

SOCIOCULTURAL DIMENSIONS IN WATER RESOURCES MANAGEMENT

Policies, Practices, and Challenges

Edited by Mikio Ishiwatari and KE Seetha Ram



Sociocultural Dimensions in Water Resources Management

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ABBREVIATIONS

4APWS	4th Asia-Pacific Water Summit
ACQWS	Advisory Committee on the Quality of Water Supplies
CBDRM	community-based disaster risk management
CFCM	comprehensive flood control measures
cm	centimeter
COVID-19	novel coronavirus disease
DRR	disaster risk reduction
DSI	State Hydraulic Works
EU WFD	European Union Water Framework Directive
FPA	flood prevention association
ICID	International Commission on Irrigation and Drainage
IDPA	inundation damage prevention area
IMF	irrigation management transfer
IWRM	Integrated Water Resources Management
km ²	square kilometer
LIA	Land Improvement Act
LID	Land Improvement District
LIP	Land Improvement Project
m ³	cubic meter
MAFF	Ministry of Agriculture, Forestry and Fisheries
MARD	Ministry of Agriculture and Rural Development
mm	millimeter
MRC	Mekong River Commission
MWG	multi-stakeholder working group
NBI	Nile Basin Initiative
NBS	nature-based solution
NDPC	natural disaster prevention and control
NIUA	Nation Institute of Urban Affairs
NMCG	National Mission for Clean Ganga
PRC	People's Republic of China
RBDRSA	River Basin Disaster Resilience and Sustainability by All
RCA	River Cities Alliance
RDG	river development goal
SDGs	Sustainable Development Goals
SFPA	storage function preservation area
SUR	specified urban river
SURB	specified urban river basin
ULB	urban local body
UNESCO	United Nations Educational, Scientific and Cultural Organization
URMP	urban river management plan
US	United States
WASH	water sanitation and hygiene
WRDBP	water resources development basic plan
WSD	Water Supplies Department
YWFK	Youth Water Forum Kumamoto

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The project’s timeline unfolded with several key milestones. Initially, we issued a call for papers, attracting many submissions that reflected the community’s interest in contributing to this critical topic. We held the first inception meeting led by the esteemed Professor Taikan Oki of the University of Tokyo, whose guidance and leadership provided a solid foundation for our work. His stewardship was pivotal in aligning the project’s vision and objectives. We extend our deepest gratitude to Kotaro Takemura for his invaluable patronage and support from the Japan Water Forum, which have been instrumental in the realization of this project. Special appreciation also goes to Keiko Tamura, Firdaus Ali, and Victor Shinde for their indispensable roles as members of the project committee team. Their dedication and expertise greatly contributed to the success of this book.

Following the inception meeting, an authors’ workshop was held, cultivating a spirit of collaboration and mutual support among the participants. This forum enabled contributors to engage in fruitful discussions, where they exchanged valuable feedback on each other’s papers, significantly enhancing the book’s content and depth.

Our collective efforts focused on preparing a publication that not only aims to influence policy makers and stakeholders at the World Water Forum 2024 but also seeks to engage a wider audience. With an eye toward inclusivity, we endeavored to make the book accessible to readers from diverse backgrounds, including high school students. This approach reflects our commitment to sharing knowledge broadly and nurturing an informed dialogue on water resources across generations.

Our deepest appreciation goes out to the authors who answered the call for papers announced on the ADBI website. Their commitment, innovative perspectives, and dedication to advancing the dialogue on sociocultural dimensions in water resources management have been crucial in bringing this publication to life. Their exceptional contributions have greatly enriched this volume.

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FOREWORD

Water resource management is an important component of sustainable development and requires a comprehensive understanding that goes beyond technical and economic considerations. This report aims to identify how sociocultural factors have influenced water issues and water resources management, and recommend policies and approaches to water resources management that take sociocultural considerations into account. Inspired by the Memorial Lecture by His Majesty the Emperor of Japan, “Hearts, Minds and Water - Touching Water in People’s Beliefs” at the 4th Asia Pacific Water Summit in April 2022, this publication was prepared by researchers and practitioners to analyze water issues from a sociocultural perspective. The lecture points to the relationship between sociocultural factors and water:

Through the history of the relationships between people and water, the culture and the society have been formed, not only in Japan, but everywhere in the Asia Pacific and the world. If you look around the world at various cultures and civilizations, you may find that water not only upholds the lives of people but affects the relationships between people and nature, and even their conception of nature and the world.

Source: Memorial Lecture by His Majesty the Emperor of Japan at the 4th Asia Pacific Water Summit (<https://www.kunaicho.go.jp/page/koen/showEn/8>).



Source: Japan Water Forum.

By analyzing case studies from countries as diverse as the Peoples' Republic of China, India, Indonesia, Japan, and the Republic of Korea, the report provides valuable insights into the evolution of water resources management in response to historical context, socioeconomic structure, and cultural influences.

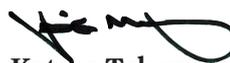
We hope that this report will serve as an important resource for policy makers, stakeholders, and all others interested in the development of effective and sustainable water management practices.



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Sustainable Water Resources Management in Asia: A Sociocultural Perspective

Mikio Ishiwatari and KE Seetha Ram

1.1 Introduction

Comprehensive and effective management of water resources requires an understanding of the complex relationships in the water cycle (Di Baldassarre et al. 2019). This complexity arises from the interaction of multifaceted factors, including natural factors such as climate and topography, and also sociocultural aspects such as cultural values, beliefs, and practices that shape societal perceptions of water (Jaeger et al. 2013; O'Brien and Wolf 2010; Mishra et al. 2021).

Effective management of water resources is critical to achieving sustainable development since water issues are relevant to various Sustainable Development Goals (UN 2023; Di Baldassarre et al. 2019). Given that water issues are exacerbated by climate change, population growth, and development, it is essential to strengthen water resources management efforts for quality growth (APWF 2022).

However, countries tend to develop water policies and strategies that do not fully incorporate sociocultural aspects, but rather focus on technical solutions and economic efficiency (Hawken et al. 2021; Pahl-Wostl et al. 2007; Rajabi 2023). For countries to formulate policies and make decisions, they need to understand that sociocultural factors influence the institutional and governance structures that improve water access and management. The Asia and Pacific region needs to be particularly sensitive to these sociocultural factors. This is because sociocultural factors are diverse and have significantly changed over the past decades due to rapid economic and social welfare developments.

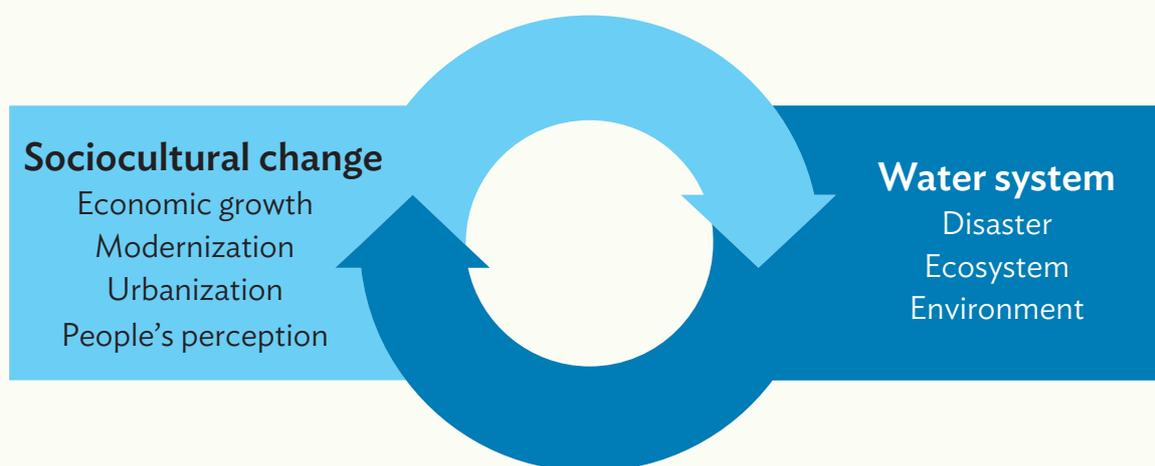
This edited report aims to propose policies and approaches of water resources management in the region that incorporate sociocultural aspects. The report brings together the expertise of scholars and experts in the area. The chapters cover cases in the People's Republic of China (PRC); Hong Kong, China; India; Indonesia; Japan; the Republic of Korea; Türkiye; and Viet Nam; and analyze various aspects of the sociocultural dimensions in the context of water resources management. This chapter is a comprehensive introduction to the edited report comprising an overview of the topics covered and synthesizes the major policy recommendations in each chapter. It examines practices and innovative approaches proposed that can help achieve quality management of water resources in the Asia and Pacific region. We hope the policy recommendations can guide policy makers and stakeholders to foster more effective water management.

1.2 Consideration of Sociocultural Factors in Water Resources Management

Recent studies have analyzed theories and concepts in the relationship between sociocultural factors and water as well as examined cases. However, there are limited studies and reports analyzing how sociocultural factors affect the evolution of national policies and regulatory and institutional mechanisms for water resources management.

Society and water systems are co-evolving and constitute a two-way feedback loop (Roobavannan et al. 2018; Figure 1). Human activities exert changes on the water cycle; and changes in the water cycle affect human society (Nakamura et al. 2020). In Asia, against the backdrop of modernization and urbanization, urban areas are facing issues related to the deterioration of the water cycle, including land subsidence, water pollution, flooding, and water shortages. Resolving these pressing water issues can lead to further urbanization in the long term. Similarly, diverse human cultures and their activities interact and co-evolve in complex ways with the eco-social systems in rivers. Understanding river culture is crucial to harmonize human activities with biological and cultural diversity in rivers (Wantzen et al. 2016). The legacy of a culture inherited from the past is deeply connected to how people perceive and treat land, water, laws, and the judiciary. In the case of Japan, urban development, daily life, food, art, and technological innovation are deeply connected to water, creating a rich cultural history, and water has been deeply linked to the identity and lifestyle of the Japanese people (Dix 2017).

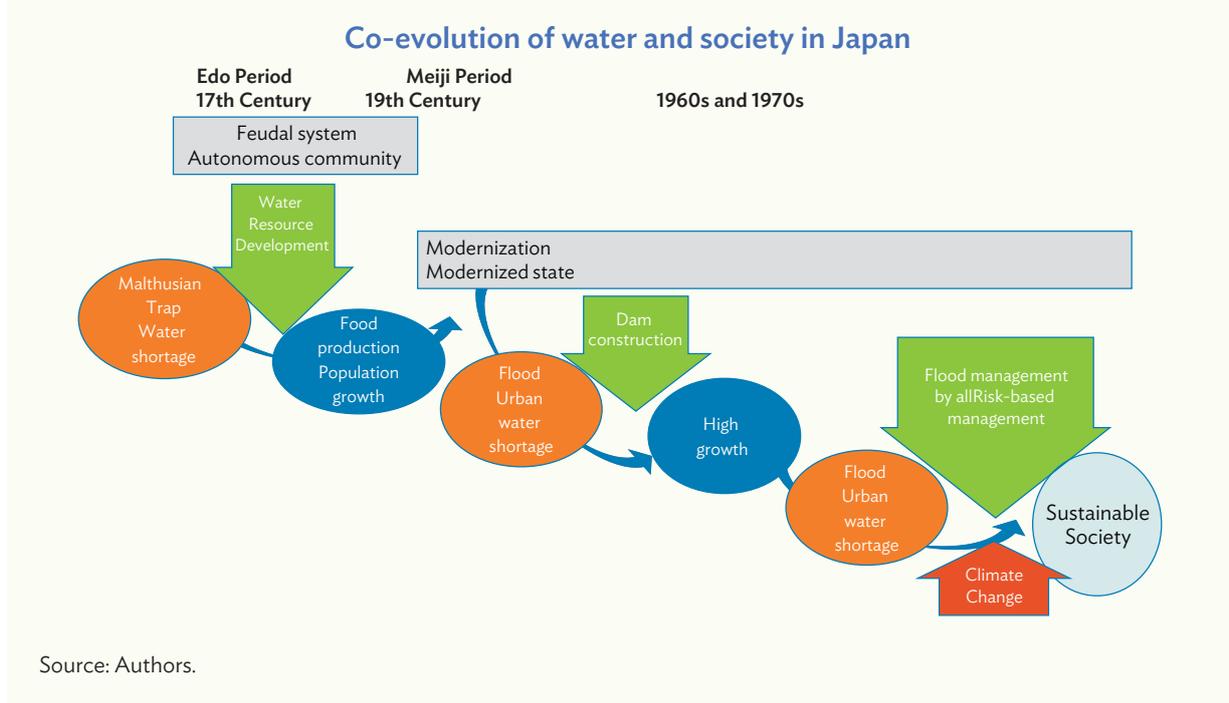
Figure 1.1: Co-evolution of Society and Culture and the Water System



Source: Authors.

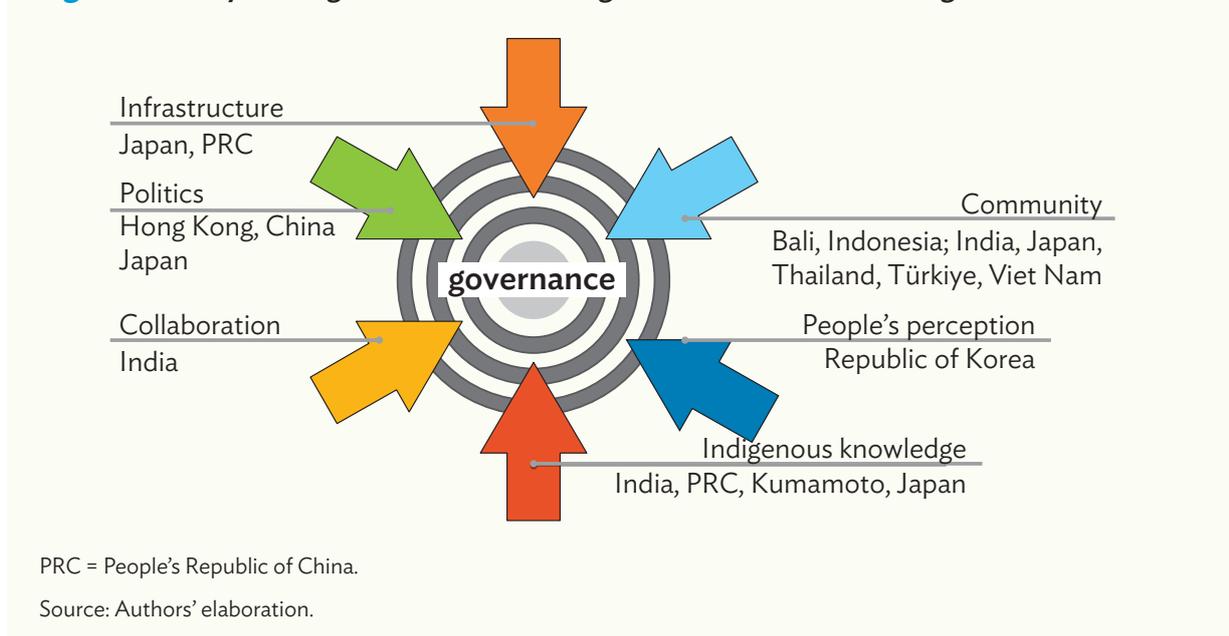
The Japanese case shows this co-evolution (Figure 1.2). Before the Edo period, Japan fell into the “Malthusian population trap” when the population did not increase because of limited food production. Sociocultural change evolved water governance, which led to water resources development, agricultural production, and population growth; and left the Malthusian population trap in the Edo period in the 17th century. This growth contributed to modernization in the Meiji period from the late 19th century. However, this modernization caused water shortages in expanding urban activities. The modernized government intervened constructing dams to supply urban water and achieved high growth. Managing water resources has contributed to resolving water-related issues and bringing about quality growth in the country, which became more resilient, inclusive, and sustainable (Ishiwatari, Nagata, and Matsubayashi 2023). Japan is currently trying to adapt to the effects caused by climate change through implementing the new approach of “river basin disaster resilience and sustainability by all” including countermeasures to mitigate flood damage.

Figure 1.2: Japan’s Co-evolution Between Society and Water Resources Management



Water resources management strategies need to consider the dynamics of social and cultural factors. Culture, consisting of values, beliefs, and norms, is key to understanding the stability and change in human–water system relationships and thus influences the coordination of water resources management (Wantzen, Tharme, and Pypaert 2023). Changes in water governance are closely related to formal institutional rules and cultural norms that characterize the political and social environment. While these cultural values related to water are considered important, they are difficult to quantify (UN 2021).

Figure 1.3: Key Findings of Factors Affecting Water Governance Arrangements in Asia



1.3 Relationship Between Sociocultural Dimensions and Water Resources Management in Asia

Across Asian countries, the management mechanisms of water resources have evolved in response to changes in historical contexts, socioeconomic structures, and cultural influences. Kim in chapter 19 of this volume demonstrates the multifaceted connection between water and culture in prosperous Asia through five case studies: the formation of religious beliefs, the impact on the arts, the influence on development, socioeconomic dynamics, and governance arrangements. The Dujiangyan weir in the People's Republic of China represents an approach that integrates water, culture, and sustainable development. The weir played a role in flood protection and water supply through annual maintenance activities for over 2,000 years and has now become a cultural heritage site (Lin et al., chapter 5). Shinde et al. (chapter 3) examine river management in India from four perspectives: (i) religious and cultural significance, (ii) inclusive development and management, (iii) community engagement and involvement, and (iv) traditional knowledge and wisdom. India integrates the religious and cultural significance of rivers in sustainable river management. The report found several critical factors influencing the arrangements of water governance (Figure 1.3). This section examines the key findings of this report.

Autonomy of local communities established throughout history is key to successful water resources management (Figure 1.4). The traditional mechanisms of water management by communities have outlived modernization and remain valid in modern times. Community initiatives enable managing water resources on the ground as shown in cases in Japan, Indonesia, and Thailand. In these countries communities have the primary responsibility for allocating water and operating and maintaining facilities. Farmers' participation in water management has fostered a strong sense of ownership and responsibility for facility management. Flexible and rapid management of water distribution has contributed to the response to droughts and floods. In Japan and Bali, Indonesia, such community-based irrigation management is embedded with sociocultural contexts and has been established and maintained for centuries (Ali, chapter 4; Watanabe, chapter 12). The traditional Subak system in Bali

Figure 1.4: Community Initiatives in Water Resources Management by Country

	Japan	Asian countries		
Irrigation and Drainage	Ch 12 (Watanabe)	Bali, Indonesia Ch 4 (Ali)	Thailand Ch 11 (Yoshida et al.)	Türkiye Ch 10 (Inanc et al.)
Flood Mitigation	Ch 18 (Tamura)	Viet Nam Ch 9 (Nhat et al.)		
Traditional Technology	Ch 13 (Matsuki)	PRC Ch 5 (Lin et al.)		

PRC = People's Republic of China.

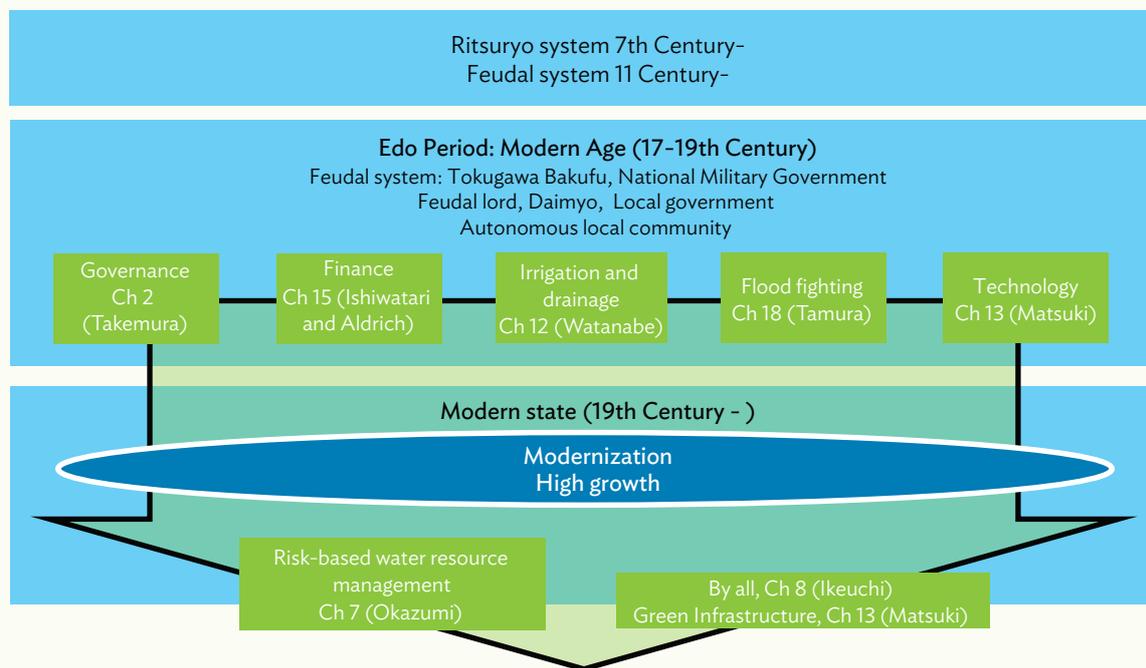
Source: Authors.

emphasizes equitable water distribution, community cohesion, and the integration of spirituality and ecology. Türkiye has been transferring the operation and maintenance services of irrigation schemes to community-based organizations of irrigation unions since the 1990s (Inanc et al., chapter 10). Türkiye is promoting this transfer by developing legislation, building capacities, and arranging governance. For flood protection, in Viet Nam and Japan, local communities have played crucial roles on the frontline, and national and local governments can support to communities' efforts (Nhat, Nguyen, and Nguyen, chapter 9; Matsuki chapter 13; Tamura, chapter 18). Viet Nam is conducting community-based programs, in which activities are conducted regularly, continuously, systematically, and creatively, and the lessons from the activities are shared throughout the country.

Collaborative governance is crucial for managing water resources. Most cases stress the importance of collaboration for managing water resources among all levels of governments, local communities, and the private sector as well as in multiple sectors, such as water, disaster risk reduction, food, environment, and urban. The Indian government is promoting the River Cities Alliance to preserve the urban environment in River Ganga (Kumar, chapter 17). The National Mission for Clean Ganga (NMCG) aims to reduce pollution and rehabilitate the river basin by adopting an integrated approach and promoting inter-sectoral coordination for comprehensive planning and management. Türkiye is improving water governance to adapt to the effects caused by climate change and sociocultural changes and response to external shocks of disasters and refugees' migration (Inanc et al., chapter 10). Constructing infrastructure modified Japanese water governance from farmers-led to collaborative governance supported by the government in each river basin (Takemura, chapter 2).

As sociocultural aspects change, water resources management mechanisms must also change. Sociocultural factors are dynamic and constantly changing. Modernization and urbanization are changing the perceptions and values of communities and people regarding water. As industrial structures shift away from the agricultural sector, communities are losing connections among their members. In Japan, key mechanisms such as community-driven management and government intervention have remained in place until now, while sociocultural changes due to modernization and rapid growth have altered governance on water allocation and cost-sharing (Figure 1.5). Japan created the foundation of the current mechanisms for water resources management in the early modern era of the Edo period from the 17th century (Takemura, chapter 2). Today, the role of farmer organizations has been succeeded as land improvement districts that manage farmlands, water, and irrigation facilities according to legislation. Government organizations are assisting community-based flood management by providing financial and technical support to communities (Tamura, chapter 18).

Approaches based on indigenous knowledge, traditional techniques, and cultural history, coupled with the support of modern technology, can address evolving issues, including climate change. For more than 2,000 years, water management functions have been maintained in the Dujiangyan weir, the PRC, through regular maintenance using natural materials such as stones and bamboo boxes and fences (Lin et al., chapter 5). Japan also has used similar traditional technology for flood protection works. These traditional technologies can be used as green infrastructure to adapt to the impacts of climate change (Matsuki, chapter 13). Green infrastructure provides not only flood protection, but also climate change mitigation, leisure, education, and many other benefits. In addition to individual technologies, traditional flood protection principles can also be useful. Japan is shifting the flood protection policy from confining flood water between long high dikes in rivers with modern technology to accommodating floodwaters on the plains (Ikeuchi, chapter 8). In pre-modern Japan, this was the principal approach for flood protection because of limited technology and financial sources. However, rather than reverting to older technologies and approaches, Japan is using the latest technology to predict rainfall and flood volumes and formulating flood protection plans at the basin level. The approach of combining traditional knowledge with the latest technology is effective not only for flood

Figure 1.5: Evolution of Japanese Water Resources Management


Source: Authors.

protection but also for water resources management in general. Yoshida, Oda, and Tanaka, chapter 11) propose an innovative approach to formulate and visualize indigenous knowledge of rainfed rice cultivation in northeast Thailand through modern technology. Local farmers originally have knowledge to maximize products even under unstable weather conditions. Japan has shifted its water resources management policy from developing facilities to meet increasing demand to risk-based management to adapt to the impacts of climate change and external shocks (Okazumi, chapter 7). To cope with an aging and declining population, Japan is introducing smart agriculture, which uses information and communication technology to lead to larger plots of farmland and shift to more profitable crops (Watanabe, chapter 12).

Financing arrangements depend on political will. The case of the water supply system in Hong Kong, China shows that social and political culture affect financing arrangements for water resources management. In Hong Kong, China, water tariffs have been kept low leading to the inability to recover costs and possibly to the waste of water resources (Eiff, chapter 6). In the case of Japan as well, politics have affected financial arrangements for investing in water resources management. Political systems have historically changed cost-sharing among national and local governments, local communities, and the private sector. During the feudal period, interventions from national authorities were limited. However, the national government started covering costs of flood protection to respond to needs from landowners in the Meiji period and to mitigate tensions with farmers in the 1910s (Ishiwatari and Aldrich, chapter 15).

Transferring knowledge to next generations is a challenge. Urbanization and modernization weaken relationships or ties in local communities, making difficult maintain community-based activities. In the Ziro Valley, India, the indigenous wisdom of wetland rice cultivation is often regarded as inferior to modern technology, neglecting valuable insights into sustainable resources management (Shinde et al., chapter 3). In Bali, Indonesia, communities are preserving the island's rich water traditions to maintain the island's identity and ensure responsible water resources management (Ali, chapter 4). Understanding citizens' perception of water culture is crucial for formulating water policies and legislation. Improving citizens' perception and community culture on water environment is required to ensure sufficient water quality, safe water quality, and healthy river in the Republic of Korea (Kim, chapter 14). Young generations in Kumamoto City, Japan, are engaged in preserving groundwater and disseminating their experience to the world and the next generation. Kumamoto City, where the 4th Asia-Pacific Summit was held in April 2002, is preserving groundwater to supply water to 1 million people (Tanaka, chapter 16).

1.4 Lessons

The main lessons learned from this study are:

Water resources management needs to integrate sociocultural aspects into its approaches and policies by incorporating local knowledge, traditions, and customs. Technical and economic considerations alone are not sufficient for effective management.

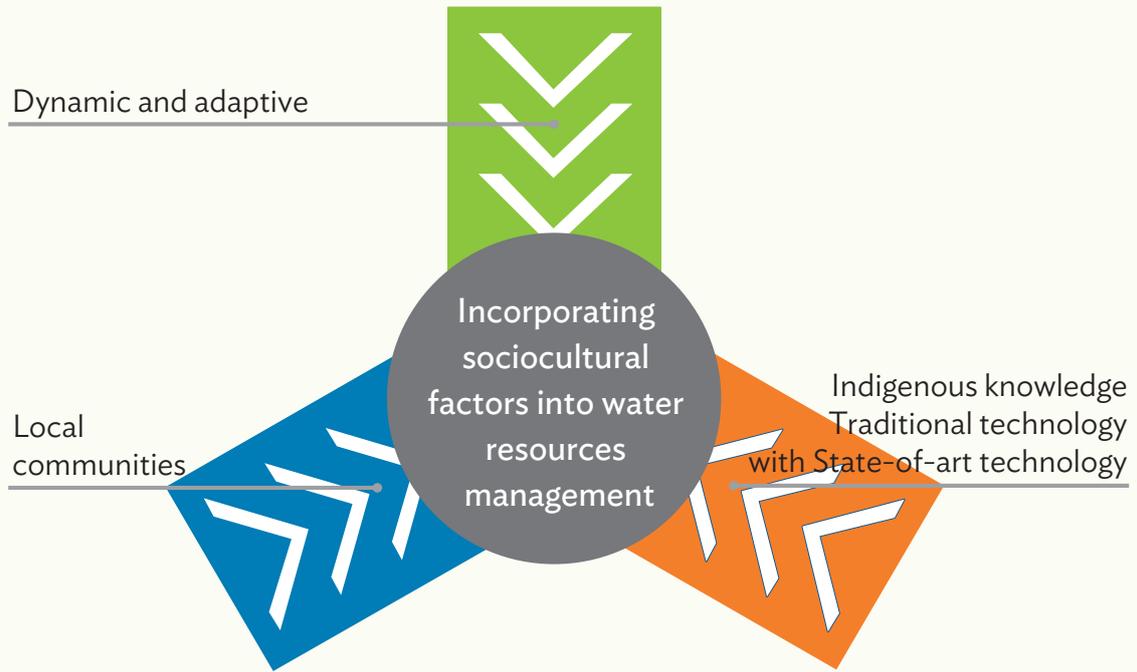
A cooperative approach is key, especially community involvement and participation in the operation and maintenance and decision-making on the ground. Strengthening such governance requires decision makers and stakeholders to consider sociocultural aspects.

Indigenous knowledge, traditional technologies, and approaches supported by sociocultural aspects are useful to adapt to the effects caused by climate change through coupling with state-of-art technology. They use energy efficiently, absorb carbon gases, mitigate climate change, provide leisure space, and preserve ecosystems. Economic analysis and technological development are needed to further promote these.

Water resources management should be adaptive and evolve in response to changing sociocultural dynamics. When sociocultural factors change because of modernization, urbanization, and development, decision makers should arrange governance and management mechanisms accordingly. Also, communities should strive to transfer their indigenous knowledge to the next generation.

Further research is needed to better understand and support peer-to-peer learning on how cultural values, beliefs, and practices can be incorporated into governance structures and decision-making processes. Many communities are already incorporating these in the Asia and Pacific region, and it is desirable to accumulate and analyze these practices and share among peers.

Figure 1.6: Key Messages of this Report



Source: Authors.

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PART I
Sociocultural Dimensions

A 400-Year History of Water Use in Japan's River Basins: The Creation of Rural Communities, Water Conflicts, Modernization, and Consensus Building through Infrastructure Development

Kotaro Takemura

2.1 Enclosure of Federal Lords in River Basin System during the Early Modern Edo Period

Tokugawa Ieyasu's victory in the Battle of Sekigahara in 1600 marked the end of the 150-year Warring States Period in Japan, during which around 200 feudal lords (daimyo) fought each other. Ieyasu then established the shogunate, a form of military government, in Edo (now Tokyo).¹ Ieyasu cleverly used the topography to govern the daimyo.

A spine mountain range runs through the center of the Japanese archipelago, and countless rivers flow down from the ridgelines of the mountain range to the sea. The country is made up of many pieces of river basins, like a jigsaw puzzle.

Ieyasu enclosed the daimyo in these river basins. The Edo period was a feudal system of shogunate and domains. But from the perspective of the topography, it was a system of power dispersion enclosed in the river basins and could be called a federal system based on river basins.

The Edo shogunate enforced a policy of national isolation on the daimyo and forbid them from invading neighboring river basins beyond the boundaries. During the 260 years of peace under the Edo shogunate, the daimyo devoted themselves to the development of river basins in the country.

The people of the river basins worked together to build levees. Many rivers, flowing freely in multiple channels, were trained inside the levees.

2.2 The Creation of National Land

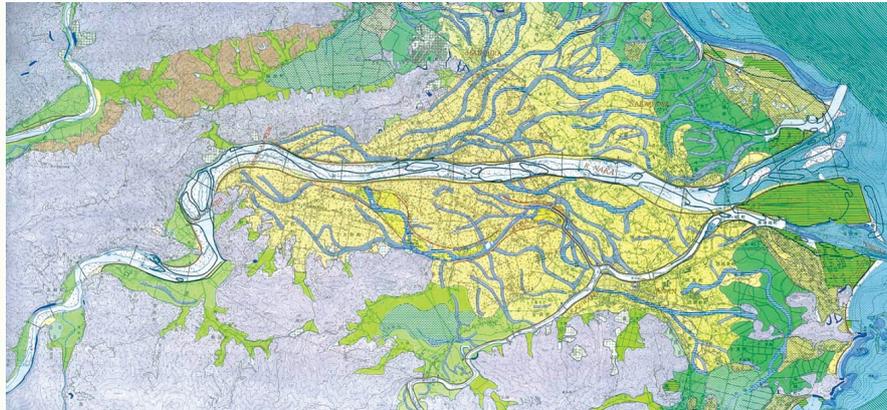
The purpose of forcing rivers inside levees was to convert barren wetlands into drylands for agriculture. By confining turbulent rivers to their levees, agricultural land could be created, and wealth in the form of rice could be expanded.

Figure 2.1 shows a map of the Naka River, a Class A river in Tokushima Prefecture in the Shikoku Island located in southwest Japan.² The two thick lines in the center are levees, representing the present Naka River. The lines around the levees are old river channels where the river used to flow turbulently.

¹ During this period, the shogun held the real power, while the emperor held only symbolic power. The Tokugawa shogunate ruled Japan from 1603 to 1868 with peace and stability.

² Class A rivers define river systems of particular importance for national land conservation or the national economy, and are administered by the national government. Class B rivers are those deemed important by the prefectural governor.

Figure 2.1: Topography and Geological Classification Map of the Naka River Basin

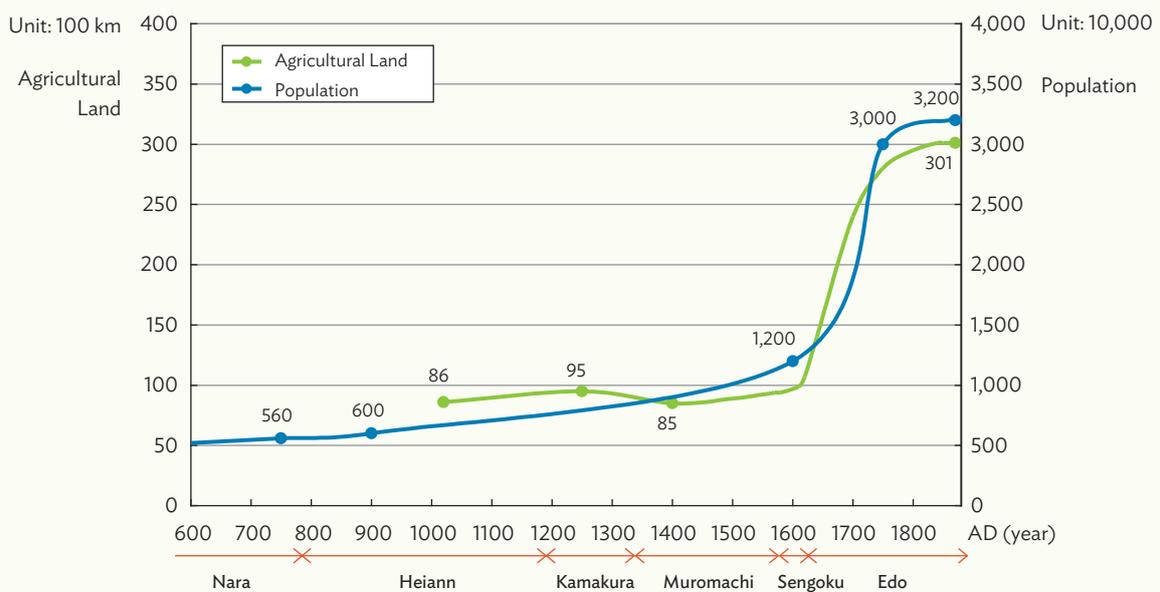


Source: Ministry of Land, Infrastructure, Transport and Tourism.

Now they are hidden underground and cannot be seen. A geological survey has revealed the old river channels, forms of Hydra in Greek mythology or Yamatano-orochi in Japanese mythology.³

Japan's agricultural land had remained constant at 9,000 square kilometers (km²) from 1,000 years ago until the Edo period. However, during the Edo period, agricultural land rapidly increased to 30,000 km². With the increase in rice production, Japan's population rose from 10 million in the 16th century to 30 million in the 18th century (Kito 1983, Figure 2.2).

Figure 2.2: Long-Term Changes in Agricultural Land and Population in Japan



Source: Prepared by author from Kito (1983). Agricultural Civil Engineering History Research Group.

³ A giant snake with eight heads and eight tails is mentioned in Japanese mythology. It lived in the upper reaches of the Hinokawa River in Izumo, liked to drink heavily, and devoured one daughter each year. Susanoo-no-Mikoto killed it, saved Princess Kiiinada, and split its tail to obtain the Ama-no-Murakumo sword.

2.3 Establishment of Robust Local Communities in the River Basins

The Japanese agricultural land was formed during the 260 years of peace during the Edo period. The Japanese could obtain the wealth of rice production through developing river basins. However, Yamatano-orochi of the old underground channels destroyed local communities. When heavy rains caused flooding, levees broke, and water overflowed into the paddy fields.

Local communities started fighting against flooding to protect their agricultural fields. Community members cooperated to protect levees from the common enemy of flooding. Throughout the country, autonomous communities emerged to fight against the enemy.

People erected shrines dedicated to their local guardian gods next to the levees. They reinforced the levees by walking on and compacting them during visits to the shrines. Various festivals were held on the levees. People walked along the levees in groups and stepped on the levees for the New Year's first visit, cherry blossom viewing in the spring, fireworks in the summer, and festivals in the autumn (Figure 2.3).

Figure 2.3: People Walking Along the Yoshiwara Nippon Embankment

Ukiyoe painting: Utagawa Hiroshige 170 years ago



Source: The Landmarks of Edo in Color Woodblock Prints, National Diet Library, Japan (www.ndl.go.jp/landmarks/).

A unique Japanese culture was nurtured on the levees. Local festivals were born on the levees. People made their first love, walked hand in hand with their children, and enjoyed festival songs and dances on the levees. Flood fighting, which protected the community from enemies, fostered a strong sense of community among the people. However, this strong sense of community led to conflicts with other communities within the same river basin. Water conflicts sometimes occurred during droughts.

2.3.1 Water Conflicts among Communities

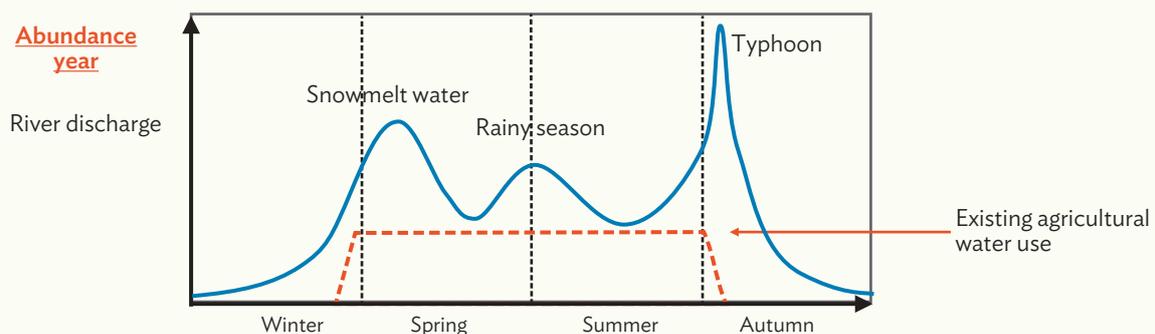
Rice cultivation requires a lot of water. Japanese people worked together to build weirs and irrigation channels to carry water to paddy fields for rice cultivation.

Japanese rivers have steep slopes, and when it rains water flows quickly into the ocean. If there was no rain for a week, the rivers quickly ran out of water, resulting in drought.

Water conflicts began between villages upstream and downstream as well as between villages on the other side of the river. These water conflicts, which were a matter of survival for the communities, often led to bloody conflicts. This was not a unique phenomenon to Japan, but a common occurrence in many parts of the world. This is clear from the fact that rival means “competitor” and is derived from rivers (flow), a synonym for competitor.

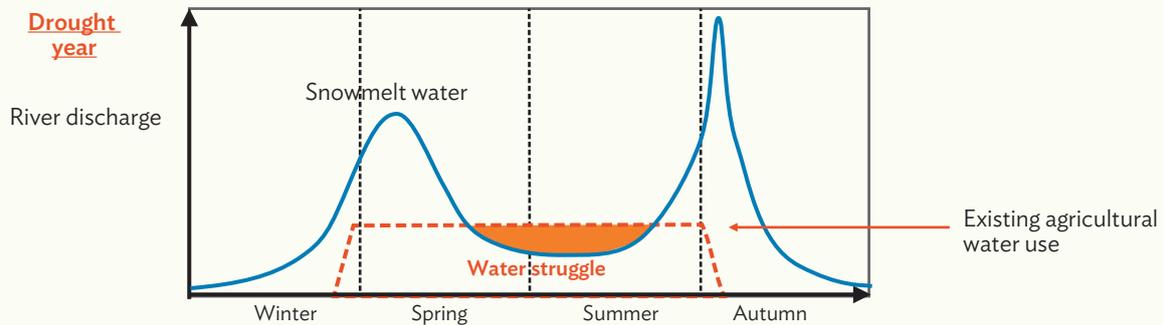
When water was plentiful, farmers used a lot of water. This meant that all river water was used up during normal times (Figure 2.4). With the river water depleted due to continuous drought in summer, farmers were not able to secure water and started conflicts (Figure 2.5).

Figure 2.4: River Water Use in the Edo period



Source: Author.

Figure 2.5: Water Struggle in the Edo Period



Source: Author.

At the end of the Edo period, water conflicts between communities were repeated in river basins all over Japan. Even in the Nikaryo irrigation system, which can be regarded as a direct subsidiary of the Edo shogunate, a disastrous conflict happened in 1821 over water between upstream and downstream communities when about 14,000 farmers from the downstream Kawasaki district attacked the upstream Mizokuchi district.

2.4 Beginning of Modernization

In 1853, four black steam-engine ships led by United States' Commodore Perry arrived in Tokyo Bay. The Japanese encountered the power of the steam engine, which was seen as the symbol of modern civilization. The Japanese people abandoned the policy of national isolation and opened the country to the outside world. To catch up with Western countries as quickly as possible, the Japanese needed to absorb modern civilization.

In 1877, steam locomotives began operating between Shimbashi in Tokyo and Yokohama, which was the symbol of modernization. Soon after, railroads were rapidly built throughout the country, and their destination was the capital, Tokyo.

Locomotives, which were the symbol of modernization, promoted urbanization, leading to concentration in Tokyo. The railways disrupted the quiet society, consisting of river basins in Edo for 260 years. Locomotives were running in front of people living inside the river basins. Young people jumped onto steam locomotives, and Japan's young labor force and capital migrated to the cities, leading to the rapid expansion of modern cities.

2.4.1 Expansion of Cities

Cities and industries required large quantities of drinking and industrial water. Japanese industries developed from fish processing to garment manufacturing and then to heavy chemical industries.

However, as new water users were added to the management of river water resources, water shortages during droughts became even more severe. Existing farming communities were not willing to readily accept new users. For hundreds of years farmers had been protecting the water at the expense of their own blood. Agricultural communities were hardcore on water conflicts.

The newcomers in the cities were in a far weaker position than the farmers. Urban water users requested the existing agricultural water users to receive their share of the extra water. When droughts persisted, and the water level in the rivers decreased, water for agriculture was prioritized. The cities' water supply experienced repeated interruptions. Production companies pumped up groundwater, causing land subsidence. These water issues became significantly severe during the reconstruction period after the Second World War.

2.5 Dam Construction in Postwar Reconstruction

After the Second World War, large typhoons struck the already devastated country, resulting in the loss of thousands of lives almost every year. Flood protection became Japan's top priority, and the government resumed the construction of dams, which had been suspended during the war.

The government attached hydroelectric power generation to flood control dams to compensate for the shortage of electricity. Flood control dams needed to be kept empty to store floodwaters. In contrast, power generation requires constant storage of water. To achieve the conflicting goals, the government moved toward building as large a dam as the topography and geology permitted.

During the period of dam construction, urban areas suffered from severe water shortages. The government arranged unique measures and decided to release water to farmers from dams during dry periods. This is because the new users in urban areas could not withdraw water from rivers in a situation where water scarcity was causing conflicts between farmers.

The government started supporting all existing agricultural communities from the Edo era by releasing water from the dams (Figure 2.6). Farmers targeted are not specified but rather any community in a river basin. This water was called "unspecified irrigation water".

2.6 The Government as a Newcomer

Historically, rural communities along the river banks had governed the rivers since the Edo period. The River Law was enacted in 1896, stipulating that the national and prefectural governments became the river administrators. Farmers did not trust the river administrators created by the new River Law to be manage the river basins.

The infrastructure of unspecified irrigation capacity of the dams led farmers to accept water governance by modern law. In the Tone River system in the Tokyo metropolitan area, the government built many dams. The Ikari Dam completed in 1956 provides 32 million cubic meters (m³) of water for power generation, which uses unspecified irrigation water. The Fujiwara Dam was completed in 1958, with 31 million m³ of water reserved for unspecified irrigation. For unspecified irrigation, 20 million m³ was reserved at the Omata Dam completed in 1959, 13 million m³ at the Sonohara Dam completed in 1966, and 73 million m³ for power generation at the Kawamata Dam completed in the same year.

By 1966, the dam capacity for unspecified irrigation water reached 170 million m³. In other words, the water capacity of the dams was equivalent to about 280 Koshien Stadiums (about 600,000 m³) for the existing farmers along the river. The construction cost of the dams for this unspecified irrigation capacity was financed entirely by taxes.

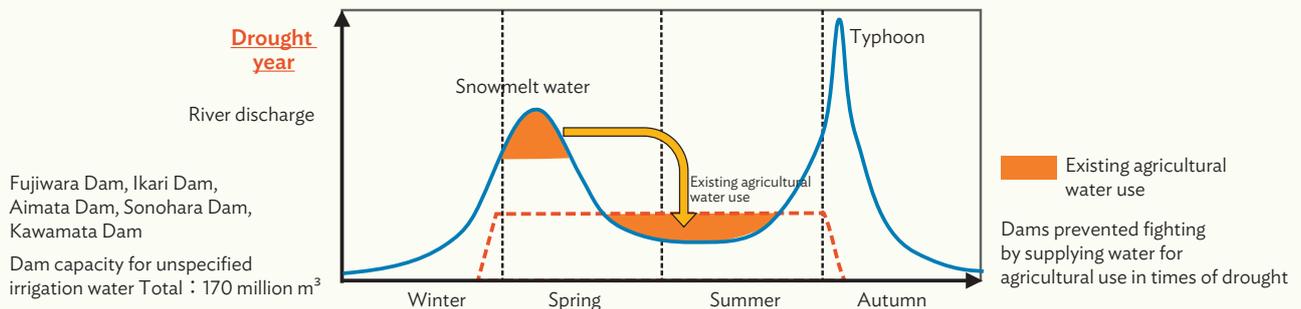
For the agricultural communities along the river, this was a tremendous gift. Water conflicts along the Tone River disappeared with the released water from the dams.

2.7 Water System in Modern Japan

The leaders of postwar Japan not only actively constructed dams but also envisioned a water withdrawal system that would facilitate economic development for the future of Japanese society. In 1957, 12 years after the end of the war, the Specific Multi-Purpose Dam Law was enacted. It was a democratic procedure and laid out the principles of rational water allocation as follows:

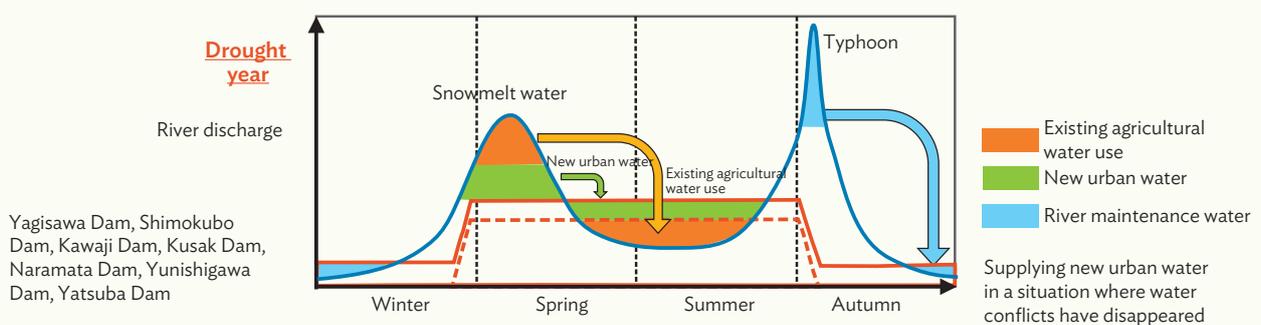
1. Dams are built to secure water for existing agricultural use on a priority basis (Figure 2.6)
2. Agreements could be obtained from the existing rural communities from the Edo period
3. With the agreement, dams will store the water for the newcomer in cities and released it toward the city (Figure 2.7)
4. The newcomers in cities bear the burden of funding the dam construction
5. Cost allocation of dam construction is calculated based on an open and impartial methodology
6. The cost allocated for water users is specified in the basic plan of each individual dam
7. The national government formulates the basic plan for individual dams, consults with relevant ministries and agencies, and obtains the opinions of prefectural governors
8. The governor shall pass a resolution of the Diet when expressing their opinion

Figure 2.6: Sufficiency of Existing Agricultural Water



Source: Author.

Figure 2.7: Water Supply to New Municipal Water



Source: Author.

In 1964, when the existing agricultural water supply of the Tone River was being secured, the River Law was significantly revised.⁴ The purpose of this revision was to include water utilization in addition to flood control. Article 1 of the law was designed to ensure the safety of existing agricultural water supply and to develop new water utilization, as described above. Article 1 also includes the phrase “maintenance of the normal functions of the river water”.

2.7.1 Maintenance of the Normal Functions of the River Water

The phrase to “maintain the normal functions of the river water” means that the river must flow at the rate it should flow as a river. In the 21st century, it is generally understood to mean protecting the natural environment of the rivers.

However, the main idea was that water must be reserved for the farmers who have historically managed the rivers. The principal purpose of this phrase was not to protect the natural environment. Urban water users must respect history in agricultural local communities and take water while preserving and maintaining the river environment. New water users should not take water away from existing farmers in exchange for money just because industrialization and urbanization had progressed.

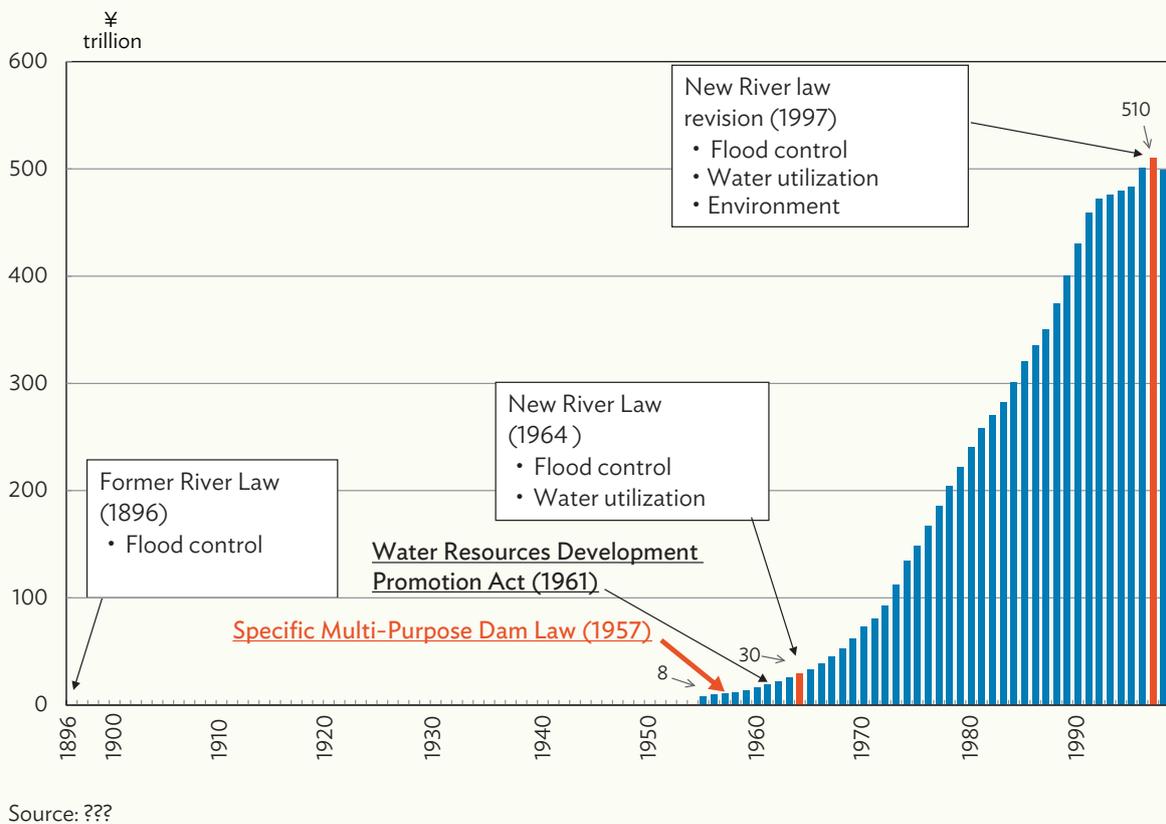
Currently, water is disappearing in rivers and lakes in Eurasia and Africa. There is no social commitment that a certain amount of water must flow in a river, given the history and natural environment of the region.

The philosophy of Japan’s River Law emphasizes the importance of respecting the historical background of the river and developing through sharing water according to the agreement of all parties involved along the river. During the 1960s, when the law was revised, Japan was striving for prosperity, and concepts like pollution and environmental preservation did not exist.

There is probably no other example in the world where the philosophy of respecting the history of existing agricultural communities in a river basin has been implemented in society through dam construction and water-related laws. Figure 2.8 shows that the Specific Multi-purpose Dam Law and the River Law have supported Japan’s modern economic growth.

⁴ In Japan, water laws do not exist, instead the River Law is the basic legislation of managing water.

Figure 2.8: Changes in Economic Growth (GDP) and River Law in Japan



2.7.2 Legal Philosophy Generated by Infrastructure Achievements

In 1997, the author was involved in a major revision of the River Law as a director of Japan's Ministry of Construction. Noteworthy was the inclusion of environment in the purpose of Article 1. However, behind this amendment, there was an important additional legal provision. It was the establishment of the new Article 53 on Water Use Adjustment during Droughts. The purpose of Article 53 is that water users shall coordinate with each other during times of severe drought, and in doing so, they must respect other water users.

The idea of respecting other users in times of drought is inherently unnatural. Throughout human history, it has been customary during such periods for people to compete vigorously for water. This concept, like "threading a camel through the eye of a needle," was incorporated into the basic law of modern national land management: the River Law.

Based on this legal principle, drought coordination councils were established where river managers, farmers, and urban water users would hold discussions during times of water shortages. At the meetings, they actively monitor dam storage, determine water conservation rates, reach consensus, and implement water saving measures.

2.7.3 Consensus Building and Legislation for Water Use History

The amendments made to the River Law in 1964 and 1997 were not replicas of Western legislation but rather unique concepts originating from practices on the ground. The 1964 amendment was a response to the construction of agricultural dams, aiming to ensure the use of water and maintenance of the normal functioning of the river water. Collaborative efforts between farmers and urban water users in monitoring dam reservoirs and conserving water during droughts influenced the inclusion of the phrase “respecting other water users” in the 1997 amendment.

Despite having various national basic laws, it is notable that only the River Law has undergone two changes to its primary objective since its establishment in 1896. Although Japan’s river administration is often criticized as ultra-conservative, it has a tradition of adapting to significant social trends. The 1997 emphasis on respect for other water users aligns with the principles of “Harmony with Respect,” found in the first Japanese constitution, Prince Shotoku’s 17-article constitution enacted in 604.⁵

2.8 Highlights

The foundation for water resources management including water rights, water distribution, and coordination during droughts in Japan up to the present day was laid during the Edo period (17th–19th centuries).

Modern mechanisms of water resources management have been formed by respecting and prioritizing the customs, which were established by communities through conflicts.

Dam infrastructure resolved conflicts among local communities by providing free water to farmers during droughts, and supplying water to emerging urban industries and residents.

Constructing infrastructure could strengthen water governance in each river basin historically established based on mutual respect among water users.

⁵ As regent, Prince Shotoku established the foundation of a centralized bureaucratic state by enacting the Twelve Ranks of the Crown and the Seventeen Articles of the Constitution. He sent envoys to China to introduce continental culture and built Horyu-ji and Shitennoji temples to promote Buddhism.

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River Management in India: Mainstreaming the Sociocultural Elements

Victor R. Shinde, Lovlesh Sharma, Jyoti Verma, and Satarupa Roy

3.1 Introduction

Rivers are among the most productive ecosystems, providing a variety of ecosystem services, including provisioning, regulating, cultural, recreational, and aesthetic to its users (Guo et al. 2021). For rivers to be able to continue providing these services, it is vital that the management of rivers accounts for the diverse drivers and enabling factors that are required for holistic management. In recent times, the social benefits of rivers are increasingly being acknowledged, which have been leveraged to restore the ecological integrity of rivers in places where there is a need (Garau, Torralba, and Pueyo-Ros 2021). As Everard and Moggridge (2012) point out, this comes from the premise that in addition to the ecological aspects, effective river management provides various co-benefits such as public health, economic value, quality of life, regional regeneration, and disaster risk reduction.

Healthy rivers not only promote a quality environment but also provide people with a place that fulfils a variety of social and psychological needs (Basak et al. 2021), and sociocultural elements are strongly linked to these needs. This is because, for many human populations around the world, river flows are linked to livelihood, identity, sense of place, religious beliefs and ceremonies, language systems, or educational practices (Anderson et al. 2019). Throughout history, and even today, rivers have an inherent intrinsic sociocultural value. Table 3.1 provides a summary of examples from across the world in this regard.

Table 3.1: Examples of Sociocultural Value of Rivers Across the Globe

Title	Description
Water Festival (Bon Om Touk), Cambodia	<p>Bon Om Touk is celebrated to mark the natural occurrence where there is a reversing of water flow between Tonle Sap Lake and the Mekong River. For most of the year, water from Tonle Sap Lake flows into the Mekong River. However, during the monsoon in June to October, the Mekong River flows into the lake, increasing its size by almost 10 times.</p> <p>Bon Om Touk is celebrated in November to thank the Mekong River for revitalizing the lake, given that thousands of people depend on it for their livelihoods. The festival was first celebrated in the 12th century during the reign of Angkorian King Jayaraman VII. The locals believe that the festival is an avenue to please the gods, who in turn will ensure that the worshippers will have enough provision of rice and fish throughout the year.</p>
Niger River Festival, Mali	<p>The Niger River is the lifeline for many parts of Mali, one of the largest countries in the African continent. The river floods the inner Niger Delta in Mali every year. In doing so, it provides opportunities for fisheries, and water for agriculture and household use, supporting the lives of 1.5 million people and millions of migratory waterbirds.</p> <p>The Bozo and Bamana tribes from the Markala region along the banks of the Niger River gather every year for the annual festival, the Niger River Festival. Very similar to Bon Om Touk in Cambodia, these local communities pay their tributes to the river and celebrate its kinship with them through the festival.</p>

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Table 3.1 *continued*

Title	Description
Amsterdam canals, the Netherlands	<p>Water has always been a prominent feature in Amsterdam's landscape. Amsterdam's historic canal belt provides a perfect setting for large city-wide festivals and bringing people together. Canals in the city are seen as active spaces and host large number of events around and in them.</p> <p>The canals are the city's central point for city celebrations across the year. Some of these events include the King's Day, Amsterdam Gay Pride (the world's only waterborne gay pride festival), the Grachten Festival (classical music canal festival), and the Amsterdam Light Festival. These events accentuate the incredible value these canals provide to the city and its citizens.</p>
Ningxia papercut, the People's Republic of China	<p>The Yellow River is widely considered the inspiration for Chinese traditional culture. The Chinese believe it to be a symbol of humanity and spirituality, bearing burdens (its sedimentation), adaptation (its course changes), and perseverance (its continual flow). The river not only supports the livelihoods of the people that depend on it but also nurtures the local tradition, and inspires many unique cultural practices.</p> <p>One such practice that has been influenced by the river is the Ningxia papercut, which has its own value in terms of representing regional culture. In 2009, this was listed as a world class intangible cultural heritage. The design and patterns of the Ningxia papercut is a reflection of popular farmers' culture in the Yellow River basin. The origin of the subjects of the patterns include various plants and vegetables, the 12 zodiac animal signs, red double happiness letters, domesticated birds, fish, flowers, etc., all of which are found in the Yellow River Basin.</p>
Tenjin Matsuri, Japan	<p>The Tenjin Matsuri, which literally translates to "Festival of the Gods" is held at the Tenmangu Shrine in Osaka and honors the deity Sugawara Michizane, the god of learning. The Tenjin Matsuri is special in that it celebrates water and the city together. The festival culminates into a river procession, which is among the highlights of the event. The purpose is to convey gratitude to the Osaka River in the form of two Mikoshi (portable shrines), which are loaded onto boats as the procession moves onto the water.</p>

Source: Adapted from NIUA and NMCG (2022).

3.2 River Management in India

In India, throughout its history, rivers have had an intrinsic sociocultural value. A well-known example is the River Ganges (also referred to as Ganga), which is a major avenue of cultural and spiritual activities for millions of Indians. Likewise, rivers like the Narmada, Yamuna, Brahmaputra, Kosi, and several others, are intrinsically linked with sociocultural connotations.

An essential component of the holistic management of rivers in India is to be cognizant of these sociocultural implications and incorporate those into planning paradigms. In 2019, the National Institute of Urban Affairs (affiliated with India's Ministry of Housing and Urban Affairs) and the National Mission for Clean Ganga (affiliated with India's Ministry of Jal Shakti) introduced a novel framework for urban river management in India. The purpose of the framework is to provide a template for river cities in India to prepare a holistic plan for reviving and maintaining the rivers within their administrative limits. The central idea of the framework is that healthy rivers have a strong bearing on livability and productivity in the cities. At the heart of the framework is a 10-point agenda (Figure 3.1) that every river city would need to adopt to prepare its city-specific urban river management plan (URMP). The sociocultural elements of river management are captured in agenda items 9 and 10. Hence, an enabling environment has been created in the country to mainstream sociocultural considerations in the management of urban rivers.

The objective of this chapter is to highlight four key sociocultural elements that are considered for river management mechanisms in India, along with case studies of how each of these has been

Figure 3.1: India's Urban River Management Plan Framework


Source: NIUA and NMCG (2020).

addressed in different parts of India. These elements are (i) religious and cultural significance of rivers, (ii) inclusive development and management of rivers, (iii) community engagement and involvement, and (iv) traditional knowledge and wisdom.

A river is a system of interconnected elements. To ensure the holistic management of this system, the sociocultural elements associated with the river are as important as other conventional elements like pollution control (Bao et al. 2022), floodplain regulations, and riverfront development (Vian, Izquierdo, and Martínez 2021), among others. Mainstreaming these sociocultural elements into the management paradigm will go a long way in ensuring truly sustainable development of river systems, which can absorb the imminent shocks and stressors that systems are increasingly being subjected to in the present times.

3.3 Mainstreaming Sociocultural Elements in River Management in India

3.3.1 Religious and Cultural Significance of Rivers: Case Study of Kanpur City

Context

In many regions of India, rivers are worshipped and have an integral role to play in certain religious and cultural rituals and practices. Understanding these religious and cultural connections can be important for effective river management. This section focuses on the case study of Kanpur in north India, which was the first city in India to develop an urban river management plan. The case study expounds on the plan that the city has made to boost its river-related economy by leveraging this religious sentiment.

Kanpur, often referred to as the “Manchester of India,” is a dynamic and historically significant city located in the northern state of Uttar Pradesh. Situated on the banks of the Ganges River, Kanpur has a rich and diverse heritage that spans centuries. With a history dating back to the Vedic period and

a prominent role during the Indian struggle for independence, the city has evolved into a bustling metropolis that blends tradition with modernity.

The city is bound by two rivers—the Ganges on one side and the Pandu River on the other. Recognizing the role of these rivers in enhancing the overall livability of Kanpur, the city took the initiative to develop a dedicated URMP to manage the rivers efficiently and sustainably.

The Intervention

One of the interventions of Kanpur's URMP is to link river management with the sociocultural value of the city. Approximately 20 kilometers (km) upstream from Kanpur is a small town called Bithoor, which is revered as a sacred place in Hinduism. It is believed to be the birthplace of Lord Ram's sons, Luv and Kush, and is associated with various episodes from the epic Ramayana. Bithoor has a rich cultural heritage, with several temples, ashrams, and historical structures that attract both pilgrims and tourists.

The intervention outlined in Kanpur's URMP is the development of a cultural theme-based boating circuit between Kanpur and Bithoor along the Ganges River. This intervention aims to leverage the sociocultural potential of the city by enhancing tourism and recreational activities on the river.

Boat rides take visitors on a journey along the Ganges River, showcasing Bithoor's rich culture, connection with the Ramayana, and India's freedom struggle. There are many such cases where themed boat rides have been exemplary in attracting tourists and providing experiences wrapped in information. For instance, Sanskruti Darshan by the Akshardham Temple in New Delhi, Pandora—the world of Avatar by Walt Disney in Florida, and boat safaris (through a virtual forest) in Singapore, among others. The intervention has been conceptualized in such a way that the river-related tourism in the Kanpur–Bithoor stretch is formalized, streamlined, and subsequently enhanced.

The cultural theme-based boat rides have a designated starting point at Atal Ghat,¹ with ticket stations and waiting zones. Visitors have the option of choosing between two routes. The first route involves a ride upstream that will take visitors on a 6 km boat ride involving themed facilities, such as sculptures, a sound and light show, and interactive activities, providing an immersive experience for tourists. The second route will take visitors 6 km downstream to the Sarsiya Ghat to observe the several ghats and their activities.

Implications for Cross-learning

Cities flourishing along the rivers have the opportunity to leverage the ecosystem services provided by the river system in terms of provisioning, regulating or recreational services. The city of Kanpur has recognized the religious and cultural significance of the Ganges River and leveraged it as an opportunity for sustainable development and river management. The development of a cultural theme-based boating circuit at Kanpur and Bithoor will boost the river-related economy and also preserve and showcase the rich religious and cultural heritage of the region. By embracing the diverse drivers and enabling factors required for holistic river management, Kanpur is paving the way for other cities to follow suit and create a harmonious balance between sociocultural elements and ecological conservation.

By promoting responsible tourism practices and raising awareness about the ecological importance of the rivers, visitors will develop a deeper appreciation for the natural and cultural heritage of the region. This, in turn, will contribute to the conservation efforts and the overall ecological integrity of the rivers.

¹ A flight of steps leading down to the river.

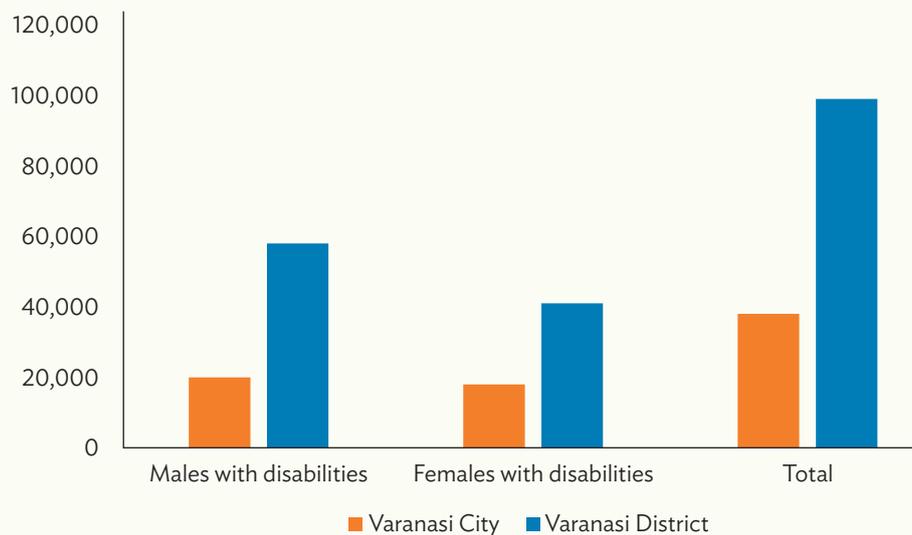
3.3.2 Inclusive Development and Management of Rivers: Case Study of Varanasi City

Context

A river is a common-pool resource. However, the benefits of a river are not always distributed equally, and can disproportionately affect disadvantaged communities, differently-abled people, and the elderly. A vital objective of holistic river management is to ensure that management actions do not exacerbate existing social and environmental inequalities. This section describes the case study of Varanasi, an ancient city located in the northern state of Uttar Pradesh in India, where the city has taken measures to make its riverfront projects more accessible to the differently abled and the elderly.

Given its religious significance, the city has 84 ghats along the Ganges River, where pilgrims visit to perform different rituals and practices. For example, one of the most popular rituals is the “Ganga Aarti”, which is performed on Dasaswamedh Ghat every evening. Thousands of visitors flock to this event from across the country. The scale of visitors to the Ganga ghats in Varanasi is increasing every year. On average about 100,000–150,000 devotees visit the Varanasi ghats and temples daily. The problem, however, is that these ghats are also a hurdle to the physically challenged, the elderly, and children due to their obvious built character. This aspect becomes more critical when considering that Uttar Pradesh State accounts for the highest number of persons with disabilities across all states in India. Likewise, Varanasi District features in the top 10 districts across the country that have the highest number of people with disabilities (Figure 3.2).

Figure 3.2: Disability Statistics for Varanasi District and City

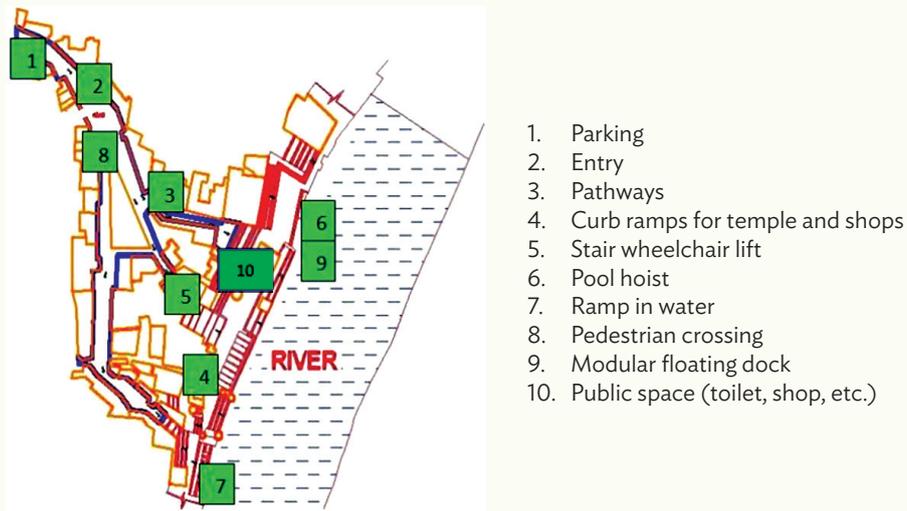


Source: NIUA (2021).

The Intervention

To address the issue of inclusivity, the Uttar Pradesh government, in association with allied agencies has carried out large-scale redevelopment work for the Assi, Manikarnika, and Dashashwamedh ghats, which have the highest footfall. The redevelopment targeted to ensure the integration of universal design elements such as ramps, handrails, accessible toilets, braille signage, drinking water facilities, etc., which will assist the differently abled to access the ghats and witness the Ganga Aarti. The redevelopment project also aimed to make the connectivity to the ghats areas easier and more inclusive. Some of the measures employed include levelling the roads to reduce uneven surfaces, strengthening pedestrian infrastructure, creating separate lanes for persons with disabilities, and setting up a dedicated parking zone to reduce congestion. Figure 3.3 presents an example of the redevelopment plan for the Dashashwamedh Ghat.

Figure 3.3: Redevelopment Plan for the Dashashwamedh Ghat that Includes Disability Elements



Source: Authors' depiction.

There are several features that have been designed from a disability perspective. The entrance and corridors are wide enough to accommodate a wheelchair. The curb ramp is designed so that wheelchairs, Segways, carts, etc., can access the area. Wheelchair lifts attached to the side rails of the staircases are installed to facilitate access of the disabled to the ghat area. The pool hoist is to help disabled people take a dip in the holy water. The project has also ensured that the roads leading to the ghats are adequately levelled to ensure minimum inconvenience to the differently abled. Likewise, there is a separate lane for the disabled so that they can reach the ghats directly from the main entrance.

Implications for Cross-learning

Making riverfronts universally accessible is a good practice in any part of the world. Not only does it allow disadvantaged sections of society to get access to a vital natural asset, but it also improves the reputation of riverfront projects. For example, as per the Varanasi local government, the number of

visitors to the Asi, Manikarnika, and Dashashwamedh ghats has doubled after the recent redevelopment. Official figures suggest that the income of people associated with the tourism sector has increased anywhere between 20% to 65% whereas employment in the tourism sector has increased by 34.18%. Hence, it is evident that investment in inclusive infrastructure and related practices has positive economic implications. The rejuvenation drive of the ghats and the transformation of the neighboring temple areas have been pivotal in nurturing the city's tourism boom.

3.3.3 Community Engagement and Involvement: Case Study of Aurangabad City

Context

Often river management plans are prepared without consulting communities and citizen stakeholders. Citizens are usually brought into the picture when plans are complete, from the standpoint of informing them about the plan and seeking their endorsement. Sustainable river management requires the active participation and support of local communities, which can help ensure that management strategies reflect local needs and priorities and that the benefits and impacts of management actions are equitably distributed. This section highlights the example of the city of Aurangabad and describes its efforts to engage with citizens for the rejuvenation of the Kham River.

Aurangabad is a city located in the Indian state of Maharashtra located on a hilly upland terrain in the Deccan plateau. The city sits in the Dudhana valley, between the Lakenvara range in the north and the Satara hills in the south. The city has two seasonal rivers flowing through it—the Kham and the Sukhna.

The Kham is a severely deteriorated river plagued by both solid and liquid waste pollution. As per recent official records, the main indicators of water pollution—biochemical oxygen demand (BOD), chemical oxygen demand (COD), and total nitrogen—were recorded as exceptionally high and above the permissible standards. The BOD concentration in different stretches of the river ranged between 160–287 milligrams per liter (mg/l), and the COD values ranged from 400–800 mg/l, indicating high discharge of untreated organic and inorganic load in the river.

The Intervention

In 2016, a survey was carried out with residents of Aurangabad where it emerged that more than 40% of the respondents did not know that the Kham River flowed through the city. However, 84% indicated a willingness to participate in the river restoration activities. This led to the launch of the Kham River Restoration Mission, which started as a pilot over a 1.5-km stretch. The initiative was anchored by Varroc Engineering, a multinational company, the Confederation of Indian Industries, and the Aurangabad Cantonment Board. While some initial results were achieved, the sewage and solid waste in the river threatened the sustainability of long-term impacts. To address this aspect, the city set up the Kham River Restoration Committee to holistically look at the management of the river, using a systems approach. The committee comprised the Aurangabad Municipal Corporation, the Cantonment Board of Aurangabad, Varroc Engineering, EcoSattva, and the National Institute of Urban Affairs (NIUA).

One of the key strategies employed by the committee was to initiate a public campaign and citizens' movement through print media, social media, and radio media as a means to reconnect people to the Kham. Aurangabad's local band "NoB" wrote the "Kham Song", which soon turned into the anthem for the campaign. Events were organized for school students where they were taken for birdwatching and butterfly walks during which experts talked about the river's biodiversity (Figure 3.4). Several women's

groups organized workshops along with cleanup and plantation drives (Figure 3.5). Likewise, industrial bodies introduced a cleanup drive relay every Saturday, where the responsibility is transferred from one industry to another week after week.

Figure 3.4: School Children and Students Sensitized to the Agenda of the Kham River Restoration Mission



Picture Credit: Sachin Bhusare.

Figure 3.5: River Cleanup Drives Organized by the Kham River Restoration Mission



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Figure 3.5 continued



Source: Newspaper clippings from the Times of India and Down to Earth magazine.

As a result of the citizen engagement activities, more than 100,000 square meters have been cleared of solid waste. Ten new ecological riverfront spaces with more than 50,000 trees have been developed along the Kham. About 150 garbage vulnerable points have been tapped that prevent solid waste from entering the river.

Additionally, as a part of the mission, an eco-friendly riverfront area, the Kham Eco Park (Figure 3.6), has been developed to build a blue-green space to enhance the citizens' connection with the river. Built along a stretch of 1.5 km along the river, this area is marked with grasses, a butterfly and dragonfly garden, a Miyawaki forest, an amphitheater made from waste tires, a fresh-water pond, wetlands, and is covered with around 50,000 native species of plants and trees. In addition to providing an ecological recreational space for citizens, the eco-park also reinvigorates the lost flora and fauna.

Figure 3.6: Recreational Avenues Developed as Part of the Kham River Restoration Mission

Source: Newspaper clippings from the Times of India.

Implications for Cross-learning

Citizens are often only considered peripheral players in river management when the fact is that citizen support is imperative for any long-term strategy for the management of urban rivers. It is easier to solicit this support from citizens when they are kept aware of the various issues and have an understanding of the role that they can play in addressing the issues. Cities should invest in dedicated citizen engagement programs to spread awareness about the benefits of healthy rivers through different dissemination mechanisms to facilitate desired behavioral changes. Such initiatives also set the narrative that river management is a societal responsibility where different stakeholders, including citizens, have a role to play. In most progressive societies, such models of co-governance have helped facilitate a transformation in the mindset of people towards the ecological assets of the city.

3.3.4 Traditional Knowledge and Wisdom for Water Management: Case Study of Apatani Tribe, Ziro Valley

Context

Many indigenous and local communities have developed extensive knowledge of their local river systems and have traditional practices that support the health of these systems. Incorporating this knowledge into management strategies can improve their effectiveness and support the continuation of important cultural practices. This section presents the example of the Apatani tribe in east India to highlight the value of traditional ecological knowledge in sustainable river management.

The historical significance of traditional wisdom in river management in India is profound, with its roots dating back thousands of years, intricately woven into the tapestry of the nation's history and culture. Indigenous communities residing along these waterways have cultivated a deep understanding of their local ecosystems, intimately comprehending the nuances of river behavior across different seasons. Their unwavering commitment to eco-friendliness and prioritizing methods with minimal ecological footprints sets traditional river management practices apart. Techniques like step wells, check dams, and tank systems, hailing from ancient times, were ingeniously devised to capture and store rainwater, ensuring a sustainable supply that replenishes groundwater.

The Ziro Valley has been inhabited since the 1100s and serves as a remarkable testament to the enduring legacy of the Apatani tribe.

The Ziro valley lies between the river valleys of Kamla and Khru in the north and Palin in the south, resting at an altitude of 1,524 meters. Covering an area of approximately 2,800 square meters, this region boasts a captivating landscape characterized by pine-clad gentle hills. The land use categorization in the valley is paddy-cum-fish cultivation (approximately 48%), clan forest (approximately 33%), bamboo forest (approximately 16%), and home garden (approximately 3%).

The Intervention

The Apatani tribe's cultivation techniques showcase their deep understanding of water management, river conservation, and traditional wisdom. One of the unique traditional practices followed is the distinctive paddy-cum-fish cultivation where the tribe harmoniously grow rice and nurtures fish in submerged fields. This ingenious approach not only secures a reliable food source but also plays a vital role in conserving the ecological balance of the region, especially concerning river ecosystems.

The practice of wetland rice cultivation is meticulously executed on broad, well-levelled terraces fortified with robust bunds called Agher, expertly fashioned using bamboo and wood to contain water and retain nutrient-rich soils. The dimensions of these bunds are tailored to the land's gradient and the field's shape and size. The terrace bunds, tailored to suit the characteristics and size of the terrain, typically span between 0.6 to 1.4 meters in breadth and range from 0.2 to 0.6 meters in height. To facilitate the transfer of water from one terrace to another, bamboo or wooden pipes are employed, ensuring a controlled flow that optimizes water distribution. The bamboo pipes are placed 15 to 25 centimeters (cm) above the bed to ensure the proper water level.

Trenches, about 50 cm deep, are dug in the field to provide shelter to fish. Moreover, the inclusion of fish pits within the plots serves a dual function: maintaining water for pisciculture even when the fields are drained, especially during the flowering and grain maturity stages. Fingerlings are introduced into these pits, and when there's ample water supply during the monsoon season, the entire paddy field is maintained at a shallow submersion level of 5 to 10 cm. This allows the fish to venture out from the pits and freely roam the submerged areas of the terrace fields. During periods of water scarcity, when water is confined to the pits, the fish retreat to them to grow and thrive. In this integrated system, the fish benefit from enhanced nutrition due to the natural fertilization of the paddy fields.

Therefore, both rice and fish production are achieved through the effective management of rainwater resources. The agroecosystems thrive on nutrients carried down from the adjacent hill slopes. Figure 3.7 provides a glimpse into this practice.

Figure 3.7: Field Boundaries and Conservation of Water Along with Fish Cultivation

Sources: CPREEC–EIACP Programme Centre, Sumpam Tangjang, and P. K. Ramachandran Nair.

Implications for cross-learning

The unacknowledged wealth of indigenous knowledge, predominantly found in the global south, has consistently proven its resilience over time. This resilience is rooted in the deep well of place-based wisdom accumulated over many years. To harness the potential of indigenous practices, it is crucial to mainstream them into a city's or country's river management models. This integration will create an enabling environment to translate indigenous wisdom from theory to practical action, fostering more inclusive, sustainable, and resilient societies.

However, in an era marked by rapid modernization and urbanization, traditional knowledge is increasingly at risk of being lost. Indigenous wisdom is often overshadowed by technological solutions, leading to the neglect of invaluable insights into sustainable resource management. The decline of these traditional practices not only erodes cultural heritage but also poses a significant threat to ecological balance. Restoring the recognition and application of indigenous knowledge in water resource management is pivotal for striking a balance between modern development and the preservation of the natural world. This balance is essential to ensure the well-being and harmony between humanity and the planet.

3.4 Conclusion

The true essence of holistic river management is its ability to address the triple bottom line of social, economic, and environmental considerations. Far too often, the environmental aspects overshadow the other two. While this may be justified, especially in areas where pollution concerns dominate the agenda of river management; it is vital to also consider socioeconomic and sociocultural aspects. This comes from the fundamental understanding that a river is a system that has several elements, which are all connected in some form or the other. River management is essentially managing this system of connected elements and related actors. Furthermore, because the river is a system of diverse elements, managing the river requires river managers to have transdisciplinary knowledge corresponding to these elements. Hence, river managers not only need to have conventional engineering and hydrological knowledge, but they also need to be cognizant of the finer nuances of landscape architecture, river economics, and social science, among others.

As the knowledge of urban river management improves, it is increasingly becoming evident that urban river management cannot be considered solely a government endeavor. General citizens have a powerful and equal role to play. In light of growing environmental awareness, more and more citizens are keen to embrace their roles in the overall governance model. The number of people adopting environmentally-friendly practices in their lifestyles is growing by the day. Hence, in the future, river governance models that mainstream citizens are likely to be the norm.

The sociocultural elements of river management are important to establish the personal connection between residents and rivers. This chapter highlights examples of how these are being mainstreamed in river management strategies of Indian cities. This is the new thinking and evolution India needs for managing its urban rivers. Socrates once remarked, “The secret of change is to focus all of your energy not on fighting the old, but on building the new”. This in many ways is apt for urban river management today. River cities are special. Embracing progressive thinking for managing urban rivers—that considers softer measures such as sociocultural interventions—is vital to ensure they remain special.

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A Sociocultural Perspective on Water Resources Management in Bali, Indonesia

Firdaus Ali

4.1 Introduction

Water is an inseparable part of human life. The growing population, coupled with climate change which has changed the pattern of water availability, has become a new burden in the provision of clean water for the community. In the aftermath of the novel coronavirus disease (COVID-19) pandemic, the world, including Indonesia, continues to grapple with a heightened state of water scarcity or crisis. This global event has also changed the pattern of water availability and consumption. Indonesia, as the fourth most populous country in the world, currently 272.7 million people (BPS 2022), has the potential for very abundant water resources, amounting to 2.78 trillion cubic meters (m³) per year in 128 river basins.

While national water reserves remain within the safe category, concerns arise regarding accessibility, continuity, and quality. Maintaining the availability of water resources to meet the needs of various development sectors plays an important role in stimulating economic growth and social welfare. In Bali, the agriculture sector uses the most water (more than 60% of all water needs), in line with the rapid development of other sectors, it is necessary to pay attention to the increasing demand for water resources (Suyarto and Kusmawati 2016). The problem of water resources in Bali is specific according to the geographical, social, economic, cultural, and tourism development sector. Situated in a region characterized by monsoons and tropical climate patterns, Bali faces both the challenges of water scarcity and the imperative of managing water resources effectively to meet the needs of its growing population, agricultural practices, and tourism industry.

The island's water resources management is deeply intertwined with its sociocultural fabric and religious beliefs, which emphasize a harmonious relationship between humans, nature, and the divine. This unique perspective is encapsulated in the philosophy of *Tri Hita Karana*, emphasizing the pursuit of harmony among people, nature, and the spiritual realm. Over time, Bali's water management practices have evolved into an intricate tapestry of traditional systems, rituals, and community-driven approaches. The cornerstone of these practices is the *Subak* system, a cooperative irrigation network that fosters equitable water distribution, while fostering social cohesion and environmental stewardship. Additionally, the presence of water temples, where rituals and ceremonies are conducted to seek blessings for abundant harvests, underscores the spiritual connection between water and life on the island.

However, amid the island's cultural richness and sustainable practices, contemporary challenges have emerged. Rapid population growth, urbanization, and the unpredictable impacts of climate change pose threats to the delicate balance maintained by traditional water management systems. As modernization advances, the need to integrate longstanding practices with contemporary scientific approaches becomes crucial to ensuring Bali's water sustainability. Considering these complex dynamics, this chapter seeks to delve into the sociocultural perspective on water resources management in Bali. By examining the historical context, traditional practices, and challenges faced by the island, this study aims to shed light on the significance of integrating cultural wisdom with modern strategies to ensure the sustainable future of Bali's water resources.

The study by Nastiti et al. (2022) shows that the culture of managing water resources is still trusted by the community in protecting its nature. The infrastructure–technology and legal–institutional dimensions fall within the same range of values. Collaboration between the government, related entities, various stakeholders, and the community in preserving Bali’s nature and culture will have an impact on improving water resources infrastructure, which also needs to be supported by strategic infrastructure technology policies.

4.2 *Tri Hita Karana*: The Balinese Philosophy of Harmony

The local wisdom in water resources management in Bali represents a sustainable cultural prospect that needs to be preserved to ensure the continuity of the lives of future generations (Nastiti et al. 2022). The term “sustainable” signifies a multidimensional agreement for development aimed at achieving a better quality of life for the community (Bond et al. 2001). *Tri Hita Karana* is a philosophy originating from Bali, which emphasizes the importance of balance and harmony between three aspects: humans, nature, and the divine. The concept of *Tri Hita Karana* in relation to the management of water resources, can be conceptualized as follows: *Parahyangan*, *Pawongan*, and *Palemahan* (Provincial Government of Bali, Indonesia 2019). This concept is considered a basic principle for community life in Bali, including the practices of managing water resources and the environment in a sustainable manner.

Based on the study by Eryani and Yujana (2018), in terms of safeguarding the natural world, the involvement of fishers and farmers plays a substantial role. By fulfilling their inherent responsibilities as fishers and farmers, they are essentially engaging in environmental conservation by creating green cover through the strategic cultivation of plants that play a crucial role in absorbing rainwater. *Parahyangan* signifies the facet concerning water resources conservation, addressing the methods for organizing water in an efficient, equitable, and just manner. Regulations exist to govern the allocation of water. The presence of such a harmonious democratic system is crucial in the context of practicing democracy in the contemporary era, with the aim of reducing conflicts. *Pawongan* encompasses the utilization of natural resources. It constitutes a component of endeavors to uphold a harmonious connection between humans and the environment. Consequently, the *Subak* system, being an ancestral legacy characterized by local wisdom, is of utmost importance to be continuously conserved.

Palemahan (the relationship between humans and nature) encompasses the control of water resources degradation, emphasizing principles such as sustainability, balance, public benefit, integration, harmony, justice, self-reliance, transparency, and accountability. The guiding principles and orientation of water resources management (WRM), along with the aspirational vision for an ideal future state and mission of WRM, in Indonesia include conserving water resources, utilizing water resources, mitigating water resources degradation, strengthening the roles of communities and the business sector, providing water resources data and information, and involving the community. This is achieved by adopting strategic approaches, such as enhancing public understanding and awareness (including that of the business sector) about the essential alignment of social, economic, and environmental aspects of water resources.

Rooted in Balinese Hinduism, this philosophy encapsulates a holistic understanding of harmony, guiding both individual behavior and collective practices to ensure equilibrium among three fundamental realms: human, nature, and the divine. The philosophy of *Tri Hita Karana* profoundly influences the island’s approach to water resources management. Balinese communities view water as a vital conduit between the three realms, a shared resource that embodies the interconnectedness of life. The *Subak* system, a testament to this philosophy, ensures equitable water distribution while reflecting harmony

with nature and communal well-being. Water-related rituals and ceremonies exemplify the integration of *Tri Hita Karana* in Balinese culture. Water temples hold a central role in these practices, acting as spiritual hubs where individuals seek blessings for fertile lands and bountiful harvests. The offerings and rituals conducted at these temples reflect the island's commitment to maintaining harmonious relationships with both the divine and the natural world.

As Bali navigates modernization and globalization, the philosophy of *Tri Hita Karana* faces new challenges. Rapid urbanization, tourism, and changing agricultural practices can strain the delicate balance advocated by the philosophy. Nevertheless, the Balinese people continue to adapt, infusing traditional values into innovative solutions for sustainable water management that resonate with contemporary needs. The philosophy of *Tri Hita Karana* extends beyond Bali's borders, offering universal lessons in the pursuit of harmony. It underscores the significance of recognizing humanity's interconnectedness with the environment and the spiritual realm. As societies worldwide grapple with environmental crises, the Balinese philosophy provides a blueprint for achieving equilibrium and coexistence in an interconnected world.

4.3 The *Subak* System: Traditional Water Management Practice

Subak is the implementation of the teachings of *Tri Hita Karana*. *Subak* is a traditional irrigation system used in Bali to irrigate the rice fields that has existed since the 9th century, a period when Balinese society transitioned to organized agriculture. Originally developed to support rice cultivation, the system has evolved into a complex network of canals, tunnels, and water temples that intricately weave through Bali's landscapes. Emerging from the need to irrigate rice fields, the system gradually evolved as communities developed interconnected irrigation networks to address water distribution challenges. Figure 4.1 shows an example of an irrigation canal in Bali.

Subak involves collaboration between farmers within an area to regulate the use of irrigation water in a fair and efficient manner. In addition to irrigating the rice fields, *Subak* also plays an important role in the social and religious life of the Balinese people. The *Subak* system stands as a testament to Bali's ingenious approach to water resources management, embodying the island's deep-rooted cultural and agricultural heritage. This centuries-old cooperative irrigation system is not only a hydraulic marvel but also a reflection of the Balinese people's harmonious relationship with nature and their community.

At the core of the *Subak* system lies the principle of equity. Water is distributed fairly among rice paddies, ensuring that every farmer receives a share, regardless of their land's location or elevation. This embodies the Balinese ethos of communal cooperation and collective well-being. The *Subak* system transcends its utilitarian purpose, embracing cultural and social dimensions. It fosters a sense of unity, as farmers come together for maintenance, decision making, and ceremonies. These interactions not only strengthen community bonds but also perpetuate traditional values.

Water temples play an integral role within the *Subak* system. These temples serve as spiritual hubs, where ceremonies and rituals are conducted to honor water deities and seek blessings for successful harvests. This symbiotic relationship between spirituality and water management reinforces the philosophy of harmony. Despite evolving landscapes and changing agricultural practices, the *Subak* system showcases its adaptability. By integrating modern technologies, such as weather forecasts and irrigation technologies, with traditional practices, the system remains relevant in addressing contemporary challenges.

Figure 4.1: Bali Irrigation Canal, Jatiluwih Village



Source: Bali-Penida River Basin Agency (2023).

Rapid urbanization, tourism, and altered land use patterns pose challenges to the *Subak* system's delicate equilibrium. The demands of modern life, coupled with climate change uncertainties, necessitate careful consideration to ensure the system's continued viability. The *Subak* system's success imparts valuable lessons for sustainable water management globally. Its emphasis on community collaboration, equitable distribution, and integration of spirituality highlights the potential of harmonizing human activity with nature. Efforts are underway to preserve and promote the *Subak* system as a United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Site, acknowledging its cultural, ecological, and social significance. These endeavors underscore the importance of safeguarding this exceptional traditional water management practice for future generations. In essence, the *Subak* system is a living embodiment of Bali's cultural wisdom and resilience, serving as an inspiration for sustainable water management practices around the world. It is a remarkable blend of tradition, community, and ecology that not only sustains rice cultivation but also nourishes the island's spirit, embodying the essence of *Tri Hita Karana*.

The *Subak* system has garnered attention as a potential model for sustainable water management in various regions, both within Indonesia and in other countries. While the system itself may not be directly replicated outside Bali due to its unique cultural and geographical context, its principles and key elements have inspired efforts to promote sustainable agriculture and water resources management elsewhere. *Subak*-inspired systems have been implemented in other parts of Indonesia, particularly in areas with similar rice-based agricultural practices. These adaptations incorporate local customs and traditions while adopting the core principles of community-based water management and equitable distribution.

The Ifugao rice terraces in the Philippines share some similarities with Bali's rice cultivation practices. Efforts have been made to apply *Subak*-like community-based approaches to terrace management, emphasizing traditional knowledge and local cooperation. In Cambodia, the Angkor Wat temple complex has ancient irrigation systems that resemble the *Subak* in certain aspects. Local communities

have been involved in restoring and maintaining these systems, drawing inspiration from Bali's Subak principles.

In various parts of the world, community-based water management initiatives have taken inspiration from the *Subak* system's emphasis on collective decision making and equitable distribution. These initiatives often involve local stakeholders in water resources governance. Beyond rice cultivation, the principles of efficient water use, cooperation, and sustainable land management from the *Subak* system have been integrated into modern agricultural practices and water conservation efforts in different regions.

Based on the study by Risna et al. (2022), the *Subak* system indeed fulfills all the criteria for being considered a nature-based solution (NBS), although the depth of its impact has not been quantitatively measured in this study. *Subak* falls under the category of NBS Type-2, which emphasizes sustainability and the multi-functionality of managed ecosystems. A more comprehensive evaluation, following the International Union for the Conservation of Nature's guidelines, is necessary, involving a more substantial body of relevant evidence and stakeholder input. We emphasize the importance of allocating research and innovation funding directly to *Subak* as an NBS that aligns with natural processes rather than working against them. Exploring fiscal schemes like "Transfer Anggaran Kabupaten berbasis Ekologi" or TAKE under the Ecological Fiscal Transfer is a viable alternative to address the financial aspects of this endeavor.

It is important to note that the successful application of *Subak*-inspired principles outside Bali depends on the local context, agricultural practices, and cultural considerations. Efforts to replicate such systems often involve adapting key principles rather than replicating the entire traditional system. While the *Subak* system remains deeply tied to Bali's culture and geography, its underlying principles of community involvement, equitable resource distribution, and sustainable water management serve as valuable lessons for promoting sustainable agriculture and water resources management in diverse contexts around the world.

Prioritizing collaboration among stakeholders, including the private sector and community social responsibility, bolstering the roles of organizations, and actively involving cultural communities in policy making related to irrigated-agricultural systems is imperative. This approach paves the way for the emergence of cocreation among involved parties to tackle problems and balance trade-offs or disruptions that may arise. Through co-management and cocreation, adaptive management practices can be developed, offering flexibility in collectively responding to and resolving challenges. Consequently, *Subak* should be integrated into strategic programs, policies, and regulations, and it should be included in regional infrastructure, procurement processes, and development planning. This aligns with the assessment results mentioned earlier. Moreover, engaging stakeholders in the assessment and evaluation processes is encouraged to enhance the effectiveness of NBS implementation.

4.4 Challenges to Water Resources Management in Bali

Bali, despite its rich cultural heritage and traditional water management practices, faces a range of complex challenges that test its ability to sustainably manage its water resources. These challenges arise from a combination of factors, including rapid urbanization, environmental changes, and the evolving demands of a modern society. The local wisdom in water resources management ideally should be consistently applied, but this social structure, in line with development and the passage of time, faces numerous challenges that consequently influence its existence. The traditional knowledge embedded in the management of water resources should ideally be an ongoing practice. However, this social framework, as it evolves over time, encounters various obstacles, ultimately affecting its continuity (Hidayati 2016).

From the study of Suyarto and Kusmawati (2016), the water needs in Bali Province can be classified into requirements for agriculture, forestry, domestic use, industry, government, and public facilities. Water needs for agriculture, particularly irrigation, are estimated at around 1,592.24 million cubic meters (m^3), while paddy fields require approximately 2,080.60 million m^3 per year. Forestry demands account for 1,031.20 million m^3 per year, domestic water needs stand at 107.65 million m^3 per year, industrial activities consume around 22.08 million m^3 per year, hotels and restaurants utilize approximately 16.58 million m^3 per year, and government and public facilities utilize about 25.12 million m^3 per year. The overall water needs in Bali Province, based on the various sectors, amount to approximately 4,239.71 million m^3 per year. Although the domestic water needs are relatively modest (107.65 million m^3 per year), they are crucial as they are connected to human life and are projected to increase in line with population growth.

4.4.1 Population Growth and Urbanization

The interplay between population growth and urbanization presents intricate challenges for water resources management, a reality faced by regions worldwide, including Bali. As urban areas witness an influx of residents, accompanied by the expansion of urban infrastructure and services, the demand on water resources intensifies significantly. The increasing urban population places immense strain on water supply systems. Domestic use, sanitation, and industrial activities require substantial volumes of clean water, exacerbating the pressure on available sources. Moreover, urbanization often brings about elevated consumption levels, including water-intensive practices like landscaping and recreational facilities, contributing to the over-extraction and depletion of local water resources.

The development of urban infrastructure, such as roads and buildings, disrupts natural water flow patterns, leading to increased runoff, flooding, and reduced groundwater recharge. Managing urban wastewater also poses a challenge, with rapid urbanization generating significant volumes of wastewater that can strain sewage systems, leading to water pollution and compromised water quality. Balancing urban development with sustainable water practices is crucial. Integrating efficient water management strategies into urban planning can ensure a consistent supply, mitigate environmental impacts, and enhance resilience to water-related challenges. Upgrading water infrastructure, promoting rainwater harvesting, and fostering community engagement are essential steps in addressing the impacts of urbanization on water resources.

By adopting an integrated approach that considers environmental, social, and economic factors, Bali can effectively manage water resources amid population growth and urbanization. Leveraging global experiences while preserving its cultural and ecological distinctiveness, the island can navigate urbanization's complexities, while securing its invaluable water resources for both the present and future generations.

4.4.2 Tourism Impact

Bali's thriving tourism industry has brought substantial economic advantages, yet it also presents intricate challenges for the island's water resources management. As a sought-after destination, Bali's captivating landscapes and cultural allure attract millions of tourists annually, significantly impacting water demand and quality. The influx of tourists escalates the necessity for water, particularly within the hospitality sector. Hotels, resorts, dining establishments, and recreational amenities require substantial water supplies to cater to visitors' needs, adding strain to already limited resources. The cyclical nature of tourism intensifies demand during peak seasons, potentially burdening water resources, especially in areas sensitive to climatic fluctuations.

The swift growth in tourism-related infrastructure, such as hotels and entertainment venues, can disrupt local water systems and alter natural hydrological cycles. Concurrently, tourism activities contribute to heightened wastewater generation and waste output. Inadequate waste disposal practices and untreated sewage can lead to water pollution and degrade water quality. Balancing the allocation of water between tourism-related activities and local communities' essential needs may lead to conflicts. Moreover, the over-extraction of water for tourism can contribute to resource depletion, impacting both the quantity and quality of water available for ecosystems and local inhabitants.

To address these challenges, promoting sustainable tourism practices is vital. Employing water-efficient technologies, raising awareness among tourists about responsible water consumption, and fostering eco-friendly tourism can help alleviate the pressure on water resources. Collaborative efforts involving the tourism industry, local communities, and governmental authorities are essential, guided by regulations that align tourism activities with sustainable water management objectives. Strategically integrating water availability and environmental considerations into planning is paramount to managing the impacts of tourism on water resources. Ultimately, Bali's approach should harmonize economic benefits with the conservation of its distinct cultural heritage and natural landscapes, ensuring that tourism contributes positively to the island's future while safeguarding its invaluable water resources.

4.4.3 Changing Agricultural Practices

The transformation of agricultural practices in Bali reflects a complex interplay between tradition, modernization, and water resources management. As the island responds to evolving socioeconomic dynamics, shifts in agricultural methods bring both possibilities and challenges to the delicate equilibrium of water utilization. Incorporating modern agricultural technologies offers potential gains in productivity. However, mechanization, increased use of fertilizers and pesticides, and shifts in crop choices can impact both water quality and consumption. The transition to more intensive farming approaches may amplify water demands, particularly during dry periods, as monocropping and larger-scale farming necessitate heightened irrigation.

Yet, the embrace of modern practices also brings concerns over potential water pollution due to runoff of chemicals and nutrients from fields. Balancing the pursuit of greater yields with the principles of sustainable agriculture becomes a key consideration. Sustainable practices, inspired by traditional wisdom, underscore the significance of water conservation and soil health. Amid these shifts, bridging traditional agricultural methods with modern ones emerges as a promising strategy. Approaches like the *Subak* communal irrigation system exemplify efficient water use, while minimizing environmental impacts. Educating farmers about the repercussions of altering practices on water resources is pivotal, underscoring the importance of responsible choices.

Collaboration among agricultural experts, government entities, and local communities holds the potential for innovative solutions. Initiatives focusing on irrigation efficiency, the promotion of organic farming, and reducing chemical use could emerge. Supportive government policies that encourage sustainable agricultural practices through training, technology adoption, and organic farming are essential. Involving farmers in decision making nurtures a sense of ownership and dedication to water conservation endeavors. Empowering communities to collectively manage water resources ensures their long-term viability. By adopting a harmonized approach that intertwines traditional wisdom and modern innovations, Bali's agriculture sector can simultaneously contribute to water conservation, adapt to a changing environment, and preserve the island's distinct cultural and environmental legacy.

4.4.4 Climate Change and Uncertainty

Bali's susceptibility to climate change exacerbates water challenges. Erratic rainfall patterns, rising temperatures, and increased frequency of extreme weather events can disrupt water availability and further stress the already intricate water management systems. As global temperatures rise and weather patterns become increasingly unpredictable, the island grapples with the profound impacts of a changing climate on its intricate water systems. This uncertainty disrupts the delicate harmony established by cultural practices such as the *Subak* system, as well as modern water distribution strategies.

Rising temperatures contribute to accelerated evaporation rates, putting additional pressure on already stressed water sources. In coastal areas, the specter of sea-level rise poses an imminent threat of saltwater intrusion into freshwater aquifers, compromising their quality and further limiting accessible resources. Such consequences can disproportionately impact vulnerable communities that depend heavily on local water sources for their livelihoods. Adapting to these climate-induced challenges necessitates a multi-faceted approach. Developing resilient water infrastructure capable of withstanding extreme weather events is imperative. Implementing water storage and management solutions to mitigate the impacts of droughts and floods can help alleviate the pressure on water resources.

Furthermore, climate change underscores the importance of a holistic perspective that encompasses ecosystem health, socioeconomic dynamics, and cultural heritage. Collaborative efforts among government entities, local communities, and experts are crucial in devising strategies that balance the needs of diverse stakeholders in the face of climate uncertainty. Bali's response to climate change is not only a battle for water resources but a testament to its resilience and adaptability. By embracing sustainable practices, integrating traditional knowledge with modern insights, and fostering community engagement, the island can navigate the uncharted waters of climate change while safeguarding its precious water resources for current and future generations.

4.4.5 Water Scarcity and Resource Depletion

The specter of water scarcity and resource depletion casts a shadow of concern over Bali's intricate water management systems. As the island grapples with the demands of a growing population, rapid urbanization, and shifting agricultural practices, the strain on its limited water resources becomes increasingly apparent. In certain areas, water scarcity is a pressing concern. Over-extraction of groundwater, coupled with decreasing river flows during dry seasons, contributes to resource depletion. This scarcity affects not only agricultural activities but also community water supply and ecosystems.

Addressing water scarcity and resource depletion requires a comprehensive and proactive approach. The integration of sustainable water management practices into all sectors becomes paramount. Implementing efficient irrigation methods, promoting water-saving technologies, and enhancing leak detection and repair systems are steps towards mitigating waste and conserving water.

Community engagement and education are crucial components of the solution. By raising awareness about responsible water use, fostering a culture of conservation, and involving local communities in decision-making processes, Bali can build a foundation of water stewardship that resonates for generations. The preservation of Bali's water resources is intertwined with its cultural heritage, ecological balance, and economic prosperity. By adopting strategies that balance the needs of different sectors while safeguarding water resources, the island can navigate the challenges of water scarcity and resource depletion while securing a sustainable and resilient water future.

4.4.6 Balancing Traditional and Modern Approaches

Bali's water management journey hinges on harmonizing age-old traditions with contemporary necessities. This equilibrium is pivotal as the island navigates urbanization, population growth, and evolving agricultural practices while preserving its cultural heritage. The introduction of modern technologies and practices sometimes clashes with Bali's traditional water management systems. Striking a balance between these approaches is essential to avoid undermining the cultural significance and effectiveness of traditional methods.

The *Subak* system exemplifies the island's ancient wisdom, employing communal irrigation and cultural rituals to sustain landscapes and ensure equitable water distribution. Integrating modern innovations, such as efficient irrigation methods and upgraded infrastructure, aligns with traditional principles while fostering both economic growth and environmental sustainability. The interplay of tradition and modernity emerges in the strategic blending of practices. Bali's pursuit of sustainable water management involves weaving traditional knowledge into forward-thinking solutions. By incorporating traditional irrigation concepts into urban planning and involving local stakeholders, the island seeks to safeguard water resources while accommodating development.

Engaging communities serves as a bridge between generations, and education plays a pivotal role in this endeavor. Enriching the younger generation about the significance of both traditional practices and modern solutions ensures the continuity of Bali's water culture. Government support, embodied in well-designed policies, plays a central role in creating an environment where tradition and innovation thrive together.

4.4.7 Infrastructure Development

Bali's journey in water resources management is intricately tied to the development of robust infrastructure. In the midst of population growth, urban expansion, and evolving agricultural practices, the strategic development of water-related infrastructure emerges as a vital pillar for the island's sustainable future. Beyond immediate needs, resilient and sustainable infrastructure is pivotal in mitigating the impacts of climate change and extreme weather events. Incorporating innovative design elements like rainwater harvesting systems and groundwater recharge strategies enhances Bali's ability to navigate droughts and floods. This approach not only ensures water availability but also aligns with the island's commitment to ecological conservation.

Balancing tradition and modernity are crucial, as the integration of traditional practices into infrastructure development maintains Bali's cultural identity and ecological balance. By adapting traditional *Subak*-inspired irrigation systems to contemporary urban contexts, Bali can promote water conservation and community engagement while fostering a harmonious coexistence between old and new. Government support, regulatory frameworks, and collaborative efforts between various stakeholders are pivotal in successful infrastructure development. These strategies ensure that infrastructure projects are not only effective but also socially responsible and environmentally sustainable. Ultimately, infrastructure development serves as the backbone of Bali's water management strategy, fostering resilience, equity, and sustainability for the island's water resources and cultural heritage. Figure 4.2 illustrates examples of dam infrastructure in Bali.

Figure 4.2: (a) Cengcengan Dam in the Oos River Watershed,
(b) Canggi Dam in the Sungai River Watershed



(a)



(b)

Source: Bali-Penida River Basin Agency (2023).

4.4.8 Policy and Governance Issues

Bali's water management weaves a story of policy intricacies and governance challenges. Amid the growth of urbanization and population, policy frameworks must harmonize cultural values and environmental concerns. Collaborating with stakeholders, including traditional leaders and local communities, ensures that policies are inclusive and aligned with diverse needs. Balancing water allocation among sectors demands policies that promote equity while preserving the environment. Integrating strategies for climate resilience and effective governance mechanisms ensures policies translate into tangible benefits. Through institutional collaboration, Bali paints a portrait of balanced water management that respects tradition, responds to modern challenges, and secures a sustainable future.

4.4.9 Awareness and Education

The changing landscape of Bali necessitates raising awareness about sustainable water management practices. Educating local communities, tourists, and decision makers about the importance of conserving water resources is vital for long-term resilience. In Bali's water management narrative, awareness and education shine as crucial elements. Amid the challenges posed by population growth, urbanization, and evolving agricultural practices, cultivating understanding and promoting responsible behavior become instrumental in ensuring the longevity of the island's water resources.

Elevating public awareness about water's significance lays the foundation for responsible stewardship. Educating communities on water conservation, the impact of pollution, and the cultural importance of water fosters active involvement in water resources preservation. Connecting traditional practices like the *Subak* system with contemporary challenges underscores the cultural and ecological value of water, nurturing a stronger commitment to its protection.

Education empowers behavioral change. Integrating water education into formal curricula equips the younger generation with skills for responsible water management. Beyond awareness, practical training in efficient irrigation and water-saving techniques translates knowledge into tangible conservation efforts. Community engagement and collaborative networks amplify the impact of education, enabling Bali to foster a generation that champions water sustainability, safeguarding its resources for a resilient future.

4.4.10 Preserving Cultural Heritage

In the context of Bali's water management, the preservation of its cultural heritage emerges as a vital foundation. Amid the challenges of urbanization, population growth, and evolving agricultural practices, safeguarding the island's rich traditions related to water becomes imperative in maintaining its identity and ensuring responsible water resources management. Bali's cultural fabric is interwoven with water, evident in practices like the *Subak* system that encapsulate community cooperation and environmental harmony. Upholding these practices preserves a sense of identity and heritage, forging a connection between past and present generations. Integrating these traditions into contemporary strategies promotes equitable water distribution and responsible stewardship.

Balinese educational efforts can play a pivotal role in preserving cultural heritage. By incorporating traditional water management techniques into curricula, future generations are educated about the island's heritage and values. Empowering local communities to actively engage in heritage preservation ensures that these practices remain relevant and respected, creating a harmonious fusion of tradition and modernity in Bali's water management approach.

4.5 Sociocultural Solutions and Innovations

The sociocultural perspective on water resources management in Bali holds profound significance, transcending conventional approaches and offering a holistic framework that enriches both human well-being and environmental sustainability. This perspective is not merely a relic of the past, rather, it represents a living testament to the intricate interplay between cultural heritage, ecological equilibrium, and societal harmony.

Preservation of Cultural Identity

The sociocultural perspective safeguards Bali's identity by preserving traditional values, practices, and wisdom. It reinforces the bond between generations and underscores the importance of cultural continuity, fostering a sense of pride and belonging among local communities.

Holistic Ecological Balance

Tri Hita Karana, as the guiding principle, emphasizes the interconnectedness of humans, nature, and spirituality. This perspective engenders a profound respect for the environment, advocating for practices that ensure the well-being of all living beings and ecosystems. By nurturing a holistic ecological balance, the sociocultural approach contributes to the island's resilience against ecological challenges.

Community Cohesion and Resilience

Sociocultural water management practices, epitomized by the *Subak* system, promote cooperation, mutual support, and unity among community members. This strong social fabric enhances the island's resilience in the face of external pressures, enabling collective problem solving and adaptability.

Spiritual Sustenance

Water is not solely viewed as a physical resource but as a source of spiritual nourishment. Rituals and ceremonies conducted at water temples underscore the sacred bond between humans and water, reminding individuals of their responsibility to safeguard and cherish this life-giving element.

Inspiration for Global Sustainability

Bali's sociocultural approach offers a compelling model for global water resources management. Its emphasis on harmony, equity, and shared responsibility provides valuable insights for societies grappling with water-related challenges worldwide, promoting sustainable practices that prioritize both people and the planet.

Enhanced Policy Development

Incorporating the sociocultural perspective into policy frameworks enriches decision-making processes. By acknowledging local traditions and values, policy makers can design strategies that resonate with the community, thus increasing the effectiveness and acceptance of water management initiatives.

Cultivation of Ethical Stewardship

The sociocultural perspective instills a sense of ethical stewardship, encouraging individuals to view themselves as custodians of nature rather than mere consumers. This mindset shift is essential in fostering a culture of long-term sustainability.

The sociocultural perspective on water resources management in Bali transcends its boundaries, serving as a beacon of wisdom and inspiration. It embodies the harmony that can be achieved when cultural heritage, environmental consciousness, and communal well-being converge. By recognizing its significance and embracing its principles, societies can embark on a transformative journey toward a more balanced and sustainable future.

In the face of evolving challenges to water resources management, Bali's sociocultural perspective continues to inspire innovative solutions that harmonize tradition with contemporary needs. These solutions emphasize community empowerment, adaptability, and the integration of cultural wisdom with modern knowledge. With the program of community-led water governance, building on the collaborative spirit of the *Subak* system, communities are increasingly engaging in participatory water governance. By involving local stakeholders in decision-making processes, water allocation, and conflict resolution, these initiatives enhance the sense of ownership and accountability over water resources.

The revitalization of traditional practices with some efforts to revive and rejuvenate ancient water management practices is underway. By combining traditional knowledge with modern scientific insights, communities are enhancing the efficiency of traditional irrigation techniques, ensuring optimal water use while conserving precious resources. Embracing the sociocultural perspective, Bali has leveraged its water-related rituals and practices to foster ecocultural tourism. This not only generates income for local communities but also raises awareness among tourists about the importance of sustainable water practices.

Incorporating indigenous wisdom, communities are engaged in hydrological restoration projects, rejuvenating water catchment areas, reforesting watersheds, and employing traditional erosion control methods. This effort is aimed at reviving water sources and maintaining their quality. The sociocultural approach promotes climate-resilient adaptations, combining traditional and modern knowledge. Communities develop early warning systems using local weather indicators and indigenous ecological observations to better prepare for climate-induced water challenges. Collaboration among cultural experts, scientists, policy makers, and community leaders foster interdisciplinary discussions. These partnerships exchange insights and design innovative solutions, addressing both ecological and cultural aspects of water management.

Educational initiatives play a crucial role in passing down the sociocultural perspective to younger generations. Schools and cultural institutions impart knowledge about water rituals, *Subak* practices, and the profound significance of *Tri Hita Karana*. Bali's sociocultural solutions have spurred cross-cultural exchange and collaboration. Global communities facing water challenges can adapt Balinese practices to their contexts, contributing to a broader movement toward sustainable water management. Seventeen primary character traits found within the local wisdom of *Subak* have been documented, encompassing attributes such as religiosity, honesty, cooperation, a love for peace, environmental stewardship, social concern, adherence to laws, discipline, transparency, adaptability, democracy, self-reliance, justice, and accountability. These character attributes hold relevance and can serve as a foundation for nurturing character development in social studies education within the framework of building a strong Indonesian national character (Sriatha et al. 2017).

The character values identified within the local wisdom of *Subak* are essentially reflective of national character values. These values align with the competencies outlined in the 2013 junior high school social studies curriculum in Indonesia. The existing model for integrating character development into social studies education has primarily been classroom-based and has shown a limited orientation toward direct engagement with society. This model stands in contrast to the core focus of social studies, which centers on the study of society and community. A limited number of researchers have involved the broader society as a learning laboratory within social studies education. One example of such research is the integrative eco-pedagogical learning model implemented in community service and research-based learning. This approach involves teacher candidate students in recontextualizing the basic education curriculum with the aim of fostering critical and creative thinking, an enjoyable learning experience, and the achievement of fundamental learning competencies: intelligence (learning to know), competence (learning to do), integrity (learning to be), and community (learning to live together).

Another noteworthy research initiative adopts a cross-cultural perspective and utilizes the *Subak* system as a model for ethnopedology. The study reveals that cross-cultural learning, with *Subak* as an ethno-pedagogical model, has proven effective in helping students realize their roles as the younger generation in preserving their cultural heritage to shape their future. Consequently, this model holds significant potential for promoting sustainable education. The incorporation of local community wisdom, including *Subak*, into social studies learning can be further developed and integrated across various components of the curriculum, encompassing learning objectives, content, instructional processes, and assessment methods.

Leveraging technology, digital platforms are used to preserve traditional water management knowledge. Online resources, interactive maps, and virtual tours disseminate knowledge, involving wider audiences in the conservation of Balinese water heritage. By embracing these sociocultural solutions and innovations, Bali demonstrates the profound potential of marrying tradition and innovation. This approach not only safeguards water resources but also serves as a beacon of hope for a harmonious coexistence between humanity and nature, transcending boundaries, and inspiring global efforts towards sustainable water management.

4.6 Government Policies and Interventions

In 2020, the Provincial Government of Bali issued Bali Governor Regulation Number 24 of 2020 regarding the protection of lakes, springs, rivers, and the sea. This regulation is formulated to ensure the sustainability of the capacity, capacity, and functions of water sources in order to maintain both the quantity and quality to meet the needs of the community.

Recognizing the significance of water resources management in Bali's sustainable development, the government has initiated various policies and interventions aimed at preserving the island's cultural heritage, ensuring equitable access to water, and addressing the challenges posed by urbanization, tourism, and climate change.

Subak Preservation and Recognition

The Balinese government acknowledges the cultural and environmental importance of the *Subak* system by supporting its preservation and promotion. Efforts include designating *Subak* landscapes as a UNESCO World Heritage Site, providing legal protection, and encouraging community involvement in their management.

Integrated Water Resources Management

Bali has embraced the principles of integrated water resources management to foster holistic and sustainable approaches to water management. This involves coordinating various sectors, stakeholders, and policies to ensure the balanced and efficient use of water resources.

Water Allocation Regulations

The government has established regulations to ensure fair water allocation among different sectors, including agriculture, tourism, and industry. These regulations aim to prevent over-extraction and depletion of water resources, fostering an equitable distribution of this vital resource.

Water Conservation Campaigns

Recognizing the importance of community awareness, the government has launched public campaigns promoting water conservation and sustainable practices. These initiatives engage local communities, schools, and businesses in efforts to reduce water consumption and minimize wastage.

Climate Change Adaptation Strategies

Bali's vulnerability to climate change has prompted the government to develop adaptation strategies. These strategies include watershed management, afforestation projects, and climate-resilient infrastructure to mitigate the impacts of changing rainfall patterns and extreme weather events.

Waste Water Management and Pollution Control

The government is working to address water pollution from various sources, including agriculture and tourism. Initiatives involve implementing waste water treatment systems, regulating industrial discharges, and promoting responsible agricultural practices.

Water Infrastructure Development

To ensure access to clean water for both rural and urban communities, the government is investing in water infrastructure projects. These projects include the construction of reservoirs, pipelines, and water treatment facilities to enhance water availability and quality.

Partnerships with International Organizations

Bali collaborates with international organizations, such as United Nations' agencies and donor countries, to enhance water resources management. These partnerships provide technical expertise, funding, and knowledge exchange to address complex water challenges.

Inclusive Policy Formulation

The government recognizes the importance of involving local communities, experts, and stakeholders in policy formulation. Participatory approaches ensure that policies are tailored to local needs, cultural values, and ecological realities.

Education and Capacity Building

Government initiatives include educational programs to raise awareness about sustainable water management practices. Capacity-building efforts empower communities with knowledge and skills for effective water conservation and management.

Through these policies and interventions, the Balinese government aims to strike a harmonious balance between economic development, cultural preservation, and environmental sustainability in the realm of water resources management. The combination of cultural wisdom, innovative strategies, and inclusive governance forms the foundation for Bali's journey toward a resilient water future.

4.7 Case Study: The Saba River Basin

From the study by Budiasa and Kato (2016), the inception of integrated water resources management for the Saba River Basin initiated as a pilot endeavor carried out in collaboration between the Research Institute for Humanity and Nature in Japan and Bogor Agricultural University in Indonesia from 2012 to 2016. The Saba River Basin constitutes one of the 391 river basins within Bali-Penida. Encompassing an area of approximately 132.89 square kilometers, it spans across the Buleleng and Tabanan regencies (BPDAS 2008). This region comprises irrigated rice fields, totaling approximately 4156.82 hectares, which receive support from eight primary rivers (Saba, Getas, Dati, Jehe, Bakah, Titab, Panas, and Ling) (BWS 2005). The management of this area involves 56 *Subak* systems (Budiasa et al. 2015). Typically, water flows in the basin are up to four times higher during the wet season compared to the dry season, and the water quality remains suitable for rice cultivation and public water needs (Budiasa and Kato 2016). However, it is not suitable for drinking water, particularly downstream.

The Saba River Basin grapples with a range of development challenges, including issues like soil erosion hazards, alterations in land cover, shifts in agricultural land use, water quality degradation, competition for water resources, and inefficiencies in irrigation channels (Figure 4.3). The degradation of both land and water resources appears to be largely associated with changes in land cover. Over the past 2 decades, there has been significant transformation in the use of irrigated land. Data from a survey conducted across 20 *Subak* systems within the basin in 2014 reveal that approximately 37% of paddy fields has been converted to other uses (1223.42 hectares in 1991 to 771.13 hectares in 2014) such as clove plantations (165.91 hectares), vineyards (129.72 hectares), dragon fruit farms (1.5 hectares), fishponds (20 hectares), buildings (including housing, tourism facilities, offices, and trading facilities) (104.16 hectares), and areas susceptible to flooding from Titab Dam (31 hectares) (Budiasa et al. 2015).

Figure 4.3: Saba River Basin



Source: Bali-Penida River Basin Agency (2023).

The overarching goal of sustainable integrated water resources management in the Saba River Basin is to enhance the quality of life within the community, rooted in the application of the local philosophy, *Tri Hita Karana*, which embodies the pursuit of three sources of happiness. Following the principles outlined by the Global Water Partnership (GWP) in 2000, integrated water resources management entails the fusion of natural system management and human system interactions. Natural system management incorporates the integration of freshwater and coastal zones, land and water, surface and groundwater, water quantity, and water quality, in addition to harmonizing the upstream and downstream regions of the basin. On the other hand, human system interaction encompasses the amalgamation of all stakeholders into the planning and decision-making processes, merging water and wastewater management, and fostering cross-sector integration, covering various water applications such as drinking water, agriculture, environmental conservation, industrial use, and more.

Concerning integrated water resources management, local communities have made significant advances in their capabilities through a series of multi-stage, multi-stakeholder meetings, research dissemination, and the sharing of best practices by the Head Communication Forum of the Cidanau Watershed and other experts. These meetings have led to the clear identification of strengths, weaknesses, opportunities, and threats (SWOT) and critical development issues in the Saba River Basin. The most significant consensus reached through this participatory approach is the establishment of the Saba River Basin Community, guided by the principle of “one river, one plan, one management.” The participation of multiple stakeholders has led to important agreements, including (i) the vision of the Saba River Basin Community, aiming for “realizing the sustainable Saba River Basin and societal well-being based on the *Tri Hita Karana* philosophy”; (ii) defining the five fundamental roles and functions of the community, encompassing communication, coordination, action plan implementation, promotion, and educational activities; (iii) outlining the organizational structure and positioning; (iv) establishing the basic rules governing the community; and (v) identifying the top 10 priority programs for 2015–2020 and the primary action plans for 2015 to 2016, which include waste management and conservation within the Saba River Basin. The effectiveness of the Saba River Basin Community is contingent on securing appropriate financial support. Establishing successful partnerships and obtaining legal backing from the governor of Bali Province or another relevant agency is deemed crucial for the Community’s success.

4.8 Conclusion

Bali’s approach to water resources management is a harmonious symphony of cultural heritage, environmental consciousness, and community collaboration. Rooted in the *Tri Hita Karana* philosophy, the island’s journey in sustaining its water resources offers valuable lessons for a world grappling with interconnected challenges of urbanization, climate change, and cultural preservation.

The *Subak* system, a testament to Bali’s ingenuity, exemplifies how traditional water management practices can transcend time and remain relevant in the face of modernization. It underscores the significance of equitable water distribution, community cohesion, and the integration of spirituality and ecology. However, Bali’s water management narrative is not without its challenges. Rapid urbanization, the demands of tourism, and shifting agricultural practices have strained the delicate equilibrium upheld by traditional systems. Yet, the Balinese people’s adaptability and innovative solutions illustrate the island’s resilience in navigating these complex waters.

The government's policies and interventions further demonstrate Bali's commitment to sustainable development. Through initiatives that blend cultural preservation with modern strategies, Bali paves a path toward equitable water allocation, climate resilience, and community engagement. In essence, Bali's sociocultural perspective on water resources management offer a profound paradigm for a world in search of holistic solutions. The island's ability to seamlessly weave traditional practices with contemporary needs reflects the enduring relevance of *Tri Hita Karana*. As Bali stands as a beacon of harmony, unity, and ecological stewardship, it invites us all to harmonize our relationship with water, nature, and each other—a call that resonates far beyond the shores of this enchanting island.

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PART II

Policies and Practices

Integrating Safety, Security, and Cultural Values for Integrated Water Resources Management: A UNESCO World Heritage Case Study in the People's Republic of China

En Lin,¹ Xuhua Hu,¹ Jianxin Mu, Shahbaz Khan, and Yufeng Luo

5.1 Introduction

In the 21st century, global sustainable development has become a core issue of common concern to the international community. In this process, cross-cutting research of water and culture, two key elements, has become increasingly important. Water is the source of life and the foundation of social and economic development, while culture is the soul of human civilization and an important driving force for social change. These two factors are intertwined in sustainable development, forming a complex interdisciplinary dimension. The interdisciplinary dimension of water and culture is of great significance to continued progress of human society as it needs multiple values for water. Rational utilization and allocation of water resources, protection from floods and droughts and restoration of water environment, as well as inheritance and innovation of water culture, all require combining multiple values for water. Only through the joint efforts of experts and practitioners in different disciplines can we effectively address the sustainable development challenges related to water and culture (Trebitz, Fennema, and Hicks 2021).

As global climate change and environmental problems intensify, water resources management and protection has become an important issue for global sustainable development (Walsh et al. 2015). In the People's Republic of China (PRC), water has always held a special place in its cultural traditions and customs. The country's rich history and civilization have been deeply intertwined with its rivers, such as the Yellow River and the Yangtze River, which have served as lifelines for agricultural development and economic prosperity. The ancient wisdom and engineering achievements of water management, such as the Dujiangyan irrigation project over 2,250 years ago have demonstrated multiple water values over time.

The PRC's irrigation projects have a long history and profound cultural heritage. Some of them are still intact and play an irrigation role, such as the Dujiangyan irrigation project, the Dongfeng weir in Leshan, Sichuan Province, the Tongji weir in Lishui, Zhejiang Province, the Mulanpo irrigation system in Putian, Fujian Province, etc., which are treasures of ancient Chinese water conservancy culture. These irrigation projects fully consider natural environment, socioeconomic, and human factors, adopt scientific and rational technologies and management methods, and focus on the unity of economic, social, and ecological benefits, embodying the wisdom and creativity of ancient Chinese people in water conservancy. The planning, design, technology, and management methods of these projects, as well as the integration of economic, social, and ecological benefits, are important components of sustainable development.

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The intricate and multifaceted connection between water and culture spans across diverse realms, encompassing religious beliefs, artistic expressions, social customs, and economic activities. Within the framework of sustainable development, a comprehensive grasp of these interrelated water and culture values becomes indispensable. An exemplary representation of this interplay can be seen in the ancient irrigation project of Dujiangyan in Sichuan Province. Through its scientific water engineering and resource management, the Dujiangyan project successfully addressed local water resource challenges. The experiences and lessons learned from its water resource management can serve as valuable references for modern society, promoting sustainable utilization and management of water resources. Furthermore, the Dujiangyan project integrates ancient Chinese philosophy, religion, and engineering techniques, project making it an engineering marvel with rich cultural significance. The water culture of the Dujiangyan project is intricately tied to the principles of sustainable development. It showcases the harmonious coexistence between humans and nature, emphasizing the importance of ecological balance and responsible resource management. This chapter delves into the impact of the intricate relationship between water and culture on sustainable development and examines how an interdisciplinary approach, using the Dujiangyan project as an example, can effectively tackle the intricate challenges associated with contemporary water management. By embracing an interdisciplinary perspective, we can fully understand the cultural values and practices that shape water resource management, leading to more sustainable and holistic solutions.

5.2 Importance of Water and Culture in Sustainable Development

Water and culture play an important role in sustainable development. First, water is the source of life, without water, there is no life. In many cultures, people regard water as a sacred element, endowing it with symbolic significance. This cultural tradition of advocating water has led to a deep awareness and value system for the protection and rational use of water. Second, the management and sustainable use of water resources is one of the keys to achieving sustainable development. By inheriting and promoting water culture, people can better understand and respect water resources, and thus develop more scientific and sustainable water resource management strategies. In addition, the inheritance of water culture also provides spiritual support and impetus for the sustainable development of society. By promoting water culture, people can inherit and carry forward the respect and gratitude toward water, and stimulate their sense of responsibility and action toward environmental protection and sustainable development. Therefore, the integration of water and culture can provide guidance and inspiration for sustainable development and provide important support for building a society where humans and nature live in harmony. Ancient civilizations such as the Mesopotamians, the Egyptians, and in the Indus Valley civilization thrived due to their proximity to major rivers. The Tigris and Euphrates in Mesopotamia, the Nile in Egypt, and the Indus in the Indian subcontinent provided fertile lands for agriculture, facilitated trade and transportation, and served as a foundation for economic and social development.

The relationship between water and culture can be traced back to the early stages of human civilization. In many ancient civilizations, people developed unique cultural traditions and customs based on their dependence on and understanding of water. For example, in ancient Egypt, the Nile River was considered a sacred river and an important symbol of Egyptian civilization. In the PRC, the Yellow River is known as the “Mother River”, the important birthplace of ancient Chinese civilization, and one of the symbols of Chinese culture. Since ancient times, human ancestors have lived along rivers and followed the water. The history of human beings living with water is a harmonious and progressive one. With the frequent interaction between humans and water, it has continuously promoted the progress of human civilization, and accompanied the emergence of water conservancy and water culture.

Water conservancy culture refers to the sum total of material and spiritual cultures formed and created by human society in promoting the benefits of water, eliminating the harms of water, protecting water resources and water environment, and related historical practices. It is the composition and reflection of culture. The Dujiangyan irrigation project is a treasure of irrigation engineering in the world (Peng and Li 2004; Sun and Wu 2015). It not only has high technical and practical value in water conservancy engineering, but also contains profound connotations of water culture. British scholar Joseph Needham once wrote about Dujiangyan in Sichuan—The Heart of Free China: combining supernatural, practical, rational, and romantic factors, no other people surpass the Chinese in this respect (Needham 1956). The annual maintenance of Dujiangyan water culture and its management system is a key means to protect and inherit this valuable cultural heritage.

5.2.1 Recognition by UNESCO

The 1972 United Nations Educational, Scientific and Cultural Organization (UNESCO) World Heritage Convention (UNESCO 1972) links together in a single document the concepts of nature conservation and the preservation of cultural properties. The convention recognizes the way in which people interact with nature, and the fundamental need to preserve the balance between the two. To be included on the World Heritage List, sites must be of outstanding universal value and meet at least one out of 10 selection criteria.

The Dujiangyan irrigation system, located in the western portion of the Chengdu flatlands at the junction between the Sichuan basin and the Qinghai–Tibet Autonomous Region plateau, is an ecological engineering project originally constructed around 256 BC. It was modified and enlarged during the Tang, Song, Yuan, and Ming dynasties, and uses natural topographic and hydrological features to solve problems of diverting water for irrigation, draining sediment, flood control, and flow control without the use of dams. Today the system comprises two parts: the weir works, located at an altitude of 726 meters, the highest point of the Chengdu plain 1 kilometer from Dujiangyan City, and the irrigated area. The system has produced comprehensive benefits in flood control, irrigation, water transport and general water consumption. Begun over 2,250 years ago, it now irrigates 668,700 hectares of farmland. As one of the oldest, largest, and most well-preserved irrigation projects in the world, Mount Qingcheng and the Dujiangyan irrigation system were included in the World Cultural Heritage list by UNESCO in January 2000 (Cui 2023). It meets the following World Heritage convention criteria (UNESCO n.d.):

Criterion (ii): The Dujiangyan irrigation system, begun in the 2nd century BCE, is a major landmark in the development of water management and technology, and is still discharging its functions perfectly.

Criterion (iv): The immense advances in science and technology achieved in ancient China are graphically illustrated by the Dujiangyan irrigation system.

Criterion (vi): The temples of Mount Qingcheng are closely associated with the foundation of Taoism, one of the most influential religions of East Asia over a long period of history.

Dujiangyan is located on Minjiang River, the largest river in Shu County. In 256 BC, Li Bing served as the governor of Shu County. Based on summarizing the local people's experience in water control, he created an irrigation system that excavated piles and opened channels to divert water (Peng and Li 2004). The establishment of the Dujiangyan irrigation system has completely solved the problems of flood and water resources in the Chengdu Plain, and provided guarantee for the local economic development and people's living standards.

The Dujiangyan irrigation system is not only a living heritage of over 2,500-year-old design and engineering ideas; it is also still in use today. The functions, religious traditions, and the special religious status of the Taoist temple cluster of Mount Qingcheng are fully preserved while still maintaining traditional building styles. The internationally accepted protection guidelines and rules have been adhered in conservation and repair projects in terms of location, design, materials, and techniques which makes it a key heritage site.

The Dujiangyan irrigation system is protected by several national laws including the Law of the People's Republic of China on the Protection of Cultural Relics, the Environmental Protection Law of the People's Republic of China, and Scenic Spots and Historical Sites Regulations. In addition to national laws, Sichuan Province has also enacted its own laws, including the Regulations on Conservation of Heritage of Sichuan Province and Regulations on Management of Scenic Spots and Historical Sites of Sichuan Province.

Figure 5.1: Headwork Hub of Dujiangyan Irrigation System



Source: Qingcheng Mountain—Dujiangyan Scenic Area Administration.

5.3 Dujiangyan: A Case of Interdisciplinary Integration of Water and Culture

The ancient floods and droughts in the Chengdu Plain were severe. The water source of Minjiang River comes from the overflow of mountain gaps on the right bank, with rainfall mainly concentrated during the rainy season, resulting in rapid fluctuations and turbulent water flow in Minjiang River. The Chengdu Plain was flooded during the flood of Minjiang River, and there was no harvest during the drought. In order to solve these problems, one of the purposes of building the Dujiangyan irrigation system was flood control. The project diverts Minjiang River water into the irrigation system, reducing flood pressure and reducing flood disasters. The project also built drainage channels and embankments to manage floods.

The main facilities at the head of the weir canal of the river include the diversion works in the middle of Minjiang River, which are piled with bamboo crated pebbles to form a “fish mouth” (Figure 5.2).

The “flying sand weir” built downstream of the fish mouth to block water, discharge flood water and sediment, and the *Baopingkou* project to control the inflow of the inland river. The river bottom gets easily filled and silted up by sand and gravel washed down from upstream, and the embankment is often destroyed by floods (Peng and Li 2004). Therefore, it is necessary to excavate the outer and inner rivers and renovate the dike every winter and spring in the dry season, which is the annual maintenance of Dujiangyan. During the winter and spring dry season every year, maintenance work is carried out on the fish mouth of the Dujiangyan irrigation system, including clearing sediment and dredging the river channel, to ensure that the maintenance is completed before the spring planting season. Traditional methods such as bamboo weirs are used for maintenance, cleverly applied to the fish mouth of the Dujiangyan irrigation system (Figure 5.3). The bamboo weirs control the direction and volume of water flow by adjusting their height. Bamboo cages are used to fix and reinforce the bamboo weirs. These ancient diversion techniques are effectively applied in the maintenance project of the fish mouth of the Dujiangyan irrigation system, achieving the goal of diverting and controlling water flow, facilitating the clearance of sediment and repair work. The reason why Dujiangyan can play a long-term and stable role is that through annual maintenance, the natural environment and basic structure of this irrigation and drainage project can be kept relatively stable for a long time, to ensure that its basic functions can continue to play normally. After more than 2,000 years, the natural environment and basic structural layout of Dujiangyan district still maintain their original basic appearance, which are inseparable from the protection of the water ecological environment of the weir district by annual maintenance, and is also an important means to maintain water culture.

Figure 5.2: Fish Mouth of Dujiangyan, Piled with Bamboo Crated Pebbles



Source: Qingcheng Mountain—Dujiangyan Scenic Area Administration.

Figure 5.3: Bamboo Cages and Macha



Source: Qingcheng Mountain—Dujiangyan Scenic Area Administration.

The Water Releasing Festival, also known as the “Water Cutting Festival” or the “Gate Opening Festival”, is a traditional cultural activity in Dujiangyan City, and an important part of the annual maintenance ceremony (Figure 5.4). It is a folk custom in Dujiangyan City by opening the gate to release water. On the Tomb Sweeping Day of the 24th solar term of the lunar calendar every year, in order to celebrate the completion of the Dujiangyan annual maintenance and the beginning of the busy season of spring plowing production, and to commemorate Li Bing, people will hold celebrations to reproduce the process of Han Dynasty officials offering sacrifices to Li Bing with the ceremony of *Shaolao*, and at the same time, cooperate with the ancient witchcraft dance to make the scene more historical.

Figure 5.4: Dujiangyan Water Releasing Festival

Source: Qingcheng Mountain—Dujiangyan Scenic Area Administration.

The combination of the Dujiangyan Water Releasing Festival and annual maintenance culture not only reflects the local people's attention to water conservation projects, but also shows the inheritance of historical culture. The celebration of the Water Releasing Festival can improve the public's awareness and understanding of Dujiangyan, and can also promote the inheritance and development of Dujiangyan's water culture.

5.3.1 Challenges to Water and Culture in Dujiangyan

As a famous ancient water conservation project in the PRC, Dujiangyan has outstanding achievements in the field of water conservation projects, and also contains rich cultural connotations. The challenges and experiences that Dujiangyan has experienced provide a good demonstration for interdisciplinarity dimensions of water and culture for sustainable development.

Water Conservation Engineering

One of the main purposes of the Dujiangyan project is to provide water for agriculture. The project introduces water into irrigation channels, providing sufficient water resources for farmland. This has promoted the development of agriculture and increased the production of agricultural products. The Dujiangyan irrigation system has brought abundant water resources to agriculture of Chengdu Plain, which helps to increase the production of agricultural products and improve the rural economy and people's living standards. Through scientific and reasonable allocation of water resources, the project not only meets human living needs but also maintains ecological balance, promoting harmonious coexistence between humans and nature. Due to the incomplete inclusion of certain irrigation projects in the plans for continued construction, retrofitting, and water-saving transformation, the inability to fully implement planned projects, and the lower standards set in the original plans, coupled with the impact of major natural disasters such as the 2008 Wenchuan earthquake and the 2013 "7.9" mega flood, the number of high-risk projects in the irrigation area has been increasing. On 9 July 2013, Sichuan Province was subjected to continuous heavy rainfall, with torrential to heavy rainfall in some places, and Chengdu, Mianyang, Ya'an, and other places were severely affected. The combination of heavy rainfall and the collapse of a dam in the upstream area resulted in a large amount of water spilling over causing

severe flooding and mudslides in the downstream areas. There is still a gap between the condition of engineering facilities and the requirements for flood control safety, water supply security, and food security. The gap is even larger in terms of management facilities and equipment for measurement and information compared to modern standards. The overall quality and competence of the talent pool are unable to meet the requirements and demands for standardized and regulated management.

Cultural Heritage

Dujiangyan is listed as a world cultural heritage site and plays an important role in the history of Chinese culture. The government and relevant institutions have taken a variety of measures, including maintaining, repairing, and protecting the buildings and sites in Dujiangyan to ensure that its outstanding universal values can be protected. These efforts will help protect the cultural heritage of Dujiangyan and enable it to continue to provide people with historical and cultural testimony today. The utilization and cultural display of heritage should be based on its essential characteristics and authentic value, as well as rooted and with a long-term perspective. It should promote regional economic development, cultural construction, and ecological environment improvement, allowing water heritage conservation to play a greater role in regional development.

Ecological Environment Destruction

With rapid urbanization and infrastructure development in the Dujiangyan area, there is increasing pressure on land and natural resources. Urban expansion, construction projects, and infrastructure development lead to habitat destruction, fragmentation, and a decrease in biodiversity. Water quality issues in Dujiangyan are also a significant concern, especially in Minjiang River and its tributaries. Industrial and agricultural activities, as well as improper waste disposal practices, can result in water pollution. Water pollution can harm aquatic ecosystems, impact the health of aquatic organisms, and affect drinking water resources for both humans and wildlife.

Water Culture

Dujiangyan is an important milestone in world water conservation history. Dujiangyan embodies humanity's harmonious relationship with nature through its annual maintenance and rituals honoring the water god. This innovative system, with its annual river repair, not only ensures stable water conservation but also preserves the natural environment, serving as a testament to ancient engineering wisdom. The Water Releasing Festival, a vital part of Dujiangyan's cultural heritage, symbolizes Chinese cultural reverence for water resources and showcases the profound connection between humans and nature, transcending time and showcasing enduring respect for the natural world.

5.4 Transdisciplinary Solutions for Integrating Water and Culture in Dujiangyan

As the intersection of water, culture, and sustainable development, Dujiangyan provides a perspective for comprehensive thinking. By studying and exploring the interdisciplinary value of Dujiangyan, we can better understand the relationship between human beings and the natural environment and explore various possibilities for sustainable development. In order to achieve this goal, it is necessary to further strengthen the implementation and management of the annual maintenance of Dujiangyan, and ensure that it plays a long-term and stable role (Cao, Liu, and Er 2010). At the same time, the protection and inheritance of Dujiangyan cultural heritage should continue to be strengthened and more effective measures should be taken to ensure its historical and cultural integrity can be inherited

and carried forward (Qi and Zhu 2020). In addition, multidisciplinary cross research can also be increased to combine the history, culture, water conservation projects and ecological environment of Dujiangyan and further enrich its traditional cultural activities.

5.4.1 Strengthening Reform in Water Resources Management

To achieve the standardized management of engineering and water supply and establish a sound management system, the organizational structure of the Dujiangyan irrigation area needs to be streamlined. Based on the management and maintenance of water projects within the irrigation area, unified management should be implemented in various aspects of water resources development, utilization, governance, allocation, conservation, and protection, aiming to achieve optimized allocation of water resources. A mechanism for an interconnected water system should be established. First, scientific implementation of interconnected river and lake reservoir systems should be carried out in the Dujiangyan irrigation area. Second, the scheduling and utilization of water projects should be optimized. Efforts should also be made to establish standards and improve the capabilities of management personnel.

5.4.2 Water Heritage Conservation

In order to integrate with the modernization of the irrigation area, it is necessary to improve protection signage for water cultural heritage. This includes setting up boundary monuments for the protection of irrigation engineering heritage areas and boundary markers along the protection boundaries. The collection and preservation of current information is one of the main measures for scientific protection, and the establishment of a heritage database and online information platform is an important task for ensuring the authenticity of the heritage, which should be combined with heritage research. The traditional layout, historical appearance, and spatial scale along the engineering lines within the heritage protection area should be maintained to preserve the natural ecological and landscape environment on both sides of the river. The protection of ancient irrigation management, water deity worship, and ritual cultural facilities should continue to be comprehensively investigated and systematically surveyed. Where conditions permit, onsite protection, restoration, and display should be carried out, and movable relics such as stone monuments should be relocated to museums for centralized protection and display.

5.4.3 Ecological Environment Protection

In order to protect the ecological environment around Dujiangyan, the government has taken a series of measures, including controlling development and construction activities, strengthening water quality management, and promoting ecological restoration and protection. These efforts have helped to maintain the ecological balance of Dujiangyan, protect the local plant and animal species, and ensure the health of the ecosystem in the Minjiang River basin. By renovating and managing ditches, canals, lakes, reservoirs, and their surroundings, a comprehensive system of roads, safety protection, and ecological greening should be constructed to improve drainage and flood control standards, enhance the water quality of the irrigation project, and ensure water supply security in the irrigation area.

Along the irrigation channels and reservoirs, ecological green corridors, inspection and maintenance roads, and safety protection facilities should be planned and constructed. Ecological dredging of reservoirs should be implemented to improve water quality and restore storage capacity. In the plain irrigation areas, dredging, slope protection, and connectivity improvements of drainage channels should be carried out to enhance drainage and flood control standards. In the hilly irrigation areas, flood discharge channels and canal slopes should be remediated and greened to prevent erosion and soil loss and protect the safety of the channels.

5.4.4 Water Cultural Conservation

To establish a scientific, effective, and sustainable heritage conservation management system, it is important to preserve and protect the historical, cultural, technological, and ecological values of the Dujiangyan irrigation project heritage site. This includes maintaining and enhancing the water management functions of the engineering heritage, strengthening the recognition, maintenance, and dissemination of its heritage values, and ensuring its role in promoting cultural, social, economic, and ecological harmony in the heritage site.

Efforts should be made to improve the capacity to protect and maintain the cultural heritage value of the irrigation project, promote the overall and systematic protection and sustainable use of the irrigation project heritage, and promote the inheritance and development of the water culture of Dujiangyan. Water culture protection mainly focuses on the excavation and exhibition of the historical and cultural heritage of the Dujiangyan hydraulic project, combined with the construction of the heritage exhibition system, including engineering and road infrastructure. Based on the needs of the national water education base, comprehensive and multi-channel promotion and exhibition should be carried out to showcase the historical, cultural, scientific, technological, and ecological values of the Dujiangyan World irrigation heritage site. This will significantly enhance the level of heritage cultural display and the effectiveness of popular science education.

5.5 Conclusion

Dujiangyan represents a miracle among the ancient yet operational water conservation projects. Since Dujiangyan has long adhered to annual maintenance, it has basically maintained its original ecological environment for more than 2,000 years, which is the reason why it can always maintain its utility, as well as its outstanding universal values compared with other ancient water conservation projects. As a great water conservation project in ancient times, Dujiangyan has faced various problems related to water and culture in its long history. By taking corresponding measures, including flood control, irrigation, cultural heritage protection, relevant environmental laws for ecological environment protection, Dujiangyan has achieved remarkable results in its more than 2,000-year history and made important contributions to the sustainable development and cultural inheritance of the region. This project integrated spiritual, cultural, and water security values therefore offers rich experiences for other regions that urgently need to promote values-based sustainable water development and management. Other regions can draw inspiration from this and develop interdisciplinary research and practice according to their own needs and conditions to improve water resources management, ecological conservation and social development. The evolutionary water management demonstrated by this project can bring culture as a key component of integrated water resources management for the achievement of the United Nations' Sustainable Development Goals.

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Conservation and Water Pricing: Effects of Long-Term Low Water Pricing in Hong Kong, China

David von Eiff

6.1 Introduction

6.1.1 Global Urban Water Management

As the global population continues to urbanize, the water resources major cities depend upon are increasingly stressed by a combination of climate change effects, which affect natural flows, and shifts from natural to urban water cycles (Sørup et al. 2020; Sedlak 2014). Population growth, increasing levels of economic activity, and higher standards of living place work in concert to further stress our scarce water resources through increases in demand (Tortajada and Joshi 2013). At the same time, changes in precipitation patterns, increasing temperatures, and more complex water cycles and decreases in water quality have decreased available supplies. This widening gap between supply and demand increases urban drought risks significantly along with their severity, as disruptions in urban water supply systems negatively impact the production of basic needs, such as food and energy, while increasing the likelihood of conflict and population displacement (United Nations 2018).

Building resilience in water systems is therefore a key task, as water scarcity is expected to affect 193 to 284 large cities, representing between 33% to 50% of the global urban population in 2050 (Zhang et al. 2019; He et al. 2021). To this end, policy makers must make timely and informed decisions to ensure our efforts to address the United Nations Sustainable Development Goals (SDGs), particularly SDG 6 and SDG 11 related to clean water and sustainable cities, are successful (United Nations 2015).

Traditionally, urban water scarcity has been addressed through engineering or infrastructure-based solutions, such as reservoirs designed to ensure continuous supplies to cities during periods of low precipitation (di Baldassarre et al. 2018). When local water resources are insufficient, inter-basin or transboundary water transfers have been employed to redirect water resources from more plentiful areas, such as the large-scale transfer of water from south to north in the People's Republic of China (Molina and Melgarejo 2016; Zhong, Cheng, and Deng 2022). Coastal and arid areas have also increasingly invested in desalination to supplement freshwater resources, despite the high cost and energy demand (Jones et al. 2019). In some cases, alternative water resources such as recycled or reclaimed water have been used, but these generally require significant public outreach efforts to be successful (McClaran et al. 2020).

Despite being necessary to augment supply, the development of water infrastructure requires significant financial, environmental, and human resources. The scale of these projects present challenges to other policy efforts, particularly toward net-zero efforts, as they possess significant embodied carbon and consume significant amounts of energy (Panagopoulos, Haralambous, and Loizidou 2019). Further, local geography and topology can present additional challenges and limitations to infrastructure decisions (Byrne et al. 2017). As a result, a growing body of research has focused on the need to approach water security from a non-engineering, supply-oriented, mindset. This shift in approach is necessary as we recognize water management as a cross disciplinary subject containing a multitude of interdependencies (Söderbaum and Tortajada 2011).

Uncertain social–political relationships between the different aspects of the economy, which include the public (government), private (industrial), and not-for-profit sectors also affect the ways in which water security should be approached. By considering these actors, water scarcity is no longer singularly tied to physical flows, but becomes embedded in political and social interactions. Therefore, a comprehensive understanding of water scarcity and the potential is required, which implies sustainable water governance is all but impossible without capable institutions (Benson, Gain, and Geoponic 2020).

Water governance in Hong Kong, China has been found to be relatively weak when compared to similar cities by academic scholars (Li, von Eiff, and An 2021; Wang and Dai 2021). Throughout these studies one of the key underlying issues was the price of water, which is one of the lowest in the world (Inglis and le Clue 2017). While price is known to be an important determinate for addressing water scarcity, among other factors such as income, studies have been mixed on how effective changes in price are in alleviating demand pressures (Olmstead, Hanemann, and Stavins 2007). However, when both price-based and policy-based measures are considered, pricing has been found to be the most cost-effective way to reduce demand (Krause, Chermak, and Brookshire 2003).

While these studies have focused on the price of water in driving conservation efforts, they have not considered the effects of long-term low pricing on a systemic basis, affecting both supply and demand decisions. In the remainder of this chapter, we will discuss the context behind Hong Kong, China's current management systems and the effects the low tariff has had on demand, supply, and the overall governance of the system. These effects include a failure to decrease per capita consumption, long-term infrastructure decisions, and the nature of the governance system.

6.2 Context

When studying any water system, it is important to understand the local context as many of the decisions made will have differing effects depending on local resources, geography, culture, and climate. This is particularly true for Hong Kong, China, which faces a number of challenges due to its geography and history. Through an understanding of how the water system was initially formed, and how decisions were made over time, we can draw lessons that are more easily applicable outside Hong Kong, China.

6.2.1 Water Supply and Management Systems in Hong Kong, China

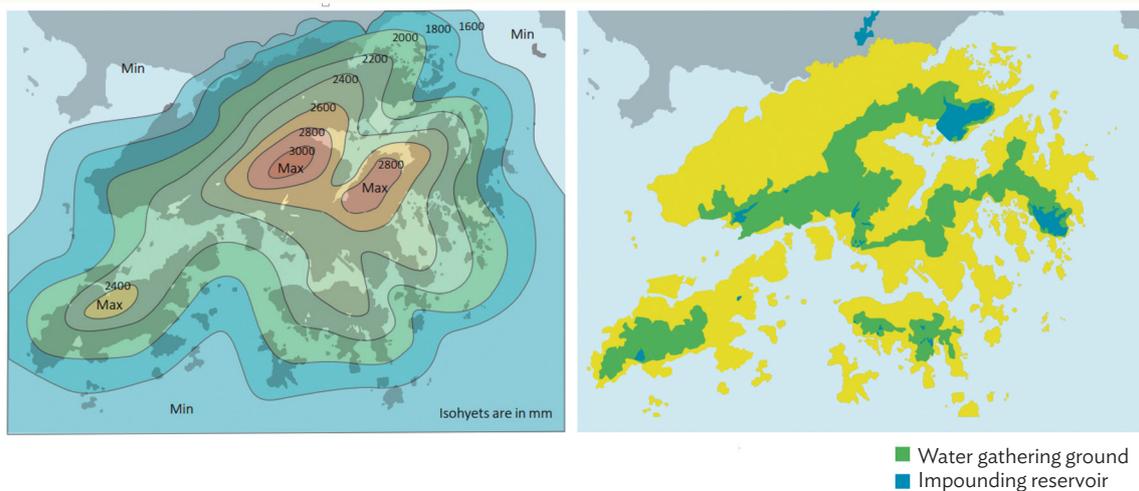
Water Resources

Hong Kong, China was called “a barren rock” when it was founded as a colony in 1841. This moniker was earned by the dearth of natural resources, with water resources at the time consisting of only five wells, as there were no substantial groundwater resources or natural lakes and rivers (Ho 2001). As the economy and population grew, the government was forced to address increasing water demand as the private sector declined to develop this aspect of Hong Kong, China's infrastructure. Early efforts in this area consisted in the development of local catchments, using reservoirs, and protected impounding grounds, for the collection of rainfall. This arrangement lasted for nearly 100 years, until increasing population growth after the Second World War forced the government to be more innovative and entertain additional solutions, such as developing seawater flushing and entering into negotiations to purchase water from the across the border.

While Hong Kong, China receives enough rainfall each year to meet its water needs, with an average over 2,400 millimeters (mm) it is difficult to convert precipitation into local yield as it exhibits an uneven distribution across both geography and time (von Eiff and Pommeret 2020). As shown in

Figure 6.1, approximately 50% of all rainfall currently occurs in designated catchment areas, accounting for one-third of the land mass, but only about 10% is collected, less than 300 mm, as the short duration and geographic concentration limit its collection (Civic Exchange 2019). The collection of additional rainwater runoff is dependent on a number of factors, such as the capacity of the soil, which has led policy makers to consider afforestation policies in catchment areas.

Figure 6.1: Rainfall Patterns and Catchment Areas in Hong Kong, China



Sources: Water Supplies Department (2020), Hong Kong Observatory (2003).

While reservoirs were expanded between the 1960 and 1970s, with Hong Kong, China's two largest and most ambitious reservoirs being constructed in this period, contributions from local rainfall peaked in 1983, with a total 436 million cubic meters (m^3) being collected. Despite rainfall having increased by an average of 6% since 1997 in the territory, collection has decreased by 12%, due to its increasingly concentrated nature. The expansion or creation of new reservoirs has been ruled out as too costly, with the cost of increasing capacity estimated to be at least HK\$20 per m^3 , having a payback period of over 250 years for any adequately sized reservoir project (McJannet, Cook, and Burn 2008).

As demand for freshwater continues to grow, the colonial government needed alternatives to ensure freshwater demand could be reliably met. As local sources could not be expanded quickly, the government turned to a unique solution and adopted the use of seawater for flushing in the mid-1950s. Seawater for flushing was supplied free of charge by the Water Supplies Department (WSD) in 1972 to encourage its adoption by local building owners. The use of seawater possesses a number of challenges, such as an inability to meter its use due to its corrosive nature and high level of suspended solids. Policy and pricing efforts have overcome the public's initial resistance to using seawater, resulting in an estimated adoption rate of approximately 85% of the population. This high level of adoption has been instrumental in ensuring Hong Kong, China's water security, replacing 25% of freshwater use. However, as the population continues to expand further from the coast, and alternatives such as reclaimed water become less expensive, its use may need to be rethought (von Eiff et al. 2023).

Prior to the construction of the two major reservoirs, combined pressures from post-war population growth and two historic droughts forced the colonial government to begin purchasing water from the People's Republic of China to increase the supply of fresh water. When water purchases began, Hong Kong, China received a relatively moderate amount, about 20% to 30% of its total supply, through the Dongjiang agreement. The colonial government insisted on paying for the water and keeping the amount low to limit the use of water as a political tool to gain favor (Lee 2014). However, as soon as it became apparent that Hong Kong, China would return to the People's Republic of China, water purchases became the predominate method of increasing supply, as it was the lowest cost alternative.

Representing the majority of WSDs spending on water, the use of Dongjiang water now accounts for 70%–80% of Hong Kong, China's total freshwater supply, representing the single largest item in its annual financial budget (Water Supplies Department 2019a). The agreement, which contains Hong Kong, China and seven other cities (Table 6.1) outlines how much water each city is entitled to in a given year. Unlike other cities, Hong Kong, China receives the same amount of water in a drought year as in a normal year, however, this comes at a cost. Hong Kong, China pays a lump sum for this water, meaning that they pay the same amount regardless of how much is used, which makes the agreement more akin to an insurance contract. Water guaranteed under the contract cannot be banked, refunded, or resold if it is not used, meaning that efforts at conserving paradoxically increase the cost of water, providing a disincentive to reduce use. While the most recent agreement includes a clause to provide a discount based on utilization, it is limited and does not fully offset this perverse incentive.

Table 6.1: Dong River Allocations
(in million cubic meters)

City	Allocated Quantities		Projected level of excess withdrawal in 2020 (%)
	Normal	Drought	
Meizhou	26	22	Unknown
Heyuan	1,763	1,706	10
Shaoguan	122	113	Unknown
Huizhou	2,533	2,405	18
Dongguan	2,095	1,944	20
Guangzhou	1,362	1,285	Unknown
Shenzhen	1,663	1,608	56
Hong Kong, China	1,100	1,100	0
Total	10,664	10,183	Unknown

Source: Legislative Council Secretariat (2015).

The nature of the contract makes it difficult to know the true cost of purchased water, and therefore its utility compared to alternatives. For example, during the 2017 contract year the quoted price was HK\$5.83 per unit. However, only 75% of the allotment was used, meaning the true cost of water in that year was HK\$7.33 per unit, or a 26% difference in price. The purchase price of the water does not reflect its treatment cost, as Hong Kong, China only pays for raw water. When the cost of treatment is

considered, the total cost of supplying Dongjiang water rises to approximately HK\$10.13 per unit. At this price, purchased freshwater is only about HK\$2 less than the estimated cost of desalinated water, which implies the costs will soon be near parity. Upward pressure on price remains considerable, with the most recent contract renewal seeing an increase in purchase price of around 6.7%, much higher than inflation, which reflects both the premium for a guaranteed supply and the increasing competition for water in the region.

In addition to local yield, purchased water, and seawater flushing, Hong Kong, China has begun to explore additional water resources including desalination and water reclamation. While rainwater harvesting is utilized in a few locations, the incredibly dense urban landscape limits its effectiveness, as the average building footprint is too small to meet any significant portion of demand (Jing et al. 2017). Water reclamation is also underutilized, accounting for less than 1% of supply. This is mainly due to a few factors such as the low price of freshwater and the lack of sufficient water treatment facilities, and the use of seawater for flushing, which makes wastewater brackish.

Desalination is targeted for up to 5% of the supply, but this will drastically increase the energy requirements and carbon emissions of the freshwater system, up to a 40% increase in energy, and will also impact the local marine environment through brine discharges (Civic Exchange 2019). This raises questions regarding the suitability of large-scale desalination for meeting freshwater demand in lieu of other less costly, and less polluting, options.

Governance in Hong Kong, China's Water System

Oversight of the water supply is the primary responsibility of the WSD, which is charged with implementing the waterworks ordinance and regulations. This gives the WSD responsibility over nearly all aspects of the water supply, including enforcement of regulations, construction of new assets, and maintenance of existing infrastructure. The wide-ranging nature of its responsibilities necessitates interaction with a number of other government departments, including the Transport and Housing Bureau, the Environmental Protection Department, the Food and Health Bureau, and the Drainage Services Department (DSD), which is responsible for oversight of sewage and stormwater. The WSD and the DSD are both considered to be “implementation agencies” because they implement the policies created by their overarching organization. In this case, both agencies are subordinate to the Development Bureau, one of the 15 policy bureaus in Hong Kong, China, which is responsible for strategic planning and management to develop public infrastructure.

In addition to these government agencies, an independent body called the Advisory Committee on the Quality of Water Supplies (ACQWS), was created to provide the public with transparency on water issues by increasing public involvement and knowledge regarding water quality and conservation related issues. The ACQWS also provides the WSD with feedback and guidance on regulatory issues as well, such as water quality labeling standards. Further, both the Audit Commission and the Ombudsman provide accountability by periodically reviewing WSD activities or by responding to public complaints and initiating investigations. Another agency that the WSD must also closely interface with is the Legislative Council and its various subcommittees as they play a large role in the WSD's operations. The Legislative Council is responsible for approving several WSD's activities, such as changing tariffs and approving large infrastructure projects. The Legislative Council also sets Hong Kong, China's overall policy agenda. A summary of the agencies found to be actively involved in Hong Kong, China's water governance and their composition can be found in Table 6.2.

Table 6.2: List of Agencies Involved in Water Resource Management Decisions

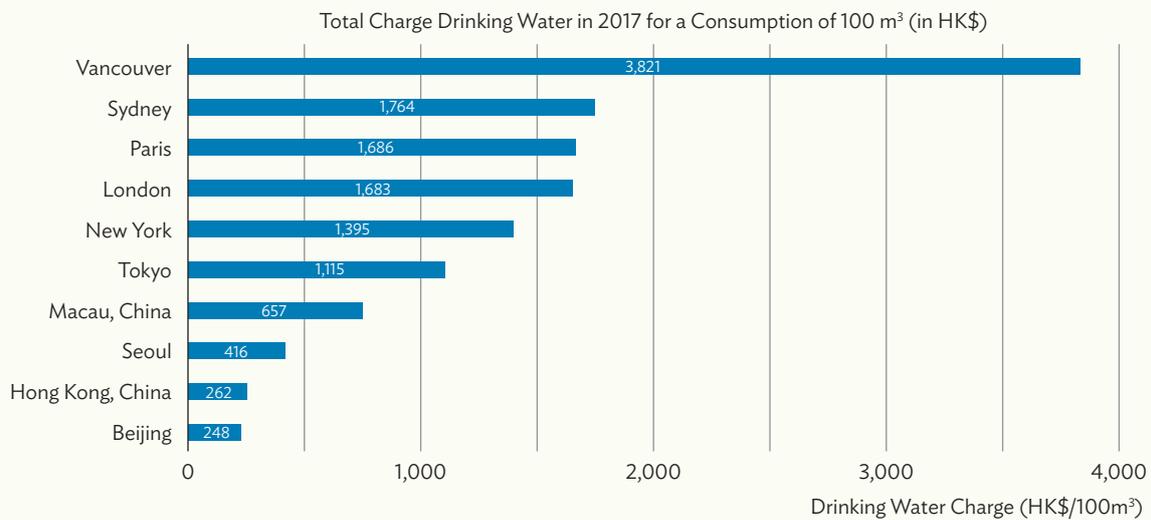
Type	Name	Composition
Administrative branch	Water Supplies Department (WSD)	Government
	Advisory Committee on the Quality of Water Supplies (ACQWS)	Government, academics, and industry
	Development Bureau	Government
	Audit Commission	Government
	Ombudsman	Government
Legislative branch	Legislative Council Finance Committee	Government, Legislative Council members from multisector backgrounds representing local constituencies

Source: Li, von Eiff, and An (2021).

Released in 2008, the only major policy governing control of the water supply is the Total Water Management (TWM) policy. The WSD formulated the TWM to be a catch-all solution, laying out its strategy for water supply diversification, water loss minimization, and reducing demand. The TWM aims to demonstrate water stewardship, containing a list of desirable water management practices with the aim of securing Hong Kong, China's water supply up to 2030 through a combination of conservation, leakage control, increased seawater flushing, and water reclamation and desalination. The TWM was last updated in 2019 following a 5-year external review (Water Supplies Department 2019b), however, despite the consideration of new water resources, such as desalination, the updated TWM does not have any additional measures, metrics, or targets, to address demand while introducing new targets for desalination.

The water tariff, which was designed based on a user pays principle, was originally a key method for managing demand. The tariff consists of four stages, based on consumption, with an initial free tier for all consumers, whether domestic, corporate, or government, followed by a subsidized tier, a cost recovery tier, and a punitive tier meant to dissuade heavy use. However, this tariff has been frozen since 1995, causing even the highest tier (HK\$9.25) to no longer reflect the true cost. Based on the latest annual report, the full production cost, not including distribution, is nearly double the punitive rate and four times higher than the first tier, at HK\$17.7. As a result, the average water bill in 2021 was only \$52 per month or about 0.3% of household income, making it one of the lowest water prices in the world (Figure 6.2). This low price also means the WSD only receives approximately 30% of its revenue from tariffs and the rest from various subsidies and charges.

Figure 6.2: Water Tariffs in Comparable Locations



Source: Water Supplies Department (n.d.).

6.3 Effects of Low Water Pricing on the Water System

While studies of Hong Kong, China's water governance have found that they generally manage the physio-chemical (engineering) component of the supply well, they have generally found the ability to manage the overall water system to be weak (Wang and Dai 2021; Li, von Eiff, and An 2021). While there are several factors that influence the quality of water supply management, the long-term low price underlies many of these issues. Aspects of both supply and demand management have suffered from these effects, which influence attitudes toward water, by both the government and civil society, technological choices, and policy decisions.

One of the less obvious effects of the low water price has been the effect on willingness to charge. As mentioned, the WSD states that it follows the user pays principle in the setting of the water price. While this is true for some aspects, such as the items that the WSD has legal control over, it is not true for the overall water price. The WSD proposes new tariffs for water supply to the Executive Council which then must be approved by the Legislative Council. As a result, the water tariff is not based on a user pays principle but on a number of factors including affordability, financial performance of waterworks operations, the prevailing economic situation, and the views of Legislative Council members.

Since the tariff has been frozen, the willingness to charge for water can be traced through the WSD's annual reports. The WSD 2001–2002 report contains sections on the level and nature of government subsidies, special concessions, the tariff freeze, and tariff revision mechanisms. The importance of water tariff reform was also given a full page in the document, saying that reform was long overdue to combat over consumption, wastage, and improve efficiency of operations. It even gives the total level of subsidy, 50% of water costs, which is not mentioned in future reports and was instead replaced with cost recovery. Most importantly, the report mentions the importance of alignment with international practices and gives a number of possible reforms including removing the free allowance that is currently provided to all users, cancellation of tariff subsidies, gradually phasing in full-cost recovery to water charges, and increasing the billing frequency to monthly, while also creating a fixed charge in addition

to the consumption charge. While removal of subsidies is considered to be important to provide clear signals to the market for conservation purposes, continuing to directly subsidize charges for low-income households only would be necessary to minimize the regressive impact of price increases.

While these recommendations are much the same as we make now, they are completely absent from future reports. In fact, the level of transparency around subsidies has decreased in each report since. First, this section has been replaced by a section called “low-cost water” or “keeping water rates low,” which speaks of the low water rates in a positive light and discusses how citizens pay less for water and that unlike other international cities, Hong Kong, China has chosen to continue to subsidize water. While rationale is never given in the reports, a letter from the Water Workers’ Association sheds some light. After 1997, water was no longer viewed as a commodity of resource, but as a fundamental right and “the public’s basic rights are vital and the key to regional prosperity and stability” (Government Waterworks Professionals Association 2006).

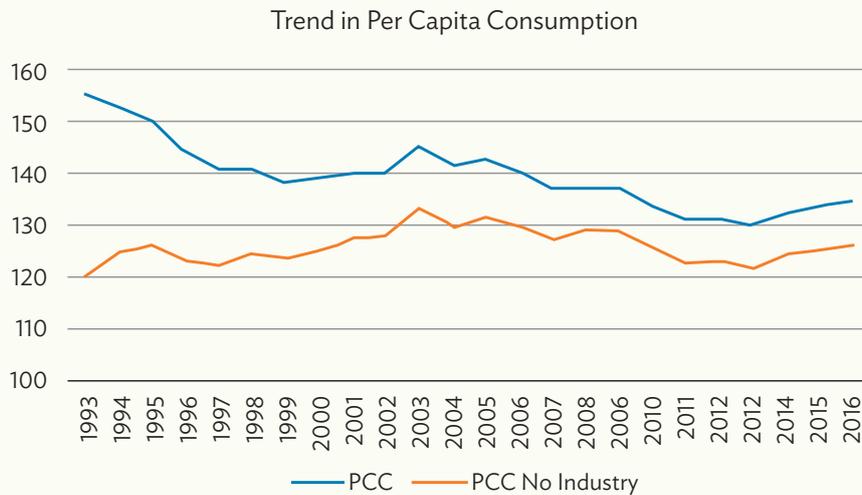
This shift from commodity to right, ties water directly to social stability and puts the WSD at odds with the Legislative Council, who must serve the public interest and protect social order. Under these competing views, the WSD will be unable to raise tariffs as they must seek legislative approval. The longer tariffs remain low the larger the adjustment must be, and the greater odds the public will reject it. As a result, the willingness to increase costs the public will bear decreases with time, as it would be seen as negatively affecting social order.

Beyond these indirect effects, the low water cost has several direct effects on the operations of the Water Supplies Department. One of the most obvious is that the department lacks the budget to undertake infrastructure projects without the need to request additional funding through the Legislative Council. As a result, the Legislative Council has an outside influence on the direction of Hong Kong, China’s water policy, requiring the WSD to focus on the Legislative Council’s policy priorities. When analyzing government documents from 1997 to 2016, a clear trend is shown of the Legislative Council’s action being followed by a response by the WSD (Li, von Eiff, and An 2021). This has led to the WSD being reactive instead of proactive and led it to focus on desalination and smart-city solutions, engineering approaches, for managing the water supply.

Leaving the WSD in a state of deficit has also led it to strive for cost-effectiveness and operational efficiency, in which it has been successful. Operational expenses, related to staffing and maintenance, have not increased in over 10 years, when inflation is considered. While this could be considered a positive result, in many ways it leaves the WSD operating in the dark. The WSD’s staff composition has not changed since it was founded, employing only engineers. It lacks internal research staff that could run pilot programs for new technologies, relying on outside contractors, which has slowed the adoption of technologies such as smart metering and prevents the generation of institutional knowledge.

The WSD also lacks sociologists or economists, who are necessary for understanding trends in water use. As an example, the WSD points to several successes in reducing overall water use, the first being the success of the TWM in reducing domestic water consumption, based on pre- and post-2008 water use, and the second being a success in reducing water leakage. While both are true on face, they do not hold up to stricter analysis. As can be seen in Figure 6.3, water use did reduce in the period after 2008, however this trend started before 2008, with the shifting of industry out of Hong Kong, China and into the People’s Republic of China. When controlling for industry, water use is roughly unchanged, or is increasing. In fact, domestic water use has continued to increase in recent years. Leakage in government mains has also decreased to 15%, which is a significant improvement. At the same time, nonrevenue water remains relatively unchanged due to slow responses to leaks in private mains. Due to the low cost of water and high cost of repair, leaks are left unaddressed for long periods of time.

Figure 6.3: Domestic Water use in Hong Kong, China



PCC = per capita consumption.

Source:

Another issue with the low cost of water is reflected in the local water efficiency labeling standards (WELS). A voluntary WELS initiative was implemented in 2009, covering a range of water-using devices, such as showerheads and washing machines. The WSD also has programs to provide households with flow control devices to be installed on showers and taps in order to limit consumption. WELS standards have been adopted in Singapore and Australia but are much stricter than the conservation thresholds in Hong Kong, China. This is due in part to issues tangential to water, such as the lowest flow shower heads available in Australia would be too efficient for water heaters in lower-income homes to operate, requiring them to be replaced. This cost cannot be subsidized by the WSD, as they lack funding, but they also lack authority, as water heaters are not regulated by the WSD. The low cost of water also creates a long payback period, with more efficient defrosting units for restaurants requiring multi-year payback, as an example.

Lastly, the low water price affects technological choice, with decisions having long-term effects. The low price of water facing the consumer makes alternative technologies, such as water reclamation, too expensive, despite their own low costs. Studies for non-potable water reuse in Hong Kong, China have found that the average unit cost is as low as HK\$5, which is still more expensive than the average price people pay. As a result, technologies like saltwater flushing have been expanded into areas far from the coast, despite their limited ability to replace freshwater resources. While Singapore, Australia, and California are embracing high levels of water reclamation, as high as 30%, Hong Kong, China has struggled to utilize more than 1%. This will have long-term effects on the public's acceptance of the alternative resource and raises questions if continuing to use water imports in Hong Kong, China is the most appropriate use of this resource, allowing the resources to remain in upstream areas.

On the demand side, the low price of water has had a significant effect on domestic consumption. The domestic sector accounts for more than 50% of all water use, without considering the areas that still use freshwater flushing. While arguments can be made about the rights to affordable water, lack of clear pricing signals has a significant effect on consumption. The low cost combined with the free

allocation has seen domestic freshwater consumption rise to 135 liters per person per day, exploding to 153 liters during the last year of the novel coronavirus disease (COVID-19). The low payback period on water conservation devices also affects the adoption of water saving devices in the domestic sector due to the psychological impact of the pricing scheme.

As pointed out in numerous studies, the low price contributes to an illusion of plenty, with many people being unaware of how much they pay for water. Surveys have also found that high-income homes with a live-in helper use more water as they do laundry daily. This would indicate that educational campaigns have had little impact on public perception. This agrees with the previous study, which found that educational programs have no metrics or targets to determine success, besides the number of people who were educated. No follow-ups are done to determine the impact of the learning materials, which has led to failure to change consumption behavior. The frozen tariffs, combined with free allotments for all domestic users, have created a false sense of security among Hong Kong, China's public who can afford to pay, that water is plentiful, and its conservation is not a concern.

6.4 Conclusion

Successful water management requires an approach that considers not just the infrastructure and engineering aspects, but the sociocultural and political aspects as well. As evidenced in the Hong Kong, China case, a focus on the technical aspects has created a blind spot when it comes to managing demand and human behavior. A lack of proper price signals has resulted in the public becoming complacent, and falsely assuming that low cost is equivalent to high security, despite the fact that water is a scarce resource. With only 20% of water coming from local sources, management of demand should be equally, if not more important, than managing the supply.

There are a number of lessons that can be drawn from the Hong Kong, China context and applied globally. The first concerns universal subsidies, and if they are appropriate. Both the United Nations Development Program and the PRC government recommend pricing water at 2.5% to 3% of household income. Low-income families can still be subsidized, but higher-income households and the commercial sector have no need for subsidies. This has led to a situation where water bottlers can buy tapped water at a subsidized rate and sell it back to the public. In the European Union, using high water tariffs to reduce water demand directly is the most common price intervention tool. Research also suggests that consumers who do not pay the full cost of water tend to use it inefficiently.

Departments must also set clear targets and metrics and should be empowered to implement them. Lack of clear targets for long-term water reductions from different conservation methods, lack of educational metrics and targets, and a lack of power to set rates has had a significant impact on the WSD. Having aspects of the water system that affect demand, such as replacing water heaters, outside their power, also effects their ability to create strong standards and policies. The same can be said for their staffing, which is focused entirely on engineering staff. Increasing diversity of backgrounds would allow for more creative problem solving, as can be seen in places such as Singapore.

The public must be educated to ensure they understand the importance and value of water. The WSD can design future campaigns and education programs to better emphasize the rationale behind specific figures, empowering the public to set meaningful personal water reduction targets. For example, when identifying a volume of water for households to save in its 2014 "Let's Save 10L Water" campaign, the rationale and impact of this figure was never explained. Visualizing these impacts is difficult for a public that assumes water is plentiful.

Water pricing should also have the goal of promoting efficient water use to help achieve the sustainability of the water resources over the medium to long term. Hong Kong, China has been dealing with the same fundamental water issues for many years, with high levels of consumption and leakage for a city of its size. The current pricing structure distorts the value of water, and the lack of the resulting lack of data and public engagement keeps policy makers in the dark about the seriousness of the problem in the long term. By generating the political will to address price, we can begin moving both demand and supply toward sustainability.

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The Shift to Risk Management-Based Water Resources Policy in Japan

Toshio Okazumi

7.1 Introduction

Due to the remarkable industrial development in Japan after the Second World War, the rapid increase and concentration of the urban population, and improvement in living standards, water demand increased rapidly in the metropolitan areas, resulting in serious water shortages. Therefore, in 1961, Japan enacted the Water Resources Development Promotion Law and the Water Resources Development Public Corporation Law as legal and organizational arrangements for the promotion of water resources development to ensure a stable water supply and to contribute to the growth of the Japanese economy and the improvement of people's lives.

Based on these legal systems, Japan designated area that urgently needed to implement wide-area water measures as Water Resources Development River System, formulated Water Resources Development Basic Plan (WRDBP), and promoted the development of dams and waterways.

In April 1962, the Tone River and Yodo River water systems were designated as water resources development river systems, and since then additional water systems have been added sequentially based on the status of water use. Currently, seven river systems, the Tone, Ara, Toyo, Kiso, Yodo, Yoshino, and Chikugo Rivers, have been designated, and six WRDBPs have been formulated nationwide, with the Tone River and Ara River systems as one plan (WRD-MLIT 2023a).

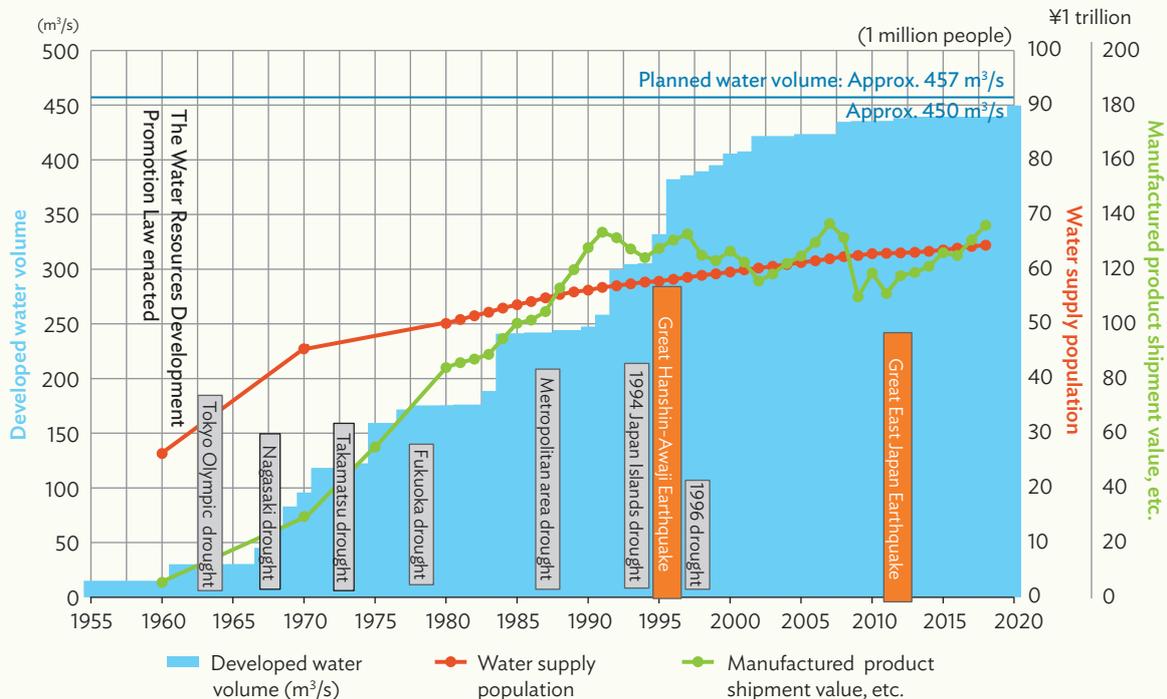
As a result of promoting development facilities for more than half a century based on the WRDBP, it is expected that the planned amount of water for development will be almost achieved, reducing drought damage and supporting the development of local industry (Figure 7.1).

Under such circumstances, in recent years it has become apparent that large-scale disasters such as earthquakes, large-scale accidents due to aging, and critical droughts (which occur infrequently) have a large impact on water supply.

Therefore, in May 2017, in order to make a new WRDBP that responds to the current state of water resources, the National Land Council compiled the "Risk Management-based Water Resources Development Basic Plan for Ensuring Water Supply (report)", which proposed a drastic shift from the conventional "demand-driven" water resources development to a "risk management-based" stable supply of water (WRDSC-NLC 2017).

Here, we introduce the background and the concept of this report and the status of the WRDBP changes in response to it.

Figure 7.1: Changes in Developed Water Volume in Water Resources Development River Systems

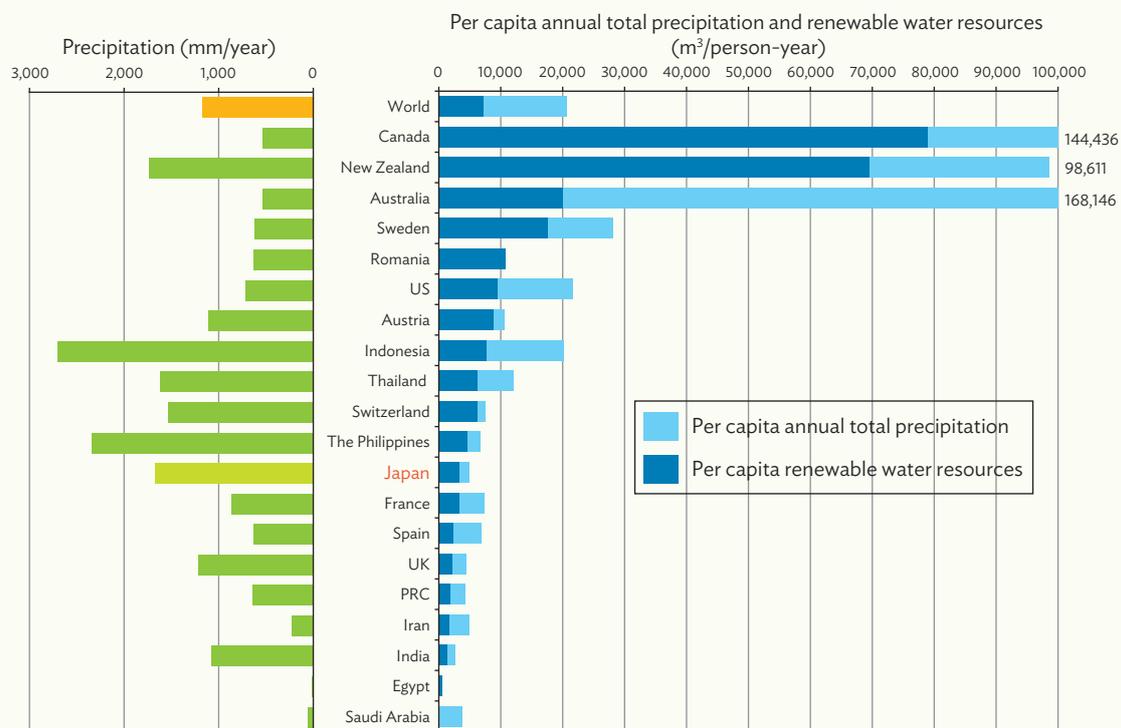


m³/s = cubic meters per second.

Source: 2021 Current State of Water Resources in Japan (MLIT, Japan).

7.2 Current Status of Water Resources in Japan and the Background Leading to Policy Change

Japan is located at the eastern end of monsoon Asia, one of the heaviest rainfall areas in the world. The annual average rainfall is about 1,707 millimeters (mm), which is about 1.5 times the world (land) annual rainfall of about 1,171 mm. On the other hand, Japan has only about 3,400 cubic meters (m³)/person/year (less than half of the world average of 7,100 m³/person/year), rivers are short due to topographical factors, and the amount of water that can be used is limited due to the seasonal and regional unevenness of rainfall (Figure 7.2).

Figure 7.2: International Comparison of Precipitation


m³ = cubic meters, mm = millimeters, PRC = People's Republic of China, UK = United Kingdom, US = United States.

Sources: Annual precipitation in Japan (Water Resources Department calculated from 51 points precipitation data from 2012 to 2021, Japan Meteorological Agency), Annual precipitation in the world (Water Resources Department calculated from 200 countries total renewable water resources (actual), AQUASTAT, food agricultural organization (FAO) (accessed September 2022).

In fact, even today, when water resources development facilities are being developed, droughts with water intake regulations are occurring all over the country. During the Great East Japan Earthquake that occurred in 2011, 2.57 million households suffered water outages for up to 5 months, and a Nankai Trough Great Earthquake is expected to cause even more damage than the Great East Japan Earthquake. In addition, of the 88 facilities built under the WRDBP, 43 facilities, about half of them, have been under management for 30 years, making earthquake resistance and their life extension measures an urgent issue. Furthermore, it is said that the depletion of water resources will become more serious in the future due to climate change, and there is a need for a major review of water resources policies from now on (WRD-MLIT 2023b).

Of these, the WRDBP region accounts for about 50% of the total shipment value of manufactured goods and population, thus, striving for a stable water supply in this region is an important issue that supports the socioeconomic conditions of Japan as a whole (WRD-MLIT 2023a).

In this way, it is necessary to consider not only the emergence of risks related to water resources, but also the arrival of a society with a declining population, changes in household structures, the spread of water-saving equipment, and the globalization of the economy.

7.3 Overview of the National Land Council’s “Risk Management-based Water Resources Development Basic Plan for Ensuring Water Supply” Report

In March 2015, the Water Resources Policy Sub-committee of the National Land Council, which consists of experts to determine the national water resources policy, compiled “Future Water Resources Management”, which presents the basic idea of the future water resources policy based on the emergence of new risks such as large-scale disasters, large-scale accidents, and critical droughts (WRDSC–NLC 2015). Then, in May 2017, the sub-committee compiled a new guidance report for the WRDBP, “Risk Management-based Water Resources Development Basic Plan for Ensuring Water Supply” (WRDSC–NLC 2017).

In other words, in order to promote urgent efforts in highly important water resources development river systems and build a risk management type water management society where safe and secure water can be stably used, two fundamental principles and two methodologies for realizing them were presented, which would greatly change the conventional WRDBP.

The points of the report are:

Fundamental Principle 1 Plans for dealing with risks in relation to water supply

In addition to ensuring the balance between water supply and demand, it is also necessary to deal with risks such as large-scale disasters, aging water infrastructure, and critical droughts, which occur infrequently but have a large impact on water supply.

Fundamental Principle 2 Plans for comprehensively ensuring the water supply security

In order to ensure the appropriate level of water supply security in the face of uncertainties in both the supply and demand of water, it is necessary to comprehensively examine the water supply–demand balance, assuming a wide range of possible drought risks, and to steadily promote measures that are in line with local conditions.

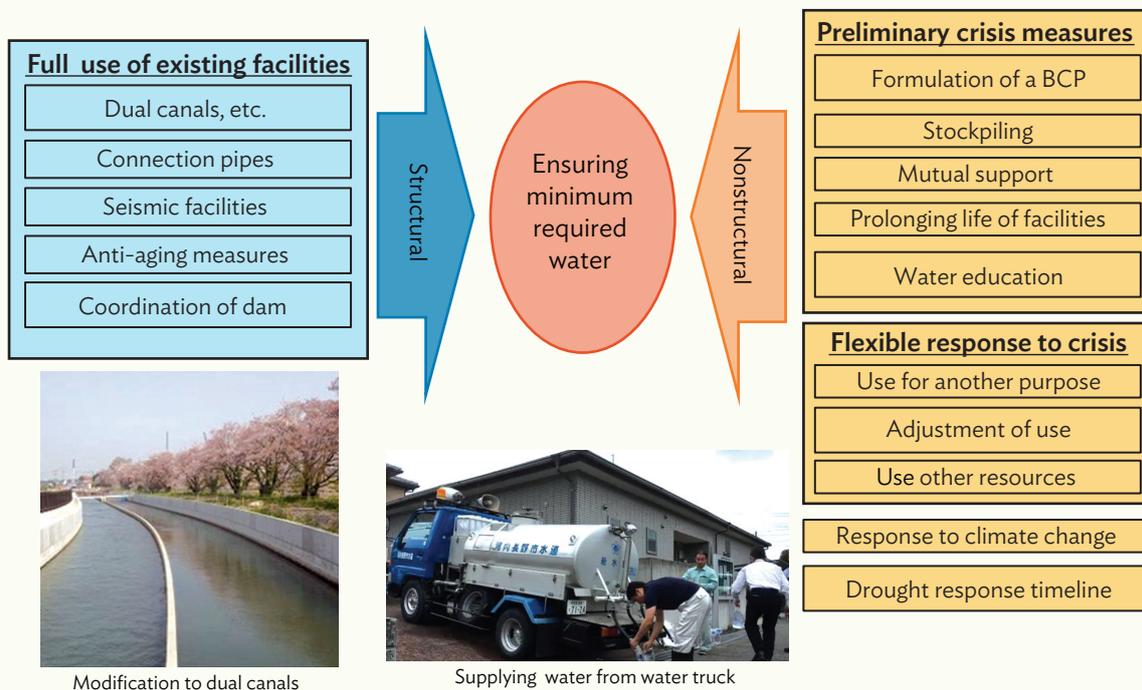
To realize these principles, the following two points were raised as methodologies that should be tackled:

Methodology 1 “Thorough use of existing facilities”

In addition to maintaining and utilizing existing water resource facilities such as dams and waterways, the basic policy is to improve their functions to cope with risks and make the most effective use of existing facilities.

Methodology 2 “Ensuring the functions of the entire system by coordinating hardware and software measures”

In order to respond flexibly and comprehensively on a case-by-case basis and to secure the functions of the entire system, measures for both hardware (structural) and software (nonstructural) will be coordinated (Figure 7.3).

Figure 7.3: Diagram of Risk Management-based Water Resources Plan


BCP = business continuity plan.

Source: WRDSC-NLC (2017).

In addition, we have raised five important points to achieve these goals:

(a) Development of measures to secure necessary water in times of crisis

Prepare a combination of hard and soft measures to secure the minimum amount of water even in times of crisis such as critical droughts, large-scale disasters, and accidents due to aging. Concerning climate change, we will continue to work on the accumulation and evaluation of data as well as consensus building on adaptation measures among relevant parties.

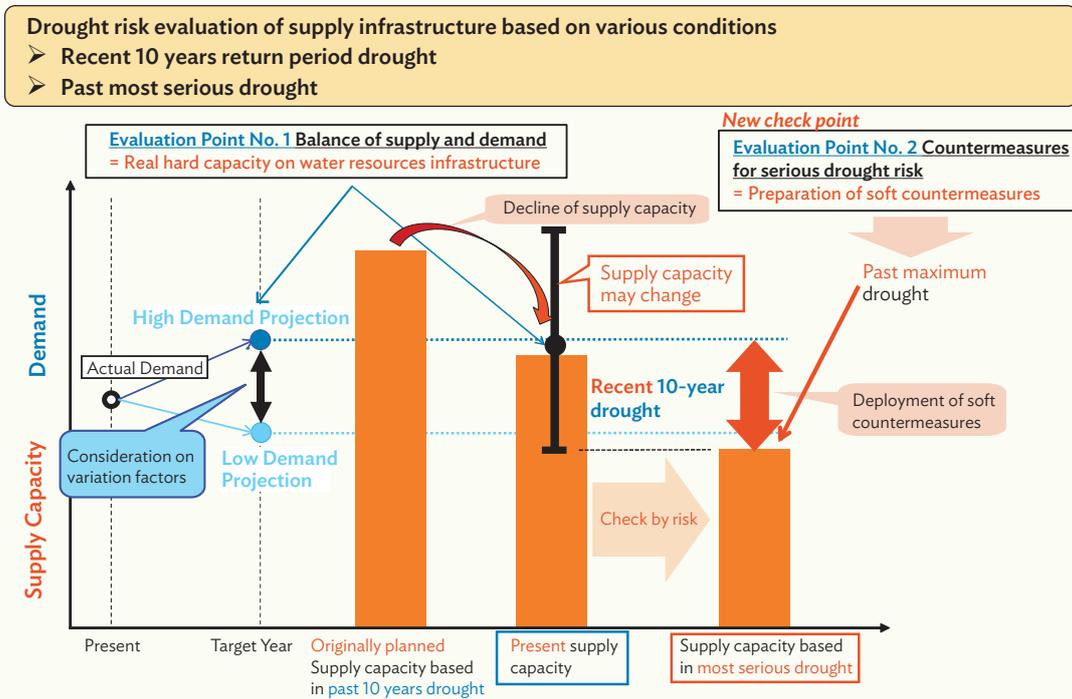
(b) Deployment of measures to ensure water supply security

Considering both supply and demand, it is important to thoroughly utilize existing facilities, conserve and use sustainable groundwater such as alternative water sources in times of crisis, and promote the use of rainwater and reclaimed water as alternative water sources in emergencies.

(c) Evaluation of water supply and demand balance

It is necessary to evaluate the water supply and demand balance from the viewpoint of risk management. In doing so, on the demand side it is necessary to consider the range of forecast fluctuations based on uncertainties, and on the supply side it is necessary to evaluate using the “the year equivalent to the worst drought year in the 10 years and the worst drought year in past history”. In addition, it is important to continue to collect scientific knowledge about changes in the supply capacity due to the impact of climate change (Figure 7.4).

Figure 7.4: New Perspective on Drought Risk Evaluation Between Demand and Supply



Source: WRDSC-NLC (2017).

d) Comprehensive listing of renovation projects

Strengthening measures to extend the life of water resources facilities and promoting their effective use are the most important issues. Therefore, in order to facilitate examination of the necessity of the project and procedures, the descriptions of water resources facilities in the plan will be changed. This will further enhance the effective utilization of existing water facilities.

e) Consistency with water cycle policy

It is necessary to coordinate with the Basin Water Cycle Plan and seek cooperation and consensus building among the parties concerned with water.

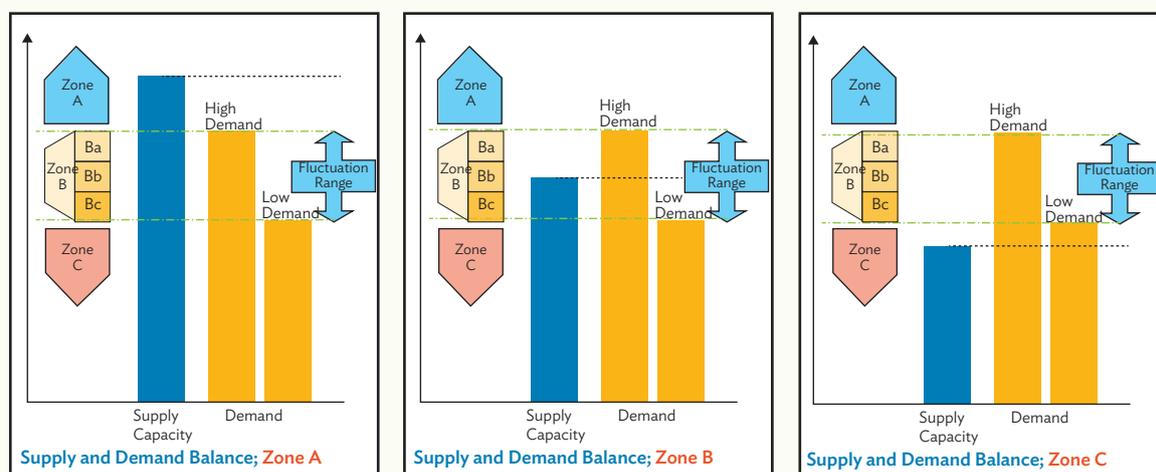
In reviewing the plan, we first worked on c) to properly evaluate the water supply and demand balance. In each river system, droughts have occurred frequently since the initial water resources plan was formulated, and it was necessary to face the fact that the amount of water that can be supplied has changed significantly from the time the plan was formulated due to changes in rainfall and other statistical quantities.

For this reason, we have fundamentally reviewed the statistics used in past plans, and started with properly evaluating the amount of water that can be supplied throughout the year by replenishment from supply facilities in two cases as mentioned in c).

In addition, on the demand side, conventional plans set a single demand amount at the time of future planning targets, but various uncertainties are being discussed in terms of society and the economy. For this reason, we have broadly assumed the current drought risk and organized our approach to responding to it. In other words, we decided to honestly show that there are “high-level estimates” and “low-level estimates” even for demand.

As a result, if the available supply exceeds the “high-level estimate” of demand, we will appropriately implement the current hardware and software measures, but if the available supply falls below the “low-level estimate” of demand, we will clearly indicate the need for new hardware facilities and the urgent need for software measures, and we will consider these possibilities (Figure 7.5) (WRD–MLIT 2023c).

Figure 7.5: Evaluation and Countermeasures on Water Demand and Supply Capacity



	Zone Division	Countermeasures
Zone A	High demand < Supply capacity	Existing hard and soft countermeasures should be implemented
Zone Ba	Low demand < Supply capacity < High demand (Ba = high, Bb = middle, Bc = low)	Additional hard and soft countermeasures should be considered
Zone Bb		
Zone Bc		
Zone C	Supply capacity < Low demand	Additional hard and soft countermeasures must be formulated

Source: WRD–MLIT (2023c).

7.4 WRDBP Change Status

After receiving this report, Japan is proceeding with the work to change all six WRDBPs one by one. In April 2019, the Yoshino River water system was changed, which has experienced the most frequent droughts among the WRDBP water systems and is urgently required to be converted to a risk management type. Following that, changes were made to the Tone and Arakawa River systems in May 2021, the Yodo River system in May 2022, and the Chikugo River system in January 2023. Plans for the remaining two water systems will be reviewed sequentially.

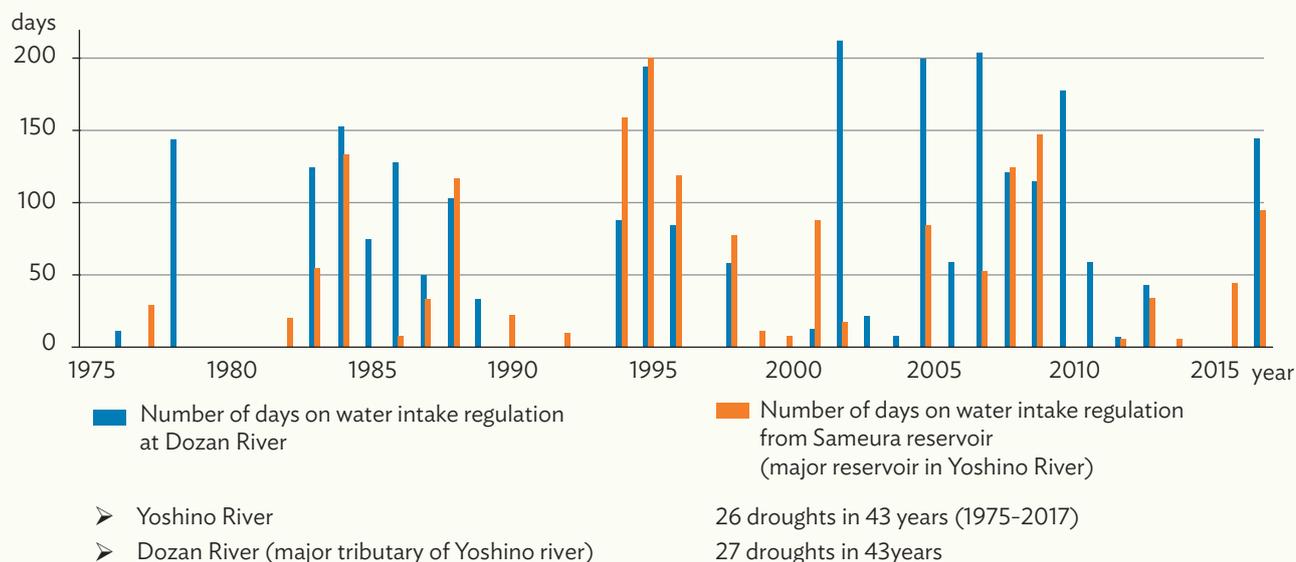
7.5 Details of the Yoshino River System Plan

First, we reviewed the Yoshino River water system, which has a remarkable frequency of droughts and a serious water resources problem. The details are as follows (Cabinet Decision 2019).

7.5.1 Basic Concept

The Yoshino River system, which occupies an important position in the society and economy of the Shikoku region, is facing new risks and issues related to water resources, such as critical droughts, large-scale natural disasters such as Nankai Trough earthquakes, and large-scale accidents due to the aging of water resources development facilities (Figure 7.6).

Figure 7.6: Number of Days on Water Intake Regulation in Yoshino and Dozan Rivers



Source: WRD-MLIT (2019).

In light of this situation, in addition to ensuring the water supply-demand balance, it is necessary to respond to new risks and issues surrounding water resources, to comprehensively inspect the water supply-demand balance based on a wide range of possible drought risks, and to steadily promote measures suitable for the region. For this reason, the basic concept of the plan is to properly maintain and manage the existing facilities and make the most effective use of the facilities, and to promote the necessary nonstructural measures in an integrated manner to create a system that enables the stable use of safe and secure water.

The planning period for this plan is approximately 10 years, but since various circumstances may change, we decided to repeat the “Plan Do Check Action” cycle and review the plan as appropriate from the perspective of risk management.

7.5.2 Concept of Water Supply and Demand Balance

Supply target

The Yoshino River system is the largest river in the Shikoku region, and four prefectures share the water resources, so society and the economy depend almost entirely on this Yoshino River.

Goals for drought

The first goal is to enable stable water use even in the event of a drought of the same scale as the worst drought in 10 years. In addition, the goal is to secure the minimum amount of water necessary to prevent serious impacts on people's lives and economic activities even in the event of a drought on a scale similar to the worst drought in history. This is extremely important in an area that has experienced frequent severe droughts in the past.

The 10-year drought in this river system occurred from 1995 to 1996 on the Yoshino River, and from 1994 to 1995 on the tributary, the Dozan River. In addition, the worst drought in history occurred in 1964 on the main river, and from 1995 to 1996 on the tributary. We simulated the situation and evaluated whether the planned facility could achieve the target.

Targets for large-scale natural disasters

This is a region where there is concern about the occurrence of a Nankai Trough megathrust earthquake. Therefore, even after the occurrence of a large-scale natural disaster, it was decided to secure the minimum amount of water necessary for living and economic activities, to minimize damage to important facilities positioned in the plan, and to restore them as soon as possible.

Goals for aging facilities

It is important to maintain and secure the functions of the facilities positioned in the plan into the future in order to maintain the achievement of the goals.

In this way, by clearly sharing the situation of past serious drought damage that remains in the memory of the region, we are sharing the goal. In addition, planning clearly positioned the future concerns about large-scale disasters and the deterioration of facilities.

Basic matters concerning the construction of facilities necessary to achieve supply targets

The maintenance and management of existing facilities and future facility development facilities positioned to achieve the supply goals shown are specified in the following: Sameura Dam, Ikeda Dam, Shingu Dam, Kagawa Canal, Old Yoshino River Estuary Barrage, Imakiri River Estuary Barrage, Kochi Diversion Facility, and Tomisato Dam.

7.5.3 Concept of Hardware and Software

Integrated promotion of hard and soft measures

In order to respond flexibly and comprehensively to various risks and uncertainties surrounding water resources, and to ensure the functions of the entire water supply system, we are promoting not only water use in times of crisis, but also in normal times. In addition to the above-mentioned physical

measures such as the development and maintenance of facilities, we are also promoting soft measures in an integrated manner according to the actual situation, such as whether other facilities can be used through simulations of droughts, what other facilities can be used, and what cooperation can be undertaken based on regional agreement.

Regarding hardware measures, our basic strategy is to thoroughly utilize existing facilities, such as renovating the facilities mentioned above to improve the necessary functions, maintenance and management such as appropriate inspections and repairs for aging facilities, and systematically extending the life of facilities by updating them as necessary.

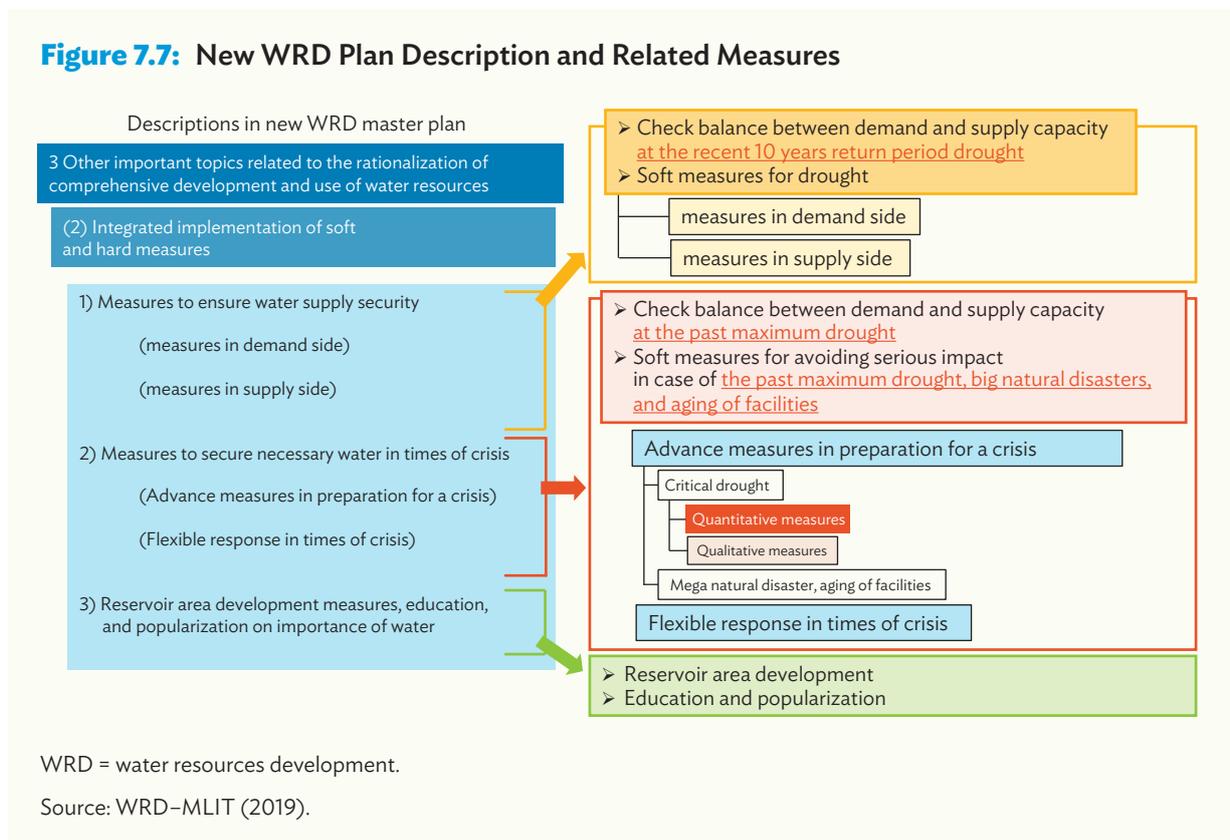
Measures to ensure safety of water supply

As for the water supply in the Yoshino River system, assuming the worst drought in 10 years, the amount of water that can be supplied from facilities in the water system is compared with the outlook for demand that depends on the water system in about 10 years. In addition, in Tokushima, Ehime, and Kochi prefectures, the amount of water that can be supplied exceeds the “high outlook” for demand.

In addition, as a result of the same comparison of industrial water, in Kagawa and Ehime prefectures, the possible supply amount is below the “low outlook” for demand, and in Tokushima and Kochi prefectures, the possible supply amount is above the “high outlook” for demand.

Based on this situation, we decided to work on soft measures from both the demand side and the supply side as shown below so that stable water use is possible throughout the region (Figure 7.7).

Figure 7.7: New WRD Plan Description and Related Measures



Measures from the demand side

Building a water-saving society

We will continue to promote water-saving efforts throughout society, such as the spread of water-saving equipment, measures to prevent water leakage, and the use of rainwater and recycled water. In addition, efforts will be made to raise awareness of water conservation.

Rationalization of water use

From the perspective of effective use of water resources, when an imbalance in supply and demand arises due to changes in socioeconomic conditions, etc., we will promote initiatives such as diversion of water across different uses while gaining mutual understanding among the parties concerned according to the actual situation of the region.

Measures from the supply side

Conservation and utilization of groundwater

Appropriate use of groundwater will be promoted, while paying attention to groundwater disturbances such as land subsidence due to over-extraction and groundwater salinization.

Promoting the use of rainwater and recycled water

The use of rainwater and reclaimed water will be promoted according to the situation, such as local needs, for further use.

Measures to Secure Necessary Water in Times of Crisis

By considering in advance measures to minimize the impact on society and the economy even in times of crisis, which had not been thought of in the past, and setting them in the plan, and by also setting out flexible responses in the event of an actual crisis, the preparations of the parties concerned will be promoted, and responses to actual crises will be made smoother and more flexible.

As a result of comparing the possible supply of water from the relevant water system and other water systems, assuming the worst drought in history, and the outlook for demand in the four prefectures of Shikoku, which depend on the relevant water system for part of their water supply in about 10 years, in Tokushima and Kagawa prefectures, the possible supply is lower than the “low forecast” of demand, and in Kochi prefecture, the possible supply is lower than the “high forecast” of demand, and the “low forecast” surpass. In addition, in Ehime Prefecture, the amount of supply that can be supplied exceeds the “high outlook” for demand. In addition, the combined supply capacity of the four prefectures will fall below the “low outlook” for demand.

As a result of the same comparison of industrial water, in Kagawa and Ehime prefectures, the available supply volume is lower than the “low outlook” for demand. In Kochi Prefecture the available supply volume is lower than the “high outlook” for demand and exceeds the “low outlook”, and in Tokushima Prefecture, the available supply volume exceeds the “high outlook” for demand. Looking at the total of the four prefectures, the potential supply is below the “high-level forecast” of demand and “above the low level”.

In the event of the worst drought in history, as mentioned above, it is assumed that it will be difficult to use water at the same level as during normal times. In addition, considering the possibility of a drought more severe than the worst drought in history, we have decided to implement the following nonstructural measures to prevent serious impacts on the lives and economic activities of the region from both the demand and supply sides.

Advance measures for crisis

In preparation for abnormal droughts, it was decided to consider measures for the demand side such as water intake restrictions, effective operation of facilities for water replenishment during droughts, and supply-side measures such as emergency utilization of dam capacity for purposes other than those for specific purposes, and to coordinate water use in a stepwise and flexible manner.

In addition to normal use, to secure the minimum necessary amount of water in times of crisis such as large-scale natural disasters including earthquakes, large-scale accidents caused by the deterioration of water infrastructure, and critical droughts, efforts were made to promote the development of emergency water supply systems and the use of groundwater, rainwater, and recycled water as alternative water sources.

It was decided that concerned parties would work together to estimate the impact and damage caused by droughts and create drought response timelines that stipulate measures to mitigate damage caused by droughts, with the aim of minimizing drought damage in the relevant regions.

In addition, we decided to work on the conclusion of agreements on mutual support in the event of a disaster, including nationwide cooperation, the formulation of business continuity plans, and the stockpiling of materials and equipment.

We decided to strive for dissemination and enlightenment, etc., to promote the formulation of business continuity plans by companies, and disaster base hospitals, etc., for prompt response in the event of a crisis.

In order to prevent water supply facilities from malfunctioning even in times of crisis, it was decided to formulate life extension plans and systematically promote aging measures and earthquake resistance measures.

Flexible response in times of crisis

In order to prevent and mitigate damage caused by droughts, we decided to cooperate with relevant parties and the media and promote the dissemination of information and calls for water conservation during normal times and at an early stage when there is a risk of droughts.

In the event of an abnormal drought, specific adjustments will be made based on the concept of adjustment of water use discussed in advance among the parties concerned.

At the stage of emergency restoration in the event of a crisis, efforts will be made to ensure flexible water supply through coordination among stakeholders such as river administrators, water users, and related prefectures.

7.5.4 Overviewing the Entire Plan

The former WRDBP was based on the premise that water demand would continue to grow as the economy developed and society expanded. However, in recent years, water demand has improved from a critical situation and is mostly meeting the demand in some regions. Instead of increasing the amount of water that can be supplied in the future, instead of increasing the amount of water that can be supplied, it will be necessary to forecast water demand that is appropriate based on recent socioeconomic conditions, or that includes uncertainty.

At the same time, to respond to large-scale disasters and malfunctions due to the aging of facilities, which are expected in the future, in addition to achieving goals through hardware development, soft measures that have not been discussed until now, measures on the supply side and measures on the demand side to ensure safety have been established.

In addition to formulating them in the plan, it is important that the local administration, water users, and residents fully understand this plan and be able to face it in the event of an emergency.

7.6 Further Efforts and Expectations for the Future

In the past, the WRDBP has tended to be a controversial plan, formulating water resources in metropolitan areas and structural measures such as dams as a national policy. As a result, there were quite a few situations where the development of facilities such as dams was delayed and discussions did not progress due to their controversial viewpoints. However, in recent years, various problems have arisen, such as a decrease in water resources supply due to changes in rainfall conditions, increased uncertainty in socioeconomic activities, frequent occurrence of large-scale natural disasters, and serious deterioration of facilities. Based on the idea of the National Land Council's report (SISC-NLC 2023), other estimated water resources plans are currently being reviewed, and plans for all water systems are reviewed. It is believed that by accelerating the efforts of society as a whole, it will lead to the construction of a safer and more secure society.

However, even in the midst of efforts to build such a society, we are still faced with a situation of continuing anxiety about the future due to the frequent occurrence of even more dangerous disasters, the emergence of the effects of climate change, and changes in industrial structures and lifestyles. From this point on, at present, with the recognition that we must seek a more fundamental change in water resources policy, the National Council is also deliberating on the direction of further deepening and accelerating water resources policy.

As described above, Japanese water resources development has matured after the post-war reconstruction and economic development, and overwhelming large-scale disasters that have hit Japan many times. Additionally, to tackle with further uncertainty, securing minimum water resources, flexibility and appropriate mixture of soft and hard countermeasures must be necessary to survive from the business continuity. These experiences have made citizens understand that not all water resources policies are the same, and should be adapted flexibly, while listening to the voices of the nation and citizens based on the economic and social conditions of the country and regions at that time. This must be effective even for people of other countries where further economic development is expected. Since it requires a long-term perspective, national leadership is the key for tackling this issue.

In the future, every country, including Japan, should not only to develop further water resources facilities, but also promote efficient water policies such as changing water use rules that allow water to be provided to people or a fundamental change of dam management methods.

It is hoped that Japan's water resources policy will be further improved through the new policy change in the future.

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Novel Approaches in Flood Management Policies in Japan: Integrating Sociocultural Wisdom in Climate Change Adaptation

Hiroaki Ikeuchi*

8.1 Introduction

Floods are one of the most devastating natural disasters worldwide, and it is projected that global warming and resulting climate change will further exacerbate flood disasters in the future. In spite of previous flood mitigation efforts, inundation is sometimes unavoidable if rainfall exceeds the capacity of flood control facilities. Japan, for example, has suffered from severe flooding events in recent years, such as Typhoon Hagibis in 2019 and heavy rainfall in 2018 and 2020. In particular, the flood disaster caused by Typhoon Hagibis in October 2019 was the most devastating in the recent history of Japan; it made landfall with its minimum central surface pressure of 915 hectopascals, resulting in more than 100 casualties (Cabinet Office 2020). In this typhoon event, mainly the eastern side of Japan suffered damage; on the contrary, the flood events in July 2018 and July 2020 caused severe damage in the west and southwest regions of the country, with more than 200 casualties in 2018 and over 80 in 2020 (Cabinet Office 2019, 2021). These facts imply that all parts of Japan is susceptible to flood disasters. Given that precipitation amounts will increase due to climate change and flood risk will be augmented worldwide (Hirabayashi et al. 2013), taking appropriate countermeasures to mitigate flood damage is an urgent issue.

In the aftermath of this devastating situation, the Japanese government made a leap forward in its flood management policy by establishing a new concept called “River Basin Disaster Resilience and Sustainability by All” in 2020. This means an integrated approach toward flood risk reduction by not only accelerating the improvement of river infrastructure but also taking various measures in river basins as a whole. In order to materialize this concept, a set of specific measures was established as “A Project of River Basin Disaster Resilience and Sustainability by All” for each of the 109 Class-A river basins, which are defined as river basins administered by the national government, and was made public by the end of March 2021. On top of that, nine related acts were integrally amended to further strengthen effectiveness of the concept, which came into effect in November 2021. Among them, the most essential is the Specified Urban River Inundation Countermeasures Act. This act was originally enforced in 2004 to address the issue of urban flooding, which is caused by the decreased permeability of land due to development. While the target of the act was originally limited to urban areas, it became evident that severe floods can take place anywhere in Japan; therefore the act was amended to meet demands for strengthening flood countermeasures.

This chapter scrutinizes the latest shift in Japan’s policy toward integrated flood management from the viewpoint of the River Basin Disaster Resilience and Sustainability by All concept. In Section 8.2, the underlying ideas of this concept are explained first, followed by more detail of the contents of

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the amendment. Section 8.3 illustrates an example where these new flood management strategies are implemented. Section 8.4 investigates that while the concept itself is newly introduced to the policy, each idea derives from the indigenous wisdom of Japanese society and culture. Section 8.5 summarizes the chapter.

8.2 Method: History and Overview of the Concept

This section introduces the core concept of Japan's flood management strategy, River Basin Disaster Resilience and Sustainability by All. First, the historical background of this concept is reviewed, followed by a more detailed explanation on the concept and regarding amendment of the acts.

8.2.1 Historical Background: Comprehensive Flood Control Measures

In the 1970s, a concept called Comprehensive Flood Control Measures (CFCM) was introduced into Japan's flood management policy. This was based on an interim report issued by the River Council of the Ministry of Construction in 1977. The basic idea was to expand measures from riverine control such as dams and levees to source control such as storage and/or infiltration and nonstructural measures such as evacuation. Since the late 1950s, urban floods took place more frequently than before as a result of urbanization. That is why the basic principle of this policy was to mitigate the increase in flood discharge due to the land use change by the promotion of rainwater storage and/or infiltration facilities (hereinafter referred to as rainwater storage–infiltration facilities), and it was mainly aimed at rapidly urbanizing river basins. Detailed explanations on the history of CFCM are provided by Takeuchi (2022). An important point that should be noted is that, while the concept of River Basin Disaster Resilience and Sustainability by All was introduced recently, its basis derives from the concept of CFCM, having around 50 years of history.

8.2.2 Revision of Flood Control Planning

In July 2020, the River Subcommittee of the National Land Development Council of Japan issued a report (MLIT 2020a) that forms the basis of the shift in flood management policy after the country faced severe flood events and realized the need for more comprehensive flood control. The report posed two major suggestions: a revision of flood control planning and the development of a new flood management policy. A more detailed background of the report is provided by Koike (2021).

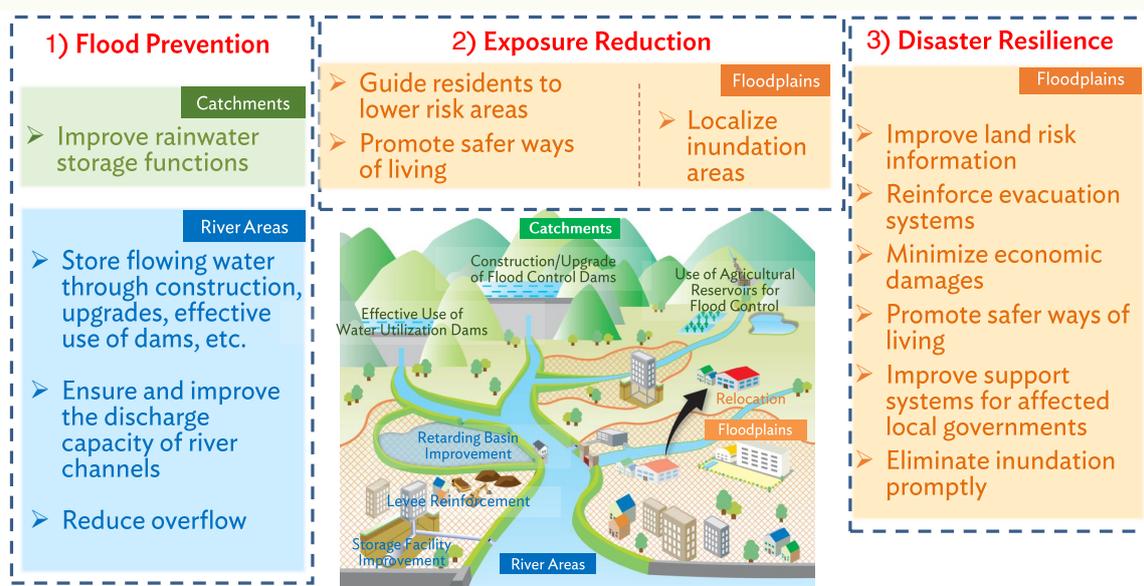
The first suggestion was to revise flood control planning. The concept of design flood discharge, representing a protection standard or safety level in flood risk management, has been set using statistical analysis of historical records of hydro-meteorological values since 1958 (Nakamura and Oki 2017). In this revision, however, it was groundbreaking in that it was based on atmospheric general circulation model outputs, using the database for Policy Decision making for Future climate change (d4PDF) (SOUSEI-MEXT 2019). The Technical Working Group on Flood Management Planning chose the Representative Concentration Pathway 2.6 of the Intergovernmental Panel on Climate Change as a future climate scenario for the revision. The working group divided the country into 15 climatic zones, and then compared probabilities of heavy rainfall events between present (1951–2010) and future (2040) conditions of the dataset for each zone. It finally obtained the results of the rates of change in probabilities of heavy rainfall events, which were 1.15 for Hokkaido and 1.1 for the other 14 regions. These rates are used to revise flood control planning, which is now ongoing in the rivers of Japan.

8.2.3 River Basin Disaster Resilience and Sustainability by All

The second suggestion by the subcommittee was to develop a new flood management policy, the River Basin Disaster Resilience and Sustainability by All (MLIT 2020b) to tackle the increasing risk of flooding, which Japan is already facing, and which is forecast to intensify under future climate conditions. The phrase “river basin” here is defined as an area of both watersheds and floodplains. The policy concept encompasses comprehensive and multilayered actions by all stakeholders in a river basin. Stakeholders include not only the public sector such as municipalities, prefectures, and the national government, but also private enterprises, water users, and residents. The underlying background of this policy implementation is threefold: climate change impacts intensifying flood disasters, societal changes where Japan’s population is declining and aging, and technological developments such as artificial intelligence that can support disaster risk reduction.

Generally, flood risk is determined by hazard, exposure, and vulnerability, where hazard is a threatening natural event with the notion of occurrence probability, exposure is values at risk such as people and buildings, and vulnerability is the lack of resistance to external forces (Kron 2005). The concept of River Basin Disaster Resilience and Sustainability by All composes three major pillars (Figure 8.1), and each of them corresponds to the three factors of risk: flood prevention (hazard), exposure reduction (exposure), and disaster resilience (vulnerability). The first factor, flood prevention, includes measures which have been traditionally taken in modern river engineering, that is, improvement of river infrastructure such as construction of dikes, dams, retarding basins, and rainwater storage–infiltration facilities. The second factor, exposure reduction, means land use regulation to guide residents to areas with lower flood risk. The third factor, disaster resilience, includes diverse adaptation measures to minimize vulnerability to floods, such as informing residents of flood risk by hazard maps, establishing

Figure 8.1: Overview of River Basin Disaster Resilience and Sustainability by All Concept



Sources: MLIT (2020a, 2020b).

early warning systems, and preparing business continuity plans for companies. Note that the first component, flood prevention, includes the idea of a reduction of flood inundation. Traditionally in Japan, at least under modern river engineering, flood control planning is mainly based on regulating design flood discharges at the designated points. However, it is not enough because the possibility of hazards cannot be ruled out with larger external forces than the target of flood control. Therefore, in order to tackle this, the idea of a reduction of flood inundation was also introduced to mitigate flood damage. A detailed explanation on the history and evolution of the concept is introduced by Koike (2021).

8.2.4 Amendment of Acts regarding River Basin Disaster Resilience and Sustainability by All

In 2021, after the finalization of the policy concept, the government amended the acts regarding the River Basin Disaster Resilience and Sustainability by All concept. As mentioned above, for each of the Class A River Systems, the project on River Basin Disaster Resilience and Sustainability by All was formulated and made public in March 2021. This is an illustration of a package of flood countermeasures taken both in the rivers and their basins to mitigate flood damage. However, given the increasing climate change impacts of more frequent and hazardous flood events, further enhancing the effectiveness of the policy concept was an urgent issue. Therefore, a legal framework was designed in the form of integral amendments of the nine acts. Both the House of Representatives and the House of Councilors of the Japanese Diet passed the amendment of the acts unanimously in May 2021, with enforcement in November 2021. The amended acts are:

- River Act
- Specified Urban River Inundation Countermeasures Act
- Sewage Act
- Urban Planning Act
- Urban Green Space Conservation Act
- Building Standards Act
- Act on Special Financial Support for Promoting Group Relocation for Disaster Mitigation
- Flood Control Act
- Act on Sediment Disaster Countermeasures for Sediment Disaster Prone Areas

Figure 8.2 provides an overview of the amended acts.

Figure 8.2: Overview of the Amended Acts

Overview of Acts Regarding River Basin Disaster Resilience and Sustainability by All Act No.31 in 2021	
1. Enforcement of planning and systems (Specified Urban River Inundation Countermeasures Act)	<ul style="list-style-type: none"> ◆ <u>Loosening the conditions of rivers to apply the act</u> <ul style="list-style-type: none"> - Expansion of the act applicability to not only rivers where inundation control is difficult due to urbanization, but also to rivers where inundation control is difficult due to natural conditions ◆ <u>Establishment of Basin Flood Control Councils</u> <ul style="list-style-type: none"> - Stakeholders such as government, prefectures, and municipalities join a council for each basin to discuss measures such as rainwater storage and/or infiltration and land use regulation, and incorporate results into a basin inundation control plan
2. Mitigation of inundation (River Act, Sewage Act, Specified Urban River Inundation Countermeasures Act, Urban Planning Act, Urban Green Space Conservation Act)	<ul style="list-style-type: none"> ◆ <u>Enforcement of river and sewage measures</u> <ul style="list-style-type: none"> - Establishment of a council to plan preliminary discharge before flooding for water utilization dams with river managers and water users such as electric power companies - Setting a target rainfall in a plan to prevent inundation by sewage - Mandatory formulation of operation rules for sewage sluices ◆ <u>Enforcement of rainwater storage/infiltration in a basin</u> <ul style="list-style-type: none"> - Introducing an “area for preserving storage function” to secure water retention - Conserving green spaces in urban areas to utilize them as green infrastructure - Supporting rainwater storage and/or infiltration facilities by municipal and/or the private sectors with a certification system, assistance, and tax rate reduction
3. Exposure reduction (Specified Urban River Inundation Countermeasures Act, Urban Planning Act, Act on Special Financial Support for Promoting Group Relocation for Disaster Mitigation, Building Standard Act)	<ul style="list-style-type: none"> ◆ <u>Cooperation with urban development</u> <ul style="list-style-type: none"> - Introducing an “area for preventing inundation damage” to inspect safety of newly built houses and facilities for those requiring special care - Expanding the target areas of promoting group relocation from high-risk areas - Development of bases for evacuation sites
4. Mitigation of damage and early recovery (River Act, Flood Control Act, Sediment Disaster Prevention Act)	<ul style="list-style-type: none"> - Enriching risk information by expanding flood hazard maps to small and medium-sized rivers - Ensuring effective evacuation by municipal advice and recommendation to evacuation plans and drills for facilities for those requiring special care - Expanding government direct support to rivers managed by municipalities for early recovery

Source: MLIT (2021a).

8.2.5 Specified Urban River Inundation Countermeasures Act

Among the amended acts, the most pivotal and improved act is the Specified Urban River Inundation Countermeasures Act. The author of this chapter (Hiroaki Ikeuchi) was in charge of designing the revisions of this act. In this subsection, the content of this amended act is introduced.

Overview of the Specified Urban River Inundation Countermeasures Act before amendment in 2021

This act was originally enforced in May 2004. At that time, inundation damage was on the rise, particularly in urban areas because of urbanization, accumulation of population and assets, and increase in intense rainfall. It became clear that relying only on improvements to river infrastructure

was not a solution to prevent inundation damage on such occasions. Thus, the act was designed with a view to promoting measures for preventing inundation damage in urban river basins.

The act was applied to rivers that satisfied the following conditions:

- The target river runs across urban areas: the percentage of urbanized areas in its basin is more than approximately 50%.
- Significant inundation damage occurred or is likely to occur with annual flood damage of more than ¥1 billion.
- Prevention of inundation damage is difficult even by improvement of river infrastructure or flood control dams due to urban development.

The target rivers and their basins were designated as specified urban rivers (SURs) and specified urban river basins (SURBs) by the Minister of Land, Infrastructure, Transport and Tourism or prefectural governors, who administered the rivers.

Once a SUR and a SURB were designated, there were some schemes and obligations stipulated in the act, such as:

- A Basin Flood Control Plan should be formulated by a river administrator of the SUR, a sewage administrator concerning the SURB, and governors of prefectures and municipalities whose territories are included in the SURB.
- The river administrator of the SUR can equip and maintain rainwater storage–infiltration facilities in the SURB for the purpose of mitigation of flood damage.
- All actions on land other than for housing that are likely to significantly hinder rainwater infiltration with an area of more than 1,000 square meters (called rainwater infiltration preventive actions) require permission beforehand from the corresponding local governor. Examples are:
 - Altering the land characteristics for housing
 - Covering land by pavements made of impermeable material

In addition, the construction of rainfall storage–infiltration facilities is necessary not to increase rainwater runoff (Figure 8.3).

Figure 8.3: Permission Scheme of Rainwater Infiltration Preventive Actions

Development of rainwater storage-infiltration facilities is necessary for rainwater infiltration preventive actions with an area of >1,000 square meters* on land other than for housing, etc.
* This threshold can be changed to between 500–1,000 square meters by prefectural ordinance.

Target Actions

- 1) Alteration of the characteristics of the land for housing, etc.

Land other than housing, etc.,
with a small runoff coefficient

mountain/forest/arable land
grassland/non-compacted land

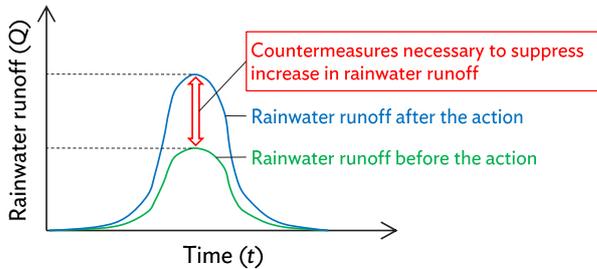
Rainwater infiltration
preventive actions



Housing land, etc.,
with a large runoff coefficient

housing land/road/pond
waterway/railway/airfield

- 2) Pavement of the land, e.g., changing farmland into a parking lot
- 3) Development of a golf course, a playground, etc., with drainage facilities
- 4) Land compaction with a roller, etc.



Example: developing a rainwater storage facility underground of a building

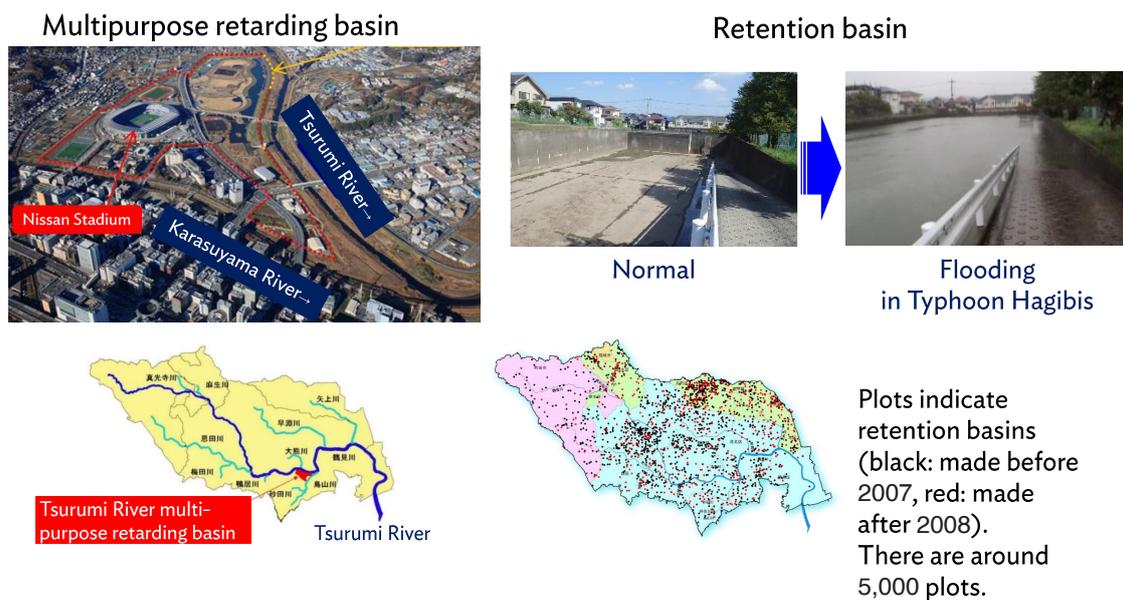


Source: MLIT (2023).

Before the amendment, eight river basins were designated as SURBs, most of which are located in large cities such as the Tsurumi River basin in Kanagawa Prefecture. The act was effective in flood damage prevention by securing and increasing rainfall storage-infiltration capacity in urban river basins (Figure 8.4). However, as mentioned above, many places, not just limited to the concentrated urban areas, are susceptible to flooding due to increasing and intensifying rainfall events, resulting in the act being amended to expand its schemes to all rivers in Japan. The following subsections introduce major revisions regarding the amendment.

Figure 8.4: Effect of Mitigation Activities Against Floods in Tsurumi River Basin in the Case of Typhoon Hagibis, 2019

In the Tsurumi river basin, basin-wide comprehensive flood countermeasures including a multi-purpose retarding basin and retention basins are taken. In case of Typhoon Hagibis in 2019, these facilities stored water of approximately 3,700,000 cubic meters, leading to approximately a 0.7 meter decrease in water level at Kame-no-ko standard point in the mainstream.



Source: MLIT (2023).

Expansion of target rivers under the act

To expand the number of target rivers under the act, the conditions that a SUR needs to satisfy were revised as follows:

- The target river runs across urban areas, such as areas promoting urbanization, with accumulation of population and assets.
- Significant inundation damage occurred or is likely to occur; the river is supposed to designate flood inundation assumed areas, stipulated by Paragraph 1 and 2 of Article 14 of the Flood Control Act.
- Prevention of inundation damage is difficult even by the improvement of river infrastructure or flood control dams due to at least one of the following reasons:
 - The river basin is urbanized such that the percentage of urbanized areas to habitable areas in the basin is more than approximately 50%.
 - The river is expected to be affected by a backwater effect from a river connected downstream, or to have limitation of water drainage to a river connected downstream.
 - Both dredging and widening of a river channel are difficult due to geographical or geological conditions, precious natural environment, or preservation of scenic sites, or water drainage can be difficult due to tidal effects.

This revision makes it easier to designate a SUR and a SURB for all rivers, not just limited to urban rivers. Note that while the term specified urban river is still used in the act after the amendment, the schemes of the act are available once a river satisfies the above conditions and is designated as a SUR, regardless of whether it is strictly an urban river or not.

Establishment of basin flood control councils and plans

Stakeholders such as the government, prefectures, and municipalities join a council for each basin to discuss measures such as rainwater storage–infiltration and land use regulation, and incorporate its results in a Basin Flood Control Plan. The council system was newly established and the items that should be included in the plan were expanded by the amendment of the act.

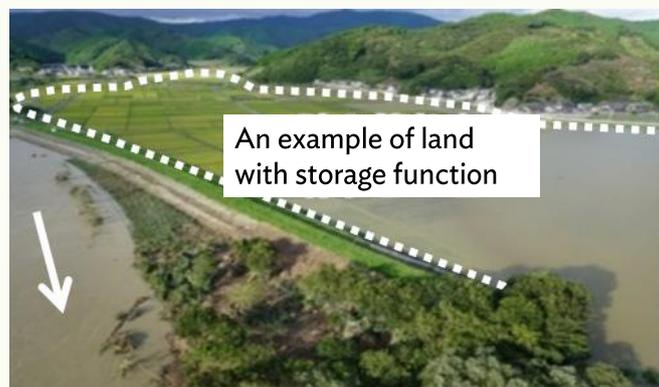
Certification system of rainwater storage–infiltration facilities

To strengthen flood mitigation countermeasures in a basin, a certification system is established for private sector development of rainwater storage–infiltration facilities. Certification is given by prefectural governors or mayors of designated cities (a “designated city” is defined as a city having greater authority than other municipalities, stipulated by Paragraph 1 of Article 252-19 of the Local Autonomy Act) after approving a Rainwater Storage–Infiltration Facilities Development Plan made by those who develop and manage the facility. Subsidies from the government and special tax systems for property tax and urban planning tax are available to promote the development of such facilities in a basin.

Storage function preservation area

A storage function preservation area (SFPA) is established, which is an area having the function of temporarily retaining inundated water and/or rainwater and has been preserved from the past such as farmland or a paddy field. The area has a utility of mitigating inundation outside the area as well as decreasing water levels downstream. An SFPA can be designated within a SURB by prefectural governors or mayors of designated cities after getting approval of owners of the area to be designated. The designation of an SFPA should be in accordance with the overall policy of the corresponding Basin Flood Control Plan.

Figure 8.5: Image of a Storage Function Preservation Area



Source: MLIT (2023).

Several restrictions are imposed on an SFPA to secure its storage function. Actions that can be thought to prevent the function of an SFPA to temporarily retain water flow from rivers and/or rainwater should be notified to prefectural governors or mayors of designated cities at least 30 days in advance of the action. The examples of target actions are a mound and setting a fence or a wall. Prefectural governors or mayors of designated cities can provide advice based on the notification from landowners if necessary. There are some exceptions for which notification in advance is not required, such as actions to manage the SFPA, actions urgently needed in case of disasters, and temporary use of the SFPA such as building of provisional structures.

The concept of an SFPA is similar to a retarding basin, which is constructed for the purpose of flood control by corresponding river administrators. Differences between them are summarized in Table 8.1. Compared to retarding basins, SFPAs are not designated as river areas, and land acquisition by river administrators is not necessary for SFPA designation. Therefore, land-use regulations in an SFPA are more lax than retarding basins, minimizing restrictions on private rights on top of spontaneous cooperation of landowners.

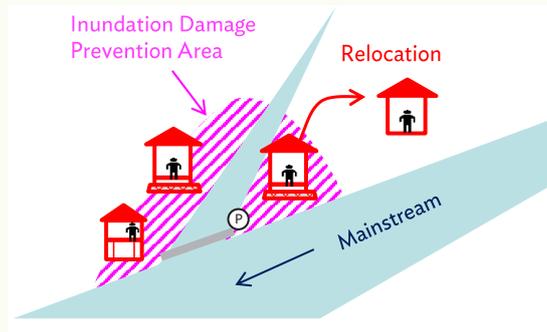
Table 8.1: Comparison Between Retarding Basin and Storage Function Preservation Area

	Retarding Basin		Storage Function Preservation Area
	Land Acquisition	Easement	
Corresponding Act	River Act	River Act	Specified Urban River Inundation Countermeasures Act
Purpose	Flood control	Flood control	Mitigation of inundation damage
Target area	River side	River side	Specified urban river basin
Designator	River administrator	River administrator	Prefectural governor, mayor of designated cities
Landowner	River administrator	Landlord	Landlord
Administrator	River administrator	River administrator	Landlord
Land regulation (in case of mound)	Permission of exclusive use Permission for mound	Permission for mound	Notification to a designator in advance for mound

Source: Author.

Inundation damage prevention area

An inundation damage prevention area (IDPA) is established, which is an area with high risk of frequent flooding even after taking flood control and mitigation measures so that land development and building construction should be regulated in advance. An IDPA can be designated within a SURB by prefectural governors. The designation of an IDPA should be in accordance with the overall policy of the corresponding Basin Flood Control Plan.

Figure 8.6: Image of an Inundation Damage Prevention Area

Source: MLIT (2023).

Several restrictions are imposed on an IDPA to secure the safety of those living there. For land development and building construction, permission given by prefectural governors or mayors of designated cities is required in advance for building facilities for those with special consideration in evacuation, such as the disabled, the elderly and infants, and houses. Permission is given for land development when the developed area is shown to be resilient to flooding by some protection measures such as revetment and lawn for protection from erosion, and for building construction when the following conditions are satisfied:

- All habitable rooms, defined as a bedroom, a living room, and a dining room, should have their floors higher than “standard water level”, which is defined as an expected water level when the target flood in the SUR occurs.
- The building should be robust enough to resist against the target flood.

There are some national subsidies that can be applied in an IDPA. For example, it is added to the target areas of the Special Financial Support for Promoting Group Relocation for Disaster Mitigation (the revision was included in the amendment of the acts mentioned in Section 8.2.2), where about 94% of the cost regarding relocation and development of houses is covered by the national government. Furthermore, the cost of elevating houses and buildings in the area is also covered by the government (23%–80%). Through these schemes and relevant financial support, it is expected to promote urban development that is resilient to flood disasters.

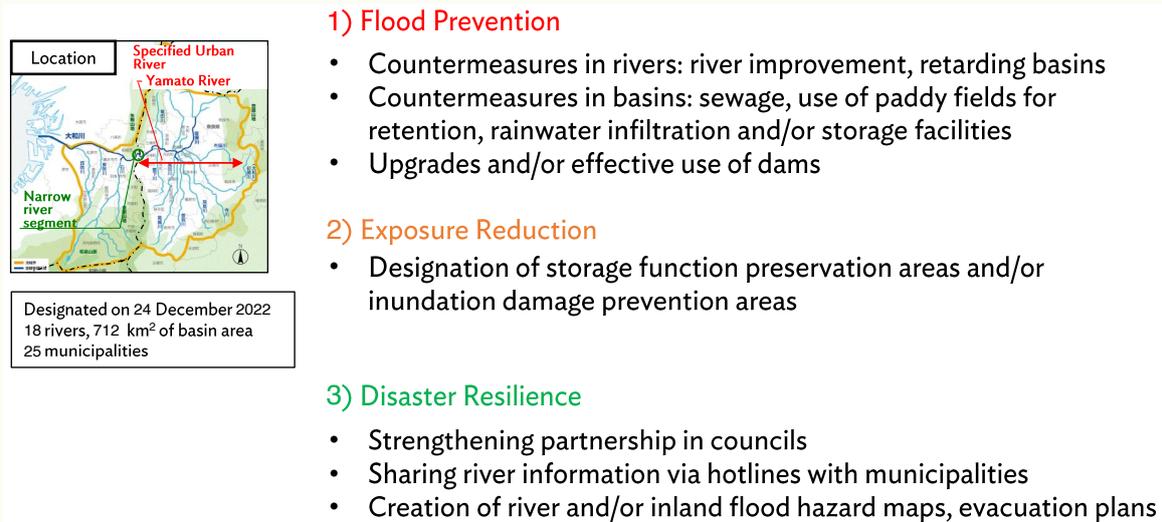
8.3 Results: Example of the Concept Implementation

This section briefly illustrates an example of the implementation of the River Basin Disaster Resilience and Sustainability by All concept. Yamato River, which is designated as a SUR and whose basin is designated as a SURB is illustrated.

The upstream river channels of Yamato River, a Class-A River flowing from Nara Prefecture to Osaka Prefecture, are designated as SURs (designated rivers are located in Nara Prefecture), with a SURB of 712 square kilometers. The region suffers from flooding because of its topographic characteristics: having a narrow river segment running between mountains, making it difficult for flooded water to be drained and resulting in inundation in the upstream basin.

River improvement and construction of retarding basins are underway, but it is remarkable that rainwater storage-infiltration facilities are planned to be developed by various stakeholders including the private sector, with explicit target volumes within 5 years stipulated in the Yamato River Basin Flood Control Plan. Both SFPAs and IDPAs are now considered to be designated in the basin.

Figure 8.7: Flood Countermeasures Taken in Yamato River Basin



Source: MLIT (2021b).

8.4 Discussion: Investigation into the Origin of Sociocultural Wisdom

In this section, the two newly introduced schemes in the Specified Urban River Inundation Countermeasures Act are analyzed in terms of their conceptual basis from a sociocultural point of view.

8.4.1 Open Levee: Indigenous River Engineering Method for Flood Mitigation

As explained above, an SFPA is an area that can retain flooded water and rainwater, mainly intended for farmland and paddy fields to be designated. Some forms of farmland or paddy fields are relatively resilient to flood inundation, such as cultivation of wet rice, which is a dominant type of rice in Japan. One typical example of co-existence of rice cultivation and flood management is an open levee (*Kasumitei* in Japanese), an indigenous river engineering method developed in Japan (Teramura and Shimatani 2021). An example of an open levee is illustrated in Figure 8.8. Water can be retained when a flood occurs through discontinuous parts of a levee. The flooded areas can be used as farmland or paddy fields, because one purpose of open levee construction is to accumulate organic matter during floods (Teramura and Shimatani 2021), and it is also found that open levees can play a role in flood mitigation (Ohtsuki, Itsukushima, and Sato 2022). The introduction of an SFPA has potential to promote flood mitigation strategies utilizing open levees. In fact, before the introduction of modern technology of

Western countries, flooded water in rural areas was not constrained within a river bank but freely inundated, which was the standard approach to mitigate flood damage (Takahasi 2012).

Figure 8.8: Example of an Open Levee and a Paddy Field



Source: Original photo taken by MLIT.

8.4.2 Importance of Geographical and Societal Characteristics in Land Use Regulation

As explained above, an IDPA is an area that is susceptible to flood risk even after flood control and mitigation measures are taken. As a geographical background, Japan is highly mountainous (approximately 70% of the total area) so habitable areas are limited. Due to convenience, the relatively flat areas such as deltas are often densely inhabited. On the other hand, there are people that find it difficult to evacuate, such as the elderly, the disabled, and infants. Establishing evacuation planning is important, but it is sometimes not enough because some people cannot easily evacuate. Therefore, the scheme of an IDPA was introduced by regulating land development and building construction in advance so that minimum measures such as habitable rooms higher than expected water levels are taken to secure the lives of people in case of flooding. This apparently new scheme is nothing but an outcome of the process of taking geographical and societal characteristics of the country into account. Note that the implementation of land use regulations should be based on social agreement and acceptance, otherwise it could lead to violation of human rights, because where to live is one principle of human rights.

8.5 Conclusion

This chapter discussed the new flood management policy of Japan: River Basin Disaster Resilience and Sustainability by All. This concept was formulated after the country consecutively encountered severe flood disasters particularly within 5 years and the need for basin-wide flood countermeasures on top

of improvement of river infrastructure was urgent. Nine related acts were amended integrally to assure their validity, and the amendment regarding Specified Urban River Inundation Countermeasures Act, the core act among the amendments, was explained in detail. Followed by an illustration of the concept application, the newly introduced schemes were analyzed in terms of their background in association with sociocultural characteristics of the country.

One essential factor that can be applied to other countries is that to take societal and cultural aspects into account can be beneficial in making flood management policies. The most fundamental countermeasures against flooding are structure-based such as continuous levees and dams, which have been the mainstream of modern river engineering, but under the changing climate, the traditional idea of acceptance of inundation can also be implemented by combining structural and nonstructural measures to enhance the resilience of society (Ishiwatari 2021).

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Management of Water-Related Disasters by Local Communities in the Central Area of Viet Nam

Le Minh Nhat, Nguyen Van Hoang, and Nguyen Thanh Van

9.1 Introduction

Viet Nam is located in an area highly affected by natural disasters, and was ranked 91st out of 108 by the 2019 INFORM Risk Index (Inter-Agency Standing Committee Reference Group on Risk, Early Warning and Preparedness and the European Commission 2023). The diversity of types of natural disasters, and more than 22 types of disasters are recorded in the Law on Natural Disaster Prevention and Control (2013). The people of Viet Nam have experienced major natural disasters throughout their history, and experience from cultural history has shown that the low cost but highly effective nonstructural investment solution is the community's awareness raising and being equipped with disaster prevention, avoidance, and mitigation skills. The motto is that people protect themselves and their family members and the surrounding community before receiving outside support. Community-based disaster risk management (CBDRM) is a component of the Natural Disaster Risk Management Project to enhance the capacity on disaster risk reduction (DRR) of villages and communes (Nguyen et al. 2011). CBDRM with integrated community awareness raising is a process in which people in a community actively participate in the identification and analysis of disaster risks, planning, implementing plans, monitoring and evaluating activities to reduce vulnerability, and enhancing the community's ability to respond and adapt to the impacts of natural disasters, especially in the context of climate change. The purpose of CBDRM is to create a positive transition from a vulnerable community to one that is capable, proactively working together to prevent, respond, and recover by making the most of available resources in the community and outside support when it is beyond capacity.

Disaster management models with CBRDM applications have been developed by countries around the world, consistent with the characteristics and capacity of each locality and country. For example, Japan, a country in Asia, has been affected by many types of natural disasters. The CBDRM model has been implemented according to a bottom-up approach, harmonizing and integrating with opposing methods such as construction solutions for natural disaster prevention. Effective implementation of CBDRM requires the cooperation of people, local and central governments, and organizations. The innovative CBDRM approach from Japan is an important lesson for other countries when building CBDRM programs.

Another example is the Philippines, a country located on the Pacific volcanic belt, suffering many earthquakes and storms every year. The Philippine government has implemented a community-centered approach to disaster management since 2002 based on the Disaster Risk Management and Reduction Act. The communities implement onsite response strategies, before receiving support from outside forces. They are concerned with protecting themselves and their property through CBDRM strategies.

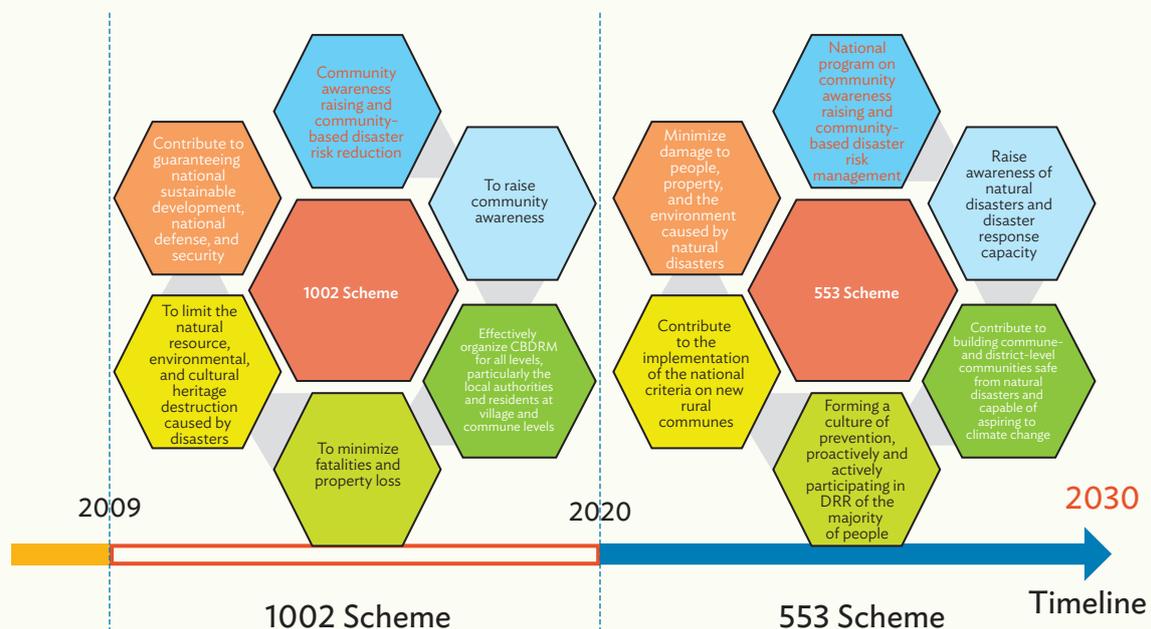
Viet Nam's National Program on CBDRM Scheme 1002 (Scheme 1002) has been implemented for a period of 12 years from 2009 to 2020. The activities of Scheme 1002 have been implemented synchronously at all levels from the central to local levels, socio-political organizations, nongovernment organizations, mobilizing resources from businesses that have actively and proactively implemented the project's activities, contributing to raising awareness and capacity of officials in charge of disaster

prevention. However, in the implementation process, there are still many shortcomings and difficulties in the implementation mechanism, tasks, information sharing, monitoring and evaluation, funding sources, and human resources to implement Scheme 1002. The program was reviewed and the next phase is being implemented with goals set in accordance with the updated situation covering 2021 to 2030 under Decision No. 553/QĐ-TTg approving the project “Strengthening public awareness and CBDRM, up to 2030” (Scheme 553). Figure 9.1 shows the timeline and main goals of the two national programs on CBDRM that had been implemented in Viet Nam.

Some key features of CBDRM in Viet Nam are:

- (i) the community plays a central and proactive role in CBDRM implementation;
- (ii) encouraging and mobilizing the active and proactive participation of all populations in the community in disaster risk management, creating equal opportunities for men, women and vulnerable groups to participate. and benefit from disaster risk management activities;
- (iii) improving community capacity, reduce vulnerability;
- (iv) is a process of continuous development, updated, adjusted and built on the lessons learned from the community’s practical experience combined with scientific and technical progress;
- (v) the direction of local authorities, especially at the commune level, plays an important role in CBDRM with the support of superior agencies and social organizations, and
- (vi) applying the four-place motto to CBDRM implementation.

Figure 9.1: Timeline and Main Goals of the Two National Programs on CBDRM



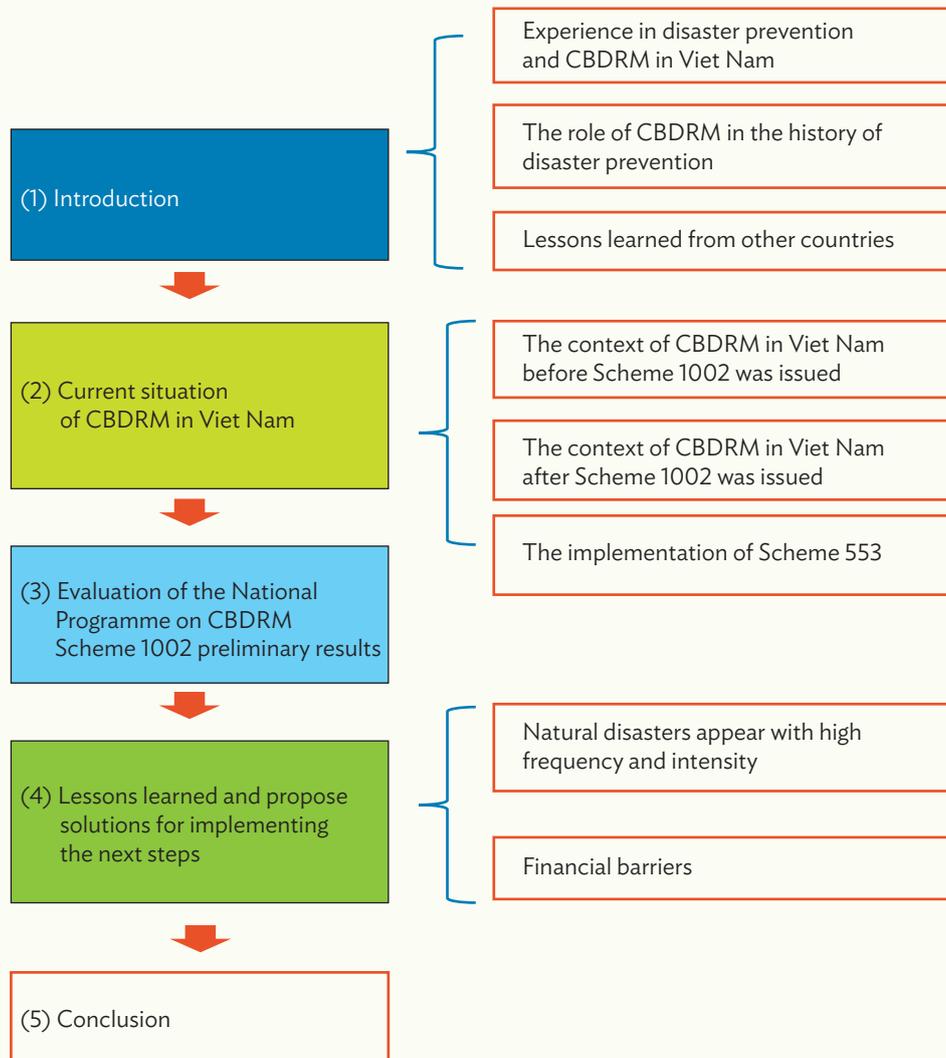
CBDRM = community-based disaster risk management, DRR = disaster risk reduction.

Sources: Government of Socialist Republic of Viet Nam, Decision No. 1002/QĐ-TTg (2009b) and Decision No. 553/QĐ-TTg (2021).

This chapter assesses the overall effectiveness of CBDRM in Viet Nam, including analyzing the achievements, lessons learned, difficulties and challenges when implementing the program, as well as recommendations for the next implementation steps.

9.2 Methodology

Figure 9.2: Flow Chart of Overall Methodology



CBDRM = community-based disaster risk management.

Sources: Government of Socialist Republic of Viet Nam, Decision No. 1002/QD-TTg (2009b) and Decision No. 553/QD-TTg (2021).

This study aims to evaluate the effectiveness of CBDRM in Viet Nam. Figure 9.2 illustrates the schematic workflow of this study.

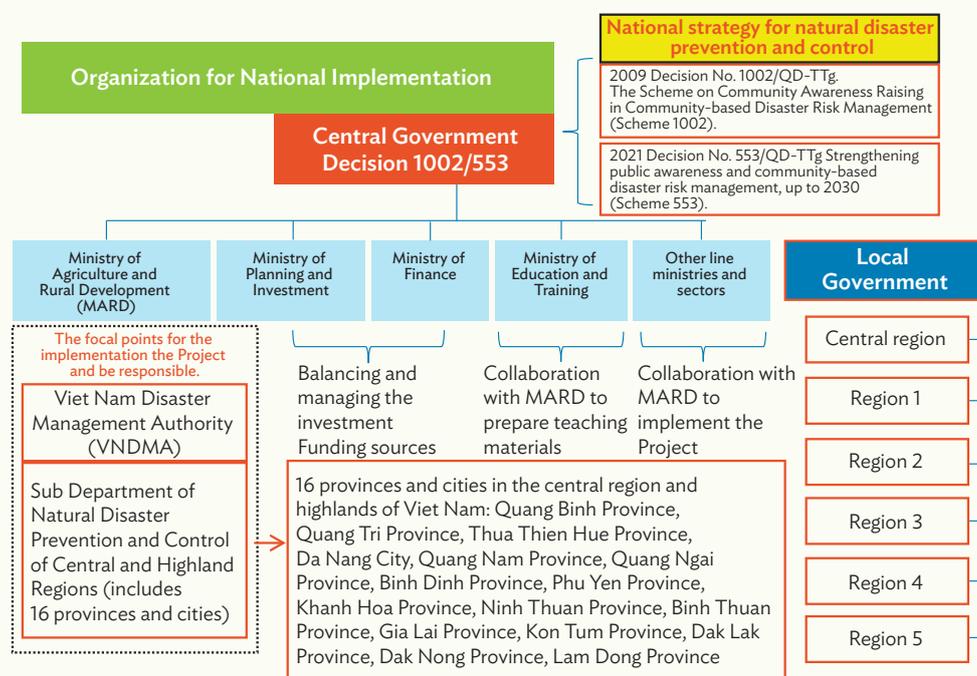
9.3 Current Situation of CBDRM in Viet Nam

9.3.1 Context before and after Scheme 1002

Before Scheme 1002, the work of natural disaster prevention, control, and mitigation was passive, mainly focusing on dealing with natural disaster situations. In natural disaster situations, people’s capacity to disaster response was slow. In disaster response, local communities were lacking experience and knowledge in disaster prevention, control, and mitigation. In addition, the response in the community has not effectively mobilized local human resources. Marketing and education programs to raise public awareness about natural disaster prevention, control, and mitigation were not regular or systematic, were mainly propagated through the mass media, and were not uniformly communicated to the public.

After Scheme 1002 was issued, it focused on guiding principles, specific goals, tasks and implementation solutions, especially a clear action plan, activities, in which the community is the center in disaster mitigation activities, through the implementation of a number of activities and programs such as (i) bringing knowledge about natural disasters into the curricula for high school students, (ii) training and disseminating knowledge and experience on natural disaster prevention and control (NDPC) for communities in areas frequently affected by natural disasters, and (iii) organizing information and propaganda on types of natural disasters and measures for prevention and control on mass media systems. Figure 9.3 shows the organization for project implementation.

Figure 9.3: Organization for Scheme 1002 Implementation

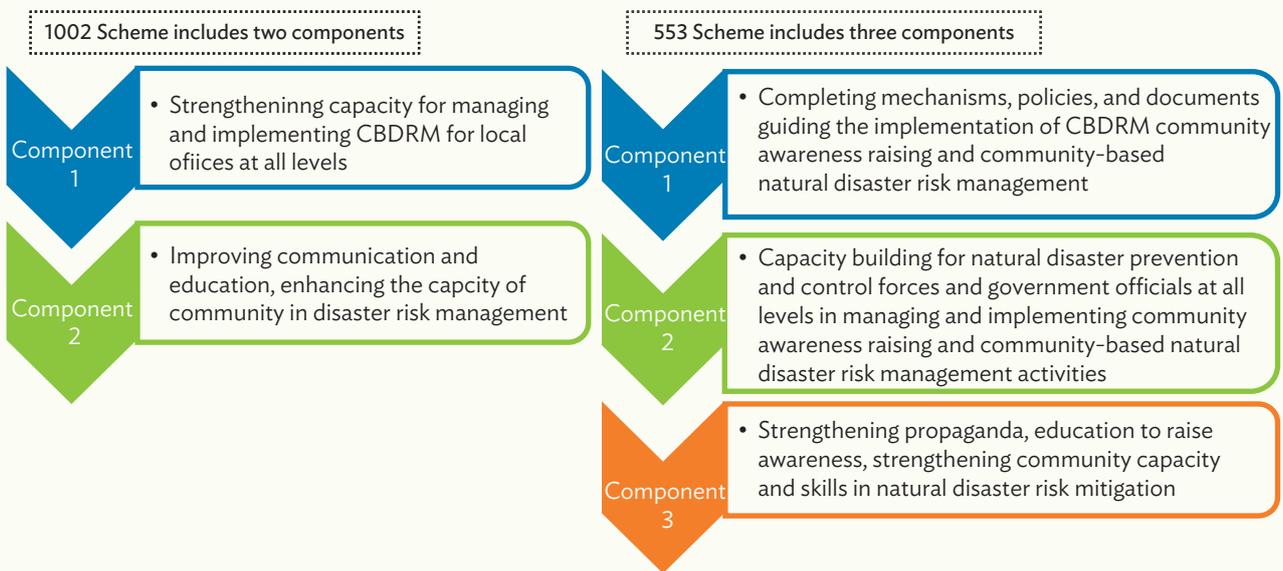


The Ministry of Agriculture and Rural Development has developed an implementation plan and assigns specific tasks to the VNDMA (the former DMC Center and the current Department of Community-based Disaster Risk Reduction) as the focal point for development; build local implementation guidelines;

CBDRM = community-based disaster risk management, MARD = Ministry of Agriculture and Rural Development.

Sources: Government of Socialist Republic of Viet Nam, Decision No. 1002/QĐ-TTg (2009b) and Decision No. 553 /QĐ-TTg (2021).

Figure 9.4: Comparing the Components of Scheme 1002 and Scheme 553



CBDRM = community-based disaster risk management.

Sources: Government of Socialist Republic of Viet Nam, Decision No. 1002/QĐ-TTg (2009b) and Decision No. 553/QĐ-TTg (2021).

9.3.2 Implementation Scheme 553

After 10 years of project implementation, the results of Scheme 1002 (2009–2020) was summarized, and the objectives and lessons learned were reviewed. Scheme 533 implements the next phase with the CBDRM goals set in accordance with the updated situation, covering 2021–2030. Figure 9.4 compares the components of Scheme 1002 and Scheme 553.

9.4 Results and Discussion

9.4.1 Evaluation of Scheme 1002—Preliminary Results

After Scheme 1002 was implemented, the roles and responsibilities of all levels of government, especially at the commune level, the capacity of officials in charge of disaster prevention and control in the implementation localities gradually improved. Figure 9.5 shows the group activities of Scheme 1002. There are positive changes in community awareness, supplemented with knowledge and skills on disaster prevention, response and mitigation, grasped trends and challenges of various types of natural disasters, then applied applicable to specific local conditions. The results showed that the activities were effective when the authorities and people participated and gave positive feedback on the activities. People proactively take preventive measures when receiving a warning; and ready to move to a safe place according to the orders of the authorities when a disaster occurs.

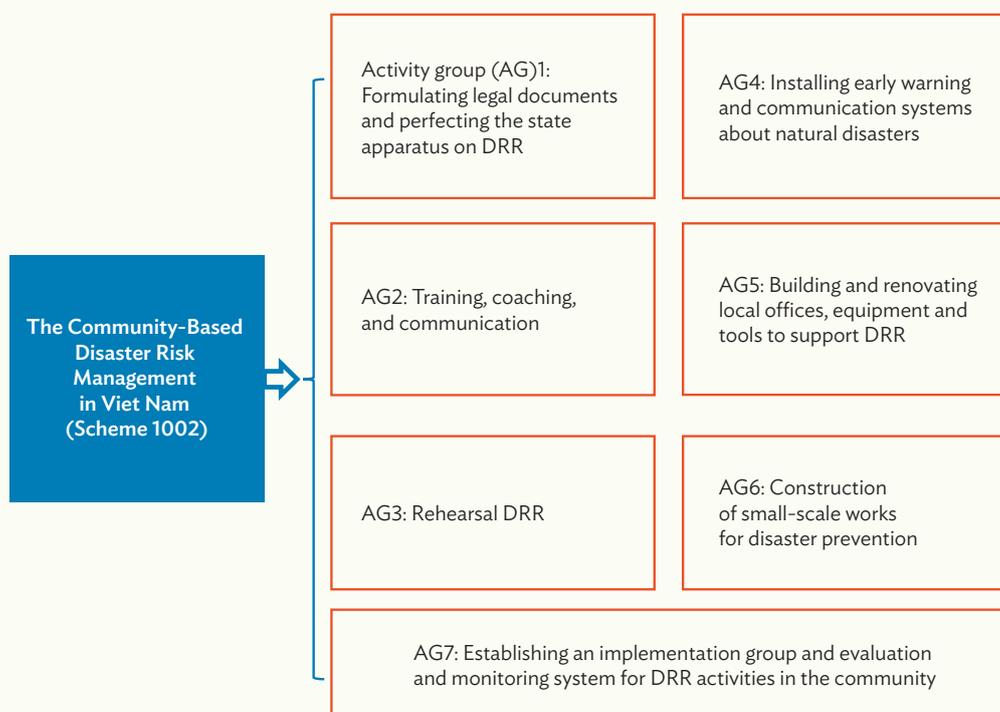
Scheme 1002 made an important contribution to the implementation of the Strategy for NDPC up to 2020 with the Climate Change Response Program and two national target programs (new rural program and sustainable poverty reduction). Table 9.1 shows the assessment areas to be evaluated according to the activities of the Scheme 1002. Some results obtained were:

- (i) Social stability, production development in localities that do well in community-based disaster management, people's living environment is safer, their production activities are protected, businesses are protected. Industry is also assured of investment and production.
- (ii) Regarding social progress, community members discussed developing a disaster prevention plan that would help open social relations, local leaders have closer contact with people and opinions of the people are heard more by the leaders.
- (iii) Through training, people's awareness of environmental protection has significantly improved. NDPC activities in the community need to be associated with environmental protection.
- (iv) The project's activities often organize the integration of disaster prevention with climate change, which has helped the community to adapt to climate change.
- (v) On the issue of equality, the vulnerable have been trained and communicated. In communication activities, the proportion of women participating usually accounts for 50%, showing the initiative and interest of women in protecting themselves and their families.

Table 9.1: Division of Areas to be Evaluated According to Project Activities

Category	Areas
Central region	In the cities directly under the Central Government
Region I	Northern midland and mountainous provinces
Region II	Red River Delta and Thai Binh River Provinces
Region III	Central provinces
Region IV	Central highlands and southeast provinces
Region V	Mekong Delta provinces

Figure 9.5: Group Activities of Scheme 1002

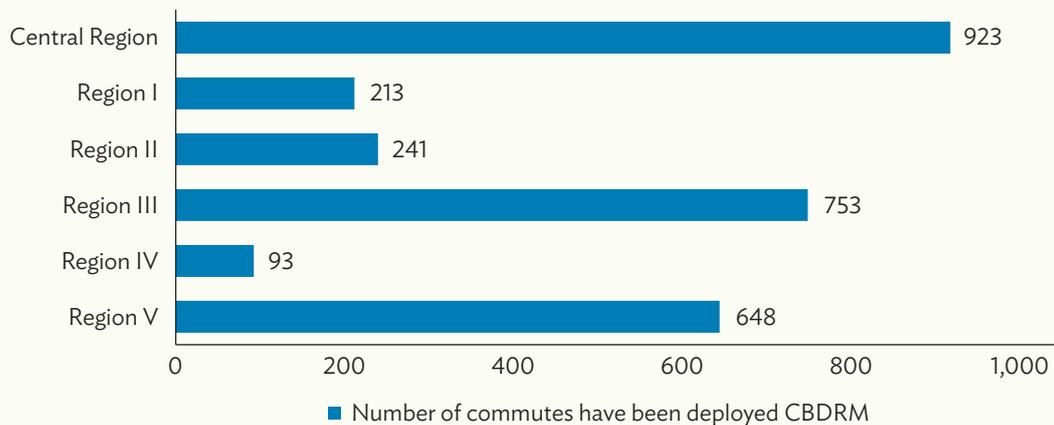


DRR = disaster risk reduction.

Sources: Government of Socialist Republic of Viet Nam, Decision No. 1002/QD-TTg (2009b) and Decision No. 553/QD-TTg (2021).

Evaluation of the project’s specific objectives implemented in the past shows that CBDRM activities have only been implemented in about 3,123 communes (compared to the plan of 6,000 communes, accounting for 52.1% of the scheme’s target). Figure 9.6 illustrates the number of communes that have deployed CBDRM. In total, 3,387 training classes have been organized for more than 114,648 officials working in anti-corruption work and teachers at educational institutions, and 244,613 students. In total, more than 7,924 training and communication classes have been organized in the community, 930 plays and competitions, and 1,619,374 other communication activities (including the broadcast of a program to improve disaster prevention knowledge) attracting about 3,725,629 trained people. At the same time, 108,874 handbooks with content on the NDPC were released during training and propaganda sessions. Evaluation of the group working on developing legal documents and perfecting the government apparatus in disaster prevention. Figures 9.7–9.12 and Table 9.2 illustrate the results achieved during the 10 years of project implementation.

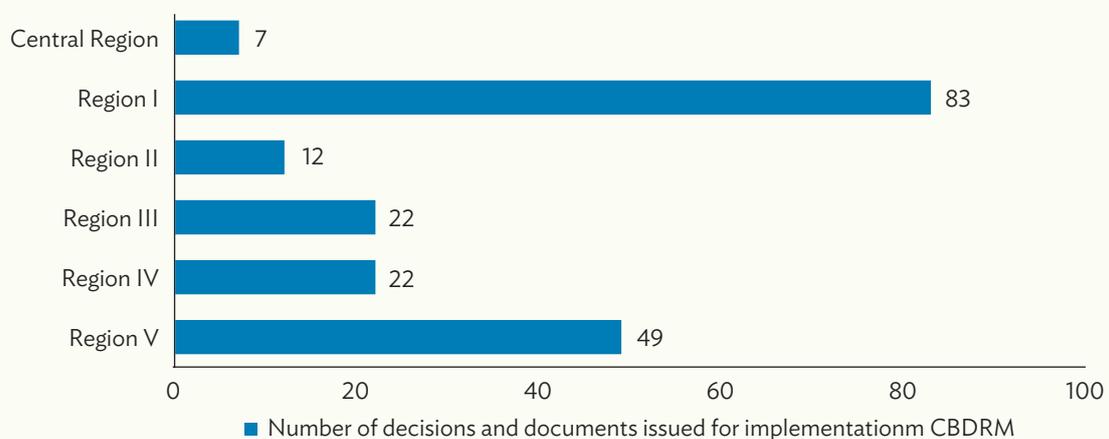
Figure 9.6: Number of Communes that have Deployed CBDRM



CBDRM = community-based disaster risk management.

Source: Vietnam Disaster and Dyke Management Authority (2020).

Figure 9.7: Number of Decisions and Documents Issued for CBDRM Implementation

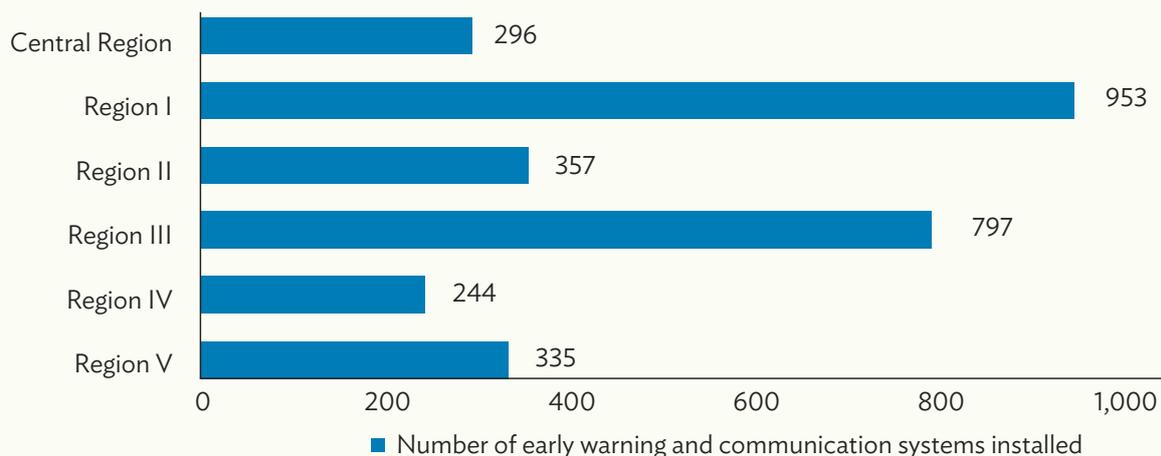


CBDRM = community-based disaster risk management.

Source: Vietnam Disaster and Dyke Management Authority (2020).

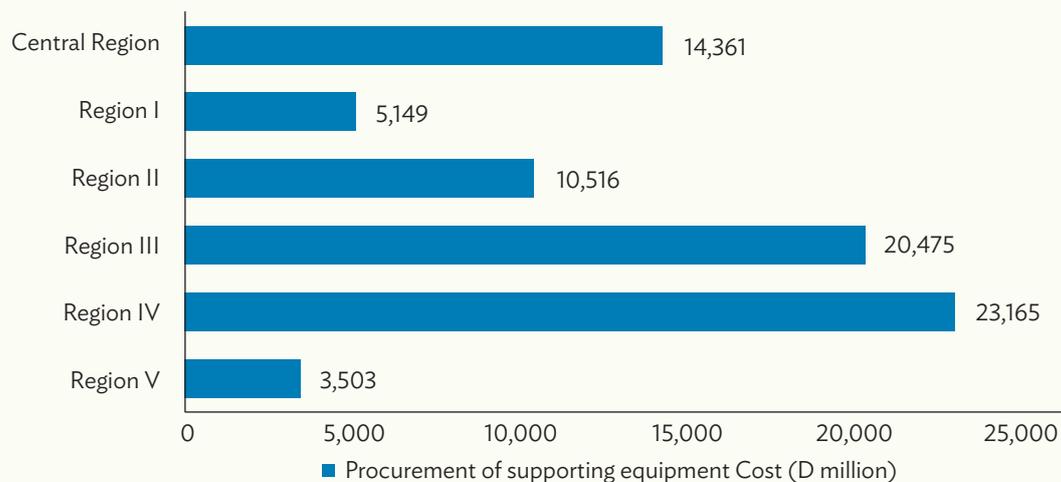
The number of decisions and documents approved from 2009 to the end of 2020 related to the scheme’s operation is 199 (Figure 9.7). All provinces and cities have decisions approving the scheme’s implementation plans consolidating NDPC apparatus from central to local levels. All provinces and cities have issued decisions approving the list of trainers at the provincial level, who are officers working in the field of NDPC of agencies and organizations in the locality.

Figure 9.8: Number of Early Warning and Communication Systems Installed



Source: Vietnam Disaster and Dyke Management Authority (2020).

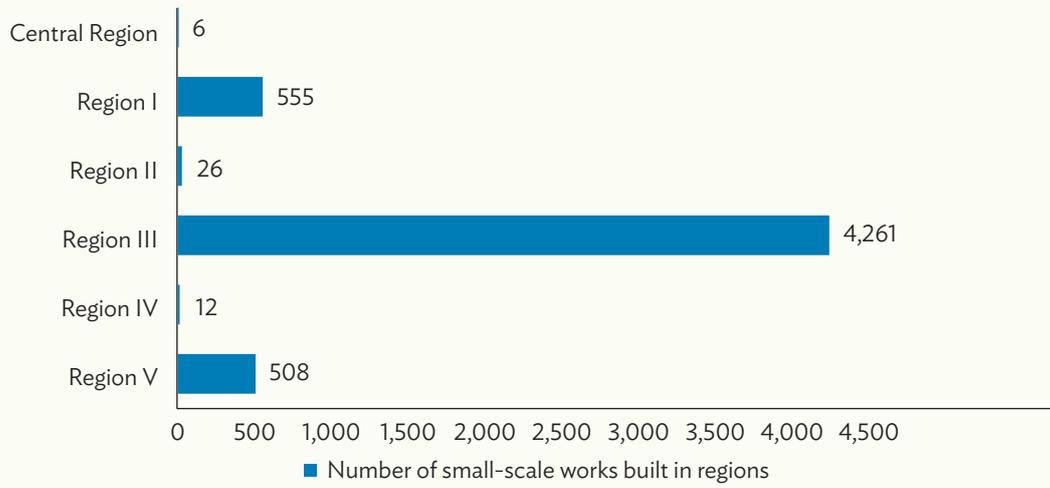
Figure 9.9: Procurement of Supporting Equipment Cost (D million)



CBDRM = community-based disaster risk management.

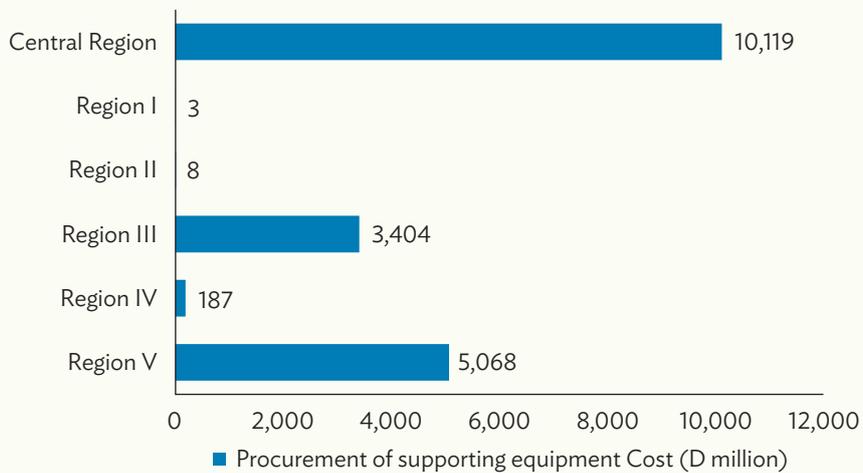
Source: Vietnam Disaster and Dyke Management Authority (2020).

Figure 9.10: Number of Small-scale Works Built in Regions



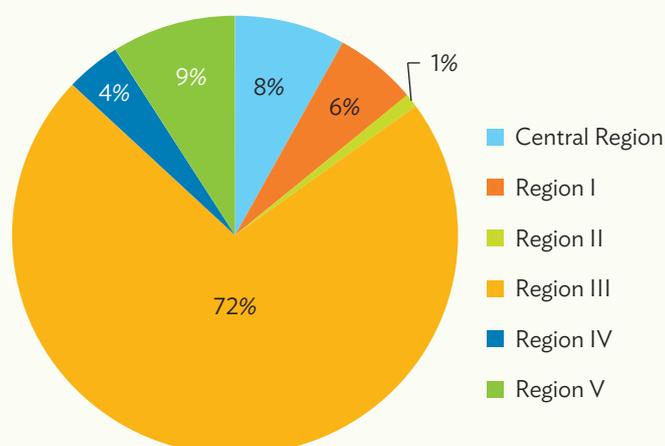
Source: Vietnam Disaster and Dyke Management Authority (2020).

Figure 9.11: Procurement of Supporting Equipment Cost (D million)



CBDRM = community-based disaster risk management.

Source: Vietnam Disaster and Dyke Management Authority (2020).

Figure 9.12: Capital Allocation for Project Implementation by Regions


Source: Vietnam Disaster and Dyke Management Authority (2020).

Table 9.2: Results of Training and Communication Activities
 (number of people)

Category	Central Region	Region I	Region II	Region III	Region IV	Region V	Total
Number of teachers, training of trainers	83	340	165	369	180	348	1,485
Number of trained staff and teachers	14,613	28,730	6,807	29,058	14,800	20,640	114,648
Number of training classes	207	432	255	1,788	189	516	3,387
Number of students being propagated	69,000	910	4,996	54,658	300	114,749	244,613
Number of maps were created	180	35	2	759	296	12	1,284
Number of guide books	99,000	1,500	349	2,143	5,880	2	108,874
Number of approved disaster prevention plans at commune level	4	12	0	290	5	33	344
Number of propaganda activities	768,527	88,874	30,175	180,696	327,984	223,118	1,619,374
Number of trainings in the community	823	568	201	1,959	735	3,638	7,924
Number of people participating	76,250	1,950,711	3,609	117,261	7,415	1,570,383	3,725,629
Number of performances	223	13	185	454	13	42	930
Cost (D million)	39,044	29,803	3,725	342,750	19,497	39,479	474,299

Source: Vietnam Disaster and Dyke Management Authority (2020).

9.4.2 Advantages and Disadvantages and Solutions for Implementing the Next Steps

The advantages

The project's activities were implemented from central to local levels, resulting in increased awareness and capacity of disaster prevention. Relevant programs, projects, schemes, and plans in the locality all integrate CBDRM activities. Socio-political organizations, social organizations, and nongovernment organizations have actively coordinated to implement the project's activities. Some organizations have signed a memorandum of understanding with the agency in charge of implementing the project. The provincial Red Cross has also signed a memorandum of cooperation with the provincial Standing Office of Disaster Prevention and Control after the memorandum of understanding was signed at the central level. Many localities have actively promoted raising community awareness and community management in many different ethnic languages, increasing the use of social networks in exploiting, updating, and sharing information, and coordinating in the implementation of the scheme. Many organizations have provided financial support to implement CBDRM projects on the basis of the operational contents of the scheme. Appendix A9.1 lists some typical models of implementing CBDRM that were carried out from 2009 to 2020 in Viet Nam. The establishment of the Disaster Prevention Fund and Decree 83/2019/ND-CP amending Decree 94/2014/ND-CP have contributed to speeding up the implementation of the scheme, being proactive in allocating resources annual implementation capital and 5-year plans at all levels.

Difficulties encountered in implementing Scheme 1002

After 10 years of project implementation, lessons learned and difficulties encountered in include:

- (i) The implementing organization has not yet specified tasks for ministries, branches, and localities in presiding over and coordinating in developing the guidelines on the regimes, policies, and implementation mechanisms. Specifically, there is a lack of financial support or staff to implement, monitor, and evaluate the implementation of the scheme, and for residents to participate in the scheme's activities.
- (ii) Funds from residents' contributions (5% in 2009–2020) are not included in the scheme in the coming period due to the difficulty in making statistics and assessments. In fact, a part is already included in resources, such as the fund for the NDPC at all levels and resources from political, social organizations, businesses, and individuals (Figure 9.13).
- (iii) Regarding the financial mechanism, the responsibilities of provinces and cities are not clearly defined to implement the scheme.
- (iv) The new scheme stipulates that the implementing agencies are the MARD and the Central Save the Children for the NDPC, the coordination of relevant ministries, sectors, and localities. The focal and advisory agency at the central and local levels has not been determined.
- (v) There is no clear regulation on coordination with agencies leading the implementation of the scheme (self-formation of a central working group with a few activities organized). This leads to a lack of information, sometimes overlapping in local implementation as well as contents of the scheme.
- (vi) A set of indicators for monitoring and evaluating the results of the scheme's implementation has been issued. However, all levels, sectors, and organizations have not seriously implemented it, so it is difficult to assess the objectives of the scheme.
- (vii) Some activities in the scheme such as small-scale works for the NDPC in the community, the assessment and monitoring system for the NDPC and mitigation activities in the community need to be directed and clarified.

Appendix A9.2 shows some activities of implementing CBDRM that were carried out from 2009 to 2020.

The incomplete targets of Scheme 1002

Some targets have not been completed according to the proposed project objectives, including:

- (i) Target “to ensure that by 2020, 100% of NDPC staff will be trained, have their capacity and qualifications enhanced in NDPC and reduction” is difficult to achieve due to the regular fluctuation on the number of staff in localities.
- (ii) Target of 70% of the population of communes in areas frequently prone to natural disasters to be provided with knowledge about disaster mitigation is difficult to evaluate because very few (about 4 million) have been taught through the training courses and other methods, as well as from distributed leaflets, communication media, radio, television, etc. (nearly 1.5 million communication activities, distributing more than 100,000 notebooks).
- (iii) The scheme is “expected to be implemented in about 6,000 hamlets and communes that are often prone to by natural disasters nationwide”, but the relevant agencies have not yet made the statistics and assessments to determine the data in the locality.

Lessons learned and solution proposals

Through the analysis of the project implementation (Scheme 1002), some recommendations for the next phase are:

- (i) The 2009–2020 period is long enough to effectively implement activities, which has been proven through the results of the above analysis and evaluation in localities, agencies, and organizations in charge of implementation and participation of residents at all levels. Propose the next implementation phase of the scheme in 10 years starting from January 2021 and ending in December 2030 (553 Scheme).
- (ii) Specify funding sources: State budget (including capital borrowing from international and national organizations); local budget (including capital borrowed by the province from international and national organizations); funding for NDPC at all levels; resources from political, social organizations, businesses, individuals, NGOs, and nonrefundable grants from international and national organizations (Figure 9.13).

Figure 9.13: Comparison of Funding Source between Scheme 1002 (2009–2020) and Scheme 553 (2021–2030)



NDPC = natural disaster prevention and control.

Source: Vietnam Disaster and Dyke Management Authority (2020).

9.5 Conclusions

In the context of climate change, natural disasters are becoming more extreme and unconventional, and cause serious damage to people and properties. In this regard, awareness raising and community participation are important. The activities have been regulated by the Viet Nam Law on Natural Disaster Prevention and Control and are the priority content of the Sendai Framework.¹ Research and practical experience have agreed that community awareness raising is a form of nonstructural investment with low cost but high efficiency in disaster prevention and control. Therefore, this work should be carried out regularly and throughout the process of preventing, responding to, and overcoming the consequences of natural disasters.

Every year, in order to minimize damage caused by natural disasters, the CBDRM program needs to be done regularly, continuously, systematically, and creatively, and the lessons learned need to be shared widely. Viet Nam's National Program on CBDRM Scheme 1002 has been issued in the international context of having to re-recognize the construction solutions that have not yet brought high efficiency. Viet Nam's disaster management is oriented to change from passive response to proactive prevention, toward proactive management of disaster risks and prioritizing solutions for disaster prevention and

¹ The Sendai Framework is an international document adopted by United Nations (UN) member states at the World Conference on Disaster Risk Reduction held in Sendai, Japan in March 2015. This document is considered the most comprehensive international agreement on disaster risk reduction.

management based on the community. After Scheme 1002 (from 2009 to 2020) achieved results, Scheme 533 is continuing to implement results, covering 2021 to 2030.

Awareness raising is not only for the general population but also for disaster prevention officers and other community groups in society. In addition, lessons learned as well as typical models on community awareness raising, CBDRM has been drawn up during the implementation of the scheme. This needs to continue to be promoted and adjusted in accordance with the actual requirements and the current natural disaster situation so that public awareness raising activities are more widely deployed, effectively and sustainably.

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Appendix A9.1: Some Typical Models of Implementing CBDRM in Viet Nam, 2009 to 2020

Project “Institutional capacity enhancement on disaster risk management, especially disasters related to climate change” (SCDM 1) funded by UNDP in 51 communes frequently affected by natural disasters of 20 provinces, with the participation of the Central Red Cross Society, Women’s Union, and Oxfam.

Project “Capacity Enhancement for Disaster Response in the Central Region of Vietnam “implemented by Japan International Cooperation Agency (JICA) in 18 communes frequently affected by natural disasters in six central provinces.

Implementation of Component 2 on CBDRM under the WB5 project implemented in 100 communes frequently affected by natural disasters in 10 central provinces.

Implementation of Component 3, the project “Improving the resilience of vulnerable coastal communities to climate change related impacts in Viet Nam” is supported with non-returnable grants through the UNDP to seven provinces.

Models implementing CBDRM in some organizations:

- Central Viet Nam Red Cross Society
- World Vision, CRS organizations

Example of implementation CBDRM in Quang Ngai Province. Strengthen the capacity of local authorities to implement the program:

- Local government has the capacity to implement the CBDRM program to develop a Disaster Preparedness Plan.
- Local authorities are strengthened to integrate NDPC and climate change adaptation into their local socio-economic development plans.
- Enhance the community’s resilience to natural disasters by implementing and developing disaster preparedness plans.
- Improve the commune’s early warning system to effectively convey early warning information to local people.
- Improve the ability to strengthen homes for local authorities, builders, and communities.
- Enhance community resilience through implementation of subprojects identified in the disaster preparedness plan.
- Capacity building for teachers, students, and education officials to adopt safe school initiatives.

Appendix A9.2: Some Activities Implementing CBDRM in Viet Nam, 2009 to 2020



Organizing training for commune and ward officials to integrate NDPC and climate change adaptation into local socioeconomic development plans



Organizing training for commune and ward officials to integrate NDPC and climate change adaptation into local socioeconomic development plans



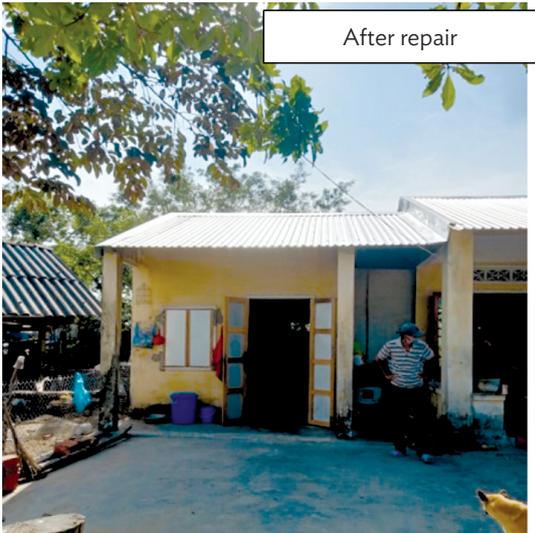
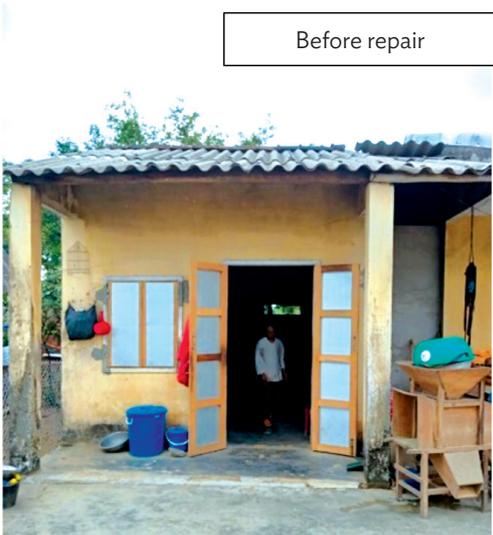
Proposal to develop disaster risk map in Quang Phu Ward



Conducting surveys in communities frequently affected by natural disasters



Upgrading and renovating the water system, Quang Phu 1 Primary School, Quang Phu Ward



Repairs and renovations to strengthen the resilience of homes in areas frequently affected by natural disasters



Support equipment for the response team to prevent natural disasters in communes and wards

PART III

Water and Food

Water Governance in Response to the Impact of Climate Change in Arid and Semi-arid Regions: The Case of Türkiye

Bulent Inanc, Burcu Calli, Mustafa Salih Sarikaya, Lutfi Akca, and Ahmet Mete Saatci

10.1 Introduction

Located in a semi-arid region, Türkiye has made significant progress in sustainable water management practices over the last few decades, to make wise use of its limited water resources. In the face of the pressures and risks that climate change poses to water management, improved water governance has played a significant role for better protection of water resources, improved water services, and enhanced water use efficiency. Good water governance structures have helped to foster more resilient, inclusive, and sustainable water management practices. In this regard, water governance does not only refer to a straight set of rules and mechanisms, but a concept that also dynamically considers country-specific social factors. However, various technical, institutional, and social challenges have also been encountered in practice.

In the last decades, Türkiye has taken important steps at the national level in the management of water resources by making legislative arrangements, improving infrastructure and water use efficiency, preparing action plans, and scaling-up water sanitation and hygiene (WASH) investments in order to ensure everyone has access to safe drinking water and sanitation services. However, emergencies such as the Syrian refugee influx, the novel coronavirus disease (COVID-19) pandemic, and the recent devastating earthquakes in February 2023 have necessitated additional measures and fueled a paradigm shift. These emergencies have underscored the significance of cooperation and coordination across multiple levels to prevent disasters, protect against crises, and prepare for emergencies.

This chapter aims to reflect on Türkiye's experiences on water governance, with a specific focus on the agriculture sector, which is the largest consumer of water, in response to climate change given its location in a semi-arid region. The socioeconomic dynamics that have shaped the water governance system in Türkiye over the last decade are also explored with the objective of analyzing the intricate connection between people and water, in order to drive inspiring insights for addressing water-related challenges and formulating solutions, for better water management in arid and semi-arid regions by drawing on the experience of Türkiye.

10.2 Water Governance in Türkiye

The origins of the early agricultural societies are believed to lie in the region where modern Türkiye is located. Regarded as a source of life, water has always been at the heart of the economic, cultural, and social life in Türkiye. This is also demonstrated by the embracement of water in all parts within the society. In the pre-republic period, fountains, public baths, cisterns, and aqueducts to which people can easily access in urban life are unique examples for the public hygiene culture. In this sense, water is regarded not solely as a source of development but also a social and spiritual element of the daily lives of people.

The 11th National Development Plan of Türkiye covering the period of 2019–2023 emphasizes the principles of good governance, which make it possible to transparent, accountable, responsive, and rapid decision making as well as to include citizens in this decision-making process (Presidency of Strategy and Budget of Türkiye 2019). Türkiye has in this context taken significant measures in the good governance of water resources.

Driven by the European Union Water Framework Directive (EU WFD), Türkiye has made reforms with regard to governance mechanisms and structures related to water in the last two decades, as a candidate country for the EU membership. Türkiye’s legislative efforts and investments in all its river basins have gained momentum following the opening of the accession negotiations with the EU on the Environment Chapter in 2009.

Similar to many other countries, the central authorities are the leading actors in the decision-making in water sector in Türkiye. These authorities are presented in Figure 10.1.

Figure 10.1: Leading Central Authorities in Water Management



GD = general directorate.

Source: SUEN (Turkish Water Institute) (2021).

The Ministry of Agriculture and Forestry¹ is the leading institution in the policy development and execution of the protection, development, and use of water resources. The ministry, through its three main water-related units, State Hydraulic Works (DSI), the General Directorate of Water Management, and the Turkish Water Institute (SUEN), is primarily mandated to develop water resources, ensure

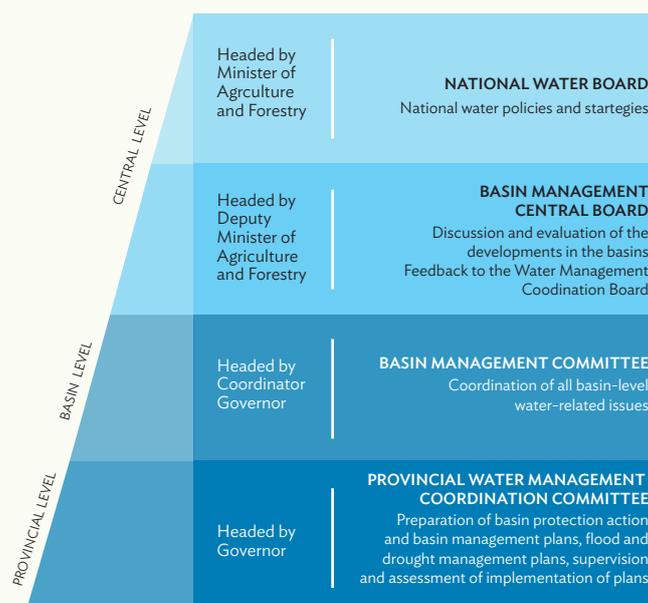
¹ The Ministry of Forestry and Water Affairs, formed in 2011, merged with the Ministry of Food, Agriculture and Livestock in 2018.

coordination of water management, prepare river basin management plans, develop measures and set objectives and environmental standards, devise strategy and policies for flood and drought risks by preparing management plans, and conduct scientific research for supporting the works noted above.

One of the major reforms initiated in 2011 in regards to water governance has been the adoption of basin-scale management of water resources, in line with the EU WFD. The Ministry of Agriculture and Forestry coordinates the preparation and implementation of river basin management plans. As water management is a multi-level public responsibility, the ministry works in close cooperation with different ministries, public bodies, and other stakeholders related to water management issues.

The National Water Board functions for the coordination and cooperation in water issues with the highest level of participation from relevant institutions. The board chaired by the Minister of Agriculture and Forestry in which other member ministries' top level officials participate, plays a critical role at the central level to steer national water policies (Figure 10.2).

Figure 10.2: Basin-Scale Water Resources Management in Türkiye



Source: Adapted from SUEN (Turkish Water Institute) (2021).

The Basin Management Committee and the Provincial Water Management Coordination Committee composed of local bodies of the ministries, water and sewerage administration, and other relevant local stakeholders, including nongovernment organizations and irrigation unions ensure the coordination of water matters at basin and provincial levels.

The 13th article of the EU WFD holds that “Member States shall ensure that a river basin management plan is produced for each river basin district lying entirely within their territory”. Although not being a full EU member yet, Türkiye completed river basin management plans in 11 basins, while planning activities in the other 14 basins are ongoing or planned to be completed by the end of 2025.

Water governance entails not only a resilient institutional structure but also a sound legislative base. As an EU accession country, Türkiye has substantially transposed the water-related EU directives into national legislation. A draft water law is due to be adopted by parliament as a framework legislation that will be a critical milestone to fully clarify roles and responsibilities in the water sector by law.

Another important aspect in good water governance is strong governance at the local level. Among the local governments, municipalities come to the fore with their extensive roles and responsibilities in local services (e.g., land development, public transportation, water and sewer services, waste management). Approximately 93% of the population in Türkiye lives within municipal boundaries. The mayors and general assemblies of the municipalities are directly elected by the local residents enhancing the accountability mechanism. A law amendment in 2013 gave metropolitan status to 14 more provinces, increasing the total to 30,² placing nearly 80% of the country population within metropolitan municipality boundaries. The primary goal for the amendment was to benefit more from the economies of scale to single-handedly plan and deliver the municipal services for the entire urban area (SUNEN 2021). Water and sewerage administration under the metropolitan municipalities are semi-autonomous entities that are mandated to supply water to households and other consumers and collect and treat wastewater of the entire city.

10.3 Water Governance in the Agriculture Sector: Case of Irrigation Unions

Türkiye is located in a region where domestication of plants, animal husbandry, and the transition from hunting and gathering to farming first began in world history. The Fertile Crescent, which includes southeast Türkiye, was the place where early practices of irrigated agriculture and water canal systems also began. This is why agriculture and water have played a vital economic and social role in Türkiye for thousands of years.

Of the 28 million hectares agricultural areas in Türkiye, 8.5 million hectares are economically irrigable. Agriculture is by far the largest consumer (77%) of the country's water resources (DSI 2022). Agriculture has been impacted by increasing fluctuations in precipitation and extreme weather events including severe droughts in the region. These events inevitably exert significant impacts on the water requirements of crops and soil. Notably, the agriculture sector also contributes to the challenges as a highly water dependent sector, the largest user and a polluter. Food security directly relies on agricultural workforce which constitutes nearly 15% of the total employment. This gives the agriculture sector a central role in addressing complex and emerging water challenges.

Over the past 2 decades, Türkiye has undertaken substantial efforts to enhance water use efficiency in agriculture. This has been pursued through structural transformations such as land consolidation, expansion of modern irrigation systems, and use of nonconventional water resources alongside the rehabilitation of the existing infrastructure.

Governments across the world have also embarked on a process of administrative reforms to tackle the increasing demands on irrigated agriculture and to enhance its performance. Among the reforms, irrigation management transfer (IMT) has appeared as the most important and far-reaching reform thus far. The two drivers of this process were the global movement toward liberalism and the call for

² There are 81 provinces in Türkiye.

a more participatory management approach. The underlying motives for IMT have been the expected increase in efficiency and productivity and achievement of full cost recovery of services (Garces-Restrepo, Vermillion, and Muñoz 2007).

As the adverse impacts of climate change have exacerbated over the years in Türkiye, water use efficiency and inclusive governance have also become essential in the irrigation sector. This necessitates stakeholder engagement underpinned by a robust institutional setting. In parallel with the global trend toward IMT, as from 1993, the DSI has initiated an accelerated transfer program of operation and maintenance services of irrigation schemes from the DSI to irrigation unions. By the end of 2022, 81% of DSI-built irrigation projects (2.87 million hectares of the total 3.56 million hectares area) were transferred to various organizations of which 84% are under the domain of irrigation unions. The remaining 16% are operated by municipalities, cooperatives, and villages (DSI 2022).

An important milestone was achieved in 2011, when the Law on Irrigation Unions was enacted in the parliament by which the unions' legal status was clarified. The unions were designed to function in a semi-autonomous manner under the supervision of the DSI. Within the geographical domain designated by the government, the unions are authorized to undertake the operation, maintenance, repair, and management works; collect payments for water use; pay back the investment cost of the facilities taken over; with the approval of the DSI, develop the facilities taken over; cooperate with the agricultural planning offices of the ministry in the planning of crop production; cooperate with other organizations in research and development and capacity building activities related to irrigation and other agricultural practices.

Some revisions were made to the law in 2018, due to experiences gained in the implementation of the original law. The major change was with regard to the appointment of head of the union. To improve the checks and balances in the system, it was enacted that the head of the union is appointed by the Minister of Agriculture and Forestry on the proposal by the DSI. Another trend accelerated since then has been the consolidation of the unions to benefit more from the economies of scale leading the number of unions to drop from 384 to 181 by the end of 2022 (SUEN 2021; DSI 2022).

Nevertheless, there is room for improvement to enhance farmer participation in the management of irrigation facilities. For instance, in Japan, land improvement districts (LID) are regarded as successful structures in terms of farmer-led irrigation management (Tanaka and Sato 2005). The boards of directors of the LIDs are elected by the member farmers where farmers are encouraged to self-manage the irrigation facilities. In addition, as an example of community-based irrigation management, farmers may be commissioned by the LID as “watchers” to watch over each irrigation line. Drawing from the Japanese experience, participation by farmers in the decision-making bodies of irrigation unions in Türkiye may be contemplated in the future by considering local sociocultural context.

The “agriculture per available water” model has been developed by the Ministry of Agriculture and Forestry placing water at the center of agricultural production planning. As per this model enacted as law in 2023, the ministry performs the agricultural production planning based on available water, as such crops that consume less water are encouraged and practices that reduce water consumption are financially supported by the government. The success of this model relies on full engagement of all stakeholders. In this regard, the national “Water Efficiency Campaign” initiated in 2023 is a critical step toward engaging all stakeholders including citizens to enhance water use efficiency awareness nationwide.

10.4 Water Governance in Response to Climate Change and Changing Socioeconomic Dynamics

Current global environmental, economic, and social challenges exert pressure on livelihoods and intensify humanitarian needs worldwide. These emerging threats raise the number of people facing water risks, food insecurity, population mobility, and epidemics. The Mediterranean Basin, where Türkiye is located, has been significantly affected by climate-change induced disasters. Climate change-induced events such as droughts and floods can pose threats to food security. Precipitation is projected to decrease by 30%–40% in the Eastern Mediterranean region, while water demand surges due to population growth and the expected temperature increase by 2–4°C (UNEP n.d.). Türkiye is one of the countries affected most by the changing conditions in the Mediterranean Basin.

While climate change has been a major factor shaping Türkiye's water needs, challenges, and governance structure over the past decades, changing socioeconomic dynamics and emergencies such as the Syrian refugee influx, the global upheaval of the COVID-19 pandemic and the recent devastating earthquakes that struck the country have also introduced new dimensions to the management of water. These emergencies underscored the significance of cooperation and coordination across multiple levels to prevent disasters, protect against crises, and prepare for emergencies.

One striking occurrence that has had a profound impact on water management in Türkiye is the mass refugee influx following the outbreak of the conflict in neighboring Syria in 2011. The number of registered Syrians living under temporary protection in Türkiye rapidly increased in the first few years of the mass inflows, reaching over 4 million and making Türkiye the country hosting the largest number of refugees in the world.

Türkiye has spent over \$40 billion to address the needs of Syrians within its borders. It is estimated that approximately 5% of this amount has been allocated for WASH-related activities in the first 5 years (WWAP 2019). WASH infrastructure and facilities at temporary shelter centers (camps) were built by state institutions providing all necessary services to meet global WASH standards. Managing WASH needs for millions of Syrians living outside the temporary shelter centers involved more comprehensive actions and planning including demographic projections and adjustments to the existing investment plans. Addressing the rapidly increasing demand required additional administrative, technical, financial, and human capacity to maintain existing water infrastructure and to develop new projects. Populations in the main refugee-receiving cities located mainly near the Syrian border, reached levels that would normally be reached in 13 to 15 years. Smaller provinces have experienced sudden population booms that necessitated rapid response measures for enhancing water supply and sanitation services capacity. As a striking case, by 2015 the population of the border province of Kilis doubled with the arrival of over 120,000 Syrians. In the border provinces of Gaziantep, Şanlıurfa, Kilis, and Hatay, new dams, reservoirs, and pipelines were constructed; and water and wastewater treatment capacities were expanded. The rise in water demand induced by the flow of Syrians inevitably has placed more stress on already scarce water resources facing the climate change impacts in the region.

The urgent response capacities of the relevant institutions both at national and local levels in Türkiye, resulted in effective WASH management under the crisis situation. Since the early years of the refugee influx, Türkiye has adopted the principle that humanitarian assistance must be coupled with infrastructure development capable of responding to the scale, scope, and protracted nature of the refugee influx (WWAP 2019).

By August 2023, only 2.23% of the 3.3 million Syrians in Türkiye lived in shelter centers, while the rest resided in cities, towns, and villages throughout the country concentrating in the areas close to the Syrian border (Ministry of Interior of Türkiye 2023). Addressing the long-term WASH needs of people is not solely a technical challenge; providing education and training opportunities is equally important for meeting future needs. To this end, capacity building projects have been developed to integrate Syrians into the social and economic life in Türkiye to ensure an inclusive and sustainable WASH management which will eventually foster regional development. The Turkish experience in water management amid mass refugee influx is a unique success story and example for the world.

Following the announcement of COVID-19 as a pandemic by the World Health Organization in March 2020, all aspects of life have been affected in a way that had never been experienced before. The COVID-19 outbreak highlighted the vulnerability of global systems and the adverse impacts of such global events on our efforts to achieve the United Nations Sustainable Development Goals (SDGs). The pandemic revealed the significance of access to WASH services. Climate change and public health concerns for the local and central administrations have become deeply interconnected. This has also demonstrated how emergencies have the potential to further stress already scarce water resources intensifying the complexity of the situation.

The Ministry of Agriculture and Forestry of Türkiye started to track the COVID-19 virus in wastewater at the national level as early as March 2020 and SUEN carried these studies to the international level in cooperation with the World Health Organization, the World Bank, the European Commission, the Joint Research Center of the EU, and many others. Through these studies that could scan asymptomatic cases as well as symptomatic cases, rises and decreases of cases could be detected at least 4–5 days in advance. Wastewater surveillance studies have revealed the prevalence and trends of infection in the community and served as an effective early warning tool for public health decision makers and highlighted the need for cooperation among the sectors. The experiences gained from wastewater-based epidemiology studies accomplished during the course of COVID-19 will ensure preparedness against possible future pandemics.

The earthquakes that struck Türkiye and Syria on 6 February 2023 once again underscored the vitality of WASH infrastructure and services. Such disasters show us the significance of coordination at different levels for the protection, prevention, and preparation in urban water and wastewater management and services in crisis situations. Following the earthquake, recovery and reconstruction in the water sector has necessitated a quick and holistic sustainable planning addressing urban, industrial, and agricultural needs and uses. Today, Türkiye is more committed than ever to ensure water and sanitation for all, using all of its capacity and expertise to alleviate the damages caused by the earthquake.

10.5 Lessons Learned and the Way Forward: A New Vision for Water

As a country which is not water-rich, Türkiye has long been committed to the sustainable and responsible use of water resources. Climate change has further underscored the necessity for this commitment and defined how water policies have been designed and implemented in Türkiye. Given the emergency situations experienced in Türkiye over the past decade, infrastructure development supported by enhanced water governance in the water sector has become a critical priority to effectively respond to the already existing water stress.

Türkiye's experience has also illustrated the necessity of enhancing emergency response capabilities and preparedness in the face of climate uncertainties and global risks such as pandemics, human migration, and natural disasters.

Developing water-efficient and modern water infrastructure, including irrigation networks and reservoirs, stands as the optimal climate change adaptation method that would ensure food security and economic stability in arid and semi-arid regions facing severe droughts. Planning agricultural production based on available water is another approach that contributes to climate change adaptation and this approach has fully been adopted by Türkiye.

Exploring the potential of nonconventional water resources presents an alternative solution to address drought conditions in arid and semi-arid regions, expanding rainwater harvesting and grey water use, ensuring the reuse of water returned from irrigation are some alternatives. Nevertheless, more studies are to be implemented with regard to the societal acceptability of wastewater as a source of supply. This demonstrates the fact that social factors may potentially act as an impediment to technical solutions. Socioeconomic dynamics influence and ultimately shape the design and implementation of water policies.

Türkiye adopts this approach in the design of its future water vision. The national "Water Efficiency Campaign" initiated in 2023 is a critical inclusive step to enhance water use efficiency awareness nation-wide.

In light of the emerging challenges, Türkiye is more committed than ever to ensure access to clean water and sanitation for all not only within its borders but also beyond. Türkiye takes its part in the collective responsibility to ensure worldwide awareness and preparedness for new waves of possible future crises such as pandemics, climate change induced and natural disasters.

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The Water Cycle and Rain-fed Rice Cultivation in Northeast Thailand

Koshi Yoshida, Hiroki Oda, and Kenji Tanaka

11.1 Introduction

Thailand is one of the world's leading rice producers and exporters, with an area of approximately 10 million hectares of rice paddy and an annual production of 33 million tons of rice. Because the market for rice is smaller than that for other crops, fluctuations in rice production in Thailand have a significant impact on the international market. In Thailand, more than 50% of agricultural land is paddy fields, and production fluctuates widely from year to year. 2015 saw a monsoon that brought below-normal precipitation and large-scale drought in the northern and northeastern parts of the country.

Most of the cultivated farmland in the northeastern part of Thailand is rainfall-dependent rain-fed paddy fields, and the production of wet-season or main-season crops is very unstable. Shimizu, Matsumoto, and Pham (2004) analyzed the relationship between precipitation and the unit yield of rain-fed rice paddies, and found no clear relationship between the two. A field survey revealed that paddy fields often use small reservoirs near the fields and water in the surrounding lowlands. Homma et al. (2004) pointed out that rain-fed paddy fields often use water stored in low-lying areas caused by microtopography within the same paddy plot. Somura et al. (2008) estimated the amount of water supplied by a small pump or from a small water pond for rain-fed rice paddies based on water storage and rice yield estimation model. The results are consistent with the findings of Shimizu, Matsumoto, and Pham (2004) and Homma et al. (2004) and indicate that there was more available water than rainfall even in rain-fed rice cultivation. On the other hand, Suzuki, Goto, and Mizutani (2003) constructed a model to estimate groundwater hydrological processes and yield in rain-fed rice paddies on the upper and lower slopes of northeast Thailand, and expressed the phenomenon of different unit yield depending on topographical conditions. They stated that in order to reproduce the slightly different hydrological environment of each paddy location, it is necessary to determine the downward infiltration capacity and its coefficient for each topographical condition (elevation difference), that is, to model not only the water balance in the root zone but also the change in downward infiltration rate from the paddy field due to groundwater level change.

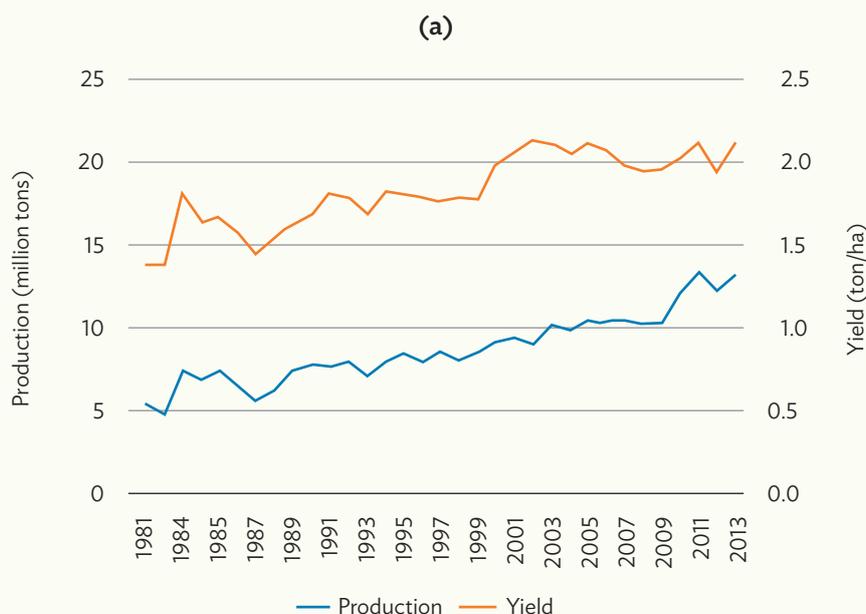
In addition, Shiraiwa et al. (2001) found in a statistical analysis of all provinces in Thailand that there are many provinces where the variation in rice production was caused by the variation in the area under cultivation rather than the unit yield. Tanaka et al. (2016) showed that the accuracy of reproducing changes in unit yield over time can be improved by considering yield stabilization strategies that reflect local farming methods, which reduce the area under cultivation and concentrate rainfall on the paddy fields planted in the rainy season, and that the effect of rainfall variability on both unit yield and harvested area can be evaluated. Therefore, it is necessary to evaluate the effects of precipitation variability on both unit yield and harvested area. This chapter introduces the relationship between water use, water cycle, and agricultural production in a rain-fed paddy-dominated region such as the northeastern part of Thailand, and the modeling to quantitatively evaluate the relationship of rice production, unit yield, and harvested area.

11.2 Rice Production, Yield, Planted Area, and Harvest Area Ratio in Northeast Thailand

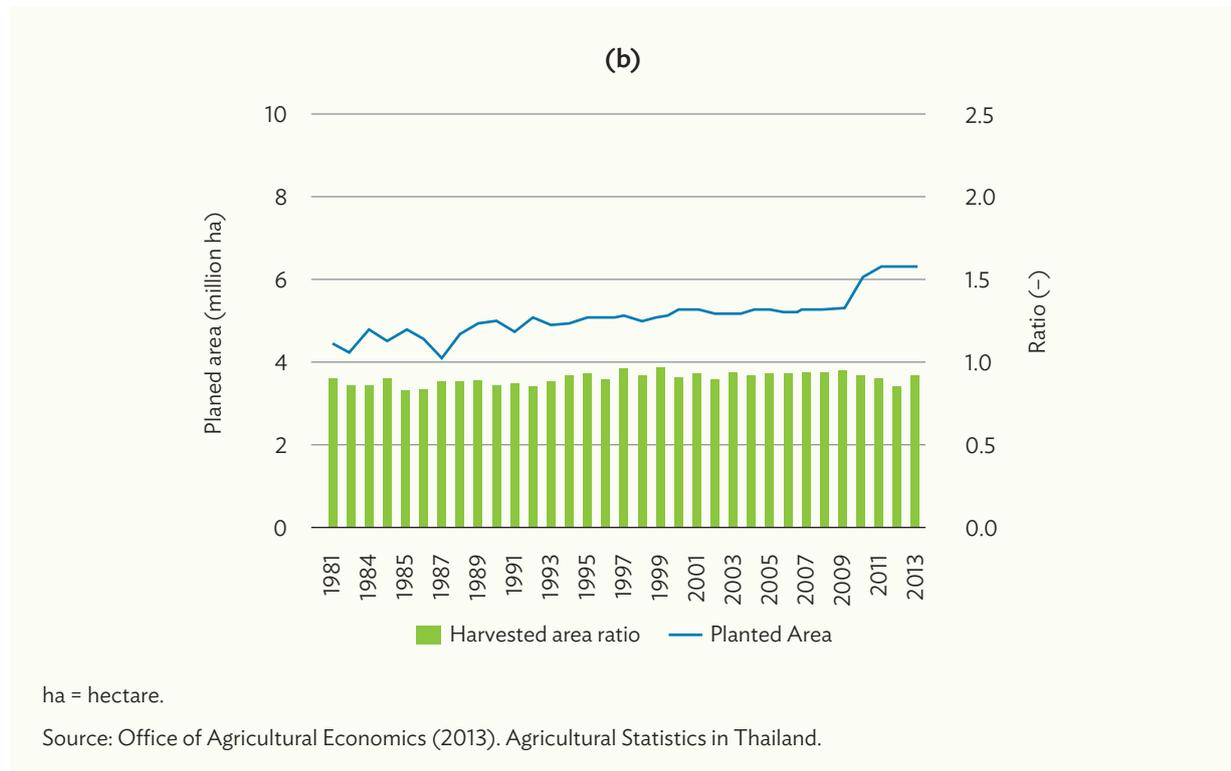
Thailand is the world's largest rice exporter, and rice is the country's most important crop. Rice paddy fields account for about 20% of the country's land area and about 50% of its farmland, of which more than half is rice paddies concentrated in the northeastern part of the country. Annual rainfall fluctuation was 800–1,400 millimeters per year, and this amount was smaller than other regions in Thailand. The majority of the agricultural ecosystem in northeast Thailand is rain-fed agriculture. The irrigated paddy field was developed to more than 250,000 hectares from 1981 to 2013 in northeast Thailand, however, the average irrigation rate in 2013 was still 7.4%. This indicates that agriculture in northeast Thailand was dependent on rainwater and vulnerable to climate conditions. Therefore, rice cultivation in northeast Thailand is mainly a one-season crop, and the yield per unit area is the lowest in the country. Compared to the Central Plains (Chao Phraya Delta), where the irrigation rate is high and two or even three-season crops are possible in some places, the yield per unit area is about half.

Figure 11.1 show the changes in production, yield, planted area, and harvested area ratio (= harvest area/planted area) of wet season rice in the entire northeast Thailand from 1981 to 2013. Rice production and yield increased gradually due to the new cultivation area development and variety or farming practice improvement. However, harvest area ratio still fluctuated in the range of 0.8–0.95. This means that some area was not cultivated in Northeast Thailand in every year. The average volatility in rain-fed rice production was 10.3% for 1981 to 2013 in northeast Thailand, which is smaller than that of Shiraiwa et al.'s (2001) estimated value of 20% by using the data for 1980–1998. It can be inferred that varieties and agricultural methods have improved over time and volatility has decreased.

Figure 11.1: Changes in Production (a), Yield (a), Planted Area (b), and Harvested Area Ratio (b) of Rain-fed Rice in Northeast Thailand, 1981 to 2013



continued on next page

Figure 11.1 continued


In northeast Thailand, there were large fluctuations in rice production due to the fact that rainfall varies greatly from year to year and the irrigation rate is extremely low. To clarify the actual production fluctuation of rice in northeast Thailand, multiple regression analysis is used to show whether the fluctuations in rice production are due to changes in planted area, harvested area ratio, or unit yield by using the statistics data for 1981–2013.

Agricultural production can be calculated as following equation by multiplying three contributed components.

$$RP = RY \times PA \times HAR \quad (1)$$

where, RP = rice production, RY = rice yield, PA = planted area, HAR = harvested area ratio (=harvest area/planted area).

In this study, the method of Shiraiwa et al. (2001) was used as a reference, and the average of the previous 5 years in each year for rice production and each of the three components was calculated, and only the deviations from the pre-5 year average were used for regression analysis to detrend the technological change, such as variety improvement, or fertilizer and pesticide input (Yoshida et al. 2019). Using the above-defined anomalies, multiple regression analysis was conducted for all 17 provinces in northeast Thailand with standardized production anomalies as the objective variable and standardized anomalies for planted area, harvested area ratio, and unit yield as the explanatory variables. The relative contribution of each component factor was compared with the standard partial regression coefficients to indicate whether the variation in production was attributable to changes in planted area, harvested area ratio, or unit yield.

Table 11.1 shows whether the variation in production of wet-season rice is due to planted area, harvested area ratio, or unit yield. Among the three factors for wet-season rice, the standard partial regression coefficient of planted area was the largest in 13 of the 17 provinces, followed by the contribution of unit yield, which was the largest in 4 of the 17 province. No province had the largest contribution from harvested area ratio. Farmers might be controlling their planted area depend on the rainfall amount to compensate the yield of rice in wet season.

Figure 11.2 shows the correlation coefficient between standardized monthly rainfall and rice production, planted area, yield, harvest area ratio in Khon Kaen Province. Rice production and planted area had positive correlation $R > 0.3$ with June–August rainfall. On the other hand, the rice yield had positive correlation with September–October rainfall. Rice transplanting normally starts from the end of June or July so that rainfall in this season is an important factor to control the rice planted area.

Table 11.1: Partial Regression Coefficient of Each Component (wet season rice)

Province	Yield	Planted Area	Harvested Area Ratio
Loei	0.66	0.70	0.56
Udon Thani	0.98	0.30	0.20
Nong Khai	0.43	0.73	0.43
Sakon Nakhon	0.74	0.81	0.31
Nakhon Phanom	0.49	0.76	0.31
Mukdahan	0.79	0.75	0.21
Yasothon	0.51	0.69	0.15
Ubon Ratchathani	0.45	0.87	0.25
Si Sa Ket	0.53	0.81	0.34
Surin	0.69	0.99	0.37
Buri Ram	0.60	0.56	0.20
Maha Sarakham	0.33	0.73	0.18
Roi Et	0.49	0.82	0.41
Kalasin	0.57	0.97	0.10
Khon Kaen	0.39	0.67	0.24
Chaiyaphum	0.52	0.74	0.22
Nakhon Ratchasima	0.72	0.55	0.32

Source: Yoshida et al. (2019).

11.3 Rain-fed Paddy Culture

Rice is the staple food of the people of northeast Thailand, and rice cultivation has remained their main livelihood. In the 20th century, the area of rice paddies in northeast Thailand increased around 10 times, accounting for nearly 40% of the total area of the region. During this rapid and marginal expansion of rice paddies, the mode of rice production changed drastically. The majority of rice paddies in northeast Thailand are rain-fed, and many of them are unstable and low-yielding due to the lack of sufficient water, but this situation was brought by rice paddy expansion over the past century. In fact, in the hilly areas of northeast Thailand, rice cultivation was practiced only in hilly valleys where irrigation was

Figure 11.2: Correlation Coefficient Between Standardized Monthly Rainfall and Rice Production, Planted Area, Yield, Harvest Area Ratio in Khon Kaen Province



Source: Authors.

well developed and relatively high yields were obtained, but since the 1950s, low-yielding rain-fed rice fields have rapidly opened on dry hillsides.

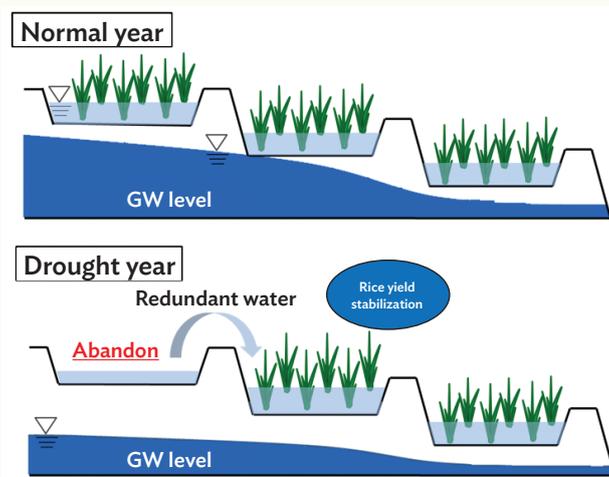
The shift from stable rice cultivation in irrigated or lowland wet paddy fields to unstable rice cultivation in dry hilly paddy fields was a major shift in survival strategy for the farmers. Although the introduction of modern agricultural materials and facilities has improved the situation somewhat in recent years, rice production in northeast Thailand fluctuates greatly from year to year depending on rainfall, and farmers in northeast Thailand have developed sophisticated measures to ensure food security, such as over-year storage of rice and intra- and inter-village rice transfers. These measures have existed for a long time, but in light of the rapid increase in rice paddy area over the past 100 years, they appear to have been formed in the past few decades.

The yield and production stability of rice in northeast Thailand depend largely on the hydrological conditions that determine how much water the paddies can stably receive, and these hydrological conditions are strongly influenced by topographical factors in addition to precipitation (Miyagawa et al. 2006). Most of northeastern Thailand is an extremely eroded plain, bordered on the north and east by the Mekong River, on the south by the Dongrak mountain range, and on the west by Phu Kradung with mountains around 1,000 meters high. The plains are generally gentle and the riverbed gradient is small, but this does not mean that the land surface is flat. There is an irregular series of undulations (hills and depressions) with elevation differences of several meters. These undulations are very important when considering the hydrological environment of the rain-fed paddy fields in northeast Thailand. The rain-fed paddy fields in northeast Thailand do not depend solely on precipitation directly brought to the paddy field plots. The inflow of water from outside the paddy field area is very important for rice cultivation in northeast Thailand, where direct rainfall alone is not sufficient. Since the amount of inflow depends on the area of land above the paddy field, paddy fields in depressions are generally more favorable for stable rice production than paddy fields on hillsides.

11.4 Strategy of Yield Stabilization in Rain-fed Paddy Fields

In rain-fed rice cultivation in northeast Thailand, supplementary use of water stored in small pond or low-level waterlogging caused by microtopography within the same paddy plot has been reported (Shimizu et al. 2004; Homma et al. 2004). This indicates that the amount of available water is greater than the amount of precipitation, even though they are classified as rain-fed rice fields. Suzuki et al. (2003) reported that the area under cultivation changes according to the accumulated precipitation from May to July, expanding from low-level to high-level rice paddies that are favorable for water use depending on rainfall conditions. In normal year, the groundwater table is sufficiently recharged and become shallow in July, and then paddy fields are planted from low-land to higher land, but in a drought year, groundwater is not sufficiently recharged and some fields give up cropping due to water shortage (Figure 11.3). The paddy fields in higher elevation that give up cropping play the role of a catchment area for the cropped paddy fields in lowlands, and water movement via surface water and groundwater affects the root zone water balance of the cropped paddy fields. The farmers' strategy is to concentrate the amount of available water in the lower cropped fields by adjusting the cultivated area, thereby avoiding the ineffective input of seeds or fertilizer and guaranteeing a unit yield.

Figure 11.3: Image of the Strategy of Yield Stabilization in Rain-fed Paddy Fields



GW =groundwater.

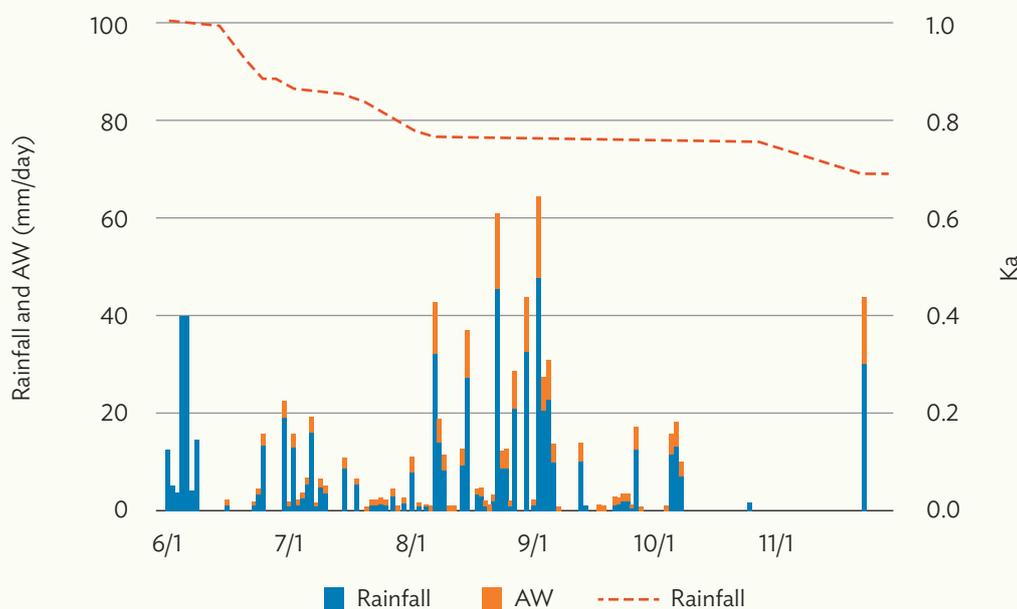
Source: Tanaka et al. (2016)

Tanaka et. al (2016) defined this as a yield stabilization strategy, and aimed to reproduce the water use specific to rain-fed rice paddies. The reduction coefficient of the area calculated by the harvested area estimation model was used to adjust the amount of available water with a decrease in the planted and harvested area. This was done to represent a local strategy to maintain the unit yield by concentrating rainfall on rice paddies under cultivation in the reduced planted and harvested area shown in Figure 11.3. In normal rain-fed rice cultivation, the only available water is the rainfall that falls on the paddy field, but the rainfall water from the abandoned upper paddy field is also assumed to be available, and the rainfall is modified as in Equation (2).

$$AW_i = P_i / K_{a_i} \quad (2)$$

where AW_i is the available water at time i [mm/day], P_i is the daily rainfall [mm/day], and K_{a_i} is the area reduction factor [-]. The available water amount AW_i is used instead of rainfall in the root zone water balance calculation of the crop growth model. This enables the reproduction of management practices that produce a stable unit yield in rain-fed rice cropping, where rainfall amount is unstable. Figure 11.4 shows the example of the change in available water during the rice cropping season, with K_{a_i} gradually decreasing throughout the cropping season and available water increasing accordingly. The total amount of water available after the yield stabilization strategy was applied was approximately 1,019 mm compared to 860 mm of rainfall, indicating an increase of about 19%.

Figure 11.4: Changes in Rainfall, Available Water, and Area Reduction Factor, Khon Kaen Province, 2012



AW = available water, Ka = area reduction factor, mm = millimeters.

Source: Authors.

11.5 Conclusion

Rain-fed rice production in northeast Thailand is unstable due to the large interannual differences in the amount and timing of rainfall, as well as the large differences in production depending on the location of the rice fields. In order to quantitatively analyze the stability of rice production, it is necessary to establish a method that can simulate rice production based on the water cycle and farmers' strategy in the rain-fed paddy fields.

In this study, characteristics of rain-fed paddy field were reported, such as the how changed rice planted area affects production, and how the unit yield becomes stable by the farmers strategy supplying the additional water from abandoned paddy into cultivated paddy. Topographic conditions of the rice paddy

fields are important when related to the local water cycle, especially the groundwater condition in the wet season. How to represent the nonuniformity of microtopography, land use, and soil conditions within a computational grid is an important issue in the field of hydrology, and modeling such variations in cropland and harvested area in conjunction with the regional water cycle is important for accurate productivity assessment on a larger-scale analysis.

Water resources and agricultural water use in the Asian monsoon region, which is in the humid zone, differ greatly from those in arid and semi-arid regions, but are characterized by the existence of distinct dry and rainy seasons and great diversity within the same region. Even during the rainy season, water resources are not always abundant, with dry spells in the beginning of the monsoon season sometimes resulting in unpredictable and unusual droughts. With their long-standing wisdom, people living in the Asian monsoon region have measures to maximize their profits even under unstable weather conditions. The formulation and verbalization of such indigenous local knowledge is also extremely important information for developing countries other than Thailand, which has a paddy rice culture, and is a key factor for improving the accuracy of rice yield and production forecasting in regions where irrigation rates are low and rain-fed rice paddies are predominant.

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Managing Water by the Local Community: Development and Implications of Japan's Irrigation Management System

Tsugihiko Watanabe

12.1 Introduction

In Japan, there is a considerable amount of rainfall in the summer when rice is cultivated. Irrigation systems have been developed for more than 2,000 years to secure water for paddy fields as rainwater alone was insufficient. As a result, canals for irrigation and drainage totaling approximately 400,000 kilometers (km) in length have been developed throughout the country. These irrigation and drainage canals have been maintained and taken over by farmers cooperating with each other since ancient times. Currently, about 80% of them are properly managed by Land Improvement Districts (LIDs) made up of beneficiary farmers.

The water management system by farmers has fostered stable paddy field agriculture and contributed to the stable supply of food. Furthermore, paddy field irrigation has greatly contributed to maintaining and demonstrating various multifaceted functions such as groundwater recharge, flood prevention, biodiversity, formation of beautiful landscapes, and inheritance of tradition and culture. It has formed the basis of Japanese society and culture.

Farmers' active participation in water management fosters a strong sense of ownership and responsibility for the management of facilities, and the resulting flexible and prompt water distribution management also contributes to responding to droughts and floods. It has played an important role in the sound development of agriculture and rural areas. On the other hand, in Japan, the number of people engaged in farming has been consistently decreasing as the aging of farmers progresses in recent years. This situation has affected the management and activities of water management organizations by farmers, and in order to maintain their functions and roles, activities and measures are being implemented to support various efforts by the region as a whole.

This chapter summarizes the characteristics, roles, and significance of Japan's water management system, and outlines efforts to resolve its current challenges. The report cites and refers to materials from the Ministry of Agriculture, Forestry and Fisheries (MAFF 2023) in Section 12.3.1 and a report by the Japanese National Committee for the International Commission on Irrigation and Drainage (ICID) (JNCID 2023) in Sections 12.2, 12.3.1, and 12.5, as well as a discussion paper previously published by the author and a colleague (Watanabe and Ogino 2003) in Section 12.4.

12.2 Outline and History of Japan's Paddy Cultivation and Irrigation Development

12.2.1 Outline of Paddy Cultivation and Irrigation in Japan

About 70% of Japan's land area is mountainous and hilly, while plains cover 25% of the land area and farmland covers 13.5% of the land area. In addition, Japan is an elongated island nation with a series of mountain ranges of 2,000–3,000 meters in the center of the islands. The rivers are short with steep gradients, and consequently rainwater runs off into the sea in a short period.

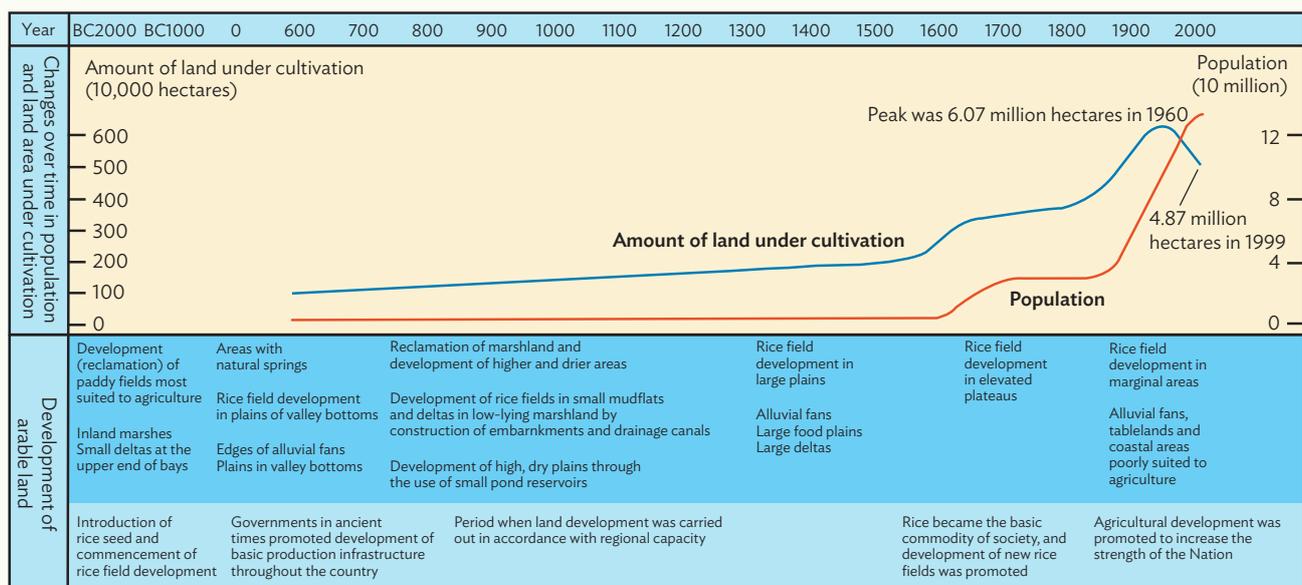
Japan belongs to the Asian monsoon region and receives about twice as much rainfall per year as the world average, but the rainfall is concentrated during the rainy and typhoon seasons, and there may be long periods with almost no rain in the summer. Due to such natural conditions, rainfall alone is insufficient to supply water for rice paddies, and so for more than 2,000 years, Japan has been cultivating paddy rice utilizing river water or reservoirs and developing irrigation facilities such as irrigation and drainage canals.

At present, about 7,700 large-scale core facilities such as dams, water intake weirs, and irrigation and drainage pump stations have been installed to supply irrigation water for about 2.9 million hectares of farmland, or two-thirds of the nation's 4.33 million hectares (in 2022), and to protect the farmland and surrounding areas, including urban areas, from flood damage. There are 400,000 km of irrigation and drainage canals, including 50,000 km of main canals.

In Japan, a community-based consensus-building system has been formed in each village over a long history of rice cultivation, and water management has also been carried out with villages as a basic unit. Since the Meiji era (beginning in 1868), the legal status of water management organizations has been gradually established alongside the development of various legal systems related to irrigation and drainage projects. Mergers of water management organizations have been promoted along with irrigation development projects for the integration of small-scale irrigation and drainage facilities in the modern era. Currently, irrigation and drainage management in Japan is carried out by groups of farmers, LIDs, for each water use system.

Historical changes in arable land area and population growth in Japan are shown in Figure 12.1. In addition, the historical development of Japan's water use and the basic framework of water policy, including those related to agricultural water, is summarized in a separate chapter (Chapter 2 by Kotaro Takemura).

Figure 12.1: Historical Changes in Arable Land Area and Population Growth in Japan



ha = hectare.

Source: JIID (2003).

12.2.2 History of Irrigation Development in Japan

The development process of irrigation in Japan is roughly divided into three periods, and each period is briefly summarized in this section.

The period from 700s to 1100s AD

In Japan, the latest agricultural engineering technology was introduced from China, and the construction technology of irrigation facilities such as agricultural reservoirs and canals spread throughout the country, resulting in improved agricultural production, elimination of hunger, and the widespread development of irrigated agriculture. Irrigation development began to take place throughout the country. While granting farmland to the people, the government of the time demanded the provision of labor and promoted the development of small-scale paddy fields through the creation of reservoirs and the use of small rivers. A typical example of this is the Manno-ike Pond in present-day Kagawa Prefecture, which was constructed around 701 by a local master, and was later renovated by Kukai, a Buddhist monk who had studied irrigation technology in China, and others, utilizing the latest technology of the time. An arch-type embankment, which was revolutionary at the time was adopted and a flood discharge was installed by excavating the bedrock to prevent flooding. It is still used today as an important irrigation storage facility for the region. Manno-ike Pond was inscribed as a World Heritage Irrigation Structure by the ICID in 2016.

The period from 1200s to 1800s AD

After the 1200s, the development of civil engineering technology for steep rivers with rapid flow was advanced. From the 1600s, the development of new rice paddies and farmlands drainage control facilities was actively carried out in conjunction with flood control projects in areas that could not be developed before, such as the flood plains of large rivers. This led to a rapid increase in farmland area and population. The Minuma-dai Yosui Irrigation System in present-day Saitama Prefecture, a representative example of low-lying land development, was constructed by the Edo shogunate in 1782. Using a construction method that takes advantage of the topography, a 60 km long waterway was excavated in just 6 months, supplying irrigation water to approximately 13,000 hectares of paddy fields. The Minuma-da Yosui Irrigation System was inscribed as a WHIS by ICID in 2019.

The period after 1900 AD

In the 1900s, the demand for power generation and industrial water surged due to the rapid increase in the population and industrial development accompanying the modernization of the country as a whole. To meet this demand, water resource development was promoted through the construction of dams, and laws related to water use were also developed. The River Law was enacted in 1896, and the Land Improvement Law in 1949. As a result, the national and prefectural governments promoted the modernization of irrigation facilities to secure water resources and increase food production, resulting in dramatic improvements in agricultural productivity.

One of the representative examples is the Shichika Waterworks in present-day Ishikawa Prefecture, a facility completed in 1903. The seven water intakes, which had been separately taken from the river, were integrated into one so that efficient irrigation could be realized. In 1968, the Dainichigawa Dam was completed upstream as a national project, further securing a stable water source and supplying irrigation water for approximately 5,000 hectares of rice paddies. Shichika Waterworks was inscribed as a WHIS by the ICID in 2014.

The modernization of agriculture, supported by water sources and irrigation facilities, led to large-scale migration of labor from agriculture to heavy industry and was the driving force behind Japan's rapid growth after the Second World War.

12.3 Land Improvement Project and Land Improvement Districts

After the Second World War, the national land improvement project system has been centered on the LIDs, which is a farmers' water management organization based on the village community and whose members are in principle farmers who are cultivators of agricultural land. The land improvement districts have continued their activities in close cooperation with related organizations such as administrative organizations and agricultural cooperatives.

12.3.1 Overview of Irrigation and Drainage Systems in Japan

Land Improvement Projects (LIPs) and Land Improvement Districts (LIDs)

The construction and maintenance of irrigation and drainage facilities are carried out in accordance with the Land Improvement Act (LIA) of 1949. In principle, LIPs, under the LIA, must be implemented with farmers' initiative and application with the consent of at least two-thirds of the beneficiary farmers in each project area. The LIA establishes the proper and smooth implementation of the project such as eligibility of participation, the establishment of a LID, the procedure for project formation, the basic policy on cost sharing including justification of government support, etc.

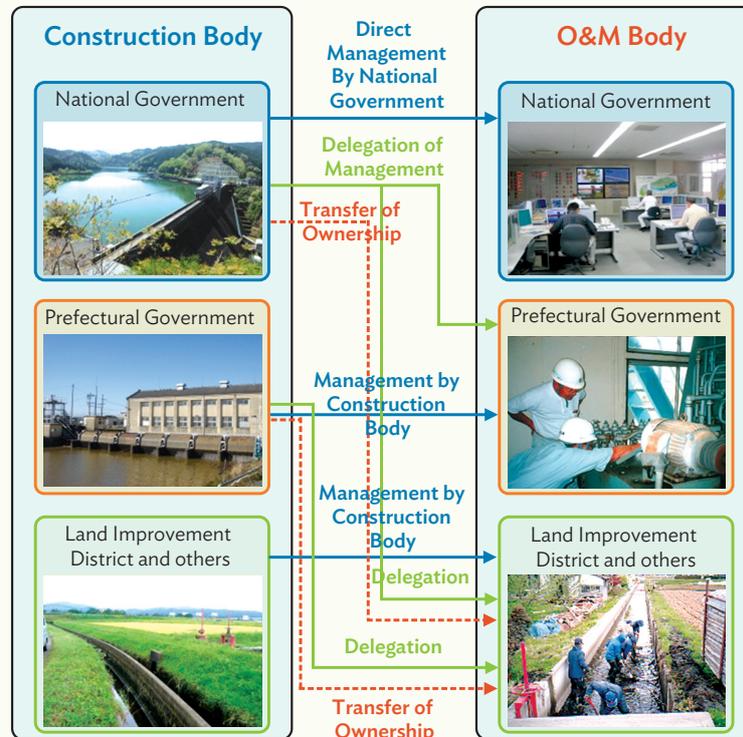
The project implementing bodies for LIPs are the national government, prefectures, and organizations (LIDs, unions of LIDs, municipalities, agricultural cooperatives, etc.), which are determined in consideration of the scale of projects, technical difficulty, etc. The project costs are borne by the national government, prefectures, municipalities, and beneficiary farmers in accordance with the types and scale of projects. Since the LIA came into effect, water management organizations based on traditional villages and organizations based on old laws have been given legal status as a LID alongside the implementation of LIPs, and now there are 4,203 LIDs (2021) with an area of 2,481,000 hectares and 3,430,000 members.

Irrigation Management of LIDs

In general, LIDs shall manage irrigation and drainage facilities developed by LIPs, such as reservoirs, head works, pump stations, main irrigation and drainage canals, etc., with the exception of large-scale and highly public facilities developed by the national government, which require special technical considerations for their management and are directly managed by the national government (Figure 12.2).

The LID water management methods include the operation of gates in main canals, irrigation, and drainage pump stations, etc., as well as water management in tertiary canals by lower-level organizations, such as villages and water use associations. Water is distributed to paddy field lots steadily and equally in principle, while in the case of severe drought period, they might introduce a rotational distribution. The costs for the operation and maintenance of the facilities are collected as a levy based on the size of the farmlands and other factors. Safety inspections, weeding, and canal cleaning are often carried out by farmers and nonfarmers in the village.

Figure 12.2: Structure of Executing Bodies of Construction and Operation and Maintenance



O&M = operation and maintenance.

Source: MAFF (2023).

12.3.2 Specific Features of Japan's Irrigation System Management

Since the introduction of rice cultivation in Japan, farmers have formed their own organizations in each irrigated area, cooperating with each other to maintain and manage their facilities and hand them down to future generations, without relying on the government or administration from time to time. In these farmers' organizations, a strong sense of solidarity, a spirit of mutual assistance, moral values, and social discipline were formed through the experience of severe natural disasters such as droughts and floods. They have also nurtured a rich traditional culture and beautiful rural landscapes.

This system of operation and maintenance by farmers' organizations has been maintained even in the process of economic development and modernization in recent years, and today the role of farmers' organizations has been inherited as LIDs that manage the land in accordance with the law. This system of farmer-led operation and maintenance has fostered farmers' independence and a strong sense of ownership of irrigation facilities, which is thought to be a factor in the efficient operation and maintenance of irrigation and drainage facilities in Japan. Furthermore, this operation and maintenance system of farmers enables flexible and prompt water allocation management to cope with droughts and floods and plays a significant role in strengthening resilience to extreme weather events and disasters, which is a current issue in Japan.

12.4 Land Improvement Districts as District-Level Water Management Organizations

12.4.1 LIDs—Farmers' Water Management Organization in Japan

Structure

The Japanese traditional village *Mura* was the base for the present farmers' association. Farmers within every *Mura* organized themselves and cooperated together to construct, operate, and maintain irrigation facilities on the tertiary level. The irrigation system in Japan consists of small-scale regional systems objectively oriented toward economic rice production and managed by a decentralized structure of irrigation organizations, within private ownership and legalized water rights, which sufficiently guarantee individual water use.

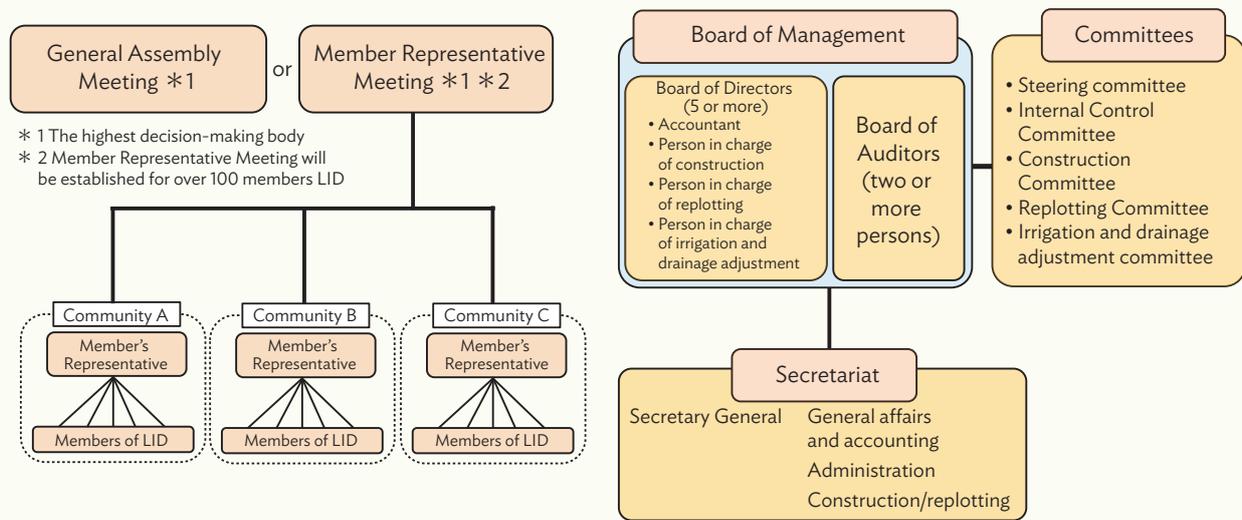
In Japan, fundamentally, farmlands are divided into LIDs, which are nonprofit entities legalized in accordance with the LIA. There are two types of LID. The first type is the land consolidation type, which executes within a specified region the necessary tasks for farmland improvements such as standardizing the field plot size and its facilities and constructing and upgrading infrastructure. The second type is the water management type, which operates and maintains irrigation and drainage facilities above the tertiary level to allocate and distribute water among users, and voluntarily preserves the ecology of aquatic systems and the waterfront landscape. The second type is normally a permanent LID, while the first type may be dissolved, converted to the second type after project completion, or merged into another land consolidation LID for more holistic development of the area.

As mentioned above, in 2021, the total number of LIDs in Japan was estimated as 4,203 with 3.43 million beneficiary members from an area of 2.48 million hectares. In 2001, these numbers were 6,816, 4.26 million, and 2.97 million hectares, respectively. Many LIDs were consolidated and the number has decreased, while the number of members and the area have also decreased due to nationwide changes of agriculture. The smallest LID command is less than 100 hectares and the largest could be as sizeable as about 10,000 hectares.

A typical structure of a LID is depicted in Figure 12.3. A general assembly, or board of representatives in case of more than 200 memberships, must be held at least once a year for the LID decision-making through equal voting rights and in a democratized manner. The boards of directors and auditors, which are recruited for a specified period, normally 4 years, administrate the LID. According to the LIA, the Ministry of Agriculture, Forestry and Fisheries may request technical and accounting reports from the LIDs, conduct on-site inspections, and compel the staff to carry out the necessary actions for whatever appears violating.

Operation and maintenance costs as well as staff remuneration and administrative expenses are basically collected from members, generally on an acreage basis. The national and prefecture governments subsidize the construction costs according to subsidy ratios dependent upon the project type and size. For the costs uncovered by official subsidy, the LID can borrow long-term loans with low interest to be redeemed as special fees collected from farmers subsequently. The LID can gain additional income from electricity companies for installing electric posts in farm roads and bridges, and from factories and houses for water disposal into drainage canals.

Figure 12.3: Typical Structure of a Land Improvement District in Japan



LID = Land Improvement District.

MAFF (2023).

Operation and maintenance of irrigation facilities by LIDs

The construction or improvement of irrigation facilities, including reservoirs, diversion works, pumps, and canals, is carried out by the national and local governments, or LIDs, depending on the scale of the facility or the beneficiary area. After the construction of the facilities, the operation and maintenance of are carried out by the LID, even if the government constructs the facility. In this case, the LID is usually entrusted with the operation and maintenance by the national or local governments, and in some cases the ownership of the facility is transferred to the LID depending on the size of the facility and other conditions. In 2023, in the major river systems of Japan, according to the MAFF statistics (MAFF 2023), 427 dams for agriculture and disaster prevention on farmlands are in operation, of which 148 dams (35%) are constructed by the national government and the national agency, and 255 dams (60%) are constructed by the prefectural or local government. Of these 427 dams, nearly half, 193 dams (45%) are operated and managed by 111 LIDs. LIDs also manage and control approximately 9,300 diversion works, 15,200 irrigation tanks (ponds), and 27,000 pump stations for irrigation and drainage.

On the other hand, national or local governments carry out the management of larger facilities, including large reservoirs and diversion works constructed across larger rivers and drainage pumping stations, which benefit extensively non-farmland. In the operation and maintenance of irrigation facilities, the LID responsibility is limited to control structures and canals above the tertiary level. Farmers' groups and individuals manage and control all facilities at tertiary and field levels.

In most cases in maintaining the canal by the LID, the cost of repairing canals is borne by the LID, while the labor for mowing and removing accumulated sediment in the canal is provided by LID members. The roles of operation and maintenance of the facilities are shared with the national government, prefectural government, and the LID according to the scale of facilities.

LIDs are inspected as necessary by the national or prefectural governments based on the LIA. The inspection consists of the organization's business operation (appropriate staffing, consultation services, accounting), and strengthening of the organization's operational infrastructure (proper identification of membership eligibility, proper collection of levies), etc. The national or prefectural government may order necessary measures to correct any violations (MAFF 2023).

12.4.2 LIDs in Decentralized Irrigation Management Arrangement

Hierarchical structure of LIDs and irrigation management institutions

On-farm or tertiary-level irrigation facilities in a command area of the LID are operated and maintained by community-based farmers' associations. Water user farmers are responsible for maintaining and cleaning one or two diversion works subject to their location. They are assigned this task by the LID on a voluntary basis or very cheap payment. While the law authorizes the LID, most of the community-based farmers' associations are not officially authorized. However, the allocation of roles in the operation and maintenance of the irrigation system is functioning well, and water distribution conflict at the tertiary level is to be autonomously settled by the association that manages the system at that level.

Here, the point that we should be aware of is that the role of the tertiary-level association is indispensable to the operation and maintenance of irrigation facilities and that it could function even if it is not legally authorized.

In the case of the irrigation system with a large command area, a federation of LIDs may be organized with some LIDs, with certain conditions. It holds a hierarchical structure consisting of some layers. Large-scale irrigation and drainage facilities, whose operation and maintenance management may affect the regional hydrological environment and/or socioeconomic activities widely, are officially under the direct control of the national or local government. Some of them are entrusted to the LID for operation and maintenance.

In Japan, there is a prefecture federation of Land Improvement Associations in each prefecture consisting of almost all LIDs in that prefecture and one national federation of Land Improvement Associations. These federations can work on political and/or strategic problems related to irrigation and drainage.

This hierarchical structure of LIDs is functioning well. Water distribution among farmers at a tertiary level is controlled by rural communities according to their environment and socioeconomic situation, and the LID tries to realize a stable water supply to the community level without any lack or excess and equitable allocation of water among tertiary level canals, monitoring and assessing the water demand on-farm level. The activities of LIDs may contribute to efficient water use, appropriate operation and maintenance works, and proper rehabilitation planning.

Liaison of LID with the centralized arrangement of government organization

LIDs in Japan usually work in close communication with a government organization like a regional office of the prefectural government. When LIDs form a federation in a prefecture, the federation may work in cooperation with the prefectural government itself. Also, the National Federation of Land Improvement Associations keeps a good relationship with the MAFF, which holds the jurisdiction over irrigation and drainage policy and administration.

As mentioned above, the operation and maintenance of irrigation and drainage systems are primarily executed by water user organizations like the LID. There is no government employee or engineer who does daily routine water management practice at the farm level, that is the bottom level of a government institution.

The liaison with the government organizations, while they are often centralized regimes, the LID can obtain useful instructions or information from the government and transfer actual conditions or problems to it. The LID can propose an irrigation improvement project and the government can suggest appropriate projects to the LID.

12.5 Recent Problems and Challenges of Water Management Organization in Japan

12.5.1 Agricultural Labor Force Decrease and Countermeasures

Currently, Japanese agriculture is facing the challenge of a super-aging farmer. As of 2018, the ratio of people aged 65 and over to the total number of farm households reached about 44%, and along with this, the total number of farm households and farmland have been consistently decreasing (the number of core agricultural workers is 1,451,000 (in 2018, it decreased 3.8% from the previous year.)

Under these circumstances, in order to maintain and develop agriculture into the future, it is necessary to save labor and grow agriculture as a vital industry. For this reason, in Japan, the public and private sectors are working together to promote the introduction of smart agriculture, such as large parcels of farmland and the concentration of farmland in the hands of leading farmers, as well as the conversion to highly profitable crops such as vegetables and fruit through the improvement of paddy field drainage and the use of information and communication technology, such as automated irrigation systems and automated farm machines.

In recent years, these measures have led to an increase in the agricultural management area per farm household (about 2.5 hectares in 2018), as well as an increase in the number of cooperative organizations of farmers in the village and farm management organizations under corporate management. These organizations are not free and independent farming by individual farmers, but more efficient farming organizations by groups of farmers, and organizations that aim for more economical management through the organization of corporations. In addition, total agricultural output, which had been declining, has increased for 3 consecutive years since 2015, with total agricultural output in 2017 of ¥9.3 trillion (up 0.8% from the previous year), and farm income is also increasing.

Meanwhile, in order to maintain farmland and agricultural facilities in the future, Japan has been implementing initiatives to evaluate the multifaceted functions of agricultural and rural areas and to support irrigation facility maintenance and management activities not only by farmers but also by nonfarmers.

- (i) **Farmland accumulation and expansion of farmland size**
The government is promoting the accumulation of large tracts of farmland and its use by bearers, or leading farmers, through field maintenance, as well as the upland crop cultivation with the improvement of paddy fields through the introduction of subsurface drains and groundwater control systems.

(ii) Smart agriculture

In Japan, the introduction of automated farm machinery that utilizes global positioning systems is being promoted in many regions. In addition, automatic water management systems that remotely and automatically supply and drain water to paddy fields based on information obtained from paddy field water-level sensors are being introduced to achieve optimum water management. In addition, the system enables the efficient use of irrigation water through optimal water management.

In the recent developments described above, it is true that the number of farmers is declining and aging, but the basic principles of traditional community-based self-governing organizations, such as village units, are still in place, and the sense of sharing and cooperative management of water utilization facilities and agricultural infrastructure among residents, including nonfarm households, has been inherited. The community-based organization is not merely a functional organization for agricultural production, but a regional organization consisting of the members of the community, and continues to be an organization that jointly conducts daily activities such as community cleaning and fire prevention, festivals including religious events, and preservation of the landscape and ecosystem. This is the root of the motivation and direction to maintain and preserve farmland, and agricultural water use facilities leading to sustainability of agricultural production and rural areas.

12.5.2 Promotion of Operation and Maintenance of Irrigation Facilities Based on Evaluation of the Multifunction

Agriculture and farming villages not only support food, but also perform various functions through agricultural production activities, such as conservation of national land, cultivation of water resources, conservation of biodiversity, formation of landscapes, and transmission of traditions and culture.

The monetary value of multifunctional functions is estimated to be approximately ¥8 trillion in the agricultural sector in Japan alone. The Japanese-type direct payment system was positioned as a legal system in fiscal year 2015, providing support for cooperative activities such as mowing of farmland slopes and repair of waterways, farm roads, and reservoirs, as well as promoting the participation of local residents other than farmers.

In particular, terraced rice paddies are regarded as valuable assets with traditions, culture, and beautiful scenery that have been built by farmers over a long period of time and protected through cooperative activities. Recently, rural development has been promoted through exchanges with urban areas, taking advantage of the landscape and traditional culture of these terraced rice paddies.

12.5.3 Disaster Prevention and Mitigation Measures in Rural Areas

In recent years, Japan has been promoting measures for national land resilience to create disaster-resistant rural communities in the face of frequent natural disasters such as large-scale earthquakes and torrential rains. Major natural disasters in recent years include the Great East Japan Earthquake (2011), the Kumamoto Earthquake (2016), the Northern Kyushu Torrential Rainfall (2017), and the July 2018 Torrential Rainfall (2018).

In the field of irrigation and drainage, agricultural irrigation facilities such as dams and head works will be made earthquake-resistant, and drainage pump stations will be developed to prevent flood damage. Measures that combine hard and soft measures such as selecting 10,000 reservoirs as “priority reservoirs for disaster prevention”, creating hazard maps showing evacuation sites and routes, repairing embankments, and conducting disaster prevention drills with local residents, are being implemented.

In addition, many of Japan's irrigation and drainage facilities were constructed during the period of rapid economic growth after the Second World War, and as these facilities have aged, the number of sudden accidents such as water leakage has increased. In order to maintain the sustainable functionality and safety of irrigation and drainage facilities, a diagnostic investigation of facility functions is being conducted to extend the service life of facilities and reduce life cycle costs through partial repair and renovation.

12.6 Conclusion—Lessons from Japan's Irrigation Management System and Organization

The agricultural water management organizations in Japan have been internationally recognized as a representative example of farmers' participatory water management, while recently they have been facing serious challenges. Based on their achievements, they have been used as a reference for improving agricultural water management organizations in developing countries, and their concepts and institutional designs have been introduced in Japan's overseas aid programs.

The Japanese LID could be a good model for decentralization in irrigation management. Even if Japan is located in a humid area with a lot of rain with completely different conditions from the countries in arid or semi-arid regions, we can learn important lessons from Japan's irrigation management system and might transfer useful experience. Major points of the important lessons are summarized as follows (Watanabe and Ogino 2003; Watanabe 2002; Kotb, Watanabe, and Ogino 2000):

- (i) District-level or branch-canal-level government irrigation management is to be privatized and renovated to a nongovernment organization, while government organizations at the upper level, such as the irrigation directorate of a national government, should keep their government identity.
- (ii) Each water users' association at the tertiary level is represented by its chairperson who shall be elected by an impartial voting system based on actual land holding or cultivation in the beneficial area. The chairperson of the association joins in electing the president or representative director or directors of a higher-level organization such as a district-level organization under the supervision of the government responsible for irrigation and drainage.
- (iii) The president and board of directors of district-level organizations are responsible for making all decisions regarding water resources management, environmental conservation, infrastructure maintenance, and construction.
- (iv) In the district-level organization, engineers, technicians, and clerks are its executive body.
- (v) In the cases where irrigation management at the district level is transferred from the government to the farmers' organization, the government engineer or employee involved at the irrigation district management level could be also transferred to the farmers' organization.
- (vi) The local government organization should regulate water among the district-level organizations located in its command area, supervise the performance of the farmers' organizations, hold the right of technical and financial inspections whenever necessary, and possess the power to oblige the poorly performing organizations to rectify their performance to meet the setup objectives.
- (vii) The district-level organization may also submit detailed proposals of large-scale projects to the national or local government requesting government finance. The project can be categorized as a large project according to the benefited area and the number of beneficiaries from all sectors. The government assesses the feasibility of the project and decides the appropriate procedures for implementation.

- (viii) Irrigation management organizations of every level will form a research program with a chairperson and board of directors to exchange their farming and institutional experience, collect farmers' common requests, and investigate and convey them to the regional federation of water use associations. The nation-level federation of water users' organizations could be the top assembly of farmers' representatives throughout the whole country.
- (ix) The institution of irrigation management described above is apt to be a closed and self-righteous system. Then, its accountability is to be clear and the system is to be operated fairly.

In developing countries, there are cases where there are no clear rules for equitable distribution of irrigation water, and therefore, the operation of irrigation facilities by nonoperators, unauthorized water withdrawal, and communal cleaning of canals for maintenance are often not properly implemented. Therefore, problems such as irrigation water being limited to only some farmlands in the beneficiary area have occurred. Although the causes of these problems vary from country to country and from district to district, it is important everywhere that water management is properly organized and managed, and that irrigation facilities are properly maintained and managed. There, it is necessary that the division of roles between the government and farmers, etc., is properly defined in order to achieve common goals.

Although the background conditions are different from those in developing countries, the Japanese irrigation management system, which was built around paddy rice cultivation and has been passed down through the changing times, can serve as a reference for improving irrigation management in developing countries. Japanese institutions and technologies for paddy irrigation management provide useful knowledge, experience, and lessons for better irrigation management in developing countries. However, it should be noted, of course, that they were developed under Japanese socioeconomic conditions, while fundamental ideas and frameworks of the Japanese lessons are often helpful under other conditions as well. Their major points to be utilized include the land improvement system (e.g., the establishment of LIDs), the administrative system (e.g., roles and involvement of related organizations), and related technologies (e.g., technologies related to water management and maintenance of facilities), and they are expected to lead to the realization of sustainable irrigated agriculture worldwide.

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PART IV
Climate and Environment

Traditional River Engineering for Social Sustainability and Environmental Preservation

Hirotsada Matsuki

13.1 Introduction

Japan had revitalized agricultural production and commercial transactions in the 17th to 19th centuries in the limited islands under severe monsoon conditions. The active economy of the Edo era was sustained by a functional land management system called “Traditional River Engineering”. This chapter analyzes its concepts and techniques to clarify time-honored lessons for today’s society. The lessons are informative also for other Asian countries, which are challenged now to enrich their economies and ecology in the international market under the changing climate.

The outputs of the traditional engineering systems are still working in rivers in Japan (Figure 13.1).

Figure 13.1: Traditional River Engineering in Japan



Masonry groynes (Onga River)



Embedded spur dikes (Kiso River)



Timber skeletons (Kamanashi River)



Pile groynes (Ibi River)

Source: Taken by the author.

Those systems various materials and structures. However, engineers selected and maintained them for appropriate river management according to traditional engineering.

To understand the ingenious techniques, the Japan River Council researched them and published a report in 2000 titled “Traditional River Engineering to Carry on Lifestyle and Culture”. The report summarizes the old-fashioned aspects into four general features shown in Table 13.1.

Table 13.1: General Features of Traditional River Engineering As Summarized in 2000

<p>A) Leveraging natural power of rivers</p> <p>So called “energy dispersion”, the engineering prefers to moderate flood wisely using natural power of the river itself rather than control it by force. (Examples: groyne, open levee, forest belt, and their combination)</p>
<p>B) Controlling total damage over floodplains</p> <p>The engineering mitigates total damage using countermeasures in floodplains in addition to river facilities. (Examples: secondary levee, ring levee, mound shelter, and their combination)</p>
<p>C) Adjusted to regional property and river characters</p> <p>The engineering was formulated through try-and-select process for hundreds of years. The non-standardized techniques arrange river facilities respecting local appearance and the individuality of each river. (Examples: a variety of groynes, conventional river ceremonies, etc.)</p>
<p>D) Incorporating river maintenance into people’s life</p> <p>The engineering merges local river maintenance and people’s life to make them continuous. (Examples: monetization of river forest, levee compaction using festival processions, etc.)</p>

Source: Japan River Council Report (2000).

The traditional river engineering had developed locally so that this chapter will focus on the rural community in Japan’s history up to the Edo era. The process of land and water development shows the traditional status of community leaders. Among documents written by them in the Edo era, this chapter will check the “Farmer’s Folk Tale” and the “River Work Handbook” to extract essences of the traditional engineering. The findings help us how to manage rivers and communities in today’s changing climate and local society.

13.2 History and Engineering

Japan has a great variety of rivers with various precipitation patterns, steep mountains, complex topography, and myriad types of geology. The mountains and rivers form outstanding natural beauty and cultural backgrounds. On the islands, many generations looked for better places to live and food supply. They eventually moved onto the floodplains back-to-back with flood risks. The ancestors had to learn how to manage and utilize river resources based on a long-range scenario.

13.2.1 Ancient Land and Water Development

Paddy agriculture came to Japan over 2000 years ago. People started plowing fertile and wet lands with wooden hoes. Native chiefs, who could access iron tools, developed new paddy fields with accessible water resources and away from flood risk. The next generations expanded the paddy little by little to increase the rice harvest and the population over several centuries.

In the 8th century, Japan imported the centralized bureaucracy system from China. Installing the continental system, the Imperial Court owned all land and people. Dispatched domain governors instructed the newest techniques to build irrigation reservoirs. County governors, who were appointed from former native chiefs, managed family registers and granted compartment paddy to each farmer. Farmers had to pay a poll tax and labor services.

The Imperial Court promoted the policy of public land management successfully but soon became deficient in paddy due to population growth. The court then issued a Private Reclamation Order to motivate high-rank temples, shrines, and officials to invest in manor development. It meant that some farmers were urged to penetrate new frontiers in flood-prone areas. They had to open the door to flood risks.

As the first step to live with floods, they needed to develop river infrastructure. The situation was described in the official regulation. The central government issued the “Yoro Code” in 757 to rule how to manage river facilities for disaster risk reduction shown in Table 13.2.

Table 13.2: “Yoro Code” issued in 757

Article Paddy-28: Resettlement after flood
After river erosion, provide new paddy to affected families.
Article Infrastructure-16: Levee to be repaired
Inspect levees near large rivers. Repair breakages after harvesting. After outflowing, recover deteriorations immediately.
Article Infrastructure-17: Vegetation around levee
Plant elms, willows, and others on levees. Supply timber material for levees and weirs.
Article Miscellaneous-9: Natural resources sharing
Share resources from mountains and rivers by all.
Article Miscellaneous-12: Irrigation to be maintained
Command beneficiaries to maintain weirs and channels.

Source: Summarized by the author.

In the floodplains, farmers were often defeated by water-related disasters but survived through the endless repair of river infrastructure. River facility maintenance, emergent recovery, planting, natural resources sharing, and irrigation management were in their day-to-day life and part of collaborative agriculture for all. These were ancient regulations for living with floods and became unwritten customary rules of Japan’s agricultural society.

13.2.2 The Manor System Toward Autonomous Corporation

The ancient society was disrupted by volcano eruptions, floods, tsunamis, earthquakes, and epidemics in the 9th century and a climatic drought crisis in the 10th century. Historians explained that many ancient communities could not endure the severe conditions in past centuries.

In the natural and social hardships, the Imperial Court was concerned by the lack of tax revenue. The court started a land tax system and enacted it each domain. The dispatched governors advertised for

investors for tax-abatement manors. Inspired major aristocrats employed rural manor developers to cultivate paddy. The developers drew water, broke ground, plant crops, and paid tax to the employers and the governor.

The manor system was reset to be managed by the central government in the 11th century. The royal family created enclosed manors that had exclusive farm areas and tax-free privileges. To produce and guard the manors, royal families recruited warriors as armed sheriffs and farm area managers. The warriors held the obligation of tax collection and rights of protection fees. For the wider area management, they developed long irrigation networks which are still working today.

After a big political disruption in the 14th century, land ownership shifted from the capital authorities to local sovereigns. They merged public and private land into their own territory and collected taxes from farming agents. In those days, the farmers formulated autonomous corporations and made deals independently.

However, the local sovereigns struggled with each other for land and hegemony. Surviving feudal lords called for rural warriors to join their armies. Farmers had to go to battles and also defend their own corporations against foreign enemies and natural disasters. That was one reason that the rural warriors became extremely conscious of floods and droughts.

13.2.3 Military Unification and Land Value Survey

The long-lasting inter-domain confusion was unified by force at the end of the 16th century. The conqueror declared a cease-fire and ordered warrior-farmer separation, sword control, and land surveys. Following the mandatory policies, the feudal lords disarmed farmers and survey farmers and farm land to draw a borderline between communities and impose land tax on each community. Estimating the land value of expected tax, the conqueror reallocated the lords into other domains to weaken their military power and eliminate border disputes.

The final winner, who established the Edo Shogunate, terminated all warfare in 1615. To hold the peaceful situation, the first Shogun gave permission for lords to be domain governors and ordered enforcement of security within the domain. The governors gathered their warriors into the domain castle town. Former rural warriors were clearly separated into government officers or rural farmers. After that, the domain government exchanged land value surveys with rural communities. Based on the results, they signed an agreement that defined land ownership of farmers and tax obligation of the community.

The divide-and-rule policy contributed to significant change in rural communities. The communities had no warriors or requirement to do military duty so that the farmers could invest all their resources into agriculture. The community headmen, rural warriors in the previous era, tried to draw up an agricultural schedule, let farmers work industriously, and maximize harvest of the community. As a result, the domain lords' external governance and farmers' autonomous internal management had developed highly productive societies.

13.2.4 River Engineering and Land Ownership

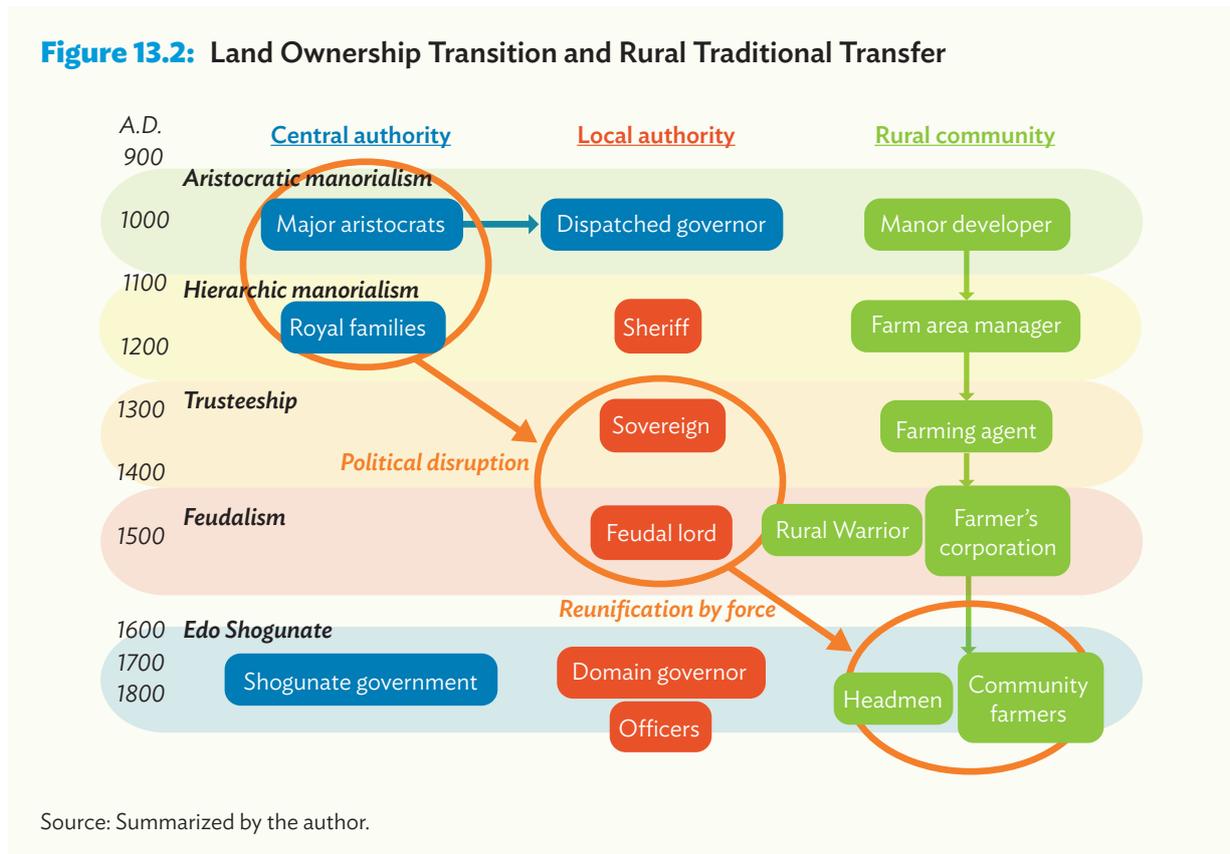
The history of Japan's rural society outlines two trends: river management obligation and land ownership.

River infrastructure was needed in the floodplains. With no reference to central or local governance, rural farmers had a mandate to maintain river facilities and accumulate experience. The knowledge was transferred as traditional engineering.

Land and people belonged to the central government and ancient aristocrats. While local warriors took the initiative, rural farmers became autonomous through their collaborative work and self-defense. Land contracts in the Edo era warranted a farmer’s ownership of land.

Owning traditional engineering transfer and land ownership transition, community headmen held river management engineering with pride and positive interest. Respecting community ownership, government officers sophisticated it to use it for rural management (Figure 13.2).

Figure 13.2: Land Ownership Transition and Rural Traditional Transfer



13.3 River Engineering in the Edo Era

The Edo era lasted 260 years with no warfare. During the peaceful period, the Shogunate and domain governments set a fixed tax amount rather than tax rate. It gave a great motive for community headmen to raise agricultural productivity to save excess harvest. Domain officers had another intention not to lose tax revenue by technical and financial assistance to each community and disaster damage control among communities. Their mindsets and techniques were described in the “Farmer’s Folk Tale” and “River Work Handbook”.

13.3.1 “Farmer’s Folk Tale”

A community headman wrote down findings in his community and lessons from other domains in the “Farmer’s Folk Tale” (*Hyakusho-denki*) in 1680. He recognized river maintenance as a farmer’s mandate with thanks to ancestors and messages to descendants.

The writer of the Farmer's Folk Tale stressed ownership of river infrastructure: he was educating farmers to maintain the infrastructure themselves. He explained the need for emergency calls for fighting floods and respect for the government officers. His messages can be summarized into two points: "routine maintenance" and "emergency control".

Ownership

A drop of water should be cherished, however, too much water would collapse mountains, wash away farmland, move houses away, and leave severe damage. Natural disasters are beyond our capacity as we cannot stop the river by hand. However, we must minimize flood damage every year through repairing ponds and rivers that have protected communities for a long time. Since ancient days, the maintenance of levees, irrigation, and rivers has been an essential mandate of farmers. The primary responsibility is to save the next generations from water disasters.

Levees

Levees are built around paddy and houses of communities. These are the most important facilities and include castles for warriors.

Good levees built by experienced engineers would not be breached even though massive floods occur. While bank-full floods overflow the levees, levees should be protected by any means possible.

Levees should be built for large-scale rivers to keep wide floodways, slow room for outflow, and plant crops on the space.

Groynes

Levee breaches can be prevented by building groynes. At bends in rivers, river flow scours the riverbed and gradually erodes the levees. Levee protection is not effective for progressive meandering. In this case, groynes can be built on both sides of the river to moderate flow, reinforce the levees, deposit sand in the pools, and shift thalweg (lowest line on the riverbed) away from the convergence points. Floods attack such sections. Usual river works are the most important preparation.

Withstand bank-full floods using stone groynes, timber cribs, bamboo gabion, willow planting, and grassing. Continual river works save paddy and houses. Careless river work ruins crops and leaves damage. Less preparation brings more damage. Inspect rivers and repair infrastructure. It is a lesson to live around rivers.

Spill levees

Leave bush and forest around the levees of large rivers. In these sections, allow overflow of extreme floods. Never permit overflow at convergence sections, or the main flow would switch the course and cause severe damage. Disperse water at the spill levees. It is the theory of levee protection.

Flood fighting

Mobilize the workforce at all levee sections for flood fighting. Small numbers of personnel can cause early levee breaches. Rural officers should be informed of the levee conditions and the crop situation. The officers might decide to breach a levee intentionally to minimize total damage, estimating rescue of farmers and horses. Today there is a small amount of damage around large rivers thanks to levees, groynes, skeletons, and cribs. However natural pools and riffles are always shifting to make dangerous conditions.

Flash floods

Flash floods rush out rapidly, collide with bends in the river, erode riverbanks, run out of the river, breach levees to wash out paddy, and deposit sand. It is important to moderate flash floods within the river, separate water out of planted levees and discharge water quickly.

13.3.2 “River Work Handbook”

A river engineer published “River Works Handbook” (*Kawayoke-shiyochō*) in 1720. The writer was a professional engineer in a government agency. He aimed to transfer the knowledge of how to manage rivers and floodplains to young successors.

The handbook showed consciousness and responsibility of professional river engineers. Because the author had a role as a tax levier, he mentioned overflow and crop damage. His sense was “Not to defeat rivers but withstand floods”. He stressed the importance of river training and routine maintenance.

Never robust

River work intends not to defeat rivers but to withstand floods. Non-professional people usually believe that bigger structures provide better protection. Ignorant farmers often want huge infrastructure, but this can be misunderstood. Many years of research shows that robust facilities attract strong flow to make deeper scouring and finally cause riverbank erosions. In such cases, the riverbank becomes unrepairable.

River work aims to make the riverbed flatter and the thalweg smoother.

Levees

Levees can be built to prevent outflow, but levees as high as the possible maximum flood level are not manageable. The crest part is dry and animals make their tunnels in it. The tunnels can be a water path during bank-full floods to cause huge levee breaches that would wash paddy away and require many years for recovery.

Build middle-level levees. These have easy access for flood fighting work. Keep the crest flat to allow overflow equally avoiding flow convergence. Then the overflow might harm crops of this year only, but it will not ruin the paddy itself.

Groynes

Groynes of 10 meters long can be embedded at high overflow sections. Never set groynes at high riverbank sections, or flood water would wash the riverbank out.

Maintenance

River work should be conducted every spring and autumn. In spring, reinforce river facilities to prepare for oncoming flood risks. In autumn, restore river facilities with timber and bamboo of better quality. Through the year, repair any breakage immediately. Besides them, monitor the river flow and improve the facilities as needed.

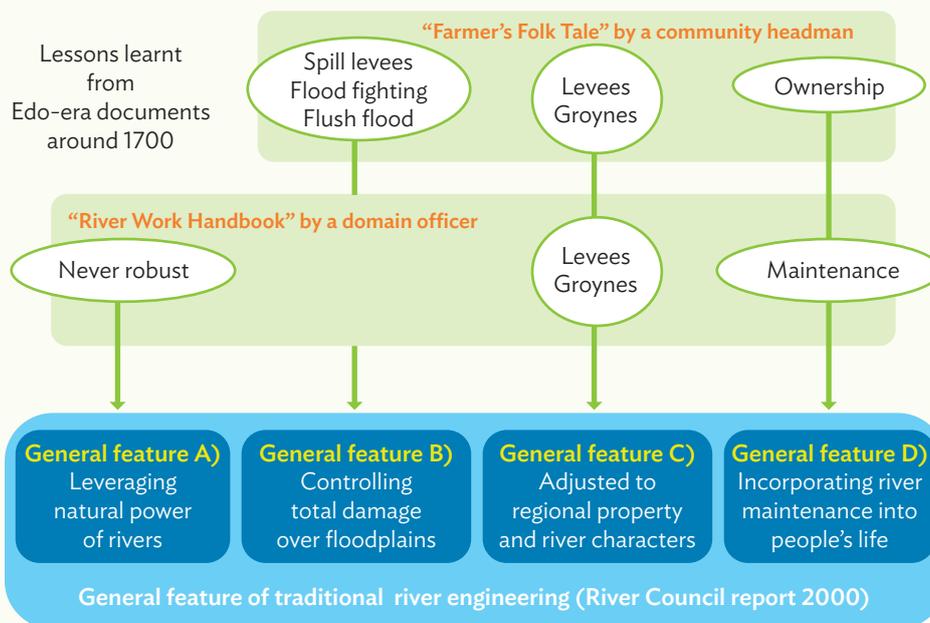
13.3.3 Lessons from the Edo Era

The writers' lessons come from 300 years of Japan's river management. The Japan River Council found general features (GF) and divided them into four categories.

The veteran engineer's "never-robust" concept is a root of "leveraging natural power" (GF-A). "Spill levees, levee maintenance, and flood fighting" are suggestions for "total damage control" (GF-B). "Levees and groynes" are partially used today to "adjust to site conditions" (GF-C). "Maintenance" and the community's "ownership" are the basic notion for "involving people" (GF-D) (Figure 13.3).

These are still valuable viewpoints to consider floodplain management and water-related risk reduction under uncertainty in the future.

Figure 13.3: Lessons of Old Documents and General Features of Traditional River Engineering



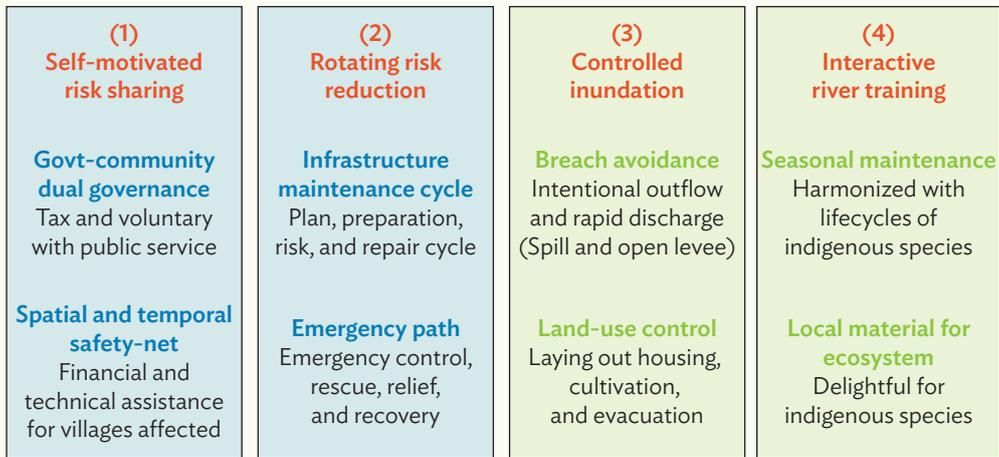
Source: Summarized by the author.

13.4 Contemporary Evaluation of Traditional River Engineering

Since ancient times, farmers in flood-prone areas could not survive without river infrastructure. Traditional river engineering developed facilities in rivers and upgraded damage control in the floodplains. It became a core technology to stabilize local society in the Edo era.

Four important points can be analyzed for today's society: (1) self-motivated risk sharing, (2) rotating risk reduction, (3) controlled inundation, and (4) interactive river training (Figure 13.4).

Figure 13.4: Contemporary Context of Traditional River Engineering



Source: Summarized by the author.

13.4.1 Self-motivated Risk Sharing

In the Edo era, communities produced agricultural commodities and paid taxes as sources of social vitalities. The domain government provided a security service for all communities resolving some conflicts among them. It was peaceful government–community interdependency within the domain.

Once an inescapable and catastrophic disaster broke out, however, communities in trouble could not reap the harvest. In such cases, the government would arrange financial and technical assistance for the communities affected. The domain government supplied food aid, material delivery, workforce mobilization, tax exemption, and engineering guidance to cope with abnormal river conditions (Figure 13.5).

Figure 13.5: Self-motivated Risk Sharing



Source: Summarized by the author.

These were needed for not only communities, but also for the government to ensure tax revenue in the following years. The emergency control scheme was working spatially and temporally as a safety-net against disaster risks.

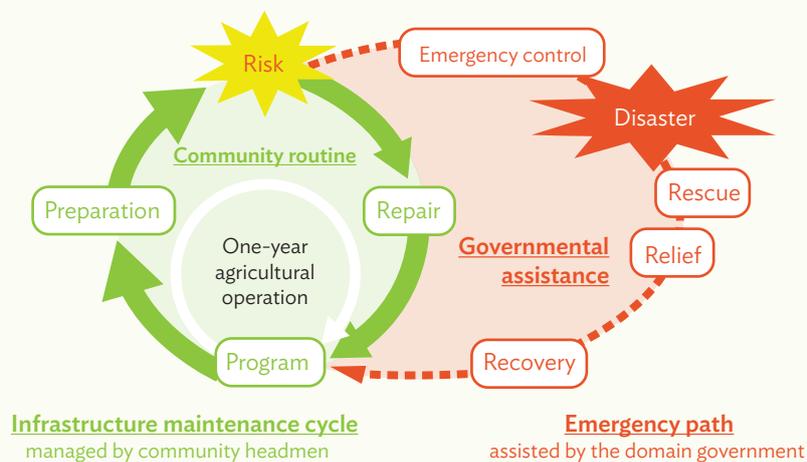
13.4.2 Rotating Risk Reduction

Understanding disaster risks, community headmen programmed facility maintenance synchronizing it with the community's agricultural operations. They injected materials and a workforce procured within the community to meet urgent needs during floods. Therefore, river facilities were repeatedly maintained in a 1-year cycle including spring preparation and autumn repair (Figure 13.6).

In case of large floods once a decade for instance, communities took counteraction to protect lives and assets. However, the scale of the disaster was sometimes beyond the capacity of the communities. Then, as a part of the security service, the domain government would dispatch emergency control officers to the communities at risk. During flood events, they supervised flood fighting activities. When actual disaster damage occurred, they carried out extra support such as rescue, relief, and recovery.

There were two separate roles. Community headmen had to manage the community to allocate resources to implement the infrastructure management cycle 10 times per decade. The government officers had to prepare the emergency path every year to assist some potential communities. The divisional cooperation accomplished a rotating risk reduction.

Figure 13.6: Rotating Risk Reduction



Source: Summarized by the author.

13.4.3 Controlled Inundation

River engineers put their top priority on breach avoidance. For straight levees, they often designed half-spec heights and vegetation coverage. These were spill levees to allow overflow without breaching. They arranged non-levee sections for rapid discharge from the floodplains. These were open levees. The intentional inundation was to omit water-level rise by river facilities and prevent unpredictable levee breaches.

According to the levee layout, community headmen outlined optimum land-use of flooding blocks. They allocated housing zones, cultivation fields, and evacuation centers to keep away from catastrophic loss and aim for the earliest recovery.

Traditional river engineering accepted inundation as a given. From the viewpoint of an ecosystem, river channels and floodplains frequently or intermittently connected each other. It meant water creatures had many chances to extend the habitat.

13.4.4 Interactive River Training

Community-based maintenance had a process of an active approach to the river and a reactive feedback from the river. Community workers continued the interaction through yearly cycles using local materials.

The seasonal cycle was harmonized with farmers' activities as well as the life cycle of wild creatures. The riverfront habitat dynamism was preserved by repeating river maintenance. The conditions were attractive for indigenous species in the local biosphere.

13.4.5 Contemporary Context of Traditional River Engineering

These analyses can indicate essential lessons on how to use traditional river engineering in today's modernized society.

One key element is community autonomy. Japan's land development history tells us that rural communities achieve land ownership in exchange for tax obligation. Then they attained government security enforcement including defense from foreign enemies. Under the guarantee, communities could save their resources for agriculture and other business.

Another topic is cyclic management. Community headmen encouraged 1-year agricultural operations together with the infrastructure management cycle for disaster risk reduction. They utilized the local budget, local materials, and the local workforce of their community. All resources were generated within the community.

The community autonomy and the cyclic management were primary fundamentals of traditional river engineering. Today's socioeconomic conditions are unlike the Edo era. However, the contemporary context is suggestive in today's Japan and in neighboring countries.

Self-motivated risk sharing

- Government–community dual governance
- Spatial and temporal safety net

Rotating risk reduction

- Infrastructure maintenance cycle
- Emergency pass

Controlled inundation

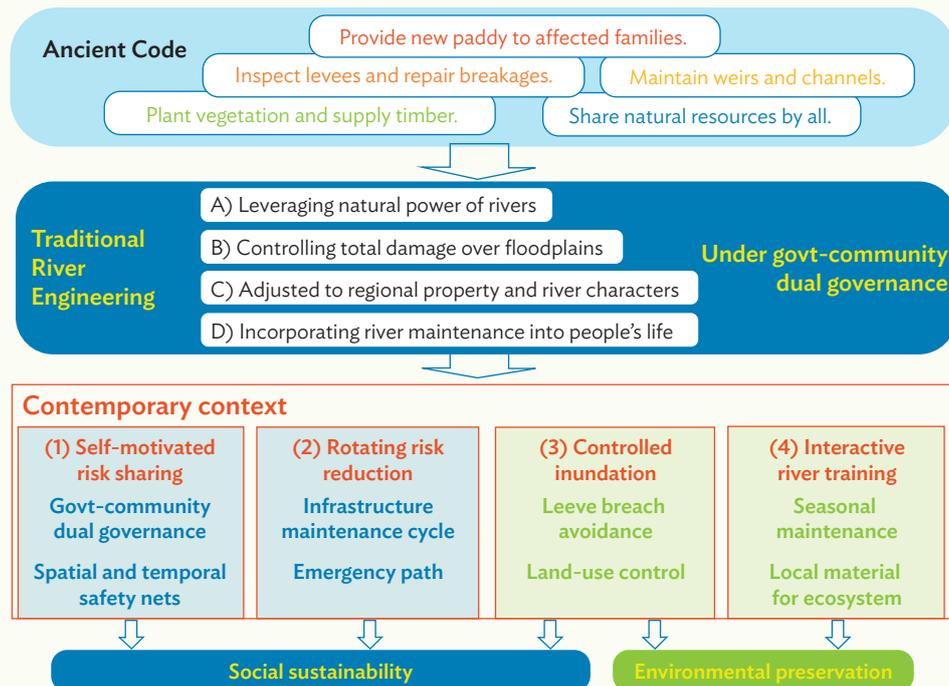
- Levee breach avoidance
- Land-use planning

Interactive river training

- Seasonal maintenance
- Local materials for ecosystem

To build capacity for disaster risk reduction, it is recommended that rural communities design an infrastructure maintenance cycle using resources within the community. At the same time, local governments should provide safety nets for extreme events. It is a down-to-earth approach to accomplish social sustainability and environmental preservation (Figure 13.7).

Figure 13.7: Engineering for Social Sustainability and Environmental Preservation



Source: Summarized by the author.

13.5 Conclusion

Since 1868, Japan has reformed its political protocol. The revolutionary government installed democratic governance, monetized taxation, mechanized engineering, and introduced other modern systems into the society. While these powerful engines boosted Japan's national economy, traditional river engineering was rebuilt in a new legal framework such as the River Law in 1896.

One hundred years since then, the rivers in Japan were improved for flood control and water resources storage. Against repeating water-related disasters, increasing safety levels accelerated Japan's national economic growth. However, negative impacts like environmental pollution would alter people's mindsets. Finally, at the end of the 20th century, Japan's general requirement shifted from quantitative wealth to qualitative richness. People were aspiring for a rich environment, beautiful scenery, and local narratives around waterfronts as precious open-spaces of water and green.

Besides that, Japan has been struck by devastating disasters such as the Great Hanshin-Awaji Earthquake in 1995 and the Great East Japan Earthquake and Tsunami in 2011. More frequently, high records of rainfall have caused massive floods that exceeded the capacity of river facilities.

In order to respond to such expectations, one practical approach is “learn from history”. The traditional river engineering in the Edo era showed actual outcomes. The engineers hedged water risks in whole basins and sustained local societies that preserved a sound ecosystem for natural creatures and human beings. The engineering-based approach and local-driven management can achieve both disaster risk reduction under a changing climate and a nature-friendly ecosystem with green infrastructure.

The features of Japan’s traditional engineering can be used as examples for river works in other Asian countries. The author had technically assisted riverbank protection projects in the Lao People’s Democratic Republic (Lao PDR) and Viet Nam (Figure 13.8). The prefectural engineers constructed some structures with local materials and a local workforce, and succeeded to leverage the natural power of the rivers.

Figure 13.8: Traditional River Engineering Applied in the Lao PDR and Viet Nam



Masonry groynes
(Mekong River, Lao PDR, 2000)



Submerged bamboo gabor
(Huong River, Viet Nam, 2012)



Masonry groynes
(Rao Nan River, Viet Nam, 2015)



Masonry groynes
(La River, Viet Nam, 2015)

Source: Taken by the author.

Traditional river engineering should not be an old technique found only in museums. It is applicable to the latest demands of changing societies. It is fruitful to enrich people’s livelihoods and local society’s conditions not only in technical matters but also in economic and environmental aspects. Traditional river engineering holds great potential to a better “River Culture” for sustaining society and preserving the environment.

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A Review of Public Awareness of Water Source Regulations and River Management in the Republic of Korea

Ik Jae Kim and Mynhyun Ryu

14.1 Background

Providing a stable supply of abundant sources with good water quality from reservoirs, rivers, and groundwater to citizens and nature is a nationally-shared responsibility and fundamental for balanced regional development. However, urgent policy issues on water source protection have emerged recently. In March 2017, three residents in Seoul, the Republic of Korea filed a constitutional petition with the Constitutional Court, claiming that the collection of a water use levy violates Article 37(2) of “Excessive Funding Principle”, and Article 11 of “Equality Principle” in the Constitution. Since 1999, the water use levy has been collected along with water bills to preserve a good quality of water supply based on the Acts on the Improvement of Water Quality and Support for Resident of the River Basins. Eight of the nine justices of the Constitutional Court ruled that the collection of the water use levy, which some citizens perceived as a heavy and improper regulation, was not unconstitutional because it is in line with the State’s responsibilities, emphasizing that improving the quality of the water supply is an important public task and is closely related to the health and living environment of the people of the Nation (Constitutional Court, Case No. 2018HUB425).

In October 2020, the mayor of Namyangju City and residents of Joan County in Gyeonggi Province filed another Constitutional Court case, claiming that Article 7 of “Designation of Water Source Protection Areas” in the Drinking Water Management Act was unlawful. The litigators argued that the Regulation of Paldang Lake Water Source Protection Area in the Drinking Water Supply Management Rules violates the freedom of occupational choice, equal rights, and property rights guaranteed by the Constitution. The case has been pending for more than 2.5 years.

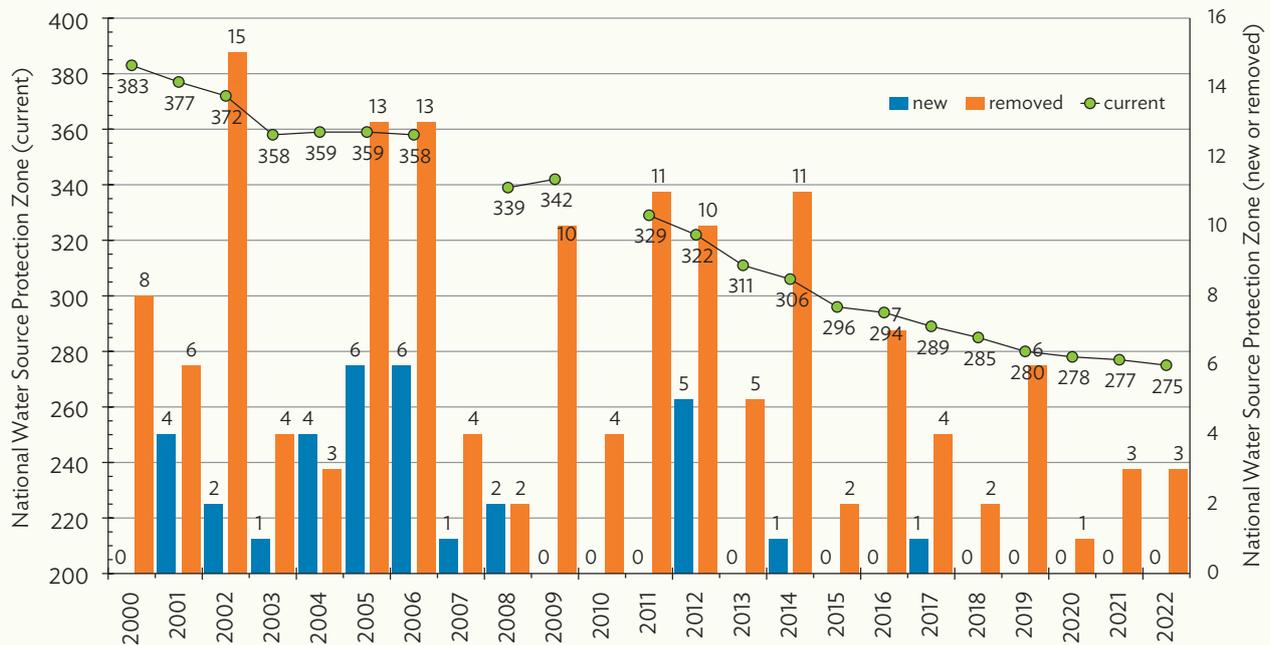
More recently in July 2023, the Board of Audit and Inspection in the Republic of Korea investigated and announced that the decision by the National Water Management Committee and the Basin Water Management Committees to dismantle river facilities a few years ago was not appropriate. Accordingly, the current government and the National Water Management Committee canceled the decision made by the previous committees several years ago.

In this way, for about 6 years in Korean society, there has been a significant shift in public perception and social focus on policies regarding drinking water management and river management among citizens and the government. The purpose of this chapter is to introduce and discuss the recent status of public awareness and satisfaction shown in two policy research studies (which are not published internationally) with respect to ongoing regulations and policy on drinking water and river management policies and suggest future policy projections.

14.2 Trends of Water Source Protection Zones

Water access coverage in the Republic of Korea increased from 87.1% in 2000 to 99.4% in 2021, while the registered population between 2000 and 2021 increased by 10% in the same period. However, water source protection zones across the country from 2000 to 2022 dramatically decreased by 29% (Figure 14.1).

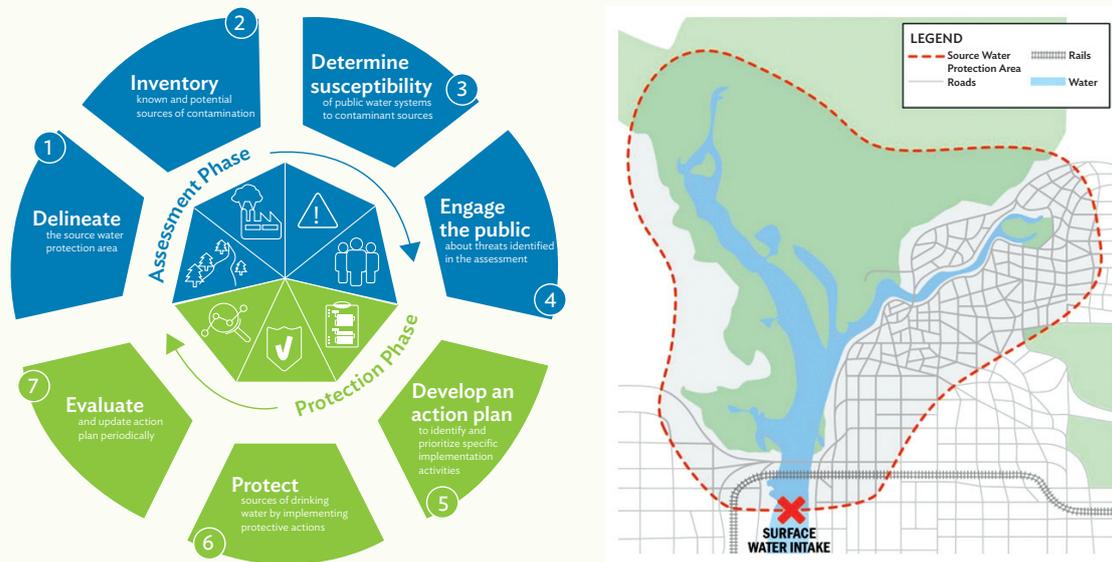
Figure 14.1: Trends of Water Source Protection Zones



Source: Analysis by Kim et al. (2024). Data from Ministry of Environment, Republic of Korea.

The regulations for water source protection zones can be broadly categorized into water quality pollutant regulations and land use regulations. First, water quality pollutant regulations restrict activities within designated water source protection zones that could lead to water pollution. Approximately 60 types of chemicals are prohibited from use within designated zones. Regarding land use regulation, the scope of siting regulations extends to upstream catchment areas up to a maximum of 20 kilometers depending on the capacity of water intake facilities located within designated zones. In other words, factories that discharge industrial wastewater are not permitted to be established on land within the catchment areas, which corresponds to 14.7% (14,743 square kilometers) of the national territory. Only industrial facilities that do not release harmful pollutants downstream are allowed to be established close to the designated zones or water intake facilities. This regulatory policy for protecting water sources in the Republic of Korea is similar to the Source Water Protection Program implemented through the 1996 amendment of the United States' (US) Safe Drinking Water Act (Figure 14.2). It is estimated that policy researchers in the Republic of Korea have adapted the US system for implementation in the Republic of Korean context. In this manner, however, the rapid decline in water source protection zones in the Republic of Korea has various reasons. But it can be attributed to stringent regulations of water quality pollution and siting restrictions.

Figure 14.2: Source Water Protection Program in the United States



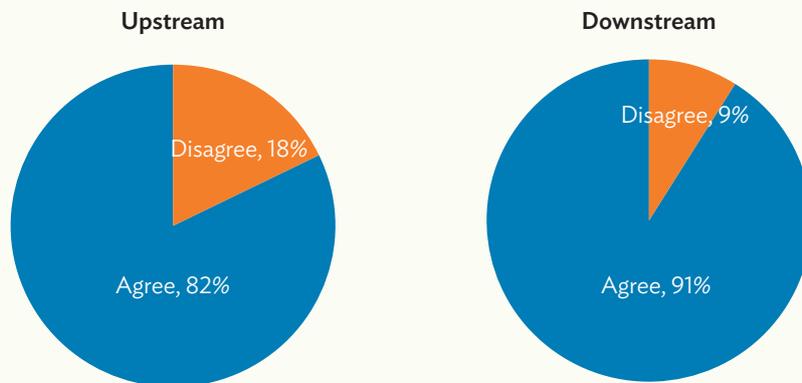
Source: United States Environmental Protection Agency. <https://www.epa.gov/sourcewaterprotection/assess-plan-and-protect-source-water#components> (left), <https://www.epa.gov/sourcewaterprotection/assess-plan-and-protect-source-water#components> (right).

Of course, considering the worsening water quality, increasing trace pollutants, and the emergence of infectious pathogens, there is an opinion that regulations for preventive measures and protection, as they are now, should be maintained. On the other hand, some argue that if regulations were to be mitigated, there should be stricter and more severe penalties for industries or entities responsible for pollution, as the current penalties for violating regulations are relatively lenient.

14.3 Public Awareness of Water Source Regulations

Ryu et al. (2023) conducted a survey to investigate the feasibility of water source protection zones by comparing public awareness in line with the economic aspect of property rights constraints and societal benefits between upstream and downstream residents in the Han River and Nakdong River basins. A total of 1,000 households were surveyed, with 500 households each from the upstream and downstream areas. Survey results showed that 89.2% of respondents in the upstream area and 73% of respondents in the downstream area had heard of the water source protection zone regulations (Figure 14.3). Relatively higher awareness of the water source protection zones was observed in the upstream area compared to the downstream area. The study also demonstrated the level of agreement on the necessity of water source protection zones. In the upstream area 82% agreed, while in the downstream area 91% agreed, indicating that both upstream and downstream areas highly recognize the importance of these regulations. A noteworthy aspect was that even in the upstream area, a significant portion agreed on the necessity of water source protection zones. This suggests public awareness of the importance of these zones even among those whose property might be affected by the restrictions imposed by the water source protection zones. It is also important to note the existence of a societal atmosphere or culture in which the public agrees on the necessity of regulations for protecting water sources by restricting industrial site locations. However, politicians elected in areas with high development demands may not be able to ignore the demands of voters who argue for loosening regulations.

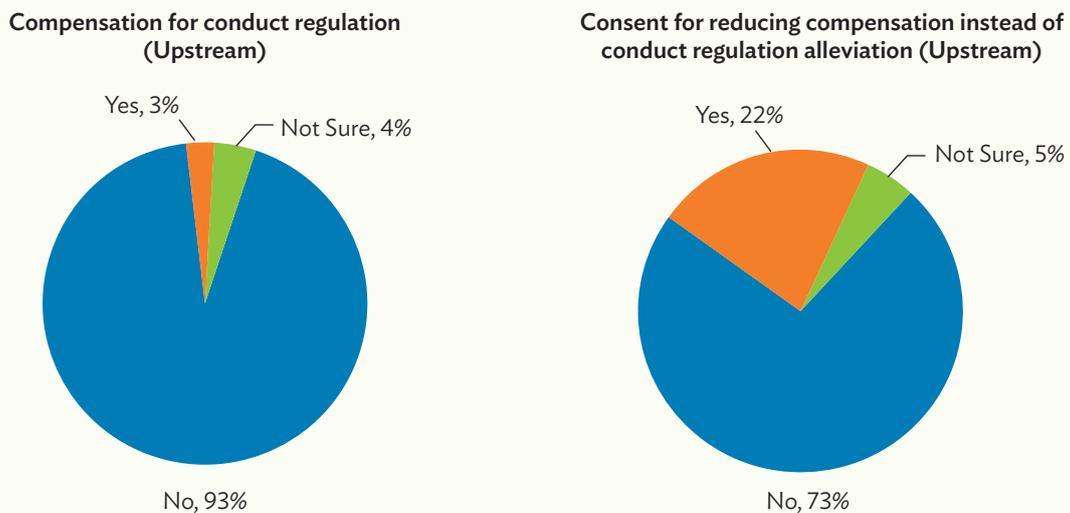
Figure 14.3: Residents' Consent for Water Source Protection Zones in Upstream and Downstream Area



Source: Ryu et al. (2023).

Figure 14.4 presents the results on whether residents in the upstream area who live within the water source protection zones receive compensation due to the regulations. Among the residents living within the water source protection zones, 93% responded that they are not receiving compensation. Additionally, 73% of these residents responded that they do not agree with the proposition of reducing compensation in exchange for relaxing regulatory measures. This result suggests that the residents who participated in this survey have a greater awareness of financial compensation rather than the relaxation of water quality pollution regulations or siting restrictions.

Figure 14.4: Compensation and Consent of Reducing Regulations (upstream)



Source: Ryu et al. (2023).

Therefore, it can be concluded that there is a significant difference in perception between some residents who brought a constitutional petition to the Constitutional Court and those who participated in this survey. This difference in perception regarding regulations can be attributed to the deep contextual relevance and regional characteristics. For instance, residents within source water protection zones located in areas where there is limited land available for industrial development might prefer to pursue business profits through attracting factories, rather than seeking financial compensation. In conclusion, while the law should ideally be applied objectively and equally to all individuals and actions, it can be considered valid to review and improve differentiated regulations that take into account the characteristics of areas where source water protection zones are designated, the features of watersheds and rivers, and most importantly, regulations that can be accepted by both upstream and downstream residents. However, under any circumstances, changes in regulations must not compromise the principles of safeguarding human health through adequate water and good water quality, as well as the sustainable development of the region. Moreover, even if intensity of water regulations were to be lowered, there should be an enhancement of social acceptance and legal accountability. This enhancement should be induced through policy measures to ensure that it becomes ingrained within societal culture.

14.4 Public Awareness of River Management

Across many countries worldwide, the wealthy aspire to live in well-managed riverfront areas and beautiful waterfront locales, while impoverished individuals are often left with no choice but to reside in flood-prone areas and spaces near polluted water bodies or reservoirs. The Republic of Korea has a unique water culture. For example, with a significant portion of its land consisting of mountains, the Republic of Korea is surrounded by the sea on three sides, and rivers are well-developed in valleys and plains. Many place names in the Republic of Korea, as well as personal names, are related to water. While rapid economic development has led to pollution in some rivers, stringent water conservation and environmental policies have gradually improved the quantity and quality of river water. Many people want to enjoy the beauty of river water, and the government and politicians are well aware of this. Therefore, it is important to conduct a public awareness survey regarding river management.

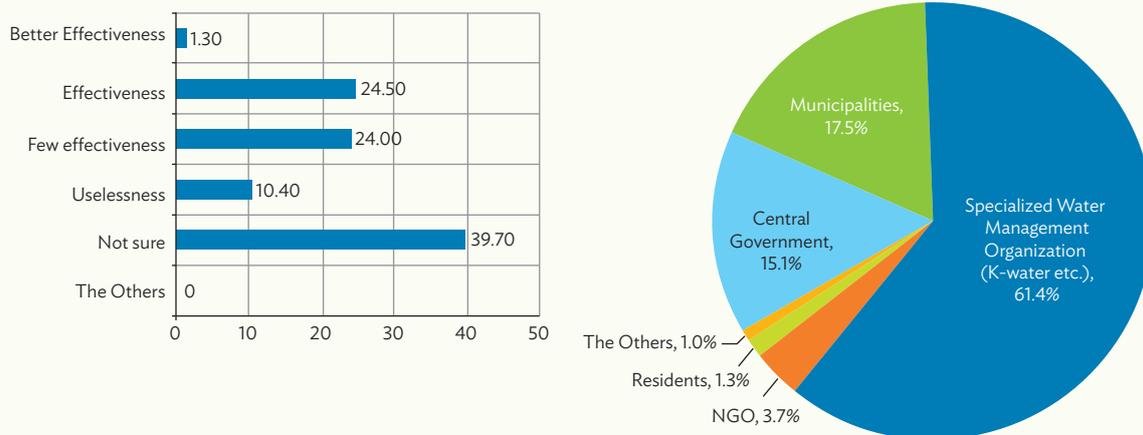
Lee et al. (2022) surveyed public awareness of 383 citizens nationwide, through face-to-face interviews using a convenience sample, on river management. Figure 14.5 represents the survey results for five categories (quantity, water quality, ecological environment, surroundings, flood prevention) reflecting the condition of rivers. Citizens evaluated the condition of rivers as poor in four out of the five categories, except for quantity. Therefore, it is concluded that there is a need for river management policies that citizens can perceive to be in place. According to the Ministry of Environment (2019), the health rating of the national river aquatic ecosystem from 2017 to 2018 showed a slight decrease in the proportion of grades B (good) and above, with an increasing trend in the proportion of grade E (poor). However, there was a significant increase found in 2019 in the proportion of grades B and above, along with a decrease in the proportion of grade E, indicating an improvement in the aquatic environment. Nevertheless, this survey results indicated that 65.5% of citizens have a negative perception of the aquatic environment. Such disparity in perception is believed to stem from inadequate provision of accurate information about river management status and the lack of positive promotion for shifting citizens' perception. This can be attributed to the increasing interest and demands of citizens for various values related to rivers beyond mere flood control and drainage, emphasizing aspects like waterfront spaces and water quality. However, this expansion of societal needs does not seem to align with the perceived lack of change in river management policies.

Figure 14.5: Public Awareness of River Management Sector (%)



Source: Lee et al. (2022).

Figure 14.6: Public Expectations of the National Water Reform and Institutional Preference on River Management (%)



Source: Lee et al. (2022).

Figure 14.6 illustrates the perceived effectiveness of river management and preferences for institutions responsible for river management among citizens following the National Water Reform in 2018. Regarding river management after the reform, the highest response was “Not sure,” indicating that citizens are not perceiving the effects of river management following the centralization of water management. Concerning the institutions that citizens believe are best suited to perform river management, water-related agencies were most preferred (61.4%), followed by local governments (17.5%), the central government (15.1%), citizens’ groups (3.7%), and local residents (1.3%). This suggests that, in order to meet the diverse demands of citizens, specialized expertise is essential in river management, emphasizing the need for professionalism in addressing various aspects of river management.

The climate crisis is dominating national water policies domestically and internationally. In order to meet the diverse needs of its citizens, water policies in the Republic of Korea need to evolve from outdated management regulations. However, the adjustment of water regulations, such as source protection zones and siting limitation, should be overly cautious because if we lose a legal system that can secure sufficient water and clear water, the development of the national economy and communities, as well as the health of individuals and the preservation of nature, will be meaningless. The direction of river management policy also needs to go beyond simple management and seek a sustainable river management plan that harmoniously coexists with humans and nature, and expertise in perspective with integrated water management. Lastly, government policy makers and legislative bodies need to conduct a scientific and thorough investigation of public awareness regarding water culture.

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Transforming Water Resources Management Investment: The Evolution of Cost Sharing among Local Communities, Governments, and the Private Sector in Japan¹

Mikio Ishiwatari and Daniel P. Aldrich

15.1 Introduction

The Asian region, which is frequently impacted by monsoons, requires extensive management of water resources for flood protection and water supply over a wide area to develop its agricultural and economic resources. This monsoon-influenced region stretches from eastern to southeastern and southern Asia, covering most of East Asia, Southeast Asia, and South Asia. The region is home to a large rural population most of whom are engaged in rice cultivation and share a common rice culture.

Water resources management in the region typically involves rivers as core sources of water that provide water to multiple communities. Water resources management infrastructure cannot be financed by individuals alone and requires investment by public, collective, or private capital. Thus, financing and cost sharing among national and local governments, the private sector, and local communities are essential for constructing and maintaining facilities.

Japan, located in the monsoon region, has managed rivers throughout its history in a variety of ways, including using waterways as transportation infrastructure along with flood mitigation. These strategies involve a combination of improving drainage and providing water for agricultural fields as well as improving the flood flow of river channels in low-lying areas. This has allowed paddy farming to adapt to heavy summer rains, high temperatures, and narrow and steep land conditions. Over time, Japan has carried out various types of water resource management through governance and societal systems. Okuma (2007) argues that rivers are a key player in the material cycle of the global environment, as well as a familiar natural feature for people, and have slowly nurtured local cultures over time amidst the contradictions of abundance and disasters.

This chapter examines the transformation processes of investments in water resources management and investigates how conventional financial mechanisms have been evolved over time in Japan. It provides insights into the transformation of cost sharing among concerned organizations. The investment roles of the central government, regional and local governments, local communities, and the private sector have changed under different governance regimes. This chapter can contribute to better policy and decision making for investment in water resource management in other countries facing similar challenges. The chapter begins by tracing the history of water resource development by the state in the 7th century CE.

¹ Acknowledgments

This study is supported by the Japan–US Global Partnership of Japan Foundation grant program, “Government and Market in Disasters: Capacity Building, Burden Sharing and Insurance”.

15.2 From a Centralized System to Involving the Private Sector in the Middle Ages

During the late 7th century CE, Japan introduced the *ritsuryō* system, a political system based on Chinese legal and ruling systems. The *ritsuryō* system sought to centralize political power in the Imperial Court and create a standardized legal system throughout the nation. The Imperial Court governed the people and paddy fields throughout the country. Farmers paid 3% of the value of their agricultural products from their lands as government taxes.

The Imperial Court recognized expanding rice paddies and developing water resources for irrigation as fundamental conditions for securing the effective national governance. The Imperial Court led developing water resources and agricultural fields to allocate rice paddies for all people under a nationwide standardized grid of arable land (Sasaki 1965, Figure 15.1). The court formulated a development plan in 722 to increase the area of rice paddies 2.5 times (Oda 2017). While the court developed infrastructure including irrigation facilities, farmers cultivated and maintained rice paddies.

However, due to population growth and limited paddy fields in the 8th century, the Imperial Court began encouraging the private sector of nobles, shrines, and temples to develop water resources and paddy fields. The court granted ownership rights to the lands developed.

Figure 15.1: Standardized Grid System in Sabae City, Fukui Prefecture



Source: Geospatial Information Authority.

Gyoki, a Buddhist leader who worked in the 7th and 8th centuries and later became the highest-ranking monk, led a group that comprehensively developed water resources in various regions. For example, in the Yodogawa River basin, an important river that flows through Kyoto and Osaka, Gyoki's group developed approximately 2,000 hectares of paddy fields by constructing dikes, diversion channels, intakes, and irrigation and drainage channels for land reclamation, flood protection, and irrigation and drainage (Oda 2017).

By allowing private ownership of developed farmland, the Imperial Court was no longer able to distribute rice paddies to all people in the 9th century CE. As the *ritsuryō* system declined in the 10th century CE, a feudal system started in which land previously belonging to the state became the private property of influential shrines, temples, and nobles. The feudal system in Japan coincidentally developed independently and in historical parallel with the European feudal system (Umesao 2002).

This governance shift minimized intervention from the central level while several thousand manors managed water and lands at the local level (Ito 2021). The nobles, shrines, and temples developed water resources and owned their own properties. Local clans, not the Imperial Court, managed these locations on the ground.

These development activities laid the foundation for the current irrigation systems used for small- and medium-sized rivers (Sano 1999). For example, a manor lord developed the irrigation systems of *Junikagoyosui* for 6,000 hectares of paddy fields in Okayama Prefecture, which is still in use today. Irrigation facilities were managed by a manager appointed by a manor lord and a water keeper selected from locals (Ito 2021). Water fees were collected from farmers and repairs to irrigation facilities were conducted by farmers' labor (Akiba 1959). Manor lords developed water resources and land within their manors but could not engage in large-scale projects beyond the boundaries of their manors. After the Middle Ages, feudal lords, *daimyo*, began leading large-scale projects.

15.3 Early Modern Period from the 17th to 19th Centuries

The governance in the Edo period (1603–1868 CE) involved a centralized military government of the Edo *bakufu* headed by *shogun* feudal domains ruled by *daimyo* (feudal lords), and the emergence of autonomous local communities. The *bakufu* had absolute political power over the *daimyos* and their feudal domains. This section examines how this governance arrangement altered water resource management, leading to the establishment of many of Japan's current financing mechanisms. It analyzes local community's roles in investment in water resources management in a case study of the Nobi Plain.

15.3.1 Overview of Edo Period

The Tokugawa Shogunate led the centralized military government of *bakufu* located in Edo, currently Japan's capital of Tokyo. The *daimyo* were responsible for developing the local economy as well as maintaining law and order within their domains. Takemura in chapter 2 of this volume argues that water resources development and agricultural expansion played critical roles in the nation's economic and population growth during the Edo period.

There were four types of projects of water resources management. The Tokugawa *bakufu* directly implemented key projects to develop capital and strategic areas and commanded the *daimyo* to support these national projects. In addition, the *daimyo* conducted projects to develop their own domains, and local communities engaged in construction and infrastructure maintenance at the community level (Tanaka 2005).

15.3.2 Autonomous Local Community in Water Management

The Edo period involved the emergence of autonomous local communities, denoted as “So” villages, which began in the 14th century CE and expanded throughout the country in the 16th century (Amino 1997). These communities achieved self-management in water resources, which had previously been organized by the manor lords. Local self-organization came out of the productive capacity and rising economic status of farmers.

The community-based mechanisms of the Japanese-style paddy field agriculture have continued until the present day. Farmers established a management organization for irrigation water at the end of the irrigation channel system. Community members formulated and enforced rules and regulations for water use, as well as maintaining and repairing canals to ensure water for their agricultural fields. They worked together to distribute the amount of water fairly among themselves. In addition, communities engaged in fighting floods during heavy rains to protect their assets and agricultural fields. The success of their collective efforts in managing water resources contributed greatly to the development and stability of the agricultural system.

These collective efforts can still be seen currently. Traditional irrigation systems are still in use, and farmers continue to work together to maintain and manage their water resource facilities.

15.3.3 The Case of Nobi Plain

The Nobi Plain, located in central Japan, serves as a compelling case of how financial arrangements can improve water management and agricultural productivity. This plain, where rice production increased by about 20% during this period, became a major agricultural production area in Japan (Ando 1975).

Three major rivers flow into the plain, repeatedly causing flooding, and making agricultural production challenging (Figure 15.2). The Tokugawa *bakufu* constructed the 50 kilometers continuous dike known as *Okakoi Tei* in the eastern part of the plain to develop the Owari area through flood prevention. This area, currently Nagoya metropolitan area, was strategically important in the realms of the economy, politics, and military for the *bakufu*.

Figure 15.2: Kiso Three Rivers



Source: Lower Kiso River Office, Ministry of Land, Infrastructure, Transport and Tourism.

On the other bank, *daimyo*, merchants, and wealthy farmers engaged in constructing 80 ring dikes to protect settlements and agricultural fields covering 1,800 square kilometers from flooding and to convert low-lying wetlands into paddy fields (Ito and Aoki 1977; Matsubara 1977). *Daimyo* and merchants invested in basic infrastructure facilities, such as dikes and main irrigation and drainage channels, and farmers migrated to new lands and cultivated in their lots. Local communities also constructed dikes and facilities by themselves. Some ring dikes continue to protect their communities even today.

In addition, the *bakufu* ordered the *daimyo* outside the plain to implement large-scale works of river channel improvement in the Nobi plain 16 times during the Edo period. One famous case came with the Horeki flood protection project in 1754 and 1755, which the shogunate ordered the Satsuma feudal domain, now Kagoshima Prefecture, to undertake. This work imposed heavy financial and social burdens on the Satsuma domain, and as many as 85 samurai committed *harakiri* (ritual suicide) after feeling responsible for the work or died of illness (Haga 2005).

With a sense of unity and camaraderie, local communities competed to construct the dikes that protected them from flooding. Local communities established a flood fighting organization inside each ring dike, constructed high mounds as evacuation places, and collectively fought against flooding by reinforcing dikes to protect from breaching during high water levels. Because such competition increased tensions between communities, projects for flood protection required the approval of the shogunate and neighboring communities. This tactic mediated potential conflicts between communities. Where locals had undertaken dam or berm construction without permission, government authorities sometimes imprisoned community leaders (Kubota 2008).

15.4 Modern State

From the establishment of the modern state in 1868 to the present day, the national government's involvement in water resources management has undergone a major shift from no involvement to the leading role. This section examines the changes of increasing investment by the government and declining by local communities.

15.4.1 National Government Involvement

At the beginning of the Meiji period, the national government invested in river navigation works to promote industrialization, while the prefectural governments and local communities were responsible for flood protection. Local communities bore the cost for development of irrigation facilities as well. The Meiji government recognized private ownership of arable land, imposed tax obligations on landowners, and did not cover the cost of irrigation facilities.

As modernization and industrialization progressed, flood damage increased, and the national government became increasingly involved in flood protection projects. Local governments and communities were unable to cope with the increasing flood disasters due to their limited technical and financial capacities (Ishiwatari and Sasaki 2022). In 1896, Japan enacted the River Law and the national government began to directly conduct flood protection works on important rivers, while prefectural governors were responsible for managing rivers in principle. Because of limited budgets, the national government could start projects on only 11 rivers by 1907 (Matsuura 2016). Prefectural governments bore one-third of the cost of these national projects. Even today, the 2:1 cost sharing ratio between the national and prefectural governments still applies to national projects. The national budget for flood protection accounted for 0.5%–1.3% of the national income until 1910 (Ishiwatari and Sasaki 2020).

The national government developed its first long-term flood protection plan in 1911, covering 65 rivers. Until the 1930s, the government completed the river systems with continuous high dikes and diversion channels on major rivers, which are the foundation of the current flood protection systems.

15.4.2 Local Community's Role

Although the national government played a leading role in flood prevention and water management, local communities struggled with the financial burden that has persisted since the Edo period. Flood prevention associations (FPAs), *Suigai Yobo Kumiai* in Japanese, were established to implement flood protection works based on local community systems in the Edo period. The FPAs bore part of the costs of flood protection projects that were not implemented by national projects. For rivers not supported by the national government, prefectural governments and local communities continued to conduct flood protection works. In the case of Niigata prefecture, the FPAs covered 30% of project costs implemented by the prefectural government (Uchida 1994). In Saitama prefecture, the prefecture government covered all costs for flood protection works of the main channels in six medium-size rivers, while the prefectural government and FPAs covered half of the costs equally for their seven tributaries (Matsuura 2016). In addition, the FPAs engaged in flood fighting activities to protect their own communities, stockpiling necessary materials, patrolling dikes and structure, and maintaining and reinforcing dikes during flooding.

The Municipal Assembly Law in 1880 and Water Association Regulations of 1890 codified the procedures that FPAs were to follow. The FPAs were autonomous bodies, collected levies from community members, and were managed by local assemblies (The assembly members were elected from community members). Membership was open to all landowners and homeowners in areas designated as flood-prone areas. As the national government had limited financial capacity, the FPAs were established to finance investment in flood protection throughout the country. The number of FPAs reached around 1,000 at the end of the Meiji period, in which over 600 associations were established in Niigata Prefecture (Okuma 2007; Uchida 1994).

15.4.3 Further Involvement of National Government

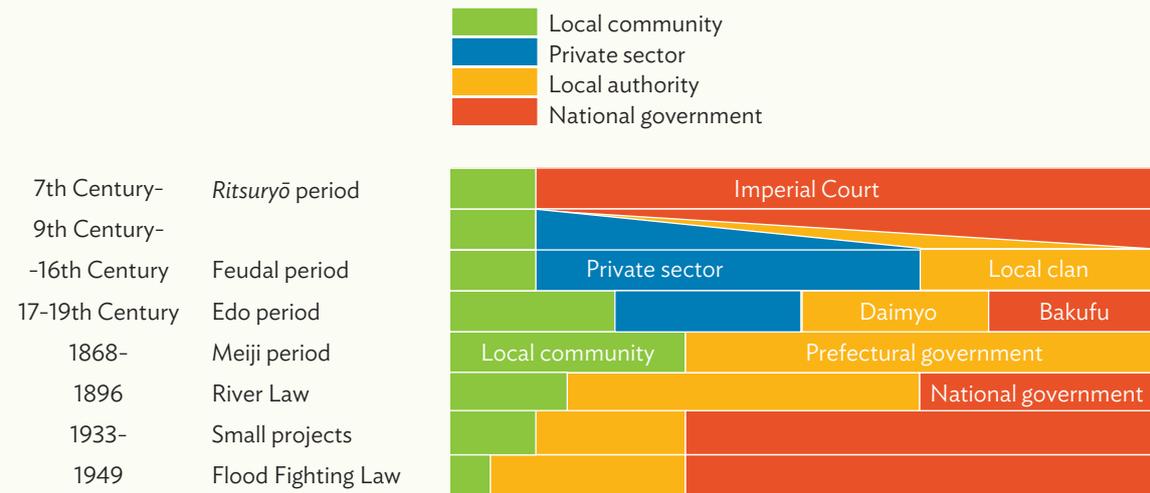
Investment by the national government increased further, while community involvement decreased. In 1933 the national government started new programs for medium- and small-scale rivers to stimulate local economies during an economic recession. The national and prefectural governments covered 50% of project costs equally, and the associations and local communities did not need to bear costs. This cost share continues until the present day, with the national government subsidizing 50% of the costs for prefectural projects.

The national government intervened in irrigation as well. In 1918, farmers rioted because of a sharp rise in rice prices, which led to conflicts between tenant farmers and the landowners. To cope with high rice prices, the government promoted water resources development and initiated financial assistance to cover 50% of the cost of developing irrigation facilities. Currently, the national government still covers 50% of the costs, while communities cover 10%–25% of project costs.

After the Second World War, the financial burden on local communities was greatly reduced, and the national government invested in financing flood protection with prefectural governments. Local governments took over the activities of the FPAs following the establishment of the Flood Fighting Law in 1949. As national and local governments promoted flood protection, the associations became less active. Also, urbanization decreased awareness of flood protection among the people. In the Nobi Plain, the FPA in Ogaki continued until 1961 when the city government took it over.

Japan developed water resources and sanitation for industrial activities and residents in urban areas. Local governments developed necessary facilities with government subsidies and users' tariffs (Ishiwatari, Nagata, and Matsubayashi 2023).

Figure 15.3: Evolution of Cost Sharing in Water Resources Management



Source: Authors' elaboration.

15.5 Discussion

This study comprehensively examines the evolution of financing mechanisms for water resources management in Japan, beginning with the *ritsuryō* system in the 7th century CE. Japan's approach to financial arrangements has undergone gradual changes, influenced by sociocultural factors and new governance regimes (Figure 15.3). During the Middle Ages we saw a shift from centralized state-led investment to private sector involvement, with nobles, shrines, and temples. National intervention was minimized, and each manor manages water resources. During the Edo period in the 17th century CE, central government involvement and investment again increased, and the sharing of roles and costs among central and local governments and communities became clearer and more routinized, laying the foundation for the present.

Even the Meiji Revolution of 1868, which transformed Japan from a feudal system into a modern state, did not significantly alter the established concept of cost sharing. Prefectural governments and local communities, rather than the national government, bore the costs of flood protection, fulfilling a role that had been fostered during the Edo period. The owners of farmland invested in irrigation facilities without support from governments.

As modernization, urbanization, and industrialization progressed, water resources management became more complex. This increased demand underscored the need for sophisticated technical intervention and substantial amounts of capital. As a result, the role and financial burden of the national government expanded to fill the burgeoning gap.

It took 3 decades before the national government began flood protection works and 5 decades for it to support major irrigation projects. Local communities had shared the costs for flood protection until the mid-20th century. After the Second World War, local governments assumed the cost burden for flood protection from local communities. On the other hand, the trend has been consistent in irrigation projects, with local communities continuing to contribute to project costs, perpetuating a historical precedent that continues to this day.

The foundation of current water resources management in Japan sits in the deep involvement of the local community. This foundation of this bottom-up engagement can be traced back to the Middle Ages when autonomous organizations emerged with rising economic power at the community level. Although government involvement has increased and the financial burden has grown, the significant role of local communities in water resources management has been maintained from the Edo period to the present.

The private sector has also historically contributed to water resources management. Shrines, temples, and nobles in particular developed water resources during the Middle Ages. In addition, during the Edo period, private investment by merchants developed water resources and rice paddies.

There are lessons from Japan's experience that can be shared with other countries (Figure 15.4). Cost sharing by local communities is crucial in any governance system or sociocultural form, although the amount of cost sharing may vary from period to period. Water resources projects that serve multiple communities require external intervention, such as government or private funding. This is because such projects require funding that communities cannot afford. In the case of further larger projects, financial support from the central government and coordination among local governments are crucial to river basin planning and the implementation of large-scale projects. During decentralization in the Middle Ages and early Meiji period, Japan could not implement these programs because of limited resources at the local level and difficulty of coordination among communities.

Figure 15.4: Lessons from Japan's Experience in Investment in Water Resources Management



Source: Authors' elaboration.

15.6 Conclusion

In Japan, from historical times to the present day, the financing mechanisms between communities, the national government, local governments, and the private sector in the water resources sector have evolved as a result of economic and social growth and governance transitions. This transition underscores the deep connection between the cost-sharing model, sociocultural values, and the dynamic structure of Japanese society.

Japan's success in maintaining community involvement, clarifying central government responsibilities, and embracing public-private partnerships to invest in water resources provides valuable lessons for addressing similar challenges in other countries. By understanding the evolution of these practices, policy makers and stakeholders can pave a sustainable path for financial arrangements for water resources management. By putting cost sharing at the core of their strategies, developing countries can promote community participation, build innovative partnerships, revitalize traditional practices, and leverage modern systems to build sustainable and resilient water management systems. In an era of rising sea levels, higher levels of extreme weather events, and deeper financial impacts from these disasters, societies need to be ready to face the future through professionalized and well thought out water management infrastructure.

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PART V

Governance

Passing on Indigenous Knowledge to the Next Generation through Water Learnings in Kumamoto, Japan

Naoto Tanaka

16.1 The Kumamoto Earthquake and Water

The 4th Asia-Pacific Water Summit (4APWS) was held in Kumamoto City on 23 and 24 April 2022, 6 years after the Kumamoto Earthquake, which struck twice with intensity 7 (Shindo 7; Magnitude 6.5 and 7.3) on 14 and 16 April 2016. During the 4APWS, Japan's Emperor and Empress, who participated online, said to the high school students of the Youth Water Forum Kumamoto (YWFK) in Kumamoto: "You had a terrible time during the Kumamoto earthquake. Are you all right?"

Originally, the 4APWS was to be held in April 2020, 4 years after the Kumamoto earthquake, but was postponed for 2 years due to the global spread of the novel coronavirus disease (COVID-19), and I believe that it was the Kumamoto high school students who grew the most in these 2 years. On Monday 18 April, it was announced that many primary and junior high schools were expected to reopen after the Golden Week holidays (a series of holidays at end April and beginning of May), while many people were living in evacuation centers following the Kumamoto earthquake. Elementary and junior high school students, together with their families, were seen at evacuation centers and throughout the affected areas, cleaning evacuation centers and volunteering in recovery efforts.

The 4APWS was held in Kumamoto when they were in the upper grades of primary school and now high school students thinking about their future in their hometowns. When the Kumamoto earthquake occurred in Kumamoto, a flood-prone area, many people became aware of the importance of water. Of course, there were people who were aware of the importance of water even before that time, but there can be no doubt that they felt a keen sense of gratitude for the fact that water is available when you turn on the tap.

The groundwater veins were disturbed by the movement of the active fault, and we witnessed the drying up of springs in many parts of Kumamoto Prefecture. Suizenji Joujuen, which attracts many tourists, was no exception. On 23 May, when I volunteered to dig gravel at Suizenji, local schoolchildren in gym clothes went barefoot and worked hard digging and carrying gravel out of the water in order to restore the spring (Figure 16.1). Their appearance gave us the courage to restore the everyday landscape of Kumamoto.

Figure 16.1: Volunteers Digging Gravel at Suizen-ji Joujuen after the Kumamoto Earthquake (May 2021)



Source: Naoto Tanaka.

16.2 Water Culture in Kumamoto

Kiyomasa Kato, whom the persons of Kumamoto affectionately call Seishoko-san, is widely known as the Master of Civil Engineering. Kiyomasa, aged 27 at the time of his death in 1588 (Tensho 16), replaced Narimasa Sassa as daimyo of the northern half of Higo Province. He completed Kumamoto Castle in 1607 (Keicho 12).

The Shirakawa River, which flows through the center of Kumamoto City, has long been famous as a raging river, with heavy water currents containing the volcanic ash soil (Yona) from Aso hitting the city center of Kumamoto every time it flooded. Naturally, the meandering the Shirakawa River is a nuisance for castle town construction. Kiyomasa is said to have straightened the Shirakawa river channel, which used to flow around what is now Kumamoto City Hall. The construction of Kumamoto Castle and, moreover, the development of Kumamoto Castle Town, requires a boat route to transport various goods. Kiyomasa separated the Tsuboi River, originally connected to the Shirakawa River, and replaced it with a canal connecting it to Kawashiri, an outer port in Kumamoto.

The Shirakawa River basin, with the Aso caldera in its upper reaches, has a unique tadpole-like basin shape, with rainfall in the upper reaches percolating underground and gushing out here and there in the Kumamoto basin as underground water. Lake Ezu, a favorite of Kumamoto citizens, also benefits from this spring water. 100% of the drinking water for Kumamoto City's water supply is supplied by this groundwater, which quenches the thirst of Kumamoto citizens. On the other hand, Kumamoto is also a flood-prone area, as evidenced by the "6.26 flood" in 1953 and the flooding of the Kuma River basin in July 2020. Kiyomasa used his outstanding civil engineering skills (Okuma 2020) to solve these unique Kumamoto water challenges in all areas of flood control, water utilization and water conservation.

In April 2021, one year before the 4APWS event was held in Kumamoto, Taikan Oki, vice-rector of the United Nations University and professor of the University of Tokyo, who spoke at a symposium attended by YWFK high school students, said that “water issues are cultural issues”. He quoted Kiyomasa, who stressed the importance of sustainability, saying that “issues that have remained unsolved for 400 years take many years to resolve”, and this has become the philosophy of our activities.

16.3 Establishment of the Youth Water Forum Kumamoto

The Youth Water Forum Kumamoto (YWFK) is an organization formed in March 2021 to support high school students in promoting Kumamoto’s water culture to the world, in collaboration with the Japan Water Forum, a certified nonprofit organization. I head the organization, and its core members comprise 32 people (as of 30 August 2023), including local government officials, high school teachers, and university students.

I have been in Kumamoto for 18 years, specializing mainly in civil engineering history and landscape management, and have worked on the conservation of cultural landscapes. Before the Kumamoto earthquake, we were working to develop human resources that could contribute to local development through local studies, such as city walks. In this context, we were also good at involving young people, from primary school children to high school students, in town planning.

Therefore, we proposed the creation of a short video, as it was required to carry out activities that would encourage young people to think about the rich water culture, which is one of Kumamoto’s regional identities, as their own business. One specific activity of the YWFK is the creation of a video by Kumamoto high school students to promote Kumamoto’s water culture to the rest of the world (Figure 16.2).

Figure 16.2: Certificate of Completion of the first Youth Water Forum Kumamoto (November 2021)



Source: Naoto Tanaka.

The organization is also active in learning, creating and passing on water culture through the Shirakawa Middle River Area Rice Paddy High School project, which is jointly organized with the Shirakawa Middle River Area Land Improvement District Council (Figure 16.3). We have adopted SUSTAINABLE as our activity philosophy in order to pass on this learning activity to future generations in the spirit of the Sustainable Development Goals.

Figure 16.3: The Shirakawa River Middle Basin Rice Field High School (October 2021)



Source: Naoto Tanaka.

What is the sustainable state? Is it eternal? What is the opposite of sustainable? We have come to believe that the opposite of sustainable is no change at all. In other words, we believe that sustainable means to keep changing in order not to change. In practicing this sustainable approach, we take the position that both staying the same and changing are important, (known as Fueki-ryuko in Japan).

Neither complete change nor everything changing is a RESILIENT situation. In other words, we take the position that it is important to update society in accordance with the times, without fear of change, while relying on what is certain and unchanging, in order to stay the same and keep changing.

16.4 Water Culture Seminar, 2022

Our main focus is to weave a story together with someone else to tell the world about Kumamoto's water culture, and in doing so, to acknowledge each other's differences. The Kumamoto Water Culture Seminar, which is at the heart of YWFK's activities, is held as a workshop where high school students in Kumamoto create 3-minute videos in teams and learn the ability to communicate what they want to say, by themselves. Together with Professor Ryouta Bato of Sojo University, we try to create a relationship in which we can use our imagination, play and acknowledge each other's marginal space.

1st Workshop (21 August 2022)

High school students from Kumamoto Commercial High School, Kumamoto Kita High School, Shokei High School, and Taishi High School, who are active as members of Youth Water Forum Kumamoto, participated in a workshop to create a catch copy of Kumamoto’s water culture for everyone to convey. They were asked to express what they wanted to communicate with the diversity of ideas typical of high school students, making use of learnings such as making use of what is available and jump rate.

2nd Workshop (3 September 2022) (Figure 16.4)

The second workshop was held under the theme “Expanding and giving shape to the story of water”. Based on the four-panel story created in the previous session, the story was solidified through the process of escaping. The first half of the day consisted of lectures by Professor Naoto Tanaka on the theme of Play and Professor Ryouta Bato on the theme of Connecting Scenes. Professor Tanaka’s lecture taught about play within constraints. Professor Bato’s lecture taught about important things in creating stories, such as (i) clear messages, (ii) indirect and metaphorical communication, and (iii) contrast. Each group was full of individuality and there were many perspectives to be gained from listening to each other’s presentations.

Figure 16.4: Youth Water Forum Kumamoto’s Water Culture Seminar (September 2022)



Source: Naoto Tanaka.

3rd Workshop (25 September 2022)

The third workshop was conducted in a hybrid style: face-to-face and online. The high school students made four videos about Kumamoto’s water culture based on what they had learnt from the previous group work and critique sessions, which were eschewed.

4th Workshop (6 November 2022)

As the 4th workshop was the last session of the Water Culture Seminar, a completion ceremony and artwork viewing was held at Kumamoto University. Each group submitted a complete piece of work after brushing up on the advice and feedback received from the third round of peer evaluations

and online essays. In 2022, eight videos were collected from four schools: Kumamoto Commercial High School, Kumamoto Kita High School, Shokei High School, and Kami-Amakusa High School.

Some of the videos were about being mindful of saving water and passing on the awareness of water conservation for the next 20 years, some explained Lake Ezu in detail, and others talked about the appeal of Kumamoto's water culture to people around the world, and the delicious taste of the rice and vegetables that Kumamoto water is used for. All the groups were creative and each group was able to convey the appeal of Kumamoto's water from a different perspective. The high school students who completed the videos and received certificates of completion showed looks of satisfaction, and at the viewing session, they looked for good points and innovations in the videos of other groups and showed a serious willingness to learn more.

16.4.1 Other Activities of the YWFK (FY2022)

World Irrigation Facility Heritage Summit in Kumamoto

The World Irrigation Facility Heritage Summit in Kumamoto was held on 11 and 12 April 2022 as a related event of the 4th Asia-Pacific Water Summit. The summit, the first of its kind in the country, provided an excellent opportunity to consider the importance of irrigation facilities and their future prospects. YWFK representatives from two schools, Kumamoto Commercial High School and Shokei High School, participated in the panel discussion and exchanged views with other panelists.

The 4th Asia-Pacific Water Summit

The 4th Asia-Pacific Water Summit was held in Kumamoto City on 23 and 24 April 2022 (2022), 6 years after the Kumamoto earthquake of April 2016 (Heisei 28). Two members made opening statements on behalf of the YWFK, three videos made in the previous year were broadcast, and members also played an active role in running the booths at the side events (Figure 16.5).

Figure 16.5: Sara Katayama Explains to Foreign Visitors at 4th Asia-Pacific Water Summit (April 2022)



Source: Naoto Tanaka.

The Shirakawa River Middle Basin Rice Field High School

In the middle reaches of the Shirakawa River, a rice paddy high school was opened in collaboration with the Shirakawa River Middle Basin Hydro-Net Council, which is involved in groundwater recharge in the Shirakawa River basin, including winter water rice paddies, to tell Kumamoto's water story to the world. This year, Kumamoto Commercial High School, Shokei High School, Kumamoto Chuo High School from Kumamoto City, and the Otsu High School participated.

Re:WATER Workshop

Re:WATER, an onsite study session aimed at learning about Kumamoto's water culture, while having fun in the waterside spaces that are part of our daily lives and familiar surroundings. In each session, the program includes a lecture by a guest, learning something that you will want to tell someone about, and then taking a photograph to pass on.

The 4th Asia-Pacific Water Summit After Event

On 21 January 2023, an after-event was held to report the results of the 4th Asia-Pacific Water Summit to the public, create opportunities for the younger generation to participate and realize a sustainable society in order to build on the momentum for groundwater conservation created by the summit. After keynote speeches were given by Kazufumi Onishi, mayor of Kumamoto City, and Yoshihisa Kasahara, president of Higo Bank. A panel discussion with high school students took place. YWFK representative Naoto Tanaka and three high school students from Kumamoto Kita High School, Kumamoto Commercial High School, and Shokei High School participated in a dialogue with Mayor Onishi and President Kasahara. Mayor Onishi suggested that we declare ourselves as Youth Waterkeeper, which will put into practice the activities of high school students in the Waterkeeper system led by Kumamoto City.

Youth Waterkeeper Declaration

We value the water culture nurtured by Kumamoto's rich nature and history, and will work together with the next generation of children, younger than ourselves, with an awareness of the links with life and livelihoods in Kumamoto, an agricultural prefecture, as well as with the economy and environment.

United Nations World Water Summit

At the UN Water Summit held at UN Headquarters in New York, United States, 22–24 March 2023, high school students from the YWFK, together with Kumamoto Mayor Onishi, introduced Kumamoto's water culture to the world (Figure 16.6). The participating high school students were inspired by the fact that, while in Japan there are many opportunities to think about “too much water: heavy rains, typhoons, and torrential disasters”, most countries around the world are thinking seriously about “too little water”, and their own generation of youth is leading the way.

Figure 16.6: United Nations Water Summit (March 2023)

Source: Naoto Tanaka.

16.4.2 Passing On Kumamoto's Water Culture

In March 2021, Japan's Ministry of Land, Infrastructure, Transport and Tourism announced priority flood control measures for all 109 Class 1 water systems and 12 Class 2 water systems in the country, which should be implemented through a combination of hard and soft measures. "River Basin Disaster Resilience and Sustainability by All" (Mushiake 2022) (RBDRSA) is defined as the cooperation of all stakeholders in a river basin—the national government, prefectures, municipalities, local businesses and residents—in taking measures to reduce flood damage.

For the RBDRSA, I believe that the project of making the city from the river in partnership with diverse actors is important. Each entity is rooted in the local climate and fosters civic pride, and in contrast to the traditional top-down image of urban planning, this is a bottom-up approach, with the active participation and collaboration of all stakeholders: local residents, government (municipalities, prefectures, and the state), and associations. It will be necessary to carry out sustainable local environmental improvement activities, making use of various local resources as well as the legal system.

To this end, it is important to understand sustainable as to continue to change in order not to change, and to have a balancing act between not changing by inheriting the thoughts of predecessors and changing by updating without settling for the status quo, and the concept of fluidity, in which both are important. We will continue to work together to develop human resources that can happily come to terms with sustainable changes in flood control, water use and the environment, and people's lives, so that we can pass on the timeless approach of diverse actors working together in harmony with the natural environment in the basin, making the most of various local resources.

In 2023, the third year of the YWFK, the first YWFK students will become university students and support the YWFK's activities, which is expected to further expand the learning experience. This year, we would like to carry out activities with the aim of creating links beyond high school and exchange projects with high school students outside Kumamoto Prefecture.

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Collaborative Governance Framework for Urban River Management

Asok Kumar Gopala Pillai, Dheeraj Joshi, Sumit Chakraborty, and Ashwini Dubey

17.1 Introduction

Rivers and water bodies—the lifelines of urban areas are faced with complex challenges resulting from unprecedented urbanization. The situation is likely to be further aggravated due to the impacts of climate change. Therefore, improved governance of urban rivers is a key focus for sustainable river management.

Hyden and Mease (2004) outline that governance is referred to as creation and maintenance of a system that governs public arenas and regulates interaction between the state, civil society, and market-based actors. Ansell and Gash (2008) further defined collaborative governance as “a governing arrangement where one or more public agencies directly engage non-state stakeholders in a collective decision-making process that is formal, consensus-oriented, and deliberative and that aims to make or implement public policy or manage public programs or assets.” They highlighted that the demand for collaborative governance has augmented due to the distribution of specialized knowledge and the strong interdependence of institutions.

Collaborative governance systems are typically unique nationally and more specifically regionally, due to the myriad intricacies of internal relationships and most importantly citizen engagement. This can range from being informed for being empowered, depending upon the participation level. The key to collaboration is alignment of stakeholder perspectives (Gray 2004).

17.2 Collaborative Water Governance and Global Scenarios

The key challenges of urban rivers—pollution, solid waste, sewerage, inadequate flow, encroachments, etc., primarily result from weak cross-sectoral governance of urban rivers. Collaborative governance approaches, considering environmental, legal, and social concerns may provide the way forward in addressing urban river challenges (Olsson and Head 2015). In the face of these mounting challenges, exacerbated by climate change, economic issues and rapid population growth, a shift from traditional governance to that of collaborative governance structures may be necessary for the purpose of achieving optimum outcomes in the domain of urban river management.

Significant reports and studies underline examples of collaboration and stakeholder engagement around the world, aimed at improving river health and wellbeing in a sustainable manner. The Murray–Darling Basin in Australia is a key example where the principles of collaboration and stakeholder engagement were utilized to improve ecological health and over allocation, generating key benefits such as saving the cost, effective implementation of activities, and better stakeholder collaboration. In this regard, the examples of the Mekong River Commission and the Nile Basin Initiative are highlighted.

Mekong River Commission (MRC): Thailand, Lao PDR, Cambodia, and Viet Nam with Upper Mekong partners, the People’s Republic of China and Myanmar as observers. The Lower Mekong River Basin with 60 million population, is rich in biodiversity and the entire population on the

floodplains is dependent on them for livelihood and economic sustainability. The MRC is an example of an inter-country collaborative governance mechanism, which demonstrates regional administrative cohesiveness. Some of the aspects which were addressed through collaborative action are summarized in Table 17.1.

Table 17.1: Mekong River Commission: Key Outcomes and Collaborative Actions Undertaken

Key Outcomes	Collaborative Actions Undertaken
Optimizing sustainable development and sharing of cost benefits	Regional strategy for flood and hydropower management
	Regional masterplan for basin development with focus on: <ul style="list-style-type: none"> • Climate change – adaptation and mitigation plans • Livelihoods – fisheries and agriculture
Strengthening protection of mutually agreed environmental resources along the floodplains at the intersection of international boundaries	Basin-wide strategy for the development, protection, and management of selected environmental resources across all participating countries
	Creation and mandating of inter-country criteria for assessment, protection, and rejuvenation of functional assets, selection of ecologically sensitive biodiversity zones/sites
Strengthening basin-wide actions and national implementation capacity across all the participating countries	Review institutional structures and suggest harmonizing measures for homogenization of capacity of the National Mekong Committees of participating countries, and implementation of support measures tailored for each country's requirements and aspirations
	Enhancing and strengthening capacity in river basin management functions across all river management authorities of the participating countries
	Periodic review and updating of Murray–Darling Basin in Australia procedures and related technical guidelines and implementation of agreed improvement procedures
Enhanced information sharing and management of inter-country communication and development of relevant tools	Harmonized and homogenized systems, models, tools, and databases for monitoring, assessment, and for purpose of subsequent dissemination
	Improving and establishing regional flood and flash flood forecasting systems
	Establishment of critical regional communication network for flood and drought management with focus on disaster response
Reduction of knowledge gaps for selected subjects focusing on the ease of access of common transboundary floodplain themes	Conducting studies and surveys for the following topics across the participating nations: <ul style="list-style-type: none"> • Fish ecology • Rural livelihoods • Climate change impacts on transboundary • Increase in storage for management flood and drought • Uses of surface and groundwater

Source: Author.

Nile Basin Initiative (NBI): DR Congo, Burundi, Egypt, Ethiopia, Kenya, Rwanda, South Sudan, The Sudan, Tanzania, and Uganda, with Eritrea as an observer: The Nile Basin covers an estimated 10% land mass of Africa, encompassing livelihoods for more than 200 million people. The Nile river flows across 10 countries, each having different requirements and priorities, but also common challenges such as increasing water demand, environmental degradation, recurrent flooding incidents, droughts, and energy insecurity. The key actions undertaken based on the NBI's collaborative governance principles are highlighted in Table 17.2.

Table 17.2: Nile Basin Initiative: Key Outcomes and Collaborative Actions Undertaken

Key Outcomes	Collaborative Actions Undertaken
Increased communication, involvement, and cooperation between Nile Basin governments and population	Sharing of flood forecasting during rainy season, which indirectly benefits 1.7 million people living in urban and rural flood-prone areas
	Nile ministers regularly approve water resources management and development projects prepared by the Nile Basin Initiative (NBI), demonstrating cooperative planning of projects having regional significance, and introducing norms that lead to achieving economies of scale, harnessing synergies, and improving regional peace and security
Enhanced basin-wide capabilities and capacities based on best practices, on trans boundary investments in the Nile Basin	Institutional and human resources capacity building through on-the-job and targeted training as well as study tours and exchange visits
	Capacity building on environmental management, power trade, water policy, knowledge management, efficient water use for agricultural production, water quality monitoring, negotiations, communications, etc.
Increased cooperative action in power development and trade, agriculture and natural resources management and development	NBI's regional intergovernmental nature and political will play a major role in replying to members' demands toward energy security challenges
	A basin-wide power development strategy by the NBI allows for larger efficiencies in the utilization of shared resources, and retains regional dialogue and trust among Nile riparian citizens
	Power infrastructure development and competitive electricity market are central to sustainable socioeconomic development and the Nile's transformation into a vibrant green economy
Enhance efficient agricultural water use with focus on food security	Collaboration within NBI member states to address the issue of food security by promoting a basin wide approach to agriculture and extending support to member states for ensuring their irrigation plans are regionally optimized and match the available water resources in the basin
	NBI support to member countries to increase efficient development of irrigation systems as well as productivity of degraded watersheds
Protect, restore, and promote sustainable use of water ecosystems across the basin	Promotion of sustainable management of wetlands with transboundary significance
	Maintaining lake and riverine ecosystems
Improve basin resilience to climate change impacts	Promoting regional policy and planning frameworks for effective climate change adaptation at both regional and national levels
	Improving basin level preparedness of countries for flood and drought risk

Source: Author.

The MRC and NBI case studies highlight the impact of international collaborative governance in addressing challenging subjects related to disputes and conflicts over the control and use of river waters, extreme poverty, urbanization, food security, droughts and floods, environmental degradation, inadequate sanitary services, water scarcity, and most significantly, the joint cooperation on shared resources.

17.3 Namami Gange and Rejuvenation of Urban Rivers

India's Constitution has allocated the responsibility of water resources development and management with individual Indian states. Cronin et al. (2016) highlight that "water governance in India and other developing nations are facing significant challenges due to myriad set of reasons such as inadequate institutional performance, duplication of roles, unclear policies, and lack of water-related expertise of urban local bodies (ULBs) and other stakeholders" at the operations and tactical level. Indian water

governance is decentralized at the federal level, wherein the Indian government is responsible for development of programs and the states are in charge of implementation and operation of key programs and projects.

The Indian government is working in coordination with state governments to achieve the United Nations Sustainable Development Goals (SDGs) by 2030. The SDGs include a water and sanitation-related goal, SDG 6. Several Indian government initiatives can be directly linked to SDG 6. The initiatives include the Water Framework Law of India 2016, the Swachh Bharat Mission, the Jal Jeevan Mission, National Mission for Clean Ganga (NMCG or Namami Gange), and the National Water Policy. Regarding water governance, the SDGs necessitate a shift toward integrated information systems by including multi-stakeholder and inter-ministerial approaches.

Namami Gange is one of the largest river rejuvenation programs aimed at ensuring pollution abatement and rejuvenation of the Ganga basin by adopting an integrated river basin approach and promotion of inter-sectoral coordination for comprehensive planning and management. The United Nations has recognized the Namami Gange program among the world's top 10 initiatives, aimed at ecosystem restoration, thereby providing a roadmap for other similar interventions across the globe (UNEP 2022).

The Namami Gange Mission recognizes that integrated river basin management needs to be interwoven with economic growth and urban transformation. Efforts have therefore been made to engage city governments in this collective responsibility of river rejuvenation and economical gains with the stretch of river flowing through or near their boundaries. This is in alignment with the Prime Minister of India, Narendra Modi's clarion call for "need for new thinking for river cities. Cities should be responsible for rejuvenating their rivers. It has to be done not just with the regulatory mind-set but also with developmental and facilitatory outlook" (NMCG 2019). A five-tier governance approach was formulated by the NMCG (National Ganga Council, Governing Council, Empowered Task Force, the NMCG, state government, district ganga committee and/or ULBs) to coordinate with multiple stakeholders for effective urban river management.

17.4 The River Cities Alliance—An Example of Collaborative Governance

The contemporary challenges for the rejuvenation of urban rivers involves complex contextualized solutions (urban sewerage infrastructure, industrial effluent management, sustainable water management, etc.), multiple stakeholders (ULBs, state departments, and ministries, agencies, and regulatory authorities at the national level) and wide-ranging implementation models (build, operate, and transfer model; design, build, finance, operate, and transfer model; hybrid annuity based public-private partnerships model, etc.). Collaborative governance is therefore a preferred approach globally, to attain the SDGs through integration of diverse interests and perspectives. Collaboration between urban areas that share a common river or within state boundaries is therefore vital to understand and overcome common challenges.

In this regard, the River Cities Alliance (RCA) was launched on 25 November 2021, as a dedicated platform for Indian river cities, to ideate, discuss, and exchange information on sustainable management of urban rivers (Ministry of Jal Shakti 2021). The RCA is a striking example of collaborative governance among central, state, and city governments, with the objective of undertaking sustainable management of urban rivers. It is a platform where the Ministry of Jal Shakti, the Department of Water Resources, River Development and Ganga Rejuvenation, represented by the NMCG and Ministry of Housing and Urban Affairs represented by the National Institute of Urban Affairs (NIUA) at the central level

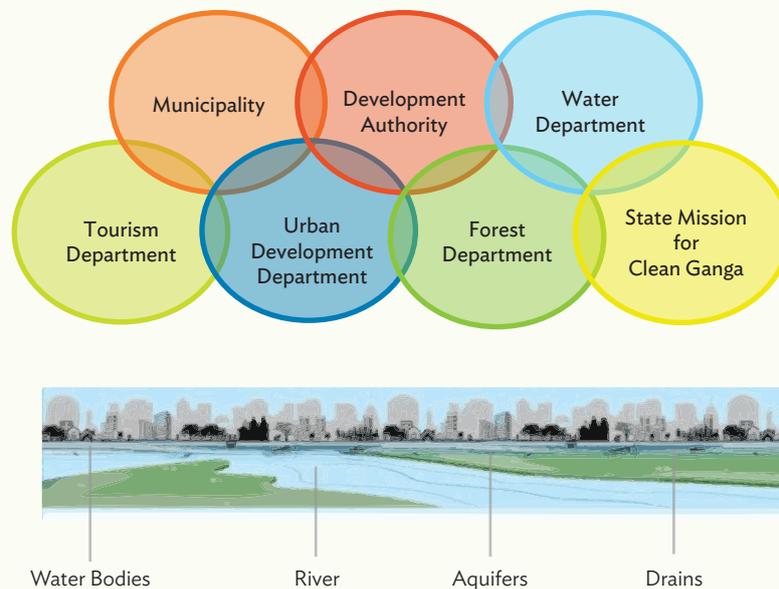
collaborate to form the secretariat, which works in close coordination with the respective states and their ULBs. Within 2 years of its launch, the number of alliance member cities increased from 31 to 145 across the country, and includes one international city—Aarhus in Denmark.

To attain the global target of the SDGs, the NMCG's New Urban Agenda (UN n.d.) leads the roadmap for RCA through the development of 10 river development goals (RDGs). The 10 RDGs are:

1. **For ensuring effective regulation in floodplain** – SDG 11.3 has direct connotation with this, as it is related to city planning and resilient cities. It is important that cities are aware of the relation with SDG 11.3 and ensure only river compatible activities in floodplain.
2. **To keep pollution free rivers** – Healthy rivers are paramount for the sustainable growth of cities. To achieve this objective, cities are required to adopt a range of interventions including engineering, regulatory, legal, economic, and social.
3. **For rejuvenation of waterbodies and wetlands in the city** – This is intended to facilitate groundwater recharge, natural treatment of wastewater, improve riverine biodiversity, and influence the micro-climate, among others, simultaneously, reviving the connection of people and natural environment.
4. **For enhancing riparian buffer along riverbanks** – The city's resilience is enhanced by protecting it from fluvial floods, erosion from river banks, and other harmful activities.
5. **For adopting increased reuse of treated wastewater** – Increased reuse of treated wastewater for activities such as agriculture, toilet flushing, road cleaning, etc., is expected to help reduce the stress on rivers.
6. **For ensuring maximum good quality return flow from the city into the river** – The increased return of flows in form of storm water and treated wastewater will contribute to maintaining the e-flow of rivers, especially in non-perennial watersheds.
7. **To develop eco-friendly riverfront projects** – Development of eco-friendly riverfront projects such as constructed wetlands, biodiversity parks, nature trails, etc., will provide environmental benefits for citizens and will also contribute to conserving the biodiversity along river banks.
8. **For leveraging economic potential of the river** – Explore the range of riverine ecosystem services and livelihood support by interventions such as agriculture, river cruises and navigation, fishery, water sports, and floating markets, etc.
9. **For river-sensitive behavior among citizens** – Enhancing citizen support to sustainably manage riverine systems.
10. **For engaging citizens in activities related to river management** – It is important to ensure participatory process for urban river management in a city that is expected to increase community ownership.

To accomplish the above RDGs, a two-pronged approach has been adopted through envisaging a governance mechanism and a cutting-edge tool for driving RCA as a city-led movement in promulgating river centric development and river sensitive planning.

Governance Mechanism: The RCA initiative kick started the beginning of the NMCG's New Urban Agenda, wherein river cities own and implement the river-sensitive development and economic rejuvenation through collaborative learning, while at the same time inspire others to take up progressive action on this front. The operationalization of the New Urban Agenda has been actualized through the medium of collaborative governance, wherein partnerships are institutionalized at each city level for the development of multi-stakeholder working groups (MWGs). The MWGs comprise representatives from ULBs, state government departments, civil society, parastatal agencies, and the private sector. The MWGs of each RCA member city are provided regular technical and capacity building support from the NMCG and key national partners such as the NIUA in this collective responsibility of river rejuvenation and economic transformation.

Figure 17.1: Multi-stakeholder Working Group Institutional Collaboration

Source: Authors.

Cutting Edge Tools: Central to the New Urban Agenda is the development of urban river management plans (URMPs) for river cities. The URMPs are essential documents serving as the vision documents for the identified river cities. The URMP comprises three key elements: environmental (river to support a habitat for biodiversity to flourish), economic (river to offer opportunities for economic development) and social (river to be celebrated among citizens), which together propose the 10 RDGs.

Both the MWGs and URMPs are intertwined with each other and work toward collaborative governance that help river cities plan interventions in a holistic manner which is required to revive and maintain rivers sustainably.

To accomplish the above RDGs, the RCA has been envisaged as a city-led movement for promulgating river-sensitive planning, and the conservation of water and existing water-bodies. Hence, the agenda and operations for the RCA are determined by the member cities. The activities being undertaken are in three broad areas:

1. **Networking:** Organizing annual river summit, facilitating exchange of official visits for member cities, twinning of cities and rivers, and publishing a bi-monthly newsletter.
2. **Capacity Building:** The RCA member cities are provided expert-led offsite and/or virtual training on water management, ground water, rainwater harvesting, wetland, drains, lakes, etc. Additionally, certification training programs for officials of member cities have been developed for improving capacity building at the state and city level.
3. **Technical and Knowledge Support:** This includes river-sensitive urban planning and interventions, innovations in urban river management, river-linked economy and rejuvenation of urban water bodies, decentralized storage of rainwater through national initiatives such as “Catch The Rain” Campaign (Kumar n.d.), safe reuse of treated water, and decentralized sanitation systems.

17.5 Impact and Way Forward for River Cities Alliance's Collaborative Governance

Moving forward, the RCA strives to take on board additional national and international cities to provide an international platform to promulgate knowledge exchange, peer learning, use of innovative technologies including nature-based solutions, facilitating institutional funding for key initiatives and partnership-based outcomes. This supports member cities in accelerating implementation of the key SDGs and realization of overarching commitments in the following manner:

SDG 6: A key component of the peer learning initiative is its focus on pollution abatement of rivers, restoration of riverine ecosystem, adoption of a circular water economy approach, and building capacity initiatives of city governments and concerned stakeholders. Under the RCA, several niche online certification programs on river management have been launched. The NMCG has published the “National Framework for Safe use of Treated Wastewater” to encourage reuse of treated wastewater, improve water use efficiency, and promote the aspects of circular economy.

SDG 11: The RCA's primary objective is to support member cities in sustainable management of urban rivers, in order to build river-sensitive cities of future. RCA was launched with the vision of developing river sensitive cities for the future. The city of Kanpur in Uttar Pradesh became the first Indian city to develop its own unique URMP. An additional 60 URMPs are proposed to be developed by the NMCG in the next 2 years (NIUA 2021).

SDG 14: Sustainable adoption of URMP components will enable cities to ensure sustenance of life. For instance, the RCA is augmenting existing efforts of the Namami Gange Mission that have led to significant improvement of biodiversity sightings such as dolphins, hilsa fish, etc.

SDG 15: A key component of the river sensitive cities is to rebuild green cover. This directly supports the restoration of riverine ecosystems and life on land. In Ganga basin, over 30,000 hectares has been afforested under the mission.

SDG 17: Central to the RCA is partnership with local, national, and international organizations, and stakeholders. The RCA is actively collaborating with countries such as Germany, Denmark, Netherlands, etc., for inclusion of international river cities as members. At present, the RCA has one international member city—Aarhus, Denmark, and efforts are underway to associate additional international cities and enable cross-city learnings.

The River Cities Alliance, through a collaborative governance mechanism envisages development and implementation of URMPs for member cities, to facilitate progressive action for urban river management.

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Community-based Disaster Management Through Linking with Traditional Community Mechanisms: Flood Prevention Units¹

Keiko Tamura

18.1 Introduction

In Japanese mythology, when a god named Susanoo-no-Mikoto came down to earth, he walked along a riverbank and saw “chopsticks” flowing from upstream. If chopsticks were flowing, there must be someone upstream. So Susanoo-no-Mikoto went upstream and saved the princess who was being attacked by a demon. This anecdote is famous as a story about the ancient use of chopsticks in Japan, but on the other hand, it also leads us to think about when people began to live near rivers.

In Japan, rivers are an integral part of our lives. They are sources of drinking water and water for agriculture, as well as habitats for a variety of creatures, including fish and wild birds. Because the Japanese archipelago is divided by a spine of mountain ranges ranging from 1,000 to 3,000 meters in elevation, rivers are much shorter than in Europe and North America. In Japan, the shortness of rivers makes them prone to flooding and landslides when heavy rains occur. Although river flood control has made progress in the past, global warming has increased rainfall, resulting in frequent flooding throughout the country (Japan Institute of Country-ology and Engineering n.d.).

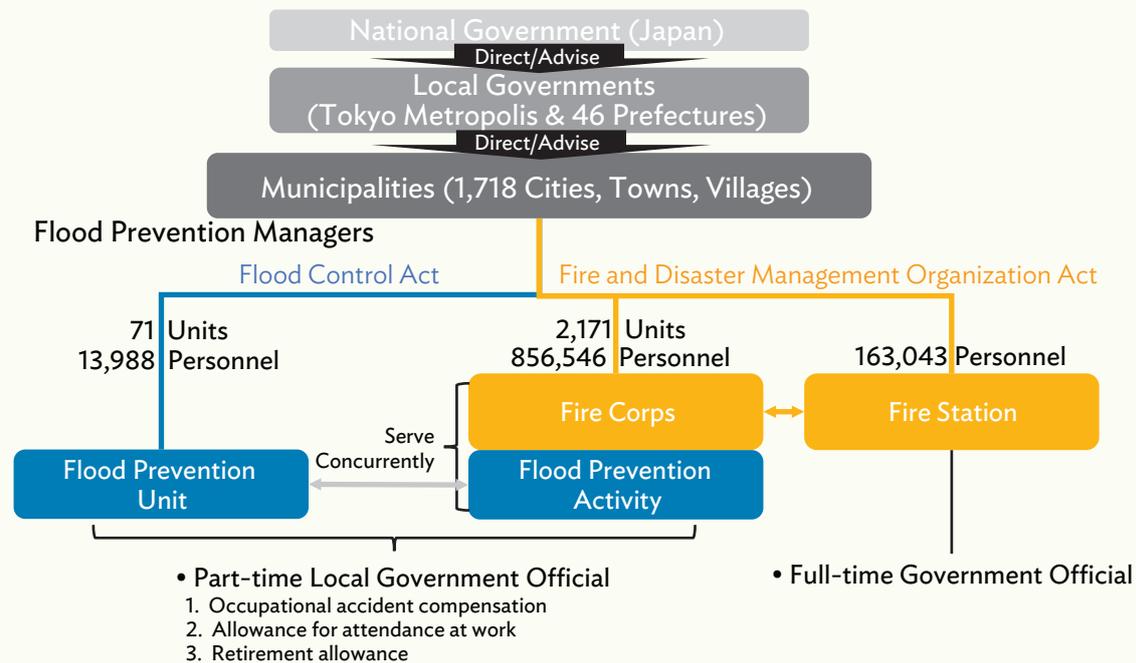
Japan, which is prone to floods and landslides, has long been engaged in flood control and flood management. As a result of this historical background, Japan has local organizations responsible for flood control. This chapter will discuss the historical evolution of the role of community-based organizations in flood disaster management in order to enhance community resilience.

18.2 Regional Organizations for Flood Prevention in Japan

In Japan, local organizations, flood prevention units (*Suiboudan*), protect the community from flood damage. Flood prevention is a community-based response measure in which local residents unite in a kinship-based manner to protect their homes, properties, land, and communities from flood inundation and to minimize the damage caused by flooding. This type of community-based organizational activity, *Suibou* differs from the flood control measures, *Chisui*, mediated by the national or local governments, such as river improvement projects. Flood control activities can be positioned as a disaster prevention system of the community, by the community, for the community (Suetsugu 2018).

¹ All statistical data in this chapter are as of 1 April 2016.

Figure 18.1: Flood Prevention Unit (*Suiboudan*) and Fire Corps (*Shouboudan*)



Source: Created by the author based on MLIT.

The flood prevention unit is a group of people tasked with responding to river overflows, floods, and other water hazards in the region (Figure 18.1). Flood prevention activities are to warn of, protect against, and mitigate damage caused by flood disasters, and include patrolling areas, guiding evacuations, and rescuing people in danger. During normal times they are trained in flood prevention methods such as sandbag making and piling in order to reinforce levees to prevent flooding.

The activities of the flood prevention units are conducted by members who have their own occupations during normal times, and they provide their free time to flood fighting activities on a voluntary basis. On the other hand, they are promised compensation such as occupational accident compensation, an allowance for attendance at work, and a retirement allowance, and are positioned as part-time local government employees.

The activities of the flood prevention units are regulated by the Flood Prevention Law, and the municipality, as the river administrator, appoints members from local residents where the units are established. The mayor of the municipality, as the flood prevention manager, directs and supervises the unit. The prefectural government and the national government provide the direction and advice to the flood control activities of the municipalities.

Unlike the fire departments with full-time firefighters, members of the fire corps (*Shouboudan*) are part-time special local government employees as well as the flood prevention units, *Suiboudan*, who rush to the scene of fires or large-scale disasters from their homes or workplaces to perform firefighting and rescue activities based on their experience. The Fire Corps is governed by the Fire and Disaster Management Organization Act, and concurrently serves as a water and disaster management organization (Cabinet Office).

18.3 Activities of Flood Prevention Units According to Alert Level

In Japan, when there is a threat of flooding, the “alert level” is the number attached to evacuation information, etc., issued by the municipality, which relates to the actions to be taken by residents and related agencies in response to the increased threat of a disaster and the information that encourages residents to take action (Figure 18.2).

Figure 18.2: Activities of Flood Prevention Units According to the Alert Level

Alert Level	River Status	Flood Prevention Unit
Equivalence 5 River inundation	Damage caused by flooding is expected to occur	Protect yourself Ensure your own safety
Equivalence 4 Inundation risk	The water level that is expected to exceed the warning water level and reach the flooding danger level (danger water level).	Pile sandbags, tarp levees, or other flood control methods are initiated
Equivalence 3 Inundation warning flood warning	Flood prevention units are mobilized to prepare for flooding and to take precautionary measures to prevent flooding.	Initiate flood control activities
Equivalence 2 Inundation advisory	Water levels that each flood control agency including the flood prevention unit prepares for flood prevention activities	Get Ready for Work
Equivalence 1 —		


 Call for evacuation and rescue activities

Source: Created by the author based on MLIT and Kami Town (2023).

Flood prevention units are deployed according to the water levels of the rivers. When the alert level reaches 2 (when there is a possibility of flooding depending on the future rise in water levels), the flood prevention team prepares and waits for the activity. When the water level of a river linked to the warning level reaches 3 (the possibility of flooding after a certain time has increased), the flood prevention units will start flood control activities if necessary and encourage local residents to prepare for evacuation, and call for the elderly and other vulnerable residents to start evacuating. When the water level of a river linked to warning level reaches 4 (a situation where the river could flood at any time), the flood prevention team will accelerate flood prevention activities, such as piling sandbags and putting sheets on the levees, as necessary. Unit members encourage all local residents to take necessary evacuation action. When the water level of a river linked to the warning water level reaches 5 (a situation where flooding has occurred), the activities of the unit shall be immediately suspended, and personal safety shall be secured immediately due to the imminent danger to life.

By operating according to the alert level, it is expected that the flood prevention units will more easily cooperate with other agencies involved in flood prevention activities and disaster response. When Level 5 is set, it is expected that unit members will protect victims from floods and also protect themselves.

18.4 Situation Surrounding Flood Prevention Units (*Suiboudan*)²

While torrential rain disasters occur frequently in many parts of Japan, there are concerns about the decline in local flood prevention capabilities due to the decrease in the number of members and the aging of the membership of the flood prevention units. About 51% of fire corps members are under 30 years old compared to 8% of flood prevention unit members, and the percentage of members over 60 years old is 5% of fire corps members compared to 44% of flood prevention unit members, indicating that the number of flood prevention members is aging.

The percentage of employees (other than the self-employed) is high, totaling 73%. When members are employed, their time available for activities is limited, and it is necessary to seek understanding of their activities from their employers. In terms of breakdown, the percentage of employees who are water fighters is 59% compared to 73% of fire fighters (as of 1 April 2016). The number of members of both fire corps and flood prevention units is approximately 870,000 nationwide, and by prefecture, the number varies from 30,000 to 40,000 in some areas and from 5,000 to 10,000 in others, depending on the region. The number of members to the capacity is generally more than 90%, but in some places it is as low as 80%.

The number of members mobilized varies from year to year, but in the last 10 years, it has ranged from about 100,000 to 300,000 per year (the average is about 180,000). The number of members mobilized fluctuates from year to year, but from 2006 to 2016 about 100,000 to 300,000 (average is about 180,000) members have been mobilized annually. The number of mobilized personnel is the total number of people mobilized (including preparation) during a series of flooding periods (MLIT).

18.5 Historical Background of Flood Prevention Units (*Suiboudan*)

Flood prevention activities, *Suibou*, can be described as a community-based measure in which local residents unite locally to protect their homes, properties, land, and communities from flood inundation and minimize the damage caused by such flooding. Flood control activities began spontaneously long ago, when people began to live in relationship with rivers, and have continued throughout history. In early modern times, flood control measures mediated by government agencies developed, and as urbanization led to a decrease in the number of residents directly benefiting from the river, flood control activities also declined. In the modern era, flood control and flood prevention activities were regulated by the law and flood prevention units were organized. Flood control activities by local communities have continued to this day.

In the times of Jyomon, Yayoi, and Kofun eras (13,000BC–700AD) the coastline receded further and plains were gradually formed. River water was used for domestic purposes and fishing began (Figure 18.3). Rice cultivation began in the wetlands created by the receding land. People began to live along the rivers. Small reservoirs were created and people began to live on the plains. The Yayoi period marks the beginning of the history of floods and flood control in Japan. This was a time of Jyomon, Yayoi, and Kofun eras when the relationship between rivers and people became closer. The necessity for flood control was recognized.

² Flood Prevention Unit (*Suiboudan*) and Fire Corps (*Shoboudan*): The English translations of the Japanese words, *Suiboudan* and *Shoboudan* are referred from the Ministry of Justice's Japanese Law Translation website, which uses the English translations of the names from the Flood Prevention Law and the Fire Fighting Organization Law (Ministry of Justice).

In the time of Nara and Heian (700AD–1200AD) arable land was created around wetlands because of accessibility to water, making it susceptible to flood damage. Flood control was limited to preventing arable land from being washed away by floods. Farmers constructed levees to enclose small farmlands.

In the time of Kamakura and Muromachi (1200AD–1570AD) flood control was initiated according to the characteristics of the rivers. Large-scale irrigation facilities were built on major rivers. Development of new rice paddies began. Farmers were obliged to carry out flood prevention works.

In the Edo era (1600AD–1870AD) riverboat transportation was developed for transporting rice and other commodities. Cities developed along rivers. In the cities, new technology conducted river water to secure clean water. Farmers built levees around village enclosures and engaged in flood prevention activity in the community base. National and local governments had a well-publicized idea of the necessity of flood prevention activity. Flood control by the governments and flood prevention by the community began to be separated.

After the Meiji era, a dual system of laws was established, one for traditional local flood prevention activity and the other for flood control from the perspective of national administration. After the Second World War, fire corps based on community base were established. Flood prevention managers (municipalities) were established and given primary responsibility for flood control. Flood control and prevention activities were centralized, but the organization of flood prevention activity was divided into two groups: the flood prevention units and the fire corps. Flood prevention management costs were borne by the flood prevention managers (municipalities) or the prefecture.

Figure 18.3: Historical Background of Flood Prevention Activity

	The history of the relationship between RIVERS and HUMANS	Flood CONTROL by governments and flood PREVENTION activities based on community
14000BC		
4000BC		
Jyomon	<ul style="list-style-type: none"> The coastline receded further and the plains were gradually formed. River water used for domestic purposes and fishing began. 	<ul style="list-style-type: none"> The Yayoi period is the beginning of the history of floods and flood control in Japan. This is the period when the relationship between rivers and people became close. The necessity for flood control was recognized.
Yayoi		
300AD	<ul style="list-style-type: none"> Rice cultivation began in the wetlands created by land receding People began to live along rivers. Small reservoirs were built and people began to live on the plains. 	
700AD		
Kofun		
600AD		
Asuka		
700AD	<ul style="list-style-type: none"> Arable land was created around wetlands because of accessibility to water, making it susceptible to flood damage. Flood control was limited to preventing arable land from being washed away by floods. 	
800AD		
Nara		
Heian		<ul style="list-style-type: none"> Farmers constructed levees to enclose small farmlands.
1100AD		
Kamakura	<ul style="list-style-type: none"> Flood control was initiated according to the characteristics of the rivers. Large-scale irrigation facilities were built on major rivers. Development of new rice paddies began. 	
1300AD		
Muromachi		<ul style="list-style-type: none"> Farmers were obliged to carry out flood prevention works.
1600AD		
Azuchi-Momoyama		
Edo	<ul style="list-style-type: none"> Riverboat transportation developed for transporting rice and other commodities. Cities developed along rivers. In the cities, new technology conducted river water to secure clean water. 	<ul style="list-style-type: none"> Farmers built levees around village enclosures and engaged in flood prevention activity in the community base. National and local governments had a well-publicized idea of the necessity of flood prevention activity. Flood control by the governments and flood prevention by the community began to be separated.
1870AD		
Enlarge		
1868	<ul style="list-style-type: none"> After the Meiji era, a dual system of laws was established, one for traditional local flood prevention activity and the other for flood control from the perspective of national administration. 	
1912		
Meiji		
1926		
Shouwa	<ul style="list-style-type: none"> After the Second World War, fire corps based on community base were established. Flood prevention managers (municipalities) were established and given primary responsibility for flood prevention activity. Flood control and prevention activities were centralized, but the organization of flood prevention activity was divided into two groups: conducted by the flood prevention units and the fire corps. Flood prevention management costs were borne by the flood prevention managers (municipalities) or the prefecture. 	
1989		
Heisei		
2019		
Reiwa		

Source: Created by the author based on Public Works Institute.

18.6 Changing Role of Flood Control and Flood Prevention Activities

There is an old Japanese proverb that says “He or She who governs the rivers can govern the nation” (Figure 18.4) because governing rivers, securing land, and cultivating crops were measures to create wealth and power. In the Edo era (1603–1868), the Edo government and local governments took the main role of governing the rivers; however, it was the farmers who actually faced the rivers and grew crops. Many communities consisted of farmers, so community-based organizations shared a fate among those with a common interest in preserving farmland and preventing disasters. In this period, self-help, mutual aid, and public assistance functioned together.

Since the Middle Meiji to Taisho eras (1868–1912), when flood control was legalized, the modern flood control system began with the composition of the government taking the lead in promoting flood control while the local community supported the actual implementation of the system. However, due to increasing urbanization and the diversification of jobs, it gradually became more difficult to support flood control from an individual or local perspective.

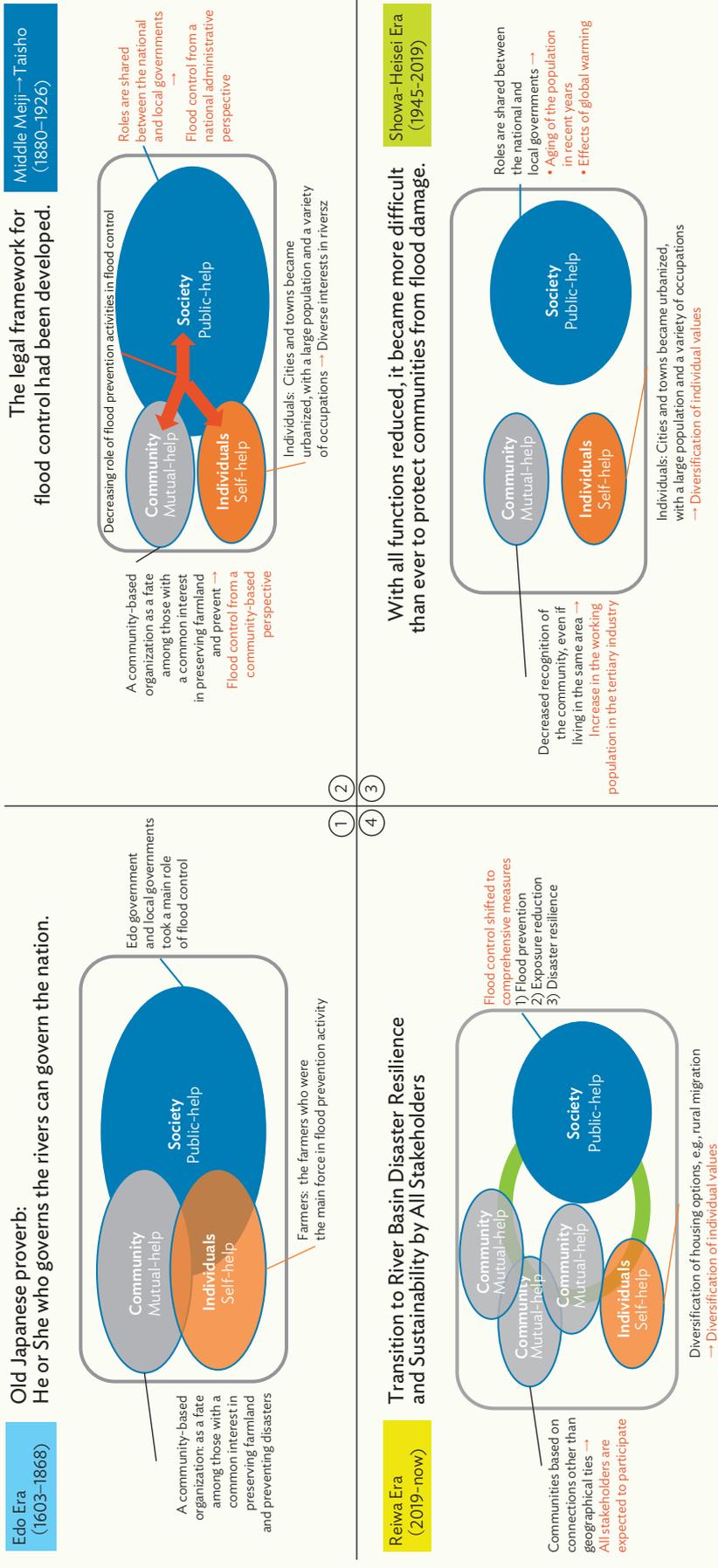
This trend from the middle Meiji to Taisho era became even more pronounced in the Showa (1926–1989) period. Meanwhile, the aging of the population and the effects of global warming made it more difficult for governments to prevent flooding, which led to increased damage.

With the start of the Reiwa era in 2019, Japan has discussed how to halt the divergence between flood prevention and flood control, between self-help, mutual aid, and public assistance, and how to achieve comprehensive flood control in Japan. As the consequence of discussion the goal was set as “Transition to River Basin Disaster Resilience and Sustainability by All Stakeholders”.

In this framework we encourage the participation of all communities interested in social safety, security, and resilience, not just those rooted in the local community. and also it aims to reduce residents’ exposure to risk, including interregional migration rooted in the diversity of individual values. it expects to implement comprehensive flood control measures aimed not only at reducing damage before a disaster, but also at strengthening response measures after damage has manifested itself,

In the future, flood prevention units may be required to perform a new functions. We will continue to monitor the future of the flood prevention units.

Figure 18.4: Changing Role of Flood Control and Flood Prevention Activities



Source: Created by the author based on Public Works Institute.

Supplementary Notes

In Japan, when rice cultivation began in the Yayoi period (4th century), the relationship between people and rivers became closer. During the Kofun period (3rd century), there are records of rice paddies being damaged by floods. During the Asuka period (592–710), a national centralized system was established and the need for flood control was recognized. Subsequently, rice paddies were privatized and levees were built to enclose them. During the Warring States period (1467–1615), flood control was developed for territorial defense and urban defense centering on castle towns. During the Edo period (1603–1867), rivers were improved for boat transportation, and levees were built around villages to prevent flooding in each village. After the Meiji period (1868–1912), the clan-based flood control system developed during the Edo period disappeared, but the dual legal system of national flood control and local flood prevention has continued to the present.

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Water and Culture in Asia Toward Shared Prosperity

Yoonjin Kim

19.1 Introduction

Throughout history, water has been an essence of life, a mode of transportation, a life-threatening force from disaster and sanitation, and frequently a central measure of social and cultural activity (Krause and Strang 2013). However, due to the unequal water context in the respective region, misuse or overuse and increasing unexpected threats by the climate impact derive challenges in our lives. Many parts of the world have nurtured and developed water resources as part of their course in history. On the other hand, other parts of the world suffer from water scarcity, and pollution and overuse have jeopardized water resources that directly impact the lives of humans and nature simultaneously.

In consideration of unchanging human dependence on water throughout the histories of different regions and societies, Bijker proposes naming human societies “water cultures” (Bijker 2012), and others refer to our settings as “water worlds” (Hastrup 2009; Orlove and Caton 2010; Barnes and Alatout 2012). Many studies have been undertaken to discover the enormous impact of water on human societies and cultures. Water challenges are also identified as political difficulties from different aspects due to the diversity of local and regional interests and ideologies (Molle, Mollinga, and Meinzen-Dick 2008). Water is an essential component of social, cultural, and political interactions (Hosseiny, Bozorg-Haddad, and Bocchiolac 2021). In this context, it is essential to remind how Wiley’s *Interdisciplinary Reviews of Water* (Lane 2018) interprets water that we have brought it into our lives in culture via art, religion, and history, which impacts how we come to understand it (Ingold 2000).

This chapter discusses five aspects of water and culture to understand the different features and perceptions of water in Asia. It aims to have a mature perception of the correlation between water and culture in our society by envisioning future global value-creation processes based on understanding the function of water in our culture and society. In addition, this chapter suggests valuing water with a balanced, ethical framework in water culture in Asia in the alignment of global paradigms such as the United Nations Sustainable Development Goals (SDGs). Eight elements of an ethical framework that were introduced by the World Commission on the Ethics of Scientific Knowledge and Technology in 2004 may be useful guidelines to achieve the aim.

19.2 Five Aspects of Water Culture and Human Civilization

When we define “civilization” for a certain period of time, it is critical to comprehend the lifestyle of a group of individuals living in a geographical location, as well as their aspirations and successes (Hosseiny, Bozorg-Haddad, and Bocchiolac 2021). Historically, civilization has been associated with a more broad and evolved culture that defines people’s perceptions of their way of life and the worth of time. Water is one of the necessary and irreplaceable resources for the lives of humans and nature and an essential part of civilization and its advancement. Hence, in the history of civilization, water culture has been developed simultaneously based on local and regional contexts and features of different religions, art and rituals, politics, and social and economic situations.

The following five categories and the regional cases represent the multifaceted connections between water and cultural development across selected countries that thrive in Asia, highlighting the role

of water in shaping religious beliefs, influencing art, affecting development, building socioeconomic dynamics, and developing governance.

19.2.1 Water and Religion (Ganges River, India)

Water has great religious importance in many Asian civilizations. Water is seen as the foundation of creation and, in some cultures, the universe's origin or a symbol of birth. Because of the importance and place of water in human life, many cultures' ideas and viewpoints in the ancient world are strongly tied to water. For example, in ancient times, people honored the goddess of water in numerous places, including West Asia. The goddess was portrayed as a fertility and birth emblem with a corpulent body, primarily associated with rain, rivers, and oceans. Plant growth, tree fruiting, and infant development in the womb were all benefits and kindness from the deity of water (Hosseiny, Bozorg-Haddad, and Bocchiolac 2021).

Hindus believe the Ganges River in India is sacred and can wash believers of their sins. The Ganges River is significant and intricate in Indian culture and religion. It signifies a spiritual link that spans generations, and its waters are thought to be able to cleanse and cure. The Ganges River is worshiped as a deity in Hinduism. Her journey from heaven to earth is chronicled in ancient scriptures and is fundamental to the mythology and religious importance of the river (Darian 2001).

Challenges

However, this holy river suffers significant environmental concerns. Balancing cultural and spiritual veneration with the need for environmental protection is a complicated issue. However, it is critical for the spiritual and material well-being of the river and the millions of people who rely on it (Figure 19.1).

Contamination of the Ganges River has increased due to industrial effluents, sewage discharge, and religious offerings, all contributing to severe contamination. Despite its hallowed position, the river's water quality needs to improve. Nongovernment organizations, government programs, and religious groups work together to revitalize the Ganges, and projects like the Namami Gange Mission seek to balance the river's environmental and cultural components are carried out (Tyagi et al. 2013). However, it is not sufficient to revive the river.

Figure 19.1: Activities on the Ganges River

(a) Ritual Ablution in the Ganges



(b) Night Activities on the Ganges



(c) Ritual Ablution in the



Source Butler (2022).

19.2.2 Water and Art Ritual (Songkran, Thailand)

Water is frequently celebrated in Asian cultures via festivals and traditional customs. The Thai New Year celebration (*Songkran*) in April, involves nationwide water fights that symbolize the washing away of misfortunes. *Songkran* highlights Thailand's creative blend of water, culture, and joy. Water serves as a medium for creative expression and cultural preservation, from traditional rites and dancing to modern street art and environmental awareness. *Songkran* celebrates regeneration and togetherness by showcasing how art and water combine to create a vivid and unforgettable cultural event. In this sense, art in *Songkran* plays a vital role in portraying the metaphorical significance of water (Intason, Coetzee, and Lee 2023). Figure 19.2 illustrates activities during the festival.

Figure 19.2: Songkran Festival

(a) Cultural Waters of Songkran



Source: TUNZA Eco Generation.

(b) Water Play at Songkran Festival



Source: Komlongharn (2023).

Challenges

While *Songkran* is a time of joyful water play and culture, there is a rising awareness of the need for water conservation. Likewise, environmental sustainability has been an issue in these cultural ceremonies or rituals during massive gatherings and celebration activities. According to Kongrut's report in the Bangkok Post (2016), to ensure that revelers and visitors have enough water to splash in, the Metropolitan Waterworks Authority supplies 100,000 cubic meters of water each day, the equivalent of 8,333 12-tonne trucks. During the event, initiatives advocating appropriate water use are sprouting. From some groups having future-oriented notions of maintaining this celebration with sustainability, some art installations constructed from recycled materials have been shown at *Songkran* festivals, emphasizing the significance of environmental sustainability. However, the cases are still limited.

19.2.3 Water and Development (Feng Shui, People's Republic of China, Republic of Korea)

Water has had an impact on Asian architecture and urban development. Similar to other regions, ancient Thai towns such as Ayutthaya were built near waterways to aid commerce and transit. Water bodies are seen as significant components in the Chinese discipline of feng shui since they impact the

vitality of a location. Feng shui, an ancient Chinese concept or philosophy based on the notion that the arrangement of one's surroundings may affect one's well-being, has significantly impacted urban development. Feng shui concepts highlight the importance of environmental balance and harmony (Wu, Yau, and Lu 2012). According to Yoon (2006), feng shui is based on the understanding that water is a potent instrument to soothe and stimulate energy depending on its placement and properties. This is generally adopted in other parts of Asia, such as East Asian and Southeast Asian countries.

In the case of the People's Republic of China and the Republic of Korea, feng shui is a traditional and currently used methodology to find a prosperous place for dwellings, infrastructure, or buildings. In the Republic of Korea, where approximately 70% are mountainous areas, feng shui refers to essential places like palaces where mountains are behind and streams or rivers in front (Yoon 2006). Likewise, water is incorporated into the urban landscapes of modern cities such as Singapore, effectively mixing culture and innovation. For example, the Marina Bay region in Singapore incorporates feng shui concepts into its architecture, including strategically placing water elements. The bay area's layout is said to encourage wealth and financial success. Furthermore, the building of Victoria Harbour in Hong Kong, China has considered feng shui concepts, with the placement of skyscrapers and other structures considering the flow of energy and water (Suri 2023).

Challenges

Although there are many cases of different Asian traditional and modern development adopting water with the concept of feng shui, modern urban development also struggles to balance traditional concepts with environmental sustainability and conservation. To secure the place where feng shui fits, people sometimes decide that it needs to align with the sustainable development plan in constructing a building or infrastructure. Cultural adaptation may be another aspect of the challenges. As Asian cities grow more multicultural, applying feng shui concepts to various cultural situations is critical while honoring their cultural history. While adopting ancient feng shui concepts to modern situations is complex, especially in urban areas where people are concentrated, the perception of the persistent significance of water in urban development demonstrates the necessity of balance and harmony in our cities and their development.

19.2.4 Water and Politics: Navigating Complexities for Sustainable Cooperation (Mekong River Basin)

In different regions where transboundary rivers exist, it is crucial to understand how the biological understanding of river basins are changed in different transboundary institutional arrangements, how various players in transboundary basins build geographical scales, and how politics over water is represented and exercised within governance and management institutions (Sneddon 2006).

Regional collaboration on the Mekong River has continued for 60 years, making it one of the earliest transboundary rivers governed by an international river organization and according to the principles of equitable use (Mekong River Commission n.d.). Collaborative political will is crucial to resolving water challenges. Some Asian water issues need regional collaboration, open discussions, and sustainable resources management to ensure water security and foster peaceful coexistence in a region where water and politics are closely connected, which correlates with social culture (Dore, Lebel, and Molle 2012). Building upstream on the Mekong River has sparked worries about the downstream effects on riparian countries of the Mekong. Long-time studies and diplomatic dialogue on the Mekong regional issues examine the complex geopolitical ramifications and the need for negotiated solutions. Hence, water is more than a national resource issue for the Mekong riparian countries. However, having a shared vision with different countries is a more political and diplomatic issue, which affects the perception of water more prudently and considers water a regional priority (Hirsch and Jensen 2006).

Challenges

Challenges of transboundary water issues usually require a shared vision with resolutions based on political consensus and consideration between countries, which requires enormous efforts by each country to have a regional and global view of the issues. Setting a vision with diverse stakeholders could be referred to as an aspect of setting cultural norms and values. First, the strengthening of regional institutions such as the Mekong River Commission and the South Asian Association for Regional Cooperation will help in promoting dialogue and conflict resolution. Encouraging data sharing and transparency in water management to foster confidence and collaboration among riparian governments is also essential to exchanging up-to-date information needed to protect the Mekong River basin. Promoting collaborative efforts to safeguard ecosystems and highlighting the need for environmental diplomacy is another item. Applying integrated ways to address the interdependence of security issues of water, energy, and food, especially in agriculturally reliant countries, and enhancing technical and institutional capacity building to enable a comprehensive perception of shared water is the basis of making the Mekong River basin sustainable with dwellers in riparian countries.

19.2.5 Water and Governance and Indigenous Wisdom (Bali, Indonesia)

It is well known that the indigenous groups in Asia have made efforts with historical local water management for rice cultivation, the main food that is sustainable and adapts to shifting water patterns, underlining the need to incorporate cultural knowledge into practices.

The Bali *Sukak* system, registered as a UNESCO Cultural Heritage Site (UNESCO 2021), is one-of-a-kind and a successful water governance approach based on indigenous traditions and community-based management (Gany 2001). Figure 19.3(b) illustrates the *Subak* system. Bali's *Subak* water administration has supported agricultural and communal life. *Subak* is a decentralized community management system, with individual *Subaks* controlling water resources in specific locations (Bali Glory n.d.) Each *Subak* comprises local farmers who work together to regulate water allocation and distribution. Water temples, or *Pura Tirta*, serve as the heart of *Subak*'s governance (Hafied 2001). They are not just Balinese religious centers but also administrative hubs where decisions about water distribution and cropping schedules are made. Water temples have elaborate calendars that regulate water allocation timetables for each farmer in *Subak*. These calendars are based on religious observance and communal agreement (Bali Glory n.d.).

Rituals and ceremonies are essential in the governance of *Subak*. These rituals ask for blessings for plentiful harvests and maintain the peace between humans and the environment, particularly concerning water (Yuliana 2017).

Conflict resolution mechanisms are also well known, referring to the *Subak* system. Disputes over water allocation or management are settled using traditional conflict-resolution procedures influenced by local wisdom and cultural norms. *Subak* meetings are the regular meetings convened to discuss water-related issues and reach consensus on important decisions. These meetings promote transparency and community involvement (Suanda, Suryadi, and Kasniari n.d.).

It shows how indigenous knowledge, rituals, and consensus-building procedures may help to ensure long-term water governance. As water difficulties become more severe, the *Subak* model offers essential lessons for modern water governance initiatives that stress local engagement, cultural integration, and adaptation.

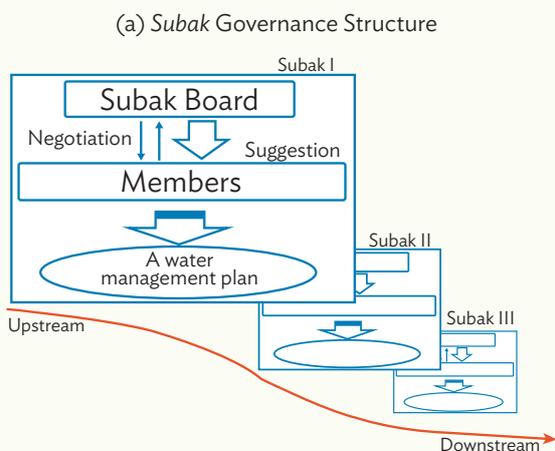
Challenges

However, the *Subak* system is also affected by climate change. Altered rainfall patterns and changing weather conditions are impacting the usual water availability that the local community has calculated in traditional ways. *Subak* communities have to adjust cropping patterns and water management strategies to cope with these challenges with future-oriented technologies or digitalization.

The *Subak* system also highlights the effectiveness of community-based, decentralized water governance. It fosters a sense of ownership among farmers by promoting local knowledge and accountability. *Subak* must adapt to the changing context or scenario of water supply and use as other water systems and governance evolve and must align not just with the Balinese situation but also with the world situation (Suanda, Suryadi, and Kasniari n.d.). Figure 19.3(a) illustrates the *Subak* governance structure.

Subak guarantees that water management is not just about resource distribution but also about preserving the community's cultural identity and values by incorporating cultural and spiritual dimensions into water administration. To ensure the continuation of the local system, the capacity building and empowerment of future generations of Balinese remain an unresolved issue.

Figure 19.3: Bali's Subak System



Source: Okura, Budiasa, and Kato (2020).

(b) Bali *Subak* System



Source: World Water Forum (n.d.).

19.3 Common Consideration for the Future of “Water and Culture” in Asia

When we examine the relationship between water and culture in a region, it is about how water is valued in society and how it is handled within the region's evolved ethical framework of water. The five aspects stated above as the essential elements to understanding the water and culture in Asia are the facets of a perception that people in Asia have in society, economy, history, politics, art, and ritual. It is not only a significant function in the development of local society and the identity of countries and regions, but it is also an essential parameter of how one society in Asia evolves by adopting changing contexts and globally agreed notions together, seeing water in our culture.

Based on that, likewise in other regions, Asians' perception of the value of water in their culture has a critical impact on global water culture. Asia is at the center of the changing world economy, politics, environment, culture, etc., with the fact that it is the home to more than 60% of the world's population and 39% of the world's gross domestic product that is projected to increase to 51% in 2030 (World Economics 2023) bolsters the idea. Hence, it is imperative to consider that the function of one regional culture in water is not limited to impact in a particular region but is closely intertwined with the perception of water in the global community.

The cases examined above have faced challenges to maintain or advance and to have sustainable notions with developed perceptions of water with the main concerns of environmental and ecosystem conditions that impact cultural sustainability and increase water contamination. Cultural sustainability with future generations' adoption of the current and historical culture also affects the level of adoption of digitalization and shifting perceptions of culture.

In this context of Asia's culture of water and its evolution toward the future, it is imperative to take into consideration the importance of valuing water in the regional culture and how each country that has different cultural ethics agrees upon a shared vision and perception of water as a member of the international society.

19.4 Valuing Water and its Ethical Framework

Water value and ethics are for both humans and nature. It is based on human–ecosystem interactions and interdependence based on water functions in our daily lives and the coexistence of nature. To highlight ethical principles in valuing water in our culture, the SDGs can be a good example.

The SDGs adopted in 2015 and will be active until 2030 imply common justice to development, economy and environmental protection, and education for future generations. Goals 6 and 14 are mainly dedicated to water and sanitation and the sustainable use of oceans. Recognizing the connection among water and society, environment, economy was discussed in the Goal 6 Synthesis Report (UN 2018) and it was additionally elaborated referring to other SDG goals associated with issues like climate change, ecosystem, health, energy and food, urban development, partnership, and education that we consider as the essential elements of cultural change and the perception of water in society.

A review by UNESCO (UNESCO 2014) presents the ethical frameworks for water. Its two frameworks reflect ongoing challenges that many Asian countries are related to, such as securing sufficient water resources, resolving competing uses, and access to drinking water. Anthropocentric values are also widespread in ethical frameworks surrounding fresh and drinkable water, which are intimately related to our everyday view of water.

The World Commission on the Ethics of Scientific Knowledge and Technology in 2004 introduced a series of values relating to water use for human beings (Brelet and Selborne 2004). Box 19.1 lists the elements of sustainable principles for “Water for Shared Prosperity”, which is the main theme of the 10th World Water Forum co-hosted by the World Water Council and the Indonesian government. It is also the genuine element to address the challenges stated in the five different cases of Asia by changing the perception of water from one that is for human use and local and national demand, to one that water is essential both for humans and nature. This change will give a better understanding of people who are the main actors in changing the culture on the interconnectivity of water use and management and conservation of the ecosystem and the environment, which will be enhanced by capacity building of future generations and the efforts based on the solidarity of individuals and countries having common goals.

Box 19.1: Sustainable Principles for “Water for Shared Prosperity”

- **Human dignity:** water is the essence of human life and nature.
- **Solidarity:** Water makes people acknowledge their inherent interdependence.
- **Everyone** should have **equitable access** to clean water.
- **Water is a shared good**, and inadequate water management reduces human potential and dignity.
- Respectful and prudent water usage is associated with **heritage value**.
- **Transparency of information and universal information access.**
- **Inclusiveness in water management policies** encompassing minorities and the poor as well as nature in sustainable ways.
- **Empowerment** is essential to promote involvement in planning and management, as well as shaping cultural perceptions of water.

Hosseiny, Bozorg-Haddad, and Bocchiolac (2021).

19.5 Conclusion

The correlation between water and culture in Asia is a complex tapestry woven through religion, tradition, art, economics, politics, architecture, development, and environmental consciousness. As water-related challenges continue to evolve, as examined in the five different cases of water in the culture of Asian regions, preserving and developing cultural practices that revolve around water become crucial. By acknowledging the deep-rooted connections between water and culture and recognizing common principles of an ethical framework in valuing water, societies can strive for sustainable coexistence and adaptation for shared prosperity.

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Sociocultural Dimensions in Water Resources Management

Policies, Practices, and Challenges

Sociocultural Dimensions in Water Resources Management: Policies, Practices, and Challenges critically explores the complex challenges of ensuring sustainable development and effective water governance amid diverse cultural contexts. Through a compilation of insightful case studies and research from across Asia, the book emphasizes the importance of acknowledging and incorporating cultural values, traditional knowledge, and community engagement in water resources management strategies. It also sheds light on the challenges and opportunities of adopting culturally sensitive approaches that recognize the intrinsic value of sociocultural dimensions in shaping sustainable water governance models.

The edited volume proposes four key policy highlights. First, policy makers should incorporate sociocultural aspects into technical and economic frameworks for comprehensive management. Second, local decision-making should be emphasized to enhance governance through active community participation. Third, merging indigenous knowledge and traditional practices with modern technology is crucial for enhancing climate resilience and underscoring the significant environmental benefits. Fourth, it is essential to advocate for the preservation and transfer of traditional knowledge across generations. These principles can form the backbone of a sustainable and culturally attuned water governance framework. The book's messages are intentionally crafted to be accessible and engaging for a wide audience, underscoring the importance of imparting this knowledge to the next generation.

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