CLIMATE AWARENESS, PREPARATION RESILIENCE AND MEASURING ADAPTABILITY OF THE GOVERNANCE SYSTEM IN ROTTERDAM FOR FLOOD RISKS

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ABSTRACT

In spite of the increasing awareness of climate change, how climate issues could and would be implied in planning strategies somehow remains confusing. Drawing primarily on information from interviews, literature review and discourse analysis, the paper highlights urban resilience as one of the climate adaptation concepts in spatial planning, and examine the *preparation resilience* in Rotterdam's planning governance for flood risks. The empirical study indicates that the planning governance in Rotterdam has a clear vertical coordination in terms of *resilient assessments.* Consider its *resilient readiness*, however, the vertical network is relatively blurred. In local perspective, climate adaptation strategies not only work for uncertain disturbances in the future, but also benefit to establish Rotterdam's own character and identity. Its socioeconomic potentials increase and strengthen the necessity for cities to be *resilient*.

KEY WORDS:
flood, multiple levels of governance, spatial planning, Rotterdam, urban resilience

1. INTRODUCTION

Climate awareness has been arisen in spatial planning due to the increasing amounts of extreme-weather disasters happened in last decades. IPCC (2007) concluded that in our age, climate change '*set in motion large-scale, high-impact, non-linear, and potentially abrupt changes in physical and biological (as well as social and economic) systems over the coming decades to millennia*,' and '*some of which be irreversible*.' Within many concepts for climate uncertainty, urban resilience, has involved in planning thinking in the early 2000s for cities' adaptation strategies. Many countries develop climate adaptation to prevent or reduce socioeconomic loss. For the Netherlands, coastal regions generate about 65% of GNP (Commissie, 2008) while are heavily threatened by climate uncertainty. Climate awareness not goes for future dreams but risks nearby.

In spite of the increasing awareness of climate change, how climate issues could and would be implied in planning strategies somehow remains confusing. Academic analysts use concepts that sometimes highly overlapped and mixed, while planners and policy-makers make use of these concepts with their own sketchy and variable understandings. For instance, the understanding of the relationships between urban resilience and related concepts such as sustainable development, adaptation and mitigation are generally limited. Decision-makers most of time mix these concepts together that make the outcomes more blurred.

Drawing primarily on information from interviews, literature review and discourse analysis, this paper aims to highlight urban resilience as one of the climate adaptation concepts in spatial planning, and examine the performance resilience in Rotterdam's planning governance for flood risks. The results argue the contributions of spatial planning to make cities more *resilient*.

2. URBAN RESILIENCE: AS A CLIMATE-ADAPTATION CONCEPT

Despite the concept of resilience began in ecological field from the 1970s, it is a relatively new concept for planning and represents a developing area of research in social sciences. The simplest definition suggests that urban resilience is the ability for cities to absorb disturbance and still retain their functions and structures. It contains the flexibility to adapt new demands in strategic spatial planning.

This part aims to propose the probable assessments of urban resilience. Because the scope of urban resilience is broad (covering economic, social and environmental aspects of resilience), this paper limits resilience concept only on its climate-related impacts and floods in particular. The argument provides a position for discussing the concept of urban resilience in Rotterdam's planning practice in the third part.

2.1 THE OVERVIEW OF DEVELOPMENT PROCESS OF URBAN RESILIENCE

2.1.1 Before the 1990s

Resilience thinking started its empirical research in ecological equilibrium stability in the 1970s. Defined as '*the system to absorb the disturbances between efficiency and persistence, constancy and change, predictability and unpredictability, in order to keep equilibrium continuously (Holling, 1973)*,' resilience focused on measuring the ability to absorb changes and still persist. It argued the variability, rather than constancy, in terms of non-linear forms of the functional responses to reproduce the stable equilibrium by

unceasingly changing. Resilience studies in the 1970s were particularly in relation to the insect spruce budworm and its role in boreal forest dynamics in North America (Holling, 1987, Ludwig et al., 1978). Followed by examples for the dynamic management of rangelands (Welker et al., 1981), statistical sampling scheme (Rouhani and Fiering, 1986), and fisheries (Walters, 1986), ecological field at this time did the studies through resilient approach generally from field works to large-scale management disturbances (Holling, 1996).

The concept of resilience impacted on cultural anthropology and environmental psychology in the 1980s that human society and culture system would also work as an equilibrium-based, non-linear system (Vayda and McCay, 1975). For instance, coastal settlements in Canada were small but able to recover from disasters, while many planned communities, with modern infrastructures and amount of population, were not self-sufficient once disaster happened (Lamson, 1986). In human geography, resilience (also called 'the new ecology') was developed in terms of carrying capacity, diversity and stability relations in human (Zimmerer, 1994). Resilience also acts in time. Ecologists proposed the concept of 'engineering resilience (Pimm, 1984, Holling, 1996)' that highlighted the 'speed of return.' A resilient society has the complex contexts of renewal, regeneration and reorganisation following disturbance. Resilient studies in socioeconomic fields focus on 'regimes' and 'attractors' that give a sense of excluding dynamics.

2.1.2 The 1990s

Planners and urban analysts addressed on resilient studies after the late 1990s. Most of them are experimental development projects, for instance, the showcase communities project (Sheehan, 1998) and Federal Emergency Management Agency's (FEMA) project. Resilient communities expect to be compatible with diversified changes by adjusting its social and institutional networks when disturbances happen (Mileti, 1999). In other words, resilient communities are less *vulnerable* and recoverable from disasters within a shorter period. Compare with non-resilient development projects, resilient communities (the New Urbanism development projects in this case) perform better in flood hazard mitigation, stormwater management, and broad categories of mitigation techniques, and they normally have a self-organised ability in neighbourhoods (Stevens et al., 2010).

Examples of resilient communities in the late 1990s emphasised on the physical and infrastructural improvements to *prevent* natural disasters (e.g. floods). They addressed very few on 'adapting' or 'recovery' from the disturbances by inward changes. Resilient communities in planning practice worked more like a new 'tagging' for project developments than conceptually shifting.

2.1.3 The 2000s

The scope of resilient studies is broadly developed in the 2000s in social science, including the arguments of social resilience (Adger, 2000), the vulnerability of cities (Pelling, 2003), migration patterns (Rajendran and Chemtob, 2010), and aging of demography (Cole and Flenley, 2008). Scholars summarise resilience in social-ecological system in two: first, the ability to cross the threshold and move into a new regime (Holling, 2001, Walker et al., 2004, Folke, 2006, Gunderson, 2000), and second, the metaphor of adaptive cycles that states move variously according to the phases where the system lies (e.g., Folke et al., 2004, Folke, 2006, Walker and Salt, 2006). From resilient perspectives, human societies today are '*vulnerable*' because we lack of preparation to perform well once the society move cross the thresholds (Walker and Salt, 2006).

Regard to the awareness of urban hazard mitigation, Godschalk (2003) argues that resilient cities can be established in terms of the measurement from structural engineering to land use planning and the demand to formulate systematic principles from resilient communities into city scale (Godschalk, 2003). A resilient city is a sustainable network of physical systems and human communities to ensure city will be able to self-sustain through disasters. It would be composed of small, semiautonomous units to be able to conduct early fault detection by using their fail-safe strategies, and establish a comprehensive social network for uncertain disturbances.

Current resilient strategies in spatial planning contribute on risk managements such as earthquakes, extreme weathers, and long-term changes like sea-level rising. Godschalk hence concluded resilient cities by different combinations, such as redundancy, efficiency, diversity, interdependency, flexibility, strengthen, autonomy and collaboration (Godschalk, 2003, Fleischhauer, 2008).

2.1.4 Summary: Between Sustainable Development and Urban Resilience

Table 1 indicates that the concept of resilience is a relatively new approach in planning thinking and practice. To summarise, urban resilience aims to deal with new demands and uncertain situations by 'embracing changes.' Urban resilience emphasise on planning system (e.g. levels of governance) as the adaptive ability in both vertical and horizontal linkages, to establish cities' mitigation and adaptation abilities for the increasing disturbances (Baud and Hordijk, 2009).

Table 1: A summary of the concept of resilience in progress

Time Phases	Theoretical Debates	Planning Concepts	Planning Practices

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The 1970s	Ecological study for species		
The 1980s	Engineering resilience (the speed to return) Adaptive cycle Environmental psychology Human geography and archaeological study		
The 1990s	Spatial resilience Invulnerable development Cross-level interactions for resilience	Resilient communities	
After the 2000s	Social resilience Regime shift Thresholds and adaptive cycles The vulnerability of cities Migration patterns Aging of demography	Resilient cities (Cities with resilience)	Risk management

Comparing with the more well-known concept of sustainable development, urban resilience and the concept of urban sustainability moved in parallel and shared in relevant theories (see Table 2). Both concepts began in ecological studies addressing on the environments (sustainable development) and certain species (resilient thinking), moved forward into social and economic fields in the late 1980s, and had been adopted in spatial planning since the late 1990s. However, sustainable development, resulted from its basic awareness of environmental issues like industrial pollution, puts its efforts on extending the (mitigation) ability for long-term survival. While urban resilience, focusing on the specific species, is used for enhancing the capability to adapt the uncertainty by 'embracing changes (Walker and Salt, 2006).'

Table 2: A summary of main approaches of sustainable development and urban resilience

	Sustainable Development	**Urban Resilience**
Starting points	Environmental protections	The equilibrium stability of certain species
Key efforts in theoretical debates	Carry capacity: to slow down the rate of environmental changes in terms of reasonable resource distribution and management Mitigation Self-maintenance	Adaptive capacity: to learn by change, and to survive by embracing change Mitigation and adaptation Self-organisation
International agreements and movements	The Rio Earth Summit Kyoto Protocol UNCCC conferences	In developing
Spatial planning	Sustainable communities Sustainable cities Assessment indicators Energy-efficiency	Resilient communities Resilient cities Risk management

In summary, urban resilience illustrates certain region's ability to accommodate changes without (or avoid) catastrophic failures. In terms of the increasing disturbances in climate uncertainty, a shifting paradigm from sustainability (self-sustainaing) toward urban resilience (self-adapting and reorganising) seems necessary. Planners and decision-makers today aim to *prepare* and *strengthen* physical and social frameworks to be more 'resilient.'

2.2 UNDERSTAND URBAN RESILIENCE

A resilient city, as illustrated before, is flexible and shifts continuously to adapt outward disturbances. This paper summarises its characters in three:

2.2.1 Adaptive Capacity

Central to debate of resilience thinking is the notion of adaptive cycles that originally emerged from studying productive ecosystems (Gunderson and Holling, 2002). The adaptive cycle frame indicates that dynamic systems, like ecosystems, societies, or economies do not tend toward some stable or equilibrium condition. Instead, they repeatedly pass through these four characteristic phases: growth and exploitation (r), conservation (K), collapse or release (Ω), and renewal and reorganization (α). See Fig.2, the phases shift from sequences of both gradual changes (exploitation and conservation phases) to rapid changes which are triggered by endogenous disturbances. An adaptive cycle changes continuously that keeps the system remains stable. Therefore, the collapse (Ω) may not be negative but contribute to overall system's health and self-regulation (Gunderson and Holling, 2002, Walker and Salt, 2006, Walker et al., 2004).

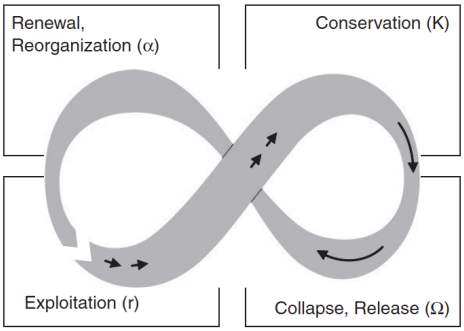

Fig. 2. Adaptive cycle
Source: Linnenluecke and Griffiths (2010); Gunderson and Holling (2002)

Resilient adaptive cycles contribute on spatial planning in two: firstly, planners and decision-makers would realise that instead of the once for all approach, resilience cities are framed continuously as a transformation process. Secondly, the twisting and cross-scale nests of adaptive cycles cause urban resilience become 'abstract and fuzzy (Pendall et al., 2010). ' However, its fuzziness is rather a negative attribute than providing focal points for improving inward ability (to adapt). Instead of looking for outward solutions, a resilient city addresses on increasing adaptive capacity via inner changes, which may happen in different levels of governance, to deal with outward and unexpected changes.

2.2.2 Represent urban resilience in cities

Another character of urban resilience addresses on its performances for disturbances. Urban resilience aims to enhance cities' ability to absorb the amount of disturbance and react appropriately. Linnenluecke and Griffiths (2010)'s study highlights and generates cities' resiliency as (i) robustness: how 'strong' a city is? How many threats a city is able to carry? Robustness takes into account the upward power to contain and carry outward uncertainty and maintain the stable of the system; and (ii) rapidity: another character of urban resilience addresses on 'the speed to return (Pimm, 1984).' How fast a city will restore or shift into a new stable paradigm? In principle, urban resilience represents the impact resistance by emphasising on the maximum amount of disturbance with systems can absord, and the time to recover. The performances are all related to the appearance of decision-making in spatial planning.

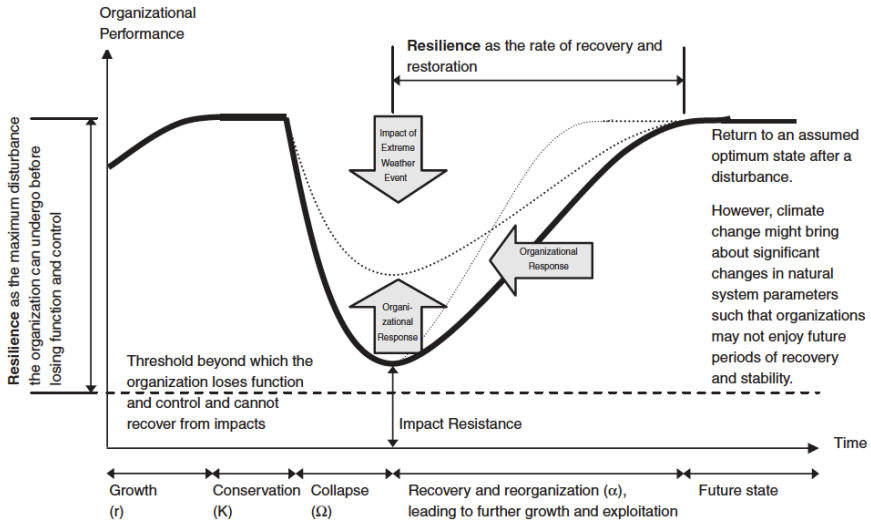

Fig. 3. Resilience framework
Source: Linnenluecke and Griffiths (2010)

Different from ecological resilience, actors in socioeconomic resilience systems draw on a set of complexity, such as formulating strategies, knowledge-based responses, sensemaking, and learning experiences (Gunderson and Holling, 2002). Consequently, the performance of robustness (the impact resistance) and rapidity (the speed of recovery), in principle, can be enhanced by appropriate ways of planning governance, for instance, the proper decisions to manage resources.

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2.2.3 BE RESILIENCE IN CITY-REGIONS

While cities are increasingly seeking to respond to climate change in planning and identifying ways of dealing with its impacts a paradigm shift is taking place from urban sustainability towards urban resilience. It means that the way of approaching the natural disasters is changing from *preventing* disturbances or threats towards adapting to new urban conditions and *managing and coping* with change (although the prevention of disturbances also remains part of the new approach). Scholars argue urban resilience in two properties: the preparation resilience for assessment and readiness, and the performance of resilience, such as response and recovery, once it passes the threshold (Foster, 2006). A resilient city is capable to assess and prepare the possible disturbances beforehand, response properly once passing the trigger point, and eventually recover (come back to normal status, or shift into a new paradigm) efficiently. The adaptive cycle goes continuously to enhance cities' probability for outward disturbances.

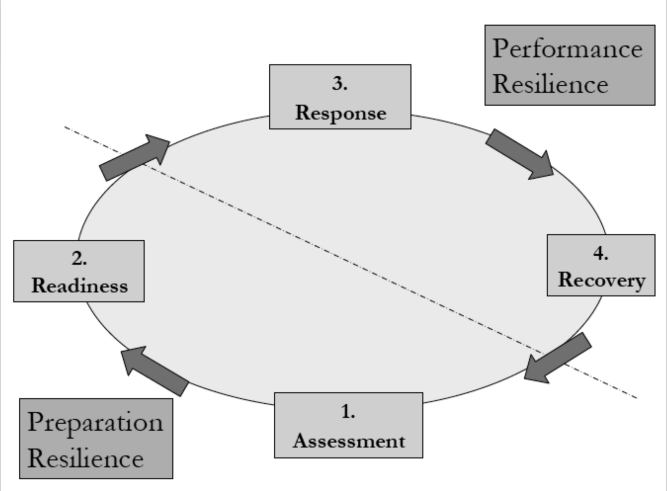

Fig. 4. Framework for assessing regional resilience
Source: Foster (2006)

The development progress for the performance and preparation resilience is not always related. For instance, a region may get high marks for preparation resilience, carefully coordination information gathering, appropriately assessing and communicating vulnerabilities and strengths, while has low marks in performance resilience by failing to recover from an event or condition. In contrast, a city-region may be weak in disaster preparations but still performs well when disaster comes.

Consider the adaptive cycle and the properties of urban resilience; this paper adopts and proposes each stage's indicators in Table 3 (Tasan-Kok et al., 2010). These criteria can be further specified when assessing particular regional dimensions or subsystems, such as the resilience of physical infrastructure or environmental resources, in the face of a particular challenge.

Table 3. Criteria to assess a region's preparation and performance resilience

Stage	Overarching Question	Measures/ Indicators
Assessment Criteria	How well can and does city assess its vulnerabilities to disturbances and its capacity for responding to disaster?	Does city have the capacity (actors, policies, processes, relations and resources) to: - monitor current conditions such as land use, population, physical environment, urban context, social and economic value - predict regional trends and patterns - identify and assess the probability of risks and disturbances, such as through vulnerability diagrams, impacts and forecasting - assess and learn lessons from prior experiences with disturbances and challenges - set up 'priorities' based on risk assessments and probabilities - invest and develop scientific scenarios for risk assessments - establish relevant 'trigger points' signaling needs for regional response - communicate findings (concepts, skills, actions) to

		entities capable of tacking actions - collaborate decision-making in different levels of governance
Readiness Criteria	How well can and does city ready itself to response the assessments and potential disturbances?	Does city have the capacity (actors, policies, processes, relations and resources) to: - warning in advance - authorize and mandate readiness actions, such as urgent and resource-management centre - coordinate readiness actions, like fixing infrastructure, filing organisational gaps, mitigating identified weaknesses and vulnerabilities, building effective networks and connections - establish engineering infrastructure - imply and enhance readiness actions, like public awareness education, back up system
Response Criteria	How effectively, in absolute and relative terms, does city respond to actual disturbances?	How well does city respond in terms of: - react at appropriate (not under- or overreacting) level to disturbance - contain and minimise physical, economic and social damage and other negative outcomes resulting from disturbance - sustain viable, cost-effective levels of service delivery - leverage and use effective networks of internal and external relations - demonstrate effective leadership in authorising, coordinating, communicating and taking actions to response the disturbance - perform capable relations to other places that have similar disturbances - frame the nature and response to the disturbance in media and other communication outlets
Recovery Criteria	How effectively, in absolute and relative terms, does the region recover from the disturbance and learn from its lessons and insights?	How well does the region recover from disturbance in terms of: - repair systems damaged in the disturbance - the speed of return to expected levels of regional functioning - the quality of back-up systems needed to bridge recovery period

Source: Adapted from Foster (2006), Tasan-Kok et al. (2010)

Despite Foster's argument successfully links resilient concept in planning process, it crucially mistakes that a city could be 'resilient' *without performing its response and recovery in reality*. A resilient city may be established from its well preparation (then no needs to real 'perform') or the previous experiences of collapse. Take two cities for example: city of Rotterdam, The Netherlands, may be always 'resilient' because of its preparations and investments, while city of Kaohsiung, Taiwan, where flood seriously last year, may learn from the disaster and become resilient (or would stay in the performance stage with no chances to get fundamentally preparations). Instead of experiencing disturbances when real disaster happens, urban resilience can be enhanced beforehand and be examined when the trigger comes.

2.3 SUMMARY

The second part of this paper argues the concept of resilience in its developments the contributions particularly for planning decision-making. It concludes that urban resilience is an adaptive process. A resilient city is established not once for all but learning from time to time. It reacts outward disturbances to become stronger (robustness) and recovery faster (rapidity). The former addresses on the capacity to carry outward uncertainty and remain normally, and the later emphasises on the demands of time to recover when triggered. In practice, Foster (2006) proposes to evaluate urban resilience in terms of assessment, readiness, response and recovery. His argument is adopted in Table 3 that proposes indicators to examine whether and how cities can be resilient.

Finally, what argues in this paper is *the adaptive governance capacity* of the urban systems to increase their *preparation* and *performance* resilience for the unexpected disasters. The following part evaluates the adaptive governance capacity of the city of Rotterdam for urban resiliency. Regard to the limitation and in fact that planning involve mostly before passing the triggers, the paper here assess only the 'preparation resilience' for flood risks in particular.

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3. DISCUSSION: PREPARATION RESILIENCE IN ROTTERDAM FOR FLOOD RISKS

In relation to flood risks, how well can and does the governance system in Rotterdam generate its adaptive capacity in spatial planning, and be able to go back to its original functions after the disaster? After a quickly overview of flood risks in Rotterdam, this paper highlights how preparation resilience addressing on current planning systems in Rotterdam, to establish its adaptive governance system for resilient strategies.

3.1 FLOOD RISKS IN ROTTERDAM

Adaptive cycle (Carpenter et al., 2001; (Gunderson et al., 1995, Gunderson and Holling, 2001) approach is very useful to explain how the Netherlands experienced flooding throughout its history and how, after each flooding, it advanced water management system further and has become one of the leading water management systems in the world. The flood risk has always been a big concern in The Netherlands (see Table 4 for an overview of the floods in history), especially in the port city of Rotterdam, and urban policies have always been paying attention to this issue. However, with the dramatic climate changes that are expected in the coming years the risks are expected to be higher. The KNMI (Royal Netherlands Meteorological Institute) scenarios suggest a local sea level rise of +0.35 to 0.85 m in 2100. If the local ground levels are included to this estimation, these numbers exceeds to +2.50-5.00 (3.25 m. average) (ref. Wardekker 2009). It is a serious number as the sea level rise of 0.40 to 0.60 m. increases the chance of flood in the Rotterdam by 10 times, the maximum rise of 1.30 meters increases the chance 100 times. At a 0.50 cm sea level the storm surge barriers will no longer suffice. With the sea level rise of 0.50 m. the new storm surge barrier, the maastluit which supposedly protects Rotterdam will no longer meet the requirements, and the same goes for the Oosterschelde surge barrier. This means also increasing serious flood risks even in the central parts of the city. As a matter of fact the entire Randstad is expected to be flooded by 2100.

Table 4: Large floods in the Netherlands throughout history

Flooding	Date	Impact
Second Saint Elisabeth Flood	1421	More than 2000 casualities reported, the Biesbosch tidal area is formed
All Souls Flood	Nov. 2nd, 1532	
Second All Saints Flood	Nov. 4th-5th, 1675	
Flood	Jan. 26th, 1682	
Flood	Jan, 1916	In particular the area around the Zuiderzee is flooded
Storm surge disaster	Jan. 31st- Feb. 1st, 1953	The water reaches an unprecedental level of 4.55 meter above Amsterdam Ordnance Datum (NAP) and there are 1835 casualities. A total of 141,000 hectares of land are flooded.

Source: van de Ven (1996)

Taking the flood risk as a serious thread, the Delta Commission was established after the 1953 flood to deal with the delta works aiming at management of risks related to water. Generally, floods in the Netherlands are caused by two reasons: (i) sea level rising, and (ii) increasing water in rivers draining into the sea. Rising sea level not only makes it more difficult for the rivers to drain into the sea but also higher sea level drives up the water level in rivers because the increasing sea level drives the heavier salty seawater underneath the fresh water in river basins especially in the periods of lower discharge. It is expected that due to this reason large amounts of salt water will penetrate the country through the rivers causing not only fatal floods especially in the Randstad area but also problem for water supply, industry and agriculture. The Western part of the country is facing even a bigger problem as large European rivers drains into the see from these and due to climate change the rivers will have to carry more rain and melt water from Europe.

In other research for operationalising resilience in the case of climate change in Rotterdam (Wardekker et al., 2009), the legal uncertainties in the Dutch system were highlighted with special focus on the unclear responsibilities and conflicting interests of the actors in various policy fields concerning the water management system in the Netherlands in general and Rotterdam city's flood risk areas in particular. Having this as a starting point, this paper analyses the Rotterdam city's urban governance and planning system in terms of its preparation resilience, as the change has not happened yet, to understand the governance system's adaptability to the increasing risk of flooding while highlighting the shift from preventing strategies, like building dikes, to managing and coping with unexpected but estimated change that may occur due to the flooding in the future.

3.2 ANALYSING PREPARATION RESILIENCE IN ROTTERDAM FOR FLOOD RISKS

How spatial planning contributes on preparation resilience for flood risks in Rotterdam? This paper examines assessment and readiness by using policy review, interview and discourse analysis. The outputs of different levels of planning governance illustrate as follow:

3.2.1 Assessment criteria

How well can and does Rotterdam assess flood risk and its capacity for responding to them? Though interview and discourse analysis, this paper evaluates assessment indicators (see Table 3). The result is organised in terms of different levels of governance details in table 5.

Regard to the capacity to monitor Rotterdam's current condition, national level governance clearly has its leading position. The municipality authorises in detail plans and proposes strategies which will be considered and become national policies subsequently. And regional governance normally follows the directions proposed by national programmes. The similar pattern illustrates on predicting future trends and patterns. National governance works on establishing a comprehensive framework for flood risk management, which is generated in EU levels and implied in regional and local planning policies. Except the vertical connection, the Rotterdam municipality also focuses on collaborative works with other cities, like other delta cities. It works intensively with Dordrecht in particular for climate adaptation strategies, flood risk assessments and basin managements.

In terms of the capacity to identify and assess the probability of risks and disturbances, flood protection programmes are proposed among three levels. Despite policy-makers aware and address on climate adaptation perspective, most of programmes achieve preparation resilience through engineering projects. The municipality is working on several redevelopment projects (e.g., Heijplaat) where aims to assess and prepare resilience based on its socioeconomic perspectives.

The fourth indicator address on the capacity to assess ad learn from prior experience, disturbances, and challenges. Planners and policies in national level generally mention about previous disturbances, especially the flood in 1953 and the near-flooding event in 1993 and 1995. In spite of addressing on planning policies in regional and local level, participants often use flood experiences in the past to illustrate current strategies. Interviewees from the municipality also compare Rotterdam's experiences with other cities like Hamburg, Germany.

All levels of governance emphasis on setting up 'priorities' in terms of risk assessments and probabilities, most of them come from socioeconomic awareness for climate change. All of them also communicate findings (concepts, skills, actions) often to entities capable of tacking actions. However, Dutch planning system has not yet establish relevant 'trigger points' signaling needs for regional response. In relation to investments and developments of scientific research for risk assessments, Rotterdam region currently is one of seven 'hot spots' in 'Kennis voor Klimaat (knowledge for climate)' project funded by Dutch national government. This research programme offers close collaborations between academics (universities), national sectors, and the city (the hot spot). Instead of the general studies, it starts from 'real problems' in local level and recommend possible solutions based on scientific assessments and measurements. Local climate adaptation strategies can therefore refer to scientific solutions and eventually propose to establish national adaptation policies. Currently, regional level governance addresses few on scientific research.

The last indicator examines the capacity to collaborate decision-making in different levels of governance. Planning in national level leads cross-actor coordination vertically between European, national, regional, and local governance. Horizontally, Rotterdam municipality has established its collaborative framework with other delta cities in American, Europe and Asia.

Table 5: Analysing assessment criteria for preparation resilience in Rotterdam

Assessment criteria	Capacity to	Governance in National level	Regional level	Local level
How well can and does Rotterdam assess its vulnerabilities to disturbances and its capacity for responding to disaster?	monitor current conditions such as land use, population, physical environment, urban context, social and economic value	Overview present situations in larger scale to recommend future developments	Mainly follow the directions proposed by national programmes	(i) Follow the concepts from national levels, and also (ii) propose future development strategies (some proposals would become national strategies)

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	predict regional trends and patterns	Create a comprehensive framework for dealing with flood risks	Mainly following the concepts proposed by national programmes	(i) Aim to enhance the safety of Rotterdam, and establish (ii) collaborative works with other cities like Dordrecht
	identify and assess the probability of risks and disturbances, such as through vulnerability diagrams, impacts and forecasting	Establish (i) assessment and measurement systems, (ii) flood protection programmes, e.g., giving the reasonable space for water proposal along rivers and the coastal regions, (iii) dike assessment and improvement programmes	Flood protection both along the coastal regions and the rivers, most of them are engineering projects	(i) Flood protections in details (ex: dike style, building technologies…), and (ii) consider the probability of urban development outside the dike (ex: Heijplaat)
	assess and learn lessons from prior experiences with disturbances and challenges	Generally yes, most of policies and participants mention the flood disasters before	Do not mention, but illustrate in interview	Not mention in texts, but illustrate in interview. Interviewees also mention about Hamburg's experience
	set up 'priorities' based on risk assessments and probabilities	Generally Yes, especially mention on the socioeconomic impacts	Yes, mostly follow the decisions from national level	Yes. Generally, socioeconomic impacts have the priority
	invest and develop scientific scenarios for risk assessments	Yes. Rotterdam is one of the hotspot in national 'Kennis voor Klimaat (Knowledge for climate)' programme	Do not mention	Yes, and work in 'Kennis voor Klimaat' programme together with academic researchers
	establish relevant 'trigger points' signaling needs for regional response	Not really	Not really	Not really
	communicate findings (concepts, skills, actions) to entities capable of tacking actions	Yes, and also work in EU level	Yes.	Yes
	collaborate decision-making in different levels of governance	Cross-actor coordination between national, provincial and local levels.	Provincial and local levels	(i) Coordination within sector in city level, and also (ii) work with other delta cities around the world

** Actors, policies, processes, relations and resources*
Source: Adapted from (Vale and Campanella, 2005), Tasan-Kok et al. (2010)

3.2.2 Readiness criteria

How well can and does Rotterdam ready itself to response assessments and potential disturbances? This paper proposes five readiness indicators in Table 3 and operationalises in Table 6.

The first indicator addresses on the capacity to warn beforehand, which is mentioned in all level of planning policies without details. Similar with assessment criteria, governance in national level responses to establish vertical coordination framework in terms of 'readiness actions.' Each governance level is response to set up its own horizontal linkage. The city of Rotterdam also aims to frame the coordination platform with other delta cities for resource sharing and connection.

The coordinate readiness action as 'heavy infrastructure' always has its priority of flood management in all governance levels. National government invests annually on scientific research and engineering projects. Regional investments emphasis also on heavy infrastructures like dikes, dams, and bridges. Local sectors authorise in details. Innovative readiness actions, like new ways of land use, infrastructures and building

technologies, increase recently. For instance, except budgets for engineer projects, the municipality invests also on urban events, like swim in the river, to increase water's public functions. Finally, innovation readiness actions also lead the capacity to imply and enhance public awareness, education, and back up system. Participants highlight that the city of Rotterdam aims to develop climate-adaptation strategies not only for the uncertainties but also for climate-knowledge productions which can be spread and collaborated among delta cities.

Table 6: Analysing readiness criteria for preparation resilience in Rotterdam

Readiness criteria	Capacity to	Governance in National level	Regional level	Local level
How well can and does Rotterdam ready itself to respond to assessments and potential disturbances?	warn in advance	Yes	Yes	Yes
	authorize and mandate readiness actions, such as urgent and resource-management centre	Horizontal and vertical coordination	Mainly follow concepts from national level	(i) Have horizontal coordination with Rotterdam, and (ii) other delta cities
	coordinate readiness actions, like fixing infrastructure, filing organisational gaps, mitigating identified weaknesses and vulnerabilities, building effective networks and connections	Yes, with budgets and investments. Mainly on research and engineering programmes	Yes. Mainly on engineering investments for dikes, bridges	Yes, including network connections (within municipality and with other delta cities), research programmes and engineering investments
	innovate readiness actions, such as new ways of land use, new engineering infrastructures and building technologies	Yes, such as the innovation programmes for dike improvements	Not mention	Yes. (ex: new ways of land use, new events along/in the river, and new building technologies as floating house)
	imply and enhance readiness actions, like public awareness education, back up system	Yes.	Yes.	Yes, especially for climate knowledge market

** Actors, policies, processes, relations and resources*
Source: Adapted from (Vale and Campanella, 2005), Tasan-Kok et al. (2010)

3.3 SUMMARY

Rotterdam has been developed for climate adaptation strategies for over a decade. In terms of assessment, national governance sectors authorise and propose future directions that are followed in regions and the municipality. Compare with the top-down relations between national and regional governance, the relations between national sectors and the municipality are closer and stronger, especially in scientific research programmes like 'kennis voor klimaat.' Sectors in local and national governance collaborate closely to establish assessment framework for resilience preparation, however, regional level of governance is somehow exclusive on developing adapted concepts.

The vertical collaboration is not so clear in terms of readiness preparation for resilient cities. In contrast, national sectors often guide and propose strategies together with the municipality. Rotterdam municipality is eager to increase the global collaborative network with other delta metropolitans. Except adapting future uncertainty in climate change, resilience preparation, in local perspective, is also a 'strategy' for city's own character and identity. As participants point out, Rotterdam needs to be *safe* and *resilient* among to keep its city competitiveness.

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4. CONCLUSION

This paper overviews the concept of urban resilience and its contributions in relation to spatial planning. Three points are highlighted as conclusions: Firstly, resilience is a dynamic and shifting process. A resilient city means it has the ability to robust and recover from a short period when expose uncertain disturbances (the collapse phase). Second, this paper applies Foster's (2006) concept indicating four stages for regional resilience: assessment and readiness before disturbances; response and recovery after the collapses. Spatial planning addresses normally on enhancing cities' preparation resilience. The indicators here (see Table 3) are used to examine how well can and does a city (region) prepare and perform its resilience.

Finally, this paper assesses Rotterdam's resilience regards to its planning strategies. In terms of its multiple levels of governance, the vertical coordination is clear in resilient assessments. However, the municipality aims to develop and frame its horizontal (global) connection particularly with other delta cities. In local perspective, climate adaptation strategies not only work for uncertain disturbances in the future, but also benefit to establish Rotterdam's own character and identity. Its socioeconomic potentials increase and strengthen the necessity for cities to be *resilient*.

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