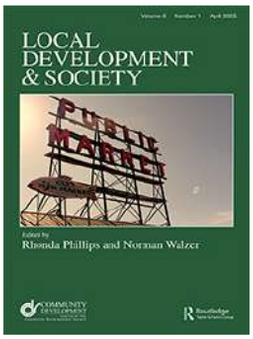

Local Development & Society

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/rlds20

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To cite this article: Sauwalak Kittiprapas & Amrita Daniere (25 Mar 2025): Community engagement in water management to enhance sustainability: A case study of Bangkachao, Thailand, Local Development & Society, DOI: 10.1080/26883597.2025.2480592

To link to this article: https://doi.org/10.1080/26883597.2025.2480592

LOCAL DEVELOPMENT & SOCIETY
https://doi.org/10.1080/26883597.2025.2480592

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Community engagement in water management to enhance sustainability: A case study of Bangkachao, Thailand

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ABSTRACT

Bangkachao, the important and largest greenspace community near Bangkok, has been threatened by several water issues such as increasing salinity, polluted water, and floods. The study conducted a participatory action research (PAR) project on water management with community participation, aiming to solve these problems from the bottom up. The research shows that community engagement in the management of water resources can enhance sustainability. The collective efforts of the research group and local stakeholders proved very effective in resolving water management issues and creating knowledge. They aided in knowledge sharing during and beyond the project period. The evidence-based argument is essential for making change. Tangible results include a significant change in the main watergate management to solve water problems and the creation of an accurate map of existing canals and water gates around the island, which support local understanding of water management and regular monitoring enhanced by statistical data and technical tools. Human and social capital gains continue to be seen in longer-term work and continued efforts to monitor water problems.

ARTICLE HISTORY
Received 22 July 2024
Accepted 10 March 2025

KEYWORDS
Sustainability; water management; community engagement; Bangkachao; Thailand

Introduction

Many Southeast Asian cities are vulnerable to climate change's effects (Fuchs et al., 2011) and must take steps toward climate resilience and greater sustainability as soon as possible. In particular, a study conducted by the Economy and Environment Partnership for Southeast Asia, which relied on an overall index to evaluate climate change vulnerability, indicated that the Bangkok region is one of the most vulnerable areas in the world (Yusuf & Francisco, 2009). The dominant hazards facing Bangkok and its surrounding area are rising sea levels and flooding (Fuchs et al., 2011, p.6, p.13).

Cities are exploring various potential investments and policies to mitigate and adapt to the predicted changes. The emphasis has been on top-down conventional engineering-led infrastructure investments, such as building walls and more powerful pumps. Many

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This article has been corrected with minor changes. These changes do not impact the academic content of the article.

scholars/experts, however, recommend pursuing pathways that rely on "softer" and more inclusive strategies designed in concert with residents and other stakeholders. Promoting grass-roots solutions and the participation of citizens in Southeast Asia is still rare (Anguelovski et al., 2019; Rizzo, 2019).

Social capital can strengthen public and private resource management in ways that build resilience and help reduce climate change vulnerability (Adger, 2003). Climate change and its impacts are likely to be more severe without collective interventions, particularly in vulnerable areas, such as Bangkok and nearby areas, where all citizens are highly exposed to the ebb and flow of the Chao Phraya River, the area's major waterway.

In many countries, a community-engaged approach to managing natural resources is embraced at the national, regional, or municipal level (McKay & Tantoh, 2021). However, there is little evidence of community engagement with urban water issues and climate resilience by Southeast Asian cities. Floods and other climate-related events are dealt with at the national level in the usual top-down way (Lebel & Lebel, 2018; Marks, 2015). Accordingly, our project, which sought to connect a community with other stakeholders to improve urban water management, was an exceptional initiative.

Bangkok, a city with one of the lowest levels of greenspace per capita in the world (The Economist Intelligence Unit, 2012), has a remarkable asset at its border, i.e. a "green island" known as Bangkachao, on the other side of Chao Phraya river. This island provides a green undeveloped "park" within spitting distance of Bangkok's traffic, skyscrapers, and megamalls. Although Bangkachao is essential as the largest greenspace at the Bangkok border and is listed as a National Environmental Protection area, it has been threatened by water problems surrounding the island. While various agencies (both public and private) and their projects have mainly concerned and dealt with the preservation of the greenspace, the water issue has been overlooked. While the area may be vulnerable to climate effects, community engagement in water management has been missing.

The island represent an ideal location for attempting to use community engagement to improve water management and quality. Particularly in Southeast Asia, local citizens rarely interact with government agencies or their representatives, as most environmental regulations are imposed from above. Typically, laws or environmental, regulations are imposed from above on provinces, municipalities, or communities. Climate change and water management policy in Thailand mainly rely on engineering solutions with little or no people participation in the decision and design, such as the building walls and water gates around Bangkachao island without consultation with community members or considering how these buildings and designs would affect their agricultural soils as well as the management of water flow. In addition, human management of existing water gates around the island could mitigate or exaggerate the saltwater problem, which has become a serious problem recently, given its close location to the sea.

Given the existing problems, exploring alternative, bottom-up approaches involving community members may provide more holistic solutions to water issues. This is also the opportunity for community members to examine the causes of the problems and build knowledge and information to manage their community water resources in the long run.

To explore the validity of using community engagement to improve water management, which usually relies on hierarchical and top-down decision-making, a small participatory research project on community engagement based in Bangkachao was initiated. Our project brought together scholars and key community members to engage in

collective action around water access and management issues, initially starting from mid-2017 to mid-2019 to demonstrate the positive potential of such efforts to improve climate change resilience through community engagement and knowledge sharing, despite little encouragement or support from official channels at the outset.

As noted by Pauleit et al. (2019), inclusion of citizens is needed in the management of more sustainable cities. Our research could provide evidence that building sustainable cities and communities (as indicated in SDGs goal 11) should include community engagement.

The main objective was to involve community members in water management planning and design to make some changes in the action research process. As Fraser (2002) described, the approach is community-led from the outset. This case study would be a valuable example of using local community-based intervention and focusing on building social and human capital by creating linkages between community members, academics, and government officials to facilitate the exchange of information and ideas.

Next, the specific context of Bangkachao, or Bangkok's green lung, is examined. It is followed by the research approach and methods, with a review of the relevant literature on community development and participatory research. Subsequently, the paper presents results from details of the activities and practices of our action research and a summary of the lessons learned about how community engagement can lead to greater climate resilience and sustainable water management. Finally, it concludes key results with the broader implications of this research.

Context

Bangkachao, a very important area in environmental concern, is an island located at South of Bangkok in Samut Prakan Province,[1] close to the Gulf of Thailand and is affected by sea-level changes (Figure 1). The island was created by digging a canal at the open (western) end of a U-shaped bend in the Chao Phraya River. Bangkachao measures just under 1,900 hectares (or 11,818 rai/16 sq km) and comprises six *Tambons* (sub-districts). Bangkachao has been home to a variety of fruit trees within this large greenspace.

The island consists of three ecosystems: mangrove forest, rainforest, and freshwater swamp forest. This ecological diversity makes the area particularly vulnerable to climate impacts, i.e. the rising sea level and flood. In addition, its location in the middle of the big cities of Bangkok and Samut Prakan encounters water pollution problems from urban and industrial areas. The greenspace in Bangkachao has declined significantly over the last five decades. Bangkachao area used to have 93% greenspace in 1973, but it declined to 58% by 2017 (Kasetsart University, 2017). Several government agencies have adopted policies to preserve the island in the past, including Ministerial regulations to implement land use planning in 2013 and declaring Bangkachao as an Environmentally Protected Area in 2019.

There is a large public park and botanical garden (about 22 ha or 148 rai); the entire island is frequently visited by day trippers, nature lovers, and cyclists, and once listed as the best urban oasis in Asia, Marshall (2006); Retalk Asia (2017). Estimates in 2011 suggest that the vegetation on Bangkachao traps more than 6,000 tonnes (Mg) of carbon dioxide each year and produces 6 million tonnes (Mg) of oxygen per day, according to a study by Kasetsart University.[2] Studies indicate that environmental quality is a source of the

Figure 1. Map of Bangkachao, a green island surrounded by Chao Phraya River and Khlong Lat Pho, between urban areas of Bangkok and Samut Prakan. **Source**: Digital Google Maps 2018

community's happiness (Kittiprapas, 2020, 2022). Bangkachao is sometimes called the "green lung of Bangkok" (Bouchet, 2013) as the wind's direction flowing from the Gulf of Thailand passes this greenspace then to Bangkok about 9 months a year, thus, generating oxygen to Bangkok as well.

Ferries and boats connect the island to Bangkok's Klong Toey and Sathorn (Chong-Nonsri) piers and a road connects Bangkok via the Prapradaeng district of Samut Prakan; thus, the area is easily accessed via both cities (as seen in Figure 1). The community is a mix of privately owned and public lands. In the past two decades, some of private land in Bangkachao has been developed into more commercial and residential areas, such as small cafes/ restuarants and resorts for tourists. The community has attracted more outside investment (Easey, 2017). It has become popular in eco-tourism recently and was later declared as a Sustainable Tourism in Protection Area in 2023.

Historically, some Bangkachao community residents may have moved to the island from the other side of the river in Bangkok in the past, while some residents are descended from the Mon people (originally from Burma) who settled on what was then a peninsula more than hundreds of years ago and several Mon Buddhist temples still exist.

Buddhist culture and simple way of life are commonly found among community people. At present, about 50,000 people are living in Bangkachao. The workforce is composed of 15–20% agriculturists and 25% unskilled laborers, with the remainder is self-employed in the service sector and skilled laborers in the private and government sectors, mainly in Bangkok and the adjacent city of Samut Prakan. Their monetary income may be relatively lower than neighboring cities. A survey in 2018 found that about three-quarter of the community people had an average income below $600 (Kittiprapas, 2022). However, the low actual income does not adversely affect the perception of their relative income in the community and happiness research found that inner happiness and environmental quality, along with good relationships and health, positively contribute to the happiness of the Bangkachao residents (Kittiprapas, 2020, 2022).

Although the island's abundant and unspoiled greenspace and proximity to Bangkok make it a target of developers, many want to preserve its unique character and natural landscape. Apart from related governmental regulations (i.e. land use and ministerial regulations), academics and naturalist groups are concerned about the decline in greenspace. There have been discussions and projects such as preserving green trees/areas, granting rights to cultivate trees in underdeveloped green areas, etc. However, an essential factor that relates to gardeners' ability to grow trees is water quality as this is neccessary for fruit trees to survive. Although many related government agencies are responsible for solving water problems, they have not holistically coordinated so far. For example, interventions for flood prevention, water salinity, and water suitable for agriculture were not integrated in the design, which affected the quality of water resources of the community. This calls for our action research for better water management, especially in light that no development organization and academics have been working seriously on such water issues on this island before.

In the beginning of our study, we learned that in the past, residents of Bangkachao had not encountered problems of long-time flooding or salinity but rather experienced seasonal changes corresponding to the natural rise and fall of the sea level. The construction of low walls and water gates around the island by the Department of Public Work in the past was meant to protect them from flooding and adversely affected the agricultural sector as they blocked the flow of fertile agricultural soil from the outside as well as the flow of water (in and out) of the island, leading to increased wastewater and salty soil (Kasetsart University, 2017). However, higher water levels will become familiar, and residents are more concerned about increasingly severe flooding. In addition, for the past decade, the community has experienced more extended periods of salty water flowing through and around the island, adversely affecting their fruit trees. Salty water is a serious problem that the community has been facing and severely affected the survival of fruit trees. This problem needs to be solved so the fruit tree can survive and the greenspace can be restored. Although climate change effects seem familiar for coastal areas, mismanagement could create even more adverse effects. The community, thus, has questions to search for a better way of management to mitigate water problems.

Key concerns and questions by community members are highlighted below:

- The annual period of salt water is much more extended than in the past. It has doubled to about 8 months from the previous 4 months (only in the dry season) in

the past 10 years. What are the causes and how to solve? The water salinity has discouraged farmers to grow trees, as many fruit trees have died and reduced agricultural earnings. Many people have decided to stop farming fruit trees as an occupation. Fruit trees have been abundant, for example, Mangifera indica (mangos), citrus sinensis (oranges), Musa paradisiaca (bananas), Psidium guajava (guava), litchi chinensis (lychee), garcinia mangostana (mangosteen), citrus decumana Linn (polemic), Dimocarpus longan (longan), Artocarpus heterophyllus (jackfruit), Cocos nucifera (coconut), Bouea macrophylla (maprang or Marian plum), Syzygium jombos (rose apple), Averrhoa carambola (star fruit), etc., but many are affected by the increasing water salinity.

- Watergate management issues. There are 34 water gates around Bangkachao that [could] control how much river water flows into the various canals on the island but left no systematic management. In the early stage of our survey, it is noticed that there has been no committee to manage those gates nor is anyone responsible for opening or closing them, apart from many gates being broken. Initially, these watergates were built by the Department of Public Works of the Department of Interior to protect the region from floods rather than agricultural concerns. Then, the construction ownership was transferred to the Samut Prakan Provincial Administrative Organization (PAO), which has the official responsibility to repair the broken gates, but that seems too far for the community to reach out. This is problematic because Bangkachao is very vulnerable to changes in water levels and quality, and yet, the residents felt as if they had no voice in the management of the gates. Specifically, the residents sought to learn who should have the authority to control the 34 surrounding water gates. How should they be managed? What mechanisms should be in place to ensure appropriate water flows during the wet and dry seasons, including protecting salt water? In addition, what is the best physical design for water gates operating in and around Bangkachao?
- Finally, to improve the overall water quality in the canals on the island. The residents agreed that water cleanliness in all canals had significantly deteriorated in the past few years. They were very concerned about how to improve water quality and flow as well as actions by clearing obstructions/garbage and connecting canal routes.

It became apparent that Bangkachao residents were already feeling the effects of climate change and were interested in building resilience locally. Bangkachao was more affected by rising sea levels and salinity than in the past. This was very noticeable as the island is enclosed by the Chao Phraya River, which flows into the sea at the Gulf of Thailand some 20 to 35 km away. Therefore, our primary research objectives focus on:

- 1. To search for the solution to manage the saltwater problem and the cause of extraordinarily long periods of salt water.
- 2. To explore existing canal routes and their connecting to 34 water gates within the island in order to provide more information for community water management.
- 3. To build up knowledge and data to empower human and social capital to enhance sustainability and resilience to climate change.

Research approach and method

Theoretical frameworks that undergird our research approach are community development and social capital, which can contribute to more sustainable and equitable urban water management. For the research method, we used participatory action research (PAR) in our working process. We set up a joint research team comprised of scholars and some local community members.

Following Matarrita-Cascante and Brennan (2012), there are three forms of community development: imposed (i.e. by the government), directed (by the government or NGO), and self-help (by residents), of which local input and involvement varied from none, limited, and high, respectively. While forms (processes) of community development may produce different outcomes, our project's interactional process can be considered a self-help form (with high local involvement) that focuses on "soft issues," i.e. the enhancement of human resources for the learning outcome of residents. Following the self-help process with technical assistance from our action research project, this case is an interactive self-help process at the local level that seeks to improve the community's living conditions with high learning outcomes and networks. This case study of community water resources tries to enhance local engagement in various capacity-building activities, especially relating to water management issues through our working process with stakeholders, to achieve community development outcomes. Effective community development often relies on strong community engagement with active participation and collaboration to ensure that initiatives reflect the needs and desires of and are directed by the community. As noted in Green and Haines (2008), p. 15), "Community development requires the involvement and participation of residents in identifying the strategies they wish to improve their quality of life." Increasing community engagement in urban water management can enhance sustainability through improved decision-making and mutual understanding between citizens, policymakers, and responsible agencies (Golladay et al., 2020).

Dale and Newman (2010) indicate that social capital with networks' bridges and vertical ties to outside government could impact sustainable community development. These have been built through our project activities. Scholars (Ostrom, 2010) find that voluntary cooperation and building trust through shared values are crucial in successful community management of natural resources. This occurs through the generation of social capital among community members (in horizontal network) and the forging of trust with external stakeholders and civil servants (in vertical network), and trust and shared norms can be supported through the kind of information exchange that is encouraged in this Bangkachao project. The project conceptual framework is demonstrated in Figure 2.

This Figure shows that this study focuses on community engagement, with high involvement from local participants in the working process, to effectively achieve the community development outcome of better living conditions through the management of water resources and knowledge building. High community engagement fosters active participation and collaboration in all working activities to reflect their needs, problems, and joint making decisions. Human and social capital is built by exchange learning, evidence-based knowledge sharing, and interactive platforms, in addition to trust among themselves. The strengthening of social capital in both horizontal and vertical ties will reinforce community development outcomes.

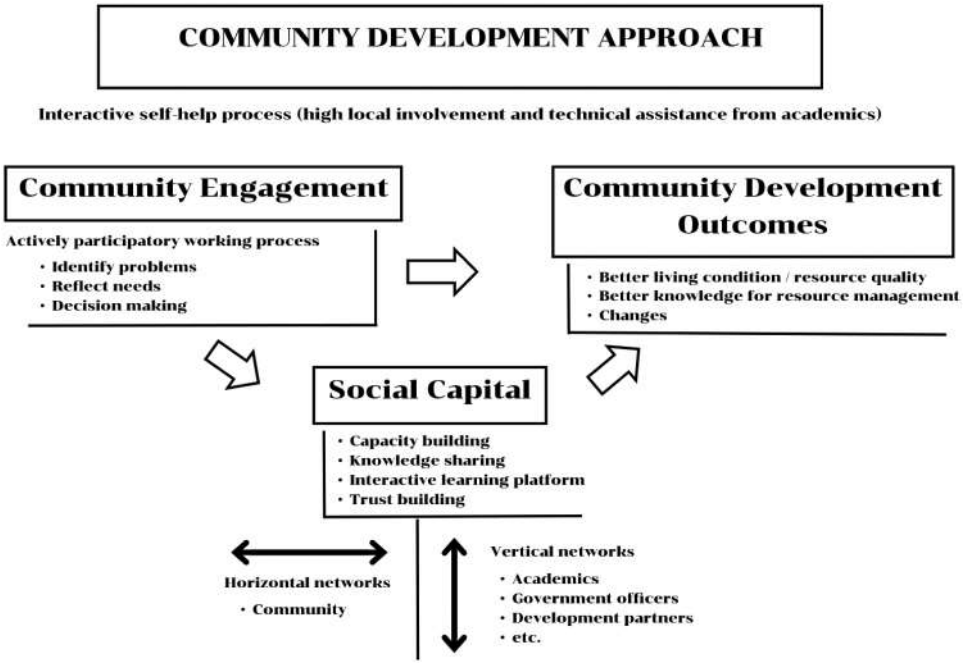

Figure 2. The conceptual framework of this action research.

Participatory action research (PAR) is recognized as a methodology committed to inclusivity and directed by the priorities and goals of the participants in this research, rather than the researchers doing the fieldwork. Following McIntyre (2008, p. 5), PAR is defined as, "an approach to exploring the processes by which participants engage in collaborative, action-based projects that reflect their knowledge and mobilize their desires." Thus, PAR is the methodology appropriately used for this action research. Typically, PAR projects are based within communities or small groups of like-minded citizens who are motivated to engage in research and knowledge-sharing that has the potential to improve their lives concretely.

Several important theories undergird PAR. Friere (Orlowski, 2019), among others, argued that the active co-construction of knowledge by both scholars and community members can catalyze profound social change (Glassman & Erdem, 2014). As noted in Green and Haines (2012), action means involvement and working with people in their communities to create change. In this project, the goal was to have both the academics and active residents of Bangkachao working together to plan, implement, and engage in joint processes of data collection, discussions, identify possible solutions, and prioritize actions and dissemination across the island to improve community's quality of life.

Working process and the selection of participants are explained below.

In early research process, the academic team learned from a small group of Bangkachao residents about worsening water issues. They were active participants in discussing island environmental issues and initiatives. Although this group may not necessarily represent the views of all Bangkachao residents, they were in touch with

many of their communities and later our team has various meetings with more participants to gather different perspectives and concerns. Generally, the island has faced similar water problems in the community contexts and shared similar identified concerns. After informally met with small groups of community members (about 5–10) a few times and design to implement a participatory project about water management in Bangkachao, the first formal meeting (about 60 participants) of the project took place in the main Bangkachao community meeting center (Suan Sri Nakorn Kuenkhun Park). It included many community members who wanted to participate and representatives from key agencies and officials working in the community. The time was used to discuss critical water problems identified by the community, the broader project objectives, possible community research goals, participants, and a tentative work plan.

Then, the selection of local participants for follow-up activities was based on actively interested persons, both female and male, gardeners and non-gardeners, who were continually willing to work on water issues and exchanged ideas in previous meetings. Consequently, this included about nine key local members acting as area-based coordinators, local researchers, and advisors (whose names are noted in the acknowledgment). This local community group and academic project directors work interactively together and are referred in this paper as "Bangkachao Participatory Action Research (PAR) Group".[3]

The specific research goals and their relative priorities were developed entirely by community participants at the first and subsequent group meetings. Prioritized research questions and goals are: 1) What caused the increasing period of salt water and how to solve the problem, 2) How to improve water quality and management and knowledge building that can enhance sustainability and improve human and social capital. A key concern that emerged was the need to learn more about recent changes in water quality in and around Bangkachao and gain access to information about potential climate change effects in the future.

Project activities and workshops were jointly decided and discussed among our participatory research group (Bangkachao PAR Group). Some of the later meetings were arranged more formally, such as workshops or seminars with academics/national water experts to gain knowledge from some specific issues. Insights from such meetings were discussed among our Group for follow-up actions and plans for dialogues with stakeholders such as government officials. In addition, other informal meetings were held in various locations on the island to involve a range of community members in different groups (i.e. women, naturalists and Tambon Administrative Organizations (TAOs) officers) in various activities and formats, while local surveys of canals and water gates were conducted in parallel.

In sum, our project conducted about 30 meetings (in various sizes and formats) between mid-2017 and 2019 to encourage further engagement and knowledge sharing as well as discuss problems and possible solutions. The smaller meetings were held in different community spaces so that individuals from different sub-districts or Tambons would have a chance to participate. These meetings were usually held on weekends and weekdays to allow as many residents and members of TAOs as possible to attend. Moreover, the Group formally discussed with local authorities and related provincial government agencies (i.e. Irrigation Department) on water problems. These activities were decided for investigating and finding solutions to solve problems as well as for

capacity building, bringing changes, and enhancing human and social capital outcomes. Over time, the Bangkachao PAR Group has met with government officials and identified essential actions that the Group could take to find possible solutions and increase their knowledge and ownership of water-related issues on the island.

Table 1 summarizes the main activities including the type and numbers of each meeting, participants, concerns, and outcome. Figure 3 briefly presents some pictures from our field works and various activities/meetings, from informal to formal ones, with different stakeholders: community groups, experts, government officials, school teachers, and students.

Table 1 and Figure 3 present some work by the Bangkachao PAR Group, which included interviews, discussion with community members and local government organizations (TAOs) in the six Tambons, conducting workshops and seminars with national experts to facilitate knowledge sharing and consultation, regular follow-up community meetings, field surveys, supporting and organizing exchange learning opportunities with other communities that have similar problems, meetings with related organizations such as the Irrigation Department, Provincial authorities (i.e. the Provincial Administrative

Table 1. Summary of main activities/meetings, partners, concerns, and results.

Types of Various Meetings	Participants/partners	Main concerns for consultation	Results and outcomes
2 Workshops/ seminars with large groups (about 50–60 persons each meeting)	Community members, related agencies, academics, and experts.	Water management: floods, salt water, dirty water, water gates.	Identified problems and get suggestions about how to proceed, what to prepare. Exchanged knowledge on water issues with experts and dialogue with officials, leading to impactful actions.
15 Community group meetings (about 10–20 persons each meeting)	Community members, different focus groups, and regular meetings of the Bangkachao Research Group.	Discuss specific problems and design a joint work plan.	Exchanged ideas for problem-solving and arranged to meet with related agencies and decided follow-up activities.
1 Local survey	Local researchers and some community members.	Integrated knowledge about water routes and management in Bangkachao.	Produced a water map of all canals and water gates in Bangkachao; being used by local agencies/schools.
1 Field trip to Mae-klong, Samut - Songkram province (about 40–50 persons)	Community groups from Bangkachao and Mae-klong communities.	Learn about watergate design and management, and add value to agricultural products.	Knowledge sharing and exchange of information about the experiences (in watergate management and upgrading the value of agricultural products).
6 Meetings with 6 TAOs (about 2 TAO representatives in each meeting)	TAO officers	Discuss problems and possible solutions	Discussed local problems and their perspectives to resolve outstanding issues.
6 Meeting with related government agencies (About 1–2 government representatives)	Irrigation Department, City Planning, Provincial Governor offices, and Provincial Administrative Organization (PAO).	Identify problems and propose solutions for watergate management and greenspace; involve related agencies in planning.	Agreed to future improvements as requested; some changes occurred; for instance, the closing of the Khlong Lat Pho water gate except during the flood season, and continue working with stakeholders.

Figure 3. Some pictures from various activities during the project period.

Organization (PAO)), the City Planning office, the Provincial Deputy Governor, as well as academics. Community members are engaged in various capacity-building activities to enhance the use of information through our working process. In addition to senior participants in the Group, our team supported young people in learning more about the local geography (with the help of several local schools and local researchers) to use the project's map conduced by surveying all canals and water gates on the island. The

following section shows tangible results and discusses in more detail how the project's working process helped in reaching the solution, building social capital, encouraging collective action and knowledge sharing, and supporting citizen-led infrastructure that can enhance their capacities for climate resilience and support sustainability.

Results and discussions

The Bangkachao PAR Group arranged some meetings with stakeholders including scholars/experts on aspects of water management. This was a significant step in supporting knowledge sharing and building social capital to make changes in water management before they began to discuss with responsible government officials. There are significant results meeting the research objectives, as follows:

Saltwater management

The cause of unusual salty water longer than the dry season over the past decades has been found and an agreement for the solution has been reached. The case study is a good example of how knowledge turned into action that can make changes, as described in the following:

A workshop held with two national water experts to consult and discuss water problems and management in Bangkachao in November 2017 became an important event. During the meeting, one of the community members, who is the natural leader of "Bangkachao as One" online group (and a participant in our PAR Group), surmised that there might be a relationship between the increase in salt water around the island and the operations of the water gates at Khlong[4] Lat Pho (see location in Figure 4) over the last decade.

Khlong Lat Pho is a historically significant canal, connecting the Chao Phraya River at Bangkachao to the Gulf of Thailand in Sumut Prakan's Prapradaeng district. Following severe floods in the early 1990s, a conventional major flood control device was constructed at this juncture so that, under flood conditions, water could be redirected away from Bangkok proper and flow more quickly out of the canal and straight into the Chao Phraya River and, eventually, the Gulf of Thailand. There are four water gates[5] standing at the juncture of the canal, which allows the water to be diverted from going around Bangkachao island before heading into the sea. When all four water gates at Khlong Lat Pho are open, water can pass directly from the canal (a distance of only 600 meters, taking 10 minutes) into the river on the other side of the island instead of flowing along the 18 km around Bangkachao island (taking between 5 and 6 hours). This change helps prevent flooding in Bangkok as it releases the water into the Chao Phraya River, on the way to the sea, much more quickly than previously. Therefore, the Khlong Lat Pho Project, using the concept of water diversion, helped solve flooding problems in the lower Bangkok area. Khlong Lat Pho water gates also help protect inner Bangkok from saltwater intrusion.

The community learned that the water gates at Khlong Lat Pho relieve pressure on the city during the rainy season and they also prevent floods during high tides. In addition to serving as a mechanism that allows the release of water to the sea and blocks water from the sea at high tide, the gates can manage water for power generation as well as for the benefit of fruit trees. Although the initiative of the Khlong Lat Pho watergate benefits

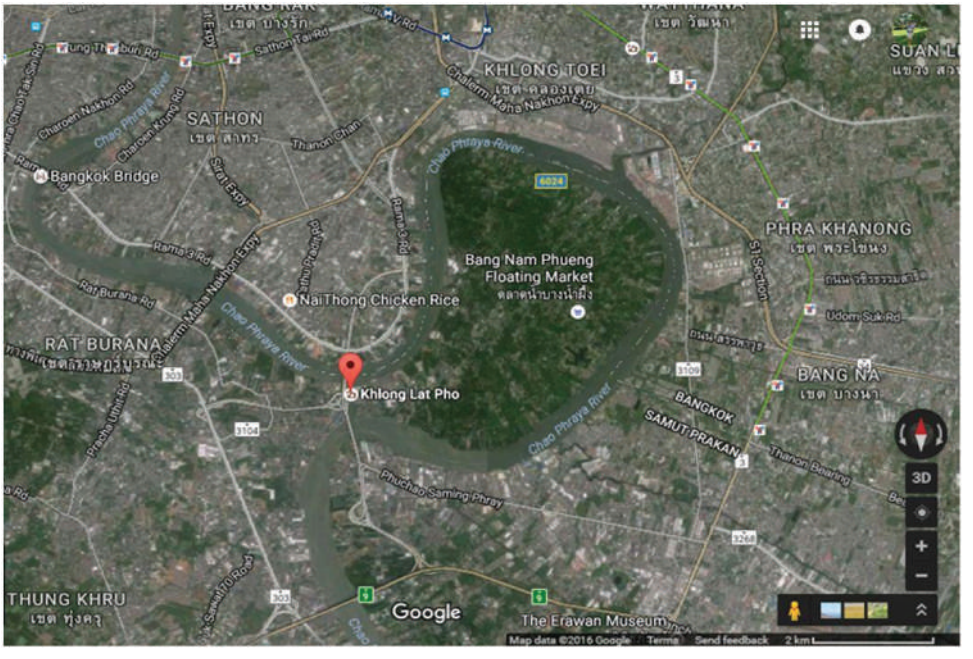

Figure 4. Location of Khlong Lat Pho. **Source**: Google Maps, 2018

flood prevention for Bangkok and some areas in the district, the watergate management could affect water salinity around Bangkachao due to its unique geography.

Based mainly on local observations, the community members believed that the Khlong Lat Pho gates are often left open, implying that water that used to flow around the island now flows directly into the river on the other side. The water flowing around the island is thus growing less diluted over time and saltier. Thus, the increased water salinity surrounding the island might relate to the management of the water gates by officials, which are out of their control.

An invited speaker in the workshop, a former senator, encouraged community members to discuss local water issues with government authorities based on their constitutional rights and advised them to share evidence of what they observed with appropriate officials. Consequently, in early December 2017, the Bangkachao PAR Group met officials at the Khlong Lat Pho operations office to learn more about the water gate management, the salt level of the river, conditions and when the gates are opened, as well as share their observations on rising periods of salt water over the last decade.

The meeting proved to be a perfect example of how facilitating discussions between different groups of engaged stakeholders can help to improve sustainability. At the meeting with the technical officer of Khlong Lat Pho's Watergate administrative office, community members suggested that increasing salt levels in the water in Bangkachao are dangerous to the community's fruit trees, and also shared data collected on the increase in salt in the water following the opening of Khlong Lat Pho gates. The community leader in Bangkachao PAR Group requested that unless necessary, i.e. when flood waters from Bangkok needed to be discharged in the Chao Phraya river, the water gates of Khlong Lat Pho should be closed so that the (non-salty) water of the Chao Phraya can flow around

Bangkachao and push some salt away (as salt water is heavier than potable water it sinks to the bottom of the river in the absence of flowing water to pressure it away). Community members were also provided with information about how to check salt water levels via the irrigation office's website, so they can assess when the salt level is unsafe for fruit trees. The technical officer agreed that official data[6] showed that the salt level in water around Bangkachao has risen and, therefore, agreed to test the community leader's hypothesis by closing the water gates for a certain period.

After the meeting, the administrative office experimentally closed the water gates, leading to a decline in the salt level around Bangkachao. Officials then realized that the routine management method of the Khlong Lat Pho water gates is a primary cause of extended saltwater periods around Bangkachao. The Khlong Lat Pho water gates were left open more often than not because, previously, the officials were more concerned about the level of water coming from the central region to Bangkok than low water flow/pressure around Bangkachao island. The community and local officials now know that the opening and closing of the gates are strongly related to the level of salt in the local water. Furthermore, they realize that the opening of the gates relates to flooding which, in turn, seems to be aggravated by climate changes, as predicted by environmental models for Southeast Asia.

The Bangkachao PAR Group discussed with both Provincial and Khlong Lat Pho Irrigation offices and the irrigation officials all agreed to close Khlong Lat Pho gates as a normal practice, especially in the dry season. As a result, the residents have perceived a difference in the level and frequency of salt water in their community. Unusual saltwater in other periods not in dry season dropped significantly as the water flow can push the sinking salt away. Although water salinity is still obvious in the dry season due to natural circumstances, the salinity level was less than before. Then, in 2018, the period and levels of salt water were much lower than that in the previous year (as evidenced in Figure 5).

The salinity-level curve in the Figure shows that in many months and during the dry season of 2017 (January–May), the curve was high, and in some months, it was higher than 10 g/l causing problems. From local experiences, salinity levels higher than 4 g/l causing problems to agriculture in Bangkachao. After Bangkachao PAR Group's negotiation with the irrigation office in late 2017 to close the Khlong Lad Pho gates, the level of salinity in 2018 was very small and higher only in a few months during the dry season (January–April), which was acceptable as it was less than 4 g/l. In 2019, the irrigation office wanted to test the salinity levels by opening the gate again for almost the whole year (January–October); the salinity levels were high again (much more than the levels in 2018) and in longer periods, including during non-dry season. This proved that opening gates can cause higher water salinity over a longer period.

Therefore, it is accepted that closing the gates can help reduce water salinity, especially during the non-dry season. Thus, the officials agreed to close them (except during the rainy season) as a verbal agreement with the community, and the local gate controller committed to operating the gates as a new normal practice. This successful negotiation shows that when local knowledge is supported by scientific or official data, accepted by officials, changes can happen. This action benefits not only Bangkachao residents, who can use more freshwater to grow their fruit trees, but also Bangkokians on the other side of the Chao Phraya River who were previously exposed to salt water from pipe water.

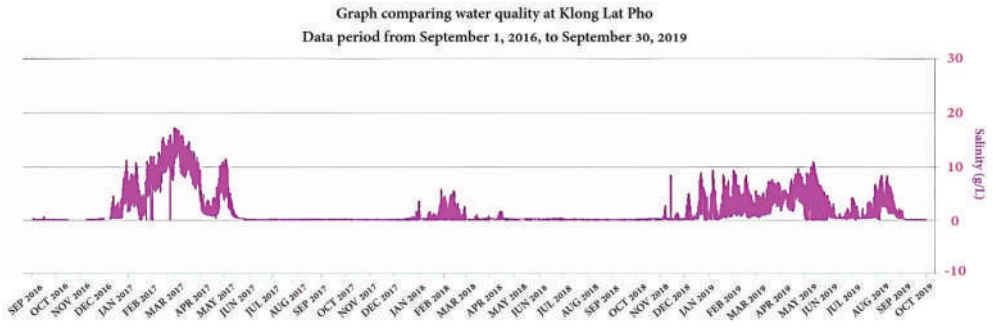

Figure 5. The level of salinity (g/l) in different months/seasons, and years (from September 2016 to September 2019). **Source**: Metropolitan Waterworks Authority (MWA), Thailand. Translated data in Thai from the MWA website.

Importantly, the solution can also maintain the original aim of flood prevention as the gates will be opened for fast water released during flooding season. Thus, both duo objectives of solving flood problems in Bangkok and salty water in Bangkachao are met in the mutual agreement of the new water gate management. These objectives, which seemed to be a conflict, turned out to be a win–win solution initiated by the community residents. This results from providing facts and local knowledge from the community side that understand local problems and reasonably accepting to change the normal practice of related officials. This agreement will continue for the long term as community representatives also put this matter in the Sub-Committee on Monitoring and Evaluation of Environmental and Natural Resource Rehabilitation Plan (on Public Water Resources) of Bangkachao Environmental Protection Area, of which some of Bangkachao PAR Group are committee members.

Although salt water from the dry season still exists naturally, this action to solve the extraordinary period of salt water and its high salinity level was remarkably successful. This reflects that human mismanagement of water resources can escalate adverse impacts from climate changes and that mismanagement needs to be corrected. This example illustrates how collective action based on citizen-led engagement can change watergate management for positive outcomes, build climate resilience, and improve sustainability.

Canal data collection and utilization

An additional initiative of the Bangkajao PAR Group by local researchers was collecting specific information about the canals on the island, which served another research goal of seeking information to improve water management. Kelman et al. (2011, p. 67) recognize that "often the process of participatory research is more important than the final result;" this is often true for the process of creating maps, which give communities (particularly island communities) to interpret and manage their own spaces. When our fieldwork started, no local canal map was available or used in the locality; consequently, our project supported local researchers in surveying them. As a result, our Bangkachao PAR group has produced an up-to-date map of all the canals and water gates on Bangkachao; documenting the location and direction of the waterways. This provides residents, local learning

centers, and the TAOs with information about the water flow patterns in the community. Ideally, this will allow residents and local officials to work more closely together on water concerns as they are documented and monitored by residents as well as used by local schools and students, community groups, and the Khlong Lat Pho Irrigation office. Figure 6 illustrates an image of the map which includes the location of water gates and canals as well as their name list (in local Thai language). This serves as basic information on locations and flow of waterways, where to monitor, and how to prevent problems, as community members and students can monitor the water situation in related canals. It is very informative to demonstrate the main canals linking the two sides of Chao Phraya River, affected by sea level and salinity, as well as related water gates (controlling water in and out) that can affect the water of those canals and can be managed to mitigate problems. Local school children also learn about their water landscape from this map, an instrument for building knowledge on water issues.

This geographical information about canal locations becomes more useful later when our local researchers participate in the following projects with handy tools to monitor water in various canals. Water monitoring information from those canals can then be sent to the local irrigation officer to integrate these local data with their official data and show these data on the map. Figure 7 is an example to show a good combination of local measurement (at points 2–8) and official measurement (at points 1 and 10) to monitor water quality in terms of salinity measurement and water levels in various data stations/locations throughout the map. These data will be integrated into different times, dates, and several measurements for water quality indicators.

The data from community members in water measurements in various canals inside the island are important for water management. For example, whenever the salinity levels from canals inside are higher than those at the river stations of Khlong Lat Pho (points 1 and 10), it indicates that the community should open water gates linking to those canals to allow freshwater from the river to enter the island and dilute the salty water.

Knowledge building on flood management

Apart from the above two key tangible results with action and map, knowledge building on water issues has served the research objective. The knowledge-sharing process includes insights into flooding problems and management that were addressed in a project workshop with Thai water experts in November 2017. It became clear that flooding problems in the country have not been resolved holistically as some provinces/areas passed protection measures separately, i.e. building their wall constructions, which caused floods in other provinces/areas. For example, in much of the lower-central region of the country, the government has built large concrete walls to protect specific spaces, such as economic zones, from flooding. However, this forces floodwaters into lower or less protected neighborhoods and regions that, through no fault of their own, inhabit less valuable space, as also noted in Henry et al. (2015). Many floods have been mismanaged by the central government for decades (Ng, 2016). As the country has developed with more industrial and construction zones, there has been less space to absorb water, and the protection from floods in one area led to the increase in a high level of floodwater in another less protected area, resulting in a more difficult situation than floods caused in

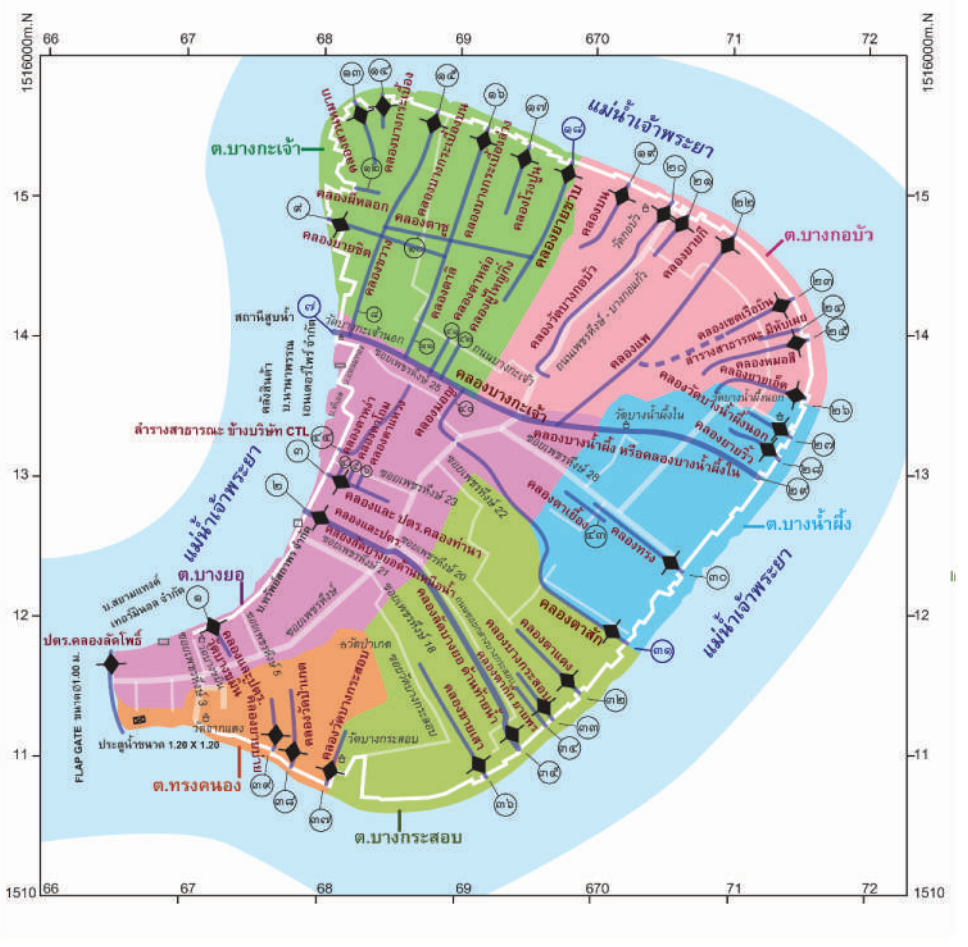

Figure 6. Map of canals and water gates in Bangkachao. Note: Marks' meanings represent the location of 34 watergates (facing Chao Phraya River) around Bangkachao island, and representing the line of 48 main canals over areas in Bangkachao community

the past (Lebel & Lebel, 2018). National flood management authorities have not thought holistically about prevention or protection (Marks, 2015).

Most recent research and practice, in line with what Thai experts in the seminar presented, argues that it is better to have space for "excess" water to spread out rather than to create situations where the flow of water is constrained and more likely to overflow its banks and to flood. Bangkachao community members seem to agree with Thai scholars that a major cause of recent flooding is the lack of space for water to be absorbed and the limited spaces into which water can flow; many modern constructions have not concerned traditional knowledge in building and architecture that allows water to flow in and out at the bottom, so flooding was not a serious problem in the past. Thus, to solve the problem, the region needs to free up more space for water as much as they

Location	Site	Salinity level (PPT)		Water level (m MSL)	
		7.00 a.m.	16.30 p.m.	7.00 a.m.	16.30 p.m.
1	Khlong Lat Pho Watergate (Upstream area)	0.12		1.22	
2	Wat Bang Kachao Noi Canal Watergate (OT)				
3	Suan Sri Sakhon Khuean Khan Park (IN)				
4	Khlong Phue Watergate (OT)				
5	Khlong Bang Nam Phueng Noi Watergate (OT)				

Location	Site	Salinity level (PPT)		Water level (m MSL)	
		7.00 a.m.	16.30 p.m.	7.00 a.m.	16.30 p.m.
6	Khlong Ta Sak Watergate (OT)				
7	Khlong Lat Bang Yo Watergate (IN)				
8	Khlong Yai Bai Watergate (OT)				
9	Wat Kong Kaew (IN)				
10	Khlong Lat Pho Watergate (Downstream area)	0.12		1.37	

Figure 7. Locations for daily measurement of salinity level (g/l) and water level around the island and Khlong Lat Pho data stations. **Source**: Irrigation Office – Khlong Lad Pho, Thailand. Translated from a Thai report at 7 am on September 30, 2022 (rainy season)

can in the current situation, and this includes removing blockages in existing canals. In other words, local canals must be cleared of garbage and construction that blocks waterways. The seminar on floods in Thailand brought home to Bangkachao community members the need to plan flood protection measures and actions with the rest of Bangkok Metropolitan Region and the need to join the regional water committee for the Chao Phraya River basin. Solving the flooding problem in the central region needs good coordination among the involved organizations to overlook water flow and absorb space holistically; thus, joint strategies are required.

At the community level, residents need to protect the island by monitoring the water level from daily information provided by the Khlong Lat Pho Irrigation officer (as shown in Figure 8). The Figure presents water levels in different locations (at far distances from Klong Lat Pho), so the residents can read by themselves when and how much water levels are close to critical levels at their locations to prepare themselves in advance, including alerting their TAOs to prepare for some operations such as fixing damaged flood protection barriers and how to manage water gates properly and in time. Daily receiving data on water measurement from local officers is essential for community members. Smart watergate management is an important method to protect the island from floods and saltwater invasion; thus, local researchers have been working on watergate controlling issues with stakeholders.

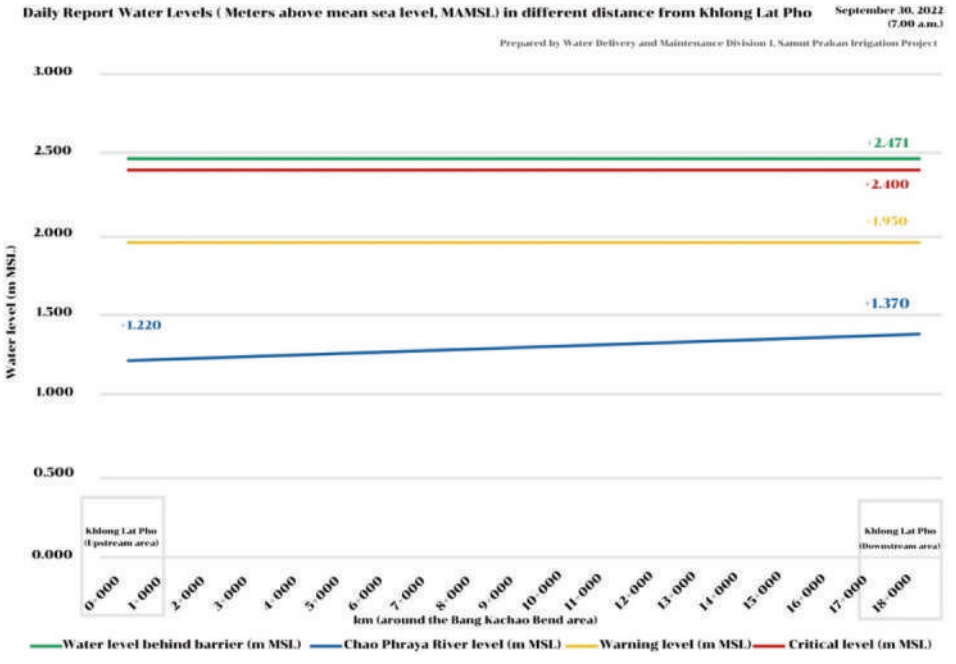

Figure 8. Daily report water levels of the river, behind the barrier, warning level, and critical level (m MSL) at different locations from Khlong Lat Pho around Bangkachao area. **Source**: Irrigation Office – Khlong Lad Pho, Thailand. Translated from Thai document.

Community residents can learn from this graph about the river's water level, whether it is close to the barrier level, the warning level or going to be the critical level or not. This is very useful data resulting from dialogue with local irrigation officers.

Other efforts to improve water management with policy planners

The project also attempted to build vertical networks outside the community. Efforts to coordinate with policy planners on water governance started in many ways. Examples during the project period were meetings between the Bangkachao PAR Group and the Deputy Provincial Governor on overall water problems and management as well as with the provincial Land Use Department. Another is the dialogue with the Chief of the Division of Public Works of the Provincial Authority Organization (PAO) about watergate management issues, which is under the organization's authority. Moreover, the Bangkachao PAR Group met with the Deputy Director-General of the National Irrigation Department in early 2019 to request that the Department consider Bangkachao as an area under the Department's responsibility. Officially, Bangkachao is excluded from irrigation area because Samut Prakan is regarded as an industrial province. However, after explaining what had done in the past year (i.e. in fighting for better water quality from the agreement in water gate management, and water is essential for keeping this greenspace), the Group has successfully convinced officials to accept responsibility for Bangkachao practically and agreed to bring resources to work with them using citizen participation in their current

and future plans. Eventually, the irrigation provincial office at that time supported the community by allocating a budget for repairing some infrastructure, actively organizing meetings with related groups, and setting up more than 20 informal Water User Organization (WUO) groups in various canals. This example is another successful case of negotiating with the government sector by the Bangkachao PAR Group. However, the change in responsible officials and government working process later affected budget allocation to support water facilities in Bangkachao.

Although working at policy and planning levels in general still faces limitations in the bureaucratic process and the regular change in government official terms, human capital and community engagement in their community development have continued. After the formal project ended, key residents in Bangkachao PAR groups have continued the work and become committee members in various Subcommittees of the Provincial Committee on the Rehabilitation Plan for the National Resources and Environmental Protection Area – Bangkachao, as well as those of the "Our Kung BangKachao" private project, with six committees in different areas.

Key successes and indicators

The success of the reached agreement on Khlong Lat Pho Watergate management for mitigating saltwater in this research primarily came from: 1) knowledge and evidence that the community residents provided to officials and 2) open-minded officials who understood local problems and agreed to change their normal practice. The evidence-based argument is an important tool for community residents to convince responsible official authorities.

Another key result is that local researchers conduct the land surveys and share their knowledge with the broader community: school children, local learning centers and offices, and TAOs, which can use the canal map for learning about the water flow system, and so can take care of their local environment.

The outcomes and impacts of these actions are enormous, for example, people on both sides of the river (Bangkok and Bangkachao) can rely on freshwater more often again. Local researchers also learned a great deal from conducting community surveys about the locations and conditions of the canals. Participating in the effort is a source of pride for community researchers who conducted the mapping exercise, particularly since it is useful to transfer knowledge to local schools and others, and young learners can inform their parents. Our local researcher has become a voluntary teacher to teach students about the water situation and how to measure it with a handy, simple tool. Our local researchers have also been monitoring canal water and cooperating with the local irrigation officers and other organizations to enhance knowledge building from the combination of local knowledge and modern information technology.

Another important impact built on new behaviors community residents exhibit is monitoring official data. Due to Khlong Lat Pho's new watergate management agreement, community members actively monitor water quality (i.e. salt level) from data posted to the official irrigation website. The Khlong Lat Pho irrigation officer provides daily data from the websites of the Metropolitan Waterworks Authority of Thailand (www.rwc.mwa.co.th) and the Royal Irrigation Department (www.hydrology.rid.go.th), as well as the Facebook site of the Irrigation Project – Samut Prakan, to community groups via several

LINE[7] groups. These daily data have proven invaluable in furthering citizen participation and empowering knowledge within the community as it lets farmers know whether or not the water is too salty to use for watering their fruit trees, water level to alert for flood prevention, and water quality (i.e., PH., oxygen and pollution levels, electrical and dissolved solids, salinity, and standard water quality). This has built local capacity by enhancing the use of available information. Furthermore, currently, the community members can measure these indicators via handy tools in various canals inside the island (as pointed out in Figure 7), which are also sent to the officer who integrates these statistics from various points into the map. This reflects the continuous learning and collaborative efforts of community members and stakeholders to achieve sustainability.

As noted in Head (2007) information-based community engagement has become far more practicable due to electronic forms of communications/technology, allowing for rapid dissemination of documents and mechanisms for feedback and dialogue (OECD, 2000, 2001). Online information and communication can facilitate discussion and ideas among community groups more easily by utilizing updated data daily.

Community members can utilize official information online as their routine daily, creating a new behavior of using data that can be considered as a successful outcome from this PAR project. This case study also shows that local residents use traditional wisdom and modern knowledge/tools to enhance their capacity to monitor water quality.

Despite the relatively short amount of time of our project, there were tangible successes within the first 24 months of this community-led program, viz., understanding what caused the increased period of salty water and possible solutions as well as flood problems in addition to the joint effort to map the canal and the specific layout of the water gates.

Key performance indicators (KPI) of the project achievement and sustainability may be witnessed from the following:

1. The lower salinity level, from previously longer periods and sometimes higher than 10 g/l to shorter periods and much lower level within the acceptable level of 4 g/l, after the Khlong Lat Pho watergate agreement (as shown in Figure 5).

2. More users of our canal and watergate map. Up to now, our local researcher has used it to teach more than 150 school children each year from six local schools, apart from displaying it in other local centers.

3. Expand knowledge building and collaboration with local irrigation officials, who send daily water situations to community LINE groups every morning.

4. More members on LINE chat groups on water issues (about 140 participants from "Bangkachao as One," "Bangkachao Water Monitoring," and "Water User Organization" groups).

5. More follow-up projects with academics, i.e. water monitoring measurement and tools (2), long-distance warning system of saltwater invasion (1), watergate management (1), multi-stakeholder dialogues (1), and possible future research from several organizations in which our local researchers have participated.

6. More dialogues at policy and planning levels and more local representatives/roles in related committees and working groups. Those works are ongoing.

7. The recent establishment of the community's Water User Organization (WUO) with about 45 members from 6 Tambons.

Key success factors from this PAR can be applied for broader applications elsewhere. Communities would be able to negotiate with government authorities if they have sufficient evidence and knowledge for their arguments, so that the authorities have to admit it.

Despite these successes, the community still faces many problems in the bigger picture due to the segmentation of authorities, lack of coherent policies and political will to solve their water issues holistically. However, as local PAR members take ownership of community water management, the works will continue and progress gradually.

Lessons learned and continuing efforts for sustainability

This section summarizes lessons learned from our formal two-year projects and following activities, showing its sustainability from continuing in capacity building and knowledge sharing from both horizontal and vertical ties. It also includes approach analysis, key indicators, and broadening up strategies as well as policy and research recommendations.

Lessons learned

The successful results of this action research project are based on several factors:

(1) It emphasizes on local or community-driven in the whole process, from identifying long-standing main problems (through informal talks and meetings with community members) to studying critical problems together, collecting scientific data, meeting with experts, and then taking action together as a team. It focuses on knowledge building (evidence-based) and sharing or "soft" approaches to water management.
(2) The project developed a consultative and inclusive process to enhance human capital rather than specific material goals. Academics and local people built trust among themselves and external agents, besides working together to share and create knowledge, a significant principle of the PAR methodology. This is a key element of managing urban natural resources collectively and sustainably (Colding et al., 2013). On a wider scale, trust among participants underpins the ultimate success of actions to protect and conserve their environments through cooperative efforts.

However, it must be admitted that the successful case of Bangkachao relied heavily on knowledgeable natural leaders, who were able to present evidence and negotiate with government authorities and a strong determination of the Bangkachao PAR Group. This study also shows that community-based initiatives led by natural leaders have been proven to foster innovation and sustainability. Thus, empowering local people with knowledge and capacity is a key factor for sustainability, resulting in continued work on water issues in the long term.

It seems that the Bangkachao community has become more engaged in knowledge and information learning, but it has experienced limitations from the slow governmental movement in preserving water quality. This may be due to the lack of interest in

responding to the community's requests or political will and not prioritizing water issues, as well as the bureaucratic system.

Another lesson learned from the solution to lessen the negative impacts of salt water from this study is that human management can add up natural effects from climate change and that mismanagement must be corrected.

Continuing efforts beyond the project period

Many community residents attended our concluding workshops to learn more about the project and its continuing efforts after our formal project ended. This is crucial and makes our initiative sustainable, as the community takes ownership of managing its own water resources and keeps monitoring water situations, as well as interacting and joining following projects with more partner organizations.

The following examples are some active movements after our water PAR initiative. Some of our local researchers in Bangkachao PAR Group formally wrote to the deputy district chief of their local Prapradaeng district to intervene in solving water problems which led to an important meeting among key stakeholders, viz., the provincial irrigation office (of Samut Prakan) together with locally Khlong Lat Pho irrigation office, Prapradaeng district and PAO officials to discuss with community members how to manage water issues, in particular, the water gate management and the roles and responsibilities of stakeholders, in one official meeting at Prapradaeng district office in 2020. Local groups and stakeholders managing various canals in Bangkachao were assigned.

Not only related government officers but also more academics from various institutions have realized water issues in Bangkachao and have come to continue supporting several water projects that build water information and knowledge in the community significantly and more holistically. More academic partners have come to work with our local PAR group on water monitoring and warning systems as well as the control of water gates with an IT system.

Recently, our local researchers have been working with academics on another simple and inexpensive tool for controlling the water gates via mobile application. This would greatly help the community overcome the problem of opening or closing water gates in person, especially at night when it is difficult to walk to those locations. They are also looking forward to learning more from initiatives on water monitoring with simple techniques controlled by mobile applications.

The more information on water management they gain, the more strategies they learn how to manage for each particular problem and adaptation. For example, they were alert when water salinity will increase, what time to close water gates to protect against the invasion of salt water or what time to open the water gates for more freshwater to enter. Similarly, they can monitor water levels and prepare the community to prevent floods or alert TAOs to do some barrier prevention.

This development shows that our small project initiative in the past was the starting point for continuing water management efforts. Another significant milestone was the setting up of the Bangkachao Water User Organization (WUO) as a registered community unit with more than 40 initial members from all 6 Tambons. WUO is expected to be a mechanism that merges local needs with upper bodies. The head of this water organization, a natural leader, can produce GIS indicating water resources with additional

surveys on local members' needs and accessibility to water. This provides basic information for considering possible solutions to local problems. This example also reflects the outcome of the self-help approach to community development that they investigate problems and create community information on their own, in addition to knowing how to use modern technology like GIS by themselves without help from outside. This knowledge building is also shared in their interactive chat platform.

Broaden up

The case study following the PAR method with high local involvement can be broadened and applied in other places conducting similar methods and efforts. This study's practices and working process can be adapted for wider applications elsewhere with similar contexts.

The steps for application learned from this study, for example, are:

(1) Inclusive community participation, gaining local perspectives from various meetings, and getting active local researchers to participate in the PAR project.
(2) Exchange knowledge with other academics and stakeholders.
(3) Regular group discussion and plan for actions.
(4) Prepare sufficient data to negotiate with related government agencies to make changes.
(5) Continue cooperation for water monitoring and new initiatives with more partners
(6) Develop more tools and comprehensive data for water management, such as simple or handy tools that community members can use.
(7) Interactive water data reporting between local residents and local officers and developing a community water database.
(8) Continue the dialogue and consultation with engaged stakeholders, academics, and policy planners for follow-up initiatives and collaboration.

In parallel to these steps, simple communication tools among community groups should be created to easily share information/data, knowledge, and ideas among group members. Interactive platforms for exchanging information and communication are essential. With an easy online chat platform (in this case using LINE group), community members can exchange ideas and data online and those who measure water quality with handy tools in various canals can send water situation data from canals to local government officers to add on their data to the office's data at the major Khlong Lat Pho locations for a more complete picture of the water situation in various water stations in the map (in Figure 6). Combining local and official data in water management and monitoring system is a good example of this study that can be scaled up in adaptation and resilience to climate change.

This practice of knowledge sharing has been upscaled for more users in Bangkachao. Up to now, a local irrigation officer of Khlong Lat Pho has been sharing information from the office and other official websites to community residents every morning via various LINE groups, i.e. "Bangkachao as One" community collective group, then creating another LINE group of "Bangkachao Water Monitoring" engaging stakeholders; these have been very active with about 60 members in the groups, and newly "Water User Organization" group with more than 40 members,

among others. These online groups have been platforms for community dialogues and exchanging ideas about their concerns and how to solve problems and adapt to climate resilience. For example, they keep up to date about salinity levels and water levels so that they can plan for watergate management. General water quality is also provided daily, so community members know when water is unsafe to use water for households and trees. These informative online tools can be applied everywhere for adaptation if people are empowered with simple information technology and know how to read and interpret data.

These exchanges have enhanced social capital that build trust and social networks, and sense of belonging, as well as effective information channels permitting individuals and organizations to access information from outside and within their community (Kay, 2006). Our local researchers and the group leader also report their up-to-date works/activities to other community members via the LINE group and their social media as well as personal meetings.

Novelty and approach analysis

A novelty of this action research is the focus on using data or evidence-based actions to make changes. The merging of local knowledge and scientific data/information can enhance capacity building and more comprehensive data for water management. This research illustrates that information-based community engagement enhances human capital.

Stakeholder involvement is essential, such as exchanging data between local officers and water community leaders and spreading such information to others via many online channels. Moreover, joining forces with academics in following up initiatives for monitoring the water situation regularly with simple and inexpensive tools can expand community engagement and strengthen both human and databases on water, leading to a community-based water monitoring system.

Another unique novelty of this research is that the new behavior of data reliability and utilization goes beyond standard PAR with a sense of ownership. From local water mapping and reading daily provided data to monitoring water situation and interaction with a local officer on community water data, currently, the water leader also produces their GIS to investigate local natural resources and problems. This shows inclusive and sustainable water management from community-led engagement.

This dynamic interaction with stakeholders makes this case goes beyond the standard community development approach that aims to generally increase local capacity building. Community members become experts in water monitoring and can advise other stakeholders on what to do. Community natural leaders also show scientific data to officials to change the way they manage water gates to improve community wellbeing. With historical experience of the greenspace and more engagement in many stakeholder activities, they can advise responsible organizations on the holistic development of the island. However, limitations include the lack of political will and bureaucracy, the un-continuity of responsible government officials (who have to be rotated elsewhere regularly) or no determination to solve the problems, lack of resources and budget allocation for some basic infrastructure and no authority for integrated actions.

Bottom-up approach analysis

As demonstrated in the project, the linkage of the community's self-help and scholars' technical assistance approaches via PAR could strengthen the engagement and eventually change the community development outcome. In this approach, the community's input and involvement in the process are high, resulting in high learning outcomes; these efforts can lead to innovation, sustainable outcomes, and feelings of attachment and ownership (Matarrita-Cascante & Brennan, 2012).

This project proved that, with community engagement, our water management initiative can be continued and sustained, even after our project period. The ongoing collaboration with stakeholders and learning new knowledge with new tools are remarkable. By engaging community members through working with other supporters and government agencies, the Bangkachao PAR group's continued efforts show a strong sense of ownership in water management and the accumulated human and social capital through learning. These are critical factors for the success of this approach.

As Green and Haines (2008) indicated, the self-help approach assumes an increase in the capacity of residents to address their problems, resulting in the ability of residents to help themselves for long-lasting effects. They can develop capacities for greater control and take over the direction of change in their community (Matarrita-Cascante, 2010; Matarrita-Cascante & Brennan, 2012; Richards & Dalbey, 2006).

The community members who participated in the project could learn and reflect upon the major water problems they face; viz., unpredictable flooding, an increase in the frequency of salt water in the canals, and the increased presence of wastewater or more polluted water. They are much more informed about what is causing these problems and seek to implement inclusive "soft" rather than "hard" engineering-based solutions. This shows the difference between the imposed form of infrastructure led by the government in the past (i.e. water wall and water gates) that residents have not known or participated in and the self-help form of knowledge sharing in our PAR project that residents can learn, identify, and seek solutions to the problems.

The outcome of this community development supports what was noted in Dale and Newman (2010) that social capital is a necessary condition for sustainable community development as it enhances linking ties that increase access to resources outside the community. Social capital with networks' bridges and vertical ties to outside government could impact sustainable community development. This project shows that the Bangkachao PAR Group continues to work with outside agencies, including the government sector, in vertical ties, in addition to horizontal ties among community organizations/groups.

Although our small project obviously cannot solve all the community's water problems in a short period, as many challenges lie ahead in preserving this large greenspace, these works have been essential processes or a starting point that enhanced capacity building and social capital for solving remaining problems for a longer term in the future.

Policy and research directions

Throughout the project, human and social capital have been raised with more vertical networks for policy and planning units. Our key members in the PAR group also joined the recently initiated "multi-stakeholder dialogue in addressing community-based water management problems in Bangkachao greenspace" project

in 2023 to initiate dialogue with more stakeholders such as the Bangkok Metropolitan Administration (BMA), Samut Prakan Provincial Administrative Organization, Irrigation Department, Office of National Water Resources (ONWR), Office of National Resources and Environmental Policy and Planning (ONEP), Pollution Control Department (PCD), and academics. Many meeting dialogues with these agencies have taken place, and the community representatives have raised key points and concerns for solving problems holistically. While some works may be in slow progress, many are not. There have still been difficulties due to the fragmented authorities and non-integrated working nature of different government agencies, affecting budget and implementation. However, a key outcome is that, with support from the Irrigation Department and ONWR, the Bangkachao Water User Organization (WUO) was formally established in 2023, under ONWR. The head of "Bangkajao as One" collective (also in Bangkachao PAR Group) became the head of this community water organization and several members in our PAR Group have roles in the administration. The head of the WUO started to build up the community data based on water resources, access, and needs of the members. This WUO is a new form of community organization expected to have more role in solving water issues for community members, especially with the connection between modern technology and local knowledge (Chuenchum et al., 2024). Currently, WUO can work as a network under ONWR channel and collaboration.

As experienced by the community, working with the government sector in general has a lot of limitations. As many agencies are responsible for managing the same issue, it seems no single agency would be able to solve it. Many segmental divisions under different Ministries are working in silo culture on water issues, resulting in incoherent, non-integrated strategies and action plans to manage water problems for a holistic solution in Bangkachao (Kittiprapas et al., 2023). The community has experienced difficulties from the slow bureaucratic process and fragmentation as well as often changes in responsible officials every year, affecting government budget allocation and continuity in investment in water infrastructure. In addition, local government (i.e. some TAOs) may not give a priority to water issues and do not cooperate well with the residents. However, the Bangkachao PAR Group has cooperated with some TAOs, which have started to understand the issue and listened to them and started to cooperate in some initiatives. Nevertheless, the Group needs to work more and convince all TAOs to understand and give a priority to water resource development and management issues.

However, working at the policy and planning level is an unfinished agenda. The community still faces many challenges and is affected by the larger development direction and national policies. Different hierarchies of governmental levels at national, regional, and local should be more integrated in operation with coherent policies. The government should listen more to community members who know their community's problems and take action quickly before the greenspace rapidly declines. Policies should also be designed to encourage agriculturalists to save or maintain this greenspace and reduce their costs; for example, find means to get more freshwater and lower water costs for gardeners, support the use of underground water with lower fees, find methods to get freshwater from Chao Phraya River, etc. In addition, policies should reward those who preserve the greenspace with lower particular land taxes and utility costs while collecting

more fees from businesses or those who benefit from the greenspace, particularly on the opposite side of the river.

Therefore, working with the community in the next step would involve more policy consultations with multi-stakeholders for a holistic view of preserving this large greenspace that requires more cooperation from concerned parties, for example, government and private sectors, to get more integrated plans and outside resources for relevant water infrastructure investment to significantly improve the quality of this green area which contribute to carbon absorption and climate change mitigation, particularly to reach SDGs Goal 13 nationally and globally, apart from Goal 11 – building a sustainable community of Bangkachao.

More research on water management should be continued, particularly on saltwater management and access to freshwater in the dry season, warning systems for saltwater invasion and flood, innovation for the integrated management of the 34 water gates surrounding the island, in addition to more complemented and friendly tools for measuring water quality in light of the utilization of AI technology. Future research can also utilize water measurement data from these tools to integrate community and official-level information for better water management, future studies, and innovation. Academics should work closely with the community with the PAR process; more action research should be encouraged for transferring know-how and solving some particular problems, while formal mechanisms face difficulties of slow movement from big structures and bureaucracy. Moreover, future research should also examine the contribution of this large urban greenspace in terms of environmental impacts for raising public awareness and preserving this important area.

Conclusions

The case study illustrates the value of community engagement in knowledge sharing and how collective action can improve water management as well as enhance the sustainability of traditional infrastructures, such as water gates and canals. Using a model of self-help community development and engagement based on PAR principles, the Bangkachao PAR Group along with local community stakeholders were able to achieve both longer-term intangible improvements in social capital as well as tangible improvements in water management that include: 1) the creation of an accurate map of canals and water gates showing water connection and control points, which enhances local understanding of water management, and 2) a significant change in Khlong Lat Pho water gate control protocol, resulting in the less salty water with beneficial effects for both sides of the river, while maintaining the original aim of the gates to prevent floods from Bangkok in rainy season. The situation was improved without the need for more technology but rather knowledge sharing and more inclusive decision-making. This water gate management case is a good example of how the community can negotiate with related government officials with knowledge and evidence to improve their water resources and continue engaging in water data management.

The strength of this action research is that we collaborated with the residents of Bangkachao for engagement in the research process as a route to greater input into decision-making, meanwhile, involved more stakeholders in the process, such as

academics and government officials and, finally, can propose their requests to government agencies. The novelty of this research stems from evidence-based actions and new behavior in data collection and utilization (with online and IT tools) that goes beyond general community engagement. Thus, empowering community people is essential to scale up this research practice.

During a relatively short and inexpensive effort to work with local community members, the project achieved some long-term benefits. The local stakeholders organized themselves to share knowledge and motivate one another and the broader community to implement positive change. The Group continues to be active with efforts to improve water management through other related projects and with other agencies and academics even after our project ended. Follow-up activities with stakeholders include water monitoring and warning system, water gate management, and water quality improvement for the whole island, especially developing new user-friendly tools for the community. A key success shared in this study is the knowledge building from the contribution of local knowledge and modern information and technology. In sum, this research and development approach from the bottom-up is an example of a pathway to achieve the UN's Sustainable Development Goals (SDGs), particularly Goal 11, which seeks to build sustainable communities, and Goal 13, of which this greenspace with more quality could reduce carbon and adverse climate change effects. This approach and method used in this PAR can be broadened and adapted for wider application elsewhere.

Further, this case study illustrates that it is possible to engage community residents in supporting and improving sustainability as long as the focus is on local priorities and includes building social capital and sharing knowledge. The research also shows that creating relationships and networks with vertical ties between citizens, academics, and local/regional/national governments offers unlimited potential for creating processes for more sustainable futures. The rights and voices of local people need to be included in policies, practices, and decisions on protecting and enhancing ecological resources.

The combined efforts of the researchers and local community members to learn, respond, and implement adaptation measures in the face of climate change are compelling. The need to adapt to climate change and manage water resources more sustainably in Bangkok Metropolitan Region is obvious. Lessons learned from this case study can serve as an excellent example to many other Southeast Asian communities and beyond with similar conditions and determination.

Notes

1. This province is considered within the Bangkok Metropolitan Region (BMR).
2. http://www.suansri-bangkachao.com/en/home/lesson4/get-to-know-bang-kachao
3. Bangkachao PAR Group consisting of academic project directors (authors), area-based coordinators, local researchers, and advisors (whose names appeared in the acknowledgment).
4. Khlong (in Thai) means canal. Khlong Lat Pho is the name of that man-made canal aiming to divert water flow from Bangkok.
5. These four gates of Khlong Lat Pho is an addition to 34 water gates surrounding Bangkachao island.

6. From official websites of the Metropolitan Water Authority and Royal Irrigation Department (www.rwc.mwa.co.th).
7. LINE is a multi-platform messaging app, similar to WhatsApp.

Acknowledgements

We would like to acknowledge the area-based members of this participatory action research team in Bangkachao, whom we include in the "Bangkachao PAR Group" referred in the paper. In particular, the project area coordinator, Pathanajarin Suankeawmanee, as well as key community members include Prakit Rodcharoen, Sukit and Rujiraka Plubchang, Bubpha Phuakwattana, Thanakorn Santharuk, and local senior advisors: Thunya Oumcharoen, U-sa Tanompongphandh, and Samarn Satienbutra, among others.

We are grateful to the Social Science and Humanities Research Council (SSHRC) of Canada for providing the main research funding for this community-based project (under "Water in the City" project) during 2017–2019, and to the Stockholm Environmental Institute (SEI) for a small grant for a follow-up project in multi-stakeholder dialogue in 2023.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

The work was supported by the [SSHRC] Social Science and Humanities Research Council of Canada [435-2012-0638].

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