Building up resilience in cities worldwide – Rotterdam as participant in the 100 Resilient Cities Programme

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Abstract
Cities worldwide are challenged by a high complexity of acute and chronic problems, including challenges related to economic development, social polarisation and segregation as well as climate change and ecological degradation. While all of these problems are complex in themselves, they are also interrelated. Addressing them in a meaningful way requires governance systems with systemic capacities to deal with complexity. In order to create resilience in urban systems, cities need to be able to learn, adapt and transform across sectors and levels. One definition of urban resilience is the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow regardless of the kinds of chronic stress and acute shocks they experience. This is the definition the Rockefeller Foundation adopts in its mission to promote the well-being of humanity throughout the world by facilitating the building of resilience in cities worldwide through its 100 Resilient Cities Programme, launched in 2013. Rotterdam is one of the first cities to participate in this programme. The city has been a front-runner in preparing for climate change and striving for urban sustainability. This paper assesses the concept of urban resilience, introduces the Rockefeller Foundation's effort in building city resilience worldwide and illustrates this with the Rotterdam case.

Keywords: urban resilience, Rockefeller Foundation, European cities, governance.

1. Introduction

Across the world, cities are challenged by acute and chronic problems. Acute problems include shocks such as earthquakes, floods, and disease outbreaks. Chronic problems are stresses that weaken the fabric of a city on a daily or cyclical basis. Examples include high unemployment, inefficient public transportation systems, unbalanced composition of the population, chronic food and water shortages, and endemic violence. Challenges may be related to economic development (Healey, 2007; MacLeod & Goodwin, 1999), social polarisation, and segregation (Wacquant, 2008; Dikec, 2007) as well as to climate change and ecological degradation (Wheeler, 2013; Mol et al., 2009). While all of these problems are complex in themselves, they are also interrelated. Policies and actions in response to economic challenges, for example, may very well affect, both negatively and positively, social and ecological aspects of the city and vice versa, adding to the unpredictability and complexity of possible solutions. In order to steer development towards economic, social, and environmental improvement, governance systems must build systemic capacities to deal with complexity. They need to be able to learn, adapt and transform across sectors and levels and to create resilience in the urban system (Hassink, 2010; Pendall et al., 2010).

Resilience finds its roots in applied sciences, where the term is used to describe the stability of materials and their resistance to external shocks (Davoudi, 2012: 300; Lu & Stead,

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[1]The authors were part of the formal monitoring team hired by the Rockefeller Foundation. This paper only reviews public documents and discusses general observations from the monitoring process.
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2013). In the 1960s it entered the field of ecology, where resilience is defined as "the magnitude of the disturbance that can be absorbed before the system changes its structure" (Holling, 1996: 33). Davoudi (2012: 300-301) explains that in this view "resilience is defined not just according to how long it takes for the system to bounce back after a shock, but also how much disturbance it can take and remain within critical thresholds. (…) What underpins both perspectives is the belief in the existence of equilibrium in systems, be it a pre-existing one to which a resilient system bounces back (engineering) or a new one to which it bounces forth (ecological)." Resilience as a notion in relation to cities and planning surfaced in the 1990s, in response to the environmental threats of adjusting social and institutional frameworks (Mileti, 1999 in: Lu & Stead, 2013: 200). The challenge of climate change required a new approach in the urban context. Planners and decision-makers gradually realised that mitigation alone was difficult to achieve and therefore favoured the more adaptive and flexible approaches of resilient strategies in decision-making (Lu & Stead, 2013; Tasan-Kok et al., 2013). The way in which urban resilience is applied in planning differs among planning cultures. Coaffee (2013) concludes that Anglo-Saxon countries differ from the European mainland in their interpretations of urban resilience. In countries such as the US and the UK the original focus was on shocks as a result of the 9/11 terrorist attacks, whereas the European mainland was more focused on climate change.

As part of its mission to promote the well-being of humanity around the world, in 2013 the Rockefeller Foundation adopted a new programme focussing on urban resilience. The 100 Resilient Cities Programme is dedicated to helping cities around the world become more resilient to the physical, social, and economic challenges that increasingly affect the 21st century. In the view of 100RC, resilience includes not only the shocks (such as earthquakes, fires, and floods), but also the stresses that weaken the fabric of a city on a day-to-day or cyclical basis. By addressing both the shocks and the stresses, a city becomes more able to respond to adverse events, and is overall better equipped to deliver basic functions in both good times and bad, to all populations. Rotterdam (the Netherlands) was one of the first cities to participate in this programme and has been a front-runner in preparing for climate change and striving for urban sustainability. This paper introduces the City Resilience Framework, which was developed for the 100 Resilient Cities Programme to underpin its strategy towards participating cities. Section 3 then briefly introduces the tools and instruments offered by the 100 Resilient Cities Programme. Rotterdam is used as an example of the resilience approach. The fourth section explores whether, and how, the thinking on resilience has shifted within the city of Rotterdam as a result of participation in the 100RC programme. The paper concludes with some considerations towards the City Resilience Framework as a source of inspiration for cities worldwide.

2. Resilience within the 100 Resilient Cities Programme

2.1 The Rockefeller's City Resilience Framework
In order to be workable and relevant for cities, the Rockefeller Foundation adopted the following definition of urban resilience:

> *Resilience is the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience.*

This definition and the accompanying resilience indicator framework were developed by ARUP's International Development team (2014) in a commissioned and coordinated study by the Rockefeller Foundation. The Rockefeller Foundation committed itself to the resilience theme in 2007, when it announced its first multi-million dollar contribution to the "Building Climate Change Resilience Initiative". This programme aimed to boost communities' resilience to the effects of climate change with a focus on poor and vulnerable people across the globe. Since then, Rockefeller has gradually developed its understanding of resilience while widening its scope both geographically and thematically from a focus on poor and vulnerable regions to western cities in advanced economies as well, and from climate

change alone to a broader perspective on disaster risk reduction, including financial shocks, terrorism, and slow moving chronic stresses (ARUP, 2014). These are themes that are (also) part of the 100RC Programme.

In so doing, one of the main challenges Rockefeller observed was the development of a framework that enables cities to understand, analyse, and assess their own resilience. In the words of the Rockefeller Foundation's managing director Nancy Kete, the local "(…) perspectives [found] were siloed, shaped by experience and expertise in one or another aspect of resilience, disaster risk reduction, infrastructure resilience, climate change, national security or business continuity" (ARUP 2014: 1). Resilience thus is regarded as an integrative challenge by Rockefeller and building resilience is understood as an interdisciplinary, cross-initiative objective (Martin-Breen & Anderies, 2011). Consequently the aim of ARUP's resilience framework is to present, on the basis of literature review, case studies, and fieldwork, a holistic integrative set of categories, indicators, and variables. In their own words, "[t]he purpose of the City Resilience Index is to provide cities with a robust, holistic, and accessible basis for assessment so that they are better placed to make investment decisions and engage in urban planning practices that ensure people living in cities, particularly the poor and vulnerable, survive and thrive no matter what shocks and stresses they encounter" (ARUP, 2014: 21).

On the basis of a literature analysis and fieldwork based on interviews, workshops, and focus groups in a number of cities, the City Resilience Framework was put together as an analytical tool. The City Resilience Framework as presented in figure 1 distinguishes between four categories (outer ring), twelve indicators (second ring), and seven qualities (inner ring) (ARUP, 2014). The framework is elaborated in figure 2. The four categories are considered basic elements available to a greater or lesser extent in all local systems. They cover (1) the health and wellbeing of individuals (people); infrastructure & environment (place); economy and society (organisation); and, finally, leadership and strategy (knowledge). The twelve indicators have been found to be critical in cities dealing with shocks and stresses and describe the fundamental attributes of a resilient city. They are performance indicators and describe the outcome of actions to build resilience, not the actions themselves (ARUP, 2014: 8). Finally, the extent to which the seven qualities are available provides an indication of how well cities are able to respond to changing situations. See table 1 for an elaboration of these qualities. It is beyond the scope of this paper to elaborate on each of these categories, indicators, and qualities.

Figure 1: The structure of the City Resilience Framework as developed by ARUP
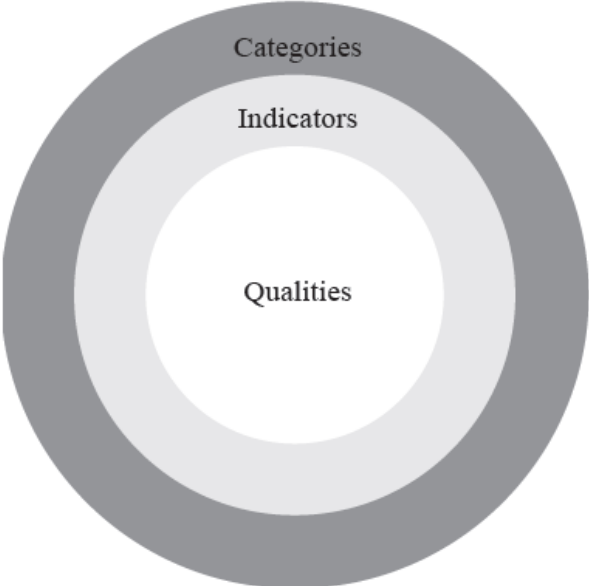
Source: ARUP, 2014: 8

Figure 2: The City Resilience Framework as developed by ARUP

Source: ARUP, 2014: 9

Table 1: The seven qualities of resilient systems

1. Reflective
Reflective systems are accepting of the inherent and ever-increasing uncertainty and change in today's world. They have mechanisms to continuously evolve, and will modify standards or norms based on emerging evidence, rather than seeking permanent solutions based on the status quo. As a result, people and institutions examine and systematically learn from their past experiences, and leverage this learning to inform future decision-making.

2. Robust
Robust systems include well-conceived, constructed and managed physical assets, so that they can withstand the impacts of hazard events without significant damage or loss of function. Robust design anticipates potential failures in systems, making provision to ensure failure is predictable, safe, and not disproportionate to the cause. Over-reliance on a single asset, cascading failure and design thresholds that might lead to catastrophic collapse if exceeded are actively avoided.

3. Redundant
Redundancy refers to spare capacity purposely created within systems so that they can accommodate disruption, extreme pressures or surges in demand. It includes diversity: the presence of multiple ways to achieve a given need or fulfil a particular function. Examples include distributed infrastructure networks and resource reserves. Redundancies should be intentional, cost-effective and prioritised at a city-wide scale, and should not be an externality of inefficient design.

4. Flexible
Flexibility implies that systems can change, evolve and adapt in response to changing circumstances. This may favour decentralised and modular approaches to infrastructure or ecosystem management. Flexibility can be achieved through the introduction of new knowledge and technologies, as needed. It also means considering and incorporating indigenous or traditional knowledge and practices in new ways.

5. Resourceful
Resourcefulness implies that people and institutions are able to rapidly find different ways to achieve their goals or meet their needs during a shock or when under stress. This may include investing in capacity to anticipate future conditions, set priorities, and respond, for example, by mobilising and coordinating wider human, financial and physical resources. Resourcefulness is instrumental to a city's ability to restore functionality of critical systems, potentially under severely constrained conditions.

6. Inclusive
Inclusion emphasises the need for broad consultation and engagement of communities, including the most vulnerable groups. Addressing the shocks or stresses faced by one sector, location, or community in isolation of others is an anathema to the notion of resilience. An inclusive approach contributes to a sense of shared ownership or a joint vision to build city resilience.

7. Integrated
Integration and alignment between city systems promotes consistency in decision-making and ensures that all investments are mutually supportive to a common outcome. Integration is evident within and between resilient systems, and across different scales of their operation. Exchange of information between systems enables them to function collectively and respond rapidly through shorter feedback loops throughout the city.

Source: ARUP, 2014: 5

What is important is that resilience is considered a much broader challenge than, for example, disaster risk reduction and the related hazards with which it is often connected. Instead, in the words of ARUP "[resilience] accepts the possibility that a wide range of disruptive events – both stresses and shocks – may occur but are not necessarily predictable. Resilience focuses on enhancing the performance of a system in the face of multiple hazards, rather than preventing or mitigating the loss of assets due to specific

events" (ARUP, 2014: 7). In so doing, the Rockefeller's resilience perspective can be considered an attempt to bridge the gap between abstract theoretical notions of resilience and a practical device to be applied by their main clients: 100 cities that aim to become (more) resilient.

2.2 Framing the City Resilience Framework

Theoretically, this framework aligns with notions of resilience taken from an ecological rather than an engineering perspective. After an impact, ecological systems are expected to adapt from one equilibrium into a new, different stable state. Cities are not regarded as stable, but rather as evolving complex systems. This mirrors more general theories on resilience that find their origin in so-called complex socio ecological systems (see amongst others: Gunderson & Holling, 2002). It is the systems view, or more specifically the Complex Adaptive Systems view, that is paramount and as such forms the basic principle behind the Rockefeller's approach to promoting resilience in cities.

Rather than in a classic systems approach, where the *system* itself is the focus of policy, within complex adaptive systems thinking the emphasis is on maintaining the *function* of the system, on guaranteeing its output, without focusing on keeping the system itself intact. In other words, in case of stress or shock a resilient city may be able to remain functional and deliver similar services, but only by adapting its system, its mode of organisation, to the new situation.

The City Resilience Framework's framing of resilience in terms of complex adaptive systems can be traced back to an extensive literature review (commissioned by Rockefeller) by Martin-Breen and Anderies (2011). Here, among others, the complex adaptive systems approach is reviewed with specific attention to understanding a system by analysing the role of feedback loops between various elements of the system, its diversity, and modularity. The key element, however, is the degree of self-organisation and self-organising behaviour, which leads to a continuous introduction of 'novelty' and innovation into the system. Functioning complex adaptive systems with self-organising behaviour and properly working feedback loops that generate constant innovation are in a state of constant flux. And so Martin-Breen and Anderies (2011: 8) appropriately state that "to use resilience in complex adaptive systems, one needs to answer both 'resilience of what?' and 'resilience to what?'" The answer is found in the concept of transformability: "the ability of a part of a complex adaptive system to assume a new function." (ibid). Adaptability and transformability are intrinsically related. On a timescale, adaptability refers to short-term behaviour whereas transformation into a new system (often as a result of many adaptations of this system) is considered to take place across a longer period. In practical terms, adaptability and transformability (as well as robustness) apply to decision-making units (see also Restemeyer et al., 2015).

3. 100RC Programme: tools and instruments

The Rockefeller Foundation established 100 Resilient Cities (100RC) as a non-profit organisation with a mission to help cities around the world increase their resilience to economic, social, and physical challenges in the 21st century. The 100 Resilient Cities Programme was conceived during the Foundation's centennial anniversary in 2013. Research into the notion of urban resilience, such as the City Resilience Framework, was commissioned before the official launch and was crucial in scoping the programme. After an international programme launch, cities worldwide were invited to submit applications to become a 100RC city and profit from the 100RC offerings. Six regions were distinguished: Africa, Asia, Central America and the Caribbean, Europe, North America, South America, and Oceania. In December 2013, 100RC began working with a first group of 32 cities. A second group of 35 cities followed a year later. For a period of two years (with a possible extension of one additional year) 100RC offers the following to each selected city:
−   Funding to hire a Chief Resilience Officer (CRO);

- Assistance in developing a resilience strategy;
- Access to a platform of innovative private and public sector tools to help design and implement that strategy; and
- Membership of the 100 Resilient Cities Network.

The novelty of the 100RC Programme lies in its broad approach to resilience. In asking cities to assess and address their stresses and shocks, 100RC also highlights opportunities within city governments to break down organisational silos and to include diverse and marginalised communities, and across city stakeholder groups to leverage private and civil sector resources. The 100RC Programme cannot predict the next disruption or catastrophe but the preparations for and responses to these challenges can be controlled, making cities better at adapting to all kinds of shocks and stresses and transforming them into opportunities for growth. The City Resilience Framework was presented to the participating cities as a source of inspiration rather than a requirement to elaborate.

Rotterdam was one of the cities that joined the programme in the first round. This paper will introduce the city's involvement in sustainability and resilience before and after 2013 and compare differences in focus before and after participation in 100RC.

4. Rotterdam

4.1 Rotterdam's involvement in sustainability before 100RC

The city of Rotterdam, entirely situated below sea level, is part of the poly-nuclear urban region of the Randstad and the most urbanised part of the Netherlands. Since 2007, Rotterdam has been actively formulating policy and projects to cope with the consequences of climate change. The city's location forces it to do so: Rotterdam lies in a major delta area downstream of the Rhine and Meuse river basins and on the North Sea coast, exposed to sea level rise.

Its history goes back to 1270 when a dam was constructed in the Rotte river and people settled around it for safety. Rotterdam is a delta city and much of Rotterdam, including the main port, lies in outer-dike areas. Since its inception the city has worked on an ingenious system to keep it safe and dry. Climate change will cause more extreme situations with a higher frequency and show the city's vulnerability to very high water levels, heavy downpours and long periods of drought or high temperatures (City of Rotterdam, 2013).

In October 2007 the International Advisory Board of the city advised that Rotterdam should become a key player in climate adaptation as well as a water expertise city. This led to the setting up of the Rotterdam Climate Initiative (RCI): a partnership between the city, companies, organisations, and residents that strives for sustainable urban development. The aim was to work towards a climate-proof city while creating maximum economic spin-off in the process.

Based on the second Water Plan, designed with the Water Boards and as part of the RCI, the Rotterdam city government initiated the Rotterdam Climate Proof programme (RCP). It was inspired by the IPCC (Intergovernmental Panel on Climate Change) reports, the recommendations of the Dutch Delta Committee (September 2008) and the case of New Orleans, as well as several small-scale urban floods caused by excessive rainfall. Starting with a series of measures to protect the city from future flooding, the programme aimed at coping with the causes and consequences of climate change, improving air quality and reducing noise pollution. These objectives were further elaborated in the Rotterdam Programme on Sustainability and Climate Change ('*Programma Duurzaam*'), which ran from 2010 to 2014. The programme produced ten clear objectives that flesh out the notion of sustainability and broadening the scope of this concept[4] (Gemeente Rotterdam, undated).

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[4] These ten objectives are: (1) Leading the way in reducing CO_2 emissions; (2) Energy savings, (3) Converting to sustainable energy and raw biomass materials; (4) Stimulating sustainable mobility and transport; (5) Reducing noise pollution and improving air quality; (6) Adding trees and green areas in the city; (7) Increasing investments in sustainability and stimulating sustainable products and services; (8) Increasing public support for sustainability

In 2013 the city council approved the Rotterdam Climate Change Adaptation Strategy (RAS - City of Rotterdam, 2013). It provides the framework and starting point for a 'future-proof' development of Rotterdam and was developed under the responsibility of the Rotterdam Office for Sustainability and Climate Change. It ensures that in the future, topics such as water safety, accessibility, and the robustness of the city are considered in the earliest phases of each (spatial) development project. The RAS is based on research carried out within the national research programme 'Knowledge for Climate' and the national Delta programme. For the first time ever, the city was analysed from the perspective of climate change and its consequences with regard to city operations. This resulted in a better understanding of the city's vulnerable areas and in an identification of opportunities for combining the necessary modifications with efforts to make the city more attractive.

Apart from local initiatives, in 2008 the Dutch national government started the national Delta programme, which aims to prepare a sustainable and integrated long-term approach to water safety and drinking water supply in the Netherlands (its time horizon is the year 2100). The sub-programme Rijnmond-Drechtsteden elaborated this for the Rhine-Maas Delta area (which includes Rotterdam). A reference strategy was presented in 2014 as a contribution to sustainable and viable spatial development. This approach for the Delta was broader than earlier national water safety programmes as it took economic aspects, population density and differentiated risks to certain disasters into account.

4.2 Rotterdam's application for 100RC

The city of Rotterdam had programmatic, networking, and financial reasons for being interested in the 100RC Programme. It had already been collaborating with other government entities and private stakeholders on a number of programmes and projects focused on mitigation and adaptation of climate change. The Rotterdam Programme on Sustainability and Climate Change was drawing to an end and the city was looking for opportunities to continue its efforts in this field. Rotterdam is a leader in the field of water safety, participating in several international networks in this field and was looking for new opportunities to both receive new knowledge and share it with other cities. At the same time Dutch local governments were facing financial cutbacks, resulting in a search for external funds.

The mayor of Rotterdam, Ahmed Aboutaleb, was actively involved in representing the city of Rotterdam in the C40 Cities Climate Leadership Group, a network of global megacities committed to addressing climate change, in 2013. The 100RC Programme was launched then and Aboutaleb made sure that his city applied. The application was written over a short course of time by a small committee, with participation from the Sustainability Programme Management Team. The writing committee did not reflect on the concept of resilience in a broad sense at the time. In the application to 100RC, the city of Rotterdam formulated its most pressing resilience-building priorities as:
– Coping with all water challenges (sea level rise; increasing intensity of rainfall; droughts; changing river discharges; changing groundwater levels; salinisation);
– Managing energy-related challenges (investing in high energy efficiency and renewable energy sources);
– Developing community involvement (awareness, participation, resilience); and
– Developing new governance and financial structures (integrated, multidisciplinary, network-oriented solutions).

As was mentioned before, Rotterdam was one of the first cities to participate in the 100RC Programme. The announcement took place in December 2013 and the formal agreement between 100RC and the city was signed in September 2014. The city will officially present its resilience strategy in May 2016.

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and firmly anchoring sustainability in education and research; (9) Preparing for the consequences of climate change; and (10) Stimulating sustainable urban and regional development.

4.3 Comparing Rotterdam's resilience focus before and since 100RC participation

In order to compare the focus on resilience in the city of Rotterdam before and since the start of its participation in the 100RC Programme, relevant policy documents were studied and a number of key persons for different sectors in Rotterdam were interviewed. These findings indicate that since Rotterdam's participation in 100RC, the scope of resilience has been broadened and themes such as cyber security, social issues, education levels, and the labour market have been receiving considerable emphasis in the process of drafting Rotterdam's resilience strategy. Discussions on the notion of resilience that were initiated in the city of Rotterdam resulted in a broadening of scope from climate adaptation and mitigation alone towards inclusion of sustainable urban development and towards becoming a resilient city in many ways. It is important not only to consider shocks and stressors, but also to positively emphasise Rotterdam's ability to optimally use its potential and to anticipate trends. On a more strategic level, the concept of resilience inspires the city to recognise opportunities and to assess the city's overall performance. Table 2 shows the shift in resilience planning before and since the participation of the city of Rotterdam in 100RC. However, it has to be noted that urban transition is an on-going process in which the 100RC Programme is only one of the drivers. Global trends such as the shift in governance, resulting in new actor arrangements and financing constructions, the focus on sustainable energy provision, and the preparedness for terrorist attacks and cybercrime support the shift by the 100RC Programme.

Table 2: Resilience planning before and since start 100RC Programme

	Before 100RC	Since 100RC

Scope	Water management and flooding	Resilience agenda Rotterdam addresses:
		- water safety in relation to flooding;
		- cyber security;
		- cyber robustness;
		- infrastructure robustness;
		- socio-economic: inclusion of socially weak groups;
		- environmental: clean air and ecological quality;
		- emergency strategy and public safety in case of disaster / shock:
		  o supply of food and drinking water
		  o access to energy
		  o access to (electronic) data.

Governance/ organisational	Led by sector with few joint-up initiatives in relation to flooding and safety	- Resilience regarded as integrative challenge; - CRO as linking pin between large variety of public, NGO and private stakeholders; - Increase in public administration of interdepartmental relations within Rotterdam.
Institutional	Resilience regarded as task for public government	Inclusive approach: resilience is regarded as task for public government, NGOs, private companies as well as individual citizens.

5   Considerations concerning the City Resilience Framework

After introducing the notion of resilience and relating it to cities and planning, this paper elaborated on the way the Rockefeller Foundation scoped urban resilience in developing the City Resilience Framework. The Rockefeller framework aims to contribute to decision-making in cities. The four dimensions that are, to a varying extent, available in every city, the twelve dimensions and the seven qualities together form a lens through which cities can examine their own resilience and identify opportunities and challenges as they embark on developing a resilience strategy. When, however, the framework and its underlying assumption that cities function as evolving complex systems (to use another term for complex adaptive systems) are confronted with another, some considerations come to the surface, particularly since it is no easy task to cater to 100 different cities with one universal framework. This paper looked at one of these 100 cities: Rotterdam, which was familiar enough with the framework to find its way in developing a resilience strategy. Although the city of Rotterdam has not yet implemented the full scope of resilience as proposed by 100RC, a number of considerations can be raised. Six considerations will be offered towards the City Resilience Framework, applied to the case of Rotterdam as an example.

A first consideration is that whereas cities can be viewed as systems (for example from a psychological perspective (Bonnes et al., 1990), a military perspective (Kilcullen, 2012), a socio-technical perspective (Hillier, 2012), as a metabolism system (Kennedy et al., 2010) or in fact as any functional system i.e. energy, transport, food, water, waste management etc.), they always function within a temporal, spatial, and governmental context. Hence, they are open systems with many relationships that extend beyond the city's borders. In fact, it may be hard to determine *what exactly are the borders of a city or city region*, as these areas perform as soft space (Allmendinger & Haughton, 2009; Allmendinger et al., 2015). This issue is highly relevant to Rotterdam, which is part of a poly-nuclear urban region. City borders define the geographical scope of 100RC, whereas other programmes such as the Delta programme, are based upon the larger river basin catchment area in which Rotterdam city is situated.

A second consideration is that, similar to the arguably quite abstract (Lansing, 2003) complex adaptive systems theory (Holland, 1992), cities can be perceived as a jumble of *overlapping and intersecting networks operating in parallel*, both physical and non-physical. Despite this similarity, it remains difficult from a governance and conceptual perspective to conceive of the city as one (comprehensible) system. Several attempts to do so have more or less failed due to issues of scale, fragmentation, and diversity. A city is a pile of systems rather than one system (Short, 2006). In other words, what kind of system is a city and can practitioners grasp its inherent complexity? With so many building blocks in all sorts of interdependent relations, it is a challenge to establish something resembling a hierarchy or, probably more useful, authority (Hajer, 2009), which is also deemed an element of complex adaptive systems. Rotterdam, as part of an extensive urban fabric, is a typical example of this, as the city is subject to overlapping governance networks on local, regional, and sometimes national levels (Spaans & Zonneveld, 2015). The resilience issues at hand determine which networks must be addressed.

A different reading of complex adaptive systems is that of '*emergence*': the idea that much can emerge from little (Holland, 1998). In this perspective the (complex adaptive) system as such emerges from a chaotic situation, though this situation is not entirely without rules. Simply put, basic elements cooperating through trial and error and through interaction and feedback loops develop certain structures and patterns, gradually discarding those elements which are unable to achieve this. The result is a system of higher competence as a whole, in the form of greater productivity, stability or adaptiveness. As Innes and Booher (1999) contend, it is on the edge of chaos that innovation and new activity patterns can occur, depending on flows of information through linked networks of agents. Yet this interpretation of a complex adaptive system is one that could be expected to emerge when in fact a shock or chronic stress factor becomes unbearable and a city's resilience is put to the test. In fact, such increased performance will only emerge in a situation in which a city failed

to adequately prepare for disturbance and has thus proven itself to be insufficiently resilient. Such a scenario, with (resilient) complex adaptive systems emerging as a result from disaster, is hardly compatible with Rockefeller's noble intentions to assist and facilitate in preparing cities to become shock and stress resistant. Rather than the evolutionary principle underlying complex adaptive systems theory, Rotterdam's efforts focus on enforcing and preparing the city's crucial infrastructures such as drinking water supply, essential communication channels, access to electronic data, road infrastructures, flood prevention and food supply, among other aspects. Whether in case of a shock or a chronic stress factor, these systems prove themselves to be resilient this will be (at least partly) ascribed to governance efforts rather than to the systems' intrinsic adaptive capacity. As such, the planned or managed resilience stimulated by the 100RC Programme focuses on the preparedness of a desired system, which is different than a system that has naturally emerged from a disturbed situation and thus has proven itself to be resilient.

Another consideration concerns the level (or levels) at which resilience and responsibilities are aimed to take shape. There is a fundamental difference between, for example, US and EU perspectives on public administrative involvement and responsibility, translating in resilience strategies being oriented on either *individual or collective approaches* (Coaffee, 2013). Organisations such as the Rockefeller Foundation, based and shaped in the cultural context in the US, strongly focus on small societal units of decision-making such as the individual and community. There is anecdotal evidence that after superstorm Sandy struck New York, US federal policy measures on flooding were immediately issued at the level of individual households (which caused the rich to begin adapting their properties, leaving the poor helplessly behind), whereas Dutch experts involved in similar situations sought (public) solutions at the city level. To what extent, then, can roles and tasks be efficiently and effectively distributed to administrative units, societal stakeholders, private parties and individuals? And how will (governance) culture affect such decisions and influence the applicability of the Rockefeller framework? Rotterdam is embedded in Dutch culture, which only recently is beginning to rely less upon public – governmental – dominance in dealing with potential shocks and stresses. The obligation to broaden its scope due to the 100RC Programme will be a chance to involve private stakeholders and the broader public in earlier stages and in different ways. It will be interesting to see how feedback from cities participating in the 100RC Programme may lead to a more culturally diversified approach.

Once resilience planning has gathered enough momentum, the question becomes how this can be sustained. Given the integrative, intersecting, and joint approach to resilience, involving many stakeholders of different kinds, maintaining a durable focus will prove quite a challenge. Strategy-building in general requires long-term processes such as changing mind-sets, breaking through established routines and forging new collaborations among previously non-cooperating stakeholders (Restemeyer et al., 2015; Hutter, 2006). In the case of Rotterdam it was observed that in its first year, the 100RC Programme has initiated a burst of creativity and brought many previously unrelated stakeholders together. What will happen, however, when the novelty of the resilience approach wears off and the 100RC Programme offerings come to an end after two years? Chronic stress factors may require continuous effort and attention, but how will preparedness for shocks, cybercrime, terrorist attacks, and other hazards be affected over time if little sense of urgency is felt? ARUP observed a clear distinction between cities that had experienced shocks and those that had not (ARUP, 2014). In other words, will a focus on resilience as such (but then: for what and what for?) be sufficient, or (taking the adaptability discourse into account) will a focus on permanent city adaptation and transformation prove more effective? And how can such continuous processes of learning (a key component in complex adaptive systems thinking) and development be stimulated and facilitated, not only on a short-term basis but particularly over a longer course of time? Elaborating on this perspective, an appropriate hypothesis may be that the more adaptable and transformative a city is, the better it can deal with stresses and shocks (and thus the more resilient it is). Such a hypothesis would turn the issue around and move away from a focus on resilience per se, in favour of a focus on perfecting the capacity

to adapt and transform. A city such as Christchurch, a participant in 100RC that faced flooding and a sequence of earthquakes in 2010 and 2011, is likely to maintain a higher sense of momentum in building up resilience towards similar shocks than similar cities that have not faced such situations. As Rotterdam has not faced such shocks in the recent past, it will have to invest more in bringing stakeholders together in order to prepare the city for building up its resilience.

In relation to this, and to add further complexity, if resilience is considered to be a holistic concept in terms of causes, effects, and approach, but also in terms of (shared) responsibility, then what is it and what is it not? Reiterating Wildavsky's (1973) famous article 'if planning is everything then maybe it is nothing', resilience planning and preparedness may require a selective rather than holistic approach. If the institutional capacity within cities alone is considered, then a balance should be found in terms of which issues can and cannot be addressed. Each type of resilience may require a different approach and strategy (Lu & Stead, 2013). Using the Rockefeller framework, which indicates several possible avenues for elaboration, may therefore in fact become an exercise in selectivity. Each city, not only the ones in the 100RC Programme, but others as well, will need to define which issues it will focus on when pursuing resilience. Rotterdam, for example, defined six focus areas: 1) social resilience and education; 2) climate change resilience; 3) critical infrastructures; 4) cyber resilience and big data; 5) changing governance; and 6) energy and harbour resilience[5] (Gemeente Rotterdam, 2015).

6 Conclusion

For all its attractiveness and practical relevance as a new buzzword in political and policy-making circles, resilience is by no means an easy concept to put into practice. This, amongst others, is what becomes apparent from analysing Rotterdam's recent experiences and after revisiting some of the concept's underlying principles. Interpreting resilience and developing meaningful policy answers to this concept within a given spatio-cultural setting seems to be one of the major pragmatic challenges that cities and regions face today, both from a substantive and a governance perspective. A complicating matter is that preparing to become more resilient is not the same as being resilient. Many decisions must be made in uncertainty, and proof of whether the correct assumptions have been applied can only be obtained in hard lessons, i.e. after a shock or chronic stress has disturbed the delicate balance of contemporary urban life. An additional challenge, particularly for cities and regions that (fortunately) do not have much experience with shocks, will be to keep resilience on the political agenda for a longer period of time and sustain its momentum.

From a more theoretical perspective, the City Resilience Framework raises questions concerning what exactly constitutes resilience, or more specifically, a resilient city. An underlying analogy between resilience and complex adaptive systems in the City Resilience Framework challenges our thinking about cities, the way they function and, in fact, what they are. From an evolutionary perspective, cities in some sense represent the current equilibrium from which they are considered to move away. In a way, then, taking the complex adaptive systems theory (which emphasises the dying-out of poorly adapted systems) further, it could be argued that cities represent today's state of resilience state. Yet this equilibrium is never perfect, and moreover, it reflects normative frames of the dominant groups from the past decennia. From a resilience perspective, a city's equilibrium might therefore look quite differently, and this may also depend on the rather political question which elements, or functions, of a city system are deemed to be(come) resilient. Add to this the focus of resilience on maintaining functions, rather than systems, and it becomes rather fuzzy to what exactly the concept of resilience refers to in an urban environment. The City Resilience Framework, in all its abstractness and universality, does not fall into the trap of outlining a roadmap. It provides a set of concepts and critical domains, intended to inspire cities to

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[5] This relates to a change from fossil-based to bio-based energy in the Rotterdam harbour

reflect upon the extent to which critical functions are capable of adapting to new situations induced by shock or stress.

Although the City Resilience Framework encourages stakeholders in a city to deal with resilience as an integral challenge, choices will have to be made. Not only Rotterdam, but all 100 cities will encounter challenges in increasing their resilience and keeping the debate going. 100RC offers an approach, but it also offers a platform for debate between academics and stakeholders in cities worldwide.

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