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The champion of urban water resources management in the Chinese city – the case of Ningbo

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Abstract. Ningbo is a coastal megacity located at the East Coast of China and developing rapidly with proactive trading and export economic activities. The city owns a ranked top ten international port and it is the major strategic spot of 21st century maritime Silk Road from the “Belt and Road” policy established for promoting further international trades and developments. In future, populations and economy in Ningbo are expected continuously growing in the next few decades. The demand of quality freshwater resources thus is enormously increasing. Ningbo municipal government has established the “*Five water management*” (五水共治) policy in 2013 that aims to manage (i) sewage discharge; (ii) flooding; (iii) surface water; (iv) water conservation and (v) freshwater supply. Indeed, the municipal government also liaised and initiated the “*Sponge City Program*” after 2015 that Ningbo was selected as one of the pilot city; these policies and practices are successful up to now. This article adopts the case study of Ningbo to investigate the reasons of municipal government to promote the policy, to understand the public perception of this water management policy in Ningbo through conducted semi-structured interviews. During the 2017 and 2019, we conducted a questionnaire (N=110) and interviews (N=10) that follow up for justification of the public perception with the local communities. Our findings indicated that the communities had not been engaged closely with these practices, but generally supporting these two urban water management practices; and agreed that the urban water conditions (urban floods and pollution) had been improved. Also, the article discusses whether these (5 Water and SCP) practices can be extensively applied in other Chinese cities. We will provide recommendations at the end of the article.

Keywords: Five water management, sewage, water supply, flooding, surface water and water conservation

1 Introduction

In recent years, China has undergone rapid economic and social development, and one of the negative consequences is the severe environmental pollution [1]. This is especially the case in Ningbo, which is one of the most developed areas and rich in water resources. It has been reported that the water qualities in many rivers in Ningbo are Grade 5, and water scarcity problems also occur because of water quality and fast development [2]; these lead to deterioration of ecological system. Furthermore, as a coastal city, Ningbo suffers from typhoons which can cause severe flooding. The problems of water scarcity, water pollution, and deterioration of ecological system have become an increasingly prominent concern of Ningbo residents, also the municipal government at Ningbo and extensively to the provincial level for Zhejiang province. For instance, there was a TV program called “*Find a river where you can swim in*”, which caused a huge impact, and also gained the attention of the government [7].

Considerable effort has been made for better water management in Zhejiang province. For example, water supply project for tens of millions of farmers, water resources protection project, and seawall project. These have launched a solid foundation for the proposal and deployment of the ‘*Five Water Management*’. The government has fully understood the weakness of existing water management. Water problems are complex and not independent. The main problem in the water management is the multi-sector involvement, which may cause contradictions among institutions and stakeholders [3]. The functions of rivers and hydraulic structures are regulated by different departments for various purposes. For example, Water Conservancy Department is concerned with the flood control; however, environmental protection authorities are concerned with water qualities. As the most economically developed area in China, Zhejiang province has received high expectations from the central government. The Zhejiang provincial Party committee put forward the strategic deployment of ‘*Five Water Management Plan*’, which includes (i) sewage discharge treatment; (ii) flood control; (iii) waterlogging discharge; (iv) freshwater supply and (v) water conservation at the fourth plenary session of the thirteenth central committee. It should be noted that the ‘*Five Water Management Plan*’ is not a single administrative activity, but a public policy with comprehensive management tasks including a series of economic development, environmental protection, and city transformation that aligns with the Sponge City Program (SCP) in Ningbo which has been selected as one of the pilot cities for adapting the sustainable urban stormwater management practice by Sponge infrastructure and achieve multiple benefits [4], which were supported by relevant legislation practices to deliver better urban water management strategies.

The aim of ‘*Five Water Management*’ is to reach the harmonious state of human and water for sustainable development. This will further force transformation and upgrade

of industry. The implementation schedule of the ‘*Five Water Management*’ plan in different time scales is: solving urgent and prominent problems in 2014-2016, and achieving some improvement; solving the fundamental problems in 2014-2018, and achieving significant improvement; solving all the problems and achieving a qualitative change in 2014-2020. The ‘*Five Water Management*’ shows the determination of Zhejiang government to solve these water environment problems. Zhejiang province serves as a pilot for other provinces in China.

Therefore, this paper aims to investigate the current five water management plan and SCP at the case of Ningbo; this aim will be followed by some specific objectives. First, we are investigating the detailed background of Fiver water management and reviewing the current progress of the ‘*Five Water Management*’ and SCP at Ningbo. Second, we would like to review whether these policy plans are successful and whether the other cities can learn from this plan. Third, we would like to provide justification from our interviews and questionnaire to triangulate and validate current practices and offer recommendations for integrated water management in China.

2. Literature review and background

2.1 Fiver Water Management

Ningbo Municipal Government has thoroughly implemented the provincial and municipal ‘Five Water Management’, encouraging all counter parts and residents to engage, boosting innovation and establishing a more comprehensive urban water supply and wastewater treatment system. The final goal is to force economic and social transformation and development by water management, and remarkable results have been achieved [15].

2.1.1 Infrastructure reinforcement (治水强基 in Chinese)

After Typhoon Fitow, Ningbo government has determined to reinforce the infrastructure to protect the city from flooding. Ningbo has invested a large amount of money for engineering measures such as the construction of riverbanks and reinforcement of hydraulic structures. For the flooding problem, the main approaches include construction and reinforcement of river banks, drainage channels, and also hydraulic structures such as reservoirs, gates and pumps. Hundreds of kilometres of river banks of Yong Jiang and other rivers that go to sea directly have been constructed. Besides, flooding discharge channel networks ranging 28 kilometres were also constructed. The obstacles (e.g. garbage, pollutants from domestic and industrial sources) in the river, which affect the flood discharge, were removed [18, 22].

2.1.2 Zero sewage discharge into rivers

For the environmental pollution, Ningbo government has tried to reduce the pollution from the source. Factories that discharge exceeded polluted water or waste has been required to upgrade and introduce new technology to reduce pollution. Major polluting industries were commanded to close and move. Pilots of zero sewage discharge areas have been established, and zero sewage discharge strategy has been promoted in Ningbo. The Municipal Ningbo Government worked to identify the characteristics of rivers including the back utilization, bridge information, sewer discharge arrangement, fishery, and rubbish disposal along the river, the green plant covering, livestock, and reclamation depot. Comprehensive measures were taken to control rural pollution from non-point sources and pollution from livestock and poultry farming. Furthermore, Ningbo has set pipelines to collect the foul water especially in rural areas [18].

2.1.3 Existing pollution control

For seriously polluted rivers, dredging, water transfer and ecological remediation and ecological restoration has been used. Ecological revetment has been utilized in rivers in rural areas [19, 20].

2.1.4 Policy innovation

In July, 2018, China's Ministry of Water Resources announced a new measure- River chief mechanism, aiming to improve China's water governance by overcoming the drawbacks of multi-sector management. It had been successfully implemented across most provinces in China. The "*River Chief*" mechanism places responsibility for protecting bodies of water squarely on the shoulders of government officials. According to China Daily [21], over 300,000 officials have been appointed as river chiefs around the country, operating on the provincial, city, county, and township levels, and another 760,000 have been designated at the village level.

River chief policy is well implemented, and the performance of the river chief is an important indicator for their career promotion is their job [21]. River Chiefs are well-placed to coordinate various governmental departments to improve the efficiency and efficacy of a multitude of water-resource management efforts, and now to face clear consequences if they fail to maintain or improve water quality in their assigned areas.

This policy does address part of the current problem with water governance in China, which is the question of inter-jurisdictional cooperation. River Chief policy is an "ingenious" method of using Party hierarchy as a lever to improve coordination between various government organs [23]. The system is a massive undertaking, with the potential to dramatically improve the quality and integrity of China's water resources, and provides effective water management tackling collaborative issues in the Chinese context, but its long-term effects and sustainability remain to be determined [23, 24].

2.2 Sponge City Program

The Sponge City Program (SCP) was initiated in 2013 and the function is parallel to some global best practices, such as the “*Low Impact Developments*” (LID) in the USA [5]; Sustainable Urban Drainage Systems (SuDs) [6, 7] and the Blue-Green Cities (BGCs) [8] in the UK; and Water Sensitive Urban Design (WSUD) in Australia [9] or Low Impact Developments Urban Design (LIDUD) in New Zealand. The SCP is required to (i) adopt BGI and SuDs such concepts which improve the effective control of urban peak runoff, and storing and filtering stormwater; (ii) upgrade traditional engineered drainage systems (e.g. construction of tanks and tunnels); and improve current land-drainage protection standards to balance peak discharges and to alleviate stormwater (to achieve 1-in-30 years return period protection standard); and (iii) reassure multi-functional objectives in drainage design and in achieving good ecosystem services [10, 11]. The SCP infrastructures in Chinese pilot cities (selected pilot 30 cities) that adopted, for example, artificial wetlands, ponds, green-roofs, bio-swales, rain gardens, pervious pavements, these infrastructures were normally often designed to enhance natural hydrological response and improve natural soil infiltration, stormwater retention, storage, purification, recharge groundwater and improve water quality of the runoff [12, 13]. Certainly, Xia, Zhang [14] indicated that the SCP development is able to deliver better urban water management and achieve sustainable development goals by encouraging ecological, social and economic perspectives to integrate with the urban drainage and master plans in Chinese cities. Ningbo is selected as one of the pilot city in the SCP in 2015 and constructed several SCP infrastructures sites (including Eco-corridor in New East Town (NET), and Cicheng Park, etc.) (see Fig. 1).



Fig.1. SCP site locations in Ningbo as interviews and questionnaire sites for this study (Locations A: New East Town; B: Ci Cheng Park; C: Sanjiangkou Park; D: Yinzhou Park; E: Nan Tang Old Street) (Source: authors)

3. Methods

3.1 Questionnaire

Questionnaire is an effective and popular method to study perceptions, attitudes, viewpoints and foresights [15]. In this study, a questionnaire was conducted to gain an initial understanding on public perspectives on the ‘Five Water Management’ and SCP in Ningbo. The questionnaire was developed according to the research questions and targeted understanding about the opinions, perceptions and viewpoints of the development of both urban water management strategies (Five Water Management and SCP). Since both water management practices are related to addressing urban water issues. The questionnaire consisted of the following parts:

- a. General questions (e.g. the information from the communities: age, education background, residential location, gender);
- b. Public perceptions on SCP
- c. Public perceptions on ‘Five Water Management’ (e.g. urban river restoration, SCP and Five Water Management)
- d. Sustainability issues (e.g. social-economic, ecology and wellbeing) in SCP
- e. Future foresights on climate change and public participation

Key Question 1: Interviewees’ perception on connections between ‘Five Water Management Plan’ with SCP projects?

Key Question 2: Interviewees’ viewpoints on future SCP should be continued?

The survey sites for questionnaires were selected from the SCP projects location in Ningbo (see Fig.1) as for investigating the communities who are living in that area or commonly using these SCP facilities (e.g. Sponge urban parks, Sponge healthy running tracks, Sponge artificial ponds and wetlands.). The survey was conducted by paper-style format, the data collection and sampling period was from June to August 2017. Due to the limited labour resources and weather conditions, this study managed to conduct 110 questionnaires. All survey data were statistically analysed using Excel and R software.

3.2 Interview

Semi-structured Interviews in this study were conducted by face-to-face in the public space (inside the SCP parks, coffee shops, café, etc.) [16]. The interviews were conducted to help understand more in-depth perspectives from the communities to Five Water Management and SCP, because the interviewees were picked randomly and each interview had gone through rather a short interview with about 10 minutes each.

Total 10 interviewees were invited for interviews who all are living around the SCP sites (within 3km radius) in Ningbo during November 2019 (see Table 1) and aiming to articulate the perception issues specifically from the 2017 questionnaire data set.

All interviewees have been informed and agreed the consent of ethical practice (approved by the ethics application at the affiliated institution, University of Nottingham). The data was transcribed and translated. The analyses based on the ground theory, and the researchers undertook manual coding that match with the key research themes in this study.

Table 1 Interviewees' information

Participant ID (Interviewees)	Age, gender and occupation	Interviewees' home location (within 3km radius at the relevant SCP sites)
A	Elderly (F), 60, retired	NET Eco-corridor
B	Flower sales-person in South Business District, 35	Yinzhou Park
C	Elderly (F), 55, retired	Sanjiangkou Park
D	Housewife (F), 40	Cicheng Park
E	Primary school teacher (M), 30	Cicheng Park
F	Student (F), 20 in South Business District	Yinzhou Park
G	Waitress (F), 35 in Nantang Old Street	Nantang Old Street, Sanjiangkou Park
H	Elderly (M), 60, retired	Nantang Old Street, Sanjiangkou Park
I	Businessman (M), 55, at reside around the Tianyi Square	Nantang Old Street, Sanjiangkou Park
J	Student (M) 20, reside around the Tianyi Square	Nantang Old Street, Sanjiangkou Park

4 Results and discussion

4.1 Distribution of the respondents

According to the general information, the respondents were evenly distributed in gender with Male (47.3%) and Female (51.8%) and 1 participant did not disclose on the gender. Most participants are at the age group of 20-29 (with 56.4%), and majority of participants in this questionnaire set were living in Yinzhou district (with 73.6%), and dominated with the education level at the Tertiary/higher education/university level (with 83.6%).

Table 2 Demographic information of participants in this questionnaire survey

Independent variables	Information	Number	Percentage (%)
Total		110	
Age	Below 20	20	18.18
	20-29	62	56.36
	30-39	15	13.64
	40-49	8	7.27
	50 above	5	4.55
Education	Primary	1	0.91
	Secondary	7	6.36
	Tertiary/higher education/ university	92	83.64
	Postgraduate or above	10	9.09
Districts	Yinzhou	81	73.64
	Haishu	11	10.00
	Jiangbei	9	8.18
	Others	9	8.18
Sex	Male	52	47.27
	Female	57	51.82
	Not disclose	1	0.91

4.2 Perceptions on Five Water Management Plan and SCP projects

In this questionnaire, we have conducted some other issues such as general information, perception on Fiver Water Management Plan, SCP, sustainability issues and future foresights about these programs. In this section, we particularly focused on illustrating the results that responding our major research questions. In this section, we particularly demonstrated that conducted five specific questions in the questionnaire set on the perception issue (see Fig.2) and listed here:

*“11.Ningbo has done a lot of works on urban river restoration under the 5 water management plan, are you familiar of this policy/what are the 5 water management about?
a. Not at all, b. little, c. modest, d. fully understood*

*12.Do you think it is useful to promote urban river restoration in Ningbo?
a. Not at all, b. a little, c. modest, d. very useful*

13. Do you think there are any connections between Five Water Management Plan with sponge city projects?

a. Not at all, b. a little, c. modest, d. a lot of connections

14. Do you think more areas in Ningbo other than East town (Jiangdong) and North district (Jiangbei) need to be undertaken sponge city and urban river restoration projects?

a. No, b. Yes

15. Do you think current awareness and participation are enough to public for these projects?

a. Not at all, b. a little, c. modest, d. enough"

We have found the results (see Fig.2) demonstrated the communities were not too familiar about the urban river restoration under Five Water Management Plan and urban river restoration (Q11) as 33.64% participants responded unfamiliar and another 44.55% respondent expressed with little understanding on the Five Water Management Plan.

Also, we found that the communities also have rather conservative viewpoints on the usefulness of promoting urban river restoration in Ningbo (Q12) as only at about 9% participants expressed that promoting urban river restoration in Ningbo was very useful, but majority were expressed not useful or only little useful. Interestingly, we also found that majority of participants found no connection (3.64%) or only with little connection (about 27%) between Five Water Management Plan with SCP in Ningbo (Q13).

Participants believed it was not too useful to promote the urban river restoration and expressed only a little connection between Five Water Management Plan, urban river restoration and SCP as according to the analysis of the connection among these practices (Q12 and Q13) (see Fig.3), which reflected the public perception to the functions and benefits in urban ecology, water management and urban flood risk management and climate change adaption with these three main strategies from the data set in 2017 were yet understood the Science and technical aspects well. That findings were implied by Q14 and Q15, which majority of community residents expressed that the SCP and urban river restoration should still be promoted and continuously expanded Five Water Management should still be undertaken (over 65%), but majority of participants admitted that their own awareness and participation were not enough (with about total 58% expressed not at all or a little awareness and participation) for these practices. That reflected the awareness and participation issues might influence the perceptions on the urban water management issues in Ningbo (include river restoration, Five Water Management and SCP) from the 2017 questionnaire data set.

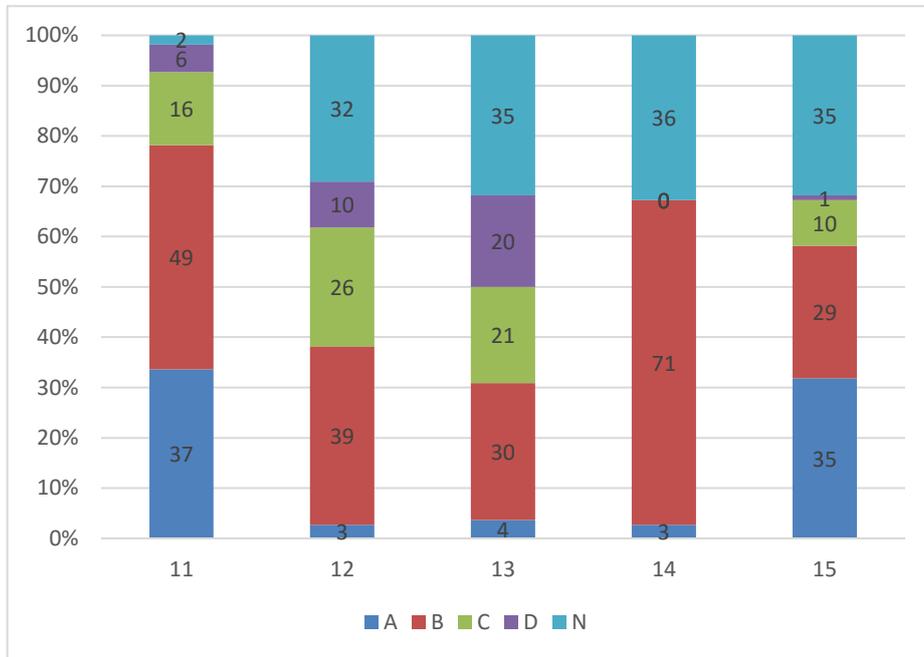


Figure 2 Public perception on urban river restoration, Sponge City Program and Five Water Management (note perception on these questions refer as above: Blue: Not at all (for Q11-13, 15)/Yes (Q14), Orange: a little (for Q11-13, 15)/No (Q14), Grey: Modest (Q11-13, 15), Yellow: fully understood (Q11)/very useful (Q12)/lots of connection (Q13)/enough (Q15), Green: Answer not valid/incomplete/not answered.

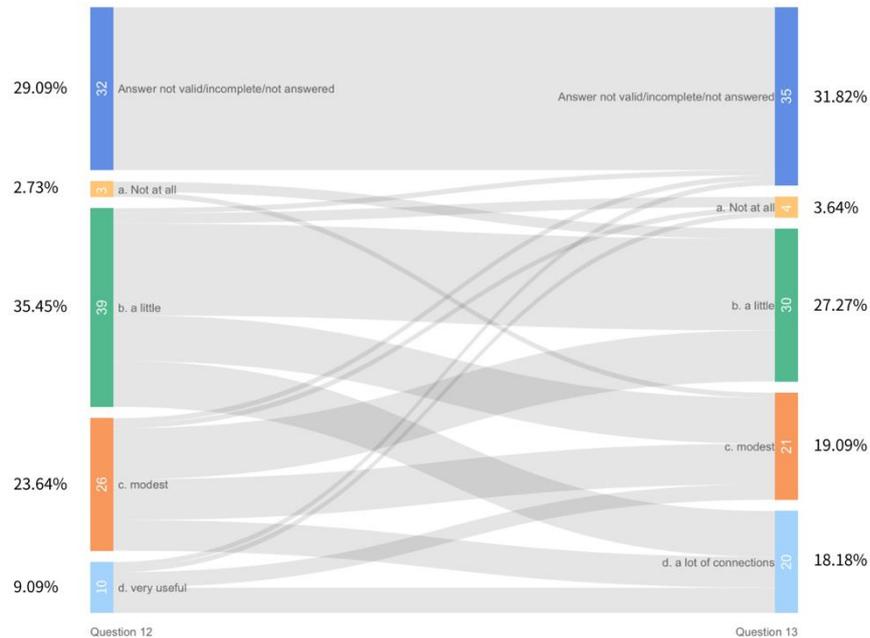


Figure 3 Sankey diagram with Q12 and Q13 on the relationship about the urban river restoration (Q12) and Five Water Management and SCP (Q 13).

For such findings on public perceptions, we justified with the 2019 interview data with the local community and found that there were some evident afterwards. For some reasons, such as lacking of education and promotion, especially to elderlies, an elderly interviewee living around the Yinzhou Park responded (interviewee A): “...I have not heard too much on these programs, because I am getting old at this age, do not pay attention...” Another elderly interviewee (interviewee H) also responded: “...read and understood it (these programs/strategies) via the newspaper but can't remember it clearly, found these are helpful policies”.

Furthermore, we interviewed some interviewees who understood these schemes via social media channels, such as via the mobile apps that the elderlies might find their difficulties to adapt the implications from technology. Two students expressed (interviewee F, resided at South Business district close to Yinzhou Park) “*Heard it in the car radio and received relevant publicity via SMS.*”; another student (interviewee J, living around the Tianyi Square close to Sanjiangkou Park) expressed that “...Saw (these programs) on app news...” Also, for the work professional age that a flower-seller operated the shops at a shopping mall around the Yinzhou Park (in-

interviewee B) expressed that: “...saw related information on mobile phone text messages...”; another interviewee working as a primary school teacher (interviewee E, Ci Cheng Park) expressed he understood about these urban water management strategies via television channels “...understanding (these programs) from TV news, three out of five water management are remembered: sewage, drainage water and flood.”

From these justifications in the 2019 interviews, we can understand that the Municipal Government has actually used and adopted multiple channels on these urban water management strategies by TV, newspaper and lately via mobile apps, internet sources for enhancing promotion and improvement on public awareness and participation.

However, the government may take more attention for the elderly group as they normally have difficulties to access media source and similar finding on the climate risk information from typhoon in Tai O town, Hong Kong that the elderly people normally difficult to access technology [17], thus the perception of these programs are understandably lower than the other age groups. We recommend the government may engage with the communities in several age groups for gathering them for some local education activities or community engagement activities to enhance further engagement.

On the other hand, we also found that the public understand the cause and consequences of urban floods quite well as that reflected from Q8 here:

“8. Why urban flooding is occurring in Ningbo?
a. Intensive rainstorms, b. storm surge, c. climate change, d. combined issues”

Over half of respondents (60%) understood that the urban flood issues in Ningbo are the combined issues that connected with the climate change, storm surges from typhoons and cyclonic effects (as Ningbo frequently have typhoons from West Pacific during August to October) and intensive rainstorms that reflected the public have good scientific understanding about the meteorological effects on flooding (see Fig. 4).

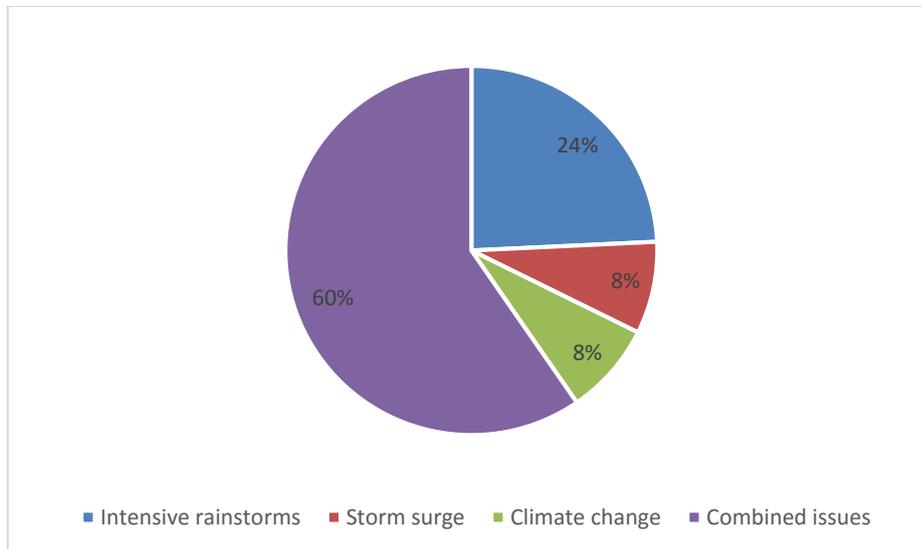


Figure 4 The percentages of participants understanding on the causes of urban floods in Ningbo

4.3 Future foresight

Sustainability issues on social, economic, ecology and wellbeing

16. *Do you think the sponge city and urban river restoration projects are able to improve the living conditions/quality?*
a. Not at all, b. a little, c. modest, d. very helpful
17. *Do you think the sponge city and urban river restoration projects are able to enhance greening to urban spaces and improve biodiversity?*
a. Not at all, b. a little, c. modest, d. very helpful
18. *Do you think there are any economic benefits from these projects, for example the reflections from property prices?*
a. Not at all, b. a little, c. modest, d. very relevant
19. *Do you think you feel happier and living with wellbeing with urban green and sponge infrastructures (e.g. swale, rain garden, green roofs, etc.) and restored river?*
a. Not at all, b. a little, c. modest, d. very happy
20. *Will you be satisfied if the municipal bureaus continue to implement the sponge city and river restoration practices alongside with current urban planning, water resources and flood management plans in Ningbo?*
a. Not at all, b. a little, c. modest, d. very satisfied

In the section of ‘Sustainability issues on social, economic, ecology and wellbeing’ (Q16 to Q20) (see figure 5), it can be found that majority participants perceived ‘a little’ as the effect level of SCP and river restoration projects, while ‘not at all’ and ‘very helpful/happy’ were considered by the least participants. Over 60% participants believed such projects have ‘a little’ and ‘modest’ values in terms of the social benefits (Q16. 70% (77 people) improvement of the living quality; Q19. 62.7% (69 people) feeling happier and living with wellbeing), ecology benefits (Q17. 64.5% (71 people) enhancing of greening to urban spaces and improving of biodiversity), and economic benefits (Q18. 70.9% (78 people) increasing property prices). Regarding the satisfaction on the municipal bureaus continuing to implement the sponge city and river restoration practices alongside with current urban planning, water resources and flood management plans in Ningbo, 13.6% participants (15 people) felt unsatisfied on it compared to fewer percentages of other four questions, which might be a reminder for relevant municipal bureaus when designing and implementing such projects to consider public perceptions and opinions. That is vitally important for the current and future urban planning and related to the local communities whether they really engage with the SCP and Five Water Management Plan and relevant programs in Ningbo. It reflected not only their perception and understanding of the functionality of these infrastructures and practices whether are beneficial to their daily life and well-being, but also the level of understanding to these water programs, which might help the Municipal Government to promote the programs further extensively to wider communities and districts in the city. Their early involvement (awareness and perception) will lead to stronger public engagement and participation, deliver of successful outcomes, and help stakeholders to make decisions that based on the needs from communities.

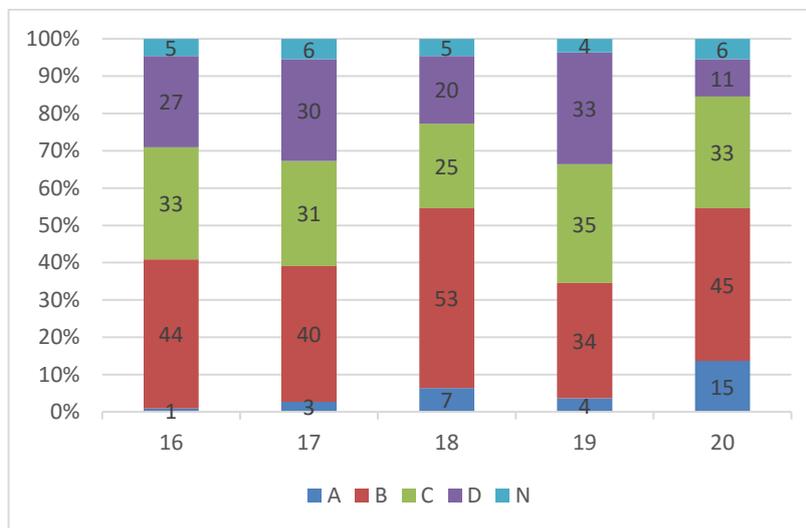


Figure 5. Sustainability issues on social, economic, ecology and wellbeing. The number labelled in the histogram is the participant number of each question option (the total number is 110).

Specifically for SCP, we also found that despite the public not being very aware and engaged with these urban water management practices from section 4.2, interestingly the communities that live nearby the SCP sites still support that future SPC projects should be continuously carrying out in Ningbo and other Chinese cities at Q10, see here:

“10. Do you think more future sponge city projects should be continue in Ningbo and Chinese cities?”

We found that there were over 95% respondents expressed the full support that the SCP should be carried on in Ningbo and Chinese cities and interestingly as we noted that majority of respondents awareness and perception remained at the inadequate level, but witnessed that the public and communities were actually understanding quite well about the cause of floods and situation as discussed in section 4.2.

Future foresights, climate change and public participation/engagement

21. *Will you support the municipal government continue to finance the sponge city and relevant projects including urban river restoration projects?*
a. Not at all, b. a little, c. support, d. very supportive
22. *Will you continue supporting 5 water management plan in Ningbo?*
a. Not at all, b. a little, c. support, d. very supportive
23. *Do you think joint venture or Public Private Partnership (PPP) will be a better choice/more economic sustainable to finance these projects?*
a. Not at all, b. a little, c. useful, d. very useful
24. *Do you think Sponge city project can address the climate change?*
a. Not at all, b. a little, c. useful, d. very useful
25. *Do you think public participation is enough on sponge city and 5 water management plan projects at the moment?*
a. Not at all, b. a little, c. modest, d. enough

In this section (see figure 6), 85% participants (94 people) supported the Five Water Management Plan (with 53% was very supportive) (Q22), which was similar to the support level of SCP with over 86% (95 people) (Q10). The continued financial support by the municipal government on SCP and relevant projects such as river restoration was supported by 85% participants (93 people) (Q21). Specifically, PPP for such projects was considered by 76% participants (40% useful and 25% very useful) as an economic sustainable mechanisms (Q23).

The lack of public participation in SCP and Five Water Management projects was expressed by 29.1% participants (32 people) with ‘not at all’ and 39.1% (43 people) ‘a little’ (Q25). Regarding the function of SCP on the climate change (Q24), over half participants perceived a weak link between them that 10% participants (11 people) have offered the answer of ‘not at all’ and 40.9% (45 people) of ‘a little’.

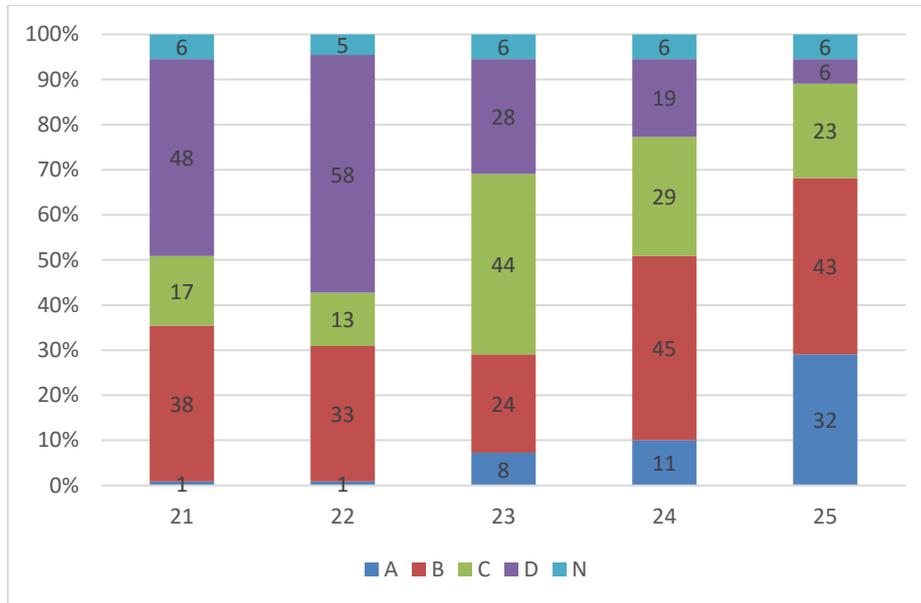


Figure 6. Future foresights, climate change and public participation/engagement. The number labelled in the histogram is the participant number of each question option (the total number is 110).

5 Conclusion

Ningbo Municipal Government has been witnessed and evidently spent tremendous efforts on improving urban water issues. The government has been addressing these issues by implementing SCP, Five Water Management and undertaking the large scale urban river restoration schemes during the last few years, despite the time needed to see the performance and effects based on the regular monitoring and review. The positive effects at this early stage is reflected in the support of these schemes in 2017 from the communities and public. These showed the current the limitation of reflecting the latest situation and phenomenon of these schemes as the data has been finalised after only 3 years of implementation.

Public perception can be improved by using several channels and adopt “*fit-for-purpose*” approach such as looking after different age groups’ understanding and learning of these strategies (i.e. elderly and other age groups). These lessons will be vitally important for other cities in Zhejiang Province to improve the urban water management strategies holistically and extensively providing good lessons for other Chinese cities or even Asian cities in the region that faced potential water risks from climate change and rapid urbanisation factors.

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