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Keeping Feet Dry: Rotterdam's Experience in Flood Risk and Resilience Building

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Abstract

Rotterdam City in the South of Holland is one of the most vibrant cities you will find in the Netherlands. The city has gone through a transformation from the time it was bombed in the 1940s up to the time that a part of the city was flooded in 1953. Through extensive rebuilding and the Delta Plan project, the city has been well protected against any flooding disaster that may come. However, how resilient really is Rotterdam? Through in-depth interviews of key stakeholders in the City of Rotterdam, the study investigates the collective engagement in the city and how this has helped shape Rotterdam's position in urban resilience. The study used the Collective Engagement Urban Resilience Framework as a framework to understand how disaster prone cities transform itself to become disaster resilient.

Keywords: resilient city, flooding, collective engagement, urban resilience, Rotterdam

1. Introduction

The City of Rotterdam has undergone several city development plans since World War II. After the bombing of Rotterdam in 1940, the city drew up a reconstruction plan which focused on the major infrastructures within the center. However, it was only after the Germans left in 1945 did the reconstruction work finally took off. In 1946, Cornelius Van Traa drew up the Basic Scheme for the Reconstruction of the City of Rotterdam, most commonly referred to as the Basic Plan [1]. Much of the earlier efforts were focused on the reconstruction of the port which serves as the major economic backbone of Rotterdam.

In February 1, 1953, a huge flooding disaster called the Great North Sea flood hit the Netherlands, Belgium and the United Kingdom. The Great North Sea flood inundated 160,000 ha of polderland and left a total of 1835 dead ([2], p. 740) in the South of Holland. The flooding disaster led to the development of the Deltaplan and in 1958 the plan was released prioritizing the implementation of the Deltaworks project which is a network of flood preventive infrastructures such as dams, sluices, storm surge barriers throughout the Rhine, Meuse and Scheldt river delta in the South of Holland. Since Rotterdam is an important port for the Netherlands the Deltaplan is very significant in the development of the city. It also coincided with the port expansion in the Botlek and Europoort areas which made Rotterdam the

largest port in the world in the early 60s. The Deltaworks project necessitated the raising of existing dikes and storm closures except for the waterway between Rotterdam and Antwerp [2, 3]. This opening was necessary to provide access to both ports.

The World Risk Report 2019 [4] indicated the risk exposure score of the Netherlands at 31.73 being a low-lying country threatened by sea level rise. However, the same report indicated that while the country has high exposure to disaster risks its vulnerability is very low and is ranked 77 over 180 countries. This can be attributed to the very strong and organized Dutch preventive infrastructure that has been in place for more than 60 years. In recent years, the Dutch have shifted its water management strategy from mitigation to a more climate adaptive way. Cities like Rotterdam have turned to this strategy since 2007 with the Water Plan 2. The city has been a frontrunner in climate change adaptation by designing innovative and inconspicuous water basins and reservoirs throughout the city. These infrastructure were built based on the studies and projections on sea level rise and its projected effects in the City of Rotterdam. The rising sea and river level remains a threat to the city especially during the storm season between October and April. But these are not the only threats present; heavy rainfall and low groundwater absorption are more often experienced in the city.

In 2014, the City of Rotterdam formally joined the 100 Resilient Cities of The Rockefeller Foundation and in 2016 released its Resilience Strategy with seven resilience goals: (1) Rotterdam: a balanced society, (2) World Port City built on clean and reliable energy, (3) Rotterdam Cyber Port City, (4) Climate adaptive city to a new level, (5) infrastructure ready for the 21st century, (6) Rotterdam network—truly our city, and (7) anchoring resilience in the city (City of Rotterdam, 2016). Rotterdam's Resilience Strategy highlight the city's strong and robust "planning and control" but also "foresee a number of new transitions and challenges and will have to stay alert and be prepared to build capacity to adapt to these challenges" (p. 26) [5]. According to Spaans and Waterhout since joining the 100 Resilient Cities, Rotterdam expanded its resilience agenda from climate change adaptation to include other urban issues such as cyber security, social issues, education, and labor market [6]. However, the Resilience Strategy did not define what resilience is, instead boasted that resilience need not be explained because it is in the DNA of the Rotterdammers.

There is no doubt that resilience is in the DNA of the Rotterdammers. The will to survive and rise up to adversity has been there since the bombing of the city in 1940—wherein a reconstruction plan was immediately created—and the Great North Sea flood in 1953—which led to the Deltaworks project. But resilience is not just about the infrastructure and while the Resilience Strategy of Rotterdam identified the Rotterdammers as resilient, how do the "Rotterdammers," the stakeholders, define resilience? And what makes a city like Rotterdam resilient? Using in-depth interviews of key stakeholders in the City of Rotterdam, this study investigates the collective engagement in the city and how this has helped shape Rotterdam's position in urban resilience.

2. Collective engagement and urban resilience

Cities are complex, multi-dimensional socio-ecological systems that have both the social systems (institutional, social, economic functions) and ecological systems (physical, spatial, built and natural environments). A resilient city uses this socio-ecological system as interrelated and interdependent networks to prepare and adapt to changes and disturbances. Natural disaster like flooding is one of the many disturbances that prompts change in cities.

Cities that have experienced a disaster often go through series of transformations at different levels and scales. One key element in this transformation after a disaster is the capacity of the people to collectively engage to support and work together to overcome the disaster and become more resilient. Participation and engagement of stakeholders in development planning allows different sectors to discuss, design, develop and create solutions that benefit the general population. There is a perception that without a multi-stakeholder participatory approach stronger and more powerful sectors or sections of society may step on weaker sectors in the planning process. This results to a skewed development that leans to these more powerful sectors. This criticism is not without basis since most government initiated participatory consultation workshops are often done to present already pre-decided development plans.

Collective engagement is considered within the realm of collaboration and collaborative processes which means that multiple stakeholders across sectors and networks engage in collective decision-making and action. This collaborative process may be through formal and informal networks bounded by trust and mutual adaptation of roles among the institutional actors and non-institutional stakeholders. Collective engagement in urban resilience is a dynamic process of transformation that goes through a series of actions and is defined as,

A collaborative process participated in by multiple stakeholders to arrive at a solution or decision to increase urban resilience through both formal and informal means. It is the collaboration between and among stakeholders over a prolonged period with varying manners in achieving a level of resilience that contributes to a collective goal of urban resilience. Collective engagement as a collaborative process is characterized by having reciprocity, trust and mutual respect between and among state and non-state stakeholders. [7]

Building urban resilience requires the collective engagement of stakeholders in the vision of the city to become resilient. There are two approaches to urban resilience, the government approach and the self-organization approach. The collective engagement urban resilience framework incorporates the two approaches emphasizing that urban resilience can be achieved when the government and the self-organization (citizen) approach has the same concern and awareness on the city's risks and vulnerabilities, and the same vision and goal to become resilient. This can be assessed in terms of the collaborative capacities of the institutional actors (government) and the non-institutional actors (citizens and citizen groups). It meets in the middle when both actors increase their capacities and collaboration to achieve their common goal (mutual adaptation of roles).

Collective engagement as a transformation framework has four dimensions—concern, action, efficacy and security. Each dimension reflects the level of urban resilience in terms of the collaborative capacities of the institutional actors and the non-institutional actors. These collaborative capacities may be in the partnerships formed by the institutional actors and the citizens and citizen groups, and/or the government-led collaborative initiatives, and/or self-organizations formed by the non-government stakeholders that contribute to the overall vision and goal of the city to become resilient. All stakeholders must have the shared vision and goals to achieve urban resilience and are committed to support these efforts.

The collective engagement urban resilience framework begins from the collective concern which refers to the shared concern of the stakeholders on the risks and vulnerabilities of the city. Resilience requires public concern (p. 26) [8] but concern is ineffective if the people do not have the capacity to participate, engage and collaborate in creating a resilient city. Knowledge, skills and awareness increases their ability

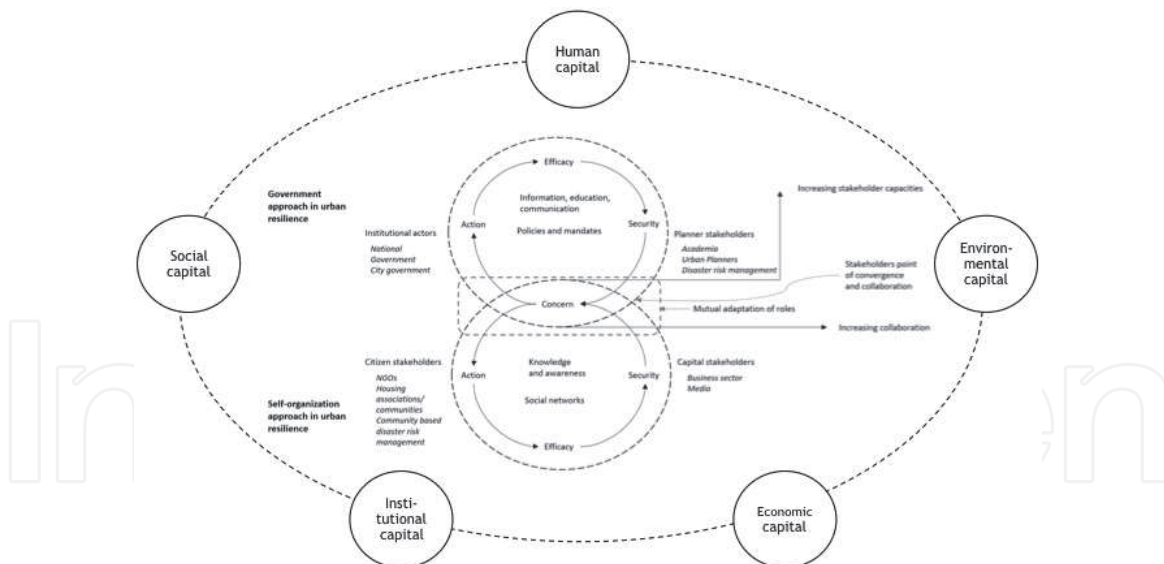


Figure 1. Collective engagement urban resilience framework. Source: Esteban [7].

to participate, empowers the citizens and increases government accountability. Concern is also the catalyst for action, the second dimension of the framework. Collective action happens when there is a shared effort to achieve an outcome. It facilitates the exchange of information, knowledge and experiences to help in creating solutions. It is driven by the networks maintained by the stakeholders as individuals and groups. Social networks help in facilitating the required action towards a given issue. The sense of community is much more evident in this dimension where stakeholders with the help of their social networks cooperate to achieve a common agenda. In this dimension, the action taken by the government driven approach will be more policy oriented and general to benefit all of the stakeholders.

The next dimension, collective efficacy, conjures a task specific construct that highlights shared expectation and mutual agreements by residents in local social control [9]. Collective efficacy is the result of having an empowered community that effectively takes action to improve their city but also a government that has a strong enabling environment and economy that help propagate growth. This dimension is built on mutual trust and regular interaction that is accessible to a wider network. Last, collective security refers to the security against disasters that the city and its citizens collectively enjoy, which is brought about by the alliance and partnership between the stakeholders and the city government. Engaging stakeholders in discussing problems and possible solutions help in developing arrangements with the government to push forward collaborative actions towards urban management and resilience. However, in order to this effectively governments should be open to collaborating with stakeholders and should have the necessary resources to be able to fully realize a resilient city.

The framework shows that both government and self-organization approach begins at the collective concern and moves towards the different dimensions in different pathways and timescales to reach a level of efficacy and converge to a level of security. As illustrated in **Figure 1** the overall urban resilience is also influenced by the human, social, institutional, economic and environmental capitals.

3. Methodology

This study is based on the findings of the first author’s fieldwork for her dissertation project “Collective engagement: from disaster-prone city to disaster-resilient city.”

The Rotterdam city case study is one of the four case studies under the dissertation research. This study draws on the secondary data and primary data collected through key informants interviews conducted from November 2018 to February 2019. It focuses on how the disaster experience of Rotterdam led to its current level of urban resilience, and the role and understanding of the stakeholders towards the vision of Rotterdam as a Resilient City. The primary data collected will be the main source of information supported by secondary data such as policy documents, scientific articles, government websites and other secondary sources.

The Rotterdam city case study is based on 19 semi-structured interviews of key stakeholders following the criteria of the collective engagement urban resilience framework. Specifically, stakeholders who fall under the government approach and the self-organization approach. The government stakeholders identified for the study are the institutional actors (government workers and the water board) and the planners (academics). Under the self-organization approach stakeholders identified are citizens (non-government organizations, community council, housing associations, private citizens) and the capital stakeholders (architectural firm and the port authority). There was an initial list of 13 key knowledgeable persons in city development and planning, and disaster risk management in the City of Rotterdam targeted to be interviewed. Using the snowball sampling each key informant interview respondent was asked to recommend one or two persons until reaching the saturation point. In total, 19 interviews were done for the case study (9 institutional, 2 planners, 6 citizens and 2 capital stakeholders).

A set of scores were used to assess the urban resilience of Rotterdam using the collective engagement urban resilience framework. Each collective dimension consists of a set of variables and further operationalized into a criteria that falls under each score using a five-point Likert scale (**Table 1**).

4. Collective engagement and urban resilience in Rotterdam

The results of the assessment of Rotterdam's collective engagement and urban resilience are discussed below. Each collective dimensions scores given in **Figure 2** were based on the discussion.

4.1 Collective concern

4.1.1 Collective memory on disaster events

The Dutch have a collective knowledge on the history of the Netherlands relationship with water through history lessons from schools. Stakeholders interviewed recalled the 1953 Great North Sea flood as the catalyst for the creation of the Delta Plan and later on the implementation of the Delta Works. The construction of the vast preventive infrastructures in the Netherlands was communicated publicly making it common knowledge. The Maeslantkering and Oosterscheldekering are two large storm surge barriers in Rotterdam and Zeeland, respectively that residents are familiar with. The residents' familiarity with the large preventive infrastructures were based on the history lessons about the 1953 flood, Delta Plan, and the Delta Works learned from school.

In 1993 and 1995, the riverine threat in the Rhine began the paradigm shift in the Netherlands from preventive measures to more adaptive measures in terms of dealing with high river discharges. This shifted the water management approach of the Dutch from preventive to more adaptive. Policies such as the Flood Defence Act (1996), Room for the River (1997), and "Dealing differently with water" (2000)

Collective dimensions and variables	Score				
	Poor	Fair	Moderate	Good	Very good
	1	2	3	4	5
Collective concern					
Strong collective memory on disaster events	Poor remembrance of disaster events or no experience of disaster	Remembers past disaster events	Remembers past disaster events and the action of the city thereafter	Past disaster events passed on to new generation	Past disaster events stimulate current development of the city
Strong network	No presence or weak presence of organized groups	Presence of organized groups such as housing or community associations	Presence of both housing associations and community organizations	Presence of housing associations, community organizations and volunteers	Locally organized groups recognized by the government and working with local government
Strong local knowledge and local adaptation measures	Absence or poor local knowledge on how to address flooding	Some local knowledge and local adaptation measures	Adequate local knowledge and local adaptation measures	Demonstrable local knowledge and local adaptation measures	Local knowledge and local adaptation measures combined with knowledge sharing within networks
Collective action					
Strong awareness and concern on disaster risk, preparedness, and management	Poor level of concern and awareness on disaster risk of the city	Low level of concern and awareness on disaster risk, preparedness, and management	Adequate level of concern and awareness on disaster risk, preparedness, and management	Aware of the disaster risks in the city and understand disaster management	Strong awareness and understanding of disaster risks in the city and disaster management
Strong presence of disaster risk management units	No presence of local disaster risk management units	Presence of locally organized groups on disaster risk management and preparedness	Presence of local disaster risk management units recognized by the local government	Presence of local disaster risk management units coordinates with local community	Local disaster risk management units have their own strategy plan
Strong information, education and communication on disaster risk management	Weak or no information, education and communication on disaster risk management	Available information, education and communication on disaster risk management	Available and accessible information, education and communication on disaster risk management	Adequate dissemination of information, education and communication on disaster risk management	Citizen led dissemination of information, education and communication on disaster risk management

Collective dimensions and variables	Score				
	Poor	Fair	Moderate	Good	Very good
	1	2	3	4	5
Collective efficacy					
Strong technical knowledge and advocacy on disaster risk management in the city	No or weak technical knowledge and advocacy on disaster risk management	Awareness of some technical knowledge and disaster risk management	Practical understanding on disaster risk management	Strong understanding on disaster risk management and organized advocacy on disaster risk preparedness and planning	Applied understanding on disaster risk management and organized advocacy on disaster risk preparedness and planning
Strong presence of city disaster risk management office	No presence of city disaster risk management office	Presence of city disaster risk management office	City disaster risk management office works closely with other departments in the city government	City disaster risk management office works closely with local communities	City disaster risk management office works closely with external agencies and organizations such as NGOs and the regional and national agencies
Regular disaster risk management drills, workshops and information campaigns	No or weak disaster risk management drills, workshops, and information, education and communication campaigns	Presence of at least one—disaster risk management drills, workshops, or information education and communication campaigns	Regular occurrence of at least two—disaster risk management drills, workshops, or information education and communication campaigns	Regular disaster risk management drills, workshops, and information education and communication campaigns	Regular disaster risk management drills, workshops, or information education and communication campaigns including at the primary and secondary education
Collective security					
Strong technical knowledge and expertise, social interest and advocacy on disaster risk management in the city, stakeholder, behavioral change	No or weak technical knowledge and expertise and advocacy on disaster risk management	Some technical knowledge and expertise on disaster risk management	Practical technical knowledge and expertise on disaster risk management	Strong technical knowledge and expertise and skills on disaster risk management and organized advocacy on disaster risk preparedness and planning	Applied technical knowledge and expertise in physical infrastructure

Collective dimensions and variables	Score				
	Poor	Fair	Moderate	Good	Very good
	1	2	3	4	5
Strong national, regional, city disaster risk management	No presence or weak concern on disaster risk management	Presence of an organization at the national or regional level on disaster risk management	Organization dealing with disaster risk management works closely with national, and regional organizations with similar function	Organization dealing with disaster risk management works closely with city government	Organization dealing with disaster risk management works closely with external agencies and organizations such as NGOs and the regional and national agencies
Strong information, education and communication on disaster risk, climate and disaster proof infrastructure in the city	Weak or no information, education and communication on disaster risk management, climate and disaster proof infrastructure in the city	Available information, education and communication on disaster risk management, climate and disaster proof infrastructure in the city	Available and accessible information, education and communication on disaster risk management, climate and disaster proof infrastructure in the city	Adequate dissemination of information, education and communication on disaster risk management, climate and disaster proof infrastructure in the city	Citizen led dissemination of information, education and communication on disaster risk management, climate and disaster proof infrastructure in the city

Source: Esteban TAO. Draft Chapter 6. Mind the Gap. Rotterdam: Erasmus University Rotterdam; 2019 (Unpublished).

Table 1.
Scoring scales for the collective engagement urban resilience framework.

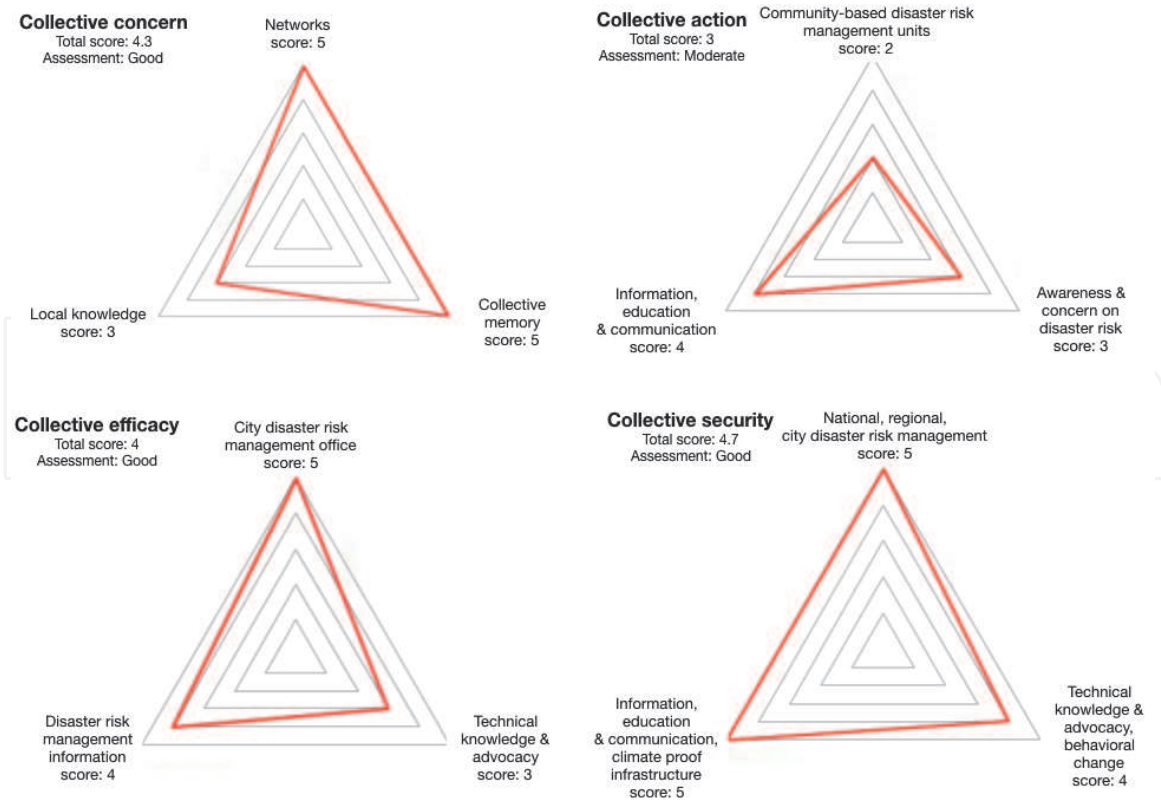


Figure 2. Scores per collective dimension. Source: Esteban TAO. Draft Chapter 6. *Mind the Gap*. Rotterdam: Erasmus University Rotterdam; 2019 (Unpublished).

[10] led to Rotterdam adapting a more climate adaptive approach to flood management and city development. These near disaster events have directed the climate change adaptation and influenced Rotterdam's plans and policies.

4.1.2 Networks

There are two organizations at the local level the *gebiedscommissie* and the neighborhood committees. Members of the *gebiedscommissie* are elected by the residents while members of the neighborhood committees are chosen through lottery. The *gebiedscommissie* or the area committees are groups of people living in the community who play the role as “eyes and ears of an area for the city council” [11]. Most of the time the *gebiedscommissie* serves as an intermediary between the community and the government. The *gebiedscommissie* holds monthly meetings called the area commission evening where people can gather to discuss their concerns. This is also a venue for the city government to present their ideas and plans for the neighborhood.

Aside from the *gebiedscommissie* and neighborhood committees, there are housing associations and building associations. These associations are mostly where residents congregate and discuss issues happening in their streets, buildings or community in general. There are also volunteers within each community such as those who volunteer in the community gardens. There are some well-organized neighborhoods in Rotterdam with a number of volunteers who help the city government in their projects. In Noordereiland, the *buur bestuur* (neighborhood governance organization) act as a vigilance group to report suspicious activities within the neighborhood. Most of the time the neighborhoods will organize themselves based on what they perceive as important in the neighborhoods. This does not necessarily mean flood disasters or climate related threats.

However, interviewees recognize that the social networks and organizations within and around the neighborhoods help make the community socially resilient.

4.1.3 Local knowledge and adaptation measures

Interviewees agree that Noordereiland is the only place where people know what to do when there is a flood. Noordereiland is a small community located outside of the dike area, along the River Meuse, and in the middle of the city. Residents of Noordereiland experience low level flooding every 2–5 years usually during the storm season. Since the residents regularly experience flooding and sea the water daily they understand that living in the area comes with risks of flooding. Most residents do not put valuables in the cellar of their buildings and know how to prepare during the storm season. They know that there is a possibility that their basements will be flooded or their cars parked on the quays run the risk of being washed away, as such many of the residents take precaution. The residents also know that they need to install wooden barriers and sand bags in front of their doors to keep the water from entering their homes.

4.2 Collective action

4.2.1 Awareness and concern on disaster risk, preparedness, and management

There is a general perception on the low level of awareness and concern of the people in Rotterdam on their flood risks and vulnerabilities. This can be attributed to the general “feeling of safety” that the people have because of the strong preventive infrastructures present in the city and in large the country. The completion of the Delta Works in 1997 with the final storm surge barriers built in Rotterdam (Maeslantkering) and Spijkenisse (Hartelkering) also marked the development of the first water management (Water Plan 1) in Rotterdam. The Water Plan 1 Urban water strategy and short term plan included a plan to increase Rotterdam’s water retention [12, 13]. This was because prior to the Water Plan 1 water retention was a “low priority in Rotterdam compared to other issues such as economic development, unemployment and safety” [14].

The level of trust and reliance on the government is high because the people hold the government accountable for the taxes that they pay for. People expect the government to maintain the dikes and to keep people safe and dry because it is the government’s job to do so. This trust on the government is warranted since the people have remained safe since the Deltaworks project was implemented. However, the collective memory on the flooding disaster is disappearing because the people do not experience flooding or any disaster, disasters happen elsewhere, people are unaware of the threats and vulnerabilities in the city. Further scientists have predicted the possibility of a disaster from happening in the Netherlands at 1 in 10,000 years. This is often translated by the people as never going to happen in their lifetime. This low level of awareness and concern is disadvantageous when it comes to crisis management and disaster preparation.

4.2.2 Presence of community-based disaster risk management units

There are no community-based disaster risk management units or any community based group dealing with disaster risks. Such there are also no community plans in the event of an emergency. The only example of a community that has its own self-organized crisis management plan is the port area as led by the Port Authority. The Port Authority has an adaptation strategy that they developed together with

other companies in the port. They base their port adaptation strategies on the Delta Program predicted sea level rise and work together with the City of Rotterdam on the future direction of the port.

4.2.3 Information, education and communication on disaster risk management

People get information on flooding, high water levels from the media, social media, television, newspapers and neighborhood newsletters but they are not concerned. Most of the interviewees mentioned that information during the storm season is often disseminated through leaflets. Information includes warnings and reminders specifically to residents in flood prone areas, i.e., Noordereiland.

Other means of communication provided by the city government to residents include information on websites such as the www.overstroming.nl, and www.nieuws.nl. The city government is increasing communications on climate change adaptation through their websites. Information lodged virtually through the websites may not be effective for some groups who do not often use the internet, who have no internet, and who do not know how to use the internet. Further if these information are not sought in the internet then there is also no guarantee on the outreach.

4.3 Collective efficacy

4.3.1 Technical knowledge and advocacy on disaster risk management in the city

The city government has a strong awareness and understanding on Rotterdam's flood risks and vulnerabilities. The city development plans have moved towards sustainable development and climate change adaptation since the 1990s. A number of plans and policies were developed to guide the direction of Rotterdam's growth towards a more sustainable, climate adaptive and resilient path. However, it was in the 2000s that climate change adaptation took a stronghold in the city development planning due to several near flooding events in 1993, 1995 and 1998. The Architectural Biennial in 2005 became the main turning point towards this direction of climate change adaptation with the Rotterdam Water City 2035 design study [12, 14–17]. What ensued after is a series of development planning, studies and strategy development that takes into account the city's position as an economic hub but also as one of the densest places in the Netherlands with highly vulnerable geographic and geologic position.

The Rotterdam Water City 2035 combined urban design and climate change adaptation strategies to transform Rotterdam to an attractive city. The Water Plan 2 was adapted in 2007 which links urban and water highlighting the urgency to address climate change through adaptive measures [12, 14, 15, 17, 18]. The Water Plan 2 was integrated to the Rotterdam City Vision 2030 the mission statement of which is to the mission “build a strong economy and an attractive place to live” [19] (City of Rotterdam, 2019). The Rotterdam Climate Initiative (RCI) was also initiated in 2007 to focus on the port, carbon dioxide reduction and energy savings, in the city the RCI included an adaptation program. The RCI envisions Rotterdam to be the leader in water innovation while increasing resilience to climate change [20]. Similar to the RCI, the Rotterdam Climate Change Adaptation Strategy adapted in 2013 aims to achieve a climate proof Rotterdam by 2025 [21]. A year after Rotterdam joined the 100 Resilient Cities of the Rockefeller Foundation and in 2016 released its Resilient Strategy.

With all the plans and strategies on resilience, there are no information campaigns widely disseminated in Rotterdam. There are also no information on disaster

management only warnings such as announcements on tv, radio or through SMS when there are gas leaks from the port. These are more reactionary exercises rather than preparatory like a drill on flooding and evacuation. Further preparation and evacuation is seen as an individual responsibility yet this is not very well communicated to the residents.

4.3.2 Presence of city disaster risk management office

The City of Rotterdam does not have a specific disaster risk reduction management office. There is no government mandate for the creation of one at the city level since disaster management or crisis management as it is most commonly termed is dealt under the veiligheidsregio (safety region). Rotterdam is part of the 16 cities under the care of the veiligheidsregio Rotterdam-Rijnmond. Each of the sixteen cities has their own disaster management plan that is part of the regional disaster management plan.

The city does have a “safety department” responsible for public safety issues and crisis management coordination with the veiligheidsregio and the city depending on the scale of the crisis. Water management and dike management are both under the jurisdiction of the waterboards. The waterboards have a dike army that regularly checks the dikes integrity. The Red Cross is also present in Rotterdam and has an existing pool of 3,000 Ready-to-Help volunteers. These volunteers are not trained but are citizens that are willing to be tapped in case of an emergency. Aside from the veiligheidsregio and the Red Cross, the City of Rotterdam also works with various academic and research institutions. Most of the time these academic and research institutions have projects within the city results of which are also shared with the city government and the residents.

4.3.3 Regular disaster risk management drills, workshops and information campaigns

There are fire drills conducted by different institutions and organizations in their workplaces within the city. But there is no citywide drill on any type of disaster that people collectively participate in. The citizens receive information on disaster and emergency situations through an SMS alert (NL-Alert). Every first Monday of the month there is an alarm at 12 noon to inform people on whether everything is secure and safe or not. Other than that there are no other drills or campaigns being conducted throughout the city and even in primary and secondary schools. There are no disaster management and training in schools and in the city in general. This is not part of the school curriculum and is not part of the wider narrative. However, it was also noted by some interviewees that there are evacuation drills only done by specific organizations concerned on crisis management like the military and the Red Cross but these are not widely known by the general population.

4.4 Collective security

4.4.1 Technical knowledge and expertise, advocacy and behavioral change

The multi-layer safety approach, prevention, spatial planning and crisis management, is known in the Netherlands and applied at the city level. Among the three approaches prevention is the highest priority in the country. Technical knowledge on water management, flood management, and climate change are translated in numerous preventive infrastructures. In Rotterdam, there is a Sand Engine Project which extends the shoreline and strengthens the dunes between Rotterdam and the

Hague. The Maeslantkering and Oosterscheldekering storm surge barriers prevent storm surges of more than 3 m high and the dikes are also heightened along the coast and river.

Rotterdam is also strong in spatial planning; the city has been in the forefront in developing climate adaptive strategies in the city that combines urban design and flood management. The city has a green roof policy and a water plan that allows public spaces to be used as retention basins like the water squares. The overall greening of the city is based on the city's climate adaptive policies; the volume of water that can be retained in the event of a heavy rainfall for each neighborhood was calculated by the city to assess areas for improvement. One such project is the urban water buffer located under the Sparta stadium which collects water in an underground reservoir [22]. The collected rainwater is treated and used to water the grass for the football area. Another example is the water storage in Benthemplein where they can store water then released gradually to the surface. According to the interviewees this strategy is what they call the "keep, store or release" strategy which is especially helpful during the dry seasons.

The biggest innovative climate adaptive infrastructure built in the city is the water storage underneath Museumpark parking garage. The Museumpark water storage has a capacity to hold 10,000 m³ in case of a flood and the biggest water storage in the country. The water storage and water squares help control the flood water level by storing the floodwater for a certain period before releasing to the open water system.

Crisis management is still fairly low in the city and relies on the veiligheidsregio.

4.4.2 National, regional, city disaster risk management

Crisis management in the Netherlands is organized under the veiligheidsregio. The city government, fire brigades, waterboards and the veiligheidsregio all work together in the event of a disaster. There is also an agreement between the city government and the Red Cross to help especially in big disasters.

In terms of flood risk management, there are three different government levels responsible, the city government, the waterboards and the Rijkswaterstaat. The Rijkswaterstaat holds most of the information including maps and simulations that is used in the entire country. Cities can access these data to predict flood events as well as design strategies based on these predictions. The data obtained from the Rijkswaterstaat on water levels are also used by the three waterboards in Rotterdam to give advice to close the Maeslantkering or not. The city government upon receiving data and forecasts gives the warning to the people and decides on whether to evacuate people or not.

The port area as a special economic area of interest has its own crisis management plan. The Port Authority works together with the city government and veiligheidsregio on this plan and looks at three possible impacts of a disaster, casualties (deaths), economic and environmental effects. The adaptation strategy includes approaches to address these impacts using the multi-layer safety principle.

4.4.3 Information, education and communication, climate and disaster proof infrastructure

According to some interviewees, the City of Rotterdam has a disaster management plan that includes pre-identified evacuation centers in the city; however, people in general are not aware where these evacuation centers are. There are no other drills or disaster risk management activities being conducted except for the fire drill done at least once a year. There are no information on how to prepare for a

possible flood event in the workplace or at home. Companies by law are required to conduct basic evacuation exercise for work safety but the rest of the population is not aware of these activities.

Still in terms of spatial planning, preventive and climate proof infrastructures, Rotterdam is equipped. However, most of these are still government driven rather than community driven. Participation of the community including information are fairly limited and mostly limited to smaller neighborhood projects that directly affect the community. Neighborhoods like Noordereiland (already mentioned), Hillegersberg and Agniesebuurt have community members who come together to find solutions for a common problem. In both Hillegersberg and Agniesebuurt, residents addressed their groundwater problems by lobbying to the city government to help address this problem and help keep their homes (mostly built on wooden poles) safe.

The national government has also mandated all cities to conduct a stress test to help assess the level of risks and vulnerabilities of their city. Rotterdam is a pioneer on this since the city has an extensive model to identify the risks and vulnerabilities as well as projections on the effects of the key flooding threats. The results of the stress test will lead to the development of strategies for different scenarios in the city covering topics on climate change such as floods, droughts, and heat stress.

5. Conclusion

The level of collective engagement on urban resilience in Rotterdam is scored at 4 or assessed as good (see **Figure 3**). The past disaster events, 1953 Great North Sea Flood, the flood threat in 1993 and 1995, pushed the government to bring out policies and plans to safeguard the country from flooding events. The government understands the importance of learning from these past disaster events in order to move forward. However, local adaptation and knowledge are only evident in Noordereiland where the government regularly communicates precautionary measures during the storm season.

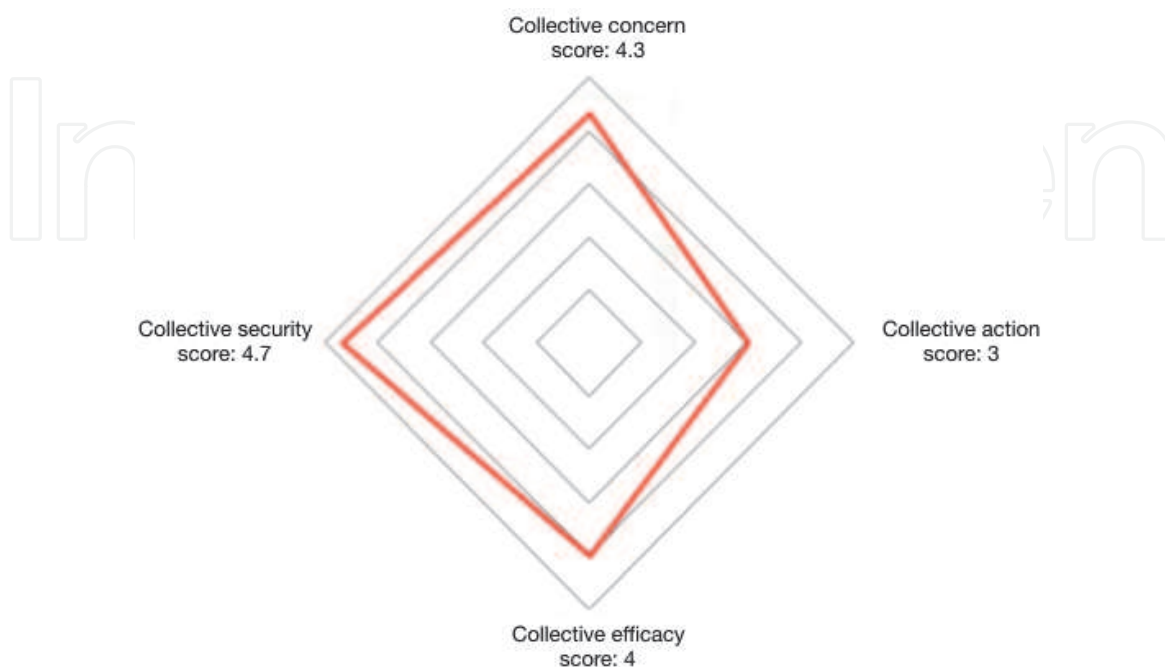


Figure 3. Collective engagement on urban resilience. The total average score for Rotterdam is 4 or “good.” Source: Esteban TAO. Draft Chapter 6. Mind the Gap. Rotterdam: Erasmus University Rotterdam; 2019 (Unpublished).

The communities autonomous nature is evident in the way they also self-organize such that issues that are important for the residents like the community gardens are given more emphasis. The community garden around the city is a community initiative to make the area more attractive and more green. Through this initiative more people can be reached and encouraged to be involved in city development. This can be a way to introduce climate change issues by explaining the benefits of greening the environment to the community and the city.

There is a level of awareness and understanding of the flood risks and vulnerabilities in Rotterdam among the residents. But the level of concern over these issues is not as strong as other issues that are present in the city such as social integration especially for lower income areas. This social and economic gap in Rotterdam is seen as a bigger threat than the threat of flooding in the city. The low level of concern over disaster issues makes it difficult for the government to encourage residents to prepare for the disaster. Many believe that since citizens pay for taxes that it is up to the government to do their job in taking care of everyone. This places a huge expectation on the government's side. This is not enough to make a city resilient since everyone needs to make sure that each one takes necessary precaution against these possible disasters.

All levels of the government from the Rijkswaterstaat, veiligheidsregio, waterboards and the city government are all involved in developing climate change adaptation strategies and crisis management. The mutually adapted roles of the key stakeholders, the city government, the waterboards, the veiligheidsregio, and the academe in delivering a level of safety and security in the city are high. Each of these actors knows the technical and scientific basis of the city development plans and policies. Programs and projects are anchored on these development plans and policies.

Still there is a need to increase the residents knowledge on these initiatives and the effects of climate change for them to understand the urgency of the matter and what they can do as an individual and a community. At present the NGOs and community groups have their community garden projects, some of them are also advocating solar panels and through these advocacies they are able to explain to the residents the value of the environment. However, the NGOs and community groups also feel that policies are not translated very well at the community level. This makes appreciation of the general framework of climate change, disasters, and resilience quite abstract.

Lastly, the collective engagement urban resilience framework used in the case indicates that Rotterdam's resilience approach is more government-led and less community-driven. This shows a rather low community resiliency although there are communities that are much more equipped than other communities. Such as Noordereiland in terms of knowledge, information and preparation for flood events are much more equipped than others, Hillegersberg and Agniesebuurt both have community members who initiate discussions with the city government to help their community and address their problems on groundwater.

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Conflict of interest

The authors declare no conflict of interest.

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