Bernoulli's principle on fluid dynamics, the fluid pressure is lowered simultaneously in regions where the flow velocity is increased. Various types of complex pressure-balanced valves in modern days are invented based on similar principles. When one wishes to increase the flow velocity (i.e., drain excessive amount of water in the pond), all it takes is to reduce the fluid pressure by pulling the plug on top of the Tongharm to release the air. This example inspires and shows that even with the lack of strong, enduring, and indestructible materials, simple, efficient, and sustainable methods for water management are possible.

Possible trail of Tongharm technique in the language

Chinese characters have a pictographic origin—a form of writing that uses pictorial drawings (Olson, 2019).[1] After

[1] The earliest known inscriptions were found on pieces of bones and tortoiseshells during the Shang dynasty in about 1200–1101 BCE.

Image 10. Mao Gong ding (cast around 780 BCE) and its inscription inside.

several transformations in history, the Chinese writing system is now defined as logographic: a letter or sign represents a word or phrase (Asia Society, 2019). The meaning of Tongharm in Chinese consists of Tong-, which means pond and pronouns in the Hakka language, and *Harm* (涵), which indicates an outlet device and culvert for pond water. The Chinese character of Harm was combined with water and a device symbol. This symbol of Harm (函) may possibly be traced back to the Western Zhou dynasty of China during 800 BCE. The word Harm () is found to be inscribed on the *Mao Gong ding* bronze vessel, which is known to have the longest ancient Chinese inscription (497 characters) discovered by archaeologists (Image 10) (National Palace Museum, 2020). Image 11 illustrates the process through which the Chinese character for Harm has evolved and transformed from the oracle bone script, Chinese bronze inscription, seal script, and the regular script into cursive writing (Vividict, 2020). From left to right, the character Harm starts as a pictograph that appears to be a container with an object inside and then it turns into a container with a plug or handle on top of it to block the object inside. Today, the word Harm means inclusion, containers, envelopes, boxes, or letters (Ministry of Education R.O.C., 2014).

The idea of Tongharm is deeply rooted in Hakka culture, as it is observed in their customs and proverbs. For example, when Hakka people say *zhuo shui gui sai Tongharm* (捉水鬼塞塘涵), they mean 'making innocent people scapegoats and letting go of the wrongdoers' or 'bold and ruthless' with a moral connotation (Hakka Council Global Website, 1998; Gu, 2012). As revealed by the evolution and transformation of Chinese characters, in addition to the migration history of the Hakka people, it is possible to infer that Tongharm may have existed for more than 2,800 years (Image 12) (TIIWE, 2016b; 2016d; Chinese Etymology, 2020). Perhaps the Hakka had started building ponds and Tongharm with their culture-based system of knowledge when they settled on the Loess Plateau.

Intangible cultural value revealed by Tongharm heritage

Cultural heritage goes beyond monuments and collection of material objects. It further includes people's expressions of life and understanding of the world that they have inherited from their ancestors and those which will also be passed down to their descendants. The UNESCO in 2013 defined intangible cultural heritage as 'the practices, representations, expressions, knowledge, skills—as well as the instruments, objects, artefacts and cultural spaces associated therewith—that communities, groups and, in some cases, individuals recognize as part of their Cultural Heritage' (Riches Resources, 2014). Intangible cultural heritage is made up of immaterial elements and forms that are 'considered by a given community as essential components of its intrinsic identity as well as of its uniqueness and distinctiveness in comparison with all other human groups' (Lenzerini, 2011). The social and economic value that the knowledge and skills transmitted from one generation to another is the 'hidden gem' that intangible cultural heritage carries.

Image 11. The transformation of the Chinese character for Harm.

a.Script of *Harm* in 780 BCE

b.Script of *Harm* in 200 BCE

c.Script of *Harm* in the 8th century

d.Illustration of *Harm* device

e.Current status of *Harm*

Image 12. The Chinese character for Harm and the conceptual model for Tongharm.

Image 13. The Fongwu Da Bei and its surrounding community.

Currently, several elements identified as intangible cultural heritage have been discovered from the Taoyuan Tableland. One of them is the Fongwu Da Bei (Fongwu great pond), which is a private reservoir that belongs to the Feng family in Longtan district for more than 100 years (Image 13) (GoogleMaps, 2020). The Fongwu Da Bei was excavated by the locally renowned Feng family who earlier lived and worked on the land. This private reservoir measures about 10 hectares and can irrigate about 30 hectares of the adjacent area (Image 14) (TIIWE, 2017b). Again, the simple plug on top of the Tongharm allowed almost everyone to operate the facility and regulate water supply easily at that time.

Descendants of the Feng family vividly remember the role played by the reservoir throughout their lifetimes. One of the descendants described the significance of the Fongwu Da Bei to him, his family, and the neighbourhood:

> *The reservoir was as big as an ocean. I only dared to look at it from far away when I was little. When I grew older, I used to play in the water and there were a lot of fish. One year, a severe draught hit the area, and the water in the reservoir dried up. Children were excited about it because they would have never imagined that they would be able to walk on the bottom of the reservoir. All I have for this reservoir is gratitude and appreciation. Everyone's life was closely connected and associated with this reservoir. We all depended on it. However, more and more houses were built near the reservoir as time went by. The fountain already dried up.*

Image 14. The size of a pond compared to the size of an irrigable land (pond area in blue and farm area in green).

> *Contaminated and dirty water coming from the households goes into the reservoir through the sewer system and it is now very polluted. Fish is gone…* (Feng, 2019).

This explains the current scene of the Fongwu Da Bei, as next to the reservoir is the Feng family's cemetery adjacent to the residential community (Image 15) (TIIWE, 2017). In many cultures, including the Chinese, it is a taboo to live so closely with the deceased. However, since the Fengs were kind-hearted and willing to share their water resources with everyone in the neighbouring area, the residents presented their respect, gratitude, and appreciation towards the Fengs by showing acceptance everything about the Fengs. The beauty and virtue of unselfishness is shown in this community with mutual respect and understanding. Today, this Bei is still important as it gives its irrigation functions in the Bazhangli area—it is full of intangible cultural and social value.

Conclusion

In modern society, hydraulic facilities, such as water gates, often rely on complex and sophisticated engineering and technical skills—they require high strength and resilient materials. The modern water resource management process is also labour-intensive. Many ethnic Chinese people have almost forgotten there was once a culturally-specific, simple, easy-to-make, efficient, and eco-friendly technique used for water storage and resource management. Apart from tangible goods and objects, intangible cultural heritage only matters when it is recognized by the communities, groups, or individuals who create, maintain, and transmit it from generation to generation or pass it on to others. This simple method used by the Hakka people for water resource management—this is a result of the interactions among mother nature, humanity, and the environment—could perhaps provide some insights for solutions to fight against climate change for subsequent generations.

Image 15. The Feng cemetery and its surrounding households.

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Spate irrigation: A heritage of human ingenuity in the face of resource scarcity and uncertainty

Karim Nawaz and Frank van Steenbergen

Image 1. Diversion of flash flow under Spate Irrigation System—Ethiopia (Spate Irrigation Network Ethiopia).

Introduction

What is spate irrigation?

Spate irrigation is the art and science of water management that is unique to arid and semi-arid environments. Spate irrigation systems have unique governance arrangements, special value systems, and exquisite resource management techniques. They are practised in the Middle East, North Africa, West Asia, East Africa, and parts of Latin America (Steenbergen, 2010); they have been in use in various parts of the world for over 5, 000 years and in some areas without interruption (Steenbergen, 2010). Flash flows managed through spate irrigation systems typically originate in mountain catchments and watershed locations from where they emerge as short-duration floods and accordingly diverted to the agricultural field systems in the plains (Image 1).

Spate irrigation systems divert seasonal floodwaters from ephemeral river beds and spread the floodwaters over large areas. The areas in which spate irrigation is practised are usually distant from and have much lower rainfall than the associated catchment areas. In spate irrigation, water is drained from normally dry river beds (wadis) when a river is in flood. The floodwater is then diverted to agricultural fields (Image 2). The flash floods generated in remote catchments are traditionally harvested by building deflection devices/ structures in the ephemeral rivers. This may be done by free intakes (a channel conveying flash floods from the main river through gravity), by diversion spurs (ridges usually made of local materials such as soil, boulders, and vegetative branches) or by earthen bunds (an embankment usually made of soil used to control the flow of water) that are built across a river bed. As a principle, this floodwater is not stored or controlled but rather guided on a gravity basis to command areas through a series of canals and channels. Traditionally, these diversion structures were made using domesticated animals (oxen, camel and donkey) and human labour. However, the use of earth-moving machinery is becoming increasingly common.

Image 2. A cemented stone masonry work canal in Ethiopia's Raya region used to divert seasonal river floods (Source: Spate Irrigation Network Ethiopia).

The flood water—typically lasting a few hours or a few days—is channelled through a network of primary, secondary, and sometimes tertiary flood channels to command areas having the right to spate flows. Command areas are blocks of agricultural fields that may range in size from a few hectares to over 25,000 hectares. The challenge in spate irrigation is not only to manage unpredictable short-term floods, but also to deal with high sediment loads that sometimes disturb the river beds and the distributary canal system. Interestingly, local farmers see these sediments as blessings and may enable the use of the sediment, for instance, in new land development, especially in uneven fields and re-fertilization of the soils. Moreover, the sediments are also used for plugging the gullies that may have developed by uncontrollable floods and/or natural weathering.

Some of the largest spate irrigation systems rank among the largest farmer-managed irrigation systems in the world. For example, the Nari river system with the adjacent rivers, in Bolan district, Balochistan, Pakistan, is capable of irrigating more than 100,000 hectares.

The spate flows are managed by local farmer groups that are responsible for managing different parts of the river (Ahmad, 1998). Remarkably, the communication between such farmer groups and various

Image 3. Use of Brushwood to divert spate flows. Next to wood is a stone and soil structure. (Spate Irrigation Network International).

local communities is so highly developed and intact that they can effectively share information with individual farmers along the rivers—even in the most remote and difficult locations. This ability reinforces the importance of spate floods as lifelines in these regions.

The spate diversion structures, constructed in the ephemeral rivers, are sometimes enormous, either earthen bunds or embankments, spanning the width of a river, or extensive spurs made of brushwood and stones and guide bunds that cover many kilometres to gently nudge the flood water over the command area (Image 3). Spate systems are made in such a way that ideally the largest floods are kept away during peak times from the command area. Very large floods can create considerable damage to the command area. However, large floods are utilized effectively once the intensity of floods and discharge flows have decreased.

Image 4. The oldest surviving spate irrigation structure, made about 1750 BC during the Queen Sheeba period in Yemen (Metameta, The Netherland, and Spate Irrigation Network Yemen).

Large floods can destroy the flood-diversion structures and associated channels, thereby causing rivers to shift. This is where the ingenuity of many of the traditional systems comes in. Spurs and bunds are generally made in such a way that the main diversion structures in the river will break when floods are too large and powerful. Breaking of diversion structures also serves to maintain the floodwater entitlements of downstream landowners. Local farmers know the techniques of breaking the structure in such a way that the reconstruction should require minimum work next year/season. Exquisite governance arrangements rule the good practice. When a river bed is deepened, channels and fields can be eroded due to heavy floods. Interestingly, the sediments then work positively to fill the depressions and level the agricultural fields.

The oldest spate irrigation systems are thousands of years old, as shown in Image 4 (Khan, 2014). The empire of the fabled Queen of Sheba was based on spate irrigation practices in present-day Yemen (Beckers, 2013). Spate irrigation represents a heritage of human ingenuity in managing water scarcity and uncertainty for the benefit of some of the world's remotest communities. Spate irrigation is also a testimony to the ability of humans to co-operate in the sharing and distribution of a scarce resource. Even in times of uncertainty, communities utilizing spate flows do so through intricate well-managed systems of water rights, irrigation allocations, and collective cooperation. These practices offer valuable lessons in the adaptive management of natural resources through a variable climate.

Local farmers engaged in spate agriculture are well aware of climate variability, droughts, low floods, and similar phenomena. So, they know how to cope with such situations. They use different crop varieties (early and late) to adjust with cropping timings. To facilitate this, old and experienced farmers, including women, play an integral role in the knowledge and guidance of plantings dependant on local conditions and situations.

Water as heritage: The case of spate irrigation in arid regions

Spate irrigation systems provide a unique governance system that illustrates how excessive and unpredictable water, in the form of flood and flash flows, is tackled by local communities. These local communities get double benefits from this resource (flash flows and floods)—to avoid its dangerous effects and converting them into opportunities and then applying it for different useful purposes for themselves and managing their farming system by their own efforts. It is important to understand the relationship between community and its spate flow occurrences: this relationship, in many cases, is contextual and also differs from one community to another. This culture and its values are a most important source of information for knowing the functionality of spate irrigation systems. Engineers, planners and policymakers can learn a lot about floods other than its havoc characteristics. We need to learn from local communities this very experience of handling and managing floods to derive benefits. Much earlier than the concept of present-day climate change, these communities learned to use floods for benefits (Image 5). In fact, the flood/flash flow from dry rivers, in the absence of any other source in dry regions, provided an opportunity of bringing all efforts and segments of society to join hands. At the same time, it will also fascinate us to learn from past experiences for a better future—it is vibrant living heritage.

Spiritual and religious aspects of water

Some communities in central Asia believe that, based on the Persian prophet Zarathustra (600–583 B.C.), there are four holy elements in the universe—water, earth, fire, and air (Habashi, 2000). Water has an important role in most spiritual beliefs, rituals, and values. These beliefs contain profound respect for water and its uses. In rural areas, dealing in water management requires a deep understanding of spiritual and local belief systems that still prevail among the local community. To foster wise and sustainable water management practices, linking local values and beliefs play an interconnected positive role.

Water is understood as an invaluable gift from God. According to Islamic teachings, life originates from water, which is also a great source of inspiration and considered a common and communal property. The word water is mentioned 63 times the holy book of the Quran. Islam prohibits the monopolization, wastage, and pollution of this divine resource. The saying of Prophet Mohammad (PBUH) mention: ‘Muslims have a common share in three things: grass [pasture], water, and fire [fuel]’ (Musnad Vol. 2, Book 22). ‘Do not waste even if performing ablution on the bank of a fast-flowing large river’ (Al Thirmidhi). According to Islamic law (shariah), upstream farmers must release water to downstream users. A farm’s proximity to a stream does not mean that the farmer has the right to monopolize water or draw excessive water for irrigation purposes. After using an acceptable amount of water, the remaining flow must be released downstream. In case of any shortage of water, an established farm takes precedence over a newly established farm’s water allocation. These practices indicate the importance and concern in Islam for a fair and conflict-free use of water.

Water plays an important role in religious beliefs, rituals, and values—this is even more evident in an arid region where water scarcity is part of life. Living in extremely arid conditions where average rainfall is up to 150 mm annually, as well as with extremely hot summers and extremely cold winters, the dependence on water is crucial. Not only is it crucial for humans and animals, but also for all requirements of rural societies. In most spate irrigation areas, underground water is either too deep to reach economically and/or too saline/ bitter to be used for humans and animals. In these circumstances, local populations have developed skills to harness floodwaters for their benefit. Since floodwater is the only major source of potable water, human activities—social, economic, or cultural—have evolved around the practices of spate irrigation.

The origin of spate irrigation is the Arab Peninsula (Steenbergen, 2010). The use of spate irrigation has been consistent for thousands of years as the intricacies of associated knowledge has been passed down for generations. The main structure across the ephemeral river is called a ‘Sad’, which literary means a ‘knot’, and it illustrates the need to bind or contain a flood as well as to release it. The same concept is used in Pakistan by using the term ‘Ghandhi’. The diversion canals, watercourses, and fields have similar terminology in the spate irrigation system in Pakistan and

Yemen; they differ from perennial irrigation terminology. Therefore, land and water records of spate irrigation in government ministries use this terminology.

In the foothills of the Suleman Range, Khyber Pakhtunkhwa and Punjab province, Pakistan, a spiritual person (male) may be brought to an ephemeral river bed to be bathed during extreme drought and delayed rains (field interviews and personal communication). It is believed that this act will result in a shower. If spiritual person is not available, a neutral person may perform the ritual. A neutral person is usually someone having a mental disability due to the belief he has a pure heart and never caused any loss/damage to anyone in his life. He is considered innocent, and innocent's prayers may be readily acted upon by the entities controlling rainfall. The similar ritual of pouring water on dolls and marchers who gather and go around for rituals is practised in some parts of Iran (Goharpour, 2000).

During drought periods and delays in spate floods, a variety of rituals may be performed. Special prayers are offered for rain and to promote spate flow. These rituals are not held in mosques but in open spaces during peak temperatures, and people must be barefoot during the prayers. Women also gather for prayers in open fields. After completion of prayers, women beat each other with thorny branches to turn malevolent forces away. In many arid regions of Pakistan and Afghanistan, some rituals may involve children who gather together, colour their faces, march around the village, collect charitable donations in the form of grain, and then cook and distribute this charity. Birds are also fed from such cooked meals. Children engaged in this ceremony sing spiritual songs praising the connection between animals, clouds, and watershed zones. In Iran, most rain rituals also involve marching. According to Iranian rituals, marching is more common among girls and children—children are naturally innocent and hence they play a more significant role in this ritual (Goharpour, 2000).

The settlements developed along rivers subject to spate irrigation are called after the names of those rivers. In some cases, local communities can adopt the rivers' names. Some of the tribes in Balochistan, Pakistan, have derived their tribe's names after the Ephemeral river. After rain and flash floods, men go to irrigate the field and children stay in the village and play games associated with spate irrigation by constructing irrigation structures canals, sub-canals, and fields as miniatures and irrigate their structures by applying rainwater from ponds. They play this game by copying the irrigation system. While men are busy in diverting water to irrigate fields, women guard fields during day to avoid any breach/leakage in or sabotage to irrigation structures. Women play an important role by narrating to their children the stories and events of significance related to spate irrigation; they are the main source of local knowledge of spate irrigation and agricultural aspects such as water rights and shares, repair, and maintenance rules of fields and irrigation structures, names of local crop varieties, fodder, plants, etc.

Spate agronomy is unique and characterized by local plant varieties and environment—soil- friendly practices such as the non-use of chemical fertilizers and pesticides. Thus, agricultural produces from spate irrigation areas, given its organic nature, can fetch high prices. In Pakistan, spate flow has enabled the evolution of distinctive breeds of animals such as Bhag Nari, Rojhan, Daajal, and Lohani breeds of cattle; the Balochi breed of sheep; and the Barbari breed of goat. Spate-irrigated areas of Southern Khyber Pakhtun Khwa province are famous for varieties of the cantaloupe melon (such as Kulachi cantaloupe). The spate areas, the mountainous zone of the Khirthar Range in Sindh (Pakistan) and its pediments, also maintain a ground of myrrh plants/trees. Given the exotic and much sought-after produces from these areas, well-established trade links have been forged to many parts of the world. In Pakistan, spate irrigation is not merely an irrigation system, but it is deeply rooted cultural system comprising social and traditional institutional aspects.

In Pakistan, central Asia, Middle East, and east African regions, spate irrigation is managed by local water user associations. These local institutions have been established since the inception of spate irrigation in those particular locations. Every community member has to contribute to the construction of the diversion structures that direct water through canals and watercourses to their fields. In some areas, irrigation management and agriculture are only practised by groups and not by any individual farmer. Each group elects a leader to manage spate irrigation events and agricultural practices through its members.

A whole set of cultural and spiritual activities are performed for sustainable use of spate irrigation and allied activities such as organic agriculture, rangeland management, livestock production, etc. Charity is offered for spate floods to occur in the form of slaughtering animals and cooking meals. At the start of the spate irrigation season following droughts, animals are slaughtered to encourage rain. At the commencement of rain and flash floods, animals are again slaughtered as a blessing. Again, at harvesting and threshing, charity is provided in the form of slaughtering animals. In this way, animal populations are kept sustainable (field survey and interviews in DG Khan and DI Khan, Pakistan).

The well-known documented poetry uses spate flow as a topic is from the 16th century—it is written by the poet Shah Hussain. The most famous poet Khawja Fareed of Kot Mitthan has mentioned spate irrigation nine times in his poetry (Jatoi, 2017). Rarely has any local poet writing on spate areas omitted to mention spate irrigation in their poetry. Local artists sing poetry about spate irrigation during local events such as fairs, marriage ceremonies, and other events. Local poets recite spate irrigation poetry in poetry sittings. In the pediment region of the Suleman Range in Pakistan, farmers have special terminology for weather and associated phenomena related to spate irrigation—such as deaf and dumb clouds are those without thunder and lightning, false proud clouds are those having no water, white thick clouds in spring and autumn have more chances of hail (Nawaz, 2016; Personal communication and interview with farmers).

Spate irrigation and indigenous culture

Water harvesting methods were a vital part of the water supply system of many ancient settlements in the drylands of the Mediterranean region and Western Asia. Various water harvesting techniques evolved during the Bronze Age or earlier, and some of these remain in use even today (Beckers, 2013).

Among these water-harvesting methods, spate irrigation is unique to arid and semi-arid regions in many parts of the world. Usually floods (flash flows) have the connotation of disaster and negative impacts, but they may be the only hope for life in arid regions. Floods in these areas are considered a great blessing rather than a disaster—they are the only adequate source of water availability. Farmer communities in these locations consider these flash flow as blessings and an opportunity. The practice of spate irrigation is done through community participation under local social organizations on a fair and equal basis.

The spate irrigation system is managed entirely by community groups with minimal institutional support from the government in terms of funding and technical assistance. However, governments play an important role in arbitrating situations in case a need or request arises by applying the traditional rules and regulations to resolve any issues. These rights and rules were developed for generations by rural communities; they are implemented and adhered to by consolidating community involvement and inclusion. In the past 10 years, however, there has been an upward trend for government and donor agencies to fund spate irrigation projects in various parts of the country.

Unfortunately, often the officials and professionals of Irrigation and Agriculture

Ministries lack sufficient knowledge and understanding of traditional irrigation systems, as these age-old practices and knowledge form no part of the current educational curriculum in academic institutions. Thus, a wide gap of different perceptions of flood management between local population and technicians has remained unbridged. To engineers, floods are considered a nuisance as they damage the costly infrastructure, settlements, property, etc. To the local population, however, floods are a great blessing and a source of life. The question of how to manage floods is treated differently by engineers and local communities. Engineers want to see floodwaters passing by without causing any local damage and continuing its path downstream, while local communities want to divert floodwaters, a critical source of their livelihoods, to partially or fully irrigate their fields. Engineers want to construct and use dams and reservoirs to control and store flood water, while local communities prefer to divert and spread water to irrigate their fields and apply it to other useful purposes such as ponds for human and animal water needs, aquifer recharge, rangelands development, etc. In reality, pure technical approaches have ignored the significance of the vital and scarce resource of water in human-made cultural landscapes and the heritage value of water infrastructures (Bensi, 2019).

Spate irrigation and local indigenous institutions

Populations using spate irrigation systems have settled along and around ephemeral rivers. Catchment areas receive rains, while command areas are arid. Flash floods can arrive anytime, and their arrival is not known to command area populations. The catchment areas are usually far away from the command areas. People gauge the occurrence of flash floods by monitoring the clouds, thunder, and lightning in the catchment area direction. This invaluable knowledge is held by experienced farmers and women—it is crucial for good irrigation outcomes for allowing the local community to be on standby for the labour-intensive work and logistical planning required during spate floods. Some of the spate irrigation systems are very large and capable of irrigating 100,000 hectares with a record of discharging 229,000 cusecs. Over some time, based on millennia of experiences, local institutions have evolved to tackle these flash floods with their accumulated knowledge, science, and art. For each spate irrigation system, there are several water users' associations to manage each event effectively.

Flash floods under spate irrigation systems last from a few hours to only a few days. The rights and rules to manage these floods are responsive in nature for water diversion, application, and drainage, all being carried out at the same time. Spate irrigation has the provision of drainage concurrently with irrigation management to flush the sediments, to decrease the burden on diversion structures, and to feed channels through alternative routes (other than diversion and distributing canals). To enable these intricate practices, indigenous water rights and rules are in place, practised, and respected. The rights and rules to manage spate flows have been in practice for a millennium. They were first codified by English rulers during the first land settlement of 1872 in present-day Pakistan. English rule did not devise the rights and rules, but the English conducted considerable consultation with local farmers and produced meticulous documentation that was applied as part of the land and water records as well as judicial systems. A separate local administration system was established to deal only with spate irrigation. This administration system still predominately prevails with some modifications. The indigenous Water User Association and government departments work together for arbitration and conflict management. All court cases about spate irrigation conflicts are referred to the district level for arbitration and a decision.

Pakistan has approximately 9 per cent irrigated areas (2 million hectares) under spate irrigation systems—the largest area under this system in the world (FAO, 2010). Spate irrigation is gaining importance and expansion in the East Africa region. Countries like Eritrea, Somaliland, and Yemen, having no perennial rivers, depend heavily upon spate irrigation (Steenbergen , 2010). In Somaliland, spate flows are more favoured towards fodder production than cereal crops. Spate flows are diverted to large areas for the production of fodder to minimize inputs and maximize profit (Nashan 2016).

Challenges

In many cases, the greatest challenges to spate irrigation are cultural and institutional rather than technological. In fact, modern technology has often proven to be ineffective in managing flash floods—there is a lack of understanding and knowledge of low-tech, traditional irrigation systems within government systems and thus sectoral policies (water and agriculture policy) do not refer to it. Consequently, budget and funding are not allocated for spate irrigation projects. The lack of knowledge of and attention to spate irrigation emerges from its absence in educational curricula in academic institutions in the country. Also, there is a lack of research on spate irrigation—such as drought-resistant and non-thirsty crops, trees, seed banks, and new varieties, as well as documentation and preservation of indigenous varieties of flora and fauna, and non-timber forest products (resins, mushrooms, truffles, honey, medicinal plants etc.). It generated inappropriate agricultural policies result in further loss of indigenous, low-cost, and replicable solutions to flood management, especially for ephemeral rivers.

Potential

The special situation of spate irrigation systems, with their delicate and responsive rules and solid governance prevailing in parts of Pakistan and elsewhere, are unique. There is an opportunity for these rules and rights, including water user associations, to govern spate irrigation and serve as a base for new administrative structures to plan, decide and implement new water projects. However, it will require a shift giving importance to flood waters from cultural understanding, blessing and opportunity as well as the participation of local communities, local institutions, indigenous knowledge and local wisdom. The revival and preservation of spate irrigation systems should not be merely seen, at best, as a wonderful past, but also as the right actions towards the future. For this, we need a thorough understanding of spate irrigation, its complexity, and the logic behind the way in which it functions. We also need to understand the elements of this system and its different components, how it was functioning in the past and how it is working in the present, and its limitations. The most important thing is to acknowledge that spate irrigation systems enable a fulfilling life that can be sustained in remote, neglected, and extremely arid landscapes. Such an approach requires a refocus towards the future while considering the past.

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2,300 years of water heritage in Dujiangyan, China

Mikiko Ishikawa

Introduction

Considering water wisdom in Asia, it is essential to analyse the historical water heritage from the perspective of sustainability. It needs to be examined based on its purpose, structure, system, and how it succeeded from generation to generation. The ancient irrigation system in Dujiangyan, Sichuan, China is a sustainable water heritage site, having been constructed around 256 BC, and is still providing services to over 5,300 square kilometres of the Chengdu Plain (Image 1).

Image 1. Areas of ancient Dujiangyan Irrigation System (Irrigation Authority of Dujiangyan).

On 12 May 2008, the Great Sichuan Earthquake occurred with a magnitude of 8.0 on the Richter scale, causing devastating damages and more than 65,000 fatalities. The city was almost completely destroyed, but the ancient irrigation system suffered few damages and continued to provide water as an essential resource for the population. The reconstruction process began on 29 May 2008, just two weeks after the earthquake. The city of Dujiangyan appealed to the international academic community for developing its reconstruction design. More than 40 planning teams expressed interest and 10 eventually joined this request, among them our team from the University of Tokyo and the Southwest Jiaotong University. During this process, it became clear that the ancient irrigation system is the basis for the fundamental infrastructure of the Chengdu Plain. The numerous agricultural communities, called Linpan, are the basic units supported by the ancient irrigation system. The University of Tokyo team of experts did the research to revitalize the agricultural areas along with the Sichuan University team. This article describes the irrigation system and explains how it has been maintained for more than 2,300 years.

Dujiangyan’s ancient irrigation system

The ancient irrigation system, constructed by Li Bing and his son in the Qin Dynasty, is located at the top area of the alluvial fan where the Min River abruptly interred into the Chengdu Plain. The Min River is the longest tributary of the Yangtze River, which flows from the mountainous areas known as the Dragon Gate Mountains, reaching to the Tibetan Plateau. Annual flooding caused by snow-melting in spring was a serious problem in this region, and the accumulation of silts from the mountainous areas turned out to have destabilized the river courses. Thus, the establishment of a stable agricultural land use system was the main purpose of this irrigation system.

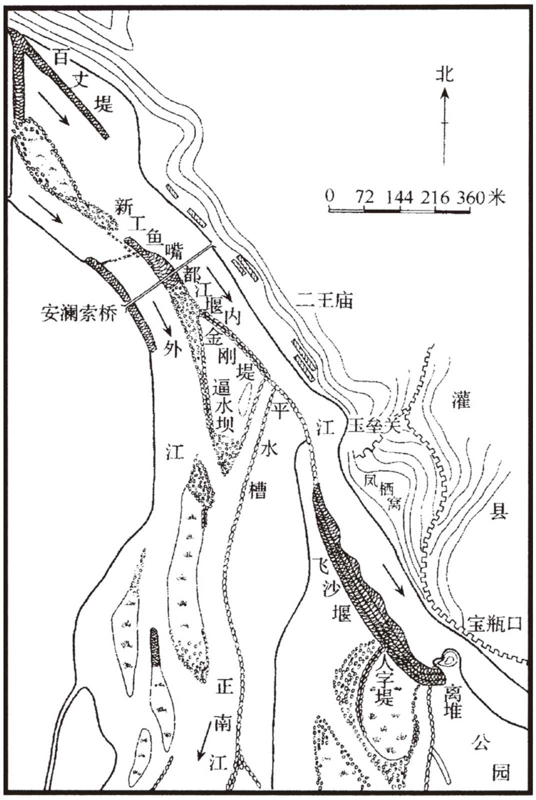

Image 2. The water entrance of the irrigation system (provided from Research Institute of Rim-pan in Sichuan University).


Image 3. Scenery of Dujiangyan (City of Dujiangyan).

Li Bing took charge of the construction. His fundamental policy was to divide the Min River into two—the outer river and the inner river. The outer river was regarded as the main flow, and the inner river was the artificial canal which would provide the stable quantity of water for agricultural uses in the Chengdu Plain. Image 2 shows the entrance zone of this irrigation system, and Image 3 gives an impression of the overall scenery of the present situation. The most difficult problem was the existence of the rocky mountain Yulei on the left side of the Min River. For excavating the necessary artificial canal, Li Bing introduced the method of using fire and water, namely heating up rocks and subsequently cooling them down quickly.Eventually, a crack

Image 4. Yuzui or Fish Mouse (Mikiko Ishikawa).

Image 5. Feishayan Spillway (Mikiko Ishikawa).

Image 6. Baopingkou Inlet (Mikiko Ishikawa).

appeared on the hard rocks that broke them, and then construction could proceed with the excavation, taking eight years to complete the task.

To control flooding and avoid the accumulation of silts, he created a sophisticated system consisting of Yuzui (Fish Mouse Levee) (Image 4), Feishayan Spillway (Image 5), and Baopingkou Inlet (Image 6). The Yuzui divided the Min River into two arms. The inner river was deep and narrow with approximately 60% of the water, and it became the source of the irrigation system.

The Feishayan Spillway was constructed to connect the outer river and the inner river. It thus became possible to prevent the flow of excessive water into the inner river during flooding season. The function of the whirlpool also made it possible to avoid mud and sediments in the inner river. The Baopingkou Inlet is the bottleneck of the canal and works as the final control system to avoid excessive water in the canal. From this entrance, the canal system started and led to prolific rice fields that supported the lives of the people.

Great Sichuan earthquake and reconstruction process

On 12 March 2008, the Great Sichuan Earthquake occurred, severely destroying the historical areas (Image 7); however, there were minor damages on the canal system (Image 8). Soon after the earthquake, intensive works took place, and the reconstruction plan was established in December 2008. The basic purpose of the

Image 7. Historical Area (Mikiko Ishikawa).


Image 8. Temple at Baopingkou (Mikiko Ishikawa).

reconstruction plan was to rebuild the old town and to create a green belt surrounding the city (Image 9). The reconstruction started from the historical area where the undamaged canal still existed. Image 10 was taken just after the earthquake. The site is an old community near the Baopingkou Inlet. Image 11 is the same place after the reconstruction in 2019. The narrow alley linking the city and the canal provided the fundamental structure of the restoration. Since the cultural landscape along the canal survived, it became the most attractive sites for tourists.


Image 9. The reconstruction Plan (City of Dujiangyan).


Image 10. The destroyed historical area in 2008 (Mikiko Ishikawa).


Image 11. The same area in 2019 (Mikiko Ishikawa).

Image 12. Dujiangyan (2018).

Image 13. Shi-Kyo (Mikiko Ishikawa).

Image 14. To-Kyo (Mikiko Ishikawa).

Image 15. Nou-Kyo (Mikiko Ishikawa).

The irrigation system in the agricultural area

As for the agricultural area, the situation was completely different. Image 12 shows the present condition of Dujiangyan. In the agricultural area on the left side of the image, the community unit Linpan was extensively developed. The number of people living in Linpan in 2017 stood at 3,824, and it covers 332.97 square kilometres in Dujiangyan. As for the total population in the whole Chengdu Plain, it is more than 20,000 people. The irrigation system is divided into four different levels—Shi-Kyo, To-Kyo, No-Kyo, and Mou-Kyo. Image 13 shows the main canal, Shi-Kyo, controlled by the Dujiangyan Irrigation Authority. The canal in Image 14 is known as To-Kyo, controlled by the individual village. Image 15 shows No-Kyo, controlled by each Linpan community, and the final level is Mou-Kyo (Image 16), controlled by individual farmers. The sustainability of

Image 16. Mou-Kyo (Mikiko Ishikawa).

the ancient irrigation system depends on this hierarchical order, and all people share responsibilities for maintaining the system.

Linpan: Basic community unit since the ancient irrigation system

The town of Juyuan is a typical agricultural area in the Chengdu Plain; around here more than 200 Linpans have been developed (Images 17 and 18), and rich rice fields surround the Linpans.The four above-mentioned types of the irrigation system have been developed all over the community (Image 19). The size of each Linpan is 5,000–10,000 square metres, and 500–1,000 farmers live in each Linpan. Image 20 shows the typical Linpan, called Kinkei Linpan, in the Juyuan town.

The community is surrounded by No-kyo, which is maintained by the community.

Basically, rice production is the major source of income, but horticultural trees

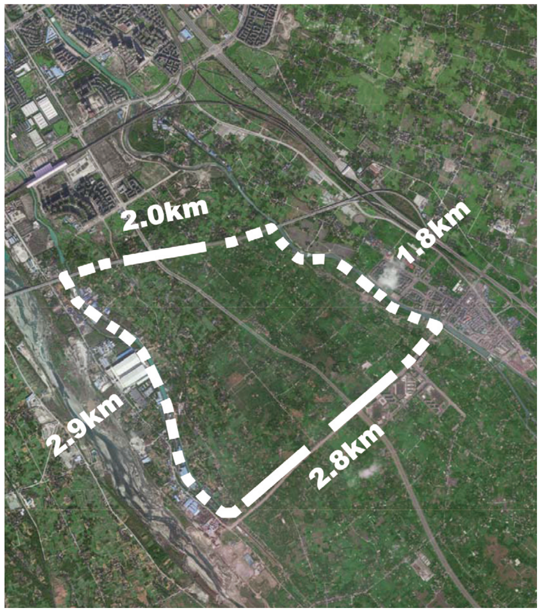

Image 17. Juyuan Town (Mikiko Ishikawa).

(cherry, plum, magnolia), fruit trees, vegetable gardens, and dairy system are practised as well. This style of farming is called agroforestry, a typical way of farming in the Asian monsoon region. Surrounding the inner area of the community, tall trees such as Metasequoia glyptostroboides, Camplotheca acuminta, Pterocarya stenoptera, Cinnamomum camphora, and bamboos are planted, providing a distinctive look to the settlements in this cultural landscape.

Conclusion

In this article, water wisdom in Asian countries, focusing on the Asian monsoon region, is considered. The case study considered the ancient irrigation system in

Image 18. Distribution of Rim-pan (Mikiko Ishikawa [2009]: Research Database of Linpan of Juyuan Town).

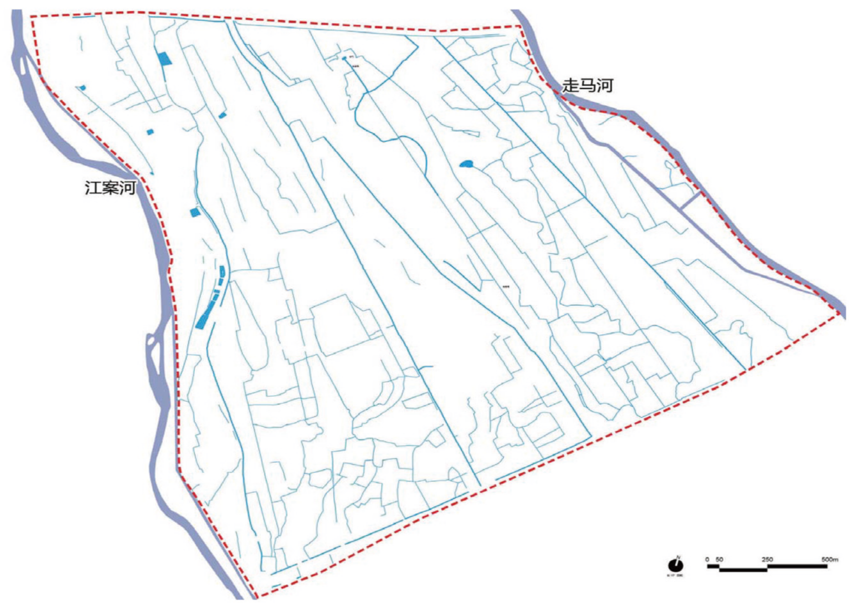

Image 19. Distribution of the Irrigation System (Mikiko Ishikawa and Kabilijiang Wumaier (2017): Fundamental Planning for the Conservation of Rim-pan in Juyan, Dujiangyan).

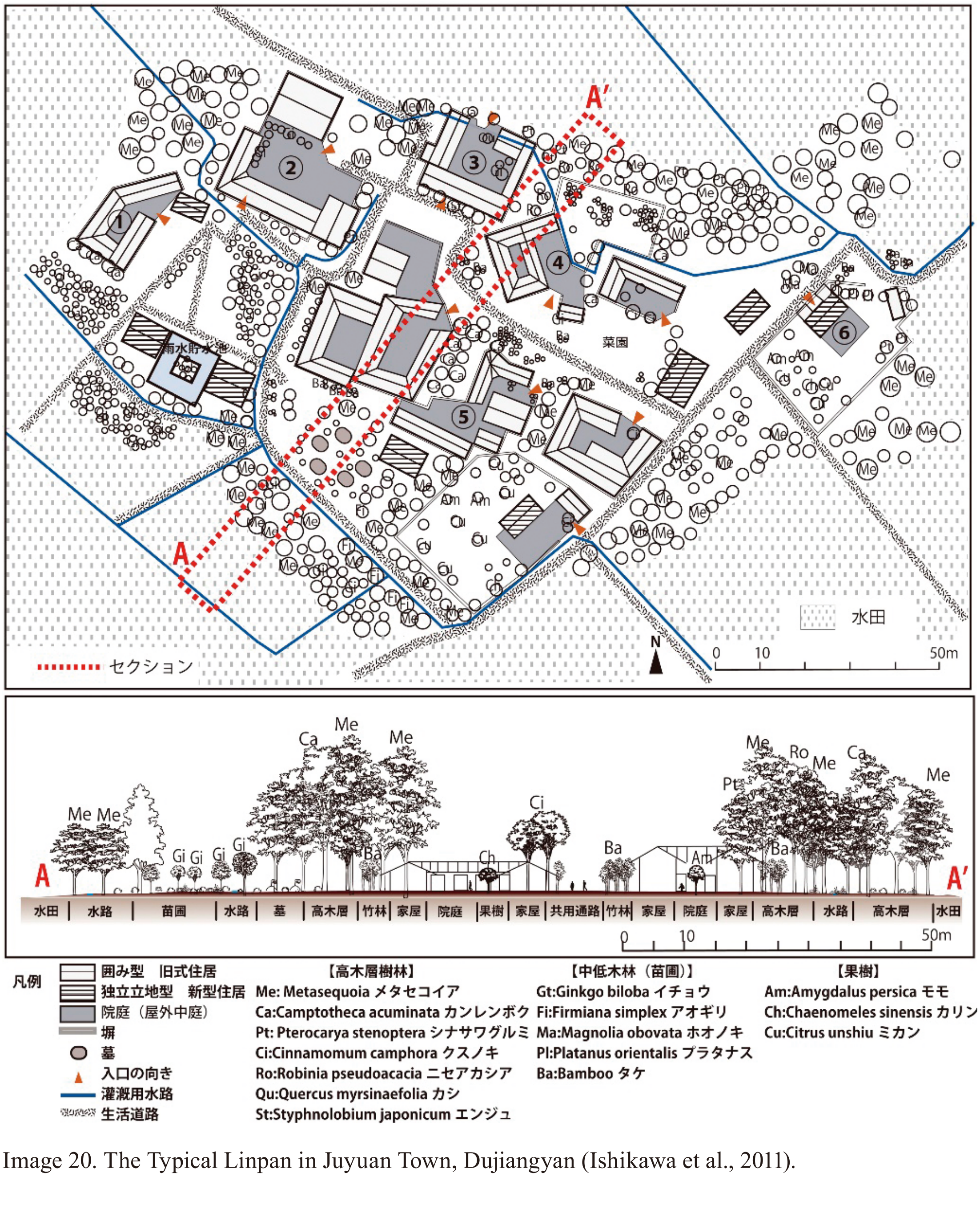

Image 20. The Typical Linpan in Juyuan Town, Dujiangyan (Ishikawa et al., 2011).

Dujiangyan, Sichuan, China, which was constructed in 256 BC. The following five points were clarified:

Purpose: The irrigation system of Dujiangyan had the clear purpose to prevent annual flooding damages and create productive agricultural lands in the Chengdu Plain.

Technique: A sophisticated water management system consisting of the fish mouse levee, the Feishayan Spillway, and the Baopingkou Inlet was created. Two problems, controlling floods and providing water for agricultural purposes, were successfully addressed.

Hierarchical water distribution system: The water distribution system was created on four levels—Shi-Kyo, To-Kyo, No-Kyo, and Mou-Kyo. The different stakeholders, such as the Dujiangyan Irrigation Authority, each town and village, the community (Linpan), and farmers, share tasks for maintaining the stability of the system.

Cultural landscapes: The experience and physical structures of 2,300 years of land use based on the old irrigation system have created a specific cultural landscape, Linpan, which gives the local people a distinct identity.

Sustainability: Based on this study, it can be said that the specific framework of sustainability consists of three main axes: natural sustainability, social sustainability, and cultural sustainability. In Dujiangyan, natural sustainability is ensured on the basis of the sophisticated, long-lasting techniques of the irrigation system. Social sustainability has been achieved by creating a system that involves multiple stakeholders such as the government, local communities, and individuals. Finally, the accumulation of time has gradually formed a cultural landscape, Linpan, and the synthesis of these axes ensures the continued sustainability of the 2,300-year-old water heritage.

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Foggara as a model of knowledge and wisdom in water management of arid regions through the centuries

Taha Ansari

Introduction

The French writer Antoine de Saint-Exupéry wrote: “What makes the desert beautiful is that somewhere it hides a well” (Antoine de Saint-Exupéry, 2000). But what makes the desert of Adrar in southwest Algeria viable and beautiful is that one can find a lot of wells—these wells form what is known as the foggara (in plural, fagaguir). The system has for centuries provided a sustainable supply of water and played an important role in sustaining the livelihoods of locals in a hyper-arid environment and until recently preserves greenery in the desert. A foggara is an underground gallery that drains the water from aquifers to the palm groves; it is composed of several wells, ending with a comb (kasria). To have water, people drilled wells and dug underground canals to connect the wells. In Adrar, 2,285 fagaguir have been built. To ensure that water remains available in the foggara system and peace between all users, the inhabitants adopted a charter of water management. This system recognizes that water is scarce and that it is a free product for the daily use. Moreover, in agriculture the same water becomes a commercial product—it is like the land inherited, sold, and bought. To apply this charter, the inhabitants used their knowledge to enact other laws to share water inside the palm grove and to use their know-how to design the measurement tools of the foggara’s flow rates, and they created flow measurement units. Each foggara is listed in a register that contains the names of owners and the quantity of water gets allocated to each shareholder. In addition, the register documents all operations of selling and buying of the foggara’s water during the measurement of the flow rate. This register is called el foggora in the local dialect of Ezmmam. No one is allowed to make any changes to this much-respected document without the presence of all the owners of fagaguir. The measurement of the foggara’s flow rate and the preservation of the register of the foggara were mandated to two people, both well known for their honesty and trustworthiness. The first of these persons makes the traditional method of the measurement of the flow rate and its very accurate method. This person is also called water bailiff (kiyal el ma in the local dialect). The second person writes the measured, sold, or bought quantity in the register and safeguards the register. The foggara is an important form of water heritage and reveals how to reach an integrated water management approach to combat desertification. To protect this heritage, it is mandatory to document all the information about this heritage. New technologies like GIS can be helpful in facilitating an easy access to such information and in creating the maps of this heritage. It also helps to share the data with all partners that are interested in the management of this heritage. All information in the inventory of fagaguir in Adrar, including the location of wells and combs, measuring of the depths of wells, and sampling of the water of fagaguir, has been undertaken. This data has been collected and stored using GIS.

The geographical location of the land of foggara

The province of Adrar (Image 1) is located in the central part of the Algerian Sahara. It is divided into four regions: Gourara, Tanezrouft (Bordj Badji El Mokhtar and Timiaouine), Taouat, and Tidikelt. The estimated population of the region is 399,714. Groundwater is the principle source of water as rainfall is rare, but the few seasonal streams can cause sudden violent floods. The Adrar region has three key geomorphological features: first, a vast plain (plateau) with a maximum altitude of about 400 m, bounded by the Tademaït Plateau to the east and depression to the west; second, a five to 10 km wide depression located along the western edge of the plain—this is where the palm groves are located; and third, small sebkhas on the western edge of the depression that form the natural outlet of the aquifer (Laureano, 2012). Sebkhas are depressions that contain brackish water after rainfall, but they are dry and covered with salt incrustations in summer.

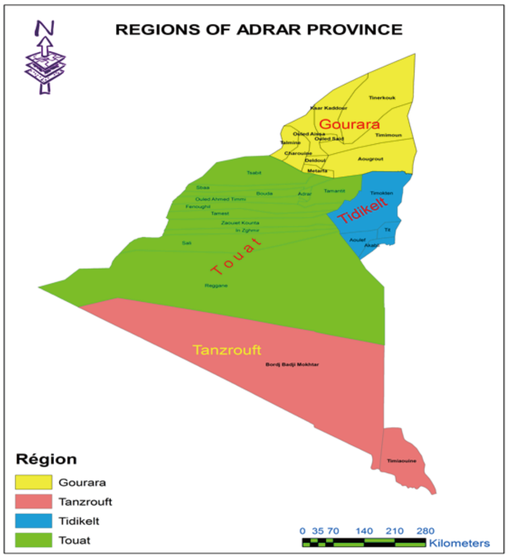

Image 1. Adrar province (ANRH-2018).

Table 1. Distribution of fagaguir by municipalities and palm groves (Inventory 2018: ANRH, 2018).

REGION	Municipalities	Number of palm groves	Number of foggara
Touat	12	141	1211
Tidikelt	4	13	116
Gourara	10	86	958

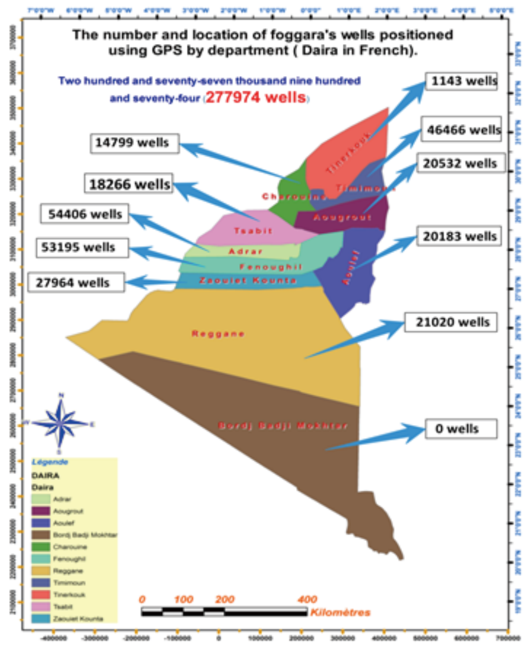

Image 2. The allocation of foggara wells positioned by the GPS of the department (ANRH Inventory 2018).

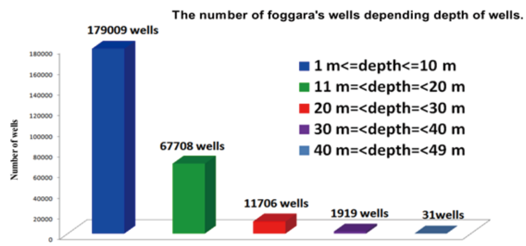

Image 3. The number of foggara wells following the depth.

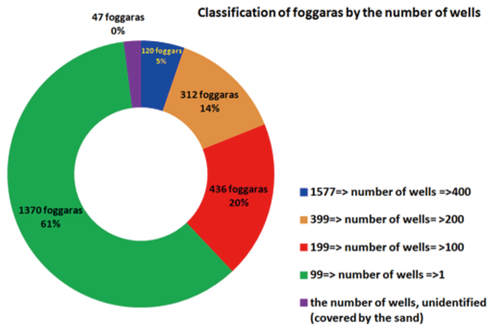

Image 4. Classification of fagaguir by the number of wells.

Foggara locations in Adrar province

The topography and depth of the water of the intercalary continental in certain regions of Adrar helped the people of this region to create fagaguir. The fagaguir are located in the regions of Touat, Tidikelt, and Gourara. Each region is divided into municipalities, and each municipality contains many oases.

All oases consist of a ksar (a village) and palm groves. The palm groves are irrigated using water from the fagaguir. A palm grove usually contains more than one fagaguir. In the past, the water of the foggara was used for domestic water supply and agriculture, but now it is used exclusively for irrigation. The total number of foggara wells in Adrar is 277,974 (see Image 3) (ANRH, 2018). The depth of the wells varies from one

Table 2. Status of the fagaguir in Adrar province – ANRH 2018 (1,143 wells are yet to be identified).

Status of the fagaguir	Number of fagaguir	Number of wells
Active fagaguir	824	124,502
Dry fagaguir (inactive)	925	104,553
Dry fagaguir (inactive and backfilled)	536	47,776
Total	*2,285*	*276,831*

locality to another, depending on the static level of the aquifer. For example, the depth varies between 10 m and 49 m in Touat (see Image 4). Also, the number of the wells of a foggara varies, depending on the nature of rock and land where the wells are dug. All the wells are dug with traditional tools (see Image 5).

The meaning and description of foggara

The entry of Arabs into the region of Touat, Gourara, and Tidkelt took place in 67 AH (687 CE). The Arabs observed the use of the foggara—they began to learn the system and gave it the name foggara. Much research has been undertaken by scholars to understand and explain the meaning of the term foggara (Ismaili, 2018). There are various suggestions about the meaning: (1) Fauker (poor): the owner of the foggara who spends and invests all his money in the service of foggara without receiving water will become poor. But this is not avoidable because the foggara owner may become rich and invest wealth in land cultivation by buying or renting other people's foggara water. Those were the habits of the people of this region (Ismaili, 2018). (2) The term 'foggara' came from the Arabic language (Tafadja elmaa) and means water that bursts out and flows from the earth's core. This explanation is more probable than the first one (Ismaili, 2018). (3) Some scholars argue that the name 'foggara' came from the similarities between foggara wells and the vertebrates of the vertebral column (Ismaili, 2018).

The foggara is a subterranean, slightly inclined gallery, which drains water from an upstream aquifer to dry downstream lands where it is used within a palm grove (Remini, Achour, and Kechad, 2010).

This process uses a gently sloping tunnel system with a length of up to 13 km, equipped with a series of ventilation wells spaced from 2 m to 8 m apart and a depth of up to 20 m. The end of the foggara is called comb (kasria). In one foggara, there are many combs. One comb is the main tunnel, while the others are subsidiary.

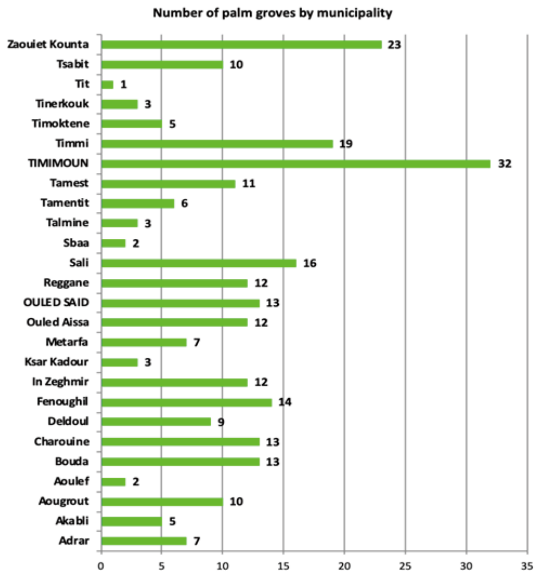

Image 5. Number of palm groves by municipalities (ANRH-2018).

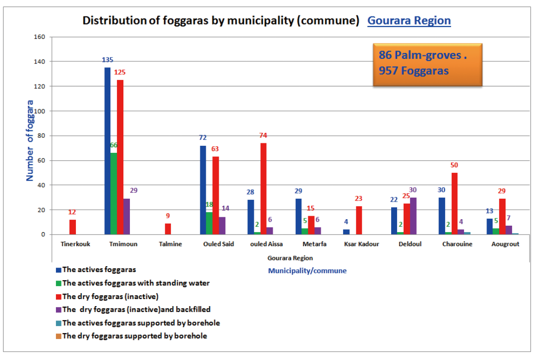

Image 6. The distribution of Foggaras by municipalities. Fogaguir is the plural of foggara in local dialect.

Organization of the foggara in oases

Among the various definitions of the oasis, two are especially relevant. Monique Mainguet defines the oasis as an artificial bioclimatic environment, developed from a pre-existing natural site that breaks with the surrounding aridity by

Image 7. Volunteering for the maintenance the fagaguir in a village (Ansari, 2016).

transforming the climatic atmosphere at the ground level and in the lower atmosphere (Monique, 2003). Toutain, Dollé and Ferry argue that oases can be defined as spaces cultivated intensively in a desert environment or strongly marked by aridity. This aridity is generally characterized by a significant deficit between precipitation and evaporation—this deficit can be attributed to high temperatures and frequent drying winds. There are, therefore, oases in continental areas with a cold arid climate. In these areas, the water balance is largely in deficit as sunshine is intense most of the year. Water is a scarce resource because low rainfall inputs do not compensate for the evaporation (Toutain, Dollé and Ferry, 1988). It becomes evident that oases need an effective water management system to stay intact. In Adrar, an oasis is composed of a source of water (foggara), a village (ksar), and a palm grove—these features are inseparably connected. In one municipality, there is typically more than one palm grove

(Image 5) with several fagaguir in the same oases (Image 6). For improving the local water management, each foggara has a name. The Algerian state demands and indeed forced the owners of fagaguir to organize themselves into an association in order to benefit from the financial subsidy of the state for the rehabilitation of their fagaguir. These associations are responsible for all rehabilitation operations and act as a bridge between the inhabitants of each ksar (village) and the Algerian administration.

Wisdom and logic: Ancient distribution (allotment) of foggara water

The management of scarce water resources is a major challenge for people living in arid lands. Water is a vital and essential factor for the preservation of these bastions of life in very arid areas. Over the centuries, dry land dwellers have overcome this challenge through specific methods of water harvesting and management, thereby ensuring the long-term sustainability of water resources through demand management and adequate resource replenishment (Adeel, 2008). In Adrar, foggara water is free for daily use. For the purpose agriculture, water is just like land in each oasis and hence any owner of the water in a foggara can sell his water rights or buy more water. He can also bequeth his share of water on to his children or family.

To avoid any social conflict about the water inside the village and to fairly share water among all foggara shareholders in an oasis, the leaders of the oasis use traditional know-how and expertise for making and issuing laws about the management of water. In the past, community members designed the measurement tools as well as the units of measurement of the foggara flow rate. These laws, tools, and units are still being used for managing foggara water. For good governance and the best management of foggara water, each foggara is managed by a document called ZEMAM (or DJRIDA). This document consists of two parts—the first is called ZEMAM TAAMIR. This document is established during the creation of each foggara. It records the date of the construction of the foggara; it contains the first date of the use of foggara water and the original owners (Ismaili, 2018). The second document is the ZEMAM EL KAIL. This document is still in use between the foggara owners and shareholders. It contains the measurements of the quantity of foggora water used by them and the foggara's flow rate. The document also records the operations of sales and purchases of foggara water.

Measurement of foggara flow rates

Since water is scarce in Adrar, it is necessary to distribute it according to agreed rules

Table 3. Measurement results of the flow rate of the foggara (Remini, 2008).

Palm grove	Traditional units	Equivalent to l/min
Adrar	Kirat Nhas	-
Timimoun	Tmen	1.57
Deldoul	Madjen	1
Charouine	S’baa	5
Tinerkouk	Aoud	3.8
Aougrout	Khorga	4.1
Ouled Said	Habba	2.6
Tidikelt	Habba Zrig	2.6
In salah	Habba Zrig	4

Image 8. Traditional measurement units of the foggara flow rate (Ansari Taha, 2006).

and the water rights of each owner. The measurement of the flow rate of a foggara is very important because this process gives each participant its share that varies with the flow rate. It does not allow anyone to regulate a comb (kasria)—whether it is a main or a secondary comb—without notifying all owners in advance.

The measurement operation consists of four essential elements (Ismaili, 2018). Three refer to persons and the fourth to the measurement tool (Table 3). These persons have been described in the following: (1) El hassab (accountant), who is the distinguished and eminent person in this operation of measurement of the flow rate. El hassab is knowledgeable in measuring the foggara flow rate. Moreover, he is responsible for resolving all problems between the owners of a foggara and to respond to any question concerning the operation of measurement. (2) Chahed (expert witness), who is a trusted person who holds and guards in secret all documents and information concerning the foggara and its owners. (3) Kial el ma (measurer of water), who is an expert regarding the measurement tool for the flow rate. Kial el ma is also an expert in the arrangement and organization of the measurement operations.

In addition, during the measurement operation, a handworker who prepares the place of measurement (kasria or comb)

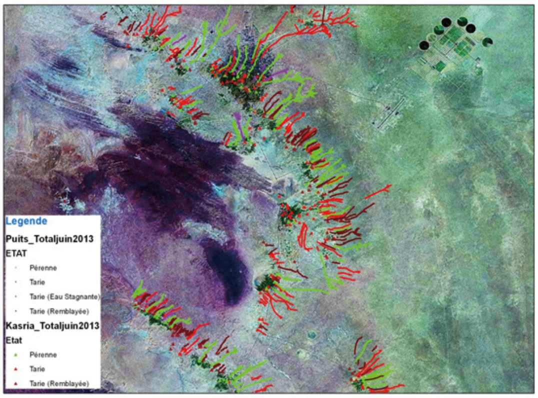

Image 9. A map of foggara extracted from the GIS. Green: Active fagaguir, Red: Inactive (dry) fagaguir, Brown: Inactive and backfilled fagaguir.

will be present. This person prepares the materials (clay) and chooses the masonry material. He is also responsible for establishing and fixing or attaching the measurement tool in the kasria. For monitoring and verifying, some of the foggara owners will be present during the measurement process.

Safeguarding, protection, and enhancement of the foggara

The Algerian state plays a leading role in the safeguarding of the foggara. Every year, it invests a significant amount of money (11,190,700 USD between 2007 to 2014) for the rehabilitation of the fagaguir. This happens because maintaining a foggara contributes to an essential part of life in oases. The Algerian state has established a mechanism to modernize the oasis by maintaining sustainable development in this arid zone by upkeeping and revitalizing the traditional foggara system. Here modern technology also helps to fulfil that aim: geographic information systems (GIS) are being used for the documentation of the foggara. A GIS is a framework for gathering, managing, and analysing data. To manage and safeguard the heritage of the foggara, it is helpful to apply GIS for documentation of information about the location of the fagaguir, facts about the foggara—information about wells and combs (kasria) and information about places and sites close to fagaguir. See Image 9 for a GIS-based inventory of active and inactive fagaguir.

Conclusion

The fagaguir of Adrar have contributed to the socio-economic development of the region through centuries. About 17,000 hectares of palm groves were once cultivated in the region— this was made possible thanks to the waters of fagaguir and the efforts of the inhabitants of the oases. Until today, the fagaguir continue to irrigate these groves. The foggara is a heritage that we enjoy today and must pass on to future generations. From this water heritage, we can learn how to fight against desertification and how to build sustainable approaches in an ecosystem as fragile as that of the Sahara Desert.

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Technological management of water and wastewater in ancient Greece as an example of implementation in the context of present-day sustainable management

Ioannis K. Kalavrouziotis

Introduction

The ancient Greeks considered water as a divine gift. In fact, Greek philosophers have expressed different views about water and the related phenomena: Anaximenes (584–525 BCE) studied the meteorological phenomena and explained how clouds are formed and snow emerges; Anaxagoras (499–428 BCE) explained how the flood of the Nile river occurs due to the dissolution of snow of the Ethiopian mountains; Alcmaeon of Croton (~470 BCE) observed that water quality can affect the health of human beings; Aristotle (384–323 BCE) set up the basic principles of the hydrological cycle, pointing out that water evaporates under the effect of the sun's energy and that the vapour leads to the formation of clouds. Apart from philosophy, Greek mythology refers to water and points out the continuous efforts of man to control the physical forces. Even engineers like Archimedes (287–212 BCE), who is considered the greatest engineer of the antiquity, expressed the principle that the upward buoyant force is equal to the weight of the displaced fluid, thereby providing the basis for successful water management.

Monumental hydraulic structures emerged in ancient Greece over time. They include dams, tunnels, water transfer pipe systems, and numerous devices for hydraulic uses of different kinds. Moreover, some of the ancient important mechanical devices for lifting water are still known today. These include the hydraulic endless screw of Archimedes—a mechanism for pumping water with small difference in height—that is still in use for transporting fluids and granular material; the hydraulic wheel of Perachora—a machine, used in the 3rd century for pumping water, which was discovered in the village of Perachora, Korinthos; and the subdivided wheel of Philon—a water-pumping machine for small and medium differences in height. Moreover, the ancient Greeks showed high ingenuity in the construction of hydraulic networks, such as the Eupalinos tunnel constructed in the island of Samos, by applying Euclidian geometry for the first time. They also constructed cisterns, aqueducts, pipe systems for water transport and distribution, fountains, toilets, and sanitary systems, some of which are still in existence. It can be concluded that all the previously mentioned technological accomplishments were important in the development of modern water technology achievements, thereby justifying the necessity of studying the ancient Greek water technology along with other ancient technologies created by other great civilizations.

The hydrological know-how in ancient Greece

Water supply systems

The first efforts to manage the use of water in crop irrigation were made in Mesopotamia and Egypt around 6000–7000 years ago during the Neolithic (May, 2007, pp. 19–54). But the first constructions to ensure the transfer of potable water were made in Palmyra of Syria and in eastern Crete during the Neolithic. So, in ancient Crete, especially during the Minoan civilization, the Minoans not only had hydrological knowledge for the transfer and management of water, but also knew how to design and construct for the improvement of water quality. Apart from the construction of small cisterns for maintaining water quality through the settlement of suspended particles, the Minoans of Knossos were using filters from loam or special structures filled with charcoal. Such filters were found in Aghios Mamas in Crete. Similar settlement cisterns were found in other areas, such as in Holy Triad and in Tylisos, during the Minoan civilization. This technology of settlement cisterns was later used by the Romans (Chatzakis et al., 2006, pp. 28–30).

Crete

Water management in Crete included a wide system of rain water collection owing to the dry climate and adverse ecological conditions. Such structures, founded during the Minoan civilization, could be seen in many Minoan towns.These structures include fields covered with paved flagstones, horizontal roofs, and stone ditches that led the water into cisterns (Lirintzis and Angelakis, 2006, pp. 163–174). Other hydrological constructions made at that time included aqueducts, water collection systems, rainwater-cleaning and storing constructions, deep wells, cisterns, and fountains. To transfer water, Minoans initially used open duct systems and these could still be found in Malia and ancient Tylisos. An important invention of that period was the closed duct system made of clay pipes (Image 1). These pipes were made of segments of 76-85 cm length and 1-2 cm thickness, while the diameter

Image 1. Water network system of the Minoan civilization (A. N. Angelakis, with permission).

was 7.5-8.3 cm; however, the diameter of bigger pipes was 15-17 cm with a conical shape (Angelakis, Koutsoyiannis and Papanikolaou, 2012, pp. 172–177). This method of water transfer showed that the ancient Greeks were well aware of hydrostatic pressure as the closed transfer systems most probably relied on it (Angelakis et al., 2013, pp. 972–987). According to Angelakis et al. (2013, pp. 972–987), it is remarkable that such structures were already being made in the ancient world. Furthermore, it is important to note that engineers in Minoan Crete knew the principle of communicating vessels—they were applying this principle during the construction of water distribution and transfer networks.

In Knossos, water was transferred through an underground tunnel with a length of 1150 m during the Roman times. Similar tunnels having a length of 1900 m were found by archaeologists in Malia. Also, an underground water tunnel was found with a length of 1,400 m in ancient Tylisos (Angelakis et al., 2014, pp. 95–102). The technological knowledge of water transfer through tunnels was also applied in other parts of Greece (Angelakis et al., 2014, pp. 95–102), and it allowed for the construction of small dams, canals, pipe ducts, and cisterns in the Aegean islands during the Cycladic (3100–1600 BCE).

Similarly, the already mentioned technologies were applied in continental Greece during the Mycenaean period (1600–1100 BCE). An important hydraulic structure of this period is the underground cistern in the Acropolis of Mycenae which supplied the networks with water through a huge rock. This structure is comparable with modern water supply systems in cities as it allowed a virtually unlimited and secure water supply to the citadel. Image 2 shows the steep passage-tunnel to the water cistern paved with stones. It is wide enough for two people to stand side by side. The cistern is located 18 m below the surface of the citadel and was supplied through underground pipes from a nearby natural spring. A large open drain is parallel to and just inside the outer wall of the citadel, probably as part of the central sewerage and drainage system, and drained water down the steep hillside outside the defensive wall.

Image 2. Cistern in the Acropolis of Mycenean (A.N. Angelakis, with permission).

Image 3. Pissistratio aqueduct, Athens (510 BCE) (N. Mamasis, with permission).

Athens

The Athenians constructed a cistern for water storage within the rock of the Acropolis. Ditches above the rock transferred the water into the cistern inside. A pelagic aqueduct, which was made of closed cyclic ducts, extended along a large distance from Kesariani to the side of the Philopappou hill. During the Mycenaean period, dams were constructed with a height of 2–5 m and a length of 250–5000 m. The volume of water that could be stored was about 2–250 million m^3. This water was used for the irrigation of agriculture crops (Knauss, 2005). The end of the Mycenaean era is considered a a dark period when the population plummeted and no new hydraulic works were made. Therefore, there was no progress in the construction of hydraulic works (Zarkadoulas et al., 2008). Following a gradual increase of the population, the Athenians started constructing deep wells and cisterns for storing water during droughts as well as to exploit rainwater. Moreover, the evolution of commerce after 700 BCE created favourable conditions, which led to the rapid development of Athens and consequently the hydraulic works started expanding. So, the water management infrastructure started to become more sophisticated as deep wells, cisterns, fountains, and canals were constructed and public networks for water distribution, including deep wells, were built. Public and private structures resulted in optimum water management (Angelakis et al., 2013, pp. 972–987). During the Archaic period (750–480 BCE) and the classical period (480–333 BCE) in inland Greece, hydraulic structures similar to those of the Minoan period emerged. Among them, the Pissistratio aqueduct in Athens (510 BCE) with a length of 2800 m—270 m of it was within a dome—is a remarkable achievement (Image 3).

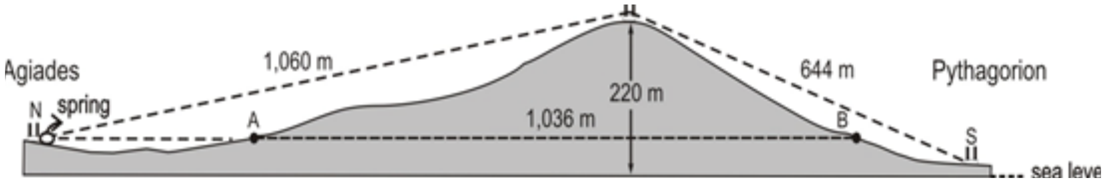

Image 4. Eupalinos tunnel in Samos (Voudouris et al., 2013, p. 1328).

In the city of Athens, many hydraulic structures, such as fountains and aqueducts, within water transfer networks and wastewater drain networks were constructed. Laws were passed by the tyrant Solon for the effective management of water resources. Some basic principles applied by the ancient Greeks in relation to construction of the hydraulic structures were economizing the use of the materials destined for construction, achieving maximum efficiency in the exploitation of rainwater, and designing structures to resist the effect of time so that these structures last as long as possible (Kalavrouziotis, Koukoulakis, and Drakatos, 2015, pp. 226–237).

Aqueducts

Around 530 BCE, the 'Tunnel of Eupalinos' was constructed in the island of Samos. In fact, this was the first deep tunnel ever made in history. Its construction started from the two ends (edges) of a hill—it was built with mathematical accuracy. The technology used was based on Euclidian geometry and the connection took place at the centre of the hill (Image 4). Within the Eupalinos tunnel and at its bottom were a series of clay pipes, where a pipe with a smaller diameter was located within another of a greater diameter (Angelakis and Spyridakis, 2010, pp. 618–628). Siphons were used in Pergamos and Syracuse around 490 BCE. This technology was effective for transfer of water through the hilly tomography. Such closed water transfer networks were also used by the Minoans. A typical aqueduct with a length of 50 km could be found in Nikopolis. It was built in 30 BCE to cover the water needs of this town—water was transferred from the source of St. George to Nikopolis, which is located 50 km away. The aqueduct was a complex structure and included an aerial system for water transfer to overcome the canyon of Louros and continued through a tunnel in the hill. The aqueduct continued up to the village of Archangelos and then crossed the villages of Samsuda and Kanali of Preveza before finally transferring the water to Nikopolis.

Later, during the Hellenistic period (323–146 BCE), as well as in the Roman period, open ducts were constructed to transfer water over large distances. A general rule applied at those periods was that the ducts must have a slope of 2% so that the water could run because of gravity. So, they built bridges for the transfer of water (Angelakis et al., 2014, pp. 95–102).

Wastewater systems

In ancient Greece, communities were dispersed in large areas and the wastewater produced by the various human activities was usually spread in the surrounding areas, where it was subjected to decomposition and oxidation under the effect of climatic and soil conditions. This caused health and hygiene problems, so people were obliged to construct drain networks for the discharge of wastewater (Brown and Lofrano, 2014, pp. 849–861). Even earlier, wastewater was commonly discharged in the streets—this was known since 6500 BCE in El Known, a region near Palmyra in Syria, as well as in the Kingdom of Mesopotamia since 4000 BCE. As far as Greece is concerned, systematically organized wastewater drainage networks have been found dating from 3000 BCE. Later, the Greeks and Romans further improved the wastewater management technology in relation to discharging systems, especially in connection with hygiene in urban centres, based on the accumulated technological knowledge (Golfinopoulos, Kalavrouziotis and Aga, 2016, pp. 28015–28024).

The drainage system of the Minoan period (2700–1450 BCE)

The golden period of the Cretan civilization was between 2100 and 1600 BCE. The Cretans constructed underground cisterns for the collection and storage of rainwater. There was, in general, good and advanced technological knowledge of the construction of water management systems. The well-designed structures for the drainage of urban wastewaters particularly contributed to a healthy life. The drainage network was covered by stones, and the wastewater was drained along with the surplus rainwater into the central drainage system, thus decreasing the possibility of stagnant water and any infection from various pathogens. According to Angelakis, Koutsoyiannis and Tchobanoglous (2005, pp. 210–220) the drainage system was completely cleaned by the rainwater transferred via the drain ducts irrespective of whether they are open ditches, closed, or pipe systems.

The palace of Knossos had a drainage system of 150 m in length. The wastewater was collected in an underground stone-made

Image 5. Drainage system of Knossos (A.N. Angelakis, with permission).

tunnel: under the palace, the drainage system formed a cycle whose highest point was located below the store house of the wastewater near a staircase in the east of the palace and under the lounge of the queen. The discharge system drained the rainwater from the roof and was also connected to the toilets of the upper floors (Angelakis, Koutsoyiannis and Tchobanoglous, 2005, pp. 210–220) (Image 5). The drain network system included trunks (water traps) for easy supervision and control of the system as well as for its cleaning and maintenance (Koutsogiannis, 2011, p. 156). Effectively designed drainage systems were also constructed in other Minoan towns like Festus and Zakro—they are still in operation after 4000 years (Angelakis, Koutsoyiannis and Tchobanoglous, 2005, pp. 210–220). There is historic evidence that the Minoans in 2700 BCE were among the first to reuse the wastewater for agricultural purposes. Also, the ancient Athenians and Spartans, as well as the people of Katerini, reused the wastewater for irrigation and improving the crop yield (Tzanakakis, Paranychianakis, and Angelakis, 2006, pp. 75–79).

The drainage systems during the classical and Hellenistic periods (500–30 BCE)

Having realized the important relation between healthy conditions and quality of life, the ancient Greeks took all the necessary measures towards improving their lives in the context of hydraulic construction efforts. So, they built baths and toilets, constructed drain networks, and even tried to reuse wastewater whenever possible. In public places, they constructed rainwater and wastewater drain networks to prevent contagious diseases caused by the pathogen- polluted water and to improve quality of life. The drain ducts were made of either stone or clay. In most cases, they were located underground, while there were surface ditches transferring the wastewater to the central ducts.

During the classical period, a long drain duct was constructed in Athens with a view to transferring the water outside the city. It had a width of 1 m, and its sides were stone-covered with flagstones. The ducts were basically underground at a depth 2.4 m, and a body of special police was established to watch the proper functioning of the drainage system (Zarkadoulas et al, 2008). The wastewater was discharged into the Iridanos river. Moreover, the wastewater was being used for the irrigation of gardens just outside the city (Lofrano and Brown, 2010, pp. 5254–5264). At the same time, drainage systems became more complex and effective. For example, each house in Delos was connected to the central network for the discharge of domestic wastewater, while the central drainage system in Pella collected the wastewater from private and public sites and buildings with smaller ducts, stone-made canals covered by flagstones, stone-made ditches, clay ducts, cyclic or square or some smaller ditches, and even pipes made of lead.

Drainage systems during the Roman period (from 27 BCE)

In the Roman period, many houses had perpendicular drains incorporated into the walls to transfer the wastewater into the central underground drainage system. Rainwater was collected along with the surplus of fountain water—it was used for the irrigation of urban gardens or simply discarded via the drainage system. At the same time, this water cleaned the drain ducts, thus protecting humans from diseases. In Patras, the wastewater from domestic sources crossed central roads via underground ducts or clay pipes and eventually got discharged into the sea. Sections of that drain network are still in operation even today. In the Odeion of Patras, for instance, the rainwater from the central seat rows is collected into a trunk, which is at the centre of the seat rows of the conservatory, and finally, the water disappears into a central underground duct without having caused any problem till today (Image 6) (Petropoulos, 2014, pp. 15–26). It can generally be underlined that the ancient theatres of Greece were constructed to include a drainage system for the collection of rainwater and its effective management. The ditches or canals accompanying the construction of the theatres were made of stone or other materials available in area. The size of the canals was analogous to the size of the theatre. In some cases, where the climate was dry, the water was collected in cisterns, such as in the Theatre of Delos.

Specific drainage systems

The agora (market) in ancient Greece was the place where various agreements were made, cultural activities took place along with rituals, social meetings, and other gatherings. Owing to the importance of the agora in relation to the social web of the town, it was planned in such a way so as to offer comfortable and hygienic conditions to people using the installations of the agora. The agora was connected to the water supply system as well as to the drain discharge network to prevent the storage of any stagnant water that may jeopardize public health. Other basic factors considered during the construction of the agora was the climate, the slope of the land, and the extent of the surrounding buildings: there was

Image 6. Roman aqueduct in Patras, Western Greece (I.K. Kalavrouziotis, with permission).

always a perimetric canal for the collection of the rainwater originating from the roofs of the houses and leading it to the central drain network.

Moreover, toilets required specific technology. The first toilets were constructed around 2600 BCE by the Hindu civilization in the valley of the Indus river in India. The Minoan civilization already knew public toilets (Antoniou, Angelakis and Mitchell 2015, pp. 41–68). In the Minoan gymnastic field of Amorgos, a 4th century toilet was found. The public toilets were constructed in such a way so as to have four or more seats. The distance between the seats was 4.5 cm and the opening of each was 85 cm. There was a ditch for the removal of the wastewater—it was connected to the main canal being constructed in parallel to the south wall of the toilet. These toilets have been found in many places like the island of Delos, in Athens, in Roman markets (Agora), and in the drain of Attalos. Both had a square form. Even other characteristic toilets have been found in the island of Kos, Philippoi, and Epidaurus. During the 2nd century BCE, toilets were constructed in almost all regions of Greece—they were connected to septic cesspools.

Ancient Greeks and present world water technology

Based on the above-mentioned information, an important question may arise regarding the relation between the ancient Greeks and modern world water technologies: is it worth studying ancient water technologies? Comparing ancient Greek hydraulic technologies with contemporary technological achievements provides an excellent example of motivation for modern environmental and conservation issues (Mays, 2007, pp. 43–76). It must not be forgotten that a number of Greek ancient technological developments are still in use (Kotsanas, 2013, p. 160). Similarly, such developments accomplished in other regions of the world are still in practice in African countries, India, Iran, Jordan etc. Furthermore, ancient methods are also being used in cases of shortage or excess of water around the world (Mays, 2008, pp. 471–484). Considering the ingenuity of the Greek technology related to the solution of hydraulic problems—cisterns, clay pipes, open and underground drainage systems, fountains, aqueducts, toilet and sanitary systems, rain harvesting, and similar developments— the Greeks along with other civilizations of the ancient world invented or improved many hydraulic devices that still facilitate the handling of water and fluids in general, thereby contributing significantly to effective water management.

The ingenious inventions of the ancient Greeks as well as of other ancient civilizations have helped significantly modern hydraulic and other technologies to proceed. They have opened up new avenues towards accomplishing contemporary technological achievements. As it has been pointed out, ancient technological developments have been considered as the basis for modern achievements. Yet, ancient technologies had been forgotten for a long time (Mays, 2008, pp. 471–484; Kotsanas, 2013, p.160), subjected to maturation, and it was only during the last two centuries that contemporary technologies revived them, used them as references, and renovated them through continuous improvements. After this time of maturation, it can be said that the present technological progress is in some cases a continuation of ancient Greek technologies. Western technologies revived ancient Greek technologies by extending from the robot servant of Philon to the cinema of Heron and from the automatic clock of Ktesibios to the analogue computer of Antikythera (Kostanas, 2013, p. 160). This reflects the influence of ancient water technologies on the modern ones.

Conclusion

The study of ancient water technologies is very important because the inventions and innovations of the ancient Greeks as well as of other ancient civilizations constitute the basis for modern technological achievements. In other words, ancient water technologies have contributed to effective water management. The ancient Greeks acknowledged the extreme necessity of water, the basic factor of existence of life, for the survival of humanity and used their ingenuity—they invented many structures and devices that helped human beings to handle important natural sources of water in the most effective and productive ways. They managed the whole process through numerous hydraulic works and constructions, as well as devices, to the maximum benefit of mankind.

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Waterways of Gouda: Past, present, and future

Hans Suijs

Introduction

At the end of the early middle ages, the first cities in Holland started to develop. This is late compared to neighbouring Flanders, Germany, and England, but the area was swampy and rough with all the discomforts of a delta area. In the first centuries, there was some population growth along the dunes and major rivers, but there was almost no habitation between the rivers in the so-called Holland Veen, which is a large peat area half the size of today's country. Around 1100 AD, at the junction of the Gouwe and Hollandsche Ijssel rivers, the initial foundations of what would later become the city of Gouda were made. Gouda has always had an intimate relationship with water. To put it more clearly, water was largely responsible for the emergence of the town. Water brought wealth and prosperity to Gouda.

The city is located on the border of the County of Holland and the Bishopric of Utrecht. Both the counts of Holland and the bishops of Utrecht encouraged the exploitation of the area. Today, the traces of the first developments are still visible: since the surface that reached up to 6 metres above the mean sea level had to be dewatered, ditches were dug and water was carried to the Gouwe and Hollandsche Ijssel rivers. When the peat of the ground was exposed to the air, it dried and shrank because of oxidation of the organic content. This process continues until the present day (in the Gouda region 1.5–2 cm each year). Soon it became apparent that dikes needed to be built with dewatering gates and stop locks in order to avoid water from being streaming into the lower parts of the country that during high (sea) tides. In 1255 Count William II decided that a specific counsel—the Water Board of Rijnland (it is called Heemraadschap in Dutch)—should be founded to control the water and to finance and built the needed dikes, locks, and other waterworks. Shortly afterwards, the water boards of Schieland and Defland were founded in 1273 and 1289. This system was eventually formalized in the constitution in 1848.

The water from the area around Gouda could not be discharged to the Hollandse Ijssel river because of the subsidence. As an alternative, the Old Rhine (north of Gouda) was used.

The mouth of the Old Rhine at Katwijk was bogged down after a storm in 1163 (St. Thomas Flood of 21 December 1163). Therefore, the surplus of water caused, for instance, by seepage or rainfall had to be discharged further to the north via Haarlemmermeer, Spaarne, and the IJ to the Zuiderzee around 1200. A stop lock was constructed at the mouth of the Spaarne. The water could stream from the Spaarne into the IJ, but it was 'stopped' when it was high tide.

On the south side of the region and the east of Zwammerdam, the Wiericke was dug to the IJssel and the Gouwe was extended to the west of Zwammerdam around 1240 from its origins at Boskoop onto the Old Rhine. The mouth of the Gouwe in the Hollandsche IJssel at a settlement around the fortified Court of Jan van der Goude was improved in the second half of that century with the construction of a port. In this way, it became possible for small ships (less than 4.70 m wide) from the southern counties to sail to Gouda. From Gouda onwards, the ships could be towed along the canals to the locks near Haarlem. From there they sailed to the IJ and the Zuiderzee to the north. It became the most important link in a busy inland navigation route between the IJ and the south. In the same period, the trade between the Hanseatic cities in Western Europe was growing. In 1230 there were only a few trade routes, but the number of routes grew steadily

Image 1. Hanseatic routes ca 1230 (Hans Suijs).

(Image 1). In 1295 there already existed a large network of transport connections, partly by the sea and partly over rivers.

Especially for small vessels (most of them were less than 5 m wide), the North Sea in spring and autumn was not really a safe place to sail. The storms and the wild seas made it dangerous—if the wind came from a wrong direction, the voyage became a long-lasting trip. By building new canals, a new inland waterway was created in the second half of the 13th century. This waterway between the IJssel and the IJ was easier, safer, and shorter than the previous way via the Utrechtse Vecht to the Zuiderzee (north-east of Amsterdam) or the way via the North Sea.

For Gouda, this new waterway was the route to the rest of the world. It became the birthplace of some great seafarers such as the explorers Cornelis and Frederick de Houtman. Moreover, through the trade made possible by the waterway, the city became particularly well known for its breweries. Thanks to the clean water from the rivers, the best beer in the country was brewed here and then exported to Belgium. In that same clean water, Gouda did the washing for other municipalities: the city of Amsterdam had its dirty washing transported there by water where it was washed and bleached at one of the numerous bleaching works just outside the ring of canals encircling the town. The name Bleekersingel has emerged from this.

Developments of the water (high)way in the city of Gouda

The village at the Gouwe mouth grew and was first named Ter Gouw and later Gouda. It received city rights in 1272 AD. The traffic over the water developed strongly and therefore the count's toll station was moved from Moordrecht to Gouda (after 1285). Profits from the toll were great, but, even more importantly, the trade became a serious economic factor and Gouda's beer and cheese were soon sold in many countries (especially in Flanders, France, and England). The ships brought back other valuable goods and stayed two to three days in Gouda, thereby contributing also to the local economy.

Land subsidence, as a result of the oxidation of the peat areas, made it necessary to build more and different types of locks to align the canals with the different heights of the land. The waterway through Holland was the leading factor in all efforts to control the water levels. In Gouda two stop locks and west (Mallegat Lock, Image 7) and east (Hanepraai Lock) from the central waterway were built. At the end of the seaport and in the middle of the city, a guard lock—the Donkere Sluis (Dark Lock)—protected the lower northern parts of the city against high water and provided passage for ships (Image 2). From there, the connection with the river Hollandsche IJssel was open. Since the river had an open connection with the sea, the harbour had high and low tides twice a day.

As a result, the passage of this Dark Lock (Donkere Sluis) was only possible when the water level of the city was almost at the same level as that of the river. Image 2 shows that this lock system stays in place even today. Originally, this lock only had one vertical trap door on one side of a broad bridge and therefore it was called the Dark Lock. Ships' passage was possible (due to tides) only twice a day during a short interval—this limited the number of ships as well as profits from the toll. To resolve this issue, the city of Haarlem, where the other toll gate was located, asked around 1400 AD for the building of another lock.

In 1436 the Amsterdam Lock (Amsterdams Verlaat), funded by the six cities of Holland (Dordrecht, Delft, Gouda, Leiden,

Image 2. Dark Lock (Donkere Sluis) at the centre of Gouda (Nico Boerboom).

Image 3. Amsterdam Lock (Amsterdams Verlaat) (Nico Boerboom).

Image 4. Harbour Lock (Havensluis) (Nico Boerboom).

Haarlem, and Alkmaar), made it possible to use the two locks and the intermediate canal of about 400 metres as a navigation lock to transfer ships from a lower water level to a higher one (Image 3). In this way, more ships than ever before could be handled.

Economic growth

The economy of Gouda grew steadily, making it the fourth city of Holland after Dordrecht, Leiden, and Haarlem. But the fire of 1438 destroyed almost the complete city—only four or five houses were saved. In 1452 AD the famous gothic city hall was built and situated in the middle of the marketplace (Image 5). All 200 leather buckets of the fire department were stored in the building to avoid a potential future disaster. At that time, the width of the ships reflected the characteristics of this waterway through Holland—they had to adapt to the size of the canals and locks. Moreover, there were some additional taxes to get a passage through the city. So, the waterway through Gouda got the nickname ‘costumed way’ or gecostumeerde vaart in Dutch. For regular users of the Gouda waterway, the toll fares were reduced. Special contracts were made for ships from Haarlem, Dordrecht, and the region, as well as those made in Hanseatic cities. However, there was no competition because the building of other locks in other places was forbidden by the Count of Holland. In case other cities tried to construct another waterway from Rotterdam to Amsterdam, the civic guard (in Dutch: Schutterij, see picture of the painting of Ferdinand Bol: *Colonel Govert Suijs and his four captains of the civic guard of Gouda* – Image 6) of Gouda was mobilized to destroy these constructions.

But despite Gouda's privileged position, at the end of the 15th century, Amsterdam, Delft, and Rotterdam had taken over as the biggest cities in Holland and later changes in the waterway occurred. In 1574, during

Image 5. City hall in the marketplace (photo Nico Boerboom).

Image 6. Civic guard of Gouda 1653 Ferdinand Boll (collection museum Gouda).

Image 7. Mallegat Lock (Mallegatsluis) (Photo: Noco Boerboom).

the siege of Leiden by the Spanish troops, William of Orange was not amused with the waiting time before Gouda for his military ships that were badly needed to help the inhabitants of Leiden. Therefore, after the siege ended, he ordered the construction of a new and larger navigation lock to the west of the centre of Gouda. In 1577 the Mallegat Lock was opened (Image 7)—it was used for warships only—and troops could be transferred without delay from that moment onwards.

Health and water

The problem with the clean and clear water around Gouda was that it got used more and more as a dumping ground for all kinds of waste, including human excrement. To cope with the increasing problem, an ingenious flushing system was designed. The Dark Lock became the heart of that system: the harbour was filled with water up to the Dark Lock at high tide. The lock was closed, and at low tide the houses along the Westhaven and Oosthaven could flush this higher water through their sewers and dump the content into the smaller canals behind their houses. This water soon became polluted and started to stink. To resolve this problem, the Dark Lock had three pairs of doors and could be opened against the water pressure so that the water flushed through the town rinsed everything clean in the direction of the north. The first pair of doors near the bridge and the harbour was closed during high water. The second pair closed afterwards and then the last pair closed, leaning on and supporting the second pair, even if the first pair was opened again. Image 8 shows the last phase in which the first pair is reopened. The last pair opens slowly, whereby the second pair also opens a little, allowing the flood in the port to pass through in a controlled manner. By slowly opening the last pair the gap becomes greater—the water travels fast through the Dark Lock and thereafter through the canals of the city in a prearranged route by using other small doors at strategic places. It was a sophisticated network of waterways, refined into small drainage canals throughout the centre of the town. Finally, the water and dirt leave the city to the north and ultimately got transported to the Zuiderzee via Amsterdam.

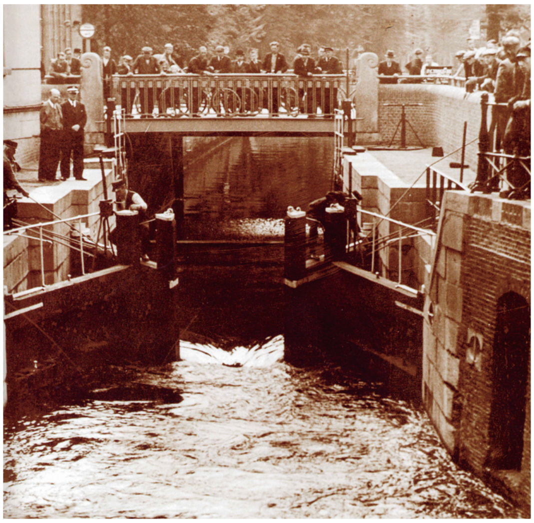

Image 8. The Dark Lock in function (Photo: Archive SAHM Gouda).

More ships and more alternatives

Later, broader ships were allowed to use the Mallegat Lock, but they had to purchase a ‘consent’ from the city hall. They also had to stay two extra days in the city and hence the crew spent some money. In 1598 the Gouda waterway was opened for every ship with consent. At other places along this waterway, similar lager navigation locks were constructed. In 1615 another lock was built at the entrance of the port. This completed a two-step lock of 800 metres. Since the water level in the city had to be decreased step by step in accordance with the subsidence of the land, this extra lock increased the capacity of the total system. From that moment on, the passage of ships became a continuous process independent of the tides, and the system formed the longest lock in the world until the completion of the Panama Canal.

In the 17th century, the so-called Golden Age for Holland, inland traffic grew rapidly over the waterways. New channels with towpaths, locks, and bridges and the well-organized horse traction facilitated a fast transport system for goods and passengers between the cities. This effective system of waterways was something road transport could not match. In 1764 a new and broader Mallegat Lock was established. At the same time, alternative routes started to emerge, especially between the large cities of Rotterdam and Amsterdam. The privileges of Gouda (consent etc.) became no longer applicable at the end of the 18th century because of the new traffic alternatives, and all tolls in Gouda were abolished in 1795. The transfer function of Gouda in the north–south route, however, continued to exist, while the export of peat (turf) via Gouda grew thanks to the almost inexhaustible sources in Reeuwijk. This process continued until the 20th century, and in 1936 the Juliana Locks were built on the west side of Gouda (Image 9). In 2014 a new navigation lock was built next to the existing one.

On the last day of January 1953, the North Sea flood hit the Netherlands. A combination of high spring tide and a storm tide resulted in a water level more than 5.6 metres above the mean sea level. The tragic result was that dikes broke and 1,836 people died. There was property damage on a wide scale. The Hollandsche IJssel reached 3.89 metres above the mean sea level (Normal Amsterdams Peil or NAP), and the local water defence structure barely resisted the flood. The Hollandse IJssel did not give way, which was a narrow escape, and the tragic flood could have caused many more deaths. After the big flood, the Gouda port entrance was blocked by a concrete construction. So far, this seems to be the end of the water (high) way through Holland. But the waterway is regarded as an important heritage and has to be reopened in accordance with the results of a survey among the citizens of Gouda. Statistics show that the waterway's importance increased until the 20th century (Table 1).

Decreasing presence of water

The strong link between Gouda and water has faded into the background slightly

Table 1. Quantity of vessels per year (source: Dolph Blussé).

Year	Dark Lock No. of ships	Mallegat Lock No. of ships	Juliana Locks No. of ships	Total No. of ships
1540	7,000	-	-	7,000
1680	14,000	6,000	-	20,000
1900	10,000	28,000	-	38,000
1930	No specification	55,000	-	55,000
1938	No specification	11,000	37,000	48,000

Image 9. Juliana Lock west of the city (photo Nico Boerboom).

during the last century. Naturally, there is still plenty of water in the city, especially in the canals, which, in combination with picturesque bridges, ships in the canals, and the museumhaven and the old buildings, presents an attractive sight for tourists. But it is mostly indefinite nostalgia as the awareness of the importance of water for Gouda has gradually faded. It seems as if Gouda now stands with its back to the water, quite contrary to the situation in its long history. It is not without reason that previously the city hall occupied such a characteristic position in the market square: it faced what used to be the most important thing to the town—the water, the open connection to the sea. The Hollandsche IJssel was a tidal river for centuries. At that time, there was ebb and flow right up to the Donkere Sluis. The sea came up to right in front of the town hall, but this situation is lost today. Another example can be found between the Agnietenkapel and Achter de Waag, a place near the marketplace and at Kleiweg and Hoogstraat. Here no one realizes that water is just below the surface. The feeling of water has been completely paved away. Water quality will also improve by restoring the open view on the water (more sun and wind means more oxygen in the water). Unfortunately, the water was pushed back and hidden, and it needs to come back into the picture and public awareness.

The revitalization of water heritage remains a cultural–historical challenge. The aim of the Historische Vereniging die Goude is to restore the old navigation route between the Hollandsche IJssel and the Gouwe through the city to its former glory so that small ships can again float through the centre of Gouda without any obstacles. All bridges and locks, except the Harbour Lock (Image 4), are ready for that. Reopening of more canals has always been an objective of society since 1932. In 2005 the responsible alderman Roland van Schelven stated: ‘I’m ready to improve the navigability of smaller waterways at the centre of Gouda. It is a question of generating more enjoyment value in the town centre so that tourists will stay longer in Gouda and locals will enjoy the town more. It produces a positive (recreational) climate, with more to experience in Gouda. People enjoy the cultural–historical elements of a city, and it is sometimes possible to meet this demand with just a little effort’ (Schelven, 2005).

New safety challenges

Two different threats are attacking the historic values of the inner city of Gouda. The first one is the continuous subsidence of the surface. The other is the changing climate and an increasing amount of heavy rain, which results in larger amounts of precipitation in a shorter timeframe than ever before.

Subsidence

People always had to deal with subsidence when they lived and survived in Holland. Since the Romans left the area and farmers tried to develop the peat areas, people have adapted to the inevitable subsidence and the rising of sea level. The Dutch managed to deal with these problems by adapting new techniques—in the beginning by building dikes and stop locks (from 1000 BCE) and later by using windmills (around 1500) and steam engines etc. When, owing to the subsidence, the level of groundwater rose relatively, agriculture became impossible. Livestock farming focused on milk and cheese production was the next phase. In fact, this was the time that Gouda cheese became famous (1100–1200). In the near future, we will most likely face again a dramatic change. Cows will no longer be able to walk in the meadows because of further subsidence.

Outside the city centre, the subsidence is 1.5–2 cm per year. At the city centre, it varies between 3 and 6 mm per year. The water at the city centre has a level of -72 cm NAP, while this level around the centre has an average of -220 cm NAP. Limited subsidence at the old historical city centre might look not too bad, but it still poses a serious threat because the distance between street level and water level at certain places is already less than 10 cm, while protection from flooding after heavy rains requires a larger distance. In other parts of the city, this distance is 40 cm or more. At the city centre, only 6% of the surface is water, while this is 15% or more in the surrounding parts. Already today, the relatively high groundwater causes humid rooms, mould, and other unhealthy conditions at the centre (Image 10).

Image 10. Turfmarkt at the centre (Photo: Nico Boerboom).

Further subsidence will increase these problems at the centre of Gouda (Image 11). One of the solutions proposed by the local government is to lower the groundwater level, but even dropping this by just a few centimetres will cause rotting of the wooden piles of about 30% of the historic houses and 70% of the houses have no piles at all. A costlier alternative—it is the better solution in my opinion—would be to place each threatened house on concrete foundation piles. However, this is not straightforward because some groups of houses are built in an interconnected way, but they have different owners. There are places where one house is on piles, while the one adjacent to it has no piles at all. The first formal proposals to the city council will be made at the time of publication.

Climate change and rainfall intensity

In each district outside the historic city centre, 15% of the surface is water. The difference between street level and water level is a minimum of 40 cm. So, 60 mm of rain in one hour can be absorbed without causing any flood. But at the city centre only 6% of the surface is water, and the difference in levels is only 10 cm or less in the weaker parts (northwest of the centre). Even a brief shower can cause a flood. Around 1500, the surface percentage of water was above 10%, but a lot of canals have been muted for various reasons since then.

In 2018 the Water Guild of Gouda, an NGO, was invited to consult a combined project of the Water board of Rijnland and the city of Gouda, assisted by universities, Deltares, and other knowledge centres in the Netherlands (Kaderplan Bodemdaling Binnenstad). The project team will make a proposal for a set of solutions for the combined problems of surface subsidence and climate change. Political decisions in this regard will be made in mid-2020. The objective is to address the current water problems with short-term solutions and at the same time to protect the cultural heritage of the city. This means that only ‘no regret solutions’ will be acceptable. It will not be an easy challenge to meet, but Gouda has managed to survive many centuries with the same water-related problems. It is not by chance that Gouda’s motto is ‘Per Aspera ad Astra’ (Through hardships to the stars).

Image 11. Six different consequences (Hans Suijs).

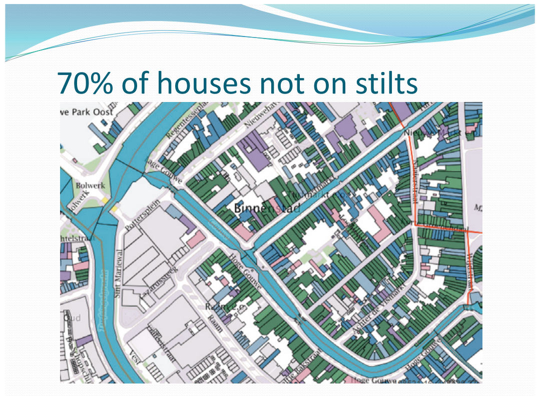

Image 13. Same area today (Hans Suijs).

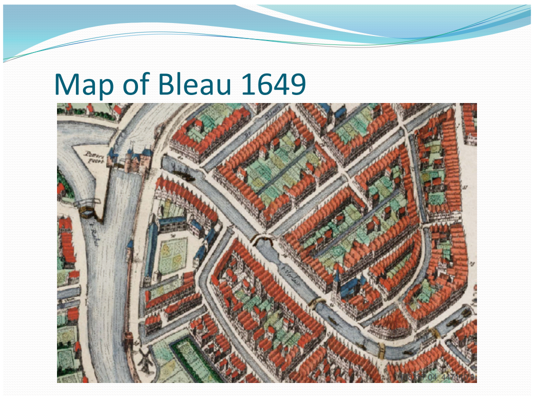

Image 12. Northwest area of the city centre in 1649 (Hans Suijs).

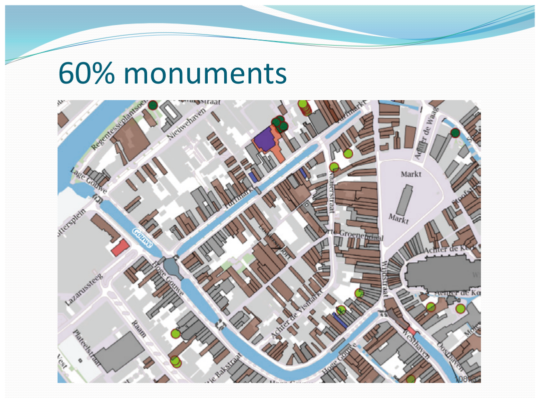

Image 14. 60% of the buildings are monuments (Hans Suijs).

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Images and maps:

All Locks: Nico Boerboom, Streekarchief Hollands Midden (SAHM) en Museum Gouda

City Hall: Wikipedia Commons, Samuel Mudrik

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Watermills: Inspiring heritage with the power of water

Edmond Staal

Introduction: Mills as identity

The Netherlands is known as a country full of waterways. Geologically, it is a delta region formed by the estuaries of the Meuse, Rhine, and Scheldt rivers as well as their tributaries. Like many other deltas around the world, this is a densely populated area. Low-lying deltas pose serious challenges in terms of water protection and land reclamation. Dutch people have enormous experience in dealing with these issues over the years. From the middle ages, the Dutch have been busy reclaiming land and creating polders—diked low-lying areas. The Netherlands is also known as Holland. This name originated from the time when the Netherlands was economically strong and played an important role worldwide. New York was originally a Dutch settlement, and the Netherlands had trading posts from Ghana to Taiwan. The name 'Holland' comes from the names of a few Dutch provinces to the west of the country. This part is actually below sea level and was drained and impoldered to create new land. The draining required pumping—the energy for this was provided by windmills. There was a time when the Netherlands had around 11,000 windmills (www.molendatabase.nl). Depending on local water issues, several Dutch regions had a certain type of windmills to drain water. Besides being used to drain water, these windmills also functioned as equipment for other purposes. For example, De Schoolmeester (the schoolmaster) in the village of Westzaan in the province of North Holland was used to make paper. It is the only wind-powered paper mill in the world. Windmills were also used to saw wood (five of these paltrok mills still remain) and obviously to grind grains. The reality is that most windmills do not exist anymore because of the absence of economical functions relating to them. Approximately, 1,100 historic windmills are still there (www.molendatabase.nl).

Over the centuries, the techniques improved and the water eventually got drained by steam-powered pump stations. One of these stations, the Woudagemaal (Wouda Steam Pumping Station), which became operational since 1920, is also on the UNESCO World Heritage Site list (www.woudagemaal.nl). Since the 1960s,

Image 1. Holland is known for its windmills (RCE, P. van Galen).

coal was replaced with heavy fuel oil and later with electricity. Even nowadays, monuments like this one remain in use to supplement the existing pump capacities of other pumping stations in case of extremely high water levels. They are working monuments with an important function. These world heritage sites perfectly illustrate the development of old drainage techniques; they show that windmills are an essential part of the Dutch identity as they facilitated the creation of the Dutch territory.

Water as source of energy

There were and still are mills that are driven by water to produce mechanical energy for other purposes. The principle of using water as a source of energy is very old and known all over the world—the oldest inventions date back around 3,000 years to Mesopotamia. Some old complexes still in existence are the so-called Norias in Syria that consist of a large, narrow undershot (see below) water wheel whose rim is made up of a series of containers that carry the water from the river to a very small aqueduct at the top of the wheel. Similar types also exist in China, Germany, and Iran.

Image 2. Wouda pumping station interior (RCE, W. van der Sar).

In the early middle ages, water was also used as a source of energy in The Netherlands, thus influencing the surrounding landscape. The oldest function of water as a source of energy was shown in gristmills because flour was an important necessity of life back then. The Netherlands is reasonably flat and therefore the streams run slowly. So, the watermills were only built on higher grounds because running water is needed as a source of energy. The natural structure of the country provides only small differences in altitude. The highest point in the Netherlands is 0.2 mile or 322 m above sea level. The slow-running water only provides little energy—this had a major impact on the development of different types of watermills in the Netherlands and they are only located in the four eastern provinces. At one point in time, that part of the Netherlands probably had more than 800 mills powered by water. Only approximately 100 remain at present, among which 45 are still in working order and only remnants of 62 remain today (Table 1).

Just like windmills, watermills can be divided into different types. Watermills played an important role in the industrialization process over the centuries. Some were sawmills such as the one in the Twickel Estate—this

Table 1. Watermills in the Netherlands (Source: www.molendatabase.nl).

Province	Working watermills	Not working or only remnants
Limburg	20	41
Noord-Brabant	07	07
Gelderland	10	13
Overijssel	08	01
Total	*45*	*62*

mill is still in working order. The wood from the trees in the estate is processed by the mill and used for conservation of monuments or sold for other purposes. There are mills that have beaters, powered by wheels, to hammer rags into loose fibres that were used to make paper. Another important type of mill is the fulling mill. Woollens were felted using hammers or beaters and a mixture of soap and hot water was applied in order to make them weatherproof and waterproof. This cloth became the basis for blankets and was also used to make uniforms, for example, for the army. As far as we know, there are no working fulling mills in Western Europe anymore (De Hollandse Molen: ww.molens.nl). However, there are such mills in Romania. With the help of local experts, a fulling mill will be reconstructed in the southeast of the Netherlands in the town of Venray. This area has a long history of sheep farming and so there is a historic link.

Another type of mills that have disappeared over the years were used to manufacture leather from animal skins. Most probably, the skins were kneaded by using hammers. Because of the stench, the location of this type of mills was usually outside towns. The copper mill (or ore mill) is a type of watermill that played a huge part during the industrial revolution. One of the watermills southern Netherlands, the Volmolen Frankenhof between Holset en Vaals, started off as a copper mill. At first, it was thought that the ore was grinded here to use it to produce bronze. Both the bellows and hammers were powered by the watermill. Since no remains of the slag-based stone or furnace were found, it is thought that the mill was used to pound copper plates in shape for creating copper pots or cauldrons (Rackham, 2018). Of course, watermills were also used to grind grains—either for food for people or for livestock. In the Netherlands, this function was common for a watermill as well as for an oil mill. In some areas, watermills had a double function as they had the machinery for grinding grain on one side of the watercourse and the machinery for extracting oil on the other

Image 3. Sawmill Twickel (RCE, A.J. van der Wal).

Image 4. Fulling mill interior.

Image 5. This is a paper factory called *De Middelste Molen* in Gelderland. It produces paper since 1622 and is the only remaining paper mill in the Netherlands; it is well preserved and still in working order (RCE).

side. Also gristmills can still be powered by water. As for windmills, the energy sources for watermills also changed during the 19th century from water to steam, to heavy duty oil, to electricity. The function of watermills ceased to exist and many of these industrial complexes have disappeared from the original buildings. At the beginning of the 20th century, local farmers took over the remaining mills and rebuilt it as gristmills for different purposes like providing food for livestock (Rackham, 2018).

Water as source of energy: Working principles

In the Netherlands, there are four types of watermills. This is determined by the

Image 6. Frankenhofmolen after restoration (SLL, H. Bussink).

drop of water and the opportunities to dam the water: since the Netherlands is rather flat, most mills are undershot mills with little water power. In the south, especially in the province of Limburg, there used to be different types of watermills thanks to the differences in altitude. As a certain amount of water is necessary to operate the mill and the supply is limited, mills in the Netherlands have several reservoirs or pond systems to get a steady amount of water. Early on, the people of Limburg changed to watermills with water turbines. Below, the four types have been explained:

Overshot mill

The Frankenhofmolen is a mill situated on the border with Germany and Belgium, 320 m (or 0.2 mile) above sea level. The current complex dates back to 1736. Historic research shows that in 1606 two copper mills existed in a single building. When there was no economic use for a copper mill anymore, it was transformed into a mill to manufacture leather. In the 18th century, producing cloth (made from wool) and blankets took off and cloth was mainly supplied to the Aachen-Liege-

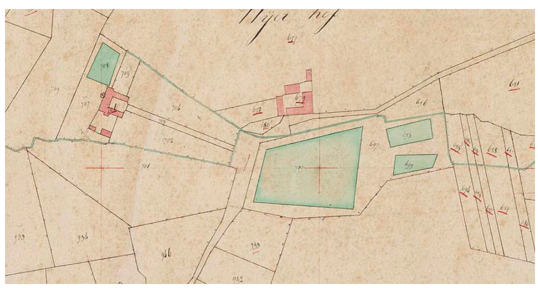

Image 7. Drawing of weirs around Frankenhofmolen.

Image 8. Overshot Watermill Frankenhofmolen (SLL).

Vaals region. The building was gradually expanded into an industrial complex. Felting wool was not the only activity anymore—the complex was a complete factory with looms, spinning mules, etc. The watermill powered the machinery by a steam engine. A boiler room was installed around 1850 to facilitate a steam engine. However, all industrial activities ceased in 1903 and the complex was turned into an agricultural business. The farmer's family restored the watermill in the 1980s, but the complex got run down rapidly. New restoration works started again in 2007. The Frankenhofmolen is a good example of a mill from the early industrial revolution; it is a valuable link between the monument and the surrounding landscape.

This map of the mill landscape of the Frankenhofmolen shows the influence of a watermill on its surroundings. Since there is hardly any running water here, the water needs to come from a water reservoir to power the water wheel. Five ponds with different functions were constructed for that purpose. Owing to the drop in the waterway, the construction of an overshot watermill was possible here. The advantage of an overshot mill: it has a lot of power because the wheel is driven by the weight of the water. The sustainable effect is that the already used water can be used again downstream as a source of energy for the next mill. Once, there were seven watermills here, but the Frankenhofmolen is the only one remaining at present.

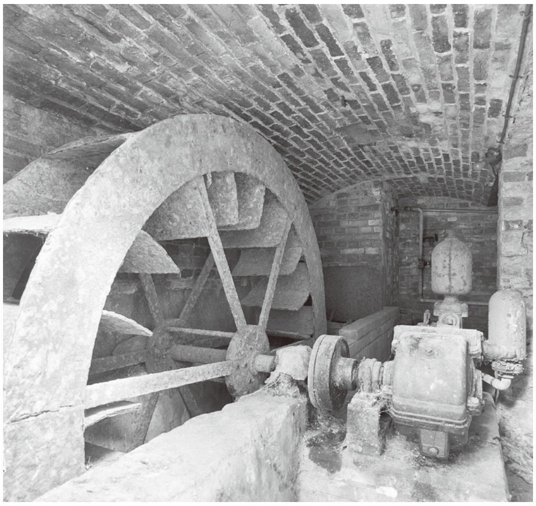

Image 9. Breastshot mill Wittemermolen (RCE, K. Roderburg).

Image 10. Wymarsche watermill (SLL, H. Heijligers).

Breastshot mill

The breastshot mill is a mill where the water enters the wheel around the height of the axis. Such mills are less efficient than overshot wheels, but they can handle high flow rates and are used for steady high-volume flows. An example of a breastshot mill is de Wittemermolen, which was once situated in a whole system of fish ponds that also functioned as weirs and a dug mill branch. The wheel is inside the building. Another example is the Volmolen (fulling mill) in the town of Epen. The landscape is different because the Geul river, a small stream, provides water permanently. As the mill branch has a weir, the water level remains high upstream.

Undershot mill

An example of the undershot watermill is the Wymarsche watermill in the village of Arcen in the province of Limburg. In an undershot mill, the oldest type of water mills, the water hits the wheel in the lower section. The mill has both an undershot wheel and an overshot wheel. The Lingsforterbeek, the nearby stream, is dammed sand and hence there is enough water to power the wheels. The higher water also prevents the surrounding nature and agricultural areas from running dry.

Mill with water turbine

Lastly, here is the example of a watermill with a water turbine instead of a wheel: the

Grathemermolen in the town of Grathem, Limburg. The mill was permanently fed by a stream and there was an undershot watermill in this location. The disadvantage of an undershot wheel is the low yield—the usual slow movement of the water has to power the wheel of the mill. Often, the wheel has a diameter of 9 metres to get as much energy as possible. At the beginning of the 20th century, undershot mills got a water turbine to produce more energy. This mill with a water turbine has a full metal wheel that is completely under water. In the first half of the 20th century, this mill provided electricity to the whole village (Rackham, 2018).

Image 12. Frankenhofmolen, restored weir (SLL, H. Heijligers).

Mill landscapes

Mills are often regarded without considering the surrounding landscape. However, mills are monuments that have a significant and defining influence on their surroundings. Millers needed enough water to make the watermill work, so they had to adjust the surrounding areas. This means mills played an important environmental role and helped preserve biodiversity. In higher parts of the Netherlands, such as in the Achterhoek and Twente, both located in the province of Gelderland in the east of the Netherlands, people dug waterways to change the flow of a stream or river towards a mill. As mills had a regional function, the surrounding areas comprised, besides the mill and the waterway, roads and water crossings. To have a sufficient supply of water, millers dammed the waterways and dug new branches. This had a huge influence on the landscape upstream.

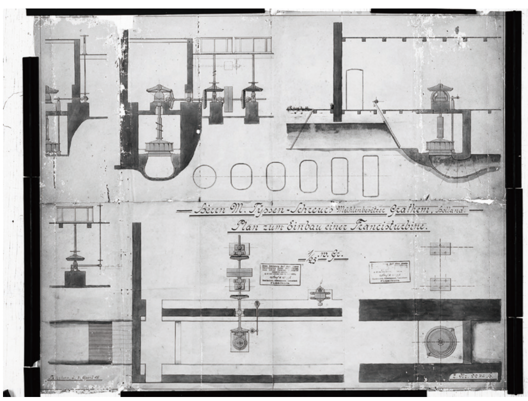

Image 11. Turbine mill (RCE).

The banks of a stream became more wet when the water was dammed, which resulted in sedimentation of sand and clay. Farmers appreciated this natural form of fertilization. However, the miller had to keep the water for quite some time, which resulted in disagreements between miller and famer in the cultivation season. When the miller dammed the water downstream, the mill's wheel slowed down. To keep some order, during the reign of Charles V in 1545, the so-called water rights were introduced to determine how much and how long a miller could dam a waterway. Mill landscapes usually remained free of housing because those areas behind the mill would get flooded. Biodiversity increased due to marshlands, wet, and less wet areas.

The future

Since watermills have no economic value anymore, the existence of these monuments of industrialization and their important link with their historic landscapes is threatened. Owing to deterioration of the buildings, only 10% of the Dutch watermills remain today. Most of them are no longer in working order. They have been transformed into restaurants or residential houses without the machinery. In the current world of production, the old functions of these mills, such as milling grain, have no economic purpose. The current challenge before the heritage sector is to provide certain monuments with economic functions. This riddle is the basis for efficient and sustainable restoration and conservation. What role will be given to these industrial monuments in future? And how can the link between these mills and their surrounding landscapes remain intact? Apart from these challenges, another issue arises from a rather unexpected point of view. For ecological reasons, at least in Europe, attention is given to fish migration, with mill weirs forming barriers for fish. As the mills are no longer in working order, the upkeep of the weirs can hardly be justified. In the Netherlands, there is another problem: the Dutch Water Authority bought the water rights that used to belong to a mill in the 20th century. Therefore, millers no longer have the right to use the water and the water authority is authorized to straighten streams so that the water flows more quickly. If ever there is a chance to reuse a watermill, there will not be enough water to power the mill.

The understanding that watermills gives an important historical perspective ignites interest in the mills that remain in the Netherlands. This is further stimulated by developments like climate change that causes unpredictable rain patterns, resulting in higher peak discharges. To limit water problems, water needs to be captured upstream. The water authority is currently looking to slow down the water discharge—historic mill structures can help in this regard. The slowdown is not only necessary to prevent water overload downstream, but also to add water layers to groundwater. Still or slow-running water is even drained vertically and ends up at groundwater level. This is useful for higher areas in times of drought. Moreover, the captured water is also beneficial for preserving biodiversity. Different animals and plants live in the surrounding areas of a watermill compared to the higher and hence dryer areas upstream. The watermill landscapes are containers of biodiversity—this is another reason for restoring mill landscapes.

Fish migration

In the past, large tracts of land around a watermill got submerged by waters from flooded streams. This gave fish the opportunity to migrate around the mill's weir. Arable lands were drained and hence no floods took place anymore, thereby making fish migration impossible. Currently, together with the water authority, so-called fish passes are being built around mill weirs. Fish can move up these fish passes and end up more upstream to spawn. So, the function of the mill also serves an ecological purpose. More and more knowledge is available regarding moments of fish migration. So, it is possible to stop the mills or close the weirs for that timeframe. However, streams that already have a low water supply do not have enough water to make fish migration possible—they do not give enough water for the mill to function. In this situation, temporal fish migration can be a solution. Along a mill complex a layer is created so that when there are higher water discharges, this area will have a water flow. Higher water discharges occur during springtime and that is exactly when fish need to spawn. Another possibility is to fill the mill ponds during the night and the remainder of the day—the water will flow through the fish passage. Because of the lack of any economic function, a mill does no longer need to work all the time (Kranenbarg and Mars, 2013).[1]

Power generation

Watermills were the first type of mill to be used for power generation. A historical mill needs to be manned permanently to be able to function day and night—it is not sustainable in an economic sense. Here a new purpose could be a solution. In the St. Elisabetsmolen in the Leudal-

[1] Recently, Sportvisserij Nederland (the Dutch angler association), Natuurmonumenten (Dutch national non-government organization for natural and cultural heritage), the Dutch WWF, and several other organizations issued a statement in which the power of water has to be denied in the Netherlands. The damage to the ecosystem is not in any proportion to the little hydroelectric power that is being generated. Some companies claim that they can produce fish-friendly turbines. However, none has proven to be able to do so. The disadvantages of damming will remain in the natural streams.

region in Limburg, a traditional generator has been linked to one of the two mill wheels and now the mill provides energy to some houses in this area. Non-used energy goes to the national power grid, which is advantageous for a densely populated country like the Netherlands. So, watermills can play a new role, even though their traditional productive functions have been lost. To achieve this, it is necessary to look at the mills in relation to their surroundings so that social functions can be linked with these monuments. It seems that more attention is currently being given to conserving these great intriguing tools from the past and to pass them on to generations to come.


Image 13. Grathemermolen, fish passage on the right (SLL, E. Staal).


Image 14. The St Elisabethsmolen in Haelen has partly been rebuilt in 2015 and now has a turbine which produces 50,000 kWh/year. The electricity is used by the next door restaurant (SLL).


Image 15. Frankenhofmolen interior after restoration (SLL). The mill itself regained its old function and has been restored.


Image 16. The ECI hydroelectric power station (RCE, K.Roderburg) is the only remaining watermill along the Roer and Vlootbeek streams. The turbine's output is 250 kWe. However, owing to the lack of water, this will rarely be achieved.

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Photos:

RCE is Dutch governmental service for cultural heritage, Rijksdienst voor Cultureel Erfgoed photo image bank.

SLL is archive Stichting het Limburgs Landschap.

All the photo names correspond with the names in the We Transfer collection. Names of the source and the photographer are linked to the photos.

Part 3

Significance of Water Heritage: Re-Activation Strategies

Waterscape biographies: The bridge connecting water heritage, water management and spatial planning

Hans Bleumink and Jan Neefjes

Introduction

The Netherlands is a land of water. It is the delta of Europe's great rivers such as the Rhine, Meuse, Scheldt and Ems (Image 1). Nearly half of the country's land lies below sea level and it is well known internationally for its polders, dykes, windmills and storm surge barriers. Its man-made landscapes are awash with the evidence and battle scars of the centuries-old struggle against water. Thus, it is only logical that much of the built heritage in the Netherlands is related to water and that many historical man-made landscapes are water landscapes. Of the ten UNESCO World Heritage Sites in the Netherlands, more than half are directly linked to water issues and one of the three main themes of the Dutch World Heritage programme is *Nederland waterland* (see www.werelderfgoed.nl).

For a long time, heritage management in the Netherlands – and in other countries too – focused on inventories, evaluation of significance and conservation. This has certainly contributed to the high number of protected sites relating to water heritage that we are fortunate to have today. Yet it has also become increasingly clear that water heritage and historical water landscapes are not static in their significance: they are living landscapes that need to adapt to the demands of changing times. Many historical landscapes and waterworks still play an active role – or indeed a vital role – in water management, land use and the (land-based) economy. Climate change has made this abundantly clear. Old dykes need to be reinforced, water storage areas need to be restructured, drainage needs to be reorganized, and fresh water supplies need to be maintained.

In the Netherlands and beyond, the heritage world as well as the water management and planning worlds have recognized that water heritage and historical water-related landscapes are living, cultural entities that require a different, more development-oriented approach. This article gives a broad impression of the history and various water heritage sites and landscapes found in the Netherlands, and of the current management practices regarding such places. It concludes with a short sketch of the development and use of landscape biographies (or hydro-biographies) in Dutch spatial planning and water management, and their promising role in advancing an integrated, development-oriented planning methodology for area redevelopment projects.

Image 1. The Netherlands with clearly visible rivers and the delta. The Netherlands is a relatively small and densely populated country. It encompasses the river deltas of major European rivers. (source: https://upload.wikimedia.org/wikipedia/commons/b/bd/Satellite_image_of_the_Netherlands_in_May_2000.jpg, public domain).

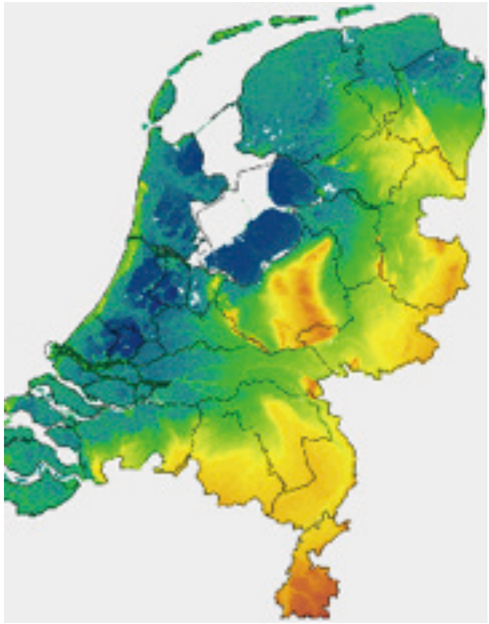

Image 2. Map of elevations in the Netherlands. Half of the land surface in the Netherlands is located below sea level (the blue and grey areas). The eastern and southern parts of the Netherlands are above sea level (the yellow and brown areas). This area has a sandy and slightly undulating surface.

'God created the world; the Dutch created the Netherlands'[1]: A brief history of water management in the Netherlands

Devastating land clearings

This section gives an impression of the development of land use and water management in the Netherlands and the resulting heritage landscapes. Numerous thematic and regional studies have been published for both the higher and lower

[1] A saying that describes a foreigner's view of the Dutch mentality in building dykes and reclaiming land.

parts of the Netherlands. For the low-lying areas of the Netherlands, the standard work *Man-Made Lowlands: History of Water Management and Land Reclamation in the Netherlands* (Van de Ven, 2004) describes the main features. Although many excellent regional studies have been carried out for the stream valley landscapes of the higher parts of the Netherlands, there is as yet no comparable overview. *A Guide to the Heritage and Restoration of Streams* (Bleumink and Neefjes, 2018) gives an overview over the current state of research on the water heritage and landscapes in the stream valleys of the Netherlands. Below are Dutch examples of the water-rich heritage sites listed on UNESCO's World Heritage list (www.werelderfgoed.nl).

The Netherlands was not always below sea level (Image 2). After the last ice age, some 11,000 years ago, the climate warmed up and sea levels rose. Behind the dunes and sand barriers, thick layers of peat and marshlands developed and these swelled along with the rising sea levels, eventually growing higher than the sea level itself (the brown areas on the left map of Image 3).

From the Middle Ages onwards, the peaty lands were intensively drained and reclaimed. Ultimately, the grounds dried out and the organic matter oxidized, the peat soils shrank and settled to a lower level – sometimes even below sea level. In many areas, layers of old peat were extracted to fuel the growing cities and, in some places, to extract the salt contained in the layers themselves. The IJsselmeer, the biggest lake in the Netherlands (encircled in Image 3), became even bigger because coastal peatlands were washed away by the sea. The peatlands in the delta of the Rhine and Meuse rivers also lost land to the water.

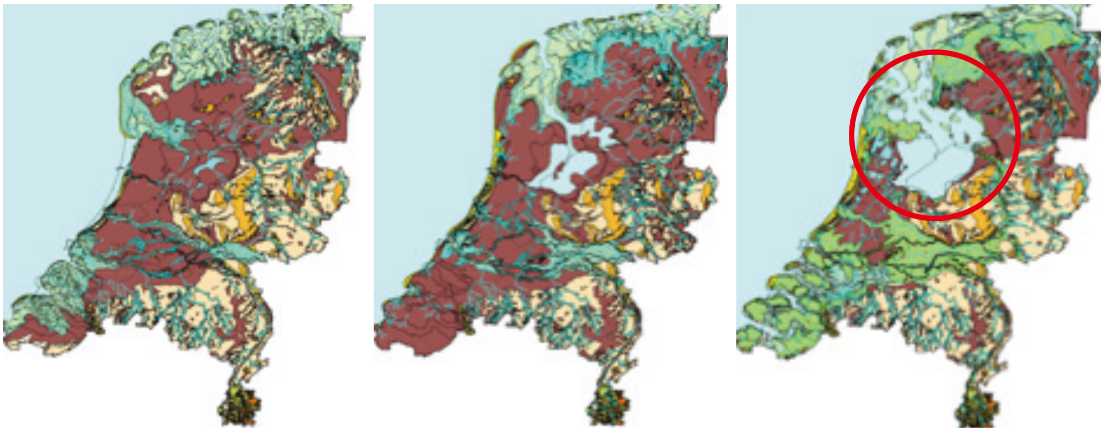

Image 3. The Dutch delta has been turned into a man-made landscape. Palaeontographic maps of the Netherlands (left to right): circa 3000 BCE, around the beginning of the common era, and circa 1500 CE (source: Vos, 2020).

Many villages, monasteries and farmlands were submerged. Dykes were needed to protect the remaining land. As the same dykes obstructed the natural drainage of water, water management became more and more complex. In order to coordinate the management, water authorities were established in the 13th century – and these are now considered to be the oldest democratic institutions in the Netherlands. From the 15th century, windmills were used to pump water away from the lower lands, and even lakes were pumped dry to create polders (Images 4 and 5). Within the dykes that protected these polders, more land sank to lower depths, even as deep as several metres below sea level. Around the turn of the 16th century, the Netherlands had truly become a 'land of water', not because this was its natural state but because the Dutch had made it so (see Image 6). Water heritage is what makes the Netherlands what it is.

Image 4. Since the 15th century, windmills were built to pump the water out of the polders. The nineteen monumental windmills at Kinderdijk were built around 1740. Kinderdijk was designated a UNESCO World Heritage Site in 1997 (Source: Beeldbank RCE / P. van Galen, 2010).

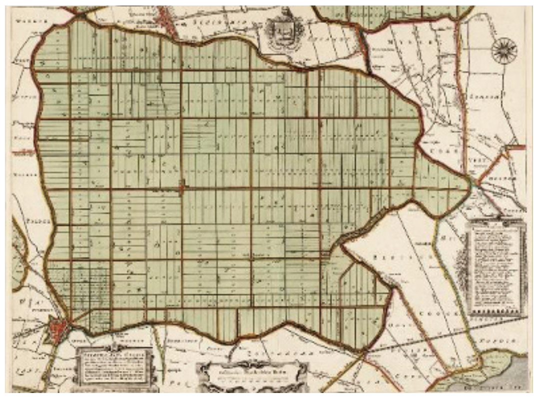

Image 5. De Beemster was an inland sea that continued to expand and overtake much of the surrounding peatlands. In 1612 it was pumped dry by 43 windmills. The fertile clay soil and rational parcelling turned the polder into one of the most productive agricultural areas in the world. In 1999 De Beemster was designated a UNESCO World Heritage Site. (Source: Beemsterlants Caerte, map of De Beemster engraved in 1658 by Daniël van Breen; source: Geheugen van Nederland; Kaartencollectie Provinciale Atlas, Publiek domein, https://commons.wikimedia.org).

Prosperous delta region

While water was often a threat, it was also a blessing. The proximity of the North Sea and the delta formed by the flow of important European rivers allowed the region to grow into an important trading centre early on. The Romans already used the Rhine as an important trading route and as a military zone of defence. At the beginning of the Middle Ages, the Dutch delta grew to become a vital hub in the Hanseatic League of cities and merchants,

Image 6. By the end of the 16th century, the Netherlands was a land of water, as can be seen on this map made by Jacob van Deventer in 1570 (Creative commons BY 3.0).

centred around the North Sea and Baltic Sea. From the 16th century, the Dutch delta, with its merchant cities like Amsterdam, Middelburg, Enkhuizen and Rotterdam, expanded into one of the most important centres of the burgeoning world economy. Colonial trade with the east – with countries like Indonesia, Formosa (Taiwan), China, Sri Lanka and Japan – was at the heart of this, and by the 17th century this had sparked unprecedented growth in the Netherlands. This prosperity is still in evidence in many historic Dutch city centres and harbours.

Constructed land

With the development of new technology and scientific innovation at the end of the 19th century, water became increasingly easier to control and the spatial configuration of the land became a means to optimize agricultural production. The 'art of engineering' took even greater flight in the 20th century. One of the most important steps was to close off the Zuiderzee from the North Sea and to reclaim parts of the land. After a flood in 1916, when the Zuiderzee coasts suffered the most losses, it was decided to build the *Afsluitdijk*, a 32-kilometre enclosure dam, and to turn much of the seabed into useable land. It is still one of the most ambitious land reclamation projects of all time. One by one the different polders were created, and these new lands are an example of the socio-cultural thinking about ideal rural planning. The initial approach concentrated on rational and efficient agricultural production by way of carefully designed model farms. Later there was more focus on recreational goals, experimental urban planning, and the development of a new wildness.

The Netherlands suffered another disastrous flood in 1953, mostly affecting the southwestern area of the country. This flood is still deeply engraved in the collective memory. It sparked another new, ambitious project – the Delta Works (Image 7) – which would close off the sea inlets for good and create higher and wider dykes. These works have become a prominent icon of Dutch hydraulic engineering, they still function as intended and have given the Dutch an international reputation as water engineers.

After the Second World War, the remaining agrarian landscape – much of which was still small-scale, badly drained and difficult

Image 7. The Oosterscheldekering is part of the Delta Works. The Oosterscheldekering has slider barriers that are only lowered at high tide. In normal situations, when the gates are open, the natural tidal dynamics are left undisturbed (Source: Beeldbank RCE).

to access – was rationalized in record time, though many historical landscapes, structures and parcellation patterns were partly saved. Post-war reconstruction projects involved unifying the many separate fragments of land, enlarging and optimizing the land-use, and straightening the many streams, creeks and drainage channels. Thanks to outstanding agricultural research and effective training programmes, the Netherlands grew to become one of the largest producers of agricultural products in the world. This tradition of modernization and innovation is part of the heritage and identity of Dutch water management.

New challenges

In February 1995, the Netherlands was, once again, rudely awakened by a near-flood disaster. This time the water flow from the great rivers towards the sea was swelling so quickly that the dykes were under threat of collapse and a quarter of a million people were urgently evacuated. The event was a wake-up call: for decades people felt safe behind the dykes, but now it became clear that an ambitious new project was needed to guarantee protection from flooding. This realization was further reinforced in the years that followed, when large parts of various regional water systems could no longer handle the increasingly intense precipitation peaks and many urban and rural places were subject to heavy local flooding.

The problems occurring in Dutch water management systems were partially caused by the first appreciable effects of climate change – though this was hardly an issue on the agendas of any political parties or lobby groups in the 1990s. In the Netherlands climate change manifests itself most notably through rising sea levels, wet winters, dry summers, and more intensified rainfall – and therefore through a greater strain on the water systems. In addition, the continuing rationalization of water management over the last century has had repercussions on the resilience of the system. All over the country during this time water became seriously polluted, natural waterways were channelled for faster drainage (leading to both flooding and extreme dryness), and areas of natural inundation were given less and less room. In the 1980s, a new movement took hold that advocated creating new nature reserves and areas where nature could take its natural course. With the near-disaster of 1995, the increasing effects of climate change, the ideas for a more resilient and natural water system, and the new concepts regarding nature development – all these issues resulted in an ambitious planning programme called *Room for the River*. The programme was the prelude to a new ambitious Delta Programme, which has now been implemented.

From conservation to development: New ways of dealing with heritage and historical landscapes

The Netherlands has a long tradition of protecting significant archaeological sites, the built heritage and historical landscapes. In the course of the 20th century, each field developed its own working method and its own conservation regime, but each maintained a central focus on building a scientifically valid collection and establishing good legal protection. In practice, this led to a predominantly sectoral and object-oriented approach, usually geared to preserving the original state. While this approach also contributed to the preservation of much water heritage over the past century, in the day-to-day practice of spatial planning, this protection-oriented approach often led to conflicts of interests or to the loss of authentic historic elements (and subsequently degraded significance).

From the 1980s onwards, a new approach gradually emerged, in which heritage was considered in a more integral and dynamic way, and more in its spatial context. The urgency of climate change in the 1990s – and other spatial challenges, like housing and infrastructure – made it extra clear that a review of the significance and use of historical water landscapes and water heritage was necessary. It became clear that water heritage and historical water landscapes have values that are not static, but are rather living landscapes which constantly need to adapt to the requirements of their time (Renes, 2019). Many historically cultivated landscapes and waterworks were still playing an active – and sometimes even vital – role in water management, land use and the economy. Pure protection and conservation were not an option. How could conservation and development be balanced?

Against this background, and building on new ideas about the nature and significance of heritage and historical landscapes, an interdepartmental government programme was launched in 1999 with the aim of connecting heritage to spatial development challenges, such as housing, nature development and climate adaptation (Nota Belvedere, 1999). The motto of this Belvedere planning policy was ‘conservation through development’. It was a ten-year stimulation and cooperation programme based on research, knowledge exchange and financial support for pilot projects. Water management was one of the spearheads of the Belvedere programme. It nurtured the development of numerous projects and sponsored seven regional water workshops which examined how water heritage could be linked to challenges related to water management and climate change.[2] Landscape architects played an important role in these workshops (see Project Bureau Belvedere 2004, 2005, 2007 and 2010).

The Belvedere programme made an important contribution to bridging the gap between spatial development and heritage. In 2011, a new national heritage vision was presented, building on the results of the Belvedere programme (*Kiezen voor karakter* – Character in Focus, 2011). This national policy vision did not focus on the sectoral valuation and protection of heritage, but on the question of how heritage could enhance the (historical) quality of spatial development projects. Water management and climate adaptation were, once again, important spearheads.[3]

In 2017, Janssen et al. analyzed these changes in the relationship between heritage and spatial development in the Netherlands and distinguished three different approaches: heritage as a sector, as a factor and as a vector in spatial planning (Image 8). In the sector approach, heritage professionals see spatial development mostly as a threat (stringent protection must prevent heritage from being damaged), while spatial developers see heritage primarily as a costly obstacle to new projects. The factor approach accepts that not all historical objects can be preserved in authentic physical condition to the same degree. Protection is then reserved for a selection of the most valued heritage objects. Within the factor approach, a more dynamic approach also gained ground, where heritage is seen as one of many factors that contribute to the quality of a place. Here, heritage is considered in its spatial context and a dialogue arises between the fields of spatial development and heritage. This shift took

[2] Well known projects are the re-discovery and re-use of military water lines for climate adaptation and regional development (see for instance Luiten et al. 2004 about the New Dutch Water Line), the ‘re-invention’ of the use of historical *terpen* (mounds) to protect agricultural properties from river floods in a modern ‘retention polder’, and the re-use of historical water meadows to retain discharge peaks, replenish groundwater, purify mineral-rich water and strengthen nature values (see for instance Baaijens et al. 2011, Brinckmann 2016 and Renes et al., 2020).

[3] Internationally, there is also a growing interest in water heritage and historical water landscapes as living landscapes and living heritage. This can be inspiring for regional development and actual water management challenges. See for instance the recent publication *Adaptive Strategies for Water Heritage. Past, Present and Future* (Hein, 2020).

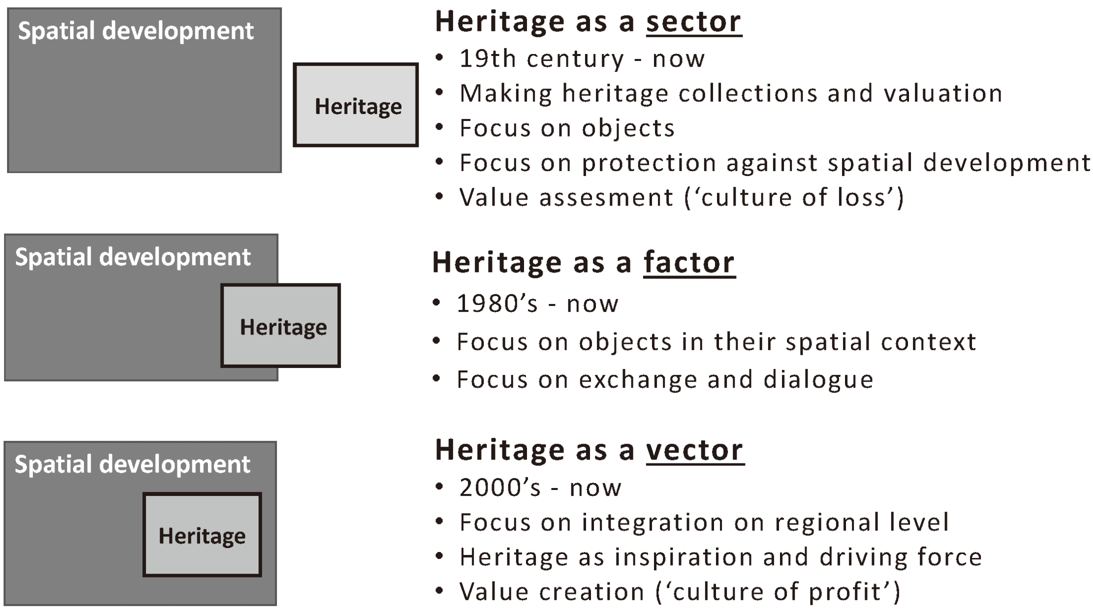

Image 8. The evolution of the Dutch heritage–planning nexus: changing views on the relationship between spatial planning and heritage and historical landscapes (after Janssen et. al., 2017).

place in a context of an increasing need for revitalization in heritage. In the vector approach, heritage is seen as an inspiration and quality impulse for spatial development. Heritage not only has a physical appearance, but also a narrative significance, meaning it tells us stories and speaks of traditions. The vector approach to heritage inspires and guides spatial planning in the broader sense, supplying it with a historical narrative. Being development-oriented and understanding the notion of continuity between present, past and future are key elements in the vector approach.

Janssen et al. (2017) show that these approaches may have been developed in a historical sequence, but the new approaches did not replace the old. They argue, rather, that the different approaches gained ground amongst different actors. Thus, three quite different ways of treating the past in the present coexist in Dutch planning practice.

The emergence of the landscape biography: A new tool to describe and analyze living landscapes

The new approach to historical landscapes as 'living' required a new methodology for analyzing and describing heritage and associated landscapes. The 'living' aspect refers to the layers of history and the continuous development of landscapes into the future, but also reflects a context in which built heritage is increasingly understood in relation to its specific landscape. A biography of a landscape can then become a useful a tool. Developed more or less simultaneously within the context of new thinking about heritage, the landscape biography has indeed become a particularly appropriate instrument in spatial planning. This type of biography has already become popular in Europe, North America and Australia, both among conservation specialists and planners, policy-makers and the general public (Kolen et al., 2018).

In their 2015 book *Landscape Biographies: geographical, historical and archeological perspectives on the production and transmission of landscapes*, the writers Jan Kolen, Hans Renes and Rita Hermans describe how the concept of a landscape biography was conceived some 40 years ago by American human geographer Marwyn Samuels. In 1979 he published an essay on the history and identity of urban landscapes, like those of Shanghai and New York, from a new perspective: the relationship between the history of life in the city and the histories of the individuals who have lived in and shaped the city. Samuels saw landscape not as an anonymous physical entity of roads, bridges and buildings, but as a constantly changing fabrication of human dreams and deeds – by those who live and work there. People are not just the users of the landscape, but also the shapers of it. Landscapes are authored by people; by the same token, landscapes are the shapers of dreams and deeds.

Roughly parallel to this thinking, new ideas about how (archaeological) objects and landscapes acquire new meanings through the ages were developed in Europe in the early 1990s, as Kolen et al. (2015) show.[4] Moreover, a biographical approach to an object or landscape was a more appropriate way of capturing the layers of history than a static description of the original significance or simple explanation of its origins. Landscapes, and the significances attributed to them, are always changing. In the Netherlands, and internationally, many landscape biographies have already been published – in all shapes and sizes, including a diverse range of themes, scales and methodologies. These biographies can result in comprehensive books, following years of archaeological, geological, historic-ecological and historical-geographical research. *De landschapsbiografie van de Drentsche Aa* (Spek et al., 2015) is perhaps the most well-known Dutch example of this. Some landscape biographies are written to appeal to a broad public, though are still well-grounded in scientific research, and

[4] Kolen et al. (2015) argue for instance that prehistoric monuments often are very durable, still surviving in the present-day landscape. They “archieve rich and complex histories through a continuous process of re-use and re-interpretation”.

others are written to serve policymakers, water experts or spatial planners – often those working on a specific assignment regarding new policy or design projects such as an urban area redevelopment, environmental development, climate change adaptations, or even a combination of these (see Image 9). Landscape biographies often deal with specifically delineated areas or landscape structures such as National Parks, stream valleys, polders or waterways. However, Kolen et al. (2015) also list less conventional international examples like the Avebury prehistoric stone circles, a shopping street in Breda, the Carlsberg factory complex in Copenhagen, and even a famous painting by Piet Mondrian: *Victory Boogie Woogie*.

Image 9. The IJsselmeer is the largest fresh water reservoir of Northwestern Europe and one of the most iconic spatial historical waterscapes of the Netherlands. It used to be the Zuiderzee, an inland sea that was partly reclaimed during the 20th century. Government parties are working on the IJsselmeer Agenda 2050, integrating challenges on sustainable energy production, housing, tourism, fishery, water safety and sea level rising. With the landscape biography, the Dutch Agency on Cultural Heritage provided historical knowledge of the IJsselmeer, that could be used as a basis for spatial development (Neefjes and Bleumink 2017). One of the four main characteristics is that the former Zuiderzee is the cradle of the nautical history of the Netherlands. In historical harbours, like Hoorn, one still finds a high concentration of water related heritage. (Picture: Jan Neefjes).

Features of landscape biographies

A landscape biography is not a well-defined, uniform, scientific method, but a collective term for a more layered and development-oriented approach to landscapes. And yet, all landscape biographies do share certain features, to lesser and greater degrees. The most important of these are[5]:

<ins>Interdisciplinarity and integrity.</ins> In a landscape biography, topics like geology, hydrology, geography, ecology, archaeology, architectural history and art history are brought together and presented as a whole history. Other cultural traits of the region can be included too, such as traditions and identity-relevant aspects.

<ins>An understanding of the interaction.</ins> The interdisciplinary and integrated approach allows for sharper insights into the

[5] This overview draws on a presentation (and later publications) by, among others, Theo Spek, Hans Renes, Jan Kolen and Jan Neefjes during a network meeting on 8 March 2019: *Landschapsbiografie in de praktijk*. See also Woestenburg (2019), Rijksdienst voor het Cultureel Erfgoed (2018) and Meijles and Spek (2009).

interactions between humans, nature, water and landscape. Such interaction is usually not one-sided, but complex and reciprocal: e.g. human interventions influence the water system, the ensuing changes influence land exploitation and habitation, and subsequently inhabitants undertake new interventions, etc.

Long-term perspectives and layered histories. A landscape biography sees change as a constant factor. Landscapes and (historical) objects change in shape, use and significance over the course of time, so their understanding as heritage cannot be limited to a static moment in time. Instead of engaging with them from a conservation perspective, landscapes are seen as living and layered places that are subject to change – also in the future. This means that a landscape biography focuses on formulating the historical spatial characteristics, rather than compressing the characteristics into an inert definition on significance.

Recognition of the 'authorship' of landscapes. Historical landscapes and buildings are not anonymous artefacts, but were made or sometimes intentionally designed by people. The story of the IJsselmeer polders is also the story of visionary engineers, designers, utopian artists and hard-working farmers. Throughout history, furthermore, our views on historical landscapes and whether we consider them important have changed by the era. The painters of the 19th century, with their romantic notions and impressionistic depictions of the fishing or farming life, introduced a new perspective on the Dutch coastal and farming landscapes – and so, to a great extent, paved the way for the growth of tourism (Neefjes and Bleumink, 2015).

A combination scientific knowledge with local knowledge. Landscape biographies are often set up in cooperation with local historians, societies and interested individuals or via citizen science projects in which specific local knowledge on the history, landscape and ecology of the area is combined with (the results of) scientific research. The interaction between local knowledge and scientific expertise increases the depth of a landscape biography and ensures greater engagement among residents with their environment.

Geared to current and future use. Perhaps one of the most important aspects of a landscape biography is its capacity to give readers and users insight into the rich, layered history of a landscape. Almost always a landscape biography is produced with a specific goal in mind and within a specific policy context – for example, when there are major urban planning interventions on the horizon or when education or recreation sectors require an appealing story about the history of the region.

Engaging, inspirational and accessible. A landscape biography translates scientific research into attractive maps, reconstructions, photographs and images that bring the past to life. Ideally it is not confined only to the academic field or policy world, but also appeals to a broad public.

Hydro-biographies

Many Dutch landscape biographies emphasize the power of water to shape the environment, the human interactions with water, and the consequences of these aspects for historical landscapes, historical waterscapes, infrastructure and water heritage. In these biographies, water-related landscapes like streams, rivers, sea inlets, polders, coasts, canals or harbours are given a prominent position.[6] In many ways such biographies can be considered hydro-biographies (or water biographies), though the scope of landscape biographies extends beyond water heritage alone.

Two Dutch biographies have been positioned as actual hydro-biographies: a biography on the former island of Marken (Van der Vegt and Kooiman, 2014) and one on the Scheldt estuary (Bosch and Sorée, 2016). Both were commissioned by the Council of Government Advisors, an independent body providing solicited and unsolicited advice to the government on current and major planning issues such as climate change adaptation and sustainable energy production. The water focus of these biographies has to do with the fact that they were written specifically for policymaking objectives regarding large-scale water safety projects. Both hydro-biographies therefore extensively examine the development of the landscapes related to water, and the way in which people have dealt with water and its threats over time. The identification of historical landscape principles (dykes, mounds, flatlands, sludge layering) informed the recommendations for the future by describing how the historical principles can be applied to present and future water challenges. It is not the methodology that distinguishes the hydro-biography, but primarily the theme, limitation and policy context – just as every landscape biography will have its own focus.

Landscape biographies in Dutch practice: A bridge between the conservation of heritage and spatial planning development

While a landscape biography is not an

[6] See for instance *The Polder Atlas of The Netherlands* (Steenbergen et al., 2009), *De ruimtelijke identiteit van de Nederlandse kust* (Neefjes, Bleumink and Strootman, 2011), *De Cultuurhistorische Atlas van de Vecht* (Neefjes et al., (ed). 2011), *Atlas van de Schie* (Abrahamse et al., 2011), *Atlas van Amstelland* (Abrahamse et al., 2012), *de Landschapsbiografie van de Drentsche Aa* (Spek (eds.), 2015), *Cultuurhistorische biografie van het IJsselmeer* (Neefjes and Bleumink, 2017), and the landscape biographies for some water-rich National Parks (Schroor, 2018; Timmermans, 2018; Neefjes, 2018a).

official instrument or a requirement in Dutch planning or heritage practice, over the past twenty years, the landscape biography has grown into an innovative, integrated and appealing way of making the story of the history of the landscape of a particular area accessible to a wide audience. Landscape researchers such as Jan Kolen, Theo Spek and Hans Renes have introduced, developed, substantiated and further developed the concept (Hiddink, Kolen & Spek, 2001 and Kolen, 2005 and 2007), and done so by applying landscape biographies in practice. For many planners, designers, policymakers and site managers, much of this knowledge had been difficult to access, while it was these groups who were working on the future of heritage and landscape. A landscape biography shows the historical connections and stories, to uncover the historical stratification and to highlight the logic of the landscape.

A key factor behind the upsurge in landscape biographies is the fact that the Dutch government has been working on a new, integrated planning process, laid down in the new Environment and Planning Act expected to take effect in 2021. The intention of this law is to simplify and streamline the rules regarding urban and rural development. Central to the new rules are landscape analyses, the integration of heritage and historical landscape elements, and a prominent place for participation and feedback from citizens, businesses and societal organizations. This leads to the making of integral regional planning visions, which provinces and municipalities are required to develop by the new Environment and Planning Act. Regional planning visions lay out the framework for future development, the environmental ambitions (nature, water, etc.), and the policies regarding landscapes. A landscape biography functions as a connector between all of these elements and in planning circles it is increasingly accepted and valued as a tool to understanding the landscape. More and more it is being used as the foundation on which the regional planning visions are built.

The Dutch Cultural Heritage Agency (*Rijksdienst voor Cultureel Erfgoed*, RCE) has used recent policy publications (e.g. on the IJsselmeer and on National Parks) to raise national awareness of this new planning approach and, more importantly, to demonstrate how landscape biographies can inspire and bolster development directions in historical landscapes. The National Parks Agency which supports the modernization and enlargement of existing national parks has made it a requirement to write a landscape biography when applying for the status of a new National Park. The designation of a new national park will therefore also consider the identity of the landscape as influenced by people. Nearly all nature reserves in the Netherlands bear traces of human intervention. Often the value ascribed to natural and ecological processes in the national parks only came about through or were strongly influenced by human actions.[7]

At this point, it is still too early to assess whether landscape biographies and hydrobiographies have truly and positively impacted the shaping of our future environment and of water management in this country. Nonetheless, numerous examples from practice have shown that a landscape biography is an inspiring and promising instrument. On the basis of the Dutch experiences, we can identify that a landscape biography:

- provides a shared starting point and builds bridges between different disciplines;
- brings parties together, unites them in a shared history;
- helps to see contemporary challenges in a historic way: a longer and wider view;
- helps to understand the logic of the landscape;
- provides inspiration for future developments;
- helps to focus on the core characteristics;
- supports local participation and education;[8]
- provides the historical landscape and heritage sector a place at the planning table.

The question of whether a landscape biography will actually be used by all professionals and whether it can fulfil its potential is partly dependent on the circumstances and policy context. If heritage experts keep their focus on valuing a static significance and conserving buildings and places, and if planners, policymakers and water managers keep viewing heritage mostly as a burden and expensive obstacle in realizing their plans, then landscape biographies will have a difficult road to travel. The implementation of landscape biographies in the Dutch context reveals that a development-oriented, integrated approach to heritage and historical landscapes requires

[7] Since 2015, governments and interest groups have been working to renew and strengthen the Dutch National Parks. The aim is to make the existing parks more robust, give them more allure, imbed them in the surrounding landscape and connect them with the regional economy. Unlike many other countries, where human influence on the natural system is relatively limited, the Dutch National Parks have a long history of human use. Some National Parks even owe their existence to man-induced disasters, like flooding or soil depletion. This has contributed to the landscape (and often also ecological) wealth of these areas, and to the appreciation by the public. Because even a lot of professionals are not much aware of these cultural roots, the Dutch Agency for Cultural Heritage started to support the National Parks with a landscape biography programme (see Neefjes, 2018 a and b; Schroor, 2018; Timmerman, 2018).

[8] The project 'Gewaardeerd Landschap' ('Valued Landscape'- Roetemeijer et al., 2019) investigates how landscape biographies can be used as an instrument to involve residents in the valuation and future design of their (historical) landscape.

perseverance. Yet we are convinced that also in the persevering, landscape biographies can play an important role in making connections between different worlds.

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One water - Multiple landside interventions: Understanding the networked heritage of port and waterfront

Carola Hein

Introduction

Historically, port and city were intimately connected, but with industrialization the two grew apart. Starting in the 1960s, cities constructed new ports outside their limits to accommodate large container ships; later, they revitalized the inner-city waterfronts that shippers had abandoned. This resulted in the functional separation of industrial shipping in the port from water-related activities for urban populations. Similarly, the people who planned or studied the port were often not in conversation with those who planned or studied the waterfront. Planning-related professions and fields emerged to variously study, redesign, and document port or waterfront urban activities and spaces - but rarely both. Though water is the single physical substance that connects these domains (the port and the waterfront), academics and professionals alike treat it very differently in each place.

This article explores planning and planning history literature in regard to two separate spatial entities after 1960: the working ports and the post-industrial waterfront. It explores several foci of planning: first, a willingness to improve the speed, safety, and logistics of the port with the use of water as an agent of industrialization; second, a desire to increase aesthetic and symbolic as well as leisure-related roles of water on the waterfront; third, the recent reconnection of cruise shipping with inner-city waterfront redevelopment, water-related heritage, and the coastline in general. In conclusion, the paper highlights recent attempts to plan for port and city in conjunction with each other. It argues that integrated approaches need to coincide with a comprehensive study of the common environmental and ecological role of water in ports, waterfronts, and port cities as a common resource and potential risk. Such an approach is also essential to the discussion on water and heritage as also discussed by several authors in the book Adaptive Strategies for Water Heritage: Past, Present and Future (Hein, 2019).


Image 1. London Docks with Sail ships in 1810 (Thomas Rowlandson, Augustus Charles Pugin).

Modernizing ports and waterfront revitalization

Controlling water, transforming water and landside structures of the port was a key to port survival and an issue of national importance. Once rivers and shores became too crowded, rendering transhipment impractical, governments and shipping companies built new docks to control water height despite tidal changes (as in London), and tidal harbours to allow for unloading despite changing river levels (Pudney, 1975) (Image 1). The Report of a Royal Commission established in 1900 to study the administration and facilities of the Port of London found that the port had failed to keep pace with the developments of the population and of commerce and that innovation was necessary, stating "We are, however, convinced that if in this great national concern, energy and courage be shown, there is no reason to fear that the welfare of the Port of London will be permanently impaired" (Owen, 1934, p. 151).

Industrialization in the 19th and 20th centuries led to the creation of mono-functional areas. It brought ever bigger and more specialized ships—sailing ships yielded to steam ships, and multifunctional transporters were superseded by container ships and oil tankers—in turn transforming the ports and related cities to which these ships travelled (Miller, 2012). New technologies and means of transhipment—such as bigger cranes but also the construction of railway lines next to the shipping facilities – also pushed cities and shippers into recurrent reconstruction of port facilities. Mono-functional areas for shipping, administration, and housing replaced the formerly integrated multi-functional buildings. Urban rebuilding, such as for the warehouse and later the office district in Hamburg, destroyed the narrow streets of old housing districts, for better and for worse - these had been the sites of major outbreaks of cholera—a water-borne disease, to which port cities were particularly prone- even as they were also distinctively picturesque (Kenealy, 1894).

As ports moved to new locations, often on the outskirts of metropolitan areas, new specialized professions focused on ongoing developments in the port and on the traditional inner-city waterfront, as documented in extensive and different sets of publications. Focusing on ports' new extra-urban locations, these port professionals, logistics scholars, and economists studied and designed waterways to facilitate shipping, transhipment, and storage (Ducruet, 2016; Song, 2015; Notteboom, 2009). Engineers, managers, and planners were concerned with the design and managements of harbour facilities, with storage sites and diverse water technologies (Ligteringen, 2012; Burns, 2014; Brinkmann, 2005; Binns, 1934, pp. 102, 163-170). Meanwhile, upon the departure of the port from traditional waterfronts, many city governments used the opportunity to redevelop the former inner-city ports, taking advantage of water access and historical buildings for renovation and branding of their cities. They aimed to reconnect people to water and to enhance local identities by celebrating their port histories with water-related events like harbour birthdays, cruise days, and historic sailing ship parades. They made facilities originally destined for port industries into water-related heritage sites or leisure and tourist venues.

Port and city continued to detach until the mid-20th century; the most important split between the two occurred after the 1960s. The following overview of the respective literature on port and waterfront planning since containerization, shows that while water as a physical object is present in publications on ports and waterfronts, scholars have focused on disparate characteristics of water, functional and symbolic ones respectively. In fact, it demonstrates that practitioners and scholars have ignored the role of water as a common facilitator for multiple areas within the city. But attention to common interests and needs is required for addressing issues of sea-level rise and climate change. As it turns out, the study of planning also reveals that ports and port cities have a long history of responding to water-related disasters including changes in sea-levels, the accumulation of silt, and flooding—a highly relevant topic today that merits further attention, both in terms of historical events and future planning—and one that ought to be discussed throughout for the whole coastline (Luo, 2015).

New ports since the 1960s: Water for global transport of goods

Over the last five decades, public and private decision-makers around the world built new ports and facilities for the increased transhipment of goods and people, responding to similar challenges and opportunities, developing new ports, dredging waterways, transforming storage and transhipment in response to changing ship sizes, new containers, and new commodity flows. They transformed water at an industrial scale.

The construction of new ports on the outskirts of cities that started in the 1960s in conjunction with containerization exemplifies the understanding that water is a facilitator of the transportation of commodities. As numerous scholars have pointed out, containerization led to wholesale restructuring of shipping networks, trade patterns, port facilities, port city hierarchies, and urban form (Levinson, 2010). But despite the globally identical catalysts for the creation of new ports, and the common role of water, the history of their construction has been dealt with in individual stories rather than as an interconnected story (Robinson, 1981; Schenker, 1968).

Such an integrated story would explore how, from the late 1960s to the late 1970s, ship sizes increased, passing the barrier of 50.000 tons gross, requiring deeper waterways and bigger harbours, and transforming port cities around the world in their wake (Hayuth, 1982, pp. 219-224). Ships, as global water-borne connectors, require the same conditions and facilities in all ports that wish to host them around the world. As few ports were able to handle container, oil and bulk carriers of increasing sizes, city governments, port authorities and shipping companies from New York, to London and Hong Kong, developed new terminals on the outskirts where deep water was available.to maintain their city's edge in a tight competition, creating new waterlines with long quays, deep-water berths bordered by cranes and next to large asphalt-covered surfaces for container storage with good hinterland infrastructure connections. On August 15 1962, the Port Authority of New York and New Jersey opened Port Elizabeth

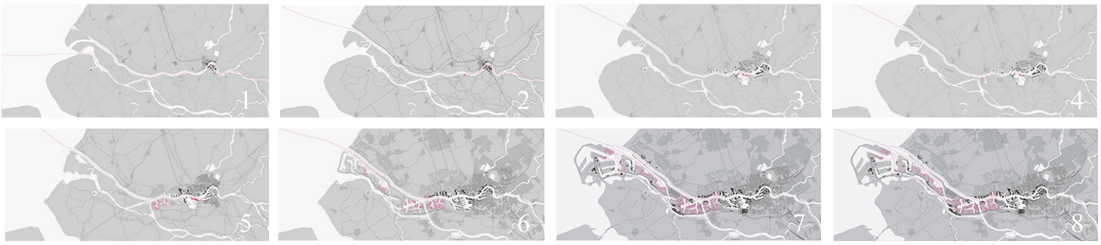

Image 2. The transformation of the Rotterdam port during the oil revolution, 1862, 1882, 1930, 1936, 1950, 1964, 1972, 2015 (Carola Hein, Bernard Colenbrander, Alexander Koutamanis - CC BY NC SA 4.0).

as the first container terminal with five berth and 18,6 hectares and had expanded to 26 berth, 22 and 307 hectares by 1977 (Pinder, 2004). Another examples of the effect of the relocation of cargo facilities is the decline of the Port of San Francisco, which was limited by its existing finger piers and topography, and the rapid development of the Port of Oakland, where the first containership arrived in 1962 and which offered dedicated container facilities and good access to transportation (Port of Oakland).

The new facilities would come to resemble each other across the globe, each changing the waterfront of large areas mostly on the outskirts of existing cities. Among the European ports, Rotterdam had historically improved its water connections, notably through the construction of the Nieuwe Waterweg in 1872 from Rotterdam to the sea. It was one of the first to receive a container ship, the Sea-Land container carrier Fairland in 1966, and to adapt its port. Reshaping the Maas River and extending the port towards the sea became a major part of the city's post-war growth as a global port and transhipment point towards the German industrial areas, a story that has been discussed by several Dutch authors (Schoor, 2013; Schraver, 1948; Walsum, 1972). Notably the growth of Rotterdam as an oil port transformed the river's path, the water's edge and the form and depths of water basins (Image 2). The success of Rotterdam is also intimately related to its connection by rail and barge to the large inland river container terminal Duisburg, a status that is notably explored in promotional literature (DeCeTe Duisburg).

Today, Rotterdam holds the first place among European ports, before Hamburg (15th), Antwerp (16th) or London (107th), all three cities that are located on rivers and limited in regard to the size of ships they can accommodate (Laar, 2004). Antwerp a long-term competitor of Rotterdam, received its first container ship in 1966 and is now receiving oil through pipelines from its Dutch neighbour, replacing water access through land lines (Cabouret, 1977, pp. 375-384; Groepering Der Havenbelangen 1969; Schoonhoven 1958;

Image 3. HHLA Container terminal. Handling a container ship at the Altenwerder terminal (HHLA. http://hhla.de/en/photos-films/picture-galleries/container/detail.html?tx_otoldnewgallery_pi1%5BshowUid% 5D=1393&cHash=5aa4155b082e46f03c6dd311609034fc).

Wellens 1988; Blomme 2002; Winkelmans 1971; Schubert, 1997). The Hamburg port, including the first container terminal in Hamburg, on Burchardquai opened in 1968, has extended South of the River Elbe. Several traditional villages had to leave to make room for new container terminals, leaving only a historical church as reminder of their historical presence (Image 3, 4). Today the container port has become a local scenery and touristic attraction separated from the city by the breadth of water (Amenda, 2006, pp. 137-158; Driesen, 2010; Gerckens, 1978; Grobecker, 2004; Kamin, 2005; Kludas, 1988; Moltmann, 1986). In Australia, Botany Bay developed in the 1970s some ten kilometres south of the city centre. Here, as in many other locations, the government and other powerful entities behind the construction largely disregarded the communities already living where the container terminals would be built (Tull, 2006). In the Thames River, the Tilbury docks that served the London port and originated in 1886 were restructured for container service by 1970 (Port Cities London). A new deep-water terminal, London Gateway in Thurrock, Essex, is under construction even further from the city centre. While located on the

Image 4. The Altenwerder Church, the only reminder of the historic village replaced by the container port expansion (Jolan Dhuique-Hein).

same river, the site will be largely under the control of authorities other than the city and thus also beyond the reach of plans by the Mayor of London to ensure that the city's future development meets new criteria of sustainability and social equity (Mayor of London, 2008; Hein, 2014, pp. 339-361).

Just as governments and other actors ignored the people in the way of the terminals, they disregarded questions of water quality, waste management, ecology, and heritage structures and landscapes. Economic growth and improving the connection to the water took precedence in these big port cities – a central, shared goal that becomes visible when we look at the literature comparatively. Whereas ample planning-related publications exist on each location, writings that study the port and water related developments in a metropolitan or regional context appear to be missing.

Thanks to the adaptations of diverse bodies of water, to coastline transformation and new port constructions, and to urban adaptations, global maritime traffic flows have facilitated the increase of global production and consumption patterns. Global trade is visible in the huge number of containers that circle the earth as well as in urban growth. The World Bank counted a little over 651.000.000 transhipments of 20-foot container units in 2013 (World Bank). The leading container ports are now located in Asia and the Middle East and the huge ships that dock there connect to Europe and America. New ports have emerged notably in China, where many goods originate and where leaders since the 1970s have emphasized the growth of ports. A look at economic statistics on leading global ports published by the American Association of Port Authorities (AAPA) in 2013 shows Singapore and Shanghai as ranking respectively first and second in terms of TEU and total cargo volume—at least partly a result of their particular water access (World Port Rankings, 2013). They are followed by several other Asian, mostly Chinese cities. These flows of goods carried by container on water are in addition to the enormous flows of bulk goods, such as petroleum and its products (1800 million metric tons in 2014 in crude oil) carried by ships.[1]

Increasing ship sizes require deeper waterways or ports that are built into the sea—further illustrating the industrial dimension and engineering of water in ports, and the common catalysts shaping far flung locations. Deep-water ports are defined as ports that can accommodate the largest ship that can cross the Panama canal's locks, so-called Panamax ships. New deep-water ports have been constructed, for example, in China, such as the Yangshan deep-water port near Shanghai that is connected to land over the new Donghai Bridge, more than 30 kilometres (18.6 miles) long. It hosts a gigantic container terminal on a man-made area between two islands. To benefit from economies of scale, traders keep ordering bigger ships, pushing the deepening of ports and waterways and the raising of bridges in Miami, New York, Seattle, and other cities around the world. With the completion of the Panama Canal expansion expected in 2016, even bigger ships, the so-called Super-Panamax ships, will require many cities to rework their ports; discussions about the changes required are already underway in port cities on the American East coast such as Savannah, Georgia (Ramos, 2014, pp. 36, 32-41).

Bodies of water also intimately related to the global exchange of energy, notably of petroleum products. Again, research on individual cities abounds, but comprehensive studies of the interrelation of planning for oil ports and the role of water therein are missing. A comprehensive history would consider the numerous new ports developed for oil shipping. The development of

[1] Transport volume of crude oil in global seaborne trade from 2009 to 2014 (in million metric tons) http://www.statista.com/statistics/264013/transport-volume-of-crude-oil-in-seaborne-trade/

Rotterdam from 1862 until today reflects the ubiquitous growth of petroleum storage, refining and transport particularly well (Hein, 2015a, pp. 27-31). Another example of oil-related port redevelopment is Port Harcrout after 1958 in Nigeria (Klieman, 2012, p. 99; Ogundana, 1972, pp. 62, 110-121; Shneerson, 1981, pp. 15, 201-216). Oil income led the Nigerian government conceive and construct the new inland capital city, Abuja; and the oil economy triggered the growth of the port of Lagos, through which consumer goods and raw materials entered the country.

Petroleum shipping transforms cities around the world, but so far, little attention has been given to these networked changes in places with and without oil (Hein, 2011b). Petroleum has redesigned places on strategic water sites even in the absence of oil sources, as evidenced through the emergence of Singapore as an oil hub. Thanks to its location near one of the choke points in global shipping, the Malakka Strait, its political status as a former British colony, and a small city-state with friendly relations to its Asian neighbours, Singapore has become a major oil hub after the construction of Singapore's first oil refinery on Pulau Bukom in 1961. But the local availability of oil and the possibility of selling it around the world was a major criterion in the design of Jebel Ali in Dubai. The sheik used foreign ideas and consultants for engineering, planning and architecture (including concepts for company towns) to reinvent and re-imagine the port city at an unprecedented new scale (Ramos, 2010). A deep-water port for oil transport exists notably in Louisiana. The Louisiana Offshore Oil Port serves supertankers since 1981 and is located in the Gulf of Mexico southeast of Port Fourchon. While pipelines carry oil from Russia to Europe or from Canada to the US, water transportation provides more flexibility; and going on the oceans is cheaper than flying over them. The emergence of new oil ports suggests that global oil flows continue to be carried by water. New waters will open as the sea ice melts, and the possibility of new shipping lanes will create numerous political challenges that are already in the news. Climate change and rising waters are already changing some port cities, yet another common theme that merits comparative investigation.

Waterfront revitalization and water as leisure and identity

Meanwhile, New York, Hamburg, Amsterdam, Philadelphia, and Sydney lost their identity as global ports. If new ports were booming in similar ways, it was because shippers and other stakeholders had abandoned older ports, which now suffered in common. The old waterfronts became ghost districts, challenges to urban development. Filled with industrial

Image 5. The Skyline of Baltimore Waterfront: Inner Harbor and sport field from Federal Hill, 2006 (Aneese / Dreamstime.com— Baltimore Inner Harbor Photo).

structures, including refineries and waste, these sites were often connected to polluted waters and needed major investment for redevelopment. Many cities had to develop new strategies for these now-empty inner-city ports and for the many people who had lost their jobs in packaging, transportation, and storage. This planned restructuring of traditional waterfronts occurred almost simultaneously around the world and is studied extensively mostly through individual case, and only a few publications can be mentioned here to suggest the larger picture (Smith, 2012; Marshall, 2001; Breen, 1996; Desfor, 2010; Ware, 2013; Schubert, 2009).

Waterfront (re)development emerged as an anchor project for urban redevelopment—whether focused on business, leisure, or multi-functional development—as models of regeneration of brownfield areas, with a special heritage appeal through the preservation and reinterpretation of traditional port infrastructure and the reuse of the water for locals. Local presses have often touted these revitalizations, celebrating water for its aesthetic appeal to residents and tourists, that is, as a setting or background: the long views it provides, the promenades along its sides, the approach across it towards new construction. They celebrate the history of the site through preservation of heritage buildings, discuss the design and events of the public spaces, and occasional events and uses of the water, such as for heritage ships, ferry landings, pleasure cruising, cruise ship events, harbour birthdays or other water-based celebrations such as Baltic Sail, a maritime festival around the Baltic Sea. Aquariums in several cities, Baltimore, Osaka, or Genova add a touristic and educational component linked to water and the local environment. (Image 5) Water quality, or the recreation of local marine habitats or water systems, appears mainly when they contribute to the use of the site. Water quality issues may mean clean-up of oil spills and other industrial waste, as the case of the Newtown Creek waterfront suggests: here 17-30 million gallons spilled from historic refineries. While projects such as the river revitalization of the Cheonggyecheon in Seoul also have tactile qualities, those are less relevant for seaport cities, where the river is less accessible and not made available for play or swimming (Busquets, 2011).

A large number of former seaports have remade their inner-city waterfronts; the literature on these transformations mostly deals with individual cities; it is so extensive that only a few sources can be indicated here (Bone, 1997; Brown, 2009; Hoyle, 2002, pp. 2, 141-162; Sepe, 2013, pp. 28, 595-613). Inner-city waterfront transformations in North America and Europe include Baltimore, New York, Vancouver, Boston, Portland, Seattle, Miami, London, Hamburg, Barcelona, Genova, Lisbon, Sevilla, Helsinki Bilbao, Liverpool, Dublin to mention just some. In Asia, Shanghai, Sydney, Osaka, Melbourne stand out.

The celebratory character of much of this literature is balanced by a few commentaries that speak to the socio-economic issues associated with urban renewal of a waterfront area and the impact of that work on the city as a whole. Thus, researchers have studied Baltimore as the model for waterfront regeneration around the world; they have also considered its impact (or the lack thereof) on the city as a whole (Ward, 2006). The revitalization of the Docklands in London has similarly seen celebratory and critical scholarship (Barker, 1986; Brownill, 1994). Occasionally do scholars raise questions about socio-economic transformation beyond physical ones and the role of social justice or the commodification of historical heritage, often in response to the redevelopment of waterfronts as part of exhibitions or mega-events, as in Sevilla, 1992, Barcelona (1992 and 2004), Genova (1992 and 2004), Lisbon (1998), Hamburg (2013-15) and even in applications to host such events such as in Hamburg for the Olympics (Wilson, 2001; Carnevali, 2003; Iba Hamburg, Hamm, 2010; Hamburg, Bauausstellung IBA, 2010).

But there are new waterfront adaptations beyond Baltimore and established European, American, or Australian models. Abu Dhabi, Saudi Arabia, Qatar, and Manama are imagining and building entirely new waterfronts, focused on upscale housing, tourism, culture and leisure activities, on land reclaimed freshly for this purpose.

The palm islands in Dubai, for example, resemble other artificial islands, such as Port Island and Rokko Island in Kobe, built in the 1960s to provide new port functions, housing, an amusement park, and sport facilities (Lafrenz, 2001). Similar land reclamation projects in the Tokyo Bay in Hong Kong and other cities provided space for new developments, including housing and a multitude of business, commercial, and cultural functions. Occasionally cities have renaturalised areas such as the Kasai Rinkai Koen, the largest park in central Tokyo and located close to Tokyo Disneyland on reclaimed waterfront land. The area aims to recall the natural habitat of Tokyo Bay and the Tokyo Sea Life aquarium located in the park features aquatic habitats from Tokyo and the world. The Marina Bay redevelopment in Singapore on reclaimed land is yet another facet of waterfront redevelopment. The annual revenue from oil and gas ($325 billion in 2006) affords the Gulf countries a financial foundation from which to reform their local economies, rebuild cities, and invent new urban futures (Boer, 2007). In Saudi Arabia, for example, the world's single largest supplier of oil plans to use oil profits to construct six economic cities worth over $283 billion and covering 430 million square miles.[2] One of these, the King Abdullah Economic City, will be a port city with not only a seaport but an industrial district, a financial centre, a residential zone with 150,000 apartments, and an educational development for 15,000 students.[3]

Waterfronts have been built and rebuilt over centuries, for shipping and for leisurely purposes and they continue to attract investments. Particularly locations facing the sea, with their impregnable views, are among the most appreciated real-estate sites. Engineers, elites and citizens have long gained experience in controlling and orienting water and developing new technologies, contemporary interventions occur mostly independently from each other and don't consider water as an encompassing entity. Questions of animal and plant life in the rivers and oceans around ports and urban waterfronts are only getting passing attention, even though such discussions occur regularly regarding waterfronts in natural or vacation sites (Berens, 2004).

Reconnecting port and waterfront: Water for pleasure cruises

Water transportation today is not only about efficient and economic movement of goods in containers or in bulk, but also about bringing people to new places,

[2] On King Abdullah City, See http://www.Kingabdullahcity.Com/En/Home/Index.html
[3] See Saudi Arabian General Investment Authority, 2007-2008, March 2009 http://Sagia.Gov.Sa/English/Index.php.

including revitalized waterfronts. People continue to travel by ship, for example, on ferries connecting islands within one nation, or crossing the Baltic and other seas for daily life purposes (including migration). Additionally, the number of people traveling for pleasure on cruise ships grows steadily. What was traditionally a pastime for the wealthy has become a mass adventure. Before World War I, at a time when the Hamburg based Hapag shipping company conveyed millions of immigrants from Europe to America, its director Albert Ballin, was developing the first custom-build cruise ships. Its draw grew steadily until World War II meant a suspension of such activities.

By the 1980s, when waterfront revitalization was expanding, cruising was starting to pick up again. Revitalized waterfronts and events provide the necessary attractions for tourism. In turn, the ships bring port activity back to the formerly abandoned central city sites, with all the environmental and social challenges that such activity entails. Their arrival also provokes questions of gentrification and inequality, as t old working ports with diverse populations have given way to housing, parks, leisure, and travel for the relatively wealthy.

Over the last decade, growing numbers of people have vacationed on cruise ships, taking advantage of water transportation and enjoying water as a background to their tourist experience, albeit often with little interest in its environmental quality. The new cruise ships are at the scale of large skyscrapers. The construction of the *Queen Mary II* in 2003 ushered in a new age of truly gigantic cruise ships, including the *Royal Caribbean Oasis* and its sister ship the *Allure*, at 225,000 tons and 1,188 feet; these cruise ships are more akin to tankers and container ships than to the pleasure ships of the past. The *Allure* can host nearly 6,300 passengers and a staff of almost 2,400 crewmembers, and offers amenities from a shopping mall to a water park, from a zip wire to Broadway-style shows. Also, over the last decade, the number of cruise ship tourists has risen steadily and cruise tourism has developed into a form of mass tourism. In 2012, US American cruise ships carried some 17 million passengers on fully catered vacations and tours to exotic locations (Mouawad, 2013). Many of these cruises take advantage of another facet of water in cities: waterfront revitalization and water as leisure and identity-producing sites (Hein, 2013, p. 26) (Image 6). The impact of cruise ships on cities such as Venice is highly contested, but yet to be fully studied. (Image 7) These new cruises require extensive facilities, and the number of terminals has grown rapidly in recent years.

The effects of cruise shipping go beyond that of industrial shipping of commodities, as the quality of the site of arrival, its urban or rural aspects, matter to the paying passengers.

Image 6. View of the HafenCity Hamburg with a cruise ship and the working port visible across the river Elbe (Carola Hein).

Environmental aspects such as water quality therefore take on new meaning. The link between cruise shipping and water quality and the environment is evident, even though it has yet to fully enter into planning practice. Activists criticize the cruise-shipping industry's use of heavy oil and unfiltered sulphurous gasoline, both of them environmentally disastrous and dangerous to the health of urban inhabitants. Several bills have been brought before the US Senate to enact national standards, requiring that waste-water generated by cruise ships be treated, but none have actually been passed (US Government, 2013). But catering to the cruise ship industry and ignoring ecological damage may backfire in the long run. For example, the loss of ice in Hudson Bay might curtail cruise shipping: many tourists are taking the ship to the bay to look for ice-based wildlife; if the ice retreats (because of climate change caused in part by the ships themselves) the wildlife may move further north and cruise ships may ignore the port (Stewart, 2009, pp. 63, 57-66). Culture and nature are largely commodified as part of the

Image 7. Cunard-line Cruise ship towering over historical Venice (June Cairns / Dreamstime.com).

cruising experience, but questions of social justice and ecology related to cruising have yet to be fully discussed in the literature (Hein, 2015b, p. 29).

So far, planners for port authorities and municipalities have treated their water-related properties separately, for industrial and shipping purposes on the one hand and those for urban leisure activities on the other. Yet the creation of new ports on waterways is a key element of globalization and economic growth, as it supports the international distribution of commodities and energy. Paradoxically the global economy and consumption that containerization fosters also contribute to global climate change and rising water levels that particularly threaten many if not all ports and their cities. A few scholars and organizations are honing in on the missing relationship between port and city planning (Carmona, 2003). The AIVP (Association Internationale Ville et Port) and The Asociación para la Colaboración entre Puertos y Ciudades/Association for the Collaboration between Ports and Cities (RETE) promote the comprehensive planning of port and city through publications and conferences (AIVP, 2015). The need to respond to issues of rising water levels and climate change, highlighted also through the flooding of New Orleans after

Image 8. More than fifty failures in the levees and flood walls protecting New Orleans led to extensive flooding after Hurricane Katrina in 2005 (Jeremy L. Grisham—U.S. Navy).

Hurricane Katrina in 2005, has also attracted interest from the Museum of Modern Art in New York, which examined it in regard to New York (Museum of Modern Art, 2011) (Image 8). Nonetheless, a broad global investigation of economic, social, cultural, ecological, and environmental aspects is missing. Around the world people are facing urgent challenges in terms of their relationship with water — how they live with it, manage it, and how they engage with water-related cultural heritage. Some of the most pressing challenges involve climate change, rapid urbanization, environmental degradation and migration. A deeper understanding of the spaces and practices around water in the past, present and future is key to understanding how societies face the challenges connected to life on this planet (Hein, Mager and Rocco, 2019).

Conclusion

Even though water is a shared resource and key characteristic of both port and waterfront design, its physical character, its ecological and environmental quality, get only passing attention in the scholarly literature except in regard to pollution. Despite the interconnectedness of ports and waterfronts, or the more recent intersection between cruise ships and inner-city ports, there are few studies that engage the urban uses of water from a comprehensive perspective and tie the different urban bodies of water, rivers, lakes, or the sea into local urban planning. Furthermore, despite the shared challenges of water that threaten port cities around the world, collective responses are so far absent.

The challenges of global water rise will require ingenuity around the world. Port cities and urban waterfronts are at the forefront of these changes. So far, scholars have given only limited attention to bringing an urban planning perspective to bear on ports, ports cities and waterfronts that are located on single bodies of water, such as the North Sea, the Baltic, or the Mediterranean. Hurricane Sandy provided a first taste of the potential dangers and challenges of flooding. New plans and planning coalitions between ports, cities and neighbouring regions, both along the shore and towards the hinterland may be necessary to address this challenge.

Academic research on ports and waterfronts has focused on isolated aspects of port engineering or management, or on the urban potential of water proximity (Hein, 2016). More research needs to be done to find a common perspective on future challenges, notably towards environmental risks, such as rising water levels and urban flooding due to climate change (Nicholls, 2017). Heritage themes and sustainability on coastlines is another important theme. New flood defences (unbreakable dykes, swimming cities) appear to be solutions that are raised locally and by cities with appropriate means. Some ports try to position themselves as so-called Green Ports that balance economic and environmental challenges.[4] Responsible innovation has become a theme for example for the Rotterdam port, which reduces fees for ships that have won the Green Award.[5] But despite recent attempts at global policies on pollution, no planning responses have yet emerged.

Economic and other factors remain the main drivers port and waterfront planning. A novel recognition of interconnected water systems, of connections between dredging the port and the need for infill to shore up the coasts, and the construction of so-called unbreakable dikes, or super-dikes, seems disconnected from planning literature. Scholarly discussion of mixed-use waterfront landscapes around historic port cities and new ports may help planners and others reconsider the relationships between cities and water. An integrated perspective on the context of the city and its hinterland, acknowledging the water as a shared resource and challenge - as a physical, economic, social, cultural but also environmental and ecological element - might help us develop common responses to contemporary challenges.

[4] Green Port, http://www.greenport.com/home
[5] Rotterdam rewards Green Award LNG tankers too, https://www.portofrotterdam.com/en/news-and-press-releases/rotterdam-rewards-green-award-lng-tankers-too

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A guide to the heritage and restoration of streams: Dealing with unprotected historical and water-rich landscapes in changing times in the Netherlands

Jan Neefjes and Hans Bleumink[1]

Introduction

The Netherlands is a water-rich country with thousands of kilometres of canals, rivers, streams and ditches. These watercourses and surrounding landscapes are an important part of Dutch heritage, but are rarely protected by a heritage listing. In fact, the responsible water authorities must make constant adjustments in the water infrastructure, because of changing requirements, for example due to climate change. Water heritage might be at risk by these physical changes in the landscape. Water authorities are not tailored to heritage. Protecting the endangered landscape is not their official task. Yet, there are many examples of water projects where heritage is protected or even enhanced. Project managers often are well aware of the value of the heritage and of methods to integrate it with other planning goals. The RCE (Dutch Cultural Heritage Agency) and STOWA (the joint research organisation of the Dutch water boards) were keenly aware of the threats and opportunities, so they initiated a research that resulted in the Guide to the Heritage and Restoration of Streams.[2] The aim is to make common practice from these examples, and to provide guide lines, tools and practical knowledge on water related heritage to water managers. The guide shows how understanding the historic context of the stream valleys can help to define a suitable restoration approach, can support conscious decision-making in the planning process, and can help to conserve and even strengthen the historical landscape. The guide was published in 2018 and written by the authors of this article. This article explains the preparation of the manual and summarizes essential information regarding water heritage.

[1] Jan Neefjes and Hans Bleumink launched the consultancy firm Overland in 2000. Overland delivers research projects and independent advice on the intersecting disciplines of spatial planning: landscape, heritage, water, ecology and agriculture. The work includes researching landscape history, advising on policy-making, creating GIS-applications and publishing books.

[2] Dutch title: *Handboek Beken en Erfgoed, Beeklandschappen met Karakter*. The book can be downloaded on the STOWA-site: https://www.stowa.nl/publicaties/handboek-beken-en-erfgoed-beekdallandschappen-met-karakter.

Water management and water heritage in the higher parts of the Netherlands

The guide deals with the water management of the higher part of the Netherlands, above the level of the sea and the major rivers. In the lower part of the Netherlands there are so called polders, where the water level is maintained by water pump stations (formerly windmills). In the higher part the water naturally flows away through streams. Dutch stream valleys are generally not deep, they are only a few metres lower than the surrounding area. However, the landscape is distinguished by the wetter conditions, different soils (humic gleysoils, peat soils), regular floodings and the vegetation. The streams and stream valleys were influenced by human use already in prehistoric times. In the Middle Ages and early modern times this influence led to landscapes and natural values that are highly appreciated these days. As can be seen in Image 1, historical intact stream valleys clearly distinguish from their surroundings. This article does not go into detail about the great variety of valley landscapes that developed since the Middle Ages. Suffice it to say, the variety resulted from different types of soil, hydrological conditions and interventions, and use by farmers, water millers, fishermen and estate owners. It is the more recent changes to the landscape, that are most significant.

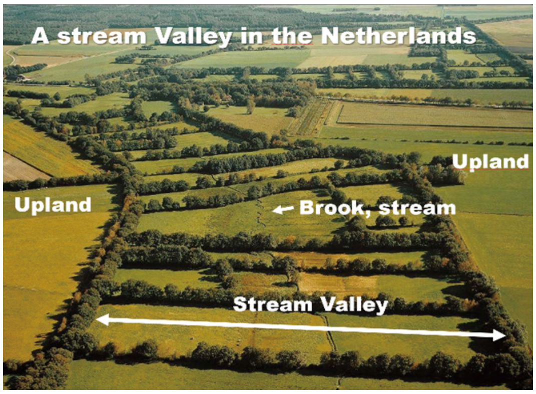

Image 1. A clearly visible valley structure with stream running through the middle and uplands to the side, in the Province of Drenthe, in the northern Netherlands (Photo: Peter van Bolhuis).

From the 19th century onwards, and especially since World War II, Dutch agricultural practices were modernized and intensified. Economically, this meant great success: the Netherlands became one of the largest producers of agricultural products in the world. This required drastic changes to water management systems and the landscape in general. Streams were 'standardised' in order to lower groundwater levels and excess water was siphoned off. In addition, wooded banks were felled and agricultural parcels were enlarged. Much of the work was carried out by water authorities. The drawbacks of this development have become evident over the past several decades: dried out stream valleys, downstream flooding, water pollution, deterioration of natural elements, and the decline of landscape diversity. It has become clear that climate change (more extreme dry spells, precipitation peaks) will make these problems worse.

Water authorities have therefore been given the task of restoring the streams.[3] The first priorities are to prevent water pollution, to increase the safety of downstream towns, and to enhance the natural value of streams and their valleys. These are concrete targets set by the European Union, the national government and the provincial authorities, such as the European Water Framework Directive.[4] Examples of measures in the Netherlands are the conversion of straight flows into meandering streams and raising the stream floors (delaying discharge; improving ecology) or increasing the flood area (water safety).[5] These measures are accompanied by the purchase of agricultural land that is being transformed into nature. Protecting historical landscapes is not a target per se, so restoring streams may be a potential threat to the traditional character of stream valleys. Some valued landscape features may be lost due to new design considerations. Yet, restoring the streams can also be an opportunity to enhance their appeal and historical significance. Restoration can be a means to reactivate lost features or fortify existing benefits.

Method used for making the guide

Interviews: The first step in preparing the guide, was to get insight in the way staff members of water boards actually use knowledge on water related heritage in their stream restoration plans, planning processes and daily water management. After all, the water boards themselves were the primary audience for the guidelines. For that reason, we interviewed several people (water policy makers, project managers) from each of the eleven water authorities. What did they understand to be landscape heritage? What do they already do within this context? Are they motivated to conserve water heritage as part of their planning goals? What additional information do they need? Where

[3] Water boards have traditionally been responsible for quantitative water management. In the last decades, they are also responsible for preventing water pollution and the preservation of the natural values of streams and their valleys. In the Netherlands, the provincial authorities are responsible for the water management policy for the regional water systems. Water Boards are democratically chosen public authorities, responsible for the implementation of the water management policy, as established by the provincial authorities.

[4] Water Framework Directive 2000/60/EG is an EU directive which commits European Union member states to achieve good qualitative and quantitative status of all water bodies. The directive states that the waters are a good habitat for the plants and animals that belong there. Legislation Summary: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM:l28002b.

[5] There are guidelines for the approach to these measures, like Buskens et al., 2012. However, these do not mention landscape heritage in stream valleys or, for instance, potential for historical-ecological values.

do interests collide?[6]

The inventory showed that many water authorities generally did not have official policies or objectives regarding water-related heritage. It is a subject not listed among their official duties, there are no budgets in place, and there is no in-house expertise. The complexity of water management planning (many stakeholders, many requirements) makes it difficult to add more considerations to the process. On an individual level, many staff were interested in the subject. They wanted to understand the development and history of a stream and its surrounding landscape. The interviews revealed that if they knew more, they would be more motivated to take historical landscape values into account. They also saw opportunities to make it happen. What they need is easy access to knowledge to inform their decisions.

Fieldwork sites: At three sites where fieldwork was in progress, we studied how heritage values could be integrated with existing water planning goals.[7] Staff from water authorities, provinces and external participants such as landscape historians, hydrologists, ecologists and landscape architects were all present. This provided insight into the often complex balance between farming, nature, recreation and landscape needs. It became clear that the water authority staff must make compromises. Our meetings also revealed the role heritage information can play in contributing to comprehensive solutions.

Historical landscape research and expert input: In the Netherlands much research has been done on the histories of various landscapes, but relatively little on the landscapes of stream valleys. We consolidated the available information by studying the literature, historic maps as well as soil and elevation data, and by conducting some fieldwork and integrating the insights gathered from our site visits.[8] Fourteen leading landscape historians came together at an expert meeting to share their knowledge of the history of stream valleys and the typologies connected to stream valley landscapes.

Focus group and reading group: A focus group with members of staff from water authorities, landscape stewardships and provinces joined the project to discuss the approach. A reading group with water authorities staff assessed the text and its accessibility for the target audience.

[6] The results of the interviews are included in Bleumink and Neefjes, 2017, an unpublishes work report. The results have been incorporated in part A and B of the guide, on the work process of water authorities.
[7] The three sites are Anloër Diepje (Water board Hunze en Aa's), Kleine Beerze (De Dommel) and Aa (Aa en Maas). Reports can be downloaded on https://www.stowa.nl/publicaties/handboek-beken-en-erfgoed-beekdallandschappen-met-karakter.
[8] The most important titles in the professional literature are mentioned in the reference list.

The guide

The guide is intended for water authorities and professionals working in water projects influenced by streams. The manual illustrates how consideration of a landscape's history and the associated water heritage can lead to better plans and contribute to solutions for water issues. The guide provides examples of both water heritage and the planning process surrounding water management projects. The manual consists of three different sections.

Catalogue of steam valley landscapes and water related heritage

This section covers the history of stream valleys, the geological origins, the natural vegetation, the prehistoric landscape stages, the uses over time, and the stream valley landscapes as they have evolved as a result of all this. This section consists of three different parts. The first part gives a thematical description of the most important 'landscape forming processes' as a result of historical land use in stream valleys, i.e. historical land reclamation and drainage systems, meadow irrigation, watermills, fishery, military functions, estates and esthetical use of water, transport, industry, and water in built environments. The second part gives a concise overview over the regional differences in the historical water related landscapes and stream valleys of the higher parts of the Netherlands. The third part provides a typology of historical stream valley landscapes, based on the visual appearance and the underlaying natural conditions (like soil type, elevation, natural ground water level etc.). This section was summarized in a comprehensive historical timeline.

Guidelines to integrate water related heritage in water management projects

This section addresses the question: why should a water authority concern itself with water heritage? We provide ten good reasons (see below) and offer advice on how to include heritage in the different planning phases and what to keep in mind in later maintenance phases. The advice varies according to the complexity and the stakeholders involved in water projects. Some projects are run solely by the water authority, other large-scale projects involve government authorities, local interest groups and multiple complex goals. We also offer advice on how the organization can better equip itself for water heritage. The ten good reasons to incorporate landscape and heritage features in water-related projects are:

1. Landscape and heritage elements can strengthen the quality and uniqueness of water projects.
2. Landscape heritage offers inspiration

and a starting point for current water objectives.

3. Attractive landscapes, together with a strong regional identity, are important factors for the economic viability of a region.
4. Knowledge of historical landscapes and heritage provides important insights into the functioning of stream catchments.
5. Ecological values are often closely related to the historical land use and water management.
6. The inclusion of heritage themes increases public support and promotes public participation.
7. The history and story of a stream contributes to improving water awareness and provides inspiration for educating younger generations.
8. Landscape and heritage features can be a strategic ally for water-related objectives.
9. Stream valley landscapes can form a meaningful connection between city and countryside.
10. Dutch environmental law focuses on the landscape with the aim of promoting public participation. It also calls for responsibility and diligence.

Guidelines on expertise, planning visions and design principles

This section outlines ways to gain information about historical landscapes. Water authorities can commission a landscape biography to understand the origins, development and character of the stream and its valley. A project will always involve the formulation of a vision, and during this process decision-makers will weigh the various needs, ambitions, uses and interests. How can water heritage be weighed against other aspects? It may be a legitimate choice to let go of certain heritage aspects. Heritage conservation is not a primary goal for water authorities. However, this section also illustrates some strategies and examples in which a historical landscape can be integrated in different ways, even when it did not initially seem possible.

Eleven golden rules

During the water authority interviews, staff asked us for a checklist. What sort of landscape features should they be taking into consideration when restoring streams? And what is the best way to conserve or strengthen these? Each restoration plan will be different, but in general the elements can be summarised by eleven golden rules to incorporate landscape features into water-related projects:

1. Find the old edges of the stream valley and make them stand out from their surroundings.
2. View stream valleys as an important spatial structure for the landscape.

Image 2. The Grebbelinie. Photo: waterboard Vallei en Veluwe.

3. Recognize the unique historic and landscape qualities of streams and their valleys, and connect to this during the design process.
4. Respect and preserve the soil and topographic archives as a source of information of natural and historic streams.
5. Take account of the stream valley for the entire catchment area and make appropriate spatial planning choices.
6. Respect and utilize the elements defined over time by an entire stream landscape.
7. Recognize and utilize the historic-ecological values.
8. Consider built heritage within the context of its related landscape.
9. Respect and utilize the spatial aspects of stream systems in urban and built-up areas.
10. Make historical stream landscapes visible and available for recreation and an enjoyable experience.
11. Recognize that stream restoration influences the landscape beyond the immediate project area.

Practical examples

The book includes 45 practical examples of heritage in stream valleys and how the heritage aspects were integrated in the planning process. Such examples are the most powerful tool in convincing water authorities about the relevancy of heritage in water projects. The examples include

Image 3. A stream valley near Eindhoven and example of golden rule #9: respect and utilize the spatial aspects of stream systems in urban and built-up areas.

the Grebbelinie and the Kleine Dommel, a stream valley near Eindhoven. The Grebbelinie (Image 2) was a centrally managed line of defence up until World War II: a large expanse of land could be inundated by water from streams to halt enemy troops moving westward to the richer regions of the Netherlands (Nieuwenhuis, 2014). Outlying banks and dams were necessary to retain the water. The trees seen on the left in the photo stand on a bank built in 1799. The dam near the centre of the photo could be opened to inundate the backlands. The line of trees on the right stand on the fortification built to defend the dam with 64 soldiers and 9 canons. There were some fierce battles around this spot in World War II. Recently it was decided to make the sluice fish-friendly, but the water authority decided to retain the ensemble of sluice, fortification and bank by digging a new, meandering watercourse and excavating a fish passage through the bank, at some distance from the sluice.

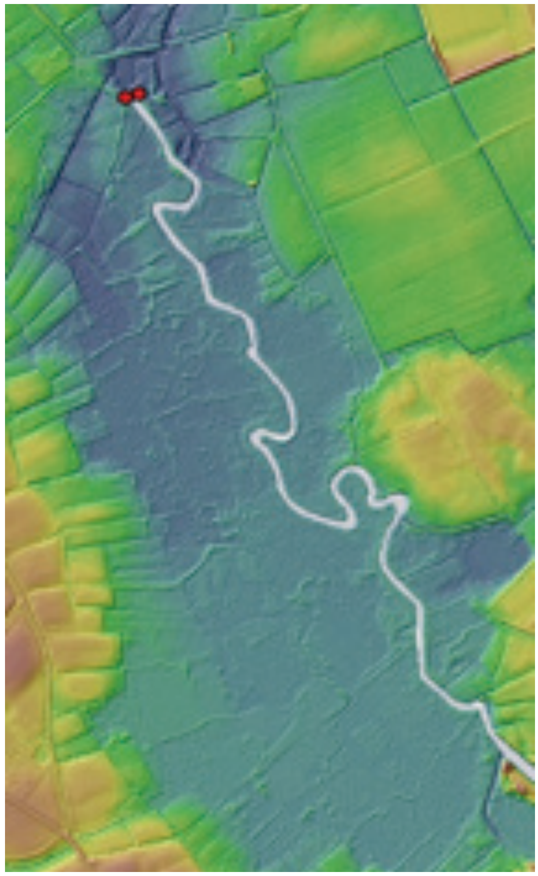

Image 4. Elevation map of the Kleine Dommel stream valley, east of Eindhoven and example of golden rule #8: consider built heritage within the context of its related landscape.[9]

The city of Eindhoven expanded greatly after World War II. The stream valleys

[9] Elevation map is made of edited data of Actueel Hoogtebestand Nederland (AHN2, www.ahn.nl).

Image 5 and 6. Renowned Dutch painter Vincent van Gogh, who lived in Nuenen, painted the watermill in 1884. The watermill is still standing and is a listed building. The painting is in the Noordbrabants Museum in Den Bosch. Photo 5: Marc Bolsius. Photo 6: Wammes Waggel, Wikimedia Commons.

had wet grounds and sometimes flooded, so remained free of buildings. The land adjacent to the streams are therefore still green areas or landscape wedges. Today the city and the local water authority are invested in these park-like settings as they contribute to Eindhoven's urban quality and influence the attractiveness of the city to business ventures – important in a city that has built a reputation as a centre of knowledge and innovation. Map: Fragment of the topographical map of Eindhoven where in blue high historical (1950's) groundwater levels I, II and III indicate the stream valleys (Image 3).[10]

The valley landscape around the Kleine Dommel stream creates a green buffer between the eastern edge of Eindhoven (Image 4) and the town of Nuenen (images 5, 6). At the northern end of the low-lying lands there stands a watermill: De Collse Watermolen. The damming of the land created an area which has often been waterlogged since the Middle Ages. This also allowed for certain types of nature to flourish. It is now a beautiful landscape with reeds, wet grasslands and alder-lined watercourses. It is important to conserve not only the mill but also its relationship with water and the surrounding landscape.

The spin-off

The guide has created more awareness for water heritage and raised the level of priority among water and other authorities.

Concrete steps are being taken. For example, in the centrally-located Veluwe area, research is being conducted on potential new uses attached to streams, so

[10] Ground water levels according to the so called COLN ground water tables https://www.wur.nl/nl/product/Historische-grondwaterstanden-1.htm.

as to increase the chances of integrating them and strengthening the landscape as a whole.[11] A large-scale project is set to be launched on the adaptive use of watermills and surrounding landscapes in response to climate change challenges.[12] Projects to examine the role of historic estates in achieving water goals in stream valleys are underway.[13] Finally, the guide gave rise to a conference on water heritage to familiarize administrators and government employees with the subject.[14] The success of the manual may lead to a sequel: research and guidelines on water management and heritage for the low-lying regions of the Netherlands.

[11] Cultuurland Advies, 2020. Toekomst voor het sprengenbekenlandschap, nieuw zicht op functies.
[12] A pilot project (Bleumink et al., 2019) has been carried out and a proposal is being made based on this.
[13] A pilot project (Bleumink en Neefjes, 2019) has been carried out and a proposal is being made based on this.
[14] Congres 'Waterbeheer en Landschapshistorie', 15'th of oktober 2019. https://www.stowa.nl/agenda/congres-waterbeheer-en-landschapshistorie

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Waterscape as a cultural heritage structural element: The Cantarranas River of the Atlixco Valley (Mexico)

Mariano Castellanos Arenas

Introduction

In ancient Mexico, Tlaloc was the Aztec God of Water and Lord of Thunder who represented fertility and abundance of crops. He lived in the underwater world known as Tlalocan—the spirits of all human beings who died from causes related to water and thunder went to his kingdom after death. It is narrated in the cosmogonic account that there was no shortage of corn sprouts (the basic foodstuff) or fresh fruits in his abode. It was also believed that Tlaloc lived in the Altepetl[1]: the mountain's personality was fused together with that of the God as this mountain was thought to contain a vessel from which water was liberated in the rainy season and retained during droughts (Oliver, 2009, pp. 40–43). In the Tlalocan, the beautiful Xochiquétzal was the wife of the old God of Water, but she was kidnapped by Tezcatlipoca, God of Heaven and Earth, who was also the source of life, guardianship, and protection of humans. Always omnipresent, strong, and invisible, Tezcatlipoca was also the originator of power and happiness as well as the owner of battles. Owing to this situation, Tlaloc joined Chalchiuhtlicue, the Goddess of Love and Fresh Water that flowed from the interior of the earth—that is, from the springs. They had two sons—the Tlalocas (clouds)—called Huixtocihuatl and Tlaloques who marked the four corners of the universe and held four clay pots from which they dropped four forms of water on earth: rain, hail, dirty water, and drought (Oliver, 2009, pp. 40–43).

Besides meaning *water* and *mountain*, Altepetl was the term to refer to a town, or also señorío, or a manor, a term that was understood as the place from which a region is governed. Image 1 represents Tlaloc in the Atlixco Valley (in Puebla, Mexico), which is crowned by the Popocatépetl volcano, the ruling mountain whose glacier-melted waters help farmers to irrigate the valley.[2]

[1] In Nahuatl (the most spoken Mexican language after Spanish) the word *atl-tépetl* is used to designate *water-mountain* (Oliver 2009, pp. 40-43).

[2] The name of the volcano means *smoking mountain*, from the Nahuatl *popocha* and *tepetl*, which means *smoke-mountain*. On the other hand, Atlixco is translated as the *water valley place*, which comes from *atl, ixtlatl* and *co*, meaning the *place of the water valley*. This allows us to understand how, from its geographical and cosmogonic origin, the Atlixco Valley is a *place of water* (Fernández and García 2016, p. 16).

Image 1. Tláloc, Chalchiuhtlicue, Huixtocihuatl y Tlaloques. Fragment of Codex Borbonicus, 16th Century Source: Codex Borbonicus (Loubat, 1899), Bibliothéque Du Palais Bourbon, FAMSI, Foundation For The advancement or Mesoamerican Studies, INC. www.famsi.org [Accesed November 30th, 2019].

The territory of the Atlixco Valley is configured by water. To understand its structure, both earlier and now, it is necessary to combine territory and water in a single concept—the waterscape. The Atlixco Valley, as a waterscape, has a mythological, historical, geographical, and cultural origins. Between the 19th and 20th centuries, the Cantarranas river and its flow structured a landscape where each of its elements are linked by the riverbed as if it were the backbone that articulates all the cultural goods of the valley. I argue that the waterscape of the Atlixco Valley is configured not only by the Cantarranas river, but also by the hydraulic installations that, despite their pre-Hispanic and colonial origins, formed a succession of cultural goods with an agricultural, industrial, and urban character which nowadays give a structure to this cultural landscape. The connections of this waterscape are water diversion dams, where intakes were installed so as to be used by haciendas, ranches, villages, hydroelectric plants, factories, a mill, and a city.

The objective of this paper is to describe and illustrate the capacity of both the river and the hydraulic infrastructure. The central idea is to understand the configuration of the territory and to value this landscape as cultural heritage. To achieve this, a description of the distribution of the different water resources along the river and the cultural heritage connected with the hydraulic network that articulates the entire waterscape is given and illustrated with pictures, graphs, and images.

This work is part of a more extensive and ongoing investigation that addresses the entire hydraulic complex of the Atlixco Valley. It is a study supported by detailed field work and systematic documentary investigation. The historical period considered by this study is from 1898 to 1928. It begins with the consolidation of *The National Water Commission of the Mexican Republic* (Tortolero, 2006, p. 55) and the hydraulic system project for the Metepec Factory, which was the last infrastructure project in the valley and the first productive unit to take advantage of the waters (Pacheco, 1984, pp. 90–120). The period ends with the *Regulatory study for the use of water from the Cantarranas river in the Atlixco Valley*, carried out by the Ministry of Agriculture and the Development of the Mexican Republic (Water History Archive, Surface Water Utilization, box 4314, files 57493, 1928, pp. 1–320). I consider that the waterscape presented here was consolidated during those years.

Space and time in the Atlixco Valley

The Atlixco Valley is a natural region of the Mexican state of Puebla with an area of 3,074,000 m^2. It is located southwest of the state capital, near the Sierra Nevada. The rivers that irrigate the valley descend from the few glaciers on the summits of the Popocatépetl[3] volcano. This valley is

[3] *El Popo* is the second highest volcano in Mexico with a maximum altitude of 5,500 m above sea level; it is with a diameter of 25 km at its base; its summit has the elliptical cut of a cone, with a northeast–southwest orientation. The distance between the walls of its crater varies between 660 and 840 m. Paleomagnetic studies indicate that it is approximately 730,000 years old. The volcano has 17million cubic metres perennial glaciers near the mouth of the cone at the top of the mountain. Below 4,000 m, the streams acquire speed and volume, and the springs are more frequent and abundant (Reyes y Sánchez 2014, pp. 81–82).

Image 2. Location of the Atlixco Valley, Puebla State, Mexico. Coordenates: 8°54′45″N 98°25′40″O and Mexico City has been located as a reference point. Credit: Mariano Castellanos.

characterized by its mild climate, moderate rainfall, and fertile soils. Among these rivers is the Cantarranas river, a tributary of the Atoyac river, that converges with the Nexapa river. Owing to the abundance of water and fertility of the land in the valley, during the 16th century, Toribio de Benavente, known as 'Motolinía', a Franciscan monk who was one of the founders of Puebla city, named it Vall de Christus or Valley of Christ, and it quickly became an important Spanish settlement. A considerable part of the irrigated indigenous land became part of private property, which was integrated into the haciendas, ranches, mills, and subsequently, into factories and hydroelectric plants. [4]During the same period, this town became

[4] The Atlixco Valley is located about 40 km southwest of Puebla City. This region was dominated by two pre-Hispanic lordships, Huejotzingo and Itzocan (today Izúcar de Matamoros), in which important cultural elements were produced. Since the mid-16th century, during the conquest of Mexico, the valley and much of the central highlands were entrusted to the Franciscans for evangelization. Around the year 1400, the space we know today as the Atlixco Valley was a conflicted border area among several indigenous lordships and various ethnicities (Garabaglia 1996, pp. 72–73) (Paredes 1999, p. 22).

the most important cereal-producing centre in New Spain and supplied these products to almost all the entire Spanish kingdom. Even after the Independence of Mexico in the 19th century, it remained as an important producer of these grains (National Catalogue of Monuments Historic Buildings, INAH, 1988, p. 9).

The extensive farming land was located next to the Cantarranas and Nexapa rivers. It should be noted that since those times these lands have been the most coveted for the quality of their soils and easy availability of water. However, the concentration of haciendas, ranches, textile factories, and hydroelectric plants was especially notable around the Cantarranas river. In this way, most of the highlands, which are less fertile, which could only be cultivated during specific times of the year and lacked irrigation water, were left to less wealthy farmers. The terms hacienda and ranch denote the rural properties that had the same agricultural functions. However, as a rule, haciendas are larger than ranches (Mertens, 1983, p. 17).

It is necessary to emphasize that the Spaniards who arrived to Atlixco after the conquest and during colonization maintained the existing irrigation works built by indigenous peoples. However, since agricultural and industrial activities increased and the population grew steadily, the Spaniards expanded and modified the irrigation system to multiply the water intakes—they built divider boxes of water and created general as well as secondary channels for the distribution of water among multiple users (Castañeda, 2001, p. 73).

During the Porfiriato (1876–1910), which was the name given to the regime of the dictator Porfirio Díaz, the key socio-economic elements in Mexico were haciendas, ranches, and factories that structured the growth and modernization of the country. But the degree of economic dependence on the hacienda and its labour system was practically feudal—a situation that eventually triggered the Mexican Revolution. In this sense, water proved to be one of the strategic natural resources for achieving the economic goals of the regime. The most important hydraulic changes took place during the Porfirian industrial expansion that surged from the new type of hydraulic energy demand (Castañeda, 2001, pp. 124–186).

Finally, it was not by chance that this region turned into an important site of attraction for farmers and workers. The great potential of its labour force along with the abundance and quality of water contributed to that. Today, all the hydraulic facilities shape an important regional cultural heritage of the region.

The Atlixco Valley as a waterscape

The waterscape of the Atlixco Valley begins at the Popocatépetl volcano, with the formation of several talwegs[5] or water lines that run right into two ravines that join approximately 15,000 m east to its crater. The Cantarranas riverbed was formed there and later fed by the water from two springs—De la Peña and Axomulco—located on the left bank as well as from others called Ahuehuete on the right bank, where the riverbed of the Cantarranas proper begins. It ends with its convergence with a larger river, the Nexapa. Along its route the riverbed receives large volumes of water from the Tianguismanalco river and from the springs with the same name, along with those of Chignahuapan or Metepec, on the left riverbank and still further from the Axocopan springs on the right. In addition, there are some ravines that drain only in the rainy season, such as those of the Tenamaxtla and the Barranca Seca. The Cantarranas river has a total length of 16,500 m, right from the first mentioned springs to its confluence with the Nexapa river. The total capacity of water per day has been determined to be 2,389 m³ (this includes De la Peña, Axomulco, Ahuahuete, Metepec, and Axocopan, plus the Tianguismanalco river). The annual average volume is 75,339,285 m³. The total amount of water used by a city, six villages, 10 haciendas, 11 ranches, a mill, six hydroelectric plants, and six textile factories was 58,680,000 m³ per day during the fieldwork period.

The water was distributed through water diversion dams, which are barriers built on the river as gorges intended to dam the water in the riverbed in order to raise its level. This was done to use the water for different purposes. The number of water-derivation dams in the Cantarranas river is 17—they are articulated by divider boxes that carried water to 50 open and closed channels, seven pipes, one elevated aqueduct, 17 natural and artificial reservoir vessels, known in Mexico as jagüeyes, and two water-storage tanks. The water was used for domestic purposes, for the generation of electricity, and for the irrigation of the cultivated land whose crops, in order of importance, were mainly wheat, vegetables, legumes, corn, alfalfa, fruit trees, avocado, beans, flowers, barley, chili, sweet potatoes, peanut, beans, sugarcanes, as well as for pastures for cows.[6] The different parts of the waterscape of the Atlixco Valley is

[5] Talweg is a German term that means ‘valley road’ and is a line that joins the lowest points in a valley or riverbed; it is the place where the stream reduces its speed and becomes a riverbed. www.memidex.com/talwegs [Accessed November 30, 2019].

[6] The distribution of the water of the Cantarranas river is based on the *Informe relativo al Estudio de Reglamentación hecha por VI zona de Puebla a los Ríos Cantarranas, Tianguismanalco y Manantiales de Axocopan de la Secretaría de Agricultura y Fomento (SAF), de la República Mexicana, Delegación de Aguas, Tierras y Colonización, Departamento Sur* (Sección del Fondo Aprovechamientos Superficiales del Archivo Histórico del Agua (AHA- Conagua), Box 4314, Exp. 57493, 1928, pp. 1–320).

described below and illustrated in Images 3, 4, 5, and 6.

First derivation: This derivation, supplied by the Axomulco springs, has two channels. One is located on the right riverbank of the river which irrigated the San Baltazar Atlimeyaya village's land, while the other, on the left bank, also irrigated farmland. A large part of the volume of water in this branch is for domestic use.

Second derivation: In the immediate vicinity of the San Baltazar Atlimeyaya town is the dam of the Compañía Industrial de Atlixco, S.A. (CIASA) that uses the water in its factory called Metepec. On the right riverbank, it has two floodgates—one is used to disengage it, while the other, which arrives at the San Pedro hydroelectric plant, is about 1,250 m downstream. The power generated by this plant is used to move the machinery to work on the cotton yarn, fabric, and finishing factory.

Third derivation: The hydroelectric plant of San Pedro Atlixco is located 600 m from the CIASA dam, which carries water through a small channel along the left side of the riverbank and irrigated some of the town's land, which has the same name, and is also used for domestic purposes.

Fourth derivation: This derivation is located immediately after the discharge of the previously mentioned power plant, San Pedro. It travels through a channel to the highest point of the territory to take water to the Casita Blanca site, where water is accumulated and its flow controlled. The pipe enables the water to rapidly descend and drive the turbines within the Metepec factory—it makes part of the machinery work through a system of synchronized cables and pulleys. After moving the turbines, the water is transported to another section of the power plant to generate electricity. This power plant has turbines that provide electrical light to both production halls and factory offices, as well as to the workers' town of Metepec.

Fifth derivation: Downstream, after the confluence with the Tianguismanalco river, there is one more dam that also belonged to the Metepec factory. The dam channels the water, which, along with those rivers mentioned above and the surplus of the Casita Blanca, is used for public and domestic purposes to meet the needs of the town of Metepec.

Sixth derivation: Next to the location of the water vent used by the Metepec factory is the dam, whose water is used by El León, a cotton yarn, and a fabric factory, on the left bank which is channelled up to the turbine inside of the factory. The surplus water is used to irrigate a small portion of land that belonged to El León.

Seventh derivation: Following the natural course of the river, a dam with more

Image 3. Composite images of the river, facilities and sites. Credit: Mariano Castellanos. Historical photos (Colección fotográfica del Archivo Histórico del Museo Industrial de Metepec, BUAP).

water resource uses is located next to the water vent of the El León factory. From this point, the water is taken to a large splitter box that served the Atlixco city, three haciendas, six ranches, a mill, and two hydroelectric plants that provided electrical light to the city. After the water is used, the surplus is poured back into the river. The water is taken to the first hydroelectric plant of Gavito to generate electricity. It is then taken to irrigate the lands of the Gamboa ranch and those of El Bosque. Next, the water is taken to the so-called solares grandes de Atlixco, where there are diverse crops. Subsequently, the Tablas ranch is supplied with water, which is then taken to the city of Atlixco to be used in public and domestic services. On the same left bank, the water is taken to the second hydroelectric plant of Gavito, to the haciendas of Cabrera and Xalpatlaco, to a small ranch called Acatzingo, and to the so-called solares chicos de Atlixco which are farmlands of the inhabitants of the city. From this place, the lands of the ranches Las Ánimas and Cotzala are irrigated. After that, there is a drain located near the Atlixco city with two branches—one that goes down the main street to the San Mateo mill and another which transports the city's slaughter sewage.

Eighth derivation: Downstream, right on the place where the river enters the Axocopan springs, there is a derivation that carried water to El Volcán factory—this water is collected during the rainy season in the Tenamaxtla Canyon and in the water vent of the second Gavito power plant. The water is also taken to the El Volcán factory from the spring. On the left bank, the water is taken to the factories of La Carolina and La Concepción through an elevated aqueduct to produce the driving force in order to take advantage of it in domestic use and to irrigate the so-called solares grandes de Atlixco. It is also used for some services in the cemetery of the City of Atlixco. Finally, it is used in an underground tunnel for the San Mateo mill, located at the centre of the city, which also uses water to irrigate its land and for domestic use.

Ninth derivation: The water generated from the water vent of El Volcán factory, plus that of this derivation, is taken to the La Carolina factory and used to produce the driving force for power generation and for the irrigation of their lands on the left bank. The water also goes to the ranches of El Cristo Chico and Las Chautlas also on the left bank, while on the right riverbank it is taken to the land of the Hacienda La Alfonsina.

Tenth derivation: The water from this dam supplied the Hacienda Cantarranas on the right bank.

Eleventh derivation: The water is used in the Carmen factory on the left bank.

Twelfth derivation: This is one of the largest diversion dams of the Cantarranas river. It is located both on the left riverbank and the right one. In the rainy season, the river swells due to the descending water from the Barranca Sea. On the one hand, the right bank's water is used for domestic uses and irrigation of the crops in the town of Acapulco. This same channel supplies water to the ranch of Castillotla and the town of Trinidad Tepango also for irrigation and domestic purposes; it also supplies water to the Tlacoxcalco and La Sábana haciendas along with the Tronconal ranch. On the other hand, this derivation crosses the river to the left bank and reaches the El Cristo Grande Hacienda to irrigate its crops as well as the ones of the San Diego la Blanca hacienda. Next, the water is taken to the first hydroelectric plant Díaz Rubín, whose energy is used by the factories of La Concepción and El Carmen.

Thirteenth derivation: 1,500 m downstream, on the left bank, is the branch used by the second hydroelectric plant Diaz Rubín. The water is then taken to two haciendas—San Diego la Blanca and Xahuantla.

Image 4. Composite images of the river, facilities and sites. Credit: Mariano Castellanos. Historical photos (Colección fotográfica del Archivo Histórico del Museo Industrial de Metepec, BUAP).

Fourteenth derivation: On the left bank, there is the dam whose waters enter the second hydroelectric plant Diaz Rubín. This water is used to move the plant's turbine and generate power for the El Carmen factory.

Fifteenth derivation: The water that comes from the water vent of the second hydroelectric plant on the left riverbank goes to the Tlacoxcalco farm and to the lands in the town of Santa Ana Coatepec.

Sixteenth derivation: Hacienda de la Concepción is located 100 m below the previous branch on the left bank. It is worth mentioning that unlike the rest of the haciendas, it has a large herd of cattle in addition to pastures.

Seventeenth derivation: The last dam takes the water to the Tlacoxcalco farm and then to the town of Santa Ana Coatepec until it gets to the Tlayehualco ranch.

This description outlines the structure of the backbone that supports and supplies water to all productive units—

Image 5. Composite images of the river, facilities and sites. Credit: Mariano Castellanos. Historical photos (Colección fotográfica del Archivo Histórico del Museo Industrial de Metepec, BUAP).

the waterscape and all the elements that configure it as a cultural heritage. At the same time, Image 6 shows the river, the springs, and the derivations, as well as all the water resource used. This suggests that it is not just any river, but also a unique example where different uses are combined and extraordinarily balanced. Likewise, Table 1 supplements information to know which is the water consumption in litres per second in each place, the annual volume in cubic metres, the surface area in square metres, the driving power, and the different uses of the water throughout the hydraulic system including domestic use, irrigation, and generation of the driving force.

Conclusion

It is important to reflect on the relationship between landscape and cultural heritage. For a long time, landscapes and cultural heritage have been presented as antagonistic concepts—any landscape was understood in scenic and visual terms. Nevertheless, such as a view, an image—an observed,

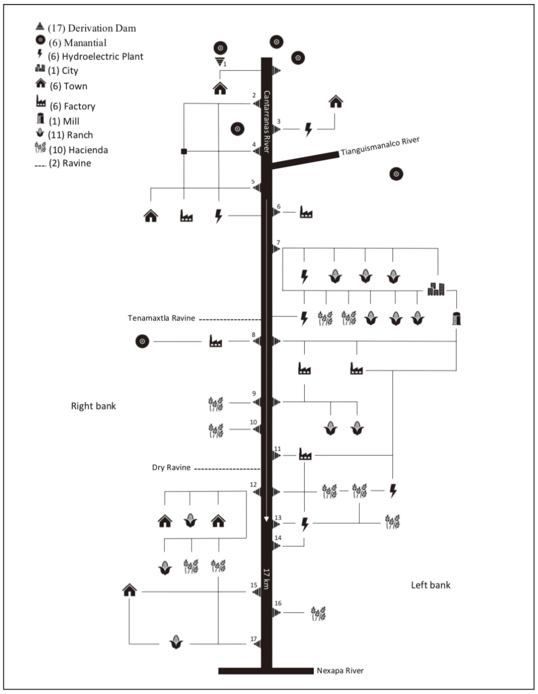

Image 6. Derivation Dams and Water Resource Use of Cantarranas River Scheme. Credit: Mariano Castellanos Based on the *Esquema del Estado de Puebla, desde su nacimiento hasta su confluencia con el Río Nexapa, con anotaciones de aprovechamientos, manantiales, estaciones de aforo, etc. etc. Secretaría d Agricultura y Fomento, Dirección del Aguas, Tierras y Colonización, VII Zona.*

real, or re-enacted thing and heritage—on the other side is seen as being represented by historical buildings, works of art, or archaeological or natural sites, as it has been expressed in the Venice Charter (1964) or the *Convention concerning the Protection of the World Cultural and Natural Heritage* (1972) and *The Cracow Charter* (2000), both by UNESCO. To understand the relationship between them, it is necessary to talk about heritage landscapes as configured through history by settlement patterns or by life forms and traditions in specific territories with infinite material and symbolic forms. In this sense, it is essential to consider the contribution of culture on the landscape as well as the idea that the landscape can become heritage as well. Although landscapes and cultural heritage have their own material expressions, heritage landscapes are not concerned only with objects, but also with a complex set of concepts and ideas. However, when talking about the waterscape as heritage, the cultural values are concentrated on the hydraulic system and its uses that facilitate the constitution of landscape heritage with a rich repertoire of cultural goods of an agricultural and industrial nature which are truly unique to the region of the Cantarranas river in the Atlixco Valley.

The process of turning the landscape into heritage, with water in its multiple manifestations (material and symbolic), has been a way of constructing new meanings to the territory. They express a long history of environment modelling and generate feelings of belonging and identity. The idea is to look at the landscape as a whole with the cultural values of its components—more specifically, those of the hydraulic system and the roads that surround it, the crops, the agricultural practices, and the structures constructed for irrigation, such as factories and power-

Table 1. Derivation Dams and Water Resource Use of Cantarranas River. Credit: Mariano Castellanos based on the *Cuadro Descriptivo de los aprovechamientos de las aguas del Río Cantarranas y de sus afluentes el Tianguismanalco y los Manantiales de Axocopan* (Sección: Departamento Jurídico; Serie Distribución de Aguas del Archivo Histórico del Museo Industrial de Metepec, BUAP; box 14, Exp. 2; 1930: 1).

Derivation Dams and Water Resource Use of Cantarranas River						
D. Dams	**Water Resource Use**	**L.P.S.**	**Annual Volume in m³**	**Surface irrigated in m²**	**Horse Power**	**Uses**
I	San Baltazar Atlimeyaya Town	1.27	40 051			Domestic
	Right Bank	50.19	529 043	3 600.00		Irrigation
	Left Bank	16.09	169 601	1 200.00		Irrigation
II	San Pedro Hydroelectric Plant	2 000.00	63 072 000		750.00	Driving Force
III	San Pedro Atlixco Town	36.40	383 685	3 200.00		Irrigation
		1.00	31 536			Domestic
IV	Metepec Factory	2 000.00	63 072 000		1925.96	Driving Force
		2 00 000	63 072 000		361.43	Driving Force
V	Metepec Town	30 000	9 460 8000		356.05	Driving Force
VI	El León Factory	2 500.00	78 840 000		285.46	Driving Force
VII	First Hydroelectric Plant Gavito	2 000.00	63 072 000		188.80	Driving Force
	Second Hydroelectric Plant Gavito	1 000.00	31 536 000		72.00	Driving Force
	Gamboa Ranch	38.20	402 658	44 720.00		Irrigation
	Del Bosque Ranch	65.90	694 639	9 265.10		Irrigation
	Solares Grandes de Atlixco	44.40	468 011	3 955.25		Irrigation
	Las Tablas Ranch	55.40	583 960	3 595.23		Irrigation
	Atlixco City	20.80	659 880			Domestic and Public
	San Mateo Mill	26.90	567 095	3 044.77		Irrigation
	Cabrera Hacienda	84.70	892 806	9 416.00		Irrigation
	Solares Grandes de Atlixco	27.21	573 630	5 296.00		Irrigation
	Xalpatlaco Hacienda	251.04	2 646 162	35 021.25		Irrigation
	Cotzala Ranch	4.45	15 379	110.00		Irrigation
	Acatzingo Ranch	21.01	221 462	2 774.00		Irrigation
	Las Animas Ranch	15.43	162 644	1 000.00		Irrigation
VIII	El Volcán Factory	2 108.00	66 477 888		114.20	Driving Force
	La Carolina Factory	51.40	541 797	6 470.00		Irrigation
	Solares grandes de Atlixco	44.40	468 011	3 955.25		Irrigation
	La Concepción Factory	495.00	15 610 320		119.50	Driving Force
		56.90	196 646	2 696.00		Irrigation
	Atlixco City	1.00	15 768			Irrigation and Public
	San Mateo Mill	495.00	15 610 320		100.60	Driving Force
		100.00	1 054 080	14 600.00		Irrigation
IX	La Carolina Factory	1500.00	47 304 000		144.60	Driving Force
	La Alfonsina Hacienda	72.80	1 534 740	17 923.31		Irrigation
	El Cristo Chico Ranch	95.30	1 004 538	12 861.20		Irrigation
	Los Chautlas Ranch	95.30	1 004 538	8 058.37		Irrigation
X	Cantarranas Hacienda	97.30	1 025 620	13 978.50		Irrigation
XI	El Carmen Factory	2500.00	78 840 000		144.60	Driving Force
XII	Acapulco Town	85.40	900 185	11 800.00		Irrigation
		1.15	36 266			Domestic
	Castillotla Ranch	4.96	52 282	450.00		Irrigation
		0.57	17 975			Domestic
	La Trinidad Tepango Town	124.40	1 311 276	17900.00		Irrigation
		1.15	36 266			Domestic
	Tlacoxcalco Hacienda	187.96	1 981 249	25 200.00		Irrigation
	La Sabana Hacienda	201.70	4 225 159	57 400.00		Irrigation
	Tronconal Ranch	96.18	1 013 814	13 000.00		Irrigation
	El Cristo Grande Hacienda	96.30	1 015 079	12 693.94		Irrigation
	San Diego La Blanca Hacienda	96.30	1 015 079	11 100.00		Irrigation
	First Hydroelectric Plant Dáz Rubin	800.00	25 228 800		201.88	Driving Force
XIII	San Diego La Blanca Hacienda	76.70	808 479	17 048.50		Irrigation
	Xahuentla Hacienda	76.70	808 479	8 660.00		Irrigation
	Second Hyderoelectric Plant Dáz Rubin	800.00	25 228 800		122.00	Driving Force
XIV	El Carmen Factory	2500.00	78 840 000		144.60	Driving Force
XV	Santa Ana Coatepec Town	222.20	2 342 166	33 000.00		Irrigation
XVI	La Concepción Hacienda	63.60	1 340 790	14 108.50		Irrigation
XVII	Tlayehualco Ranch	161.00	1 697 069	24 350.00		Irrigation

generation plants, as well as the towns and cities, their populations, and their cultural practices. All these interconnected elements are integrated into the idea of a heritage landscape. So, the waterscape as heritage requires a renewed vision capable of assuming both the complexity of the concept and the need for its application on an analysis proposal from a transdisciplinary point of view that goes far beyond geographical boundaries. So, we must reflect on the concept of *landscape of water* (waterscape) from the different definitions and perspectives, analyzing all its historical, social, cultural, and economic components in order to propose ways to legally defend and protect it.

It is important to say that the landscapes of water, besides being heritage, are excellent indicators not only of the state of the environment, but also of the quality of life of its inhabitants and ecosystems. High-quality waterscapes offer us pleasant sensations, (both aesthetic and sensory) as they are heritage landscapes with which many people establish atavistic, affective, and cultural links. Hence, I argue that water landscapes must be seen beyond biological or environmental considerations, since waterscapes have important cultural and emotional attributes and qualities that make them a common good.

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How can the massive reuse of Shanghai's former industrial waterfronts become more than a city branding strategy and reconnect the city with the water?

Harry den Hartog

Introduction

A lot of research has been implemented on urban waterfront transitions and the reuse of former negative experienced or polluted spaces into attractive new spaces for urban culture (Meyer, 1999; Porfyriou and Sepe, 2016; Schlichting, 2019; Zukin, 2020). Although partly in line with global predecessors, the case of Shanghai is rather unique due to its extreme large scale and speed: 42 km have been transformed in less than a decade, which is dwarfing waterfront transitions in Tokyo, London, and New York, among others. This is possible thanks to the fact that the government owns all the land and can act extremely resolutely and quickly without any obstructions. The question is to what degree this different approach results in better quality and sustainability? Research on the waterfront transitions in Shanghai so far is limited to a few papers that deal with smaller parts of the whole project (Li, 2016; Li, 2018; Zhang and Zhang, 2011).

Since the late 20th century, Shanghai is transforming itself from an industry- and agriculture-dominated city—large parts of the directly controlled municipality are still mainly agricultural—into a service-oriented metropolis. In this process of transition, the water system has been degraded from a transportation and urbanization backbone into a decorative element without much sense of its historical importance and former uses. The use and appreciation of waterfronts has changed drastically in the context of China's extremely rapid and largescale urbanization since the end of the century (Hsing, 2014). In the last decade, Shanghai—and China in general—faced an unprecedented metamorphosis. The urban lifestyle and appearance changed completely. Although many local families have been able to escape from poverty thanks to China's economic miracle and the quality of life for millions of people has been improved, there is a lot of collateral damage, especially an escalation of environmental problems. China's contemporary method of building cities using largescale superblocks on a tabula rasa caused an irreversible loss of historically valuable buildings and even complete historic (urban) landscapes. This is gradually changing, for example, by the reuse of industrial sites along the Huangpu river in Shanghai, which is a mainly successful journey of trial and error.

This paper focuses on former industrial waterfronts along the Huangpu river in the directly controlled municipality (equal to a province) of Shanghai. Historical continuities and recent discontinuities will be explained and assessed regarding the appreciation and usability of urbanized watersides. This paper will conclude with some lessons and suggestions for further improvement. Data collection for this paper is the result of more than 10 years living and working in Shanghai. During these years, I have visited all locations multiple times, before, during, and after their transformation. I have also spoken with key stakeholders such as local authorities, planners, developers, real estate agents, residents, visitors, and others.

Shanghai's rich historical relationship with the water

Shanghai and its wider urban region with neighbouring cities and towns used to be crisscrossed by many waterways. The city's name literally translates as 'upon the sea'

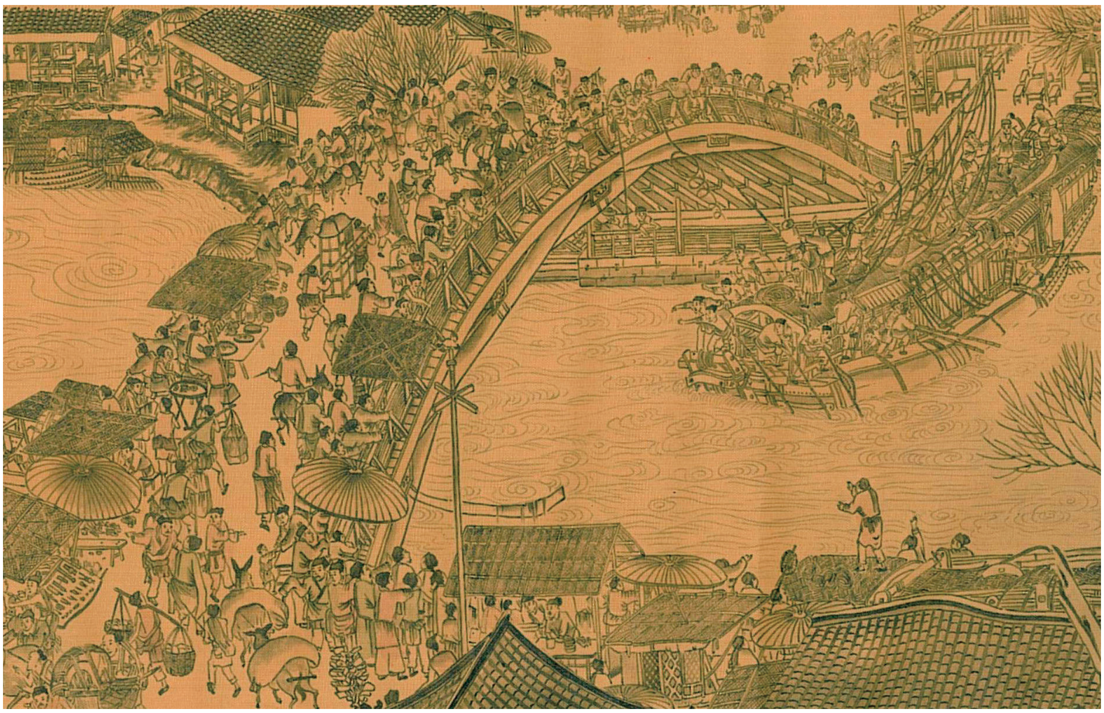

Image 1. Fragment of the classic painting Qingming Shang He Tu – original painting by Zhang Zeduan. Twelfth century, Handscroll, 24.8 x 528.7 cm (Source: Beijing - Palace Museum).

Image 2. There used to be a more direct interaction between urban life and water, also for washing laundry and cleaning food (photo by Harry den Hartog, 2013).

as the coastline has been shifting eastwards due to the sedimentation processes of the Yangtze river and its tributaries. Water is not only a means of transportation but also a bearer of stories, local myths, and cultural practices. The classic Chinese painting *Qingming Shanghetu*, painted in the early 12th century, is the perfect illustration of the importance of water in Chinese urbanization. One of the many functions of water is transport and trade, and the *Qingming Shanghetu* depicts the rich mix of economic activities on the urban waterside and embankments, symbolizing the vitality of a relatively compact city clearly defined within its city walls. Lying in the swampy Yangtze river delta, the former fishing village of Shanghai witnessed an industrial boom following the establishment of its treaty port after the Opium Wars. Later, largescale land reclamation projects since the 1950s have made great tracts of marshland suitable for human habitation, albeit with negative side effects for ecology and flood protection.

Until the mid-19th century, the spatial and economic development of the Yangtze river delta was propelled by an efficient network of waterways and canal towns (Ball, 2017). In *Farmers of Forty Centuries*, a tremendous 1911 travelogue, F.H. King described how more than 3,000 km of waterways provided an ingenious transport system that simultaneously supported soil fertility and irrigation in China (King, 1911). This in turn prevented soil erosion and increased crop yields, turning the delta region into a 'rice bowl'. King also predicted that China would become a world superpower as 'tilling the earth is the bottom condition of civilization'. To improve the fertility of land, a great deal of mud was dredged from the canals and creeks and spread across farmers' fields. At the same time, night soil from the cities was transported to the fields by boat to be used as natural fertilizer even until the late 1990s (the author's own observation). To a large extent, these techniques contributed to the self-sufficiency of the region and of China as a whole.

Later, under Mao's leadership, the Chinese government adopted policies that imposed technocratic engineering on the surrounding landscape. This mechanical and top-down approach is ubiquitous and has become even more extreme since Mao's doctrine: 'Man must conquer nature' (Shapiro, 2001). Natural capital and rural values around Shanghai (and elsewhere in China) have been largely neglected for a long time in favour of rapid urbanization. Current planning practices are based on a tabula rasa approach and steered by GDP-oriented motives with a lot of collateral damage for ecosystems and liveability. During this regime, many natural waterways in this region have been transformed into canals, while others have been dammed or filled in completely. The eastward shift in the world's economic centre of gravity at the end of the last century has made highways, railroads, and airports the new flywheel of Shanghai's development—a process accelerated by mass migration to the city from rural areas. Of late, many remaining waterways and canal towns are under revision again. The few remaining canal towns have been rediscovered and are being exploited more and more as tourist attractions, so the region is losing its original population due to gentrification processes. Simultaneously, many remaining waterways around Shanghai are being transformed into scenic landscapes due to experimental landscape 'beautification' policies. The long and fruitful relationship between the urban landscape and its water systems has changed drastically. Asphalt and rails have become the new backbones of the new economy and urbanization pattern (Den Hartog, 2010).

Shanghai is 'striving to become an excellent global city', according to the credo on the first page of the 2035 Master Plan of Shanghai (Shanghai Planning and Land Resource Administration, 2017). To facilitate this, in the central city a large number of waterfronts have recently been transformed from the source of mainly industrial usage into a hub of recreational and commercial usage with abundant public recreational space, offices, shopping, and hotels, offering a welcome and pleasant relief from urban congestion. The role and experience of water have simultaneously changed, especially regarding daily usage. Earlier, living by the waterside in Chinese cities was rarely an attractive option. Industrial developments, especially since the 19th century, made many of them dirty and smelly, while others became repositories of household waste. Hence, aside from the few remaining traditional canal towns, there are very few attractive waterside housing developments in Shanghai. However, during the last two decades, a gradual transition in this regard is taking place. Real estate developers and policymakers are increasingly rediscovering watersides as an added value (Den Hartog, 2019).

Experiments with urban regeneration and creative clusters in Shanghai

Contemporary Chinese cities fulfil all the conditions for experimenting with architectural typologies, building technologies, and planning concepts—economic prosperity, a vast and relatively cheap labour force, a growing educated middle class, and a financially strong government that legally owns all the land. Experimenting refers to try something new, evaluating the results, and repeating the experiment, if necessary. While outcomes may vary, the spirit of experimentation is something to be celebrated. China is home to its fair share of failed architectural experiments, but it has also seen many promising results, especially regarding new urban transportation systems. Failure and success go hand in hand while experimenting. Recent projects in the fields of architecture and urban planning have largely been in line with China's 20th-century tradition of social and economic experimentation.

Shanghai is a forerunner of experiments and innovations in architecture and urban design in China (Den Hartog, 2016). Moreover, regarding the protection of heritage, Shanghai is setting the trend in China with samples and pilot projects that are guiding the direction of secondary and tertiary cities elsewhere in the country (Den Hartog, 2017). The protection of industrial buildings in China appeared on the agenda early this century—it happened for the first time in Shanghai: 'Shanghai is not only the cradle of China's modern revolution, but also the birthplace of China's modern industry and China's modern culture' (Shanghai Municipal People's Government, 2004). Since then, more Chinese cities started rediscovering the (economic) value of their remaining built industrial heritage. Shanghai nowadays counts more than a hundred re-used abandoned industrial heritage buildings that are being reused as creative factories. Almost every Chinese city, even small towns, has their so-called creative clusters. Since China has rapidly transformed from an industrial–based into a service–oriented society to stimulate the new middle class to consume, most of these creative clusters are nothing more than a collection of fashionable boutique-style shops, restaurants, and coffeehouses decorated with bookshelves where you can order 'international' food and drink coffee and wine.

Both the 10th (2001–2005) and 11th National Five-Year Plans for National Economic and Social Development (2006–2010) emphasized the importance of cultural industries as a national strategy for development, which is materialized by the construction of massive amounts of museums, theatres, and other cultural facilities. Also, the transformation of former industries into creative clusters has been used to promote culture by building museums—Shanghai is a frontrunner in this (Den Hartog, 2017). The 12th National Five-Year Plan (2011–2015) emphasized the use of creative clusters as accelerator of the urban regeneration strategy, awhile in the 13th Five-Year Plan (2016–2020) the focus area was widened with 'innovation' and 'greening' as strategies which have been materialized in the transformation of the Huangpu Waterfronts in Shanghai. Heavy industries and shipbuilding bases have made place for creative and innovation clusters. Greening is used in a decorative way to promote ecological living and culture to attract environmental technology industries.

Since the late last century, Shanghai rapidly transformed its industry driven economy into a commercial centre with skyscrapers and glimmering shopping malls. Predominantly during the last five years, this city has become further sophisticated with cultural clusters and museums that aim to make this metropolis as a competitor of Tokyo, London, and New York (Bergman, 2015), all of them built along riverbanks. In spite of censorship, China is currently the world's third largest art market—the aim is to become the number one (Hastings, 2019). Shanghai has a large share of high-income residents, and mainly the highly educated and well-travelled younger generation demands real culture, not just entertainment (Adam, 2016). A question is whether the ongoing urban regeneration and already extremely high rental prices will push artists away.

Image 3. The former Expo site has been largely underused for almost ten years now - New office parks are currently developed instead of sorely needed housing (drone photo by Harry den Hartog).

Regeneration of urban waterfronts in the central city of Shanghai

The 2010 World Expo was a turning point (Li, 2016) in redefining Shanghai's relationship with its waterfronts. It started with cleaning up the Huangpu riverbanks, which had been used intensively by the navy and shipyards. Most of these wharfs and related industries have been relocated to outside the city during last two decades. The planning authorities of Shanghai arranged Expo 2010 in a relatively central urban area, deliberately aiming to further densify the city instead of contributing to the suburban sprawl. The expo gave officials also a chance to clean up the waterfronts and to reconnect the city with the water (Li, 2018; Zhang and Zhang 2011). The plans to reuse the former expo site after 2010 are ambitious.

However, at present, 10 years after the event, the expo gradually starts to realize its oft-quoted slogan 'Better City, Better Life' by redeveloping the watersides, though most of the adjacent areas are still waiting to be redeveloped. Positive exceptions are the Power Station of Art, a

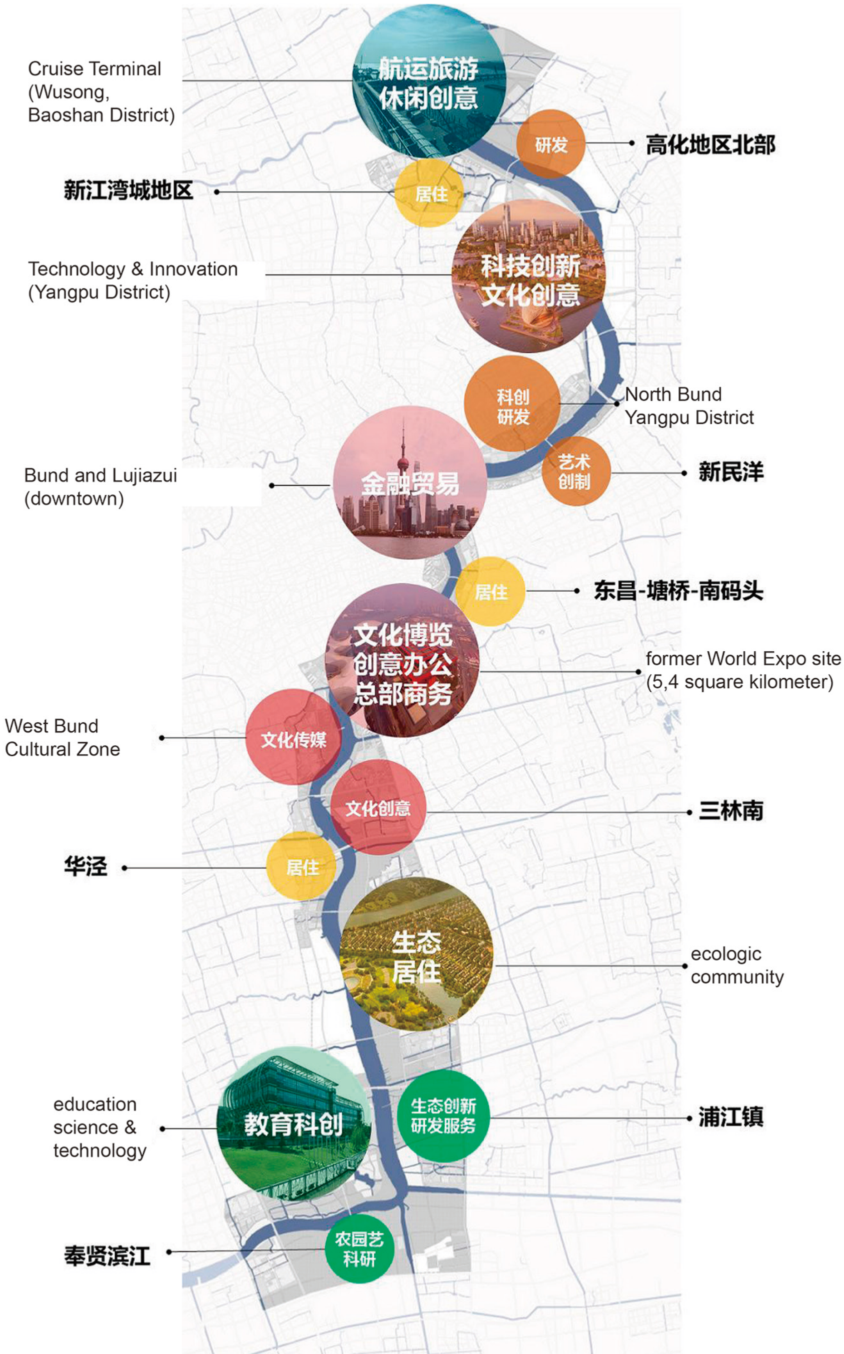

Image 4. Plan for 120 kilometer Huangpu Riverfront Transformation (image adjusted by author; original by Shanghai Planning and Land Resource Administration).

former power plant that became home to one of China’s most avant-garde galleries, while the China Art Museum and the Mercedes Benz Arena still play host to popular events. Nevertheless, most of the other buildings have been demolished, and on the south bank of the river a dozen office towers were constructed three years ago without showing any signs of urban street life. For municipal officials, mega events are great excuses for revitalizing and rebranding the city (Van Vrijaldenhoven, 2007). But too often the vitality of the host city is undermined by a lack of long-term strategy. Meanwhile, huge residential and commercial areas are sprawling across fertile agricultural land in the countryside outside Shanghai. The ambitious promise to give the expo site back to the city has so far not been fulfilled yet, with only a few dozens of underused new office complexes and malls on the site, instead of the urgently needed housing. However, this could change soon if more residential complexes are built and if the accessibility is improved.

Since the expo ended, many ambitious waterfront projects are seeking to rejuvenate the Huangpu’s riverbanks, an indication that Shanghai is starting to embrace its position at the mouth of one of the country’s most iconic waterways. Since 2010 the Huangpu’s waterfronts have been redesigned into recreational spaces for the city and its citizens. Local authorities have made a very serious effort to clean up the riverbanks and improve Shanghai’s image as a city along the river. Starting with the completion of the redevelopment of the classic Bund in 2010, policymakers and planners have reimagined waterfronts as recreational spaces, with a series of design competitions (between 2013 and 2018) in a 42-km stretch of waterfront along the river: South Bund, West Bund, North Bund, and East Bund. Shanghai is rediscovering itself as a city above or along the water, and long stretches of waterfronts are being used as recreational spaces for the city and its citizens for the last few years (Shanghai Planning and Land Resource Administration, 2018). Redevelopment of the Suzhou Creek, which used to be one of China’s most polluted waters only two decades ago, is another indicator of change in appreciation of watersides among developers and policymakers. Luxurious high-end housing complexes have sprung up along its banks, overlooking the newly odour-free river. Currently, the Hongkou Creek is preparing itself for a similar transformation.

Along the Huangpu’s waterfronts, after the Expo 2010, the West Bund project was initiated with a biennial, in line with the Museum Mile in New York and South Bank in London. Big names like Oriental DreamWorks, IMAX, Legoland

Image 5. A small fragment of the 42 kilometer of new waterfront with many references to its industrial past (photo by Harry den Hartog).

Discovery Centre, Centre Pompidou, and Prada Foundation were attracted to settle down here. Opposed to grassroots artist initiatives, West Bund is totally government-driven. The state-owned West Bund Development Group organized an art & design fair in September 2014. This also attracted investors and entrepreneurs—the Chinese–Indonesian tycoon Budi Tek asked the Japanese architect Sou Fujimoto to transform an old airplane hangar into the Yuz Museum.

However, an issue yet to be addressed is the fact that most of the above-mentioned ambitious waterfront projects have so far taken the form of large amounts of offices and some high-end apartment buildings and hotels, and most of them remain empty due to speculation motives. The new public spaces look very attractive, but they are used by a relatively small part of the citizens—they are far from metro and bus lines and there are many limitations pertaining to usage. While the dangers of swimming are clear, even fishing is prohibited and it is often hard to find a place to just sit down and enjoy the view of the water. Additionally, the construction of barriers against a rising water level means that people in many places are prevented from interacting directly with

Image 6. The connection between the city and the waterfront park is limited and many of the adjacent buildings still turn their back to the park and the water (photo by Harry den Hartog).

Image 7. A positive exemption is the West Bund Cultural Zone which is intensively used for playing and picnic (photo by Harry den Hartog).

Image 8. Tank Space - A high end exhibition space in reused oil tanks that opened last year (photo by Harry den Hartog).

the water. The Cool Docks is a promising redeveloped area along the South Bund that opened in 2010—this is one example of an area where glitzy restaurants, hotels, and penthouses remain relatively empty. Currently, this area is already undergoing its second redevelopment, less than 10 years after its start.

The current transition of Chinese society is reflected in the controlled transition of public spaces and urban settings along the watersides. All these are aimed at bringing in economic prosperity and improving the public image and status. The real potential of urban watersides seems to have been unnoticed by managing authorities, while the space for spontaneous usage (fishing, playing) is strictly limited to certain areas. Meanwhile, many buildings along the waterside are still not turning their front to the water—they are oriented towards the roadside.

Testing out different ways of making better cities, often with foreign collaboration, are supposed to be a key to this strategy of improving the quality of live and stimulating the economy. Although the process of collecting inspiration and innovative ideas through 'shopping' under international design competition entrees appears to be highly experimental, it sometimes remains unclear if the decision-makers learn that during their innovation journey. Nevertheless, multiple

Image 9. A former cotton spinning factory which has been temporary reused as exhibition space during an art biennial in 2019 (photo by Harry den Hartog).

adjustments during the process of design and implementation suggest that there is at least an intention to learn and discuss. The situation of the Cool Docks is a clear sample. Here several tests and improvements have been executed—tests with various typologies of integrating a flood barrier in the public space, and tests with activating this formerly remote area by implementing an artificial beach— and currently a new boardwalk with improved visibility of the water is being built.

Discussion and conclusion

The Ministry of Construction of China aspires urban expansion and construction of real estate as primary tools to stimulate the economy and raise the standard of living. But cities are meant principally as living spaces, and the creation of a sense of home and belonging is essential. An increasing uncertainty in terms of climate change, environment, and the national economy calls for a paradigm shift in architecture and urban planning.

Policymakers, developers, architects, and urban designers across the country should articulate a more coherent vision for the readjustments that should be made to our living environments. China has proven to experiment seriously—it is much more than just improvisation. It is very exciting to see what this transition could mean for the appearance of architecture and urban planning in the near future, as well as its scope in forging public–private partnerships and new forms of citizen participation in urban development. Hopefully, more thoughtful experiments will follow and result in inspiring trend-setting samples that are going to transform China into a world-leading urban lab for sustainable building and urban innovation.

Though lot has been changed in a very positive way, the new relation between city and water is still a platonic one and based largely around visual factors. The new relation is mainly decorative and sometimes even defensive. That is a pity because the likes of Barcelona, London, New York, Rotterdam (Meyer, 1999), Boston, Düsseldorf, and Hamburg have shown that a wide range of design solutions are possible to bring people closer to the water safely either by introducing green slopes or by providing walkways closer to the water's edge. Hopefully, new upcoming projects will show us how we can live together with water instead of fighting or neglecting the water. This will create more opportunities for establishing new places.

Shanghai faces extreme urban and economic pressure due to an accelerated shift from a production economy towards a consumption society. Although the general quality and appearance of the implemented projects is very high, it is not automatically accompanied by the expected improvement in the quality of daily life. The revitalized industrial heritage and creative clusters are used as a top-down strategic tool in urban regeneration and especially for branding as well as adding real estate values. The new watersides have a high decorative degree, yet without fully utilizing all their potential. China is in a different phase of development as most other countries, and its unique situation of large-scale and extremely rapid transformation is unavoidably accompanied by the trial-and-error method. Lessons are being learned and improvements made continuously through new experiments.

The rediscovery of industrial heritage is very much appreciated, but it needs to go a step further with long-term goals and a more people-oriented approach. The use of industrial heritage only as a tool for branding and adding real estate values will not automatically result in a lively attractive scenery. To reach that goal, regular consultation with people using these spaces is urgently needed. People need to feel attracted in a spontaneous way. The gentrifying effects of the current projects might result in an increasing lack of diversity of users and increases the societal gap between different classes. Nevertheless, this can be overcome by integrating existing settlements and spatial structures, and if necessary, by gradually improve them, instead of wiping them out and chasing away existing residents. There seems to be a discrepancy between expectations and the needs for daily life. Although the quality of the implemented new public space is very high, there is still a disparity with what is really needed: accessibility, sufficient places to sit and rest, and the space for spontaneity—the space to play. China's unique phase of development, in combination with the high speed of development and political reality (financially strong, fast changes and decisions), requires a reconnection with the reality of daily life to realize a sustainable innovation journey (Den Hartog, 2019).

The relation between urban settlements and the water used to be very direct in this region. This shifted during the period of industrialization since the late 19th century. There is now a new shift, geared towards service industries, recreation, and tourism. To be able to facilitate this in a better way, more awareness of the place-making possibilities of watersides is needed in line with already existing local conditions (historical, ecological, and socio-economical). This will most likely result in a more dynamic, functional, and pleasant urban life as a reinterpretation of the classic Chinese painting *Qingming Shanghetu*.

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Disclaimer

This paper is a further elaboration of a section taken from an earlier paper which I wrote for the European Journal of Creative Practices in cities and Landscapes (Den Hartog, 2019).

The cultural history of hydropower in Taiwan

Yu-Pang Cheng and Chin-hsing Chien

Introduction

Taiwan Island is formed on a convergent boundary between the Philippine Sea plate and the Eurasian plate. Located along the Tropic of Cancer and surrounded by the sea affected by the monsoon, frequent earthquakes, typhoons, and floods have left Taiwan with an extremely varied terrain that includes forests, mountains, and plains. Taiwan's rainy climate, abundant water resources, and fertile soil attracted people to settle there and create a culture of indigenous people. These attractive features have also drawn new residents along the rivers and the sea. During the immigration flow in the past century, a water culture, including forests, water resources, power technology, and ecological corridors, has been established there. In colonial times, the Japanese rulers used abundant local water resources for hydropower generation. Hydropower technology is related to hydrology, civil engineering, machine and electrical processes, and the construction of power plants and reservoirs. Taken together, all these have resulted in advancement of science and technology by developing a water culture, thereby promoting the development of diverse cultural zones along Taiwan's rivers.

Taiwan's electricity power industry, developed in 1897, was originally privately owned. Since having sufficient and reliable power supply was considered necessary for meeting people's basic needs, the power industry eventually became a public-owned entity. However, owing to the lack of flexibility in public electricity operations, the speed and scope of power supply could not meet the demand for electricity and the Governor's Office of Taiwan allowed private companies to supply power locally. In 1919 the Governor's Office established the 'Taiwan Electric Power Co. Ltd.' to provide abundant and low-cost electricity in order to meet the rapid growth of electricity demand. It developed the 'Sun Moon Lake Hydroelectric Power Generation Plan' to drive industrial growth. At the same time, the Taiwan Electric Power Co. Ltd. gradually integrated both private and public electricity industries to operate the island's electricity industry. The development of Taiwan's electric power industry is based on hydropower. The change and evolution of electricity generation assisted the development of the domestic economy and industry. These changes and evolution show not only the development process of the Taiwan Power Company (TPC), but also the process of industrialization and modernization in Taiwan over the past 100 years (Civil Affairs Bureau of the Governor's Office of Taiwan, 1918; Civil Bureau of the Governor's Office of Taiwan, 1919; Lin, 1997; Lin, 2011; Watanabe, 1946).

After completion of the first run of a river hydropower plant (old Kueishan Power Plant) in northern Taiwan in 1905, the Houli Power Plant in central Taiwan and the Zhuzhimen Power Plant (now the Chumen Power Plant) in southern Taiwan were gradually and successively built. Until the 1910s, owing to a massive hike in the demand for electricity demand, the Governor’s Office of Taiwan surveyed to measure the power generation potential of all water systems in Taiwan, taking stock of rivers available for the development of power plants, in order to understand the potential of Taiwan’s water resources. In 1919 a map of hydropower sites of Taiwan was drawn, showing a whole picture of Taiwan’s hydropower generation potential. Prior to 1960, Taiwan’s electricity supply was mainly powered by hydropower, and water was the only resource for electricity (Bureau of Cultural Heritage, 2010; Tachiachi Power Plant, 1999; Taichung County Government, 1989; Taipei County Institute of Cultural History, 2005; Taiwan Power Company, 1967).

Owing to the geographical obstacles, eastern Taiwan developed independent power systems in response to the needs of aluminium production and the livelihoods of locals. Since 1919, hydropower has been developed here. Natural disasters and the impact of the Pacific War led to severe damage of the power plants. After 1945, however, the TungPu Power Plant successively developed new power plants after repairing the damaged ones and expanded and reorganized its business. The eastern Taiwan power system is operated and maintained by the TungPu Power Plant. Each hydropower plant is scattered in the regions of the Heping river, Liwu river, Mugua river, and the Shoufeng river, each with its own unique historical story. In addition to providing reliable power in the eastern region, it also provides stable irrigation water for downstream farmlands. The ChinShui Power Plant, which started operating in 1939, is currently the oldest unit in eastern Taiwan. The dedicated hydro-generator has been operating for 80 years and the old power plant building is also in good condition, witnessing the change of the times. The TungPu Power Plant owns various hydro-generators. At the same time, owing to its geographical location, this power plant develops an independent overhaul and maintenance technology—it has become the leader of TPC's hydropower maintenance technology (Taiwan Power Company, 1958; 1986a).

Rural civilization

At the beginning of the 20th century, the Governor's Office of Taiwan further set up hydroelectric power plants to utilise agricultural irrigation water resources. The run-of-river power plant uses the water level from agricultural irrigation to generate electricity, and the water flow after electricity generation is used for agricultural irrigation. The run-of river hydroelectric power plant usually has a sedimentation tank, which decreases the turbidity of the water by allowing sand and gravel suspended in the water to settle. This reduces the degree of power plant turbine wear and provides cleaner downstream water for people's livelihood and agricultural activities. A rural civilization industrial culture was established in combination with the run-of river hydroelectric power plant and agriculture. A well-preserved example of these first-generation run-of river hydroelectric power plants can be seen at the Houli Power Plant, Chukeng Power Plant, and the Chumen Power Plant (Taiwan Power Company, 1971).

The Chumen Power Plant in Meinong, Kaohsiung City, southern Taiwan, is the oldest run-of river hydroelectric power plant and its facilities are still in good condition. In 1908 the Governor's Office of Taiwan started construction of the Chumen Power Plant and the Shizitou Canal irrigation system. In future, it will develop more than 60 km of canals to irrigate nearly 5,000 hectares of farmland in Meinong areas and to meet the electricity demands of Dagou's (called Kaohsiung City nowadays) Port Project. The Chumen Power Plant looks like the heart of the Meinong plain. The canal flowing through the tail water of the power plant is like the aorta of that plain. Each paddy field is like a cell of the body. This aorta transports nutrients and water to every piece of rice fields, and the people of Meinong depend on the food that grows in these fields and the culture that grows out of the grain.

In 1991 the TPC took steps to rebuilt the Chumen Power Plant. The original plan was to demolish the old power plant building and the turbine generator for the new unit. One of the resident technicians, Mr Zhong Xing Fu, based on the close connection between the Chumen Power Plant and the development of the Meinong area, successfully petitioned for the preservation of the original facility. In 1992 the Chumen Power Plant was designated as a third-level monument.

It was later designated as a national monument in 2003. The site was the first industrial monument in Taiwan. The plant and turbine generator of the Chumen Power Plant had been in operation since 1909 and were decommissioned in 2002. Under proper maintenance by the TPC staff, the well-preserved condition for such cultural heritage has impressed the original manufacturer and experts. Even in 2008 the aged and new plants and units were still in function. The combination itself reveals the spirit of sustainability of hydropower generation and the TPC's management concept (Taiwan Power Company, 2010b).

Subsequently, when the Choshui Power Plant project was renewed in central Taiwan in 2004, the old plant and turbine generator sets were retained as historical evidence of the water culture. During the Japanese rule, the engineer Yata Yuichi designed farmland water conservancy projects for southern Taiwan, built the Chianan irrigation system in Tainan, and built the Choshui Power Plant to supply the required power. The power plant is the only run-of river hydropower plant located on the central Taiwan plain. The facilities and unit were built during the Japanese rule and are still in good condition (Taiwan Power Company, 2011a; Yunlin County Government, 2008).

Industrial civilization

To support the Pacific War during the Japanese rule, the 'Five-year Hydropower Project, focusing on the Zhuoshui river, was conducted in 1934. Completion of the 'Sun Moon Lake Hydroelectric Project', which was centred on the Sun Moon Lake, can be found in central Taiwan and acts as a reservoir. The works included the Wujie Dam, which was built in the upper reaches of the Zhuoshui river to intercept the water. The water, which is used for power generation, is sent to the Sun Moon Lake for storage. The Shuishih Dam and the Toushih Dam, which were built in the Sun Moon Lake, increase the capacity of the lake. Waters of the Sun Moon Lake can be directed downstream through the Takuan and Chukung power plants for power generation (Taiwan Electric Power Co., Ltd., 1935).

When the Takuan Power Plant was completed, it became the largest power plant in Asia as well as the first power plant in the Zhuoshui river basin. It was Taiwan's most proud achievement. The tail water, in turn, gets discharged to the lower reaches of the Zhuoshui river where it is used for further power generation, irrigation, tourism, public water supply, and other benefits. By affording sufficient power supply, Taiwan's industrialization progressed by leaps and bounds. Sun Moon Lake hydropower plants promoted the development of an industrial culture in the downstream areas (Taiwan Power Company, 1995).

After 1945 the TPC successively completed hydropower generation facilities such as the Wusheh Dam, Wanda Power Plant, Wanda Expansion, and the Songlin Branch in the Zhuoshui river basin. The TPC uses the Sun Moon Lake’s water volume and geographical location to develop pumped storage power plants. Over nearly a 100 years (from 1918 to 2012) of hydropower construction, restoration, and expansion, the Zhuoshui river basin became the largest hydropower generation area in Taiwan (Taiwan Power Company, 2012).

The Zhuoshui river basin also has an enriched water culture and industrial cultural assets. There are not only properly preserved power station buildings, turbines, generators and equipment installed during Japanese rule, but also modern hydroelectric generators and pumped storage power plants. New and old equipment coexist simultaneously. Representing the cultural heritage of the TPC’s hydropower, it has contributed greatly to Taiwan’s industrial civilization (Zhongxing Engineering Technology Research Development Foundation, 2011a; 2011b).

Technical industrial civilization/ Civilized living

The Dajia river has a steep slope, plenty of water, and a hard side rock formation, all of which make it an excellent candidate for hydropower generation. In 1922 the Sheliaojiao (the current name is Sheliao) run-of river hydroelectric power plant was built to provide electricity and cleaner water for agricultural and livelihood use downstream. In 1939 the ‘Ten-year Hydropower Plan’, focusing on the Dajia river basin, was conducted. The construction of a large-scale hydroelectric power plant (Tienlun Power Plant) began. Since 1945, the TPC promoted the ‘Dajia Integrated Development Plan’, which was implemented after 60 years. From downstream to upstream, power plants and dams, such as Tienlun, Kukuan, Chingshan, and Techi, were built, while the Ma'an Power Plant was completed by 1998. Hydropower plants along the Dajia river have been able to operate in a series of water storage and utilization of the Techi Reservoir, making full use of the hydropower resources in the Dajia river basin. It is an important base for the TPC’s conventional hydropower (Zhu, 2016; Taiwan Electric Power Co., Ltd., 1941; Taiwan Power Company Civil Office, 1947; Taiwan Power Company Tianleng Agency, 1953).

The TPC has accumulated abundant experience in the construction of hydropower plants and dams through a series of hydropower plant project in the Dajia river basin, enhancing the Taiwan dam technology. It introduced unit operation technologies from Japan, Europe, and the United States. Together with the intelligent work of its employees, the TPC developed unique electricity-specific hydropower operation and maintenance technologies. Five large (1.15 million kilowatts) serial hydroelectric power plants were set up in the Dajia river. In the Sun Moon Lake, the Takuan Pump Storage Power Plant (1 million kilowatts) was completed in 1985, while the Mingtan Pump Storage Power Plant (1.6 million kilowatts) was built in 1993. Taken together, they can provide nearly 4 million kilowatts of power during peak periods to support the Taiwan power system for high-quality power supply. So, they helped regional industries in Taiwan to enter the period of science and technology. Taiwan is supported by high-quality electricity. High-tech industries and a flourishing economy have led to the betterment of civilized living in Taiwan (Taiwan Power Company, 1985; Zhongxing Engineering Technology Research Development Foundation, 2012).

Ecological civilization

In the 1990s and early 2000s a series of natural disasters led to a great deal of reflection on the interdependence between power plant construction and the natural environment. On 21 September 1999, the 921-Earthquake hit Taiwan and directly damaged the Shigang Dam at the lower reaches of the Dajia River. Owing to serious collapse of earth and stone in the catchment area of the Dajia river basin in the years after the earthquake, the Dajia riverbed has greatly increased. Furthermore, a series of typhoons—Taozhi and Mintoli—continued to hit Taiwan in 2001 and again in 2004, thereby causing flooding and other serious damage to the large hydropower plants along the Dajia river basin. All these incidents made the TPC rethink and re-evaluate the relationship between nature and power construction. The TPC, therefore, conducted reconstruction of the plants in the Dajia river basin, the Kukuan Power Plant, and the Chingshan Power Plant with an increased attention to eco-friendly and sustainable construction technologies, one after another to repair silting, damaged power plants and waterway facilities. The TPC considers limited environmental impact and forced remediation of collapsed land, as well as the promotion of the ecology of hydropower and low-carbon fossil power plants as the main measures to move towards eco-civilization along with other industries in Taiwan (Taiwan Power Company, 2010a; 2015).

The TPC provides high-quality services and regards the sustainability of surroundings as essential. The transformation process between water and electricity resources provides a lot of wisdom from which humans can learn and continue to follow a water-based cultural model.

The TPC has actively promoted the construction of an eco-power plant in recent years. In 1993 the construction of the Ma'an Dam in the Dajia river basin was taken up for reducing the human impact on the environment and the ecosystem. For the first time, a waterway for fish was established on the dam to allow the coexistence of technology and nature. While considering the needs of different types of fish, ladder-shaped waterways and traditional waterways for fish were built. A subsequent waterway for fish was built on the Shilin Dam in the Da'an river basin. The Tachiachi Power Plant promotes various environmental protection measures and has been given the Annual Enterprises Protection Award (AEEPA) and the Taiwan Corporate Sustainability Award (TCSA). The promotion of the Dajia River Ecological Corridor will enable the past century's water culture of the Dajia river basin to be combined with environmental conservation, thereby leading the next generation of Taiwanese cultural development (Taiwan Power Company, 2002; Tachiachi Power Plant, 2012).

In 2010 the Wanda Power Plant actively integrated its environmental resources in the local area. They launched a rare plant rebreeding programme, Taiwan soybean, and in 2017 obtained the Environmental Protection Agency's (EPA's) Environmental Education Facility Site Certification. Other hydropower plants are also actively participating in fish fry release, butterfly rebreeding, and/or environmental monitoring to ensure an eco-friendly environment and co-existence of power facilities.

Achievements of TPC water cultural assets

The TPC's hydropower plants have kept a large number of hydro-generators and buildings for more than 50 years. Some original equipment is no longer available or cannot be obtained. The maintenance technology has been passed down from one generation to another. New work methods and technologies have been studied and examined to maintain the normal operation of old hydro-generators. It is said to be the pioneer of the circular economy. At the same time, a large number of drawings, technical documents, and photos left over from the Japanese rule were saved, except for the maintenance and operation equipment. There are enthusiastic employees who devote their efforts to the preservation and organization of the history and historical data of power plants so that younger people can understand the glorious traditions of the power plant and the inheritance from one generation to another. The TPC's hydropower culture combines the advantages of Taiwan, Japan, Europe, and the United States and develops its own unique culture.

In the late 20th century the TPC has preserved the concept of the cultural heritage of the hydraulic industry. However, the TPC Cultural Heritage Management Team originally focused only on old power plant buildings or buildings that have been registered as monuments or historic buildings. For example, in 1987, when planning the reconstruction of the Cukeng Power Plant by taking the initiative to fully retain the plant built in 1909, only two old water turbine generators were dismantled and upgraded to new units, while other existing hydro-generators were kept for public visit. Later, some power plan buildings were subsequently announced as monuments or historic buildings. For instance, the Chumen Power Plant in 2003 was designated to be a national monument and was also the first industrial monument in Taiwan. In 2004 the Zhuoshui Power Plant was designated to be a monument in Yunlin County. In 2005 the Dongxing Power Plant was registered as a historical building in Taitung County. In 2011 the Kueishan Power Plant, Wulai Power Plant, and the Chukeng Power Plant were registered as historical buildings in New Taipei City. In 2019 Unit G of the dormitory of the Tongmen branch of the TungPu Power Plant was also registered as a historical building in Hualien County (Taiwan Power Company, 2018a; 2018b; 2018c; 2019a; 2019b).

Fortunately, since the TPC launched the Major Cultural Assets Preservation, Operation, and Maintenance Project in 2016, the scope of cultural assets' preservation should be divided into documentary and non-documentary categories (including machinery, equipment, and buildings). Because of the project, a lot of resources have been put into the process for the preservation of hydropower documentation. From 2016, it carried out the investigation and collection of cultural and historical data preservation for the Chumen Power Plant, Zhuoshui river basin, Dajia river basin, Xindian river basin, and the Mugua river basin. Based on the guideline of 'collecting research first and then displaying education', the methods to build an inventory of cultural assets and interview employees and residents are used in order to preserve the hydropower cultural assets accumulated by the TPC for 100 years as well as to witness the cultural development of the hydropower industry. The implementation results include exhibitions, films, and books (Taiwan Power Company, 2019c):

1. Exhibition: Through the investigation and collection of thematic historical and historical data, we will organize and research all related historical contexts. We will also conduct oral historical interviews to form the storyline of the 'exhibition'. The results will be physically displayed in each exhibition hall.
2. Film shooting and book publishing: Convert the graphic content of research results, oral historical interviews taken, and the process of inventory of cultural relics into books or videos, thereby accumulating inventory results and benefits.
3. Digital collections and digital museums: Thematic curatorial exhibits are digitally collected through digital operations such as taking pictures and scanning. All digital art files and digital archives obtained from the curation will be converted into digital museums for online display so that the public can appreciate them. It can also be combined with company policies to achieve the goal of educational communication.

The result of this inventory has been demonstrated by the Taiwan Power Cultural Heritage Preservation Special Exhibition. Through the promotion of the 2018 Power Land and 2019 Power of River and Electricity, the TPC has become a pioneer in preserving and displaying cultural heritage for state-owned enterprises. Through interpretation and exhibition, the TPC can display the values of cultural assets and the results of its efforts to the public. These efforts by the TPC have been receiving positive feedback.

TPC's future perspective on water culture

The TPC will continue to carry out asset inventory, filing, and archival management on the existing basis through interpretation and exhibition. It looks forward to re-empowering and giving values to relics and library data with the following long-termed goals:

1. Finding the missing puzzles: The TPC started with the Chumen Power Plant, Zhuoshui river basin, Dajia river basin, Xindian river basin, and the Mugua river basin, based on cultural history data collection and documentation in 2016, for cultural heritage preservation. The TPC further plans to systemically collect and document historical data on different themes on hydropower to show its strength on cultural heritage preservation.
2. Virtual reality interaction system: The application of a virtual reality interaction system and online database helps wider scopes of communication with the common people. The development of an online documentary database

helps building up the inventory, user profiles, and follow-up management and maintenance operations. Moreover, after accumulating a certain amount of online data, an integrated digital museum can be launched to provide the public with more flexible and easier ways to search and browse for cultural and historical data, material, and literature on electricity in Taiwan. The TPC aims to enhance the overall experience for its audience and present a friendlier image to the public.

3. Networking with experts, scholars, and specialists: The TPC continues to host forums, seminars, education training, and other networking mechanisms with experts, scholars, and specialists to communicate with professionals on the TPC's power electricity heritage preservation in a better way. The exchange of ideas and knowledge will continue to help the TPC find innovative ways of preserving its cultural heritage.
4. Cultivation of cultural heritage on power and electricity: The TPC integrates the historical data of different power plants with the historical pattern of regional development. This is being done to show its value and invite local historians as well as residents to participate in the programme.
5. Ensure the most suitable arrangement and development is made for the cultural heritage preservation for the TPC:

In addition to hydropower generation, TPC cultural assets include strategic administration, fossil power, nuclear power, construction, power supply, power transmission, and distribution. The TPC's cultural heritage preservation covers a wide range in data collection, research themes, maintenance, record keeping, exhibition, education, and other highly professional fields. So, the TPC will recruit professional teams having expertise in these areas to ensure that it has the appropriate targeting audience and organization system to run operations. The appropriateness of the exhibition, along with regular update of the online database and its maintenance, will also be monitored.

Conclusion

The TPC will properly keep and maintain various water cultural heritages in accordance with the Cultural Assets Preservation Law. Based on its historical heritage responsibility and sustainable business philosophy, we will continue to promote the preservation of cultural assets. Through the mechanism of preservation and maintenance, it will implement the work of preservation, maintenance, education, and inheritance. It is expected that in the preservation of water cultural assets, we will demonstrate the evolution of the TPC's heritage in hydropower operation and maintenance in future and strive to achieve diversity in the preservation of cultural assets. With the promotion of power construction, the TPC’s tangible and intangible industrial and cultural assets are the most authentic and indispensable proof of Taiwan's historical development and industrial culture, and they can provide contemporary or future generations with references.

The TPC expects that the planning of important cultural heritage preservation, operation, and maintenance project on various themes would allow its employees, staff members, and the public a thorough understanding of the importance of cultural heritage preservation.

We expect to achieve the following objectives:

1. Preservation: Record the TPC’s precious cultural heritage and explore the common memory of the development of Taiwan's electricity industry in order to consolidate the emotions and consensus of employees.
2. Research: Record the joint growth process of the electricity industry and Taiwan's economy and present the TPC’s culture and glory, especially how it has become a historical power electricity information centre over the years.
3. Social communication: It is expected to serve as an information media centre for sustainable development of the enterprise and to promote closeness to the people. It is also expected to prosper regional development and communicate with society.

The TPC will systematically organize and preserve the documents and historical data accumulated over the past 100 years in Taiwan’s power industry. Through these documents and the data, the TPC can gradually build up a historical and cultural scope not only to retain the collective memory and recognize the past developments of the Taiwan society, but also to preserve industrial cultural assets within the TPC in a sustainable manner.

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Integrating water into heritage conservation – Cheng Mei Ancestral Hall, Second Babao Irrigation Canal, and Yongjing

Queenie Lin and Yin-Chun Wei

Introduction

The Cheng Mei Ancestral Hall (成美公堂, Cheng Mei Kong Tong, Image 1), located in Yongjing Township, Changhua County, Taiwan, is the ancestral estate of the renowned Wei family from Central Taiwan. It was built in 1885 adjacent to one of the biggest irrigation systems in Taiwan, Babao Canals (Image 2), allowing the Wei family to manage the canal affairs for Yongjing. The mansion was built following traditional construction methods and in accordance with the family's emotional cohesion, which not only creates an environment to nurture the offspring and acts as the social and cultural centre for the local community, but also portrays outstanding craftsmanship and cultural significance. It is a unique fusion of Hoklorized Hakka[1] (fulao ke, 福佬客) culture and architecture, which is considered one of the most important historical residential estates in Taiwan. Therefore, the mansion was designated as a County Historical Building in 2008.

Like other historic residences, the Cheng Mei Ancestral Hall had its ups and downs over the past centuries, including overoccupancy and negligence of maintenance. In addition to natural hazards like humidity fluctuation, salt efflorescence, and pest infestation, other threats due to climate change, such as heavy rainfalls and typhoons, also increased. The disastrous Chi-Chi Earthquake in 1999 was the last straw to devastate the Hall; however, this calamity united the Wei family and initiated a comprehensive conservation plan to prevent their ancestral home from further destruction. In 2004, the Wei family started preparing the long-term conservation project of this mansion,

[1] The Hoklorized Hakka culture is a unique hybridization of Hakka and Minnan cultures in Taiwan, which are ethnically of Hakka origin but is completely integrated with the Minnan society, language and lifestyle. Therefore, a large number of Hoklorized Hakka people are not aware of their Hakka origins. It has very complex provenances and various forms of expression, so no infinite definition has been confirmed. For details regarding the definition and significance of the Hoklorized Hakka culture that the Wei family and Cheng Mei Ancestral Hall represent, please refer to the research by Lin and Huang, 2020.

Image 1. The Cheng Mei Ancestral Hall surrounded by the Second Babao Irrigation Canal in Yongjing, Changhua (Tinghsin Hote Foundation).

Image 2. Irrigation Layout and Water Supply Plan of Babao Irrigation Canals Managing Organization (八堡圳水利組合給水計畫圖) (Center for GIS, RCHSS, Academia Sinica).

including extensive family history research and Yongjing area study, in order to interpret the relationships between the Cheng Mei Ancestral Hall, the Second Babao Irrigation Canal, and the Yongjing area. The architectural conservation process started in 2009 and was completed in 2012. It was one of the first architectural conservation projects in Taiwan initiated by private sectors, and one of the first to follow international conservation principles and practices.

This article aims to analyse how the family mansion was built in accordance with the canal and in balance with nature, and how to preserve the building from risks caused by water. Many original planning perspectives were revealed during the research process, including how the mansion was designed according to Feng Shui[2], the Chinese geomantic principles, and how water played a crucial role in leading the energy flow of the house. Furthermore, it analyses how the water element was carefully considered during the architectural conservation process in order to prolong the lifespan of the building and provide a sustainable environment for the Yonging community. Finally, this research will emphasize how the family looks after the canal and cooperates with the local community in order to maintain sustainability with the regional transformation and regional identity.

Babao Irrigation Canals

Water has always played a critical role in the regional agriculture in the Changhua Plain. The Changhua Plain in Central Taiwan is an alluvial fan between the Zhuoshui River and the Dadu River which gradually descends and forms a declining slope from the Bagua Mountains in the southeast to the ocean in the northwest. The longest river in Taiwan, the Zhuoshui, runs all over Central Taiwan and the Changhua Plain, dominating farmland fertilization in Taiwan even today. The high temperate all year long and inconsistent water supply due to distinct wet and dry seasons originally limited farming, and the Chuanghua Plain was barren and could only serve as a hunting ground for Pingpu aboriginal tribes (Huang and Chien, 2019, pp. 51–52). Therefore, the Babao Irrigation Canals extracting water from the Zhuoshui River were constructed between 1709 and 1719 during the Qing Dynasty, and they still serve as one of the three oldest and largest irrigation canal systems in Taiwan till today (Wang, 2003, p. 104). In 1709, the canal construction was led by Mr Shi-bon Zhi, an officer (candidate for the Imperial Examination, 貢生) from the Qing government (Wang, 1976, pp. 42–49). The canal provided abundant and stable irrigation supply that attracted many immigrants from the Chinese mainland to cultivate in the Changhua Plain, which ignited the development of Central Taiwan.

Apart from the construction methods used in building individual dikes and sluices, the Babao Canal was built under a comprehensive planning based on the irrigation of the entire Changhua Plain (Image 3). The canal intake was set at the highest point in the Changhua Plain, allowing the water to flow naturally in line with the height difference of the terrain, and the canal was built accordingly to form a meticulous irrigation system (Ku,

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[2] Feng Shui (風水), literally means 'wind and water', is a traditional geomantic practice that comes from China, allowing energy forces to harmonize individuals with their surrounding environments.

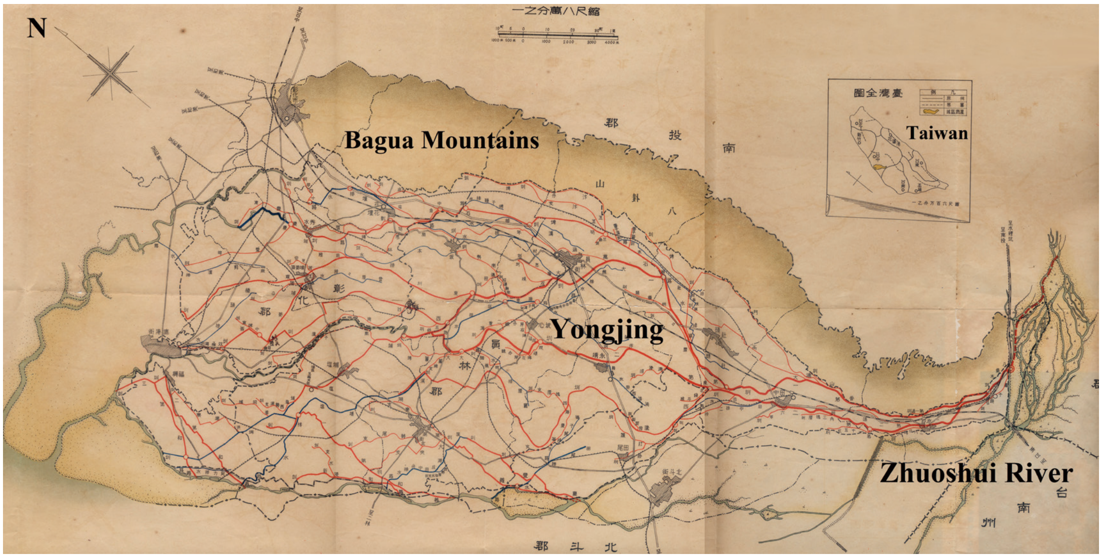


Image 3. The network and location of Babao Irrigation Canals and relative location in Taiwan ('The Babao Irrigation Canals Managing Organization [八堡圳水利組合概要], 1939', collection of Taiwan Chang Hua Irrigation Associations).


Image 4. Mr Lin's Temple (Lin, in 2019).

2000, pp. 53–57). Legend has it that Shibon Zhi encountered many obstacles at the early stage of constructing the canal and eventually managed to resolve the problems with the help of a local peasant, Mr Lin, who advised on barrage-building techniques. Therefore, a Mr Lin Temple (林先生廟, Image 4) was built near the canal intake to pay respect to those who contributed to the establishment of the Baobao irrigation canals. The name Babao emerged in the Japanese period (1895–

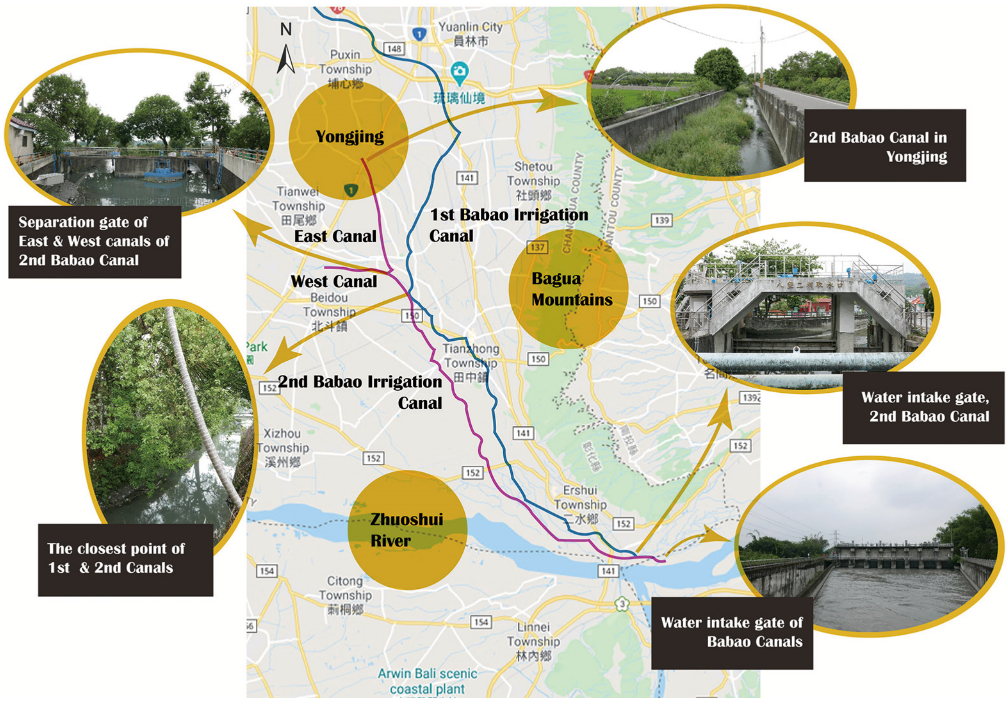


Image 5. The landscape and current state of the Second Babao Irrigation Canal: 1. Water intake gate of the whole Babao Irrigation Canals (designated Historical Building); 2. Water intake gate of the Second Babao Irrigation Canal; 3. The Second Babao Irrigation Canal in Yongjing; 4. The closest point of the two Canals; 5. Separation gate of East & West canals, the Second Babao Canal (drawn by Queenie Lin; photographed by Queenie Lin, 2019; map: retrieved from Google Maps).

1945), representing the eight administrative districts that the canals connect and irrigate. It has two main branches, the first canal to the east and the second to the west. It is the second canal that runs through Yongjing and the Wei family mansion. The Babao Canals irrigate around 18,200 hectare of farmlands each year, which dominates the farmland fertilization in Taiwan even day (Wang, 2003, p. 104; Huang and Chien, 2019, p. 53).

The Second Babao Irrigation Canal and Yongjing

Yongjing is a rural township of the Changua County in Central Taiwan. It has an area of 21 square km and a population of 37,000 people nowadays[3]. The main source of irrigation water in the Yongjing township is the Second Babao Irrigation Canal (Image 5), which was proposed and funded by a local gentleman named Shih-ching Huang (黃仕卿) in 1721 and was

[3] For a detailed introduction of Yongjing, including area size, population, weather, landscape etc., please refer to Zhang (1995, pp. 37–40).

originally called Shi-Wu-Zhuang Canal (十五庄圳), meaning ‘the canal for 15 villages’, including the Nangang West Village where the Cheng Mei Ancestral Hall is located[4]. Thanks to the Babao Canal, Yongjing was one of the major rice farming areas in Taiwan, and nowadays it is a famous high-end agricultural production site for orchids, bonsai plants, and organic vegetables.

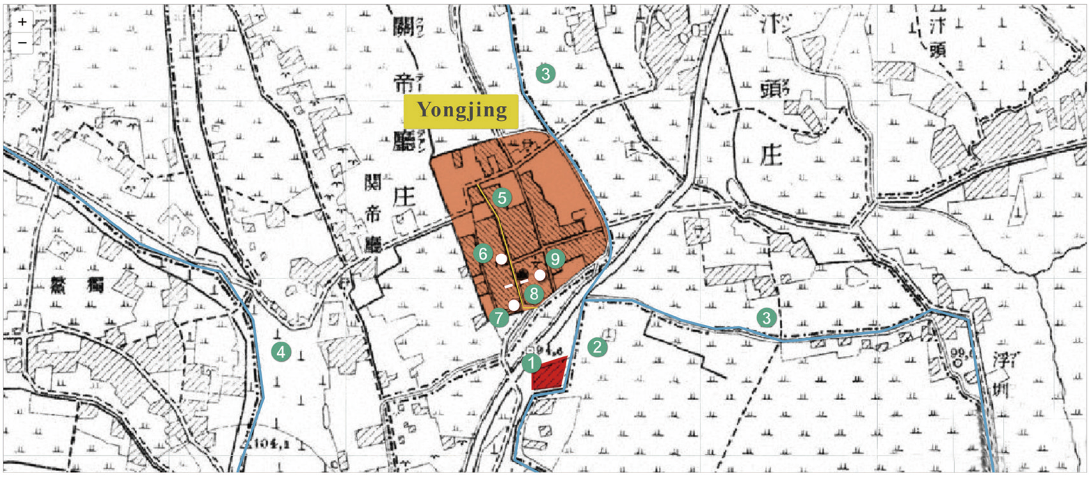
The Wei Family

The canal not only nurtures Yongjinga and sustains the picturesque landscape in the Changhua Plain, but also provides an important base for locals to form unique cultures. Among them the most notable person is Shang-ying Wei (1845–1901), a director at the Imperial Academy during the Qing Dynasty, appointed as the head of the Yongjing township and canal master to manage the Shi-Wu-Chuang Canal. He was also a traditional Chinese medicine doctor who owned a medical shop entitled ‘Wei Chengmei’, besides being an agricultural economist; many establishments of the Second Babao Canal were created under his management. With Shang-ying Wei’s active involvement with local affairs and his commitment to community welfare, he established the Yongjing Public School (1898) and Yong-dian Temple (永奠宮, 1893) together with the renowned Chen family from Yongjing (Figs. 6 and 7). His offspring inherited his will and continued to make substantial contributions to their hometown.

The Wei family and canal management

The development of irrigation systems in Taiwan relies heavily on private sectors for financial support and manpower; therefore, organizations are established for management and operation once the irrigation canals are complete (Chen, 2009, p. 96). Accordingly, new levels of management positions are also constituted, among them the most critical job being the Canal Master (圳長). Shang-ying Wei was appointed the Canal Master by the Japanese government in 1897 to manage the canal-related affairs because he was a Feng Shui expert, who had knowledge of astrology, geography, mathematics and biology, which allowed him to properly

[4] In 1907 the Shi-Wu-Zhuang Canal was incorporated into the Babao Irrigation Canal. The old Babao Irrigation Canal was renamed ‘the First Canal of Babao Irrigation Canal’, while the Shi-Wu Zhuang canal was renamed ‘the Second Canal of Babao Irrigation Canal’. For details regarding the history of the Shi-Wu-Zhuang Canal, please refer to the Institute of Taiwan History, Academia Sinica (2015, pp. 85–87). This family research, called ‘The development history research of Cheng Mei Ancestral Hall and Yongjin’, was commenced by Tinghsin Hote. It was funded and conducted by the Institute of Taiwan History, Academia Sinica during 2013–2015 as part of the conservation process. The copyright is owned by the Tinghsin Hote Foundation; therefore, many historical sources regarding the Wei family and the Yongjing area are derived from this research.



1 Cheng Mei Ancestral Hall
2 Nan-gang West drainage
3 East Canal of 2nd Babao Canal
4 West Canal of 2nd Babao Canal
5 Yongjing Street
6 Yong-an Temple
7 Yong-dian Temple
8 Cheng-an medical shop (the founding shop of Wei family)
9 Yongjing Public School (nowadays Yongjing Elementary School)

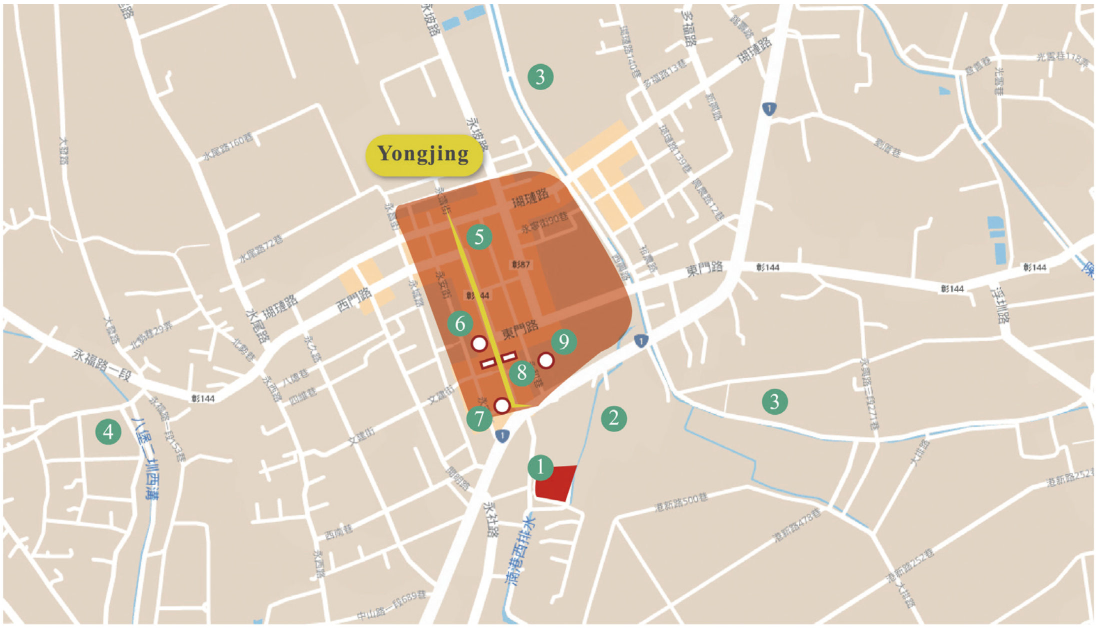
Image 6. The locations of the Cheng Mei Ancestral Hall and important establishments in Yongjing during the period of Japanese rule. (drawn by Queenie Lin; map: 'Taiwan Bau-Tu' [The map of Taiwan, 臺灣堡圖], © Center for GIS, RCHSS, Academia Sinica).

regulate the water level in the canal[5]. This was especially important as, for instance, parts of the land the Second Babao Canal crosses used to be a swamp and below water level, which is why the canal section had to be raised. Other challenges for the Canal Master included water allocation, waterway management, settling irrigation-related disputes, and water rent collection from farmers for maintaining the canals (Image 8). Since Shang-ying Wei had the expertise to sustain and balance the canal water, he was deeply trusted by local farmers, who were willing to pay the water rent. Shang-ying Wei's son Jing-ren Wei (Image 9) also became the Canal Master, continuously serving the canal and the Yongjing people.

Building the family estate—the Cheng Mei Ancestral Hall

In 1885, Mr Shang-ying Wei built the family mansion Cheng Mei Ancestral Hall as the family prospered adjacent to the canal, in order to facilitate the management of the canal affairs for Yongjing. The name 'Cheng Mei Ancestral Hall' (Chengmei Kong Tong) is derived from Shang-ying Wei's medical shop name 'Wei Chengmei',

[5] Shang-ying Wei was appointed Canal Master and the Yongjing Township Mayor in 1897 by the Japanese government as Taiwan was already under Japanese rule (1895–1945) at that time.



1. Cheng Mei Ancestral Hall
2. Nan-gang West drainage
3. East Canal of 2nd Babao Canal
4. West Canal of 2nd Babao Canal
5. Yongjing Street
6. Yong-an Temple
7. Original site of Yong-dian Temple
8. Original site of Cheng-an medical shop (the founding shop of Wei family)
9. Yongjing Elementary School (originally Yongjing Public School)

Image 7. The current locations of the Cheng Mei Ancestral Hall and important establishments in Yongjing during the period of Japanese rule (drawn by Queenie Lin; map: Google Maps).

which was given to remind the family of the family legacy and ensure the prosperity of the community.[6] The mansion was built using traditional building methods, which are fusions of Han Chinese, Hakka, and local Taiwanese traditions. In 1885, the hall was first constructed as a single bamboo structure building and then expanded twice, eventually achieving the current layout of two courtyards and double wings in 1917. It was built according to the family's emotional cohesion, which not only creates an environment to nurture the offspring, but also portrays the craftsmanship and heritage value which have been continuously appreciated; therefore, the mansion was designated as a County Historical Building in 2008. After conservation, the Cheng Mei Ancestral Hall became part of the Cheng Mei Cultural Park, which opened in 2013 (Image 10).

[6] For details of the construction of the Cheng Mei Ancestral Hall, please refer to Wei (2008, pp. 55–106) and the Institute of Taiwan History, Academia Sinica (2015, pp. 241–258).

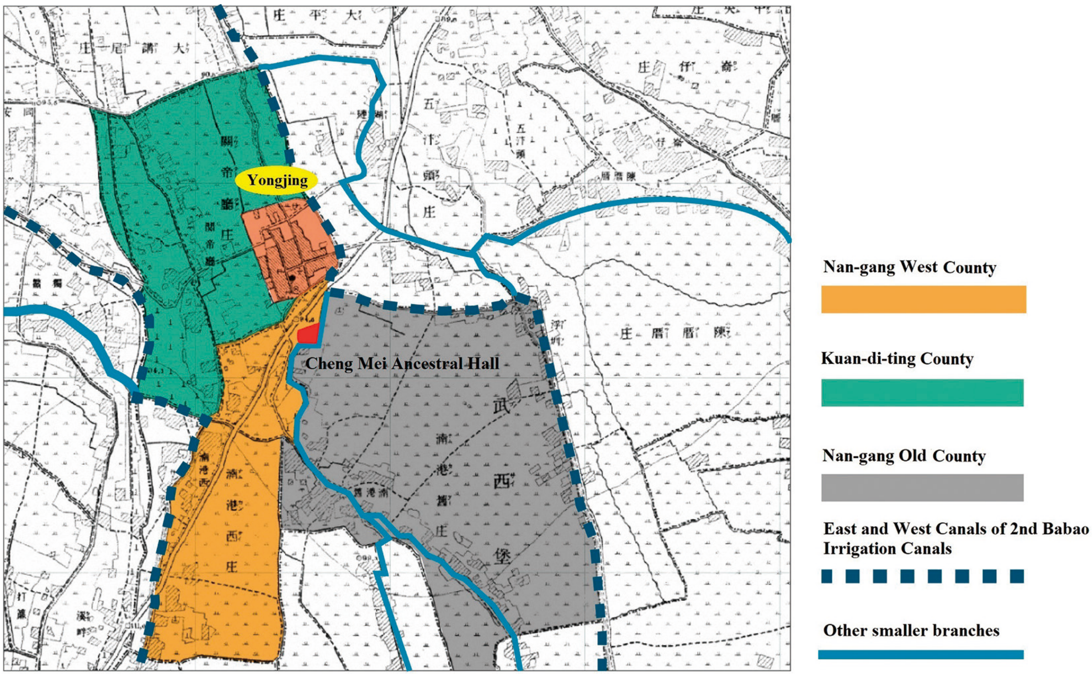


Image 8. The Cheng Mei Ancestral Hall is adjacent to the three main counties of Yongjing and forms the centre of the intensive Second Babao Irrigation Canals network that allows the Wei family to manage the canal affairs efficiently. (drawn by Queenie Lin; map: 'Taiwan Bau-Tu' [The map of Taiwan, 臺灣堡圖], © Centre for GIS, RCHSS, Academia Sinica).

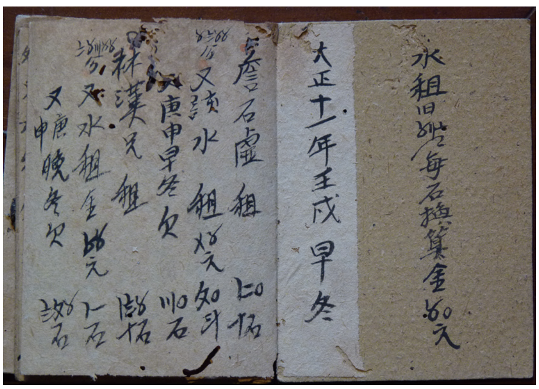


Image 9. The original water rent inventory books from Jing-ren Wei in 1922 (Tinghsin Hote Foundation).

Image 10. Current State of the Cheng Mei Ancestral Hall (Tinghsin Hote Foundation).

Water heritage of the Cheng Mei Ancestral Hall

The Cheng Mei Ancestral Hall faced severe deterioration over time due to raising damp from a high level of ground water around the canal, as well as water damage from roof leakage. In order to meet the rising concerns about the vanishing heritage of the mansion and Youngjing, Tinghsin Hote Foundation started a conservation process in 2009. Series of family and regional history research as well as intensive heritage conservation appraisals were carried out, providing valuable information about how the building was constructed in order to tailor the conservation treatises. Many original planning perspectives were revealed during the research process, for instance, how the mansion was designed according to Feng Shui principles and how water played a crucial role in leading the energy flow of the house.

Site choice and Feng Shui concern

When Mr Shang-ying Wei started building the family mansion in 1885, he chose the location at Nan-gang-Xi (湳港西) village, right across the town center of Yongjing. He specifically chose the location of the Hall embraced by the Second Babao Irrigation Canal in accordance with nature, which allows good energy flow to accumulate at the estate. In addition, it provides convenience for canal management (Academia Sinica, 2015, pp. 247–248). Water plays a critical role in designing the Cheng Mei Ancestral Hall, not just because it was built next to the canal, but also the Feng Shui consideration of waterways, including typical layout of the water at the front and a hill, Hua-tai (化胎), at the back for protection and blessing. Moreover, the terrain is high at the back

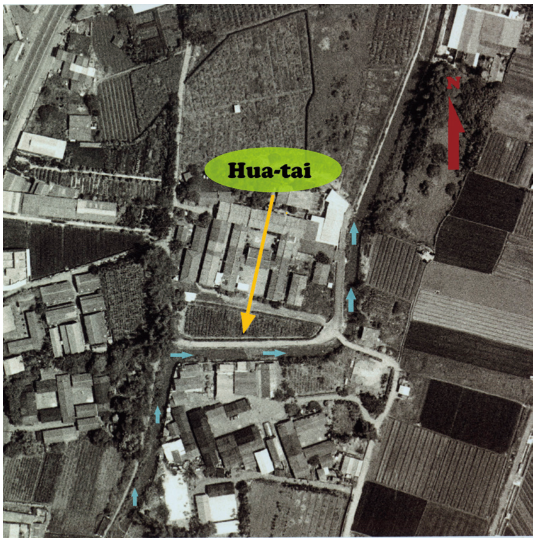


Image 11. Site choice and Feng Shui concerns of the Cheng Mei Ancestral Hall: 1. The water at the front and a hill—Hua-tai (化胎) at the back for protection and blessing; 2. The two main halls sit on the central axis that absorb the chi from the hill and water, which is also accumulated by the 90-degree turn of the canal (Tinghsin Hote Foundation, © 2016 Aerial Survey Office, Forestry Bureau, Taiwan).

and low at the front. The Second Babao Irrigation Canal flows by the Cheng Mei Ancestral Hall from the south to the north, which turns west in a 90-degree angle right in front of the Hall, then turns another 90 degrees towards the north after about 100 meters, creating a perfect accumulation of chi (great energy) and good fortune brought by the water, allowing the estate to absorb (Image 11). Contrary to most building customs that consist in avoiding water and humidity from the building, and apart from the convenience for canal management, the fact of locating the Hall adjacent to the canal was strictly a Feng Shui

Image 12. The first room of the inner courtyard tilts and leans towards the main structure, which stands for the family's business that relies on a secure foundation and implies 'Keeping the wealth within the family' (Photographed by Queenie Lin, 2019).

Image 13. The turning slope eaves (轉溝) which allow the rainfalls collected towards the courtyard bear both moisture adjustment function and auspicious meaning.

concern, which allows good energy flow to accumulate around the estate. In addition, the surrounding Canal served as a physical defence that created a boundary, following Han Chinese people, especially the Hakka custom to use natural landscapes such as valleys or waterways as a first barrier of protection, then subsequently use manmade structures such as bamboo stockades or walls for secondary defence (Lei, 2015, p. 200). It also serves as a spiritual obeisance to nature. These Feng Shui conditions created by the surrounding natural landscape closely correspond to the Feng Shui designed within the estate. Additionally, the canal serves as a spiritual defence and allowed a connection with nature.

Collecting wealth by collecting water

The Cheng Mei Ancestral Hall follows the traditional Han Chinese belief in collecting wealth by collecting water at the house. For instance, the first room of the inner courtyard tilts and leans towards the main structure as Image 12 shows, which stands for the family's business and relies on a secure foundation, implying 'Keeping the wealth within the family'. Another feature is a typical Hakka architectural design, the turning slope eaves (轉溝 , Image 13) that allow the rainfall to be guided from the ridge of the roof towards the courtyard and drain through the drainage systems along four sides of the courtyard, which allows lowering the moisture content and temperature from the roof and indoor space, and symbolizes wealth creation for the family through the metaphor of water (Lin, 2020, p. 23).

Well design: Square outside and circle inside

Besides its functions as a water-provider and a fire-preventer, the well is the core of collecting chi—the energy flow in a building according to Feng Shui practice. According to Feng Shui, it is essential to have a running water source on the premises, which provides a stable water source for people's well beings, while the running stream of well water symbolizes endless wealth. In addition, the well at the Cheng Mei Ancestral Hall (Image 14) has a square-outside and a circle-inside design that represents the cosmos: the sky is round, and the earth is in a square shape. This cosmos ideal is a typical feature of Hakka architecture, which also represents the Hakka belief that social interactions entail a combination of harmony and sophistication (circle), and rules and righteousness (square) (Chiang, 2015, p. 83). In addition, there is the Chinese Feng Shui belief of the Wuxing (五行)[7]. The Wuxing (五行), also known as the Five Elements, Five Agents, or Five Processes, implies five types of chi (energy flow): Metal (金), Wood (木), Water (水), Fire (火), and Earth (土). The ancient Chinese divided everything in the universe into these five categories according to its characteristics. It is a conceptual scheme used to explain a wide array of phenomena, from cosmic cycles to interactions between internal organs, and from the succession of political regimes to the properties of medicinal drugs. According to Wuxing, there are two sequences: in order of 'mutual generation' (相生), they are Wood, Fire, Earth, Metal, and Water; and in order of 'mutual overcoming' (相剋), they are Wood, Earth, Water, Fire, and Metal. For this reason, the well design of the square shape outside and circular shape inside is thought to generate the best energy flow; following the 'mutual generation' ideal of Earth (square) creates Metal (circle), while Metal collects water, which also represents wealth accumulation.

[7] For further detailed explanation of Wuxing, please refer to: Wuxing https://en.wikipedia.org/wiki/Wuxing_(Chinese_philosophy) [Accessed 10 Apr. 2020]; Wuxing (Wu-hsing) https://www.iep.utm.edu/wuxing/[Accessed 10 Apr. 2020].

Image 14. The well at the Cheng Mei Ancestral Hall has a square-outside and circle-inside design that represents the cosmos and wealth accumulation (Photographed by Queenie Lin, 2018).

Integrating water into the conservation process of the Cheng Mei Ancestral Hall

The sad condition of the Cheng Mei Ancestral Hall before the conservation work is shown in Figs. 15–17, demonstrating the urgent need for preserving the vanishing family estate. The documentation and condition survey process started in 2005 by the Tinghsin Hote Foundation, supported by the Wei family, and then the actual conservation process took place between 2009 and 2012[8]. Many distinguished experts and scholars in Taiwan came together to provide insightful advice and solutions for the conservation project, including aspects of administrative regulations, conservation designs and methods, material supply, and craftsmanship. The project included the preservation and restoration of the remaining houses in the ancestor worship hall (公媽廳), as well as the conservation and reconstruction of the collapsed areas. This project not only preserved buildings, but also safeguarded traditional artisan skills and helped to extend the family legacy.

[8] Information regarding the survey, the condition before the conservation, and the methods used in the conservation of the Cheng Mei Ancestral Hall are retrieved from a series of unpublished notes, meeting memoranda and reports from 2005–2012 by the authors with permission of the Tinghsin Hote Foundation.

Image 15. The Cheng Mei Ancestral Hall before conservation (Tinghsin Hote Foundation).

Image 16. Salt efflorescence on timber structure before conservation (Tinghsin Hote Foundation).

Image 17. Timber pillar misplaced on the stone pedestal and the cracking of the foundation due to distortion caused by moisture fluctuation (Tinghsin Hote Foundation).

Yongjing has the highest density of family houses and ancestor shrines in Taiwan, giving its rich Hakka and Hoklorized Hakka ethical backgrounds that are famous for actively preserving family legacy. This project serves as an archetype for sustainable use of the family houses and ancestor shrines, and plays a positive and exemplary role in the conservation of nearby architectural heritage, especially the preservation of ancestor houses in Yongjing, demonstrating the feasibility and potential for the conservation of historic buildings, instead of demolishing them and constructing anew.

The enduring conservation success also depends on the knowledge of water around the Cheng Mei Ancestral Hall, which includes moisture content, water passage, suitable drainage, as well as knowledge of the appropriate conservation materials or preventative methods to prevent the timbers, tiles, and traditional clay walls from threats caused by moisture, and how to preserve the building from the risks caused by the canal water and extreme weather conditions due to the changes in climate (Image 18). Conservation initiatives to counter the treats of weathering, salt efflorescence, humidity fluctuation, and pest infestation were also experimented during the restoration, while careful consideration of groundwater flow routes was applied to prolong the life of the mansion. Accordingly, the conservation principle abides by the original construction

Image 18. The flooded courtyard of the Cheng Mei Ancestral Hall after Typhoon Kalmaegi in 2008 (Tinghsin Hote Foundation).

design in order to respect and coexist with nature.

During the conservation process, several distinct preventive and risk-mitigation measures were applied to prolong the life of the mansion and to extend the family legacy, while successfully safeguarding tangible and intangible heritage in Taiwan.

Elevation of the foundation

The ancient name of the location of the Cheng Mei Ancestral Hall, Nan-gang-Xi (湳港西 , west muddy plain) suggests the high water content of the soil. The original low-lying site and high ground water content threaten the stability of the estate, causing severe deteriorations. Therefore, during the conservation, the whole structure, including the timber truss system and brick masonry, was disassembled, carefully labelled and recorded, reinforced and then restored accordingly while maintaining the authenticity. This allows the reinforcement of the foundation design, and the entire foundation of the compound was raised 48 cm in a reinforced concrete base to avoid ground subsidence, dampness, fluctuation of humidity, and possible flooding (Image 19). The design also left space for future piping/electricity systems, to avoid further openings of the foundation to reduce leakage possibilities (Images 20 and 21).

Preventive waterway route design for suitable drainage and protection

Another work for integrating water in conservation was to redesign the waterways in order to create better a drainage system to avoid possible dampness and to ensure better coexistence with the canal (Image 22). Additionally, the waterway route was redesigned to comply with Feng Shui principles for better energy flow. According to Feng Shui practice, the waterway needed to be rearranged so that it flowed in front of the shrine of the village deity to help maintain the family fortune (Image 23).

Material sustainability

Fluctuation of moisture content is the worst enemy to timber structures; therefore, special attention was paid to keep the moisture content of the timbers. More durable timbers such as Taiwan cypress (hinoki) and teak were chosen to replace the degrading China fir during conservation, in order to

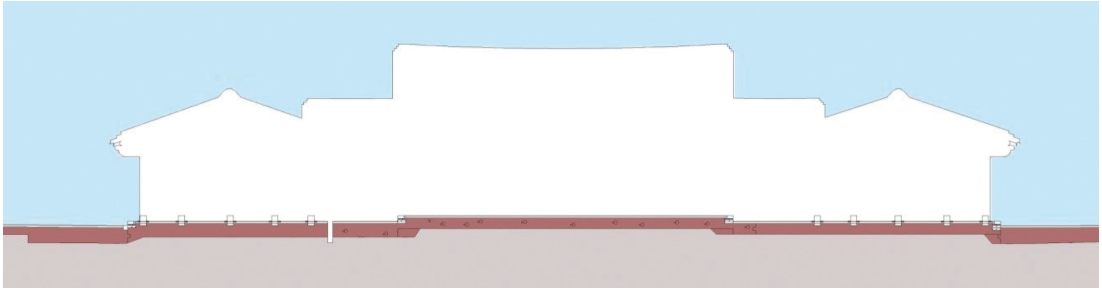


Image 19. In order to prevent the rising dampness from the high content of ground water, the foundation was elevated 48 cm during the conservation. The new foundation for the whole compound is shown in brown, keeping all building heights and sequences in their original conditions (Tinghsin Hote Foundation).

Image 20 and 21. The new raised foundation leaves space for future piping/electricity systems (Tinghsin Hote Foundation).

prolong the life of the timber structures and to achieve material sustainability. All timbers were prepared and naturally dried for three years in advance in order to ensure the moisture content under 20% that would minimize the probability of termite infestation.

Techniques used in the reconstruction zone

Along the conservation process, a techniques reconstruction zone was installed for better understanding of not only the construction methods, but also the possible degradation process and measurements in response. A 1:1-scale model of the most complex joint area was built to study the most likely leaking points between two eaves (Images 24 and 25).

Moisture insulation mechanics for timber structures

Following the ancestors' wisdom, which involves using local natural materials, the

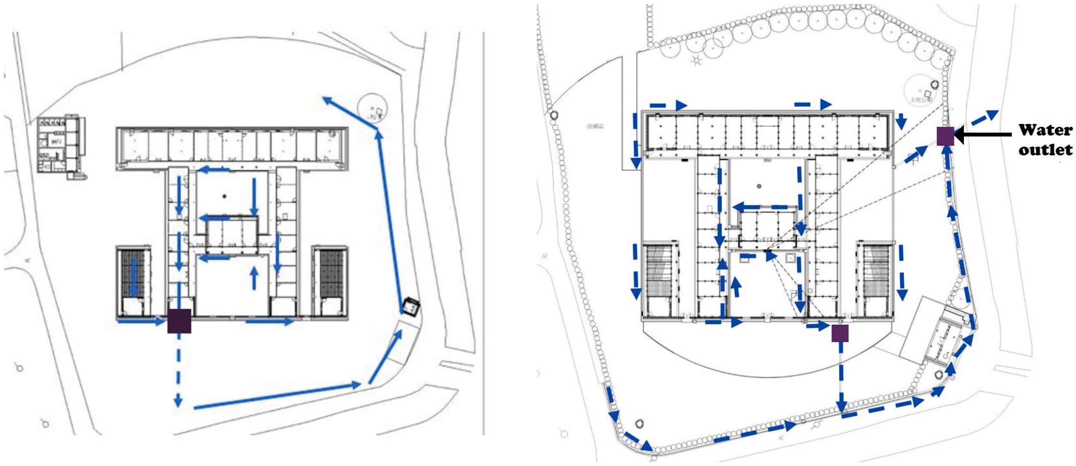


Image 22. The original and redesigned waterway route and drainage system after conservation: 1. The original drainage route before conservation; 2. The water route after conservation (Tinghsin Hote Foundation).

Image 23. The waterway route was rearranged to flow in front of the village deity's shrine according to Feng Shui principles so as to ensure the family fortune (Lin, 2019).

Image 24. Original location of the Techniques Reconstruction Zone (Tinghsin Hote Foundation).

Image 25. The Techniques Reconstruction Zone (Tinghsin Hote Foundation).

traditional Chinese building technique—bamboo wattle and daub walls (Image 26), the earth construction technique combining woven bamboo splits with clay provided the Hall of Grace with good ventilation, heat and cold tolerance, and proper weather acclimatization. However, this traditional material had degraded and become less and less resistant to the rapid heat and humid fluctuations under rapid climate change. As a result, preventive

Image 26. The original bamboo wattle and daub wall that was in a state of degradation (Tinghsin Hote Foundation).

Image 27. The new water insulation mechanism installed during conservation (Tinghsin Hote Foundation).

mechanisms were added to the traditional techniques to increase stability and prolong the life of natural materials. One of these—a unique invention of moisture insulation mechanism—was easy to install and less aesthetically intervening to the natural materials (Images 27 and 28). This set of moisture insulation mechanics for timber structures uses brass sheet as a barrier, inserting between the bamboo wattle and daub walls and timber pillars. It provides an adequate barrier against the rainwater or high moisture content from the surrounded canal penetrating through the joints between walls and pillars, which are usually most vulnerable to leakage or moisture accumulation.

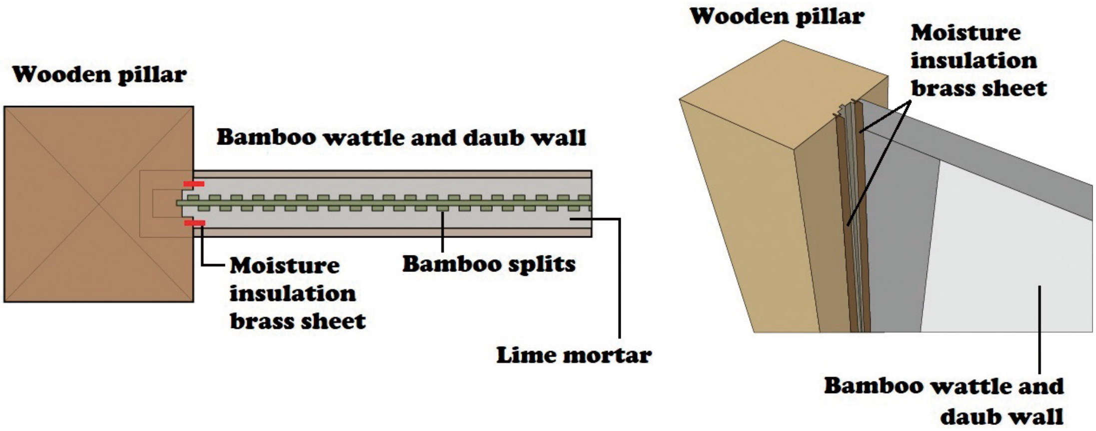


Image 28. The moisture insulation mechanism between bamboo wattle and daub walls and timber structures (drawn by Queenie Lin).

Preserving the legacy of the Babao Irrigation Canals at the Cheng Mei Cultural Park

By extending the Wei family's legacy, the restored Hall of Grace now hosts the Cheng Mei Cultural Park, which has been open to the general public since 2013 and includes the historic structure as a house museum. It also houses the Garden He-De, which commemorates the father of the Wei brothers, He-De Wei, and which celebrates the cultural landscape of the horticultural industry and agriculture in Yongjing. The turning of the old buildings into a museum, while retaining their heritage character and their overall contribution to the family's sense of place, will be a significant contributor to the local economic development. After the completion of the restoration in 2012 and more than three years of trial operation, two sets of conservation and heritage management plan were drafted in order to protect the heritage and landscape of the Cheng Mei Cultural Park: The management manual of Chang-hua County-designated Historical Building—the Hall of Grace (彰化縣歷史建築魏成美公堂管理維護計畫), 2016 and The contingency plan for the Hall of Grace in Yongjing (永靖成美堂因應計畫書), 2018. Based on these risk and maintenance management plans, the Cheng Mei Cultural Park worked hard to improve its capabilities by fostering innovative approaches and viewpoints to heritage conservation and natural preservation.

Meanwhile, the Cheng Mei Cultural Park also promotes the sustainable use of heritage for resilient land utilization by cooperating with the local community and traditional knowledge so as to maintain sustainability with the knowledge of the Babao Canals, regional identity, and the transformation of Yongjing. In light of this, various exhibitions or long-term display on water-related themes are presented at the Cheng Mei Cultural Park; therefore, the historical relationship between the Babao Canal and the Wei family is reconstructed and interpreted through the museum exhibition and restored architecture in order to reshape and inherit its water heritage. For instance, the history of the Second Babao Canal is presented in the Historical Record Room of the Second Babao Canal, as well as the documents representing the Wei family's contribution to canal management. The Chui Yu Hall (垂裕廳 , the Hall of inheriting prosperity), the original space where the Wei family hosted guests and collected farm lease rent and water lease rent, is now designed for exhibiting cultural relics related to water rent collection, such as abacus and account books, in an attempt to reconstruct how the family operated their business.

The Hall of Grace has created niches for many character-defining features

Image 29. The ceramics cutting and pasting decoration on the cornice depicting the scene of the Wei family's contribution to the Babao Canal (Lin, 2019).

made by traditional local artisans. These commemorate the family legacy while presenting auspicious meaning and blessings to the family. These intangible heritage items embody a culture of wisdom and craftsmanship, reflecting an inherited understanding of nature and interpersonal relationships in traditional Chinese society. For example, the architectural decorative reliefs of ceramics cutting and pasting[9] on the Shui-Che-Du (水車堵 , cornice) depict the canal construction theme in order to commemorate the Wei family's contribution to the foundation and management of the Babao Irrigation Canal (Image 29). The various decorative calligraphy inscriptions on both interiors and exteriors have not only recorded the family's legacy, but also set standards and virtues for descendants to follow. The couplets starting with the characters ' 成 ' (cheng) and ' 美 ' (mei) on the sides of the traditional bamboo style window indicate the close relationship between the Cheng Mei Ancestral Hall and the Second Babao Canal, as well as the surrounded Bagua

[9] Artisans create vivid human, animal, or natural features that depict important family history or portray auspicious blessings with ceramics cutting and pasting and clay sculpture techniques, which become the dominating decoration on the walls and roofs in the Hall of Grace.

Image 30. The couplets on the sides starting with the characters ‘成’ (cheng) and ‘美’ (mei) indicate the estate’s inseparable relation with the Second Babao Canal.

Mountains and natural landscape, bringing blessing to the family (Image 30).

Conclusion: Sustainable development for the Babao Irrigation Canals and Yongjing

The Cheng Mei Ancestral Hall in Yongjing, Taiwan, not only represents the fine traditional Han Chinese architectural style originating in China, but also portrays a unique fusion of the Minnan–Hakka culture and identity in Taiwan. The conservation project and the subsequent regional regeneration of the Yongjing area made the Hall a social and cultural centre for the local community, as well as a private-sector pioneer in initiating and leading heritage conservation projects in Taiwan. The Cheng Mei Ancestral Hall was opened for professional visits during the conservation process, and it continues to host various programmes on tangible and intangible heritage preservation, aiming to provide Yongjing and Taiwan with a cultural and conservation learning centre, as well as to promote public awareness about sustainability.

The Tinghsin Hote Foundation cooperates with the canal and local community to maintain sustainability with the regional transformation and regional identity. Shang-ying Wei’s offspring inherited his will to make substantial contributions to their hometown, where the Foundation has committed itself to regional development and conservation of tangible and intangible heritage within the Yongjing area since 1998. By extending the Wei family’s legacy, the Cheng Mei Ancestral Hall is now part of the Cheng Mei Cultural Park, which is dedicated to the diversity in cultural expressions and traditional artisanship, while also ensuring the greater inclusion and preservation of the shared heritage of the two ethnic groups, Hakka and Minnan, as well as Chinese and local Taiwanese cultural significances. Many sustainable development programmes for Yongjing and Babao Canals have been organized over the years, such as:

Local canal renovation/preservation: The foundation collaborates with the government to renovate/preserve the Babao canals and to provide the public with access to clean water and sanitation for all.

Canal mural painting workshop: To continue the ancestors' lifework by promoting the canal legacy, many canal-related educational activities are hosted at the Cheng Mei Cultural Park, making the Yongjing community environmentally aware. Furthermore, it also creates social cohesion and fosters socio-economic regeneration for Yongjing in order to enhance long-term tourism benefits by preserving cultural resources. For instance, a series of Canal mural painting workshops were hosted by the Tinghsin Hote Foundation in 2014.

Cultural landscape research of the Babao Canals: In 2020, the foundation has initiated intensive researches on the Babao Canals—the Babao Canal Cultural Landscape—including preserving the tangible, intangible and natural heritage related to the canal and Yongjing.

As a private-sector organization in Taiwan, the Tinghsin Hote Foundation intends to create new responses to emerging challenges. It is continuously strengthening the means of implementation and revitalizing the global partnership for sustainable development, promoting Taiwanese cultural heritage to international community, in order to preserve the cultural heritage in a global scale.

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Appendix
Author Biographies

Appendix - Author biographies

Taha Ansari is the director of the National Agency of Hydraulics Resources in the south-west region of Algeria. The agency covers of all water management projects across the country. He holds a degree in hydraulic engineering from the University of Tlemcen and a diploma in management from Ahmed Draia, Adrar University. He is a senior engineer and author of technical papers on the traditional system of exploitation of groundwater (Foggara).
ans1967@gmail.com

Mariano Castellanos Arenas is a professor and researcher at the Benemérita Universidad Autónoma de Puebla (Mexico). He is a historian and holds a PhD. in human sciences and culture from the Universitat de Girona, Catalonia, Spain. He is a member of the National System of Researchers of Mexico (Level 1), an active member of ICOMOS Mexico, and the Mexican Network of Heritage Landscapes Studies.
castellanos.arenas@gmail.com

Hans Bleumink studied irrigation water management at Wageningen University (MSc). He studied and worked in Brazil, Bolivia, and Portugal. He worked at the Dutch Centre of Agriculture and the Environment (CLM) from 1995 to 2000 on innovations in agricultural water management. Together with Jan Neefjes, he set up Overland in 2000 and has worked on development issues regarding planning, cultural landscapes, and water-related heritage.
bleumink@overland.nl | www.overland.nl

Yu-Chuan Chang received his doctorate in agricultural engineering from National Taiwan University and was an associate visiting professor at the University of Tokyo, Japan. Yu-Chuan Chang has more than 30 years of research experience in the fields of agriculture and environment. He is currently a professor at Hsing Wu University, Taiwan.

Yu-Pang Cheng is a retired director of the Tachiachi Power Plant and former deputy director of the Department of Generation. He is the chief consultant of the All Light Group, the Taiwan Public Construction Records. During his tenure at the Taiwan Power Company, he put a lot of effort into the preservation of cultural assets of hydropower generation. He led the Tachiachi Power Plant team to win the 23rd Taiwan Corporate Sustainability Award.

Chin-Hsing Chien is the director of Shih-men Power Plant. He has been serving the Taiwan Power Company for 28 years and has long invested in the preservation and maintenance of hydropower culture. He participated in the Major Cultural Assets Preservation, Operation, and Maintenance Project in 2016 and contributed to the special exhibition of 2018 *Power Land* and 2019 *Power of River and Electricity* of Taipower's cultural assets.
u496733@taipower.com.tw

Saranya Dharshini is a graduate of the University of Bath and the University of Mumbai. She is currently practising in Mumbai as a conservation architect. She has more than eight years of international experience in architecture, including working on conservation projects and nomination dossiers for UNESCO world heritage cities and sites. She is an emerging professional from ICOMOS India and also active in teaching and research.
ar.saranyadharshini@gmail.com

Eriberto Eulisse is the executive director of the Global Network of Water Museums, a UNESCO-IHP flagship initiative. He currently works as the coordinator of the UNESCO Chair 'Water, Heritage and Sustainability' at Ca' Foscari University of Venice, the director of Civiltà dell'Acqua International Centre, and the project manager of the Water Museum of Venice. He has been serving The European Commission for 4 years as project officer in social sciences.
eriberto.eulisse@unive.it | info@watermuseums.net

Harry den Hartog is a Dutch urban designer and researcher based in Shanghai since 2008. In 2004 he founded the think tank studio 'Urban Language' (www.urbanlanguage.org). Since 2012, Harry den Hartog is a faculty member at Tongji University in Shanghai, College of Architecture and Urban Planning (http://en-caup.tongji.edu.cn/index.php/people/info/64/361.html).
harry.den.hartog@urbanlanguage.org

Carola Hein is a professor of the history of architecture and urban planning at Delft University of Technology. She has published widely and received a Guggenheim, an Alexander von Humboldt fellowship, and other major grants. Her books include *Adaptive Strategies for Water Heritage* (2020), *The Routledge Planning History Handbook* (2018), *Uzō Nishiyama, Reflections on Urban, Regional and National Space* (2017), *Port Cities* (2011), and *The Capital of Europe* (2004).
C.M.Hein@tudelft.nl

Wen-Yao Hsu received her master's degree from the Graduate Institute of Building and Planning at National Taiwan University, Taipei, Taiwan. Wen-Yao joined the Taiwan International Institute for Water Education (TIIWE) in 2012. She currently works as an associate research fellow at TIIWE. She has more than five years of research experience in water culture and heritage. She has recently published the book *Learning Water Heritage from Shihmen Reservoir.*

Mikiko Ishikawa is a landscape architect and certified city and regional planner. She is a professor of environmental design at Chuo University. She is also the Emeritus Professor at the University of Tokyo. She is an associate member of the Science Council of Japan and a member of ISCCL, ICOMOS. In 2008 she received the National Green Award. Among her publications is *City and Green Space* (Tokyo: Iwanami Syoten, 2000).
ishikawa.27w@g.chuo-u.ac.jp

Ioannis K. Kalavrouziotis holds a PhD in environmental geochemistry from the Department of Geology, University of Patras, Greece (1999). He is currently a professor and the dean of the Hellenic Open University, School of Science and Technology. He is also the director of the Master's Degree in education on wastewater management, a visiting fellow in the University of Derby, UK (2015–2018), and a guest professor at Hubei University, China (2019–2022).
ikalabro@eap.gr

Nupur Prothi Khanna has degrees in physical planning and landscape architecture from SPA, Delhi, India and heritage conservation studies from York University, U.K. As founder of a research based design practice, Beyond Built (www.beyondbuilt.in), her scholarship and practice is focused on public spaces across India. She is currently based in Stockholm. She has held position in ICOMOS, IFLA/ISOLA and ISOCARP Institute.
nupurprothi@gmail.com

Da-Wei Kuan (Daya) received his PhD degree in geography from the University of Hawai‘i at Mānoa and is currently an associate professor in the Department of Ethnology at NCCU. His research interests include: indigenous geography, indigenous land policy, indigenous community mapping, and community-based resources management. He collaborates with different indigenous communities in many traditional territory mapping, land-use planning, and community development projects.
daya@nccu.edu.tw

Queenie Lin is a consultant at the Cheng Mei Cultural Park for cultural heritage preservation and international engagement. She is a PhD candidate in cultural heritage and arts Innovation studies at Taipei National University of the Arts. Queenie studied the history of art and architecture at the University of Virginia (MA) and the conservation of fine art at the University of Northumbria (MA).
queeniebee8484@gmail.com

Pei Hua Lu received her PhD in sociology from the University of Saskatchewan, Canada. She worked as a research data centre analyst and management information system specialist in the Microdata Access Division, Statistics Canada. She is currently an assistant research fellow at the Taiwan International Institute for Water Education (TIIWE).

Tino Mager is assistant professor of the History and Theory of Architecture and Urbanism at the University of Groningen. He was a postdoc at the Faculty of Architecture and Built Environment at Delft University of Technology, fellow of the Leibniz Association and the University of Queensland. Tino is a member of the board of ICOMOS, Germany and published widely on cultural heritage.
tino.mager@rug.nl

Karim Nawaz is the country coordinator of the Pakistan Spate Irrigation Network. He is a consultant of the research organization Metameta (Netherlands), member of various civil society groups, and member of the Pakistan Engineering Council. He has served in FAO-UN as a national expert on Community Development, coordinator for Global Environment Facility/Small Grants Programme of UNDP, and an advisor to the Department of Political Affairs (UN) in New York.
knawaz99@yahoo.com

Jan Neefjes studied soil science, geomorphology, spatial planning, and historic geography at Wageningen University (MSc). He worked at Nieuwland as a planning consultant. Together with Hans Bleumink, he set up Overland in 2000, where he specialized in conducting historic geographic research, both in more scientific research projects and more practical view-oriented projects. Overland specializes in advice on policy matters and spatial planning related to heritage and cultural landscapes.
J.neefjes@overland.nl | www.overland.nl

Dave Pritchard is a proponent of stronger links between the worlds of environmental policy, cultural heritage and the creative arts; and he has worked for over 35 years in a variety of research, policy, legal, management and governance roles in all these sectors. His many honorary roles include acting as the coordinator of the Culture Network of the Convention on Wetlands (Ramsar Convention).
dep@dendros.org.uk

Maurício Andrés Ribeiro is a Brazilian architect and writer. He was a visiting research Fellow, IIM, Bangalore, India, 1977–78, secretary for environment, Belo Horizonte, Brazil, 1990–92, as well as the president of the State Environmental Foundation, MG-Brazil, 1995–98. He served as the director and councillor in the National Environmental Council, Brazil, 2001–15, and a consultant at the National Water Authority, Brazil, 2002–2020.
ecologizar@gmail.com | http://ecologizar.blogspot.com/

Sérgio Ribeiro has a master degree in sustainable development and works on sustainability and water conservation as a campaign coordinator and senior analyst for WWF-Brazil. In 2015 he took over the position of the undersecretary of water and climate in the Federal District of Brazil. In May 2018 he took over as the general director of the International Centre on Water and Transdisciplinarity (CIRAT).
sergioaugustoribeiro@gmail.com

Henk van Schaik has been the ambassador for water and heritage to ICOMOS Netherlands since 2012 and the international director of the International Centre for Water and Transdisciplinarity (CIRAT) in Brazil since 2019. Until August 2019, he was chairman of the Advisory Committee of the Netherlands Government Sustainable Water Subsidy Fund.
henk.vanschaik19447@gmail.com

Prachi Sharma is a knowledge officer at the International Commission on Irrigation and Drainage (ICID). She is a water resources expert with specialization in agricultural water management. Prior to this, she worked with the Food and Agricultural Organization (FAO). She has also worked in the private sector as a Project Manager.

Po-Kang Shih holds a PhD from the Department of Bioenvironmental System Engineering at National Taiwan University. He is an assistant professor at the Centre for General Education of Chung Yuan Christian University. He loves to teach students the spirit of science and the sustainable issues of the ecological environment. He also works on the study of ecological engineering and agricultural irrigation and drainage ecosystems.
sportgun@cycu.edu.tw

Edmond Staal studied biology and chemistry at the University of Applied Sciences in Tilburg. Since 1986, he has working as a staff member at Stichting het Limburgs Landschap, a private foundation which owns nature reserves and a range of monuments including wind- and watermills in the southern part of the Netherlands.
e.staal@limburgs-landschap.nl | www.limburgs-landschap.nl

Frank van Steenbergen is the director of MetaMeta (www.metameta.nl) and the convenor of the Flood Based Livelihoods Network (www.spate-irrigation.org). Over the past 30 years, he has worked in water resource management and food security. In his work, he combines policy, programme development, research, actual implementation support, capacity building, business development, and network development. Flood-based farming systems is a long-time passion.
fvansteenbergen@metameta.nl

Hans Suijs is a Dutch software manager and business developer. Since 2002, he is the chairman of the 'Water Guild' of Gouda, a not-for-profit organization that covers all issues related to the heritage related to water (i.e. canals, locks, etc. and waterways through Gouda). Since 2014, he also covers the consequences of climate change for infrastructure and buildings in the historic centre of Gouda.
hans.suijs@hetnet.nl

Yin-Chun Wei is the founder of Tinghsin Hote Foundation, who is also dedicated to the sustainable development of Yongjing, Changhua. He was the Chairman of Wei-Chuan Foods CO., LTD and Matsusei Business CO., LTD. His great contribution to the food industry has won him the Outstanding Food Entrepreneur Award in 2004 and Taiwan Food Industry Special Contribution Award in 2008.

Chia-Ying Wu received her master's degree in civil engineering from National Chung Hsing University, Taichung, Taiwan. She currently works as an assistant research fellow at the Taiwan International Institute for Water Education (TIIWE). Chia-Ying has more than 14 years of work and research experience in water conservancy planning and public participation in policymaking.

Sarah Lily Yassine is a politically engaged landscape architect and urbanist. She serves on the advisory committee of the University Saint-Joseph in Beirut to establish its School of Architecture. She is also part-time faculty at the department of landscape architecture at the American University of Beirut. She is the ICOMOS Lebanon secretary general and is a published author on themes of landscape memory and borderlands. She regularly collaborates with art projects.
sarahyassine@gmail.com

Sinite Yu is director of Education, Research and Development at the Taiwan International Institute for Water Education (TIIWE) and was assistant professor at National Chiayi University and Huafan University and research fellow at the Ecological Engineering Research Center and Disaster Prevention Research Center of National Taiwan University. He specializes in the integration of water and land resources planning and management, ecological engineering, management of water conservancy and flood control, wetland restoration, natural water treatment, and water heritage evaluation.

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