Toward adaptive water governance: An examination on stakeholders engagement and interactions in Semarang City, Indonesia

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CASE STUDY

Toward adaptive water governance: An examination on stakeholders engagement and interactions in Semarang City, Indonesia

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Abstract

There is an urgent call for a transformative movement to endorse water solutions that may maintain the social-ecological systems in which governance is considered the backbone of this process. This paper aims to examine the water governance arrangement for the case of Semarang based on the stakeholders' engagement and interactions. The Semarang case is expected to contribute to the implementation of adaptive water governance at the city-level with limited capacity as well as authority in dealing with the complexity of water-related issues. Identification of stakeholder role and Social Network Analysis (SNA) were applied as analytical tools. Perspectives from 14 types of stakeholders and four types of interactions were elaborated through a series of Focus Group Discussions and interviews. The types of interactions include knowledge sharing/transfer of information (K/I), flow of funding (F), guidance (G), and technical assistance (TA). Semarang has gone through numerous pathways of water governance in interaction with various stakeholders to solve water-related problems. The City has succeeded in creating an environment that enables active involvement of various stakeholders. Current emerging challenge is relevant to the City's capability to operate adaptive water governance, particularly to further mobilize its own resources and gradually remove its dependency on the National Government and International Agency.

Keywords Water governance · Water management · Stakeholder engagement · Social network analysis · Semarang City

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1 Introduction

Water is a cross-cutting matter that includes multi-sectoral problems and needs. Critical water issues such as flood and drought should be addressed by creating a conducive environment for more investment to enhance water resilience (Hoegh-Guldberg et al., 2018). Falkenmark et al., (2019) define water resilience as a state in which socio-ecological arrangements are present to safeguard and sustain water cycle, to ensure sufficient water supply, and to provide a stable climate system. There are at least three different functions of water to achieve a certain level of water resilience (Falkenmark et al., 2019). The first is water as a resource, commonly specified as water supply. The second is water as a subject of change due to water-related disasters, and the third is water as an agent of change due to its prominent position in the hydrological cycle closely related to the spatial settings. As water has various roles and functions, different interests under the authority of different institutions have an impact on which specific water solutions are considered (Green et al., 2006). Governance is of substantial interest as it is a fundamental element in the decision-making process (Grigg, 2016). There is evidence that water-related problems are not solely related to the need for integrated engineering concepts. Beyond the technical solutions, it is crucial to provide solid institutional settings and mechanisms to ensure that all water solution concepts may be executed accordingly (Yasmin et al., 2018).

Water governance is a strategic role to enhance water resilience. It could only be achieved by promoting transformative thinking to adapt to various disturbances, a process that requires active involvement of multiple stakeholders and decentralized decision-making mechanisms (Rodina, 2019; Biggs et al., 2007; Pahl-Wostl, 2007). Thus, there is an urgent call for a transformative movement to endorse water solutions that may maintain social-ecological systems in which governance is considered the backbone of this process. Correspondingly, Kooiman (2003) proposed co-management as a model of governance in relevance to natural resource management in cross-boundaries areas with water features. Adaptive governance through the co-management principle is focused on collaboration and cooperation between the government and society, characterized by multi-stakeholder involvement rather than the domination of government intervention based on hierarchical orders. Bruce et al., (2020) state that stakeholder participations and interactions within the adaptive co-management governance framework is important to build resilience. Accordingly, network is an essential element in promoting co-management approach. By understanding the network, we can define weak and powerful actor(s) (Kharanagh et al., 2020), assess the level of interactions (Stein et al., 2011), and identify the influence and strategic position of each actor (Mills et al., 2014). This comprehension is strategically important in the decision-making process, a core activity in governance.

Several studies demonstrated the importance of water governance to address development issues. Pahl-Wostl (2019) compared the role of governance in the water sector in five selected countries across continents. Hooper (2006) compiled studies on water management in several countries worldwide, which shed light to the crucial role of governance. Both studies consider water management as a wicked problem that requires multi-sectoral solutions supported by various stakeholders with different roles and responsibilities. However, the elaborations were very much at the macrolevel. Some details might have been missed, particularly those related to the city-level experience with limited capacity as well as authority in dealing with the complexity of water-related issues. This paper aims to examine adaptive water governance arrangements in the city of Semarang (furthermore referred to as Semarang) based on the comprehension on the stakeholders' engagement

and interactions. We addressed two research questions herein: (1) To what extent have the principles of adaptive water governance been applied in the interactions within selected water-related initiatives in the City? (2) To what extent has the municipality government managed to establish its role in promoting adaptive water governance?

Semarang was chosen as a case study for at least two reasons. First, Semarang has been facing a severe water problem due to climate change in combination with other issues arising from rapid urbanization, including flood, drought, and land subsidence (Mulyana et al., 2013). Second, Semarang is a leading city in Indonesia in addressing climate change impact. The city has been a member of the Asian Cities Climate Change Network (ACCCRN) since 2009 (Sutarto et al., 2012), and it has actively participated in the 100 Resilient City initiative pioneered by the Rockefeller Foundation since 2014 (100 Resilient Cities (100RC) 2016). As a result, Semarang was chosen as one of the three cities engaged in the Water as Leverage (WaL) Program initiated by the government of the Netherlands in 2018 (RVO, 2018) as well as some other international-driven water management programs. The Semarang case is expected to contribute to the implementation of adaptive water governance at the city-level. This would be valid as Kooiman (2003) and Huitema et al., (2009) emphasized adaptive co-management as a continuous learning process carried out through a series of structured experimentation (i.e., Semarang pathways in various initiatives) to achieve improvements.

Interactions among stakeholders in relation to water-related issues are mainly assessed based on the Social Network Analysis (SNA) (Ahmadi et al., 2019). This method demonstrates the intensity and type of interactions among involved stakeholders to show the emerging governance arrangements (Kharanagh et al., 2020; Stein et al., 2011; Ahmadi et al., 2019). Previous investigations that relied on stakeholder mapping and SNA include that on the natural resource governance in Tehran (Ahmadi et al., 2019), infrastructure planning in the Swiss water sector (Lienert et al., 2013), and water governance in Tanzania (Stein et al., 2011). Accordingly, a similar approach was applied in this study to understand the interactions and connections among stakeholders on water management in Semarang. The next part of this paper further provides a theoretical framework for water governance. This is followed by a description on methods for stakeholder analysis and SNA. In addition, we also describe water-related problems in Semarang, how the City addressed them, and their corresponding results in response to our research questions.

2 Adaptive water governance and the resulting interactions

Different stakeholders with different interests may strategically be involved in solving water-related issues. Subsequently, Pahl-Wostl (2015) reveals that water management demands for collaborations among different actors to optimize water functions and, ultimately, to achieve water resilience. Biggs et al., (2015) further believe that there needs to be an inclusive process and less hierarchical government in order to promote resilience. Adaptive water governance through co-management then appears as a critical water resilience trajectory at the practical level (Pahl-Wostl, 2015). Co-management indicates distribution of duties, responsibilities, and power to all involved stakeholders, both across sectors and levels (Huitema et al., 2009). There are at least four institutional features in adaptive co-management: (1) Collaboration in a less-hierarchical governance system that holds multiple centers of power involving many institutions with no rigid ordered level, (2) Inclusiveness, meaning that there is a partnership between the government and

non-government for each process, (3) An experimental approach on resource management through a series of cooperative trials to determine the capability and capacity of all parties involved, and (4) Management at the river basin scale. Thus, polycentricity governance, in which there are less hierarchical decision-making processes and broader participation, either through collaborations among various levels of government or among the government and non-governmental stakeholders, is important in promoting more adaptive water governance (Huitema et al., 2009; Pahl-Wostl, 2015; Chaffin et al., 2016).

In a broader context, Kooiman (2003) highlighted two elementary components in assessing governance arrangements: (1) Emerging interactions among various actors involved; and (2) A set of solved problems as a result of interactions. Schulz et al., (2017) state that governance comprises the various roles of stakeholders and it should be less hierarchical. A network that implies connections among engaged stakeholders eventually appears as an essential indicator to assess the applied governance arrangements. Interactions become a central point in ensuring proper governance arrangements (Kooiman, 2003). Pahl-Wostl (2020) proposed at least four main governance functions as the outcome of the interactions among different types of stakeholders, i.e.,: rule formulation, learning process leading to knowledge generation, the course of problem-solving, and coordination as part of the planning procedures. Some scholars (Schulz et al., 2017; Tortajada, 2010) have also highlighted that decision-making in the context of governance should not only be dominated by governmental actors, but rather involve private sectors, communities, and other entities with various roles in the development process. Indeed, interaction through varied participation of stakeholders should be regarded as an essential key in water governance. There are several benefits of different stakeholders involvement, including the contribution of ideas, thoughts, and experiences from different stakeholders; the increase in accountability and community trust on the policies and implemented program; and the reduction in risks and problems in the implementation process (Ruiz-Villaverde et al., 2017). In water management, interaction and involvement will help each involved stakeholder to be more aware of the capacity and conditions of others. Likewise, participation is a tool for conflict resolution and reconciliation (Priscoli et al., 2004).

Tortadja (2010) states that a good governance mechanism requires beyond interaction and participation as it prompts for a partnership among actors through a transparent and accountable mechanism. Several studies mentioned the various types of interactions in water governance, which are funding, information and knowledge exchange, and collaborations (Kharanagh et al., 2020; Stein et al., 2011). Hileman (2018) further included policy network as another important type of interaction. Combining Kooiman's (2003) conception of governance with the notions of adaptive water governance developed by Pahl-Wostl et al., (2020), Fig. 1 illustrates the concept of governance and adaptive water governance within the context of the need for interactions and collaborations among various stakeholders.

3 Materials and methods

3.1 List of initiatives and stakeholders

Seven major influential initiatives launched since the establishment of the National Centre for River Basin Management in 2006 were examined in the study (see Table 1). The establishment of the Centre is a remarkable moment for the implementation of integrated

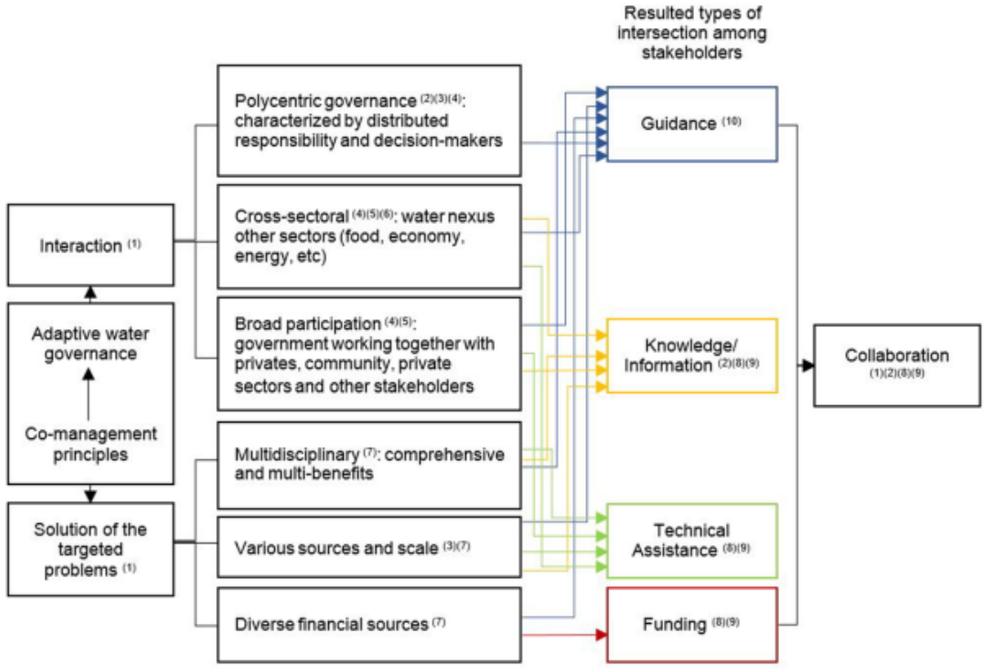

Fig. 1 Adaptive Water Governance and the Resulted Interactions

water management in Indonesia, including in Semarang. Each initiative consists of several activities that include stakeholder involvement from various types. Stakeholder identification was the initial step to further study their engagement and interactions in water-related initiatives in the City. Fourteen types of stakeholders were identified, and each type was represented by various amount of institutions/organizations (Table 2).

3.2 Stakeholder analysis and grouping of initiatives

Descriptive analysis was conducted to further comprehend the role of each type of stakeholder and the characteristics of each initiative. The analysis was used to explore the extent to which adaptive water governance has been applied based on the deliverables. Stakeholder roles and existing initiatives were identified based on information gathered from interviews and Focus Group Discussions (FGDs) with representatives of all types of stakeholders. These were conducted in line with several initiative meetings in 2019, such as that for the ICZM (one FGD) and WaL (six FGDs) program. Interviews with the key informants from each type of stakeholder were done. Key informants are individuals representing an institution or organization. The FGDs were conducted in two phases, main FGDs and small FGDs (Fig. 2). The main FGDs were attended by representatives of all types of stakeholders. Meanwhile, the small FGDs were attended by a smaller group of stakeholder representatives. This was intended to validate the results of the main FGDs. During the main FGDs, stakeholders were asked to map their connections (i.e., knowledge/information, funding, guidance, technical assistance) and identify their roles based on the interaction in water management. Furthermore, in the small FGDs, stakeholders were asked

Table 1 List of Water-Related Initiatives in Semarang

No	Initiatives	Program description
1	IWRFMP (Integrated Water Resources and Flood Management Project)– West Semarang	Flood management project supported by Ministry of Public Works and Housing, Semarang City Government, and Japan International Cooperation Agency (JICA) in 2009–2012. IMWRFMP is aimed to establish flood management, sea water intrusion and land subsidence risk reduction, watershed management, and drinking water supply provision. The two primary activities include structural program (normalization of West Flood Canal, development of Jati Barang dam, and drainage improvement) and non-structural program (watershed management and water-related disaster management)
2	ACCCRN (Asian Cities Climate Change Resilience Network) (ACCCRN, 2011)	The network is aimed to promote Climate Adaptation and Resilience Building initiatives supported by the Rockefeller Foundation. Some pilot projects were conducted in 2009–2016. The outcome of the program is enhanced stakeholder capacity to carry out the Climate Resilience Strategy (CRS) through some micro-interventions, including the Flood Early Warning System (FEWS), rehabilitation of coastal village, and promoting Rain Water Harvesting (RWH). This program has also led to other initiatives such as (Zurich Flood Resilient Program) as a follow up to FEWS pilot programs
3	ICZM (Integrated Coastal Zone Management)	The program was established in 2010. It was strengthened following the signing of an MoU among the Indonesian Ministry of Public Works and Housing, Ministry of Environment and Forestry, and Special Envoy for International Water Affairs – the Netherlands in 2019. The program covers the Northern Coast of Central Java, including Semarang. The initiatives include: (1) Regulation arrangements involving 17 regency/city government in Central Java; (2) Revitalization and rehabilitation to address flood, land subsidence, rob, abrasion, drinking water supply, and declining biodiversity; and (3) Capacity building with the support from NUFFIC (the Netherlands Organisation for International Cooperation in Higher Education) by establishing ICZM Center in Diponegoro University in 2020
4	100 Resilient Cities (becomes Global Resilient Cities Network since 2020) (ACCCRN, 2011)	Continuing the ACCCRN program, Semarang has been a part of 100 RC network since 2014. Its main achievement was the launch of Climate Resilience Strategy document in 2016. The 100RC program has facilitated the city in implementing some strategies by connecting the City Government with International partners. This includes knowledge development activities through joint research between local and foreign universities

Table 1 (continued)

No	Initiatives	Program description
5	Water as Leverage (WaL, 2019)	The program was initiated by Special Envoy for International Water Affairs – the Netherlands in collaboration with Netherlands Enterprise Agency. It is aimed to promote innovative strategies related to climate adaptation and finance through collaborative approach into several bankable projects. This project facilitated stakeholder engagement (not only local parties, but also national and international parties) to develop urban climate adaptation strategies, pilot project, and financial scheme support
6	IWRFMP (Integrated Water Resources and Flood Management Project)—East Semarang	The project is a replica of an earlier project on the west canal (no.1). It includes East Flood Canal normalization, riverbanks adjustment, and development of water tourism through public space provision
7	National infrastructure project	Tom-down project under the coordination of Ministry of Public Works and Housing. Some big projects conducted in Semarang include normalization of selected rivers, dam construction, and harbor toll road construction as a seawall

Table 2 Types of Stakeholders Involved in Water-Related Initiatives in Semarang

Types of stakeholders	Number of stakeholders
National Government	7
Province Government	4
Local (Semarang City) Government	9
Local University	4
Foreign University	10
Funding Agencies	8
Network Platform	8
Local NGO	5
International NGO	5
Local Consultant	5
International Consultant	10
State-Owned Enterprises	5
Local Private Sector	2
Community Group	10
TOTAL	92

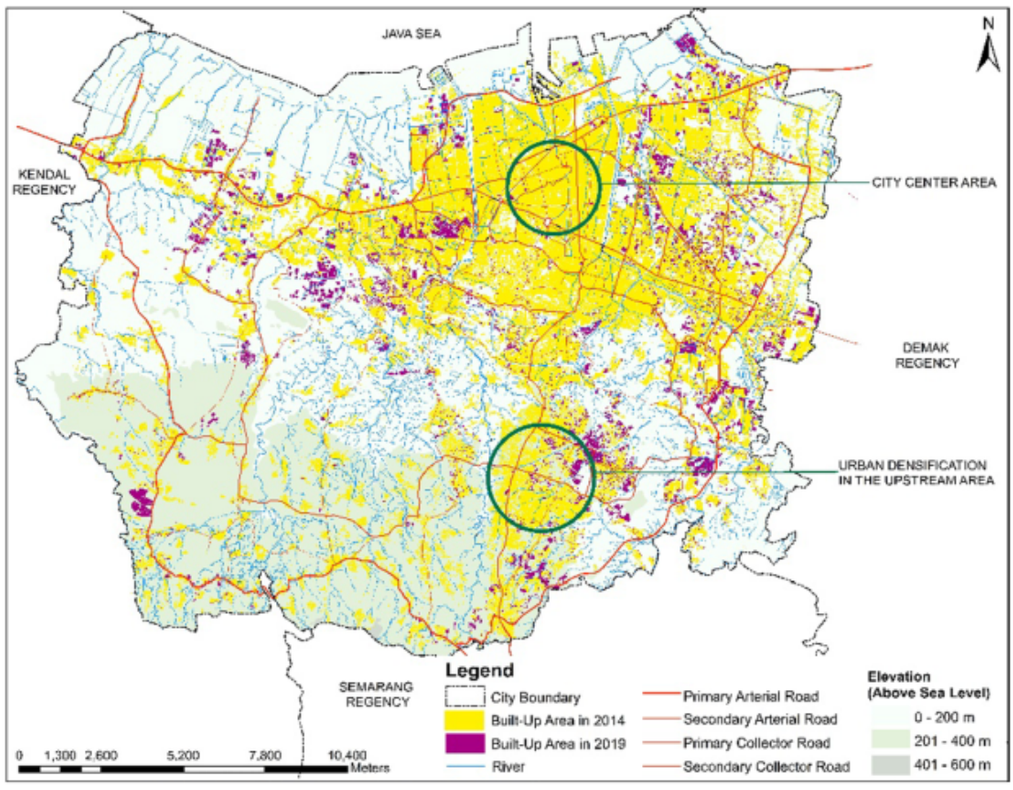

Fig. 2 Semarang City

to validate the matrices of connection that were recorded based on the main FGD. Such validation step is necessary because the representatives who participated in the main FGDs might not be a decision maker in their institution. In-line with the FGDs, interviews were also conducted to collect and validate data regarding the roles and responsibilities of each institution. Accordingly, stakeholders were asked about their involvement and initiatives in Semarang water management, specifically those related to ICZM and WaL.

All initiatives were then grouped based on their deliverables (outputs and outcomes of the activities), as validated by multiple outcome documents, such as project reports, modules, monographs. As a result, four main deliverable categories were identified:

- Spatial: mix initiatives within a defined geographical area (district and neighborhood level)
- Technical: initiatives that are focused on solving water-related problems through physical constructions.
- Knowledge generation/skill improvement: initiatives that are aimed at improving the capacity of targeted beneficiaries.
- Rulemaking and policy advocacy: initiatives that are targeted at policy dimension as the main element of solutions to water-related problems.

3.3 Social network analysis using gephy

Stakeholder analysis complies with Social Network Analysis (SNA) in examining governance arrangements (Ahmadi et al., 2019). While stakeholder analysis is used to identify the actors involved and their roles, SNA is a method for studying relationships as well as visualizing and quantifying the interactions among actors (i.e., stakeholders) (Kate et al., 2015; Scott, 2000). SNA was used as a tool to characterize and to quantify current network of Semarang water governance. In this analysis, the connections among stakeholders were identified and classified based on their interactions. There were two main steps in conducting SNA: (1) Identification of types of connections among stakeholders; (2) Network analysis.

(1) Identification of types of connections among stakeholders

Interactions among stakeholders in the network vary based on the role and responsibility of each stakeholder. Hence, the identification of connection types within a network is essential to further understand the interactions among stakeholders involved (Juana & Sejarah, 2020; Mills et al., 2014; Moftakhari et al., 2017; Sutarto & Jarvie, 2012). In the case of Semarang water-related initiatives, four types of connections among stakeholders were identified based on a combination of existing literatures and FGDs, including:

(a) Knowledge sharing/transfer of information (K/I); knowledge sharing or transfer of information from and to stakeholder by all means of communication (i.e., emails, phone calls, meetings, social platforms)
(b) Flow of funding (F); financial flow within a stakeholder in financing water-related initiatives
(c) Guidance (G); guidelines, policies, rules provided by a stakeholder in water management
(d) Technical assistance (TA); non-financial assistance, such as training, capacity building.

(2) Network analysis

The types of connections (nodes) among stakeholders (edges) within the network were visualized and quantified using Gephi Software ver. 0.9.2. The edges in network indicate that there is an interaction among stakeholders, which can be direct or indirect. The network analysis was conducted for each type of connection to see which stakeholder plays an important role for another. Therefore, there are three general steps in network analysis for Semarang water governance:

(a) Defining the interaction

A total of 92 stakeholders were identified and classified into 14 types of stakeholders. Data derived from the FGDs and Interviews were recorded as interactions among stakeholders. The presence of interaction between two stakeholders was marked as "1" in the stakeholder matrix, whereas the absence of interaction was marked as "0". In this case, the interactions were grouped based on the types of connections mentioned previously. To define these connections, a square case-by-case matrix described by John Scott (2000) was used. The rows and columns in the matrix represent the stakeholders for each type of connection, while individual cells show whether there is a connection between them (see Table 3). The interactions were further classified based on whether they are direct or indirect.

(b) Quantifying the degree

The number of interactions among stakeholders as scored in the matrix was further calculated and expressed as degrees. Each interaction was further specified as in-degree or out-degree based on whether the stakeholder was at the receiving or contributing end of the interaction, respectively. The higher the amount of degree, the more significant and important a stakeholder is. Visualizing the connection

The connections among stakeholders were visualized as nodes (stakeholder), edges (connection), and degrees (interaction). Thus, the interactions were mapped as a network of stakeholders with their interactions. The size of each node indicates the amount of interactions linked to a specific type of stakeholder. Different types of stakeholders are labeled by a different node color.

Table 3 Case-by-case Matrix. Source: Scott, J. (2000) Social Network Analysis: A Handbook 2nd ed. London: SAGE Publication Ltd

	Stakeholder		
Stakeholder		a	b
	a	0	0
	b	1	0

4 Semarang city: water-related problems and pathways toward solutions

The city of Semarang is composed of two morphological characters, the hilly area in the southern part located at the foot of Mount Ungaran and the alluvial coastal plains in the northern part commonly known as the lower City (Marfai et al., 2007). The upper City is located at 150–348 m altitude above sea level with above 15% slope, whereas the lower City has an altitude of 0.75–150 m above sea level with a slope of 0–15% (Central Bureau of Statistics, 2020). Likewise, the eastern and western parts of Semarang are mostly categorized as the lower City with an altitude of 2–11 m above sea level and a slope of 0–15% (Central Bureau of Statistics, 2020). Indeed, the difference in morphological characteristics influences the direction of city development. According to the Semarang City Spatial Plan 2011–2031 (Semarang Government, 2011), the southern region development is directed for the optimization of water infiltration, while the land use allocation for northern Semarang is mainly for business and settlement. The eastern and western parts of Semarang have been well-developed and will be preserved as settlement and industrial areas (see Fig. 3).

However, evidence shows that the most extensive land conversion in Semarang occurs intensively in the southern part of the City (Handayani et al., 2014), which is supposed to be reserved for conservation areas. Rapid urbanization, as indicated by significant population growth, is the main cause of the increasing proportion of repurposed

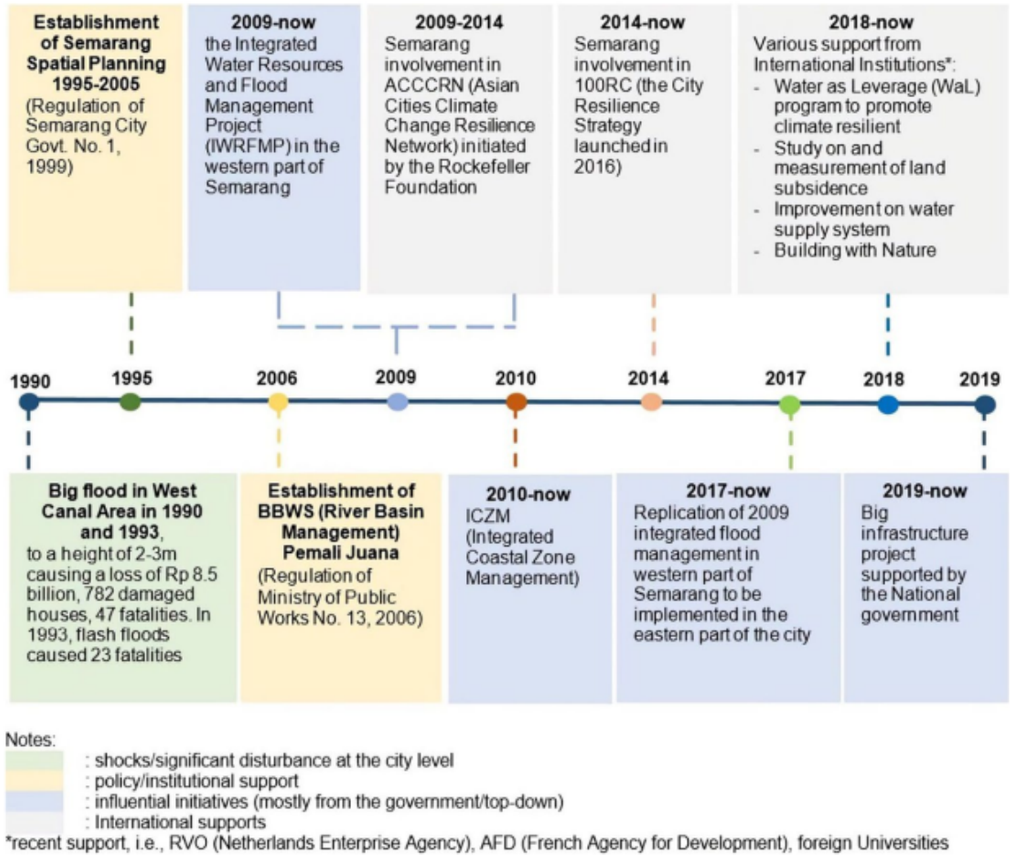

Fig. 3 Milestones on Semarang Water-Related Initiatives

to conserved land. The number of inhabitants in Semarang has grown from 1.7 million in 2015 up to more than 1.8 million people in 2019 (Central Bureau of Statistics, 2020). This growth rate is the highest among other cities in Central Java Province. In addition, the population growth rate in south Semarang was above 6% annually in the last five years (Central Bureau of Statistics, 2020).

Land conversion, especially in the conservation areas, reduces land coverage and water absorption, making the surrounding areas prone to landslides and drought. Twenty five out of 177 *kelurahan* (urban village) in Semarang are categorized as drought-prone areas (Semarang Government Planning Board, 2019). Clean water provision is an emerging problem that needs to be overcome immediately. As implied in the Semarang Annual Planning Document, the government's current effort to overcome drought by providing a budget to purchase water tanks is likely to be a short-term solution. Long-term efforts such as the rehabilitation of conservation areas are difficult to implement as they require a more complicated process involving many stakeholders and multi-layered governmental interventions. In addition to clean water provision, industrial growth in coastal areas demands for a significant amount of water, which triggers excessive groundwater extraction and this contributes to land subsidence issues (Buchori et al., 2018; Yastika et al., 2019). Such conditions have worsened in recent years due to other factors such as natural soil consolidation and tectonic activities, leading to land subsidence of up to 13 cm/year (RVO, 2020). Exploration and utilization of groundwater in Semarang should be based on Central Java Provincial Regulation Number 3 in 2018 (Central Java Government, 2018). However, the existence of this regional regulation fails to reduce land subsidence significantly as there is a need for better mechanisms for monitoring and land use permission approval.

The increased land cover has significantly impacted the level of natural water absorption in the upstream area, thereby increasing the runoff to the downstream region. Such situation, in addition to the fact that Semarang is passed through by 21 rivers, has increased flooding occurrence and severity, impacting more that 50 out of 177 kelurahan in the City (Handayani et al., 2019). There are at least three types of flooding that have hit the City in the past: fluvial, pluvial, and coastal flooding. Fluvial flood happens when a river cannot accommodate rainfall due to the increase in river sedimentation level as a result of soil erosion, and/or due to higher rain intensity as a result of climate change (Moftakhari et al., 2017). Pluvial flood mostly takes place as a result of urban growth that is not supported by a proper drainage system (Michelson et al., 2019). Meanwhile, coastal flood occurs due to sea-level rise. In 1990, a flash flood occurred at Garang watershed, causing significant losses (Handayani et al., 2019). The latest case of fluvial flood happened in 2018, during which the East Canal overflowed, forcing 3000 households to evacuate. Pluvial flood repeatedly hits the downtown area as well as the upstream area, especially during the high rainfall season, and one of the reasons is because the drainage system was clogged by garbage or sedimentation.

Semarang Government, in collaboration with other stakeholders, has made some efforts to address water-related problems. Figure 4 illustrates important milestones in solving water-related problems in Semarang since the big flood in early 90 s. The National Government and International institutions played a significant role that resulted in not only hard infrastructures or engineering solutions but also in covering softer infrastructure results such as research, policy advocacy, and capacity building. Semarang involvement in global networks such as ACCCRN and 100RC encouraged the City to be more proactive in water management and climate change actions. Most importantly, such involvement has brought the City to the attention of other international platforms, which further played a

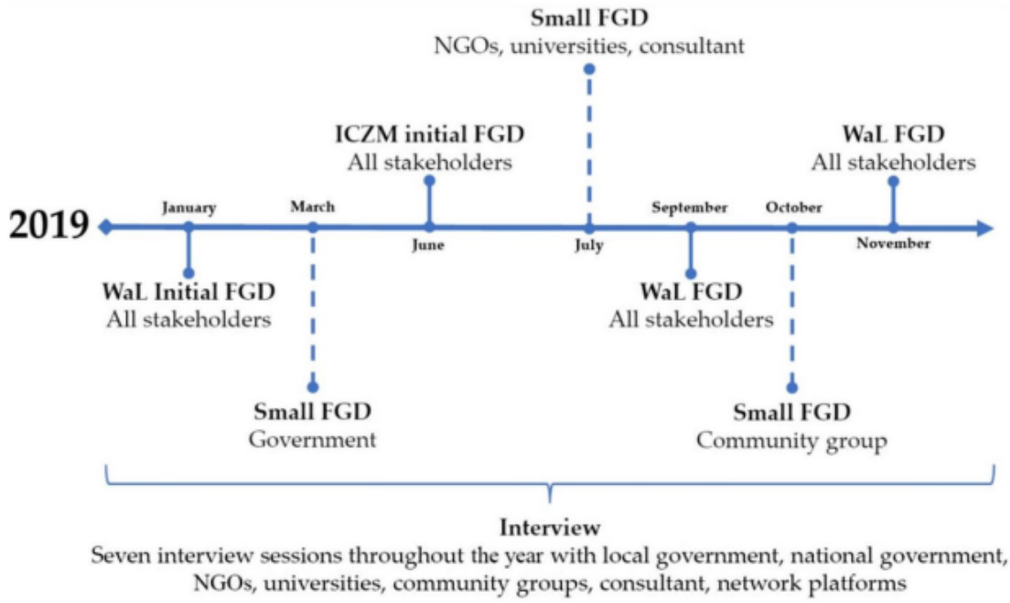

Fig. 4 Time frame of Focus Group Discussions (FGD) and Interviews

contributing role in solving the City's water-related problems in search of long-term, sustainable, and transformative initiatives.

5 Results

5.1 Role of stakeholders and water-related initiatives in Semarang

Water governance involves multi-stakeholders, which not only consist of water stakeholders but also non-water stakeholders. In this study, water stakeholders are defined as government institutions directly related to the water issues, not only at local but also national level, whereas non-water stakeholders refer to stakeholders from the social, political, and economic sectors. For instance, universities and NGOs have a significant role in water governance as neutral parties, thus it is essential to involve them in monitoring and evaluating water projects (Zogheib et al., 2018). Moreover, many water-related studies are conducted by local, national, or international universities, giving significant insight to water stakeholders. Non-water stakeholders include funding agencies and consultants, which influence water governance through their foreign policies and engagement in bilateral and international relationships, in the context of financial assistance, donations, investment, lending, and trading (Dore et al., 2012). Advocacy network groups such as Polder Banger management community group and Garang River community watch also play a crucial role in representing communities that are directly impacted by water problems.

Different institutions with various functions and involvement significantly affect water management as the backbone of achieving good water governance. Table 4 describes the general role of each type of stakeholders, followed by examples of selected activities to further illustrate their contributions in promoting water management in Semarang. Despite that most of the initiatives in water governance implementation in Semarang are likely to

Table 4 Role of Stakeholders in Water-Related Initiatives in Semarang

No	Type of stakeholder	Role	Highlighted activities
1	National Government	Regulatory support Assisting the local government both financially and non-financially, mostly in water infrastructure provision	Pemali Juwana River Management Center as a leading institution in the Integrated Water Resources and Flood Management Project (IWRFMP) at the West and East Flood Canal in Semarang
2	Provincial Government (Central Java)	Facilitating regional water infrastructures development	Contributing budget for land acquisition in some big initiatives in collaboration with national and local government 1000 ponds program throughout Central Java Province
3	Local Government (Semarang)	Regulatory support at the city level Responsible for coordinating and executing water management at the city level according to their authority and jurisdiction	Working together with Pemali Juwana River Management Center in the Integrated Water Resources and Flood Management Project (IWRFMP) Coordinating stakeholders in ACCCRN and 100RC program
4	Universities (Local and Foreign)	Transfer of knowledge	Diponegoro University (Local University) as a knowledge partner in several water-related projects in Semarang funded by foreign agencies
5	International development funding agencies	Assisting financially in most of the big initiatives in Semarang	JICA's involvement in the Integrated Water Resources and Flood Management Project (IWRFMP) program by providing loans for Jati Barang Dam construction and Garang River normalization Rockefeller Foundation through ACCCRN and 100RC program RVO (the Netherlands Government) water-related program to promote climate resilience and to control land subsidence
6	Network platforms	As intermediaries to connect the City with international platforms Assisting the City in promoting water resilience	City Resilience Strategy launched in 2016 ACCCRN and 100RC as the initial step for Semarang to engage in other programs such as Water as Leverage, Building with Nature
7	NGOs (Local and International)	As intermediaries between the Government and community	Community empowerment programs to become more resilient against disasters Building with Nature program by involving local people for mangroves rehabilitation

Table 4 (continued)

No	Type of stakeholder	Role	Highlighted activities
8	Consultants (Local and International	Partnering with the government in water management	Professional expertise in technical measurements: Land subsidence modelling Assessment/concept development for flood management Feasibility studies and other measurements to fulfill project readiness criteria
9	State-Owned Enterprises (SOE)	A part of the government party to provide better public infrastructure delivery financially and non-financially	Involvement of PT. SMI and PT. PII to improve credit worthiness in the financing of West-Semarang Water Supply System Project
10	Local Private Sectors	Partnering with the government in water management	Providing public infrastructures, such as reservoirs for rainwater infiltration and reducing runoff
11	Community Groups	As local institutions to accelerate community empowerment As beneficiaries who get a direct benefit from the water management	Initiating mangrove cultivation in coastal areas, Leading stakeholders in flood management through community self-help activities

Due to similarities among the 14 groups of roles in Table 2, the local and international Universities, NGOs, and Consultants are merged into one role, resulting in 11 types of roles in total

be initiated by the government, the involvement of various non-governmental stakeholders is quite significant.

Before the decentralization era in 1999, water management in Indonesia was very much reliant on directions from the National Government (top-down) and it was fragmented into different sectors. Infrastructure development, for example, was under the authority of the Ministry of Public Works, while the task force on river basin management was under the National Development Board (BAPPENAS). The National Government played a central role, while the provincial/local government as well as non-government players were not much involved (River Basin Management of Pemali Juana). The establishment of River Management board in 2006 under the Ministry of Public Works (see Fig. 4) is a significant milestone to bring water management toward a more integrative approach at the river basin level and to involve broader participation. To illustrate this, the spatial measures type (i.e., Integrated Flood Management and Water Supply Project in the western part of Semarang) was initiated in the 1990s, but it has only been executed after the board was established in the following decade. Table 5 further highlights selected initiatives in Semarang since 2009, grouped based on their major targeted deliverables. In general, in alignment with its typical characteristics, the government plays a vital role in strategic programs derived from spatial and technical measures, while the NGOs and Universities contribute on knowledge generation/skill improvement and rulemaking/policy advocacy. Active involvement of international institutions has also resulted in diverse deliverables.

Diverse types of initiatives and deliverables may indicate at least two things regarding the pathways of water governance practice in Semarang. The first is that water solutions in the City have gradually moved beyond the initial approach that was very much focused on infrastructure construction. It is likely that physical and/or infrastructural development have improved due to other activities, including policy support/advocacy and capacity building through training and modules development. The second is that these pathways have passed through different trajectories in terms of scale (city–sub-district–neighborhood) and outputs (covering both hard as well as soft infrastructures). Indeed, there have been significant contributions and support from the National Government, international organization, local NGOs, and academic institutions during the process.

5.2 Social network analysis on water-related initiatives in Semarang City

The result of SNA using Gephi software shows the network among contributing water-related stakeholders in Semarang City. This network represents the type and intensity of connections among 92 stakeholders (see Table 1). Accordingly, a 92×92 matrix representing 8464 connections was used to visualize a network among four types of interactions: (a) Knowledge sharing/transfer of information–K/I; (b) Flow of funding (F); (c) Guidance–G; and (d) Technical assistance–TA. Table 3 summarizes the number of interactions (degree) of each type of stakeholder in the network.

Knowledge sharing/transfer of information has the highest total degree compared to the other three types of connections. It indicates that the most intensive interaction among various types of stakeholders occurs at the level of information/knowledge exchange, while technical interaction and funding a relatively low degree, meaning that fewer stakeholders contribute to those purposes. Among the 14 types of stakeholders, the Local Government (Semarang) has the highest degree for all types of connections (I/K: 655, F: 19, G: 203, TA: 30). It shows that the Semarang Government plays a central stakeholder role in initiatives within water-related network. By pinpointing the most influencing stakeholder in the

Table 5 Water-Related Initiatives in Semarang in 2009 – to date

Groupings based on deliverables	Program name	Targeted deliverables	Leading stakeholders (Funder and Implementing Agencies)
Spatial	Sub-district level		
	Integrated Water Resources and Flood Management Project (IWRFMP) in the western part of Semarang and the replication in the eastern part of the City	River normalization DAM construction Drainage system improvement Green open space improvement Establishment of community groups on eco-based tourism and local economic development Informal sector re-arrangement Clean water provision	National Government: River Basin Management Agency Semarang City Government
	ICZM (Integrated coastal zone management program)	Mapping of sea-level rise Study of coastal damage and rehabilitation initiatives Developing Regulation on Zoning Plans for Coastal Areas	DKP (Marine and fishery office) Central Java Province Diponegoro University (UNDIP) Semarang City Government
	Neighborhood level		
	Asian Cities Climate Change Resilience Network (ACCCRN)	Mangrove restoration Flood early warning system Establishment of disaster preparedness group	Rockefeller Foundation NGO: Mercy Corps Indonesia, Bintari Foundation Semarang Government
Technical	Big infrastructure project	Toll road embankment & seawall River normalization DAM construction	National Government: Ministry of Public Works Provincial Government Semarang City Government

Table 5 (continued)

Groupings based on deliverables	Program name	Targeted deliverables	Leading stakeholders (Funder and Implementing Agencies)
Knowledge generation/ skill improvement	Zurich Flood Resilient Program (ZFRP)	Training on disaster preparedness Training on waste processing	Z Zurich Foundation NGO: Mercy Corps Indonesia, IUCCE Semarang Government
	100 Resilient Cities (100RC)	City Resilience Index	ARUP Semarang Government
	Joint Studio between local and foreign Universities (part of 100RC activities)	Vulnerability Assessment	Diponegoro University (UNDIP) University of Hawaii
	ACCCRN (Asian Cities Climate Change Resilience Network)	Modules for disaster preparedness	Diponegoro University (UNDIP)
Rulemaking/ policy advocacy	100RC	City Resilience Strategy	The Rockefeller Foundation Semarang Government IUCCE
	ZFRP	Community Based Disaster Risk Management	Z Zurich Foundation NGO: Mercy Corps Indonesia, IUCCE Semarang Government
	Regional Action Plans for Climate Change Adaptation	Climate change adaptation action plan for Semarang	Semarang Government NGO: IUCCE

network, we can better understand which party holds a strategic position in the network (Mills et al., 2014), and this may aid in good decision-making process (Bruce et al., 2020).

Figures 5–8 further illustrate a summary of Table 6 in the form of networks for each type of interaction. The network of knowledge sharing/transfer of information is the most complicated as about 30% (2960 out of total 8464) of interactions take place within this element, either through giving and/or receiving knowledge/information. As a single institution, Bappeda (Planning Board Agency in Semarang) and Diponegoro University (a Public University based in Semarang) contribute to the highest degree as represented by more prominent nodes compared to the others (see Fig. 5). However, based on the type of stakeholders, the three highest degrees are represented by the local government (655), international consultants (364), and local community groups (290). Not all in- and out-degrees are balanced for each stakeholder. For example, the out-degree (192) for local community is significantly higher compared to the in-degree (98). The community is likely

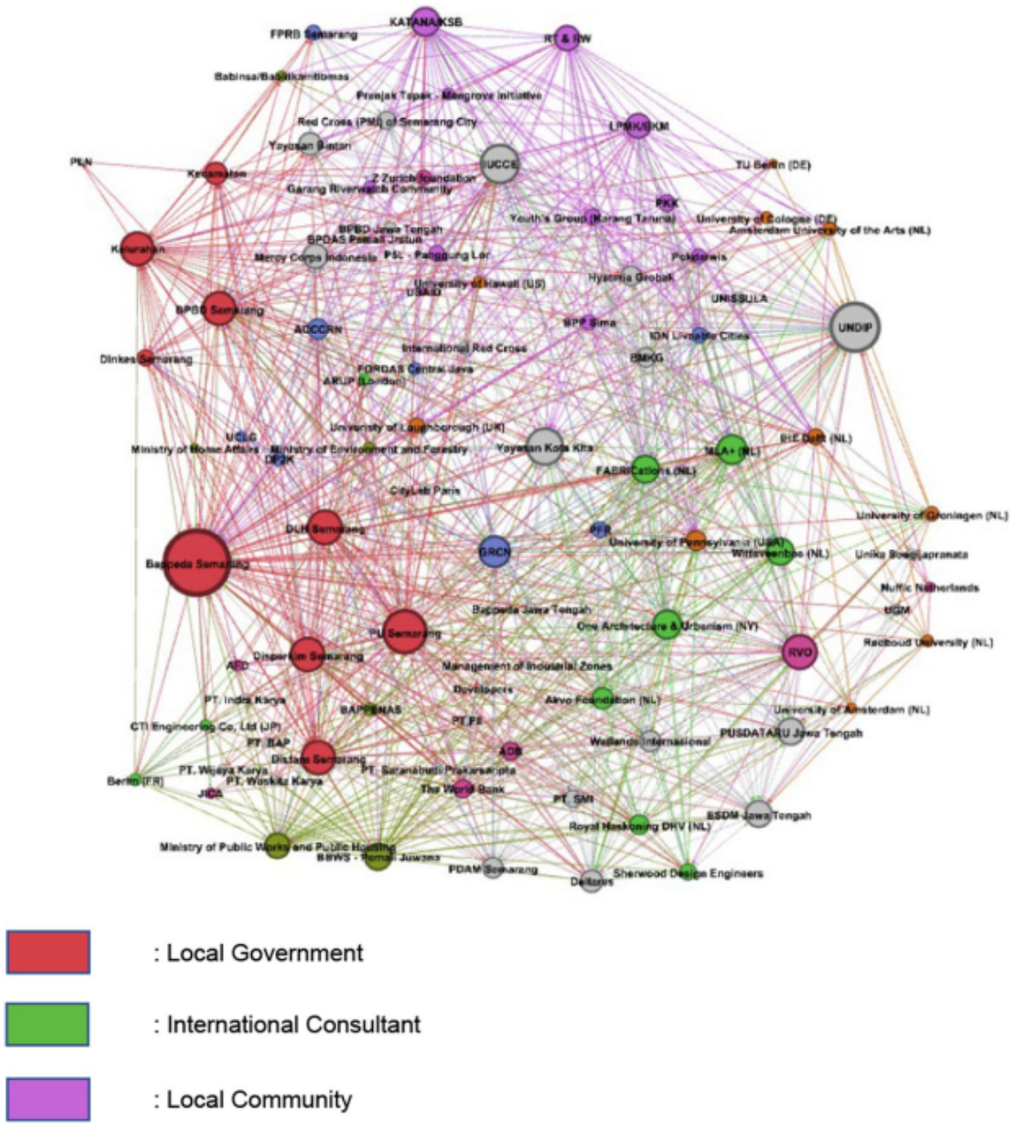

Fig. 5 Water-Related Initiatives Network–knowledge sharing/transfer of information

Table 6 Degree of each stakeholder in the network

Stakeholders	Knowledge sharing/transfer of information (K/I)			Flow of funding (F)			Guidance (G)			Technical assistance (TA)		
	Degree	In-degree	Out-degree	Degree	In-degree	Out-degree	Degree	In-degree	Out-degree	Degree	In-degree	Out-degree
National Government	149	40	109	14	7	7	106	2	104	6	3	3
Provincial Government	127	59	68	3	1	2	72	16	56	13	13	0
Local Government (Semarang)	655	339	316	19	8	11	203	64	139	30	22	8
Local Universities	130	56	74	6	6	0	11	11	0	25	3	22
Foreign Universities	185	141	44	5	3	2	27	27	0	0	0	0
Funding Agencies	218	93	125	14	0	14	36	30	6	6	0	6
Network Platforms	246	121	125	7	4	3	21	17	4	11	3	8
Local NGOs	260	139	121	18	8	10	19	19	0	28	8	20
International NGOs	154	96	58	6	3	3	25	24	1	6	2	4
Local Consultants	54	19	35	0	0	0	17	17	0	0	0	0
International Consultants	364	230	134	15	8	7	70	67	3	3	0	3
State-Owned Enterprises	109	39	70	0	0	0	8	8	0	0	0	0
Local Private Sectors	19	10	9	0	0	0	7	7	0	0	0	0
Community Groups	290	98	192	11	11	0	4	4	0	20	20	0
TOTAL	2960	1480	1480	118	59	59	626	313	313	148	74	74
Minimum	19	10	9	0	0	0	4	2	0	0	0	0
Maximum	655	339	316	19	11	14	203	67	139	30	22	22
Average	211	106	106	8	4	4	45	22	22	11	5	5

to be acknowledged more as a source of information. It also indicates that in most of the interventions, the information was collected from primary sources. However, they did not receive much knowledge/information in return (see in-degree).

The network of funding is quite particular compared to the other types of interaction as there are three distinct groups of funding connection created from the listed initiatives (see Fig. 6):

(1) The biggest network was generated from various activities that involved international partners. International institutions such as those under ACCCRN and 100 RC program create partnerships with local NGOs as project implementers and with universities for research/knowledge development. Some of the funding managed by the appointed local NGOs/Universities was then redistributed to local communities as part of the deliverables.
(2) Another smaller network was generated based on initiatives that involve the National Government, mostly in the form of infrastructure development such as the Integrated Water Resources and Flood Management Project (IWRFMP). As illustrated in Fig. 5, in some cases, the National Government has also received support from international donor agencies such as World Bank and ADB.
(3) The smallest network was between USAID and an American University based in Hawaii. This type of network is a clear illustration that some foreign institutions may provide support for Semarang through various activities or deliverables. Still, finance is all managed by the aid institutions, as there is no flow of money to any local stakeholders.

Apart from these three forms of interactions, in some cases, as also characterized by other types of interactions, there are unbalanced interactions among the involved stakeholders. As an example, the community mostly acts as a receiver as there is no out-degree coming from this type of stakeholder. Most of the funding for Semarang water initiatives either come from the government or from international institutions. There has been a lack of bottom-up initiatives relevant to water-related interventions in Semarang.

It is apparent that most out-degree guideline interactions come from the government, both at the national (104) and local level (139), while other types of stakeholders mostly act as a receiver or user of the guideline (Fig. 7). As a regulating body, the government has a role and responsibility in providing regulations or policy instruments to ensure that all of the initiatives are implemented according to current law and regulations. Figure 7 shows that, similar to other types of interactions, the most significant node represents Bappeda Semarang, the coordinating agency at the city level.

Figure 8 presents interactions for technical assistance. The three highest degrees for this connection are represented by the Local Government (30), Local NGOs (28), and Local Universities (25). The highest out-degree is shown by the local universities (22) and local NGOs (20), indicating that technical assistance was mostly delivered by these two types of stakeholders. Figure 6 shows that the most significant nodes represent a local university (Diponegoro University (UNDIP)) and local NGOs (IUCCE and Bintari). These two types of institutions provide technical assistance, such as training and facilitation. For example, UNDIP gave a local training in the Flood Early Warning System (FEWS) Program for the local community to increase their capacity in disaster preparedness. In collaboration with UNDIP, NUFFIC also provided a series of training to empower stakeholders within the ICZM program. On the other hand, the beneficiaries of technical assistance, as seen from

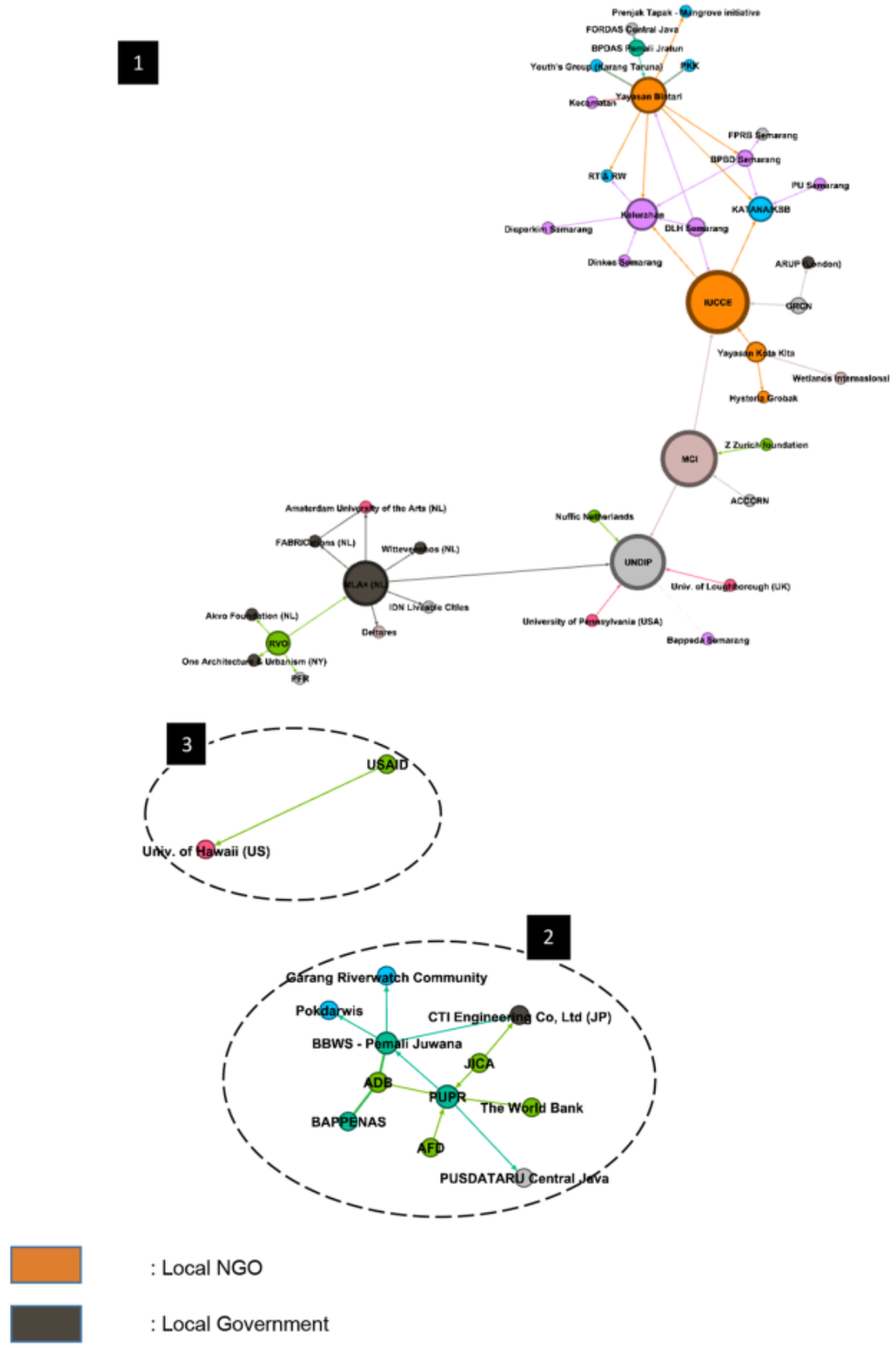

Fig. 6 Water-Related Initiatives Network–Funding

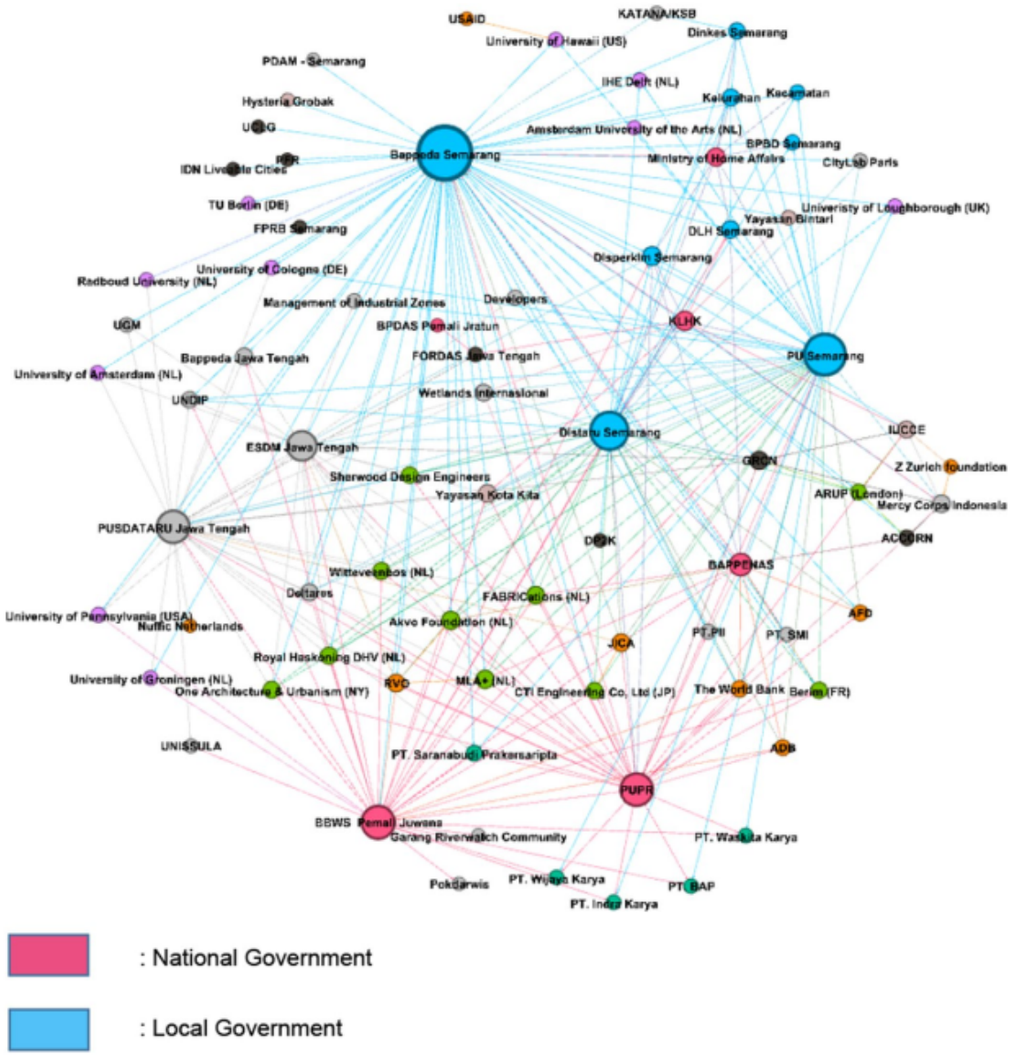

Fig. 7 Water-Related Initiatives Network–Guidance

the number of in-degree in Table 6, are mostly the local Government (22) and local community (20).

6 Discussion

Stakeholder Analysis and Social Network Analysis on water-related initiatives in Semarang have demonstrated the complexity of emerging interactions in four categories of network/connection. The results showed various initiatives for different measures and deliverables that cover the various functions of water. The adaptive water governance framework and its relevant interactions (Fig. 1) revealed that under significant support from various stakeholders, Semarang might be on the right path to achieve water resilience. There are several initiatives resulting in spatial deliverables (Table 5) that involve distributed responsibility, broad participation, multiple benefits, various scales and diverse financial sources at the

Fig. 8 Water-Related Initiatives Network–Technical Assistance

cross-sectoral level. Indeed, from the perspective of adaptive water governance implementation (Pahl-Wostl, 2019) in various countries, such initiatives and interactions should be supported by an enabling environment that is fundamentally influenced by appropriate and adaptive governance arrangements.

In alignment with adaptive water governance through co-management principles (see Fig. 1), the following are some reflections based on emerging interactions in seven selected initiatives:

6.1 Polycentric vs. hierarchical governance

Adaptive governance requires shared authority and balanced roles among stakeholders as represented in the polycentric government model. As shown in Table 5, various leading agencies/stakeholders have initiated numerous water-related interventions in Semarang. Nine local institutions at the city level (see Table 2) have contributed significantly

in seven initiatives through the lens of all types of interactions (see Table 6). Even though most of the big projects were initiated by the National Government or International Funding Agencies, there have been significant contributions from the local government as well as other stakeholders at the city level, exhibiting a certain degree of shared role and responsibilities.

The Semarang trajectories, referring to Pahl-Wostl (2019) and Huitema (2009) investigation, to a certain degree are in line with the water governance pathways in the Netherlands. Owing to the fact that the Netherlands has been a leading donor agency in water initiatives in Indonesia, there are some interesting comparisons to be made. Similar to the Netherlands experience, some big flood events have triggered more awareness and involvement of different stakeholders. This is demonstrated by the establishment of initiatives in response to two major flood events in 1990 and 1993 (Fig. 4) and the number of degrees identified in SNA (Table 6). The water initiatives in Semarang have been gradually transformed from the top-down approach (dominated by the National Government) to that involving broader stakeholder involvement that allows for innovation and intervention from different directions. The "room for the River program", a key milestone in the Netherlands water initiatives (Pahl-Wostl, 2019), to an extent has inspired the establishment of several initiatives in Semarang, such as IWRFMP and Water as Leverage (see Table 1). Accordingly, Semarang water initiatives likely put an emphasis on environmental considerations. Initiatives relevant to environmental conservation are done through informal interactions among non-governmental stakeholders, which overall complement formal policy development by the government side.

However, broader involvement and active interactions among multiple stakeholders may not immediately reduce the National Government's dominance in leading strategic interventions at the local level. The decentralization policy in Indonesia that has been implemented since 1999 has yet to produce its expected outcomes. At the practical level, due to limited capacity and resources, without sufficient support from the National Government, such initiatives at the local level will not function effectively (Friend et al., 2014). Hence, despite the evidence for transformation in delivering water initiatives, there is still an unavoidable hierarchical system that, to some degree, may hinder the proportionate distribution of roles and responsibilities in governance mechanism in Semarang.

6.2 Approach, sources, and scales

There are indeed various approaches, sources, and scales as indicated by numerous deliverables and stakeholder involvement described in Table 5. As stated by Handayani et al., (2020), the City has been able to mobilize different sources, resulting in a wide range of interventions. Even within the spatial type of deliverables alone (see Table 5) there are direct/explicit co-benefits with other related sectors. IWRFMP and ICZM, both cover most elements of water governance described in Figure 1 for at least two reasons. First, both initiatives activated cooperation among National, Provincial, and Local Government as there are different authorities involved according to the regulations in place. Second, both entail diverse activities, including water-related infrastructural works, community empowerment, and policy advocacy to the government. The National Government, under the authority of Ministry of Public Works, plays a very strategic and dominant role in coordinating a large cross-sectoral initiative that requires significant investment.

6.3 Diversity of participation

Horlitz (2007) states that the increasing of participation is indicated by improved awareness and the development of learning approaches in society. Jonsson (2005) further argues that participation in water management can be optimized only if the local community receives direct benefits or impact from the activities. For instance, community members need to understand the need to maintain the natural and environmental balance because it has a great impact on water quality. Problems in gaining mutual understanding among different stakeholders, policy arrangements, and level of trust are at least three influential factors that shape stakeholder participation. Despite that, Hurlbert and Gupta (2015) further stated that not all types of development interventions would require public participation.

Nonetheless, broader participation has taken place in the water-related solutions in Semarang, as indicated by stakeholder identification and SNA analysis results. The various types of stakeholder engagement are a good sign of governance arrangements (Pahl-Wostl, 2007; Hurlbert et al., 2015). However, according to Arnstein's classical ladder of participation (Arnstein, 1969) and Horlitz (2007), stakeholder involvement in the seven selected initiatives might only be at the level of "tokenism," in the sense that such wider participation has been featured as information exchange or consultation, yet it did not leverage awareness, power, and balanced partnership among the community as suggested by Tortajada (2010). A majority of the emerging interactions are merely in the form of information and knowledge sharing.

6.4 Funding

The National Government and international donors have played a strong role in supporting water-related initiatives in Semarang. It is interesting to highlight Semarang's success in maintaining its central role in managing all of the initiatives horizontally alongside local stakeholders and vertically with the National Government, and, most importantly, in maintaining its international networks. Three major countries made the most contribution to water solutions in Semarang, i.e.,: USA (Rockefeller Foundation), Japan (JICA), and the Netherlands (various institutions). In addition, other international development agencies, namely the World Bank and Asian Development Bank (ADB), also played a role in this context. Through other pathways, the international partners have been able to leverage Semarang's capacity to a certain extent to mobilize various sources in executing the initiatives.

The results of stakeholder role identification and SNA analysis based on the Semarang experience are further associated with an argument made by Hall et al., (2019) and Falkenmark et al., (2019), that water resilience could be achieved through proper trajectory on water governance transformation. Correspondingly, there are two correlations among selected Semarang initiatives and Pahl-Wostl's (2007) viewpoint on how adaptive co-management concepts may take place to activate governance at a practical level. First, adaptive water governance could be implemented through various co-benefits derived from multiple initiatives. In Semarang, this was demonstrated through spatial deliverables generated from the initiatives (see Table 5). They contrast with technical deliverables likely linked to the engineering perspective, in which water-related problems were solved by very much focusing on infrastructural work (seawall construction, polder construction, river normalization, etc.). Such strategies demand for a significant amount of investment (Handayani

et al., 2020). Second, adaptive water governance should be supported by more stakeholder involvement, in which the Government plays a role as an enabler and facilitator rather than an executor. In due course, Pahl-Wostl et al., (2020), as stated earlier, proposed a polycentric government system that showed more flexibility and equal distribution of responsibility to ensure proper water governance mechanism and achieve water resilience.

Semarang has gone through numerous pathways of water governance in interaction with various stakeholders to solve water-related problems, the main pillar in leveraging water resilience. Due to the city's limited funding and autonomous authority, the national Government and international donors play a significant role and allow for a learning opportunity for stakeholders at the city level to move forward with their solutions. Hence, current dynamic situation has moved toward adaptive water governance. This is clearly shown by the increased involvement of a broad range of stakeholders and contribution of different levels of government, as compared to before the decentralization era beginning in 1999, and most critically, before the establishment of the River Management board in 2006. To some extent, the Semarang case study, based on seven implemented initiatives, may enrich Pahl-Wostl's (2019) findings on the transformation of water governance in five different countries and Hooper's (2006) elaboration on Integrated Water Resource Management (IWRM) practices in selected countries. An important retrospective part of the Semarang case is that the city experience may not be replicable as interactions and participations are very dynamic and are likely influenced by specific local settings. Semarang might be a particular case as the city has the 'luxury' to be a part of a global network that provides more opportunities for capacity improvement, funding support, and innovative water solutions. The trajectories of each city may differ, yet the Semarang case shows promising results for the promotion of adaptive water governance.

7 Conclusions

This paper showcases engagement and interactions among different types of stakeholders in water management in the city of Semarang. Several trajectories have helped the City find the most suitable governance mechanism to improve water management practices through various initiatives with multiple deliverables. Accordingly, multiple stakeholders have been engaged for different purposes, indicating that Semarang has succeeded, at a certain level, in mobilizing resources to deal with various water-related problems. Many scholars, such as Pahl-Wostl (2020) and Kooiman (2003), emphasized the importance of stakeholder involvement supported by a proportional hierarchical system in the decision-making process to indicate shared responsibilities among different layers of government for decent and proper water governance. SNA illustrates the established hierarchy through emerging interactions. Indeed, rules and regulations will not sufficiently mediate the decentralization of roles and responsibilities without proper capacity of all institution involved.

A transformation in the water management in Semarang has taken place, in which the system is likely adaptive and able to accommodate the role of different government institutions according to respective authority. The City has succeeded in creating an enabling environment to encourage active involvement from various types of stakeholders. However, based on its experience, disparate capacity among different layers of government/stakeholders may hinder the need to establish a better water governance mechanism. Thus, the National Government and International Organizations, play a strong and dominant role behind the City's success in promoting different measures to deal with water-related issues.

Eventually, current emerging challenges in water management in Semarang are relevant to the City's capability to implement adaptive water governance, particularly to further mobilize its own resources and gradually remove its dependency on the National Government and International Agency. There should be concerted efforts to decentralize governmental/stakeholder's capacity and to empower local stakeholders, for the purpose of creating innovative solutions to water-related issues at ground level.

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Declarations

Conflicts of Interest The authors declare no conflict of interest.

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