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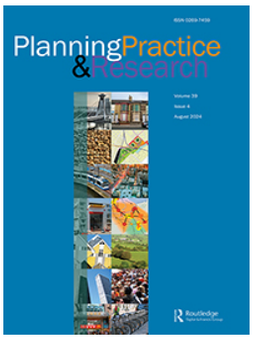

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Adapting a systems perspective for sectoral coordination: approaching flood resilience in Houston and Accra

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ABSTRACT

Increasing resilience to flooding is a complex process that requires horizontal and vertical coordination between institutions in policy making and implementation. This paper explores the effect of institutional coordination on managing flood risk in two cities plagued by flooding. Our results show that efforts on building urban flood resilience can be undermined by lack of proper coordination between urban development, water management and land use planning. We find that this complexity is magnified by the emergence of the concept of resilience as an urban development goal that is increasingly pursued by various authorities, but that is inherently contested in practice.

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Flood resilience; systems approach; coordination; Houston; Accra

1. Introduction

Institutional coordination that facilitates action and collaboration has been a key component of the United Nations Development Plan following the 2030 Agenda for Sustainable Development (UNDP, 2017). As part of this Agenda, a collection of interlinked objectives are designed, also known as the Sustainable Development Goals (SDGs), and new institutional frameworks for countries are encouraged with the intention to integrate national and subnational policies across sectors. While this agenda references the growing attention to complexity and interdependence in city and regional systems (see Davoudi *et al.*, 2012; Tainter & Taylor, 2014), it touches upon academic debates that discuss the importance of the multiple interactions occurring at multiple interacting scales and how they impact on the spatio-temporality of people's everyday activities (Beilin & Wilkinson, 2015). Making sense of these multiple interactions is not only crucial for developing new institutional frameworks but also for enhancing a planning research perspective in relation to understating complexity in a period of uncertainties (Weick, 2001; Hutter & Kuhlicke, 2013; O'Hare & White, 2013).

The recognition that the challenges that cities experience are complex has stimulated discussions on the ways in which systems approaches can be applied to understand the interdependencies within cities (van Bueren *et al.*, 2012). The systems approach provides a holistic perspective within which there is a focus on relationships between the elements

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and constituents of systems (Cumming, 2011; Cumming & Collier, 2005; McLoughlin, 1969; Senge, 1990). It can provide an integrated framework for cities to cope with temporal shocks towards transformation to have lasting impacts. It examines the interaction of disparate sectoral approaches of managing common resources (Ostrom, 2009). However, despite the widely recognized need for approaching cities as systems, it has been argued that the institutional set-up of planning does not take a holistic cross-sectoral approach, especially in the context of water management (Romano & Akhmouch, 2019). Traditional public administration tends to be structured along sectoral lines, splitting up responsibilities for policy, development and management of different urban needs, such as economy and housing, and different services and amenities, such as water management, drinking water supply and sanitation, energy provision, transport and waste management (Freire & Stren, 2001).

Today, this compartmentalisation of institutions has resulted in multi-layered, sectoral networks of public and private stakeholders and third sector, non-governmental organisations. They have established modes of horizontal and vertical coordination for the formulation and delivery of the specific policy goals and ambitions, involving relevant stakeholders at other geographical scales, such as at regional and district level. Our main assumption is that these webs of institutionalised, networked relationships strongly influence urban systems' performance, and organisational change of institutions is thus key to changing urban outcomes. A systems approach to urban development and management concentrates on the crossovers and interactions between sectors and government levels at a practical level. In this paper, we explore how institutional coordination is capable of inducing system change via coping, adapting and transforming. We conduct this exploration by focusing on a specific system property, e.g. resilience, and apply this to an urgent planning problem: urban flooding. A systems perspective on flood resilience explicitly helps to identify a need for institutional changes between sectors and administrative levels, in contrast to traditional planning for regional and urban water management, which have generally been dominated by sectoral, engineering-driven concerns and stakeholders. In addition, attempts for coordination should be identifiable in terms of institutional collaboration and should be identifiable in terms of physical change of the built environment.

2. Towards assessment of flood resilience of urban systems

Understanding systems is a challenge in itself as cause-and-effect relationships within defined boundaries are intractable and hence make it difficult to know where to intervene and how interventions would work out in practice. In the literature, understanding systems has been conceptualised to understand how system components can exert influence over one another as well as outcomes. The socio-ecological systems explore interconnections between human and natural systems and how the system dynamics can be analysed through actors, institutions, cultures and economies (Folke, 2006). The political-ecological systems refer to the ways national and global politics interact with people and ecosystem services (Lawhon & Murphy, 2012; M'Gonigle, 1999; Peterson, 2000). They explain the interaction between the political decision-making and how people adopt their behaviour to prepare for a future dependent on ecological dynamics. The socio-

technical systems address the complex relationships between people and technology and how the social aspects of society and technical aspects of organisational structures or processes come together (Geels, 2010; Hudson & Marvin, 2010; Fuenfschilling & Truffer, 2016). The common message of all these systems approaches is that to be able to understand change within systems, we need to understand how ecological, technological, political and social components of a system work and interact with each other (Cumming, 2011).

An essential part of literature that complements the discussions above derives from the concept of resilience (Gunderson, 2000). In the 1960s, the concept of resilience emerged in the field of ecology, later being applied in different scientific traditions (Davoudi *et al.*, 2012). A resilience approach implies an interdependency between social and ecological systems (Nelson *et al.*, 2007). In this approach, some scholars have refered to 'engineering resilience' to talk about a system's ability to return to a state of balance (see Holling, 1973), while others refer to 'ecological resilience' to discuss a system's ability to absorb changes (Gunderson, 2000). The main difference amongst these two approaches lies within the way they react to changes as the latter approach rejects the existence of a single state of balance and acknowledges possibilities of change (Davoudi *et al.*, 2012). In this way, cities and their system components can be investigated through a period of change in space and time across multiple levels (Davoudi *et al.*, 2012).

Theories of system change show that there are several types of change. In general, systems can cope, adapt or transform (Nelson *et al.*, 2007; Redman, 2014). In relation to the built environment and the use of space, systems are increasingly challenged by external shocks (e.g. storms, extreme rain and earth quakes) and continued stress (e.g. resulting from continued urbanisation), which require systems to change (Beilin & Wilkinson, 2015). A systems approach, consisting of an integrated planning towards urban flood resilience, can move the capacity of cities from coping, which is overcoming shocks on a temporary basis, towards adaptation, that is going beyond coping towards transformative effects that have lasting impacts (Table 1). Institutional learning is an essential component of this transformation as institutions integrate sustainability discourses in their values and approaches, and they can go under a necessary reorganisation to integrate policy and practice in the long term (Connor & Dovers, 2004; Steele, 2011). An integrated approach recognizes the interdependencies within urban and regional systems and calls for systemic solutions and gives rise to reshaping of the institutions needed for making such changes.

In this paper, based on two cases of urban systems that have been challenged by flooding, we explore whether institutional efforts towards increasing flood resilience

Table 1. Assessment of flood resilience of urban system.

	Learning by institutions	Change in the built environment
Coping	Institutions remain focused on *sectorally implementing mandates, no improved coordination on long-term resilience efforts*	*Mere recovery* of what has been lost; not 'building back better'
Adapting	Institutions demonstrate some proof of learning: i.e. *adapting and streamlining policies, coordination*	*Limited change* in the built environment, i.e. installing equipment for early warning
Transforming	Institutions demonstrate strong proof of learning based on their experiences and new information, *modifying standards or norms based on emerging evidence rather the status quo*	Considerable change in the built environment that reduces vulnerability to flooding, i.e. *resettlement, improved infrastructures, flood proofing vulnerable construction*

have impacted on institutional learning and the changes in coping, adapting and transforming. Whereas changes in physical structures may be easier to detect by comparing geographical situations before and after interventions, institutional change is more challenging to identify. Institutional learning is often used as an indicator for institutional change during which stakeholders or actors are able to reflect on their practice to address change (Johnson, 1992). In other words, institutional change is considered a result of learning and is in this paper approximated by learning by stakeholders (e.g. instrumental change), efforts to adapt (change of aim, showing awareness of relation to other policies, levels, sectors) and efforts to transform (change of the institution itself, showing awareness of the cross-over coordination needed and the need for shared norms and procedures, reflecting awareness of the changed system boundaries).

3. Method

In our paper, we explore the extent to which institutional coordination impacts a city's efforts to build resilience to flooding, using two case studies: Houston, Texas, US, and Accra, Ghana. Both cities have been subject to a number of flooding events, particularly following the Hurricane Harvey in 2017 in Houston, and following heavy continuous rainfall in 2015 in Accra. In each city, efforts towards flood risk management are heavily reliant on public spending and linked to new growth paths and long-term sustainability goals. Each city has specific general governance characteristics that can be of relevance and complementary to flood resilience. In Houston, flood risk reduction exists in terms of multilevel governance, while in Accra, this is characterised by a mixture of formal and informal institutions.

In our approach, we follow Jennifer Robinson's critique of the comparative method (Robinson, 2002). She argues that this method is a way of acknowledging the diversity of how global processes can yield different outcomes when confronted with a series of actors, rules and local conditions. Robinson refers to this method as going beyond a single case study example and enabling richer conversations in comparative case studies (McFarlane & Robinson, 2012).

The evidence base of our paper has been gathered using qualitative methods, in the form of semi-structured interviews with urban planners, policy makers and those affected as a result of flooding in both cities. In Houston, this involves an extensive, multidisciplinary fieldwork of academic staff and students from the fields of spatial planning, political studies, policy analysis, hydrology, urban design and hydraulic engineering. In total, 11 semi-structured interviews were conducted. In Accra, this was based on 20 semi-structured interviews with public, private and non-governmental institutions. The empirical data were collected between 2012 and 2018 in Houston and in 2018 in Accra. The details of those institutions were selected at different spatial scales and listed in Appendix A. The interviews were analysed via deductive content analysis for testing our previous knowledge of flood resilience and guided by semi-structured analysis (Jeladze & Pata, 2018).

4. Understanding flooding in Houston and Accra

Being the largest city in Texas and the fourth largest in the US, Houston is rapidly expanding. The city is considered low-density and car-dependent with single-purpose land use patterns and covered with hard surfaces (Sebastian *et al.*, 2017). The city has adopted a free market economic and urban development policy in which a traditional-free market idea is embedded without any zoning idea (Qian, 2011). The city's economic growth is powered by the petrochemical industry and medical services: Houston hosts both the biggest petrochemical harbour and the largest complex of hospitals (Texas Medical Center) in the US. Frantic re-building activities within the existing urban fabric and expansion of the suburban fringe go hand in hand. Being referred to as 'America's Flood Capital' (Erdman, 2016; Comes *et al.*, 2017), Houston has little topographic relief, and the capacity of its wide and shallow floodplains to store and release floodwater in the 22 bayous and creeks is limited by the addition of impervious surfaces. In recent decades, the region of Greater Houston suffered from a series of hurricanes that were caused by a combination of severe rainfall and overflow (compound flooding).

Accra, the capital city of Ghana in West Africa, is located in an urbanized delta, like the majority of global or first-tier cities. Since the early 1930s, flooding has been a major issue in Accra (Rain *et al.*, 2011). As with many large urban conglomerations, the city faces flood risks due to excessive rainfall and impervious surfaces that reduce permeability of the soil and exacerbate runoff, leading to higher and quicker discharges of the water system.[1] On June 3, 2015, Accra experienced an unprecedented flash flood which resulted in loss of lives, the displacement of people and loss of property. The flooding caused a petrol station to explode, further increasing the death toll.[2]

Complicating matters further is the rapid urbanisation and the ownership status of land coupled with weak planning institutions (see Korah *et al.*, 2017; Berke *et al.*, 2019). In Ghana, the growth of cities and towns is influenced strongly by the behavior of customary landholders (Yeboah & Shaw, 2013; Korah *et al.*, 2017). The Accra Metropolitan Assembly (AMA) constitutes one of the 23 Municipal Assemblies that fall within the Greater Accra Metropolitan Area (GAMA) and it contains the majority of floodable areas and represents the greatest urgency in terms of urban flood resilience (World Bank, 2019). Figure 1 shows that the majority of AMA's informal settlements and/or slums are located within the flood hazard zones, with a particular emphasis on the high risk (below 17-meter elevation) area. More than half of AMA's geographic jurisdiction is located in flood hazard zones and the high-risk flood hazard area contains virtually *all* the registered land uses: high-, middle- and low-income residential areas, but also sites where the main land use is commercial or industrial (Brand *et al.*, 2019a, 2019b).

Despite the lack of zoning, the local government in Houston has been proactive in terms of restructuring urban development (Qian, 2011). For instance, in order to prevent flood risk, local government has collaborated with both federal and state agencies via a series of governmental programmes and regulations (Sebastian *et al.*, 2017). In addition to multiple federal, state and local agencies, there have been other organsiations such as the US Army Corps of Engineers (USACE) that support construction, maintenance and operation of large infrastructures, like the Addicks and Barker's Reservoirs north-east of Houston that were designed to catch storm water runoff before it runs downstream into the city. Similarly, Harris County Flood Control District (HCFCD), an independent

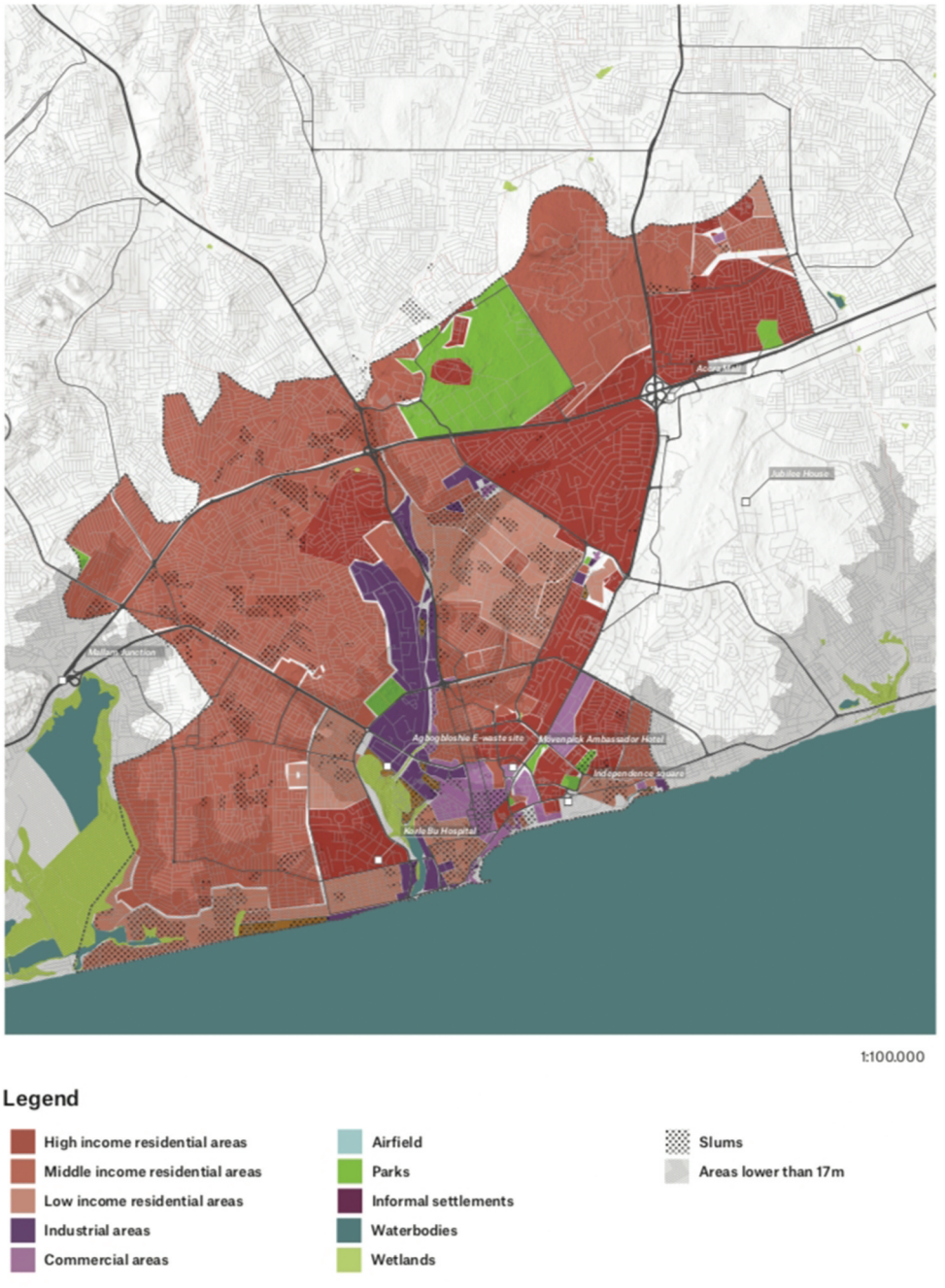

Figure 1. Land use within AMA's jurisdictional boundaries (added with informal settlements/and or slums. (Source: Authors).

district dedicated to flood alleviation within the boundaries of Harris County, manages the channelization of bayous since the region's first catastrophic flood in 1973. In Greater Houston, flood losses are mitigated by compulsory flood insurance (NFIP) in the administrative 100-year flood plain, supported by evacuation assistance provided by the Office of Emergency Management or the Houston TranStar agency (Brand *et al.*, 2019a): 'both are public services related to the Federal Emergency Management Agency (FEMA), a federal-level institution: FEMA defines the height of location of mandatory flood insurance, and assists local emergency managers in their recovery and response efforts after the US president has signed a federal disaster declaration'[3] (Brand *et al.*, 2019a, p. 7). Emergency management is performed by the specific departments at the state, county and city-level, accompanied by multiple private and NGO organizations (Sebastian *et al.*, 2017). To illustrate the risk of flooding, the location of the 100-year floodplain has been provided for the public (Blackburn & Bedient, 2018), shown in Figure 2.[4]

In Accra, a series of actors whose work relates to urban flood resilience operating at different levels ranging from community to city, ministerial/sectoral, and national-level. The Ministry of Environment, Science, Technology and Innovation (MESTI), the Ministry of Sanitation and Water Resources, the Ministry of Works and Housing are the key players at the national level, as well as the National Disaster Management Organisation (NADMO) which is part of the Ministry of Interior. The Department of Urban Roads is in charge of road and drainage construction and development, and the Physical Planning Department is in charge of land use planning, physical development and control.

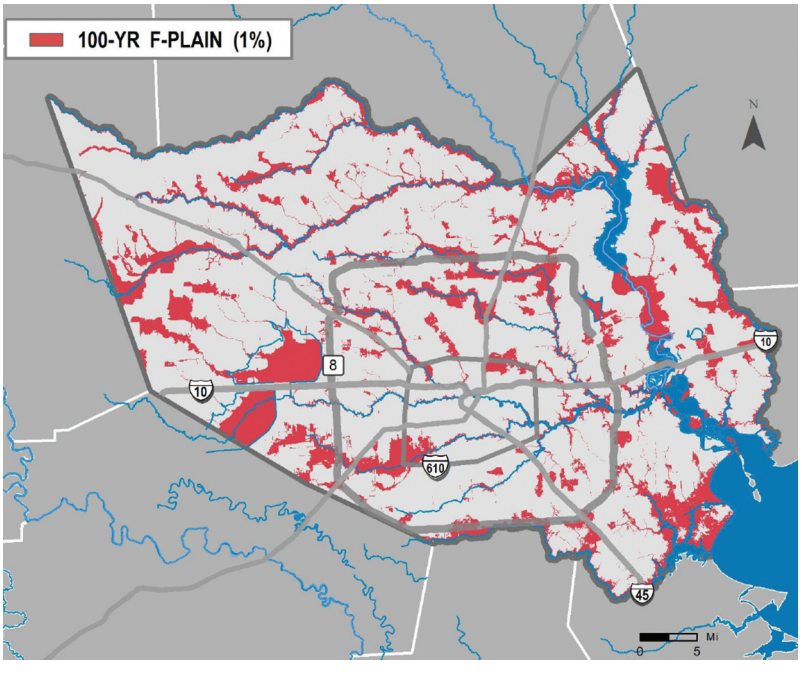

Figure 2. The current 100-year Floodplain map of Harris County. (Source: Blackburn & Bedient, 2018, p. 8).

Beyond the national government, supra-local grassroot organizations operate without an official mandate but are key in shaping the flood resilience-oriented behaviours of institutions, as are international donors such as the United Nations (UN), the Danish International Development Agency (DANIDA) and the Rockefeller Foundation's 100 Resilient Cities network, which in partnership with AMA appoints a Chief Resilience Officer to increase resilience-building efforts. Last but not least, traditional authorities (most notably chiefs) have an important role in the institutional landscape in Accra. For example, in terms of coordinating and streamlining efforts in the built environment, the (statutory) Spatial Planning Committee has been established as a key platform. The committee, apart from the city's Mayor as chair and the Director of Physical Planning Department as secretary, has seats for customary landowners. This is challenging for a city that has about six different major paramount traditional chiefs and several sub-chiefs operating at different levels of land ownership and administration. As a result, recent rapid urban growth, combined with institutional crowdedness, political interference in planning practices and complex land tenure system have impacted on the growth and development of Accra as has been also illustrated in other Ghanaian cities (see Cobbinah & Korah, 2015; Fuseini & Kemp, 2015).

5. Case examination and discussion

5.1. Coping

Based on the analysis of our empirical data, we have found out that each city demonstrates partial responses to flood resilience. In terms of *coping*, in Houston, institutions have predominantly pursued urban resilience efforts that are within their mandates. Both FEMA and the State of Texas support the buyout (purchase of flood-damaged properties at pre-flood values) of properties with repetitive losses that are part of the NFIP. Two months after Harvey, Harris County had received over 3,000 requests for buyouts, and 'in February HCFCD notified the state it would request $180 million for home buyouts' (McCormick, 2018, p. 29). FEMA promised more financial support for Houston, in addition to funds for individual recovery assistance and the clearance of flood debris.

The Texas Legislature is the law-making body of the state and convenes every other year. It has been asked to consider a range of proposals to increase flood resilience, such as (1) increasing local governments' capacity to control urban development, (2) changing the operational regulations for reservoirs and (3) mandating disclosure of flood risk (McCormick, 2018). Despite convening twice since Hurricane Harvey, little evidence of progress on these issues can be found. The exception is the establishment of the Gulf Coast Protection District, a special governmental entity created to build flood control and surge protection needs for coastal infrastructure and coastal communities.[5]

Officials in Houston's Harris County planned to finance flood control projects, while capital improvement projects were executed by HCFCD to renovate channels along the county's major swamps (McCormick, 2018). USACE is pressed to step up with the long-overdue maintenance of the existing reservoirs. According to McCormick (2018, p. 27): 'a system-wide upgrade to protect the region fully from a 100-year storm would require estimated 52,000 additional detention acres, but the cost of acquiring that land exceeds HCFCD's annual budget several times over'. It is widely anticipated that none of these

efforts will be enough to recover all losses or make a substantial plan to build flood resilience (Blackburn & Bedient, 2018).

In Accra, coordination problems have been more prominent following a new government in 2017 seen with a series of vertical and horizontal fragmentation and disorganisation of flood resilience efforts. Several entities, including the Ministry of Works and Housing, the Water Resources Commission and the Metropolitan Department of Urban Roads, reported that (some of) their previous responsibilities regarding flood resilience had been transferred to other institutions. For instance, the Water Directorate was moved from the Ministry of Works and Housing to the Ministry of Sanitation and Water Resources. Again, aspects of drain maintenance have been transferred to the Water Resources and Sanitation Ministry. This is because the Ministry used to be known as the Ministry of Water Resources, Works and Housing (MWRWH), until it was split into two ministries (Works and Housing; Water Resources and Sanitation). The same issue applies in drainage design, construction and management/maintenance. Division of responsibilities for drainage management, including operation and maintenance, is spread across Hydrological Services Department (HSD), the Department of Urban Roads (DUR) and the Works Departments of the MMDAs, resulting in weak coordination, planning and enforcement (City Strength Diagnostic, 2017). Such vertical and horizontal fragmentation can lead to inconsistency: misalignment of primary, secondary and tertiary drains is a known driver of flooding in Accra and was mentioned by multiple respondents.

5.2. Adapting

In terms of *adapting*, in Houston, the City of Houston and Harris County have both been pushing for adaptation of policy – with the county also pushing for less non-committal forms of cooperation. As a trend, 'officials are pivoting to stricter regulations on building new homes in floodplains, and considering a wide range of flood mitigation strategies, infrastructure needs, and development changes. These include creating new flood barriers and detention facilities, rehabilitating urban drainage systems, buying out more homes in flood-prone areas, and creating green infrastructure' (McCormick, 2018, p. 21). Houston regional officials may also use some of the region's 200 golf courses as detention basins due to the low-cost redevelopment. Such plans, as of February 2022, still have to be finalized. Harris County has extended its flood management regulations to the 500-year flood plain after Hurricane Harvey, thus hoping to better capture the flood hazard area. Moreover, as early as October 2017, Harris County officials established new strategies and regulations for regional flood control: 'The plan also proposed buying out all homes that are located in the 100-year floodplain or that have flooded repeatedly, a massive expansion of an existing county buyout program. The ambitious plan relies heavily on cooperation by other institutions' (McCormick, 2018, p. 25). So far, buyouts have predominantly proceeded in Meyerland, a residential area notorious for its repetitive flooding. After the disastrous evacuation in response to Hurricane Rita, 'evacuation has become more organized based on zipcode areas, evacuation routes and contra-flow. Houston TranStar operates in the entire metropolitan region, but struggles to warn and evacuate a growing population using a limited regional and national infrastructure network' (Brand *et al.*, 2019a, p. 7).

In Accra, there have been attempts to streamline policies and coordination within the institutional structure of Accra. An example is the creation of the new Ministry for Inner-Cities and Zongo Development (MICZD), with its cross-sectoral and site-specific mandate. The new ministry was found to be a key stakeholder and the main local counterpart – replacing the Ministry of Environment, Science, Technology and Innovation as the cross-sectoral coordinator of the flood resilience efforts. The ministry was created in response to calls from a number of urban poor groups as well as Zongo communities in Ghanaian cities and towns for fair urban citizenship and equitable distribution of infrastructure.[6] It was revealed during the interview with the People's Dialogue for Human Settlement that the creation of the Ministry might have resulted from the numerous engagements between the urban poor and the state. Hence, the involvement and leadership role being played by the Inner Cities and Zongo Development Ministry can be seen as a shift in mandate towards building flood resilience. Similarly, National Disaster Management Organisation (NADMO) also expanded its efforts to include early warning systems, most notably in collaboration with the UNDP-funded Community Resilience through Early Warning project. The aspirations of NADMO align with those of the UN in general, an institution that pushes for better preparation for natural hazards with a focus on marginalized groups.

5.3. Transforming

In terms of *transforming*, the Houston region is 'reconsidering its "build and let build" attitude. [Hurricane] Harvey has occasioned a rethink – though not a complete redo – regarding urban planning and development' (McCormick, 2018, p. 21). The City of Houston is developing a Resilience-plan and a Flood Mitigation Plan, the first with support of the Rockefeller Foundation's 100 Resilient Cities Program. A Resilience Officer was appointed in 2016, a council member with a background in water management who was in charge of the city's urban redevelopment and drainage taskforce. The taskforce's recommended new detention rules are under consideration (Blackburn, 2017). A chief recovery officer, a former employee of a petrochemical company, was appointed shortly after Hurricane Harvey and is expected to expedite disaster recovery and prepare the city for new storms. The resilience and recovery officers are tasked to report to the mayor so that policy recommendations could be carried out for a vote on the elected council. The county's elected officials are in charge of setting up new rules and regulations for unincorporated areas. For example, Post-Harvey, all new buildings on unincorporated land should be raised above the flood plain in Harris County (McCormick, 2018). In terms of new buildings, 'the first finished floor of new construction must be at least as high as the 500-year flood level. New houses in the floodplain must be built on piers and cannot be used to fill dirt to elevate construction' (ibid., p. 26). The regulations, however, apply only in unincorporated areas of the county. Houston and the other 23 municipalities make their own regulations and have their own criteria for drainage systems (McCormick, 2018). An unexpected response to Hurricane Harvey is the adoption of a preferred alternative for coastal flood protection by USACE, with the support of Texas State decision-makers. The much-contested proposal to mitigate storm surge has been in the making since Hurricane Ike in 2008. US Congress now has another

10 years to consider it. The proposal, however, would not mitigate a severe rainfall-event like that experienced during Hurricane Harvey. A key obstacle in the building of Houston's flood resilience is a structural form of cooperation and streamlining in the regional scale. According to McCormick (2018), HCFCD, among others, has asked for a more strategic argument but the City's Resilience Officer has stated that he would not support a regional flood mitigation authority to avoid overlaps: 'Rather than creating an overlapping entity, we need intergovernmental agreements' (ibid., p. 25).

In Accra, the Land Use and Spatial Planning Act (2016) is a step towards transforming urban resilience efforts in flood management in Accra. The Act sets up a structure for the establishment of a Spatial Planning Committee[7], which is made up of the heads of all decentralized departments, chaired by the Mayor, with the director of Physical Planning Department as its secretary. In projects that involve a number of ministries, departments and agencies, technical committees are established to ensure the coordination of efforts. An example of this is the formation of a technical committee for the Greater Accra Resilient and Integrated Development (GARID) project.[8] Nevertheless, legal instruments that facilitate inter-jurisdictional collaboration have not yet been implemented, and little was experienced during the City Strength Diagnostic exercise in 2017. Officials from the various MMDAs that participated in the City Strength Diagnostic have created a social media platform. However, many of these officials have been transferred from their duty stations, and therefore may no longer have a direct interest in what happens on the subject of Flood Resilience in the Greater Metropolitan Area of Accra.

Another transformative effort can be seen in the sanitation sector. Efforts in urban sanitation (including the design and allocation of facilities, (re)alignment of drains and waste collection and transfer) have recently been streamlined via a Technical Working Committee that meets regularly and also has seats for donors. Different respondents mentioned the Committee independently, and in a positive manner. Next to the integration of different subsectors in water and sanitation, WAPCOS is also creating an Integrated Urban Sanitation Masterplan (supported by World Bank funding) that should coordinate and harmonize the efforts of many actors. Interviews revealed that the sector has been able to divert funding towards remedial actions of drainage hotspots after the 2015 flood, oftentimes through guidance from the World Bank.

5.4. Institutional complexity in urban flood resilience

Our results from both Houston and Accra are consistent with existing evidence that suggests coordinating flood risk management, urban development, urban water management and land use planning may generate increased institutional complexity surrounding urban flood resilience (Faude, 2020). We find that this complexity is magnified by the emergence of resilience as an urban development goal that is increasingly pursued by various authorities. However, as O'Hare and White (2013, p. 278) argue resilience is 'inherently contested and in practice is frequently subject to conflict. Many tensions emerge for societal and institutional bodies involved in shaping urban environments as well as for communities subjected to these transformations'. Given the sector-based management of the built environment and the flood risks it faces, the pursuit of urban resilience implies that many actors are subject to the creation of urban flood risk and its future mitigation and adaptation at the same

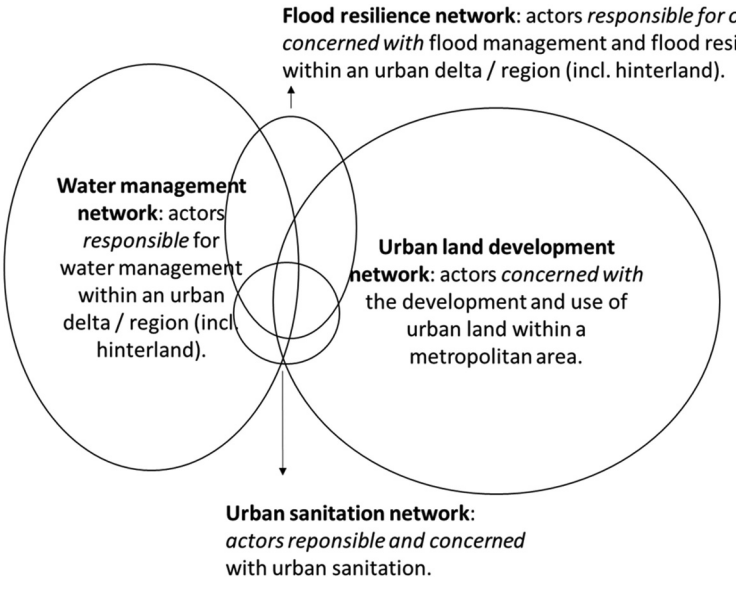

Figure 3. An attempt of a schematic overview of actor networks involved in urban flood resilience.

time. This requires actors to act against their own short-term interests, while it is uncertain how future effects of different interventions work out for those involved. In countries with a weak state, the governance of these processes, which relies on a certain level of institutional capacity and institutional trust, is particularly challenging, and often institutional capacity building is considered to be a binding constraint (Potter & Brough, 2004).

Figure 3 attempts to conceptualise the institutional complexity of urban flood resilience, by showing the different kinds of actor networks generally involved.[9] As illustrated, the urban and water management systems are managed by different sectors that contain a multitude of institutions with different mandates, tools and resources, which contributes to institutional complexity. Each of the networks operates at multiple scales, administratively and geographically, raising many internal coordination issues, while urban flood resilience raises the need for coordination amongst the different networks involved. This result overlaps with the implementation challenges of flood resilience in decentralised governance (Restemeyer *et al.*, 2019). Adopting a flood resilience approach requires an integrated approach between large-scale infrastructure projects and local efforts. The inclusion of the same actors in multiple networks supports coordination, but overlapping responsibilities and jurisdictions may also lead to institutional crowdedness and conflicting rule regimes, as has also been demonstrated in our case studies. These networks of actors and their inter-relationships are situated in the urban sub-systems and are continuously shaping institutional mandates and decisions. To efficiently target flood resilience, streamlining institutional mandates is essential. Otherwise, the sectoral or siloed approaches result in deeper complexities that may reduce the effectiveness of urban flood resilience efforts. Adapting a system approach enables the researcher to overview a diverse range of actors involved in urban flood resilience and situate where the issues such as the coordination problem, fragmentation and vulnerability emerge.

6. Conclusion

A systems perspective on flood resilience has shown the importance of coordination efforts between institutions across different levels and sectors in the context of the built environment. The focus on institutions within a particular geographical area has highlighted how flood risk management is influenced by the actions of various institutions at multiple levels, operating within and outside their boundaries. The added value of the comparison between Houston and Accra is that even though the governance characteristics of flood resilience differ between two cities, both cities emphasize that a sectoral approach, even vertically integrated, will not suffice by itself. Each case study yields different outcomes when confronted by flooding. Nevertheless, there is a clear need for understanding the whole range of shocks and stresses to which urban systems are exposed to prioritize action, to more justly distribute risks and to prevent inefficient public and private expenditure on solutions that will not work. This requires understanding interconnections between subsystems, framing values and motivations of different actors, defining the scope and the scale of the problem and identifying the drivers, trends, enablers and leverage points to intervene in complex systems, regardless of a geographical location in which two cities that are not commonly put together are compared (Robinson, 2002).

There are some general lessons we can learn from adapting a systems perspective in planning. The first lesson is related to the way we think about interconnections amongst actors and the complexities of the built environment at a practical level. For an integrated project to be successful, failure of one component can result in overall failure of the effort. For example, the upgrading of drainage infrastructure downstream will only work if implementation of the reservoirs upstream is successfully implemented. Similarly, the relocation of communities with residual flood risk will only reduce flood losses if new communities do not resettle the cleared lands (also see World Bank, 2019). The systems thinking enables us to create new ways of thinking and communicating with others.

The second lesson is related to the behavioural change of actors. The majority of our respondents pointed to challenges in the land management sector as it undermines flood resilience efforts. They include issues such as the informal and non-transparent power of certain actors, delays in land title/deed registration, or inadequate adherence to urban land use regulations. This problem has many interdependent components such as a lack of compliance with land use regulations, interference with pursuing mandates, and informal land transactions. To address the challenges of the land sector and consolidate the modest gains made, a better understanding of the forces that keep the land management sector from performing is required, ranging from the operation of the informal land market, to how this affects implementation of land use planning. Nevertheless, the adoption of such a systems perspective by all actors is not a straightforward process, and hence it will take time. Moreover, the spatial fragmentation across horizontal governance as well as global politics leads to 'institutional proliferation' in which the number of institutions operating to manage flood risk management increases complexity (see also Rowan, 2021). As has been illustrated in the last figure, a series of institutions can be identified as a response to increasing flood resilience in both cities but that does not necessarily mean an ideal scenario. Over the last three decades, Accra has almost 10-fold

the number of its municipalities at the local level, which may impact the management of flood resilience from a systems perspective.

The last point is about regards the challenges of distinguishing between the three levels of change when assessing urban flood resilience. Although the current debates on resilience differentiate coping, adapting and transforming as three levels of systems change on a theoretical level, our analysis shows that this could be a difficult task to achieve in practice. The interventions that have been made do not always lead to intended changes. This could be related to the fact that those actors that are involved in coordinating actions perceive flood resilience as meeting performance measures rather than embedding it within the functioning of institutions. Nevertheless, it is important to absorb such efforts within the institutional structure so that they become more integrated and effective. This assumption overlaps with Ostrom's argument that the governance of natural resources needs to evolve towards a more interactive and dynamic understanding of systems at multiple levels (Ostrom, 2009). This research sheds some light on undertaking further research on institutional theoretical analysis in which understanding of how, when and where the principles of flood resilience management are applied, as well as how they interact with various institutions and policies.

At the moment, most of the institutional changes are at the level of coping and adapting rather than transforming. This is also related to the urgency and priority of the political agenda. Although improved coordination has been assumed to reduce complexity, sometimes it can increase the complexity due to the conflicting goals. Moreover, the unwillingness to participate in planning regulations further complicates the operation of the land management sector. Sometimes such unwillingness is firmly rooted in political norms, which tend to increase the vulnerability of urban flood resilience efforts. Instead of avoiding building in the floodplain, 'emphasis is placed on easier-to-achieve activities (e.g. emergency services, public information campaigns, structural protection of in situ development) that avoid property rights issues, do not threaten economic interests, and do not generate political opposition' (Berke *et al.*, 2021, p. 916). A key question is whether the same mechanism will prevent a regional effort to mitigate flood damages. In Texas, political norms prevent land use regulation, while in Ghana, it may have something to do with a population that simply has other priorities such as housing. But in both cases, it results in the unchecked growth of flood risk, with a flood management sector and emergency services sector that is always lagging behind.

Notes

1. Urban conglomerations impact the overall water system in the region, often via over-exploitation of underground water resources and calling for expensive infrastructures to secure water supply by transporting water over large distances, thus affecting the regional water system at a large spatial scale.
2. https://www.theguardian.com/world/2015/jun/05/death-toll-accra-floods-petrol-station-fire
3. FEMA coordinates government-wide disaster relief by 'preparing for, protecting against, responding to, recovering for, and mitigating all hazards. FEMA is also responsible for administering the National Flood Insurance Program (NFIP) and funding Hazard Mitigation Assistance (HMA).

4. For a detailed look at the 100 and 500-year floodplains, the online Flood Education Mapping tool of HCFCD is helpful: https://www.harriscountyfemt.org. The flood plain maps have not been remapped completely since 2001, but are currently updated. Updating the Harris County Flood Plain Maps is a lengthy and costly process that involves both HFCDC and FEMA. In 2021, HCFCD planned to submit the new draft flood plain maps to FEMA by the end of the year. FEMA can subsequently process the maps and issue the Preliminary Flood Insurance Rate Map. These results are expected in the Summer 2022, followed by the updated insurance rates. Source: https://communityimpact.com/houston/lake-houston-humble-kingwood/environment/2021/01/25/harris-countys-preliminary-flood-plain-maps-to-be-released-in-late-2021/, accessed February 28, 2022.
5. https://gov.texas.gov/news/post/governor-abbott-names-temporary-executive-director-and-appoints-six-to-gulf-coast-protection-district-board-of-directors, accessed February 28 2022.
6. Zongo communities represent settlements with immigrants of different ethnic and cultural background. See Sarfoh (1986) for more information.
7. This committee had existed as the Statutory Planning Committee for all MMDAs under an earlier legal regime, The Town Planning Ordinance of 1945, (CAP 84). This has been repealed and replaced with the Land Use and Spatial Planning Act (Act. 925, 2016).
8. The path to enhanced resilience in GAMA therefore requires multi-level, multi-sectoral and interjurisdictional coordination and harmonization of planning and investment interventions among the many actors" (City Strength Diagnostic, 2017).
9. Do note that the actor networks have not been investigated exhaustively.

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Appendix A: List of institutions interviewed in Accra

Institutional Stakeholders/Actors	Mandates, Interests or stakes in flood management
A1) Ministry of Inner Cities and Zongo Development (MoICZD)	Newly created national ministry responsible for slum upgrading, support for urban poor, vulnerable and marginalized people.
A2) Ministry of Sanitation and Water Resources (MoSWR)	Newly created ministry responsible for policy and action on waste management (especially in the cities) and protection of water resources (especially in urban areas).
A3) Ministry of Local Government and Rural Development (MLGRD)	National level institution with oversight responsibility over Metropolitan, Municipal and District Assemblies (MMDAs); the key unit under the MLGRD relevant for the Accra Case Study is the Urban Development Unit of the ministry; they provide policy direction and training on the activities of MMDAs; they have also been involved in a number of the Banks Projects on Urban Environmental Sanitation, flood management and resilience in Accra and other cities in Ghana.
A4) Ministry of Works and Housing	National level institution in charge of water provision, housing and other related institutional infrastructure/government estate; they are in charge of housing policy, management of public housing etc.
A5) National Disaster Management Organization (NADMO)	National level organization but they also have units/offices at the local government level; their responsibilities include: risk management, disaster prevention; emergency response; post-disaster rehabilitation; prepare national disaster management plan; community education and sensitization on flooding; co-ordinate flood management activities and institutions; evacuation, provision of relief items, rehabilitation, and reconstruction after flood disasters
A6) Physical Planning Department (previously known as Town and Country Planning Department)	Decentralized departments under the MMDAs in charge of land use planning, physical development and control of GAMA. They are in charge of land use planning and regulation to prevent flood along river bodies; supporting NADMO through the provision of safe havens for flood victims; and public education and sensitization in flood prone communities
A7) Department of Urban Roads (Accra Metropolitan Office)	Decentralized department under the AMA in charge of road and drainage construction and development; they are in charge of construction of primary, storm and secondary drains; periodic maintenance of primary and storm drains; and drainage and channel improvement
A8) Ministry of Lands and Natural Resources	National level ministry for the administration and management of land; the relevant agencies under the Ministry include: Lands Commission – for the management and administration of Urban Land including the Greater Accra Metropolitan Area (GAMA); Geological Survey Department – Producing topographical maps etc; Office of the Administrator of Stool Lands (O.A.S.L) – For the management of customary lands in urban areas. The relevance of the Ministry is based on the involvement of the above institutions.
A9) Land Use and Spatial Planning Authority (LUSPA)	The mandate of the Authority is derived from the following legal instruments. They include: Land Use and Spatial Planning Act. (ACT 925) 2016; Town and Country Planning Ordinance, 1945 (Cap 84); Local Government Act, 1993 (Act 462); Local Government Service Act, 2003(Act 656); Local Government Establishment Act, 2003(Act 656); National Development Planning Commission Act, 1994 (Act 479); National Development Planning (Systems) Act, 1994 (Act 480); National Building Regulation, 1996 (L.I. 1630); Local Government (Department of Assemblies) (Commencement) Instrument 2009 (L.I. 1961)
A10) Ministry of Environment, Science, Technology and Innovation (MESTI)	National level institution and mother ministry of relevant institutions such as: Land Use and Spatial Planning Authority (LUSPA) and Environmental Protection Agency (EPA)

(*Continued*)

(Continued).

A11) Department of Works	Decentralized department under the AMA in charge of monitor and evaluate the implementation of policies, plans and programmes for the sustainable management of public landed properties, drainage and coastal protection works, operational hydrology
A12) United Nations (Accra)	They work in partnership with the Government and people of Ghana for sustainable economic and social development, peace, and human rights http://gh.one.un.org/content/unct/ghana/en/home/about.html
A13) Lands Commission	The Lands Commission is established by Article 258 of the 1992 Constitution and the Lands Commission Act, 2008 (Act 767). The functions of the Commission can be found on https://www.lc.gov.gh/about-us/
A14) Ghana Federation of Urban Poor	Ghana Federation of the Urban Poor (GHAFUP) is a network of community savings groups in informal settlements and poor communities in 8 regions in Ghana, including four of Ghana's five largest urban areas: Accra, Kumasi, Ashaiman, and Takoradi. GHAFUP is helping communities to make improvements through daily savings, local and international exchanges, community settlement profiles, and negotiating and building partnerships with local governments.
A15) People's Dialogue for Human Settlements	People's Dialogue on Human Settlements (PD) is a Ghanaian development organization committed to building collaborative partnerships between organized communities and (especially) local governments in contexts of deep urban poverty, landlessness, joblessness, and homelessness. Together with GHAFUP, they are demonstrating community-led solutions to address urban poverty in Ghana and help communities to improve living conditions.
A16) West African Gas Pipeline Company (WAPCOS)	WAPCOS is a consultancy company. They have a strong global presence in the field of Water, Power and Infrastructure sectors http://www.wapcos.gov.in/overview.aspx
A17) Accra Metro Roads Department	Decentralized department under the AMA in charge of road and drainage construction and development. They are in charge of the construction of primary, storm and secondary drains; periodic maintenance of primary and storm drains; drainage and channel improvement
A18) Ghana Water Company	National level institution. They are in charge of meeting increasing demand for better service delivery through efficient management of potable water and customer management in urban areas of Accra.
A19) Water Resources Commission	National level institution. They are in charge of the management of river basins/catchment; managing and monitoring river bodies and their buffer/catchments, e.g. Densu and Weija dam on the western part of Accra as well as other catchments on the eastern side of Accra.

List of institutions interviewed in Houston

Institutional Stakeholders/Actors	Mandates, Interests or stakes in flood management
H1) City of Galveston (mayor)	Municipality of Galveston, a local institution ('locality' in the form of a general purpose-government) with complex land management responsibilities that comprise the pursuit of local economic, social and environmental development of the island-city of Galveston
H2) City of Houston (City's Resilience Officer)	Senior-level advisor to the Mayor that ensures resilience is a cornerstone of program planning and execution within City departments and functions as well as with partners across the region. While the CRO will be directly accountable to and report directly to the City of Houston's Mayor, they will be required to maintain strong relationships and regularly dialogue with key public and private stakeholders to ensure their needs and resources are fully integrated into the strategy. The CRO will also work with Departmental Resilience Officers in each City Department to implement Resilient Houston and other resilience building efforts
H3) Galveston Park Board	The Park Board of Trustees of the City of Galveston, is a special district (special purpose government) created by the Texas Legislature in 1962 for the purpose of directing all tourism efforts for Galveston. The Park Board of Trustees' mission is to promote Galveston Island, its natural resources, attractions, and heritage; to attract visitors to Galveston Island; and to assure that Galveston's assets, for which the Board of Trustees is responsible, provide visitors and residents with exemplary experiences in an environment that is safe, clean, accessible, fun, and environmentally sensitive.
H4) Galveston Economic Development Partnership (GEDP)	A private-public partnership focused on the expansion of Galveston's employment and tax bases; supports existing and new businesses by providing the infrastructure to be globally competitive while creating an atmosphere that promotes knowledgeable citizens while preserving the aesthetic and environmental quality of life
H5) Texas General Land Office (TGLO)	State agency of the U.S. state of Texas, responsible for managing lands and mineral rights properties that are owned by the state. The TGLO also manages and contributes to the state's Permanent School Fund.
H6) Harris County Flood Control District (HCFCD)	A special district (special purpose government agency) that was established to reduce the effects of flooding in Harris County, Texas, United States. The flood control district has its headquarters in Houston.
H7) US Army Corps of Engineering (USACE)	An engineer formation of the United States Army, that has three primary mission areas: Engineer Regiment, military construction, and civil works. The USACE is primarily focused on large-scale infrastructures, and is organized in geographic districts. The Houston-region falls under Galveston District.
H8) Office of Emergency Management (OEMs)	An agency at the local, tribal, state, national or international level that holds responsibility for comprehensively planning for and responding to and recovering from all manner of disasters, whether man-made or natural. An OEM may also be requested to provide consequence management for large special events such as major gatherings, visiting dignitaries
H9) Houston Galveston Area Council (H-GAC)	The Houston-Galveston Area Council (H-GAC) is a regional organization through which local governments consider issues and cooperate in solving area wide problems. Through H-GAC, local governments also initiate efforts in anticipating and preventing problems, saving public funds.